Health Impacts of Diesel PM Emissions: An Update

November 19, 2009
Sacramento, California
Presentation Overview

• Health effects of diesel PM
• Methodology for estimating premature deaths
• Control programs and PM trends
Health Effects of Diesel PM

- ARB and OEHHA evaluating diesel exhaust since 1989
- Listed as a toxic air contaminant in 1998
- Responsible for 70% of air toxics cancer risk
- Listing formed the basis of ARB’s Diesel Risk Reduction Plan
Diesel PM Also Linked to Premature Death

- Diesel PM is a component of ambient PM2.5
- Ambient PM2.5 associated with many adverse health effects, including premature deaths
- Assumed diesel PM and PM2.5 have equal toxicity
Guest Speaker

- Professor Jonathan Samet, USC
  - Chair of U.S. EPA’s Clean Air Scientific Advisory Committee
  - Chair of Department of Preventive Medicine at USC
  - Founding Director of Institute for Global Health at USC
  - Topic: Evidence for premature death from PM2.5 exposure
Presentation by Jonathan Samet

Placeholder (replace with your slides)

• Focus on epi data that show risk from PM2.5 exposure
  – NAAQS basis
  – Biological plausibility
  – total number of papers & funding commitment
  – uncertainties

– 7 minute presentation
Presentation Overview

- Health effects of diesel PM
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PM2.5 Exposure and Premature Death

Key Steps in ARB’s Review of Health Literature

U.S. EPA’s Panel of Experts Review

Public Workshop

Draft Report

Peer Review

Board Briefing

Public Workshop

Public comment period

Final Report
ARB Mortality Report

- 78 peer-reviewed publications
- No books or opinion pieces
- Included all U.S. studies through August 2008
Peer Review Evaluation

Advisors

• Dr. Jonathan Levy, Harvard University
• Dr. Bart Ostro, Office of Environmental Health Hazard Assessment
• Dr. Arden Pope, Brigham Young University

UCOP Peer Reviewers

• Dr. Jeffrey R. Brook, Environment Canada
• Dr. Mark D. Eisner, UC San Francisco
• Dr. Richard C. Flagan, California Institute of Technology
• Dr. Alan E. Hubbard, UC Berkeley
• Dr. Joel D. Kaufman, University of Washington
• Dr. Joel D. Schwartz, Harvard University

Additional Peer Reviewer

• Dr. Philip Hopke, Clarkson University
How Was ARB’s Estimate Developed?

• Pooled estimates from independent panel of 12 leading experts
• Most weight given to American Cancer Society and Six Cities cohorts
  – Includes LA study with improved exposure methodology
Public Health Statements

- **American Medical Association**
  - “… AMA support efforts to significantly reduce particulate air
    pollution by reducing the amount of particulate matter from diesel
    sources …”

- **American Heart Association**
  - “… epidemiological studies conducted worldwide have shown a
    consistent, increased risk for cardiovascular events, including heart
    and stroke deaths, in relation to short- and long-term exposure to
    present-day concentrations of pollution, especially particulate
    matter.”

- **World Health Organization**
  - “The effects of PM on health occur at levels of exposure currently
    being experienced by most urban and rural populations in both
    developed and developing countries. Chronic exposure to particles
    contributes to the risk of developing cardiovascular and respiratory
    diseases, as well as of lung cancer.”
Quantified PM2.5 Health Effects

- Premature death
- Hospital admissions
  - Respiratory illnesses
  - Cardiovascular illnesses
- Acute bronchitis
- Asthma and other lower respiratory symptoms
- Minor restricted activity days
- Work loss days
Additional PM2.5 Health Effects

- Non-fatal heart attacks
- Infant death
- Low birth weight, premature birth
- Emergency room visits for asthma
- Exacerbation of asthma
- Chronic bronchitis
PM Reductions Improve Public Health

- Steel mill closure in Utah Valley
  - Reduced hospital admissions and deaths with reduced exposure

- Life expectancy and PM2.5 levels in the United States
  - 0.61 year increase in life expectancy for every 10 µg/m³ reduction

- Children’s Health Study in California
  - Improved lung function growth in children moving from higher to lower pollution area
Risk from Diesel PM Exposure

Primary Diesel PM
19%

All Other PM2.5
81%
### Annual Statewide Diesel PM Health Impacts

<table>
<thead>
<tr>
<th>Health Endpoint</th>
<th>Mean (cases)</th>
<th>Range (cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>3,500</td>
<td>1,000 – 6,400</td>
</tr>
<tr>
<td>Hospital Admissions, Cardiovascular</td>
<td>740</td>
<td>480 – 1,100</td>
</tr>
<tr>
<td>Hospital Admissions, Respiratory</td>
<td>390</td>
<td>190 – 600</td>
</tr>
<tr>
<td>Lower Respiratory Symptoms</td>
<td>56,000</td>
<td>22,000 – 90,000</td>
</tr>
<tr>
<td>Acute Bronchitis</td>
<td>4,700</td>
<td>0 – 10,000</td>
</tr>
<tr>
<td>Minor Restricted Activity Days</td>
<td>2,100,000</td>
<td>1,700,000 – 2,400,000</td>
</tr>
<tr>
<td>Work Loss Days</td>
<td>350,000</td>
<td>300,000 – 410,000</td>
</tr>
</tbody>
</table>

