Workshop on Strategies to Evaluate Diesel Emissions in the ACES Project

November 6-7, 2003
Denver, Colorado

Background

The Advanced Collaborative Emissions Study (ACES) is a cooperative, multi-party effort initially proposed by the Engine Manufacturers Association (EMA) to determine the emissions and health effects of new, controlled heavy-duty diesel engines being prepared for market to meet 2007 on-road heavy-duty emissions standards. For this project, the Coordinating Research Council (CRC) would undertake characterization of emissions and the Health Effects Institute (HEI) would be responsible for health effects assessment. The overall effort would be guided by a Steering Committee consisting of representatives of all key stakeholders and funders of the effort.

This workshop, jointly organized by HEI and CRC, represents the initial step to aid in developing an approach and guidelines for emissions characterization and health effects evaluation. The main aims of the workshop are to (a) describe the content of current diesel emissions and how they are expected to change both chemically and physically with new technologies, and (b) discuss and make recommendations on:

1. Approaches to emissions characterization
2. Methods of dilution and sampling of exhaust;
3. Methods for in vitro and in vivo exposures to whole exhaust or components of the exhaust;
4. Hypotheses for health effects relevant to the emissions to be tested and to future decisions about risk from exposure to diesel exhaust.

Workshop Planning Committee

Brent Bailey, CRC
James Ball, Ford Motor Co.
Tim Belian, CRC
Melvyn Branch, University of Colorado
William Bunn, International Truck and Engine
Steven Cadle, General Motors
Maria Costantini, HEI
Kenneth Demerjian, University at Albany
Rogene Henderson, LRRI
David Kittelson, University of Minnesota
Doug Lawson, NREL
Mani Natarajan, Marathon Ashland
Shankar Prasad, California ARB
Stephen Rennard, University of Nebraska
Joseph Somers, US EPA
Lorraine Twerdok, API
Mark Utell, University of Rochester
Leendert van Bree, RIVM Netherlands
John Vandenberg, US EPA
Annemoon van Erp, HEI
Jane Warren, HEI

ACES Workshop Agenda

November 6, 2003

8:00 am Introductory Comments

8:00 am **Dan Greenbaum** (Health Effects Institute)

8:05 am **Tim French** (Engine Manufacturers Association)

8:20 am Emissions Characterization

Session Chairs: **Jim Ball** (Ford) and **Shirish Shimpi** (Cummins) *What will the 2007 engine look like? What will be the changes in emissions with the new technology? What will be new emissions components?*

8:20 am **Graham Weller** (Ricardo): 2007 Engine Hardware and Aftertreatment Impacts on Emissions
(What will be included in the 2007 engine system and aftertreatment hardware? What will be the changes in the quantity of emissions and in their composition? What uncertainty is there in our current understanding?)

8:40 am **John Storey** (Oak Ridge National Laboratory): 2007 Aftertreatment and New Impacts on Exhaust Chemistry
(What are the NOx emissions products from advanced NOx control technologies expected in 2007? What is the uncertainty in these predictions and in the technology that will be used?)

9:00 am **Mike Leister** (Marathon-Ashland Petroleum): 2007 Diesel Fuel Composition & Impacts on Emissions
(How will the 2007 diesel fuel be different from what is in use today? What will the chemical composition changes be? How are these changes expected to change emissions quality and quantity? What uncertainty is there in our current understanding?)

9:15 am **Shawn Whitacre** (National Renewable Energy Laboratory): 2007 Lubricant Impacts on Emissions
(How will the 2007 diesel engine lubricants be different from what is in use today? What will the chemical composition changes be? How are these changes expected to change emissions quality and quantity? What uncertainty is there in our current understanding?)

9:30 am **Jamie Schauer** (University of Wisconsin): Detailed Chemistry of Current Diesel Engine Emissions
(What are the general classes of compounds present in today's engines? Does the vehicle operating cycle change the chemical profile in the exhaust? What quantities are being emitted? What are the lower limits of detection for the future analytical techniques?)

Break 9:50 – 10:05 am

10:10 am Dilution, Sampling, and Exposure Methods

Session Chairs: **Bruce Cantrell** (US Environmental Protection Agency) and **Melvyn Branch** (University of Colorado) *What are the appropriate temperature and dilution conditions for exposure of animals and cells while maintaining the properties of the exhaust? Can we collect realistic particle samples for health studies?*

10:10 am **Shirish Shimpi**: EPA Protocols for Sampling 2007 Diesel Exhaust
(What are the expected PM concentrations? What are the background concentrations from dilution air and from sampling lines? How does the standard certification procedures differ from ambient conditions?)

10:30 am **Matti Maricq** (Ford): 2007 Exhaust Composition and Sampling Artifacts
(What are the positive and negative artifacts expected in filter samples? How will artifacts impact characterization of PM samples from filter samples? What will be the impact from volatiles, semi-volatiles, and carbonaceous components on sample characterization? How can samples be collected for properly determining nitrate composition especially during long-term filter sampling? What is appropriate for residence chamber and dilution/concentration sampling? What techniques can be used for sampling total exhaust?)

