DIESEL EXHAUST CONTROLLED EXPOSURE FACILITY & HUMAN STUDIES

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What is Diesel Exhaust?

EPA

Health Assessment Document For Diesel Engine Exhaust 2002

- Complex mixture of gases
  - •CO2, CO, NOx, and SO2
  - • carbonaceous particles with adsorbed organic compounds
- Diesel exhaust is classified as “likely to be carcinogenic”

DE Exposures

- Typical Ambient Exposures
  - Average estimates for DPM in general population 1.4 µg/m^3
  - 4 -20 µg/m^3 in urban outdoor environments
  - Worst cases (downtown bus stop) near 50 µg/m^3
- Occupational Exposures
  - miners <=1,280 µg/m^3
  - railroad workers 39 -191 µg/m^3
  - firefighters 4 -748 µg/m^3
  - public diesel transit personnel 7-98 µg/m^3
  - mechanics and dockworkers 5-65 µg/m^3
  - truck & bus drivers 2-7 & 1-3 µg/m^3

Current Issues: DE and Policy

- Transition to low-S fuel by June 2006
- Changes in truck emission requirements and evolving non-highway regulations
- Increased concern regarding children's exposures on school buses
- Diesel & Global Climate Change: CO2 vs PM

UW Diesel Exhaust Exposure Facility

Exposure Generation

- Goal:

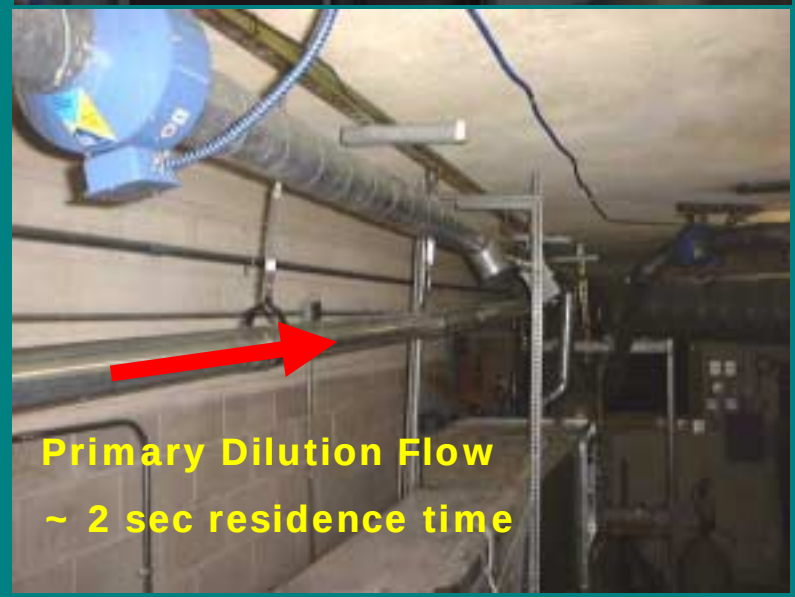
  mimic realistic exposures from contemporary on-road light heavy-duty diesel engines using the current fuel supply

www.amazing3d.com/_services/trkdlvh1.html

www.lkcinc.com/projects_managementreviews.html

Generation Method

- Rationale:
  - Laboratory generation, formation, and dilution needs to be comparable to real-world conditions
- Diesel engine and load bank at 75%
- Two-stage dilution and mixing
- Feedback control for stability of selected concentration