Year 2005 emission inventory
Presentation Overview

- Health effects of diesel PM
- Methodology for estimating premature deaths
- Control programs and PM trends
## Progress: New Engines and Fuels

<table>
<thead>
<tr>
<th>Major Task</th>
<th>Action</th>
<th>Adoption status</th>
</tr>
</thead>
<tbody>
<tr>
<td>New engines</td>
<td>Truck standards reducing NOx/PM by 90% (2007-10)</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td>Off-road equipment engine standards reducing NOx/PM by 90% (2011-15)</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td>Locomotive/harbor craft standards (EPA)</td>
<td>Complete</td>
</tr>
<tr>
<td>Fuels</td>
<td>Ultra-low sulfur diesel, on- and off-road</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td>Ship auxiliary engines</td>
<td>Complete</td>
</tr>
<tr>
<td>In-use compliance/</td>
<td>On-Board Diagnostics for heavy trucks</td>
<td>Complete</td>
</tr>
<tr>
<td>enforcement</td>
<td>In-use testing and recall program</td>
<td>Complete</td>
</tr>
</tbody>
</table>
## Progress: Existing Engines

<table>
<thead>
<tr>
<th>Major Task</th>
<th>Action</th>
<th>% of PM</th>
<th>Cost (millions)</th>
<th>Adoption Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean-up existing engines</td>
<td>Urban transit buses</td>
<td>&lt;1</td>
<td>122</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td>Trash trucks</td>
<td>2</td>
<td>155</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td>Portable equipment</td>
<td>3</td>
<td>350-420</td>
<td>Complete</td>
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<tr>
<td></td>
<td>Stationary engines</td>
<td>2</td>
<td>47</td>
<td>Complete</td>
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<tr>
<td></td>
<td>Cargo handling equipment</td>
<td>&lt;1</td>
<td>71</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td>Municipal fleets</td>
<td>&lt;1</td>
<td>157</td>
<td>Complete</td>
</tr>
</tbody>
</table>
## Progress: Existing Engines

<table>
<thead>
<tr>
<th>Major Task</th>
<th>Action</th>
<th>% of PM</th>
<th>Cost (millions)</th>
<th>Adoption Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean-up existing engines (cont.)</td>
<td>School buses</td>
<td>&lt;1</td>
<td>200</td>
<td>Prop 1B</td>
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<td></td>
<td>TRUs</td>
<td>2</td>
<td>87-156</td>
<td>Complete</td>
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<tr>
<td></td>
<td>Idling limits</td>
<td>1</td>
<td>Savings</td>
<td>Complete</td>
</tr>
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<td></td>
<td>Stationary ag. engines</td>
<td>1</td>
<td>34-42</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td>Aux. engines OGV</td>
<td>3</td>
<td>165-171</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td>Port trucks, ships</td>
<td>9</td>
<td>400</td>
<td>Prop 1B</td>
</tr>
<tr>
<td></td>
<td>Off-road non-ag.</td>
<td>30</td>
<td>3200</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td>Private trucks</td>
<td>37</td>
<td>5500</td>
<td>Complete</td>
</tr>
<tr>
<td></td>
<td>Ag. equipment</td>
<td>8</td>
<td></td>
<td>2010</td>
</tr>
</tbody>
</table>
Trend in Statewide Annual PM2.5 Concentration

Statewide Average PM Concentration

PM2.5 Level (µg/m³)

Year


3 Year Moving Average

Annual Average

Estimated 3 Year Moving Average

Estimated Annual Average

+55%

VMT

+40%

Population

Historical monitoring network

New monitoring network
Additional PM Reductions Are Needed

- Reduce premature deaths
- Reduce diesel PM emissions by 85% by 2020
- SIP attainment in South Coast and San Joaquin Valley
- Attain increasingly tighter federal PM2.5 standards
Research to Address Remaining Issues

- U.S. EPA PM Centers
  - Ultrafine PM
  - Biological plausibility
  - Toxic components of PM
  - Pollutant mixtures

- CA-specific studies
  - California Teachers cohort
  - American Cancer Society cohort
PM2.5 Exposure

1987

1999

2007

micrograms per cubic meter

1.31 - 9.57
9.58 - 12.03
12.04 - 14.00
14.01 - 15.59
15.60 - 17.46
17.47 - 20.74
20.75 - 23.16
23.17 - 25.61
25.62 - 28.54
28.55 - 44.74