

## ACES Phase 2 Study Shows Dramatic Reductions in Emissions from Newer Diesel Engines

New results from the Advanced Collaborative Emissions Study (ACES) demonstrate that heavy-duty diesel engines designed to meet standards set in 2010 by the U.S. Environmental Protection Agency (EPA) — engines which power virtually every large truck and bus sold in the United States — emit substantially lower levels of air pollutants than their older-technology predecessors and more than satisfy the 2010 requirements.

*For a number of the most important pollutants, levels were substantially lower than those required.*

As detailed in the ACES Phase 2 report, released in December by the nonprofit Coordinating Research Council (CRC), the 2010-compliant engines had a greater than 94% reduction in the levels of nitrogen dioxide (NO<sub>2</sub>, an important contributor to ozone smog) and substantial reductions in all other pollutants, even when compared with engines first designed to meet 2007 EPA standards. For a number of the most important pollutants, levels were substantially lower than those required.

ACES, a joint effort of HEI and the CRC, has entailed the most rigorous emissions testing ever done for modern heavy-duty diesel engines. It was undertaken to characterize the emissions and health effects of heavy-duty diesel engines designed to meet strict pollutant standards established by the EPA — specifically,

*Continued on page 2*



Notables including George Washington, Thomas Jefferson, and John Adams frequented Gadsby's Tavern, a center for politics, business, and entertainment in Alexandria, Virginia, in the late 18th and early 19th centuries.

ALEXANDRIA CONVENTION AND VISITORS ASSOCIATION

## Annual Conference in D.C. Area Will Spotlight Science to Inform the Future

This spring HEI will host its Annual Conference from May 4 through 6 in historic Alexandria, Virginia, just a few miles across the Potomac River from Washington, D.C. A multinational audience of scientists, institute sponsors, and policymakers will join HEI at the Westin Alexandria Hotel, where lively sessions will feature the latest research on air pollution and health. Technical sessions include the following:

**The Future of Mobility** In an increasingly urban world, a key challenge today's cities face is providing transportation systems that economies and inhabitants of all ages and abilities can rely on far into the future. Growing populations and numbers of

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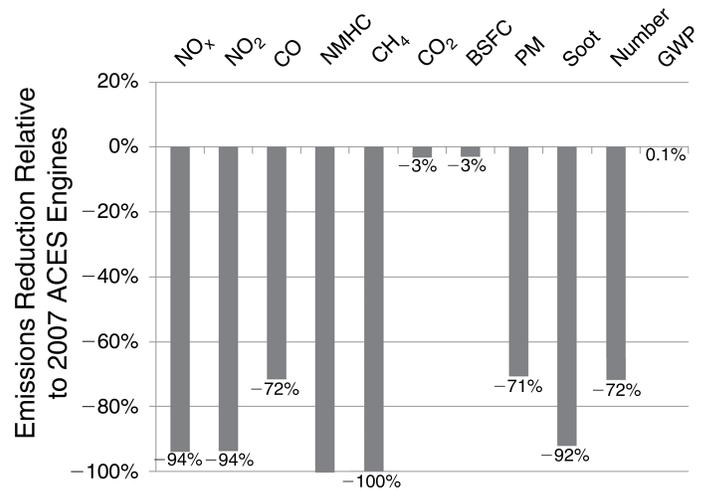
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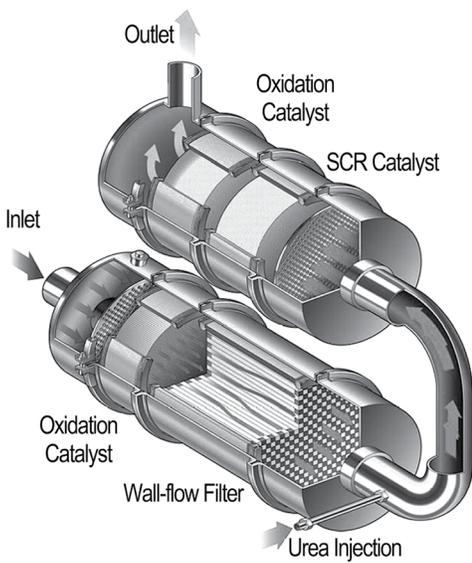
standards set for particulate matter (PM) in 2007 and oxides of nitrogen (NO<sub>x</sub>) in 2010. Emissions-characterization results for 2007-compliant engines (tested in Phase 1) were published in 2009.

