HEI HEALTH EFFECTS INSTITUTE

update

SUMMER 2012

HEI Research Contributes to Review of Diesel and Gasoline Cancer Risk

In June, the International Agency for Research on Cancer (IARC), an agency of the World Health Organization based in Lyon, France, issued its new evaluation of whether exhaust emissions from diesel and gasoline engines are human carcinogens. Based on the review of a large number of epidemiologic, toxicologic, and mechanistic studies of older diesel engines and gasoline engines, an IARC expert panel concluded that diesel exhaust is a Group 1, or known, human carcinogen and gasoline exhaust is a Group 2B, or possible, human carcinogen. HEI produced a large volume of data for the review, President Dan Greenbaum served as an observer at the IARC meetings, and HEI Principal Scientist Aaron Cohen served as an invited specialist.

IARC concluded that diesel engines have evolved over the past 25 years, in response to regulations in the United States, Europe, and elsewhere around the world, from "traditional" (unregulated) engines to "transitional" engines (regulated 1988–2006) to "new-technology" diesel engines and fuels.

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In session at the Drake Hotel. PHOTO BY JAY MALLIN

Annual Conference Highlights New Findings and Major Issues

Over 200 people from around the globe — from industry, government, nongovernmental organizations, the media, and many academic institutions — gathered in mid-April in Chicago, Illinois, for HEI's 26th Annual Conference, held at the Drake Hotel on the shores of Lake Michigan. Leading international researchers outlined results from a rapidly growing number of studies funded by HEI and others, in presentations designed to provide a critical review of the latest research on major air pollution issues.

This year's opening Sunday session began with a discussion of new scientific evidence on the nature of diesel emissions and associated health effects. John Wall of Cummins set the stage with an overview of how diesel emissions have changed over the past several years. Jacob McDonald of the Lovelace Respiratory Research Institute (LRRI) reported on the Advanced Collaborative Emissions Study (ACES), HEI's joint project with the Coordinating Research Council. McDonald presented results from the first stage of animal testing: 1-, 3-, and 12-month exposures to exhaust from a new-technology diesel engine. Eric Garshick of the Veterans Administration Boston Health Care System reviewed the epidemiologic evidence on diesel emissions and cancer, culminating with a summary of the recently published Diesel Exhaust in Miners Study sponsored by the

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Also in This Issue

David Eaton, chair, HEI Research Committee, and Carol Henry, Cummins consultant.

Margo Oge, U.S. Environmental Protection Agency.

Richard Celeste, chair, HEI Board of Directors, and John Wall, vice president, Cummins.

Mel Peffers, U.S. Environmental Protection Agency, and Fred Reitman, Shell.

Susan Collet, Toyota, and Rashid Shaikh, HEI director of science.

Daniel Costa, U.S. Environmental Protection Agency, and Robert O'Keefe, HEI vice president.

Homer Boushey, chair, HEI Review Committee, and Tom Hesterberg, Navistar.

John Godleski, Harvard School of Public Health, left, and Morton Lippmann, New York University School of Medicine.

Charles Ris and Joseph Somers, both of the U.S. Environmental Protection Agency.

ANNUAL CONFERENCE (*Continued from page 1*)

National Cancer Institute and National Institute for Occupational Safety and Health. The session concluded with comments by Nigel Clark of West Virginia University, Katharine Hammond of the University of California–Berkeley, and Tom Hesterberg of Navistar.

On Sunday evening, the 2011 Walter A. Rosenblith New Investigator Awards were presented to Juana Maria Delgado-Saborit of the University of Birmingham, United Kingdom, and Richard Peltier of the University of Massachusetts–Amherst. The award, named for the first chair of the HEI Research Committee, supports the work of a promising scientist early in his or her career.