Typical Diesel Exhaust Profile

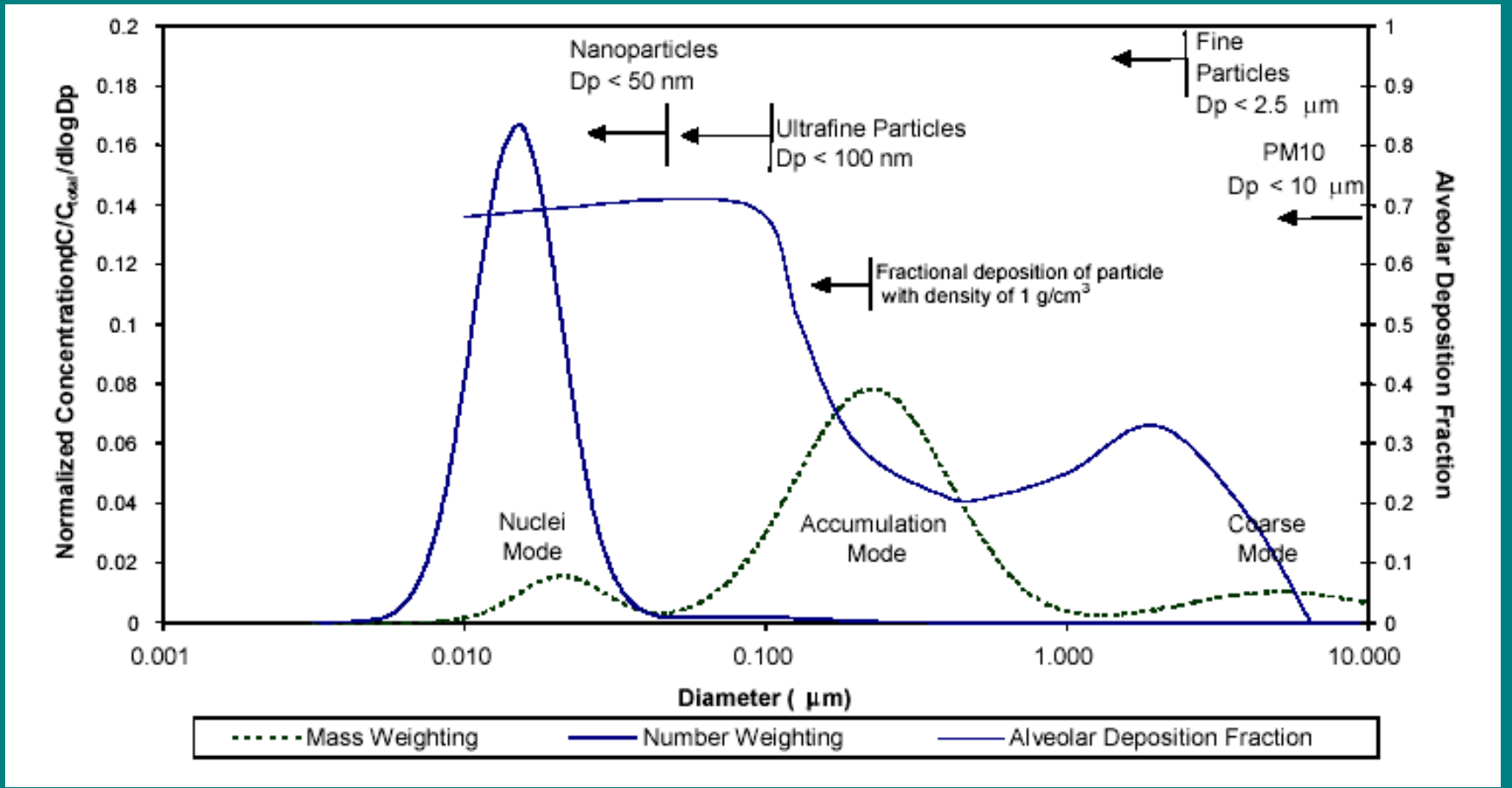
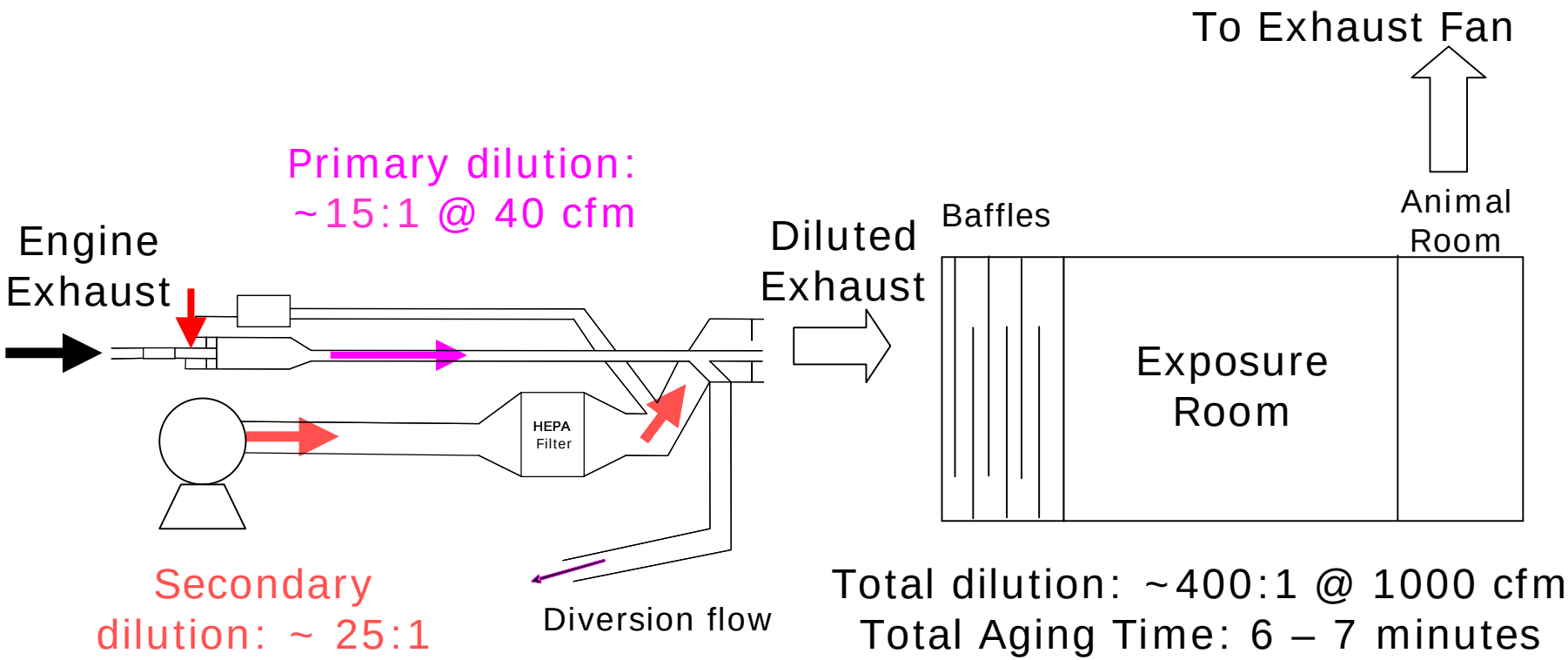