Investigators in Phase 2 tested heavy-duty diesel engines from three major manufacturers, subjecting them to well-established federal test procedures and to a much more rigorous 16-hour operation cycle designed especially for ACES. All the engines were equipped with aftertreatment devices to reduce emissions of PM and NO<sub>x</sub>. Using the same protocol as in Phase 1, the investigators tested the engines during multiple repetitions of these cycles and measured more than 300 regulated and unregulated air pollutants in accordance with the highest laboratory standards.

The testing demonstrated that NO<sub>x</sub> emissions from the newer-technology diesel engines are 60% below the current standards and more than 90% lower than the emissions that had been reported for the 2007 engines. Substantial reductions were also observed in all other pollutants, such as PM, carbon dioxide, and non-methane hydrocarbons (see figure). A number of unregulated compounds (not shown in the figure) were also further reduced.



Reduction of emissions by 2010-technology engines compared with 2007-technology engines, based on repeated testing during 16-hour operation cycles. Abbreviations: NO<sub>x</sub> = oxides of nitrogen; NO<sub>2</sub> = nitrogen dioxide; CO = carbon dioxide; NMHC = non-methane hydrocarbon; CH<sub>4</sub> = methane; CO<sub>2</sub> = carbon dioxide; BSFC = brake-specific fuel consumption; PM = particulate matter; Number = particle number; GWP = global warming potential. (Adapted from Phase 2 of the Advanced Collaborative Emissions Study, Figure 1.)



Diesel particulate wall-flow filters and selective catalytic reduction (SCR) systems like these are found in all of the newest on-highway diesel vehicles. © COPYRIGHT JOHNSON MATTHEY PLC

The authors noted that “the observed reductions in PM (total mass, elemental carbon, and particle number) and unregulated emissions from 2007 to 2010 engines are likely due to differences in active DPF [diesel particulate filter] regeneration operation.” Regeneration refers to the process by which the filter that traps PM is periodically cleaned by burning the collected soot at a high temperature, which releases some PM into the atmosphere. The 2007 engines generally triggered two regeneration events during the 16-hour cycles, while the 2010 engines did not trigger any events. Since the bulk of PM in the 2007 tests was emitted during regeneration, the authors could not reach firm conclusions on “how much the average PM and unregulated emissions on the 2010 engines may have increased if the test were continued to include regeneration events.” Nevertheless, the study’s principal investigator and its sponsors found sufficient evidence to conclude that the levels of PM emissions from the 2010 engines would still be lower than those from the 2007 engines. This issue is discussed in detail in the report.

## 2013 Annual Report Now Available

The 2013 Annual Report describes HEI’s unique ability to work with scientists, government, industry, and the environmental community to produce impartial, relevant science that can be trusted for use in often controversial public policy decisions. The report outlines HEI’s responses to important, tough questions posed by government and industry on several fronts, including whether some sources of particles are more or less toxic, whether new epidemiologic studies on the potential for exhaust from older diesel engines to cause cancer are suitable for risk assessment, and global questions on air quality and health. Download the report at <http://pubs.healtheffects.org/view.php?id=414>.



While the Phase 2 testing was under way, animal testing for emissions from one of the four 2007 engines was being conducted at the Lovelace Respiratory Research Institute in Albuquerque, New Mexico. Results of the short-term studies were released in April 2012 and then published in September 2012 in HEI Research Report 166, *Advanced Collaborative Emissions Study (ACES) Subchronic Exposure Results: Biologic Responses in Rats and Mice and Assessment of Genotoxicity*. Results of the long-term studies will be published toward the end of this year.