HEI Vice President Robert O'Keefe opened Monday's proceedings with an overview of new developments in air quality regulation in the United States and abroad. A session on "Long-Term Exposure to Photochemical Oxidants and Chronic Disease: Current Evidence from Epidemiologic Cohort Studies" explored the scientific challenges to understanding photochemical oxidants, what they represent in the overall air pollution mix, and how they may be related to long-term effects on respiratory and cardiovascular health.

Margo Oge of the U.S. Environmental Protection Agency (EPA) captivated conference attendees during Monday's luncheon with a perspective on the policies governing diesel engines and the motor vehicle industry's successful technological innovations that have led to substantially reduced emissions; she then offered a look toward the future.

The Monday afternoon session featured the results and critical discussion of HEI's four-year research initiative, the National Particle Component Toxicity (NPACT) study, designed to examine whether some components of particulate matter are more harmful to health than others. NPACT included integrated toxicologic and epidemiologic studies of cardiovascular outcomes in U.S. cities with different compositions of particulate and gaseous air pollution. Investigators Morton Lippmann and George Thurston presented results for the New York University research team; Sverre Vedal and Matthew Campen presented results for the University of Washington/LRRI team. Afterward, members of the HEI NPACT Review Panel, chaired by Bert Brunekreef of the University of Utrecht

(*Continued on page 3*)

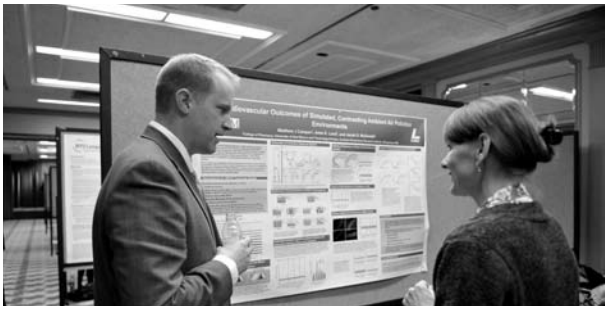
Mary Ross, U.S. Environmental Protection Agency.

Eun Sug Park, Texas A&M University, and John Molitor, Oregon State University.

ACES investigators, from left: Daniel Conklin, Qinghua Sun, Lance Hallberg, Jeffrey Bemis, and Jacob McDonald, with Christopher Tennant, Coordinating Research Council.

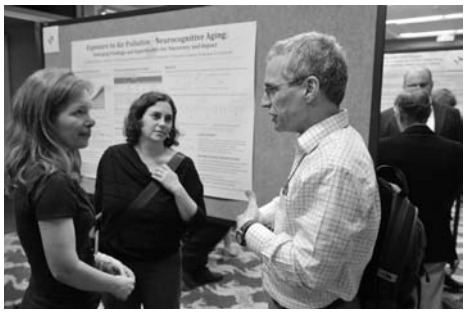
HEI President Dan Greenbaum and Andre Welch, Ford.

Arlean Rohde, Conservation of Clean Air and Water in Europe.



Matthew Campen, Lovelace Respiratory Research Institute, and Barbara Hoffmann, Leibniz Research Institute for Environmental Medicine.

From left, Susan Collet, Toyota; Hiroe Watanabe, Nissan; Hiroaki Minoura, Toyota; and Rashid Shaikh, HEI director of science.



Jennifer Weuve, Rush Institute for Healthy Aging; Sara Adar, University of Michigan; and Stuart Batterman, University of Michigan.

From left, John Wall, Cummins; David Foster, HEI Research Committee; and Christopher Dea, Caterpillar.

ANNUAL CONFERENCE (*Continued from page 2*)

and Ted Russell of the Georgia Institute of Technology, both members of the HEI Review Committee, shared their perspectives on the findings.