Figure 2. Typical diesel engine exhaust mass and number weighted size distributions shown with alveolar deposition

Kittelson, Fine Particle (Nanoparticle) Emissions On Minnesota Highways
http://www.lrrb.gen.mn.us/PDF/200112.pdf

Dilution and Layout Schematic



cfm= cubic feet per minute

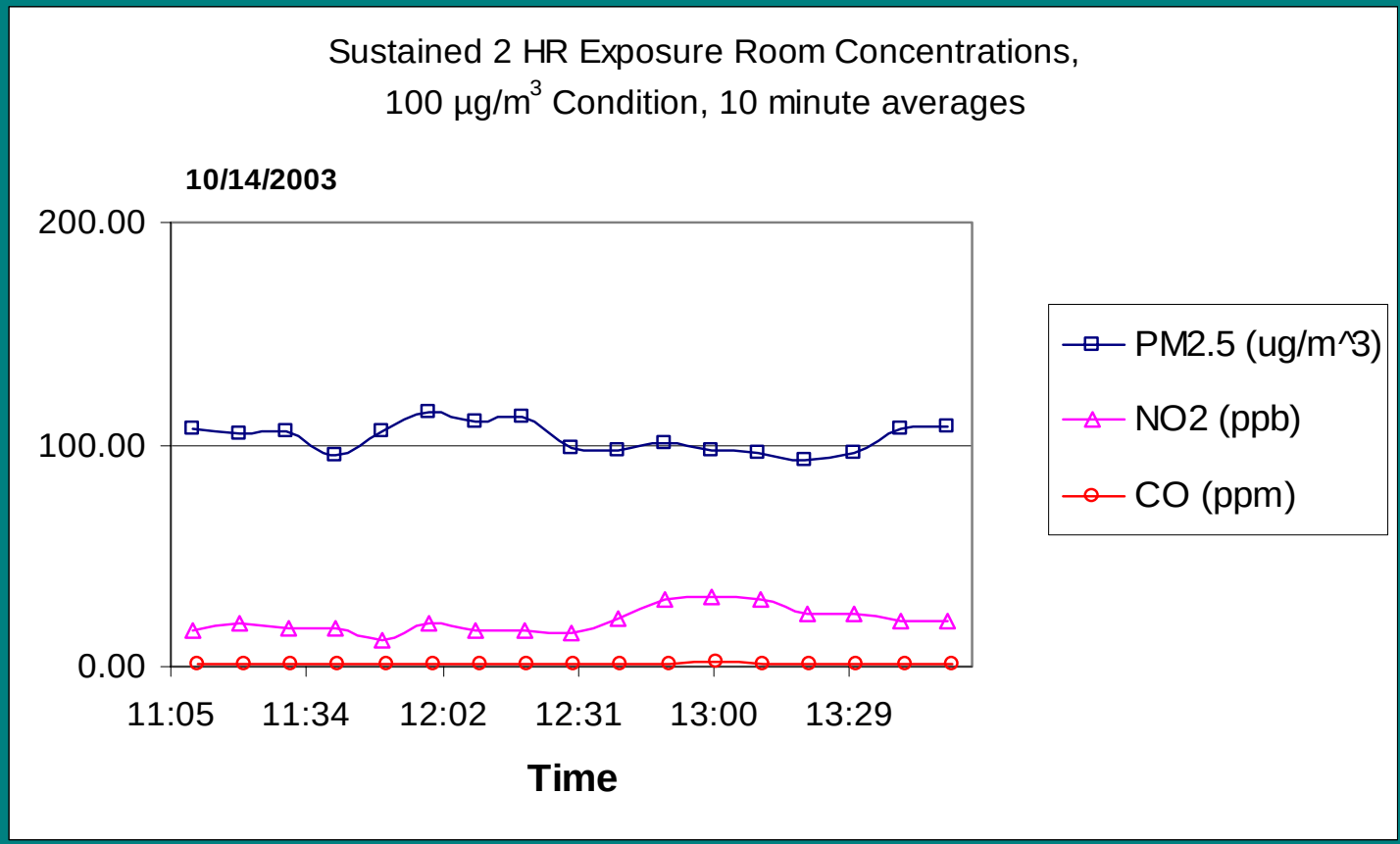

Room dimensions 24’x18’x8’

Exposure Characterization

Continuous Measurements during a diesel exposure session

Parameter	'Low' Exposure	'High' Exposure	Instrument Info.
$PM_{2.5}$ (mg/m3)	50	200	**TEOM** Rupprecht & Patashnick Model 1400a
NO_2 (ppb)	10	35	**$NO/NO_2/NO_x$ Analyzer** Thermo Environmental Instruments Model 42
CO (ppm)	0.7	1.8	**CO Analyzer** Lear Siegler 9830
Particle number > 20 nm (cm^{-3})	6×10^4	2.6×10^5	**CPC** TSI 3025 Condensation Particle Counter
Particle number > 100 nm (cm^{-3})	1.5×10^4	4.6×10^4	**CPC** TSI 3010 Condensation Particle Counter