Phase 2 of the Advanced Collaborative Emissions Study is available for downloading at [www.crcao.org](http://www.crcao.org).

vehicles are straining transportation systems, reducing mobility, and adding to existing concerns about air quality and climate change. This session will explore emerging multimodal approaches to these problems — new fuels and engine technologies, vehicle-sharing, increased use of physically active modes of transport, and changes in urban planning — and the implications for health, climate, and economic growth.

### Can We Breathe More Easily?

**Chronic Respiratory Disease and Air Pollution** Chronic respiratory diseases are a growing cause of lost years of healthy life around the globe. This session will focus on two chronic respiratory conditions — chronic obstructive pulmonary disease (COPD) and asthma. Both diseases have been associated with air pollution exposure, but the role played by air pollution in their incidence remains uncertain. Speakers will discuss what is currently known about the prevalence of these conditions, their clinical manifestations and mechanistic pathways, the role air pollution may play, and how additional research could reduce uncertainties.

**HEI Update** HEI will present its progress in current research projects, review programs, and publications. Highlights will include ongoing work on ozone exposure and health outcomes, an update on the Advanced Collaborative Emissions Study's animal chronic inhalation study of diesel exhaust from new-technology engines, the status of the HEI diesel epidemiology project, and plans for research on other topics. The recipient of the 2013 Walter A. Rosenblith New Investigator Award will be introduced.

### Multipollutant Research: Challenges and Progress

Investigators interested in relationships between airborne



The conference will be held just across the Potomac from Washington, D.C.

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pollutants and human health face challenges in estimating the effects of individual pollutants and their interactions in complex multipollutant atmospheres. Correlations among pollutant concentrations over time and geographic space, possible interactions among pollutants, and differences in the availability of data for individual pollutants pose enormous statistical challenges. In this session, presenters will describe the motivations for developing a multipollutant approach, examine recent progress in methods development, and explore remaining challenges and future directions.

### New Directions in Air Pollution Research and Risk Assessment

Recent advances have improved both the type and complexity of information available for life sciences research. This session will focus on new approaches that are being applied in air pollution research and risk assessment. It will provide a perspective on how technologies to assess exposure and health are evolving; information on new tools for improving personal-exposure assessment and for obtaining individual-level health data for population-based studies; and a discussion of the U.S. Environmental Protection Agency's new methods in the Next Generation (NexGen) of Risk Assessment.

**The HEI Strategic Plan for 2015 through 2020** A draft of the next Strategic Plan, HEI's blueprint for the future, will be presented and discussed. Conference attendees are encouraged to suggest and comment on areas in which enhanced science will be needed and on priorities for HEI's research programs and other activities during the next five years. [HEI](#)

Program updates and hotel registration information are available at [www.healtheffects.org/annual.htm](http://www.healtheffects.org/annual.htm).



A poster session at last year's HEI Annual Conference, in San Francisco.

PHOTO BY JAY MALLIN

## HEI Hosts Diesel Epidemiology Workshop

On March 6 HEI expects a full house when it hosts a workshop to discuss recent epidemiologic studies of the associations between occupational exposure to diesel exhaust and the risk of lung cancer. The meeting is part of HEI's ongoing Diesel Epidemiology Project (see *HEI Update*, Spring 2013), and its focus is on two large, recently published studies: the Diesel Exhaust in Miners Study (DEMS), led by Debra Silverman and colleagues at the National Cancer Institute and the National Institute of Occupational Health (NIOSH); and a study of U.S. trucking industry employees, led by Eric Garshick and colleagues at Harvard University.

The goal of the workshop is to provide a forum for thoughtful scientific discussion of the strengths and limitations of these important studies. Such discussion will inform the HEI Diesel Epidemiology Panel's ongoing deliberations about the studies' potential use in quantitative risk assessment, particularly for the evaluation of general outdoor levels of diesel exhaust.