Tuesday's sessions were devoted to ultrafine particles and traffic-related emissions. In the morning, Katherine Walker, an HEI senior scientist, introduced HEI's forthcoming review of the literature on ultrafine particles and health, conducted by a panel chaired by Mark Frampton of the University of Rochester and the HEI Review Committee. The review provides a broad assessment of the current evidence on ultrafine particle exposures and health outcomes. Its overarching purpose is to evaluate to what extent this evidence supports the hypothesis that ultrafine particles — which may increase as a result of expanded use of new, more fuel-efficient vehicle technology — have unique health effects independent of those associated with other, larger particle-size fractions. Frampton and fellow panelists Leonidas Ntziachristos of Aristotle University in Greece, Stefanie Sarnat of Emory University, and Mike Brauer of the University of British Columbia and the HEI Review Committee presented the major conclusions of the report. A lively discussion with the audience followed.

The final session addressed methods for improving assessment of exposure to traffic-related pollutants. Richard Baldauf of the EPA spoke about near-road studies and air quality; Fred Lurmann of Sonoma Technologies discussed how local atmospheric chemistry and transport can affect scientific strategies for measuring air pollutants; and Jeffrey Brook of Environment Canada suggested possible approaches to improving current methods for characterizing traffic-related exposures. This session, along with HEI's Special Report 17 on traffic-related air pollution (2010), laid the groundwork for a follow-up workshop, held the next day, to outline new research strategies.

The final conference program and all presentation slides are available at *www.healtheffects.org/annual.htm*. Mark your calendar for next year's Annual Conference, scheduled for April 14–16, 2013, at the Palace Hotel in San Francisco, California; registration information will be available at the same Web page early in 2013.

Conference photos by Jay Mallin

Current and former recipients of the Walter A. Rosenblith New Investigator Award, from left: Jiu-Chiuan Chen, Qunwei Zhang, Juana Maria Delgado-Saborit, Thomas Barker, Jun Wu, Richard Peltier, Charles Stanier, and Yifang Zhu.

SAVE THE DATE

HEI Annual Conference 2013

April 14–16
Palace Hotel
San Francisco, California

NEW HEI RESEARCH REPORT

Air Quality Outcomes of National Limits on Power Plant Emissions

In 1990, Congress amended the Clean Air Act to address the growing problem of acid rain. Because electric power plants were the largest emitters of the sulfur dioxide (SO_2) and nitrogen oxides (NO_x) implicated in acid rain formation, their emissions were required to be drastically reduced. Lowering the levels of SO_2 and NO_x, which react in the atmosphere to form particulate matter (PM), was expected in turn to reduce concentrations of $PM_{2.5}$ (PM with an aerodynamic diameter of 2.5 µm or smaller). As described in the forthcoming HEI Research Report 168, *Accountability Analysis of Title IV Phase 2 of the 1990 Clean Air Act Amendments*, Richard D. Morgenstern and colleagues at Resources for the Future (a nonprofit group focused on environmental economics) and Yale University analyzed the extent to which the reductions in coal-fired power plant emissions were associated with lowered $PM_{2.5}$ concentrations in the eastern United States between 1999 and 2005. This study was a part of HEI's larger program on health outcomes (or accountability), which funds research to evaluate the effectiveness of regulations and other actions intended to reduce air pollution and improve health.

Richard Morgenstern and colleagues analyzed the extent to which the reductions in coal-fired power plant emissions were associated with lowered $PM_{2.5}$ concentrations in the eastern United States between 1999 and 2005.

Morgenstern, his colleague Winston Harrington, and others used a statistical analysis linking emissions and air quality–monitoring data. They created a "source–receptor" model based on measurements of $PM_{2.5}$ at pollution-monitoring stations as well as inventories of SO_2 and NO_x emissions from power plants before and after the installation of emissions-control equipment required by Title IV of the Clean Air Act Amendments. The group predicted $PM_{2.5}$ levels at the monitors by constructing "emission zones" surrounding the monitors and modeling the relationship between emissions in various zones and the measured levels of $PM_{2.5}$. In addition, their models accounted for weather conditions, overall energy generation and consumption, and a number of other variables believed to affect the modeled source–receptor relationships.

