

NEW HEI RESEARCH PROGRAMS

Accountability
PM Components
Advanced Diesel Engines

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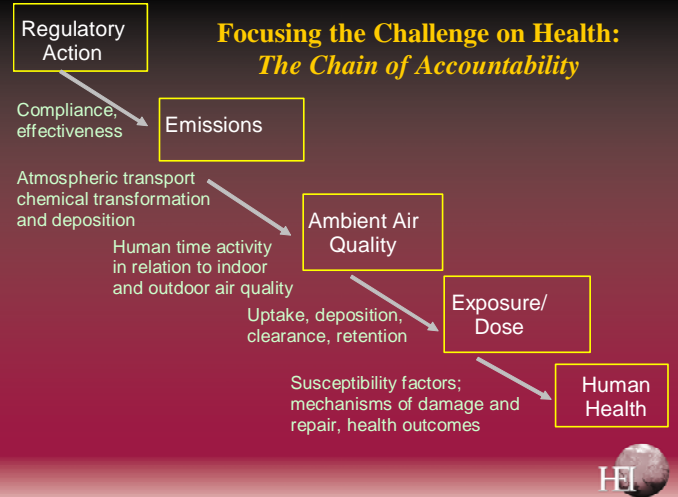
ACCOUNTABILITY

Health Impact of Actions
to Improve Air Quality



History of HEI's Accountability Program

- Initiated in Strategic Plan for 2000 – 2005
- Published monograph on concepts and methods for accountability research in 2003
- Issued RFAs in 2002 (2), 2004
- Now have substantial program (8 studies/5 new)
 - 7 ongoing
 - 1 to start in June
- First accountability report due May 31



What Does Accountability Involve?

- Measuring indicators along entire chain from emissions to human health
- Evaluating concurrent changes that affect exposure and health effects. *This relates especially to regulations implemented over long time periods.*
- Participation of experts from broad range of disciplines



HEI Accountability Studies

Short-Term Interventions

- Coal ban in Irish cities
- Limiting traffic
 - During Atlanta Olympic Games
 - Congestion charging scheme and low-emission zone in London
- Replacement of old wood stoves with less polluting stoves in US
- Decrease in sulfur content in gasoline (to 0.5%) in Hong Kong



HEI Accountability Studies

Actions over Longer Term

- Modernization of factories and increased use of diesel engines in the 1990s in eastern Germany
- Regulations requiring decreased SO₂ emissions from power plants in eastern US



PM Components Research



A Key Question Looking Forward: Which Particles Are Most Toxic?

- Current PM standards are broad size ranges: PM₁₀, PM_{2.5}, PM_{10-2.5}
- Over long term, more specific standards could
 - Target particles most likely to contribute to effects e.g., narrower size range, specific chemical constituents
 - Affect fewer source types, enable industries to control specific PM components
- This will require knowing which particle components are most toxic



What Attributes of PM Are Associated with Adverse Health Effects?

Many Hypotheses Being Tested

- | | |
|---------------------|-------------------------|
| • Mass | • Biological material |
| • Size | • Sulfates and nitrates |
| • Surface area | • Peroxides |
| • Acidity | • Soot |
| • Reactive metals | • Co-pollutants |
| • Organic compounds | • Oxidative potential |



Which Particles Are Most Toxic?

Much research has been done: But clear answers have been elusive

- Many types of particles in ambient air
- Combinations or co-pollutants may be important
- Many differences in studies make comparisons difficult
 - Different susceptible populations
 - Broad range of endpoints
 - Variations in design- e.g., timing of measurements
- Some progress has been made, but more systematic studies are needed



First steps in HEI's PM Components Program

Planning started under Strategic Plan 2000 - 2005

- Created internet-accessible database of air pollutant information to facilitate research
 - Monitoring information from EPA's 54 sites in PM_{2.5} Chemical Speciation Trends Network
- August 04 workshop to discuss study design issues for multi-site toxicology and epidemiology studies
- RFA issued July 2005 for planning and full studies



Implementing HEI's PM Components Research Program

RFA issued in July 2005 sought applications for

- Multidisciplinary investigator teams
- Hypotheses about components or sources
- Systematic, comparative studies
- Coordinated toxicology/epidemiology (encouraged)
- Consideration of effects of gaseous pollutants

Both planning studies and full studies of interest



Status of Applications

- 5 applications for planning studies Fall 05
 - 1 funded to gather air quality and health data to evaluate feasibility of conducting an epi/tox study along the Southwest US border with Mexico
- 8 applications for full studies Winter 06
 - reviewed by panel in February
 - discussed by Research Committee in March
 - 3 of interest; final decisions at upcoming Research Committee meeting
 - Studies expected to start by late 06