The original investigators for the studies will present and discuss their findings. Other speakers will include private consultant

Kenneth Crump, Paolo Boffetta of the Mount Sinai School of Medicine, and Suresh Moolgavkar of Exponent Inc., who are conducting further analyses of the DEMS data on behalf of the Engine Manufacturers Association; and Roel Vermeulen of Utrecht University and his colleagues, who have recently published a study combining evidence from the DEMS, the truckers study, and other research in an effort to further characterize the exposure–response relationship.

The workshop's closing session will provide perspectives on the use of such data for risk assessment and for decisions by government agencies. It will include presentations by Robert Parks from the Risk Evaluation Branch of NIOSH; Vincent Coglianò, acting director of the Integrated Risk Information System for the U.S. Environmental Protection Agency; and Joseph Rodricks of Environ Corporation, a coauthor of the National Academy of Sciences reports *Science and Decisions* and *Environmental Decisions in the Face of Uncertainty*. [HEI]

Registration materials and the full workshop agenda can be found at [www.healtheffects.org/meetings.htm](http://www.healtheffects.org/meetings.htm).

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## Making Data on Air Pollution and Health Accessible

Over the past two decades many government officials, scientists, and other environmental stakeholders have been interested in reviewing the primary health and emissions data that are gathered during air pollution studies. HEI has a long track record of gaining access to and reanalyzing key data sets from studies conducted by other research organizations. Also, in consultation with investigators whose research it funds, HEI has frequently provided external parties with access to primary data from its own studies, both to enhance the transparency of analysis and results and to facilitate further scientific investigation. Recently, HEI's role in these efforts came to the fore when members of Congress asked the U.S. Environmental Protection Agency (EPA) for data underlying studies of air pollution and health, and in that process the EPA and members of Congress both consulted HEI on the best ways to accomplish data sharing.

HEI routinely takes a number of steps to make its results and data available, publishing comprehensive, intensively peer-reviewed reports covering all results of research it funds (not just those that investigators might select for publication in a peer-reviewed journal) and posting extensive additional details online. In cases where it has full ownership of and rights to data produced for its studies,

HEI endeavors to make those data widely available to other investigators and, as part of this effort, publishes entire data sets and analytic programs on the Web. With such transparency, however, comes an important responsibility: when the epidemiologic data include personal-health and other information on individual study participants, their privacy rights must be protected.

“HEI has had considerable experience in developing mechanisms to share data while safeguarding study participants' confidentiality, and it is in the interest of science, and the public policy informed by such science, to find ways to do so,” says HEI President Daniel Greenbaum.

In responding to the EPA's request for advice on how to make data available, Greenbaum noted that air pollution studies rely on several kinds of statistics — air pollution and census information, records from the National Death Index, and extensive data collected for individual participants or locations — and that the latter two categories carry with them detailed legal responsibilities for not divulging the identity or health information of any particular person. HEI also advised that the best and most modern air pollution studies require investigators to have knowledge of where each participant lives, a fact that is both essential to accurately estimating their exposure

and challenging, because that information makes it easier for others to identify individual participants. Thus HEI commented on the difficulty of providing a fully anonymous data set that would allow full-scale replication and further analysis of an important study.

There are options for sharing data, however. Among them are direct collaboration with the original investigator or, alternatively, the provision of independent access to detailed personal data sets — but only if those requesting the data enter a legally binding agreement to ensure that no individuals' data are ever released. The latter approach is currently used by the National Institutes of Health.

Challenges accompany the protection of individual study participants' privacy when the data underlying studies of air pollution and health are shared. But if these issues can be carefully and rigorously addressed, then giving other researchers opportunities to conduct additional analyses of these epidemiologic data sets is of scientific value — and it has the potential to broaden the scientific knowledge that informs decisions on air-quality policy. [HEI]

For more information on data access, or to request a copy of HEI's advice on the challenges of and opportunities for making data available, please contact HEI President Dan Greenbaum ([dgreenbaum@healtheffects.org](mailto:dgreenbaum@healtheffects.org)).