10:50 am **David Kittelson** (University of Minnesota): Dilution and Sampling of Diesel Exhaust to Preserve Ambient Particle Integrity
(What are the appropriate temperature and dilution collection conditions for exposure of animals and cells to maintain the properties of the exhaust? Can we collect appropriately realistic particle samples for health studies? What are the sampling impacts on PM physical properties and how can we best design a chamber exposure system taking into consideration the major problems in matching size distribution, surface area, and number in a test cell to meet some defined ambient condition?)

11:10 am **Steven Cadle** (General Motors): Measuring 2007 PM Emissions
(What research is planned to begin the study of 2007 PM emissions? What are the key issues to be addressed in this research to improve the measurement of low PM levels in the exhaust and what additional work is needed for understanding the ambient pollution effects from 2007 engine technology?)

11:30 am **Discussion**

Lunch 12:00-12:40 pm

12:40 pm Dilution, Sampling, and Exposure Methods, continued

12:40 pm **Petros Koutrakis** (Harvard School of Public Health): Possible methods to enrich PM content of diesel exhaust (using concentrators or denuders)

1:00 pm **Jean-Paul Morin** (Institut National de la Santé et de la Recherche Médicale, France): A method for exposing cells to whole exhaust.

1:15 pm Health Effects Assessment

Session Chairs: **Bob Devlin** (US Environmental Protection Agency) and **Dan Greenbaum**
Current programs investigating health endpoints after exposure to emissions or other pollutant mixtures.

1:15 pm **Joe Mauderly** (Lovelace Respiratory Research Institute): Assays used to evaluate health effects of emissions from diesel and other combustion sources: their sensitivity and relevance to diseases/adverse effects and to humans; thoughts about exposure levels, health endpoints, and control exposures for ACES studies

1:50 pm **Maria Costantini** (Health Effects Institute) and **Michael Davis** (US Environmental Protection Agency): Tier 2 testing of biodiesel

2:10 pm **Mike Madden** and **Bob Devlin** (US Environmental Protection Agency): In vitro and in vivo evaluation of toxicity of particles from different sources; relevance of in vitro assays and their potential role in health effects evaluation.

Break 2:35-2:50 pm

Health effects endpoints and possible animal/cellular models to consider
What are the best endpoints for cancer, asthma, oxidative stress, other important conditions, considering relevance to human effects and sensitivity?

2:55 pm **Mark Frampton** (University of Rochester): Oxidative Stress and Inflammation

3:15 pm **Ian Gilmour** (US Environmental Agency): Asthma /Allergy

3:35 pm **Byron Butterworth** (Butterworth Consulting): Cancer

What health effects are most important and relevant for diesel exposure risk assessment?
Discussants will comment on endpoints presented earlier; discuss health effects of short-term and longer-term exposure in relation to diesel risk assessment.

4:05 pm **Sverre Vedal** (University of Colorado School of Medicine; National Jewish Medical and Research Center)**:** From the risk assessment perspective, what kinds of health effects and endpoints are most important?

4:20 pm **Roger McClellan** (Advisor, Toxicology and Human Health Risk Analysis): Comments on health end points discussed, other health end points of potential interest; thoughts about study design options (exposure levels, comparative exposures) to consider

4:50 pm **Discussion**

5:20 pm **Charge to Working Groups**

5:30 pm Adjourn

November 7, 2003

8:00 am **Parallel Working Groups on (1) Emissions Characterization and (2) Health Effects Testing**

8:00 am *I. Emissions Working Group*
Working Group Chairs: **Steven Cadle** (General Motors) and **Joe Somers** (US Environmental Protection Agency)
Rapporteur**: Brent Bailey** (Coordinating Research Council)

Identify steps necessary to produce, sample, and characterize emissions from advanced (2007+) low emission diesel engines

- Engine and control systems for 2007+ strategies including several of the leading pathways; appropriate engine(s) to serve as reference exposure
- Sampling and exposure methodologies including appropriate dilution, temperature, residence time, and perhaps concentration steps
- Best chemical and physical analysis approaches to identify the true emissions signature and eliminate artifacts

8:00 am *II. Health Effects Working Group*
Working Group Chairs: **Rogene Henderson** (Lovelace Respiratory Research Institute) and **Jane Warren** (Health Effects Institute)
Rapporteur: **Annemoon van Erp** (Health Effects Institute)

Discuss and prioritize assays for health effects testing

- Most important health endpoints, best ways to assess them—endpoints and animal models
- Supporting endpoints (oxidative stress, inflammatory indicators, etc.)

Discuss study design issues: Exposure atmospheres, reasonable levels of emissions to test, exhaust components to test, appropriate exposure controls for comparison

Breaks called by working groups (time window: between 10:00 and 10:30 am)

11:30 am **Concluding Plenary Session**

11:30 am **Report from Emissions Working Group**

11:50 am **Report from Health Effects Working Group**

12:10 pm Discussion of Next Steps in ACES
Tim Belian (Coordinating Research Council)
Dan Greenbaum

12:30 pm **Adjourn**