ACES

The Advanced Collaborative Emissions Study

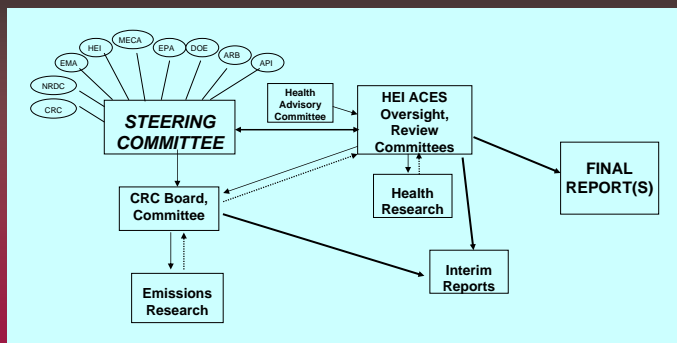


Advanced Collaborative Emissions Project

- ACES is a Significant Opportunity to evaluate new technologies before widespread
- Collaborative multi-party effort with interest and support from
 - Industry (engine, fuel, emission control)
 - Government agencies (CARB, DOE, EPA)
 - Environmental groups
- Industry to provide production intent engines with control technologies for
 - Emissions characterization (Coordinating Research Council)
 - Health effects testing (HEI)



ACES Organization



Diesel Engine Technology is Improving... Dramatically!

- Most diesel health assessments based on 1980s and earlier technology
- Substantially cleaner engines with aftertreatment systems now available
- Much lower emissions for heavy-duty diesel required by 2007-2010
 - 2007 – PM and NOx reductions
 - 2010 – Greater NOx reductions



2007/2010 Engines

- The combination of
 - advanced-technology, compression-ignition engines,
 - aftertreatment systems,
 - and reformulated fuels and oilswill result in substantially reduced emissions
- Substantial public health benefits are expected from these reductions
- With any new technology, however, it is prudent to conduct research to ensure that there are no adverse impacts to public health



Testing of 2007 Engine Emissions

Phase 1 Mid 2006	Emission characterization at certification facility of 4 production-intent heavy heavy-duty engines with control systems; selection of 1 for health effects testing
Phase 3A Sept 2007	Emission characterization of selected engine system and duplicate (backup) at health facility
Phase 3B Jan 2008	Chronic bioassay in rats and mice to evaluate cancer and noncancer effects (2-year exposure)
Phase 3C Feb 2010	3-month study after completion of the bioassay to evaluate some of the endpoints measured in the early months of the bioassay—now with an aged engine



ACES Hypothesis

Emissions from combined new heavy-duty diesel engine, aftertreatment, lubrication and fuel technologies designed to meet the 2007 NO_x and PM emission standards will have very low pollutant levels and **will not cause an increase in tumor formation or substantial toxic health effects in rats or mice at the highest concentration of exhaust that can be used** (based on temperature and NO₂ or CO levels) compared to animals exposed to “clean air”, although some biologic effects may occur.



Emissions Measurements

- Regulated emissions
 - HC, CO, NO_x, PM
 - Size distribution of PM
- Unregulated emissions
 - As complete a speciation as practical
 - List of 800 compounds
 - 3 categories by importance
 - Must be measured – about 190 compounds
 - Should be measured if reasonable to do so
 - Measured if it done concurrently with higher priority compounds or at little additional cost



Endpoints in Chronic Bioassay

- Standard NTP endpoints at terminal sacrifice:
 - Histopathology, tumor incidence, weight of major organs
- Standard NTP endpoints at intermediate sacrifices
 - Histopathology in key organs
- Additional endpoints in animals allocated to intermediate sacrifices and unassigned animals
 - Pulmonary function
 - Inflammation
 - Vascular markers
 - Genotoxicity
 - Immunotoxicity
 - Resistance to respiratory infection



ACES Is Moving Ahead

- CRC issued RFP for emissions characterization in February; work to start in mid 2006
- HEI to issue this spring:
 - RFP for developing an engine and exposure facility, characterizing emissions and exposure, and conducting the chronic bioassay
 - RFA for additional health endpoints in the bioassay (genotoxicity, inflammation, immunotoxicity)
- Projected start times of major events:
 - Construction/renovation of engine and exposure facility (Fall 06)
 - Emission characterization at animal facility (Fall 07)
 - Bioassay (January 2008)