## New Funding Opportunities: Traffic-Related Exposure Studies

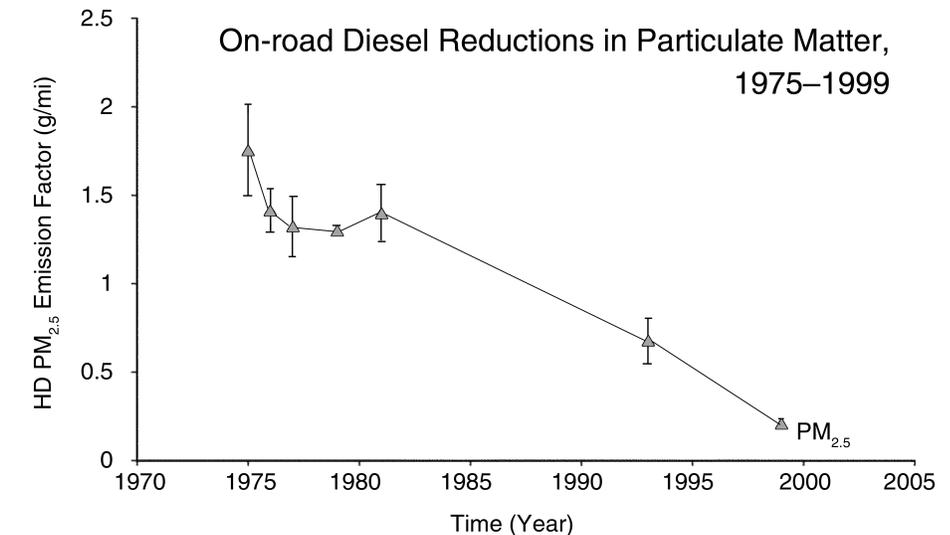
### HEI Seeks Research on Non-Tailpipe and Tailpipe Emissions Near Urban Roads and in Tunnels

Following on HEI's selection of five studies aimed at improving assessment of exposure to air pollution from traffic (see *HEI Update*, Fall 2013), the Research Committee is launching additional requests for targeted studies on traffic exposure. Although the institute received an unprecedented number of strong proposals in response to this program's request for applications (RFA 13-1), the Research Committee identified two areas in which additional important work is needed: better characterization of non-tailpipe emissions, and use of tunnels as study locations to gauge changes in emissions from motor vehicles over time. To address both areas of inquiry, HEI recently issued a request for preliminary applications (RFPA 14-1), "Enhancing Near-Road Exposure Assessment Through Characterization of Non-Tailpipe and Tailpipe Emissions Near Urban Roads and in Tunnels." The RFPA process is used to identify and fund generally smaller studies in important areas not targeted by RFAs.

*Given the significant reduction of tailpipe PM emissions resulting from the introduction of new-technology diesel vehicles, interest in non-tailpipe emissions from motor vehicles is increasing.*

HEI's main objectives in issuing the RFPA are (a) to generate research characterizing the composition of non-tailpipe particulate matter (PM) emissions — specifically, those from brake and tire wear — and their contribution to total near-road PM; and (b) to implement new tunnel studies designed to allow an evaluation of changes in emissions over time that are attributable to new vehicle technologies and fuels.

Given the significant reduction of tailpipe PM emissions resulting from the introduction of new-technology diesel vehicles, interest in non-tailpipe emissions from motor vehicles is increasing. Among many elements present in non-tailpipe PM emissions, transition metals such as



The new request for preliminary applications will seek updated results of earlier tunnel studies, like these results from *Real-World Particulate Matter and Gaseous Emissions from Motor Vehicles in a Highway Tunnel*, published in 2002 (Alan Gertler et al., in HEI Research Report 107). This figure is adapted from Figure 9 of the report. HD denotes heavy-duty diesel vehicle.

copper, iron, and zinc are of toxicologic interest because they may play a role in the pro-inflammatory effects of PM. However, not much is known about the exact composition of non-tailpipe PM emissions and the extent to which they contribute to ambient concentrations in the near-road environment.