Morgenstern and colleagues were able to model the relationships between reductions in $PM_{2.5}$ concentrations at the monitors during the study period and reductions in emissions of SO_2 and NO_x at the power plants. They found that the Title IV Phase 2 emissions-reduction policy was associated with an average reduction of 1.07 (± 0.11) µg/m^3 at $PM_{2.5}$ monitors in the eastern United States during the study period.

Their modeled results compared favorably with projections generated through the Community Multiscale Air Quality (CMAQ) model, a widely used atmospheric chemistry model for predicting air quality. The authors believe that their source–receptor approach provides a reliable method for verifying changes in air quality after regulations to reduce emissions are implemented. Although the HEI Review Committee, in its independent evaluation of the study, found the data-driven source–receptor approach potentially useful, it did express reservations about potential uncertainty in the results owing to the large number of variables the models require. It noted that uncertainties associated with the CMAQ model also must be considered when making comparisons. HEI

Research Report 168 will soon be available for downloading, free of charge, at *http://pubs.healtheffects.org;* printed copies can be purchased from HEI. For more information, contact Kate Adams (*kadams@healtheffects.org*).

NEW HEI RESEARCH REPORT

Study Tests Potential Uses of Satellite-Based PM Measurements

Over the past decade, estimates of ground-level pollution derived from satellite-based estimates have emerged as a potentially important source of information on human exposure to health-damaging pollutants such as $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5 µm or smaller) and nitrogen dioxide. Researchers have begun to use satellite-based estimates of $PM_{2.5}$ for epidemiologic research; however, the accuracy and precision of such estimates and the circumstances under which they might make the most important contributions remain uncertain. Christopher Paciorek and Yang Liu address these issues in HEI Research Report 167, *Assessment and Statistical Modeling of the Relationship Between Satellite-Based Estimates and Measurements of $PM_{2.5}$ in the Eastern United States* (May 2012).

The study's overall objective was to assess the ability of measurements from National Aeronautics and Space Administration satellites to fill spatial and temporal gaps in existing ground-level monitoring networks in the eastern United States. Paciorek (Harvard School of Public Health and University of California–Berkeley, and a winner of HEI's Walter A. Rosenblith New Investigator Award) and Liu (Emory University) developed statistical models for integrating monitoring, satellite, and GIS (geographic information system) data to estimate monthly average ambient $PM_{2.5}$ concentrations. They then used those models to estimate monthly average $PM_{2.5}$ concentrations across the study region. They developed and applied statistical methods to quantify how the degree of uncertainty in exposure estimates based on ground-level monitoring data might be reduced.

The investigators report that satellite-based aerosol optical depth (AOD) measurements did not improve the accuracy of $PM_{2.5}$ predictions for the eastern United States when compared with predictions from other geospatial models. They attribute this finding to the spatial discrepancy between satellite-based estimates and measured $PM_{2.5}$, particularly at smaller spatial scales — a discrepancy which needs to be accounted for in statistical models. They conclude that there is little evidence that current satellite-based estimates of AOD can improve prediction of ground-level $PM_{2.5}$ at small-to-moderate scales in the eastern United States.

In its independent evaluation of the study, the HEI Review Committee recommended the use of approaches that combine information from multiple sources — satellite-based estimates, model-based estimates, and ground-level measurements — and noted that recent studies that have taken such an approach can explain a fair amount of between-city variability in $PM_{2.5}$. The use of satellite-based estimates, the committee concluded, may offer promise for estimating exposure to $PM_{2.5}$ in regions with the highest levels of pollution that currently lack ground-level monitoring. Addressing remaining uncertainties, however, will require a systematic effort that includes measuring ground-level $PM_{2.5}$ in selected global regions to assess the factors that most affect the relationship between satellite-based and ground-level estimates.

Research Report 167 is available for downloading, free of charge, at *http://pubs.healtheffects.org*; printed copies can be purchased from HEI. For more information, contact Aaron Cohen (*acohen@healtheffects.org*).