bsp (m^{-1})	8×10^{-5}	3.3×10^{-4}	**Nephelometer** Radiance Research Integrating Model M903
PAH surrogate (m^{-1})	1.1×10^{-4}	4.7×10^{-4}	**PSAP** Radiance Research Particle Black Soot/Absorption Photometer

Stable Exposures Generated



Objectives - Human Health Outcomes

Exploring potential underlying mechanisms of toxicity in humans

- Is diesel exhaust particulate:
  - related to endothelial dysfunction by a concentration gradient ? (Expt 1)
  - associated with systemic oxidative stress? (Expt 2)
- Can antioxidant supplementation modulate health effects of DE? (Expt 3)

Human Studies Experiment Timeline

- Pilot Feasibility Study
  - Exposures completed 7/2004
- Experiment 1
  - begin 9/2004
- Experiment 2
  - begin 1/2005
- Experiment 3
  - begin 9/2005

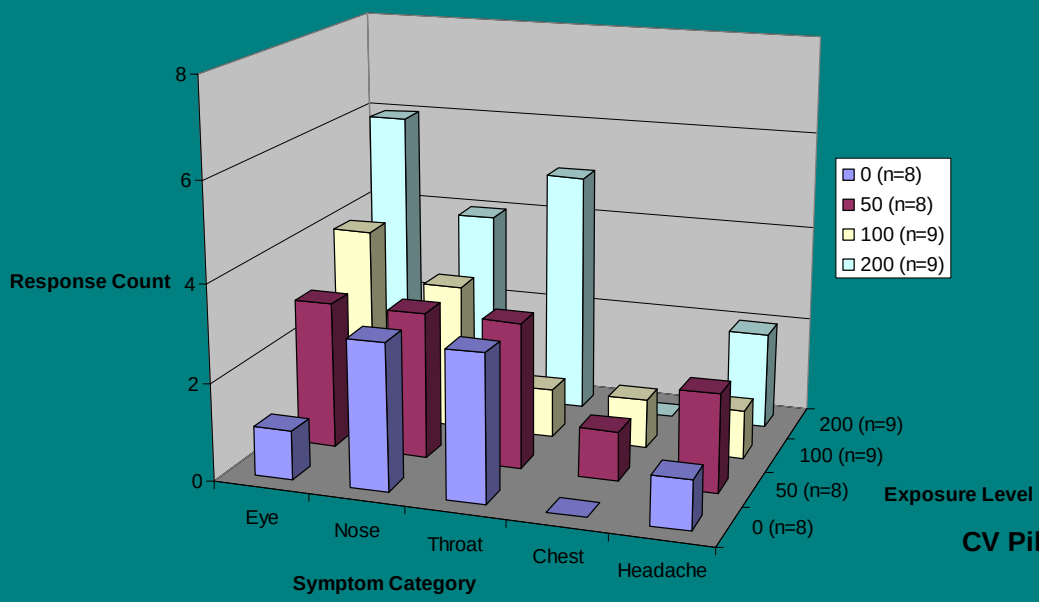
Human Studies Key Outcomes