Tunnel studies provide an opportunity to assess both non-tailpipe and tailpipe emissions of motor vehicles in a well-defined, quasi-closed environment — such measurements are difficult to obtain otherwise. The new HEI studies would be designed to compare emissions from the current fleet with emissions from previous (older-technology) fleets, preferably at the same location where earlier measurements were made. [HEI](#)

RFPA 14-1 provides funding for 1- to 2-year studies. Preliminary applications are due by March 3. After review by the HEI Research Committee, a subset of applicants will be invited to submit full applications, which are due by April 25. For more information, contact Hanna Boogaard ([jboogaard@healtheffects.org](mailto:jboogaard@healtheffects.org)) or Maria Costantini ([mcostantini@healtheffects.org](mailto:mcostantini@healtheffects.org)).

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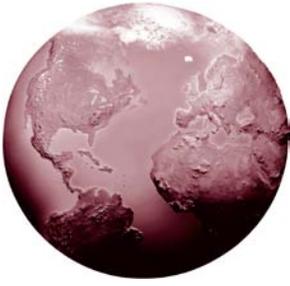
HEI is a nonprofit organization funded jointly by government and industry to research and evaluate the health effects of air pollution. An overview of HEI, information on its current research program, and all published HEI reports are available for downloading, free of charge, from the Web site.

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## Window on Tomorrow: Building the HEI Strategic Plan 2015–2020

**H**igh-quality science to inform policy does not just happen — it takes a careful strategic effort, drawing from the best minds in the policy making and scientific worlds, to ensure that the most relevant answers can be produced in time for key upcoming decisions.

Nowhere is this attention to strategic thinking more essential than in the *HEI Strategic Plan for Understanding the Health Effects of Air Pollution*, the document HEI crafts every five years in collaboration with its sponsors, the scientific community, and the broader community of environmental and other stakeholders. The plan, which HEI has now produced four times in the past two decades, provides an invaluable guide to focus the institute's resources, all the more important as dollars invested in science become more scarce. And it is from this plan that HEI's future requests for applications, special scientific reviews, and other targeted projects will spring forth.

HEI has now launched its efforts to develop a Strategic Plan for 2015 through 2020, building on the foundation of the current plan's key components: investment in multipollutant exposure, epidemiology, and toxicology research; the study of emerging technologies and fuels; assessment of the health outcomes of air quality improvements (accountability); and development of an international perspective. The institute is also scanning the regulatory arena to identify the range of decisions likely to occur during

the next five years — and has reconvened its Special Committee on Emerging Technologies — so that the Strategic Plan is as well tuned as it can be to the needs of tomorrow, not just today.

To ensure the most well-informed and responsive plan, HEI is undertaking extensive consultations:

*Fall 2013:* HEI senior staff meetings with sponsor groups and other stakeholders to gather ideas

*February 2014:* Meeting of the HEI Research Committee and sponsors to discuss future research needs

*May 2014:* First draft of the Strategic Plan presented and discussed at the HEI Annual Conference

*Summer 2014:* Draft plan revised and sent to sponsors, stakeholders, and members of the scientific community for comments and suggestions

*Fall 2014–Winter 2015:* Plan formally adopted by HEI Board of Directors

Most important to the plan will be getting your ideas. Please look for and comment on the plan as it is developed — and send your suggestions to Dan Greenbaum ([dgreenbaum@healtheffects.org](mailto:dgreenbaum@healtheffects.org)), Bob O'Keefe ([rokeefe@healtheffects.org](mailto:rokeefe@healtheffects.org)), or Rashid Shaikh ([rshaikh@healtheffects.org](mailto:rshaikh@healtheffects.org)). 