International Agency for Research on Cancer headquarters in Lyon, France.
PHOTO BY AARON COHEN

IARC (*Continued from page 1*)

This new technology, beginning in 2006–2007 in the United States and more recently in Europe, integrates ultra–low-sulfur diesel fuel with new catalyzed diesel particulate filters and diesel oxidation catalysts. Based on the initial phase of HEI's Advanced Collaborative Emissions Study (ACES), the only major health study of new-technology diesel currently under way and reporting results, the panel noted that on a per-km basis, particulate mass emissions from engines using this new technology have been reduced by over 99% and nitrogen oxide (NO_x) emissions by 98% compared with traditional diesel engines.

The panel members based their broader diesel review on epidemiologic studies of workers exposed to diesel exhaust from the 1940s through the 1980s and on studies of animals exposed to engines built with 1980s and 1990s technology, as well as on some studies of human exposures in the 1990s and early 2000s. They noted that, with the exception of ACES, they were not able to base their evaluation on health data from studies of new-technology diesel engines. The panelists based their review of gasoline exhaust on a limited number of animal and laboratory studies.

"We are pleased that IARC considered HEI's research on both older and new diesel technologies and fuels in its review," Greenbaum said. "It is clear that in much of the world the older diesel technology on which the IARC panel based its review is still in widespread use, and it is likely that IARC's determination will help encourage adoption in more countries of the fuel and technology improvements industry has been making in concert with U.S. and European government agencies."

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Daniel S. Greenbaum, *President*

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 a list of published HEI Research Reports are available on request or from the Web site.

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HEI in the News

In the spring, leading online news outlets that focus on environmental, energy, and diesel-fuel issues publicized the first results of the most comprehensive study ever undertaken of the health effects of exposure to new-technology diesel engines, HEI Research Report 166, Parts 1–3, *Advanced Collaborative Emissions Study (ACES) Subchronic Exposure Results: Biologic Responses in Rats and Mice and Assessment of Genotoxicity* (April 2012). The study was the first to expose rats and mice to emissions from a heavy-duty diesel engine meeting stringent 2007 U.S. Environmental Protection Agency (EPA) standards that reduce emissions of fine particles and other pollutants by more than 90% from levels emitted by older engines. The investigators have found no evidence of gene-damaging effects in the animals studied thus far, and only a few mild effects on the lungs. Parts 1–3 of the study are being conducted, respectively, by Jacob McDonald of the Lovelace Respiratory Research Institute, Albuquerque, New Mexico; Jeffrey Bemis of Litron Laboratories, Rochester, New York; Lance Hallberg of the University of Texas Medical Branch, Galveston; and their colleagues. Subchronic results from a fourth part of the study by Daniel Conklin and Maiying Kong will be released later this year.

Greenwire

Study Suggests Diesel Technology Controls Are Working (April 12, 2012)

Greenwire reported that both industry representatives and environmentalists hailed the results from ACES testing for demonstrating how the new diesel technologies installed on older diesel engines are reducing health risk. It quoted Allen Schaeffer, executive director of the Diesel Technology Forum, an industry nonprofit, and Conrad Schneider of the Clean Air Task Force, as well as HEI President Dan Greenbaum, who said, "We will be communicating these results to the International Agency for Research on Cancer, the U.S. National Toxicology Program, and the U.S. EPA in order to ensure that the significant improvements in emissions and effects for these new diesel technologies are considered and compared with the data on older engines when those agencies reach their conclusions."

InsideEPA.com

HEI Study Spurs Call to Differentiate Health Risks of "New" Diesel Exhaust (April 16, 2012)

InsideEPA.com noted that the ACES results show higher concentrations of particulate matter in emissions from older engines than newer engines. It quoted a participant in HEI's Annual Conference held in April (see related story), John Wall of engine maker Cummins, who "stressed the need for researchers and others to differentiate between risks from old diesel exhaust and 'new-technology diesel exhaust.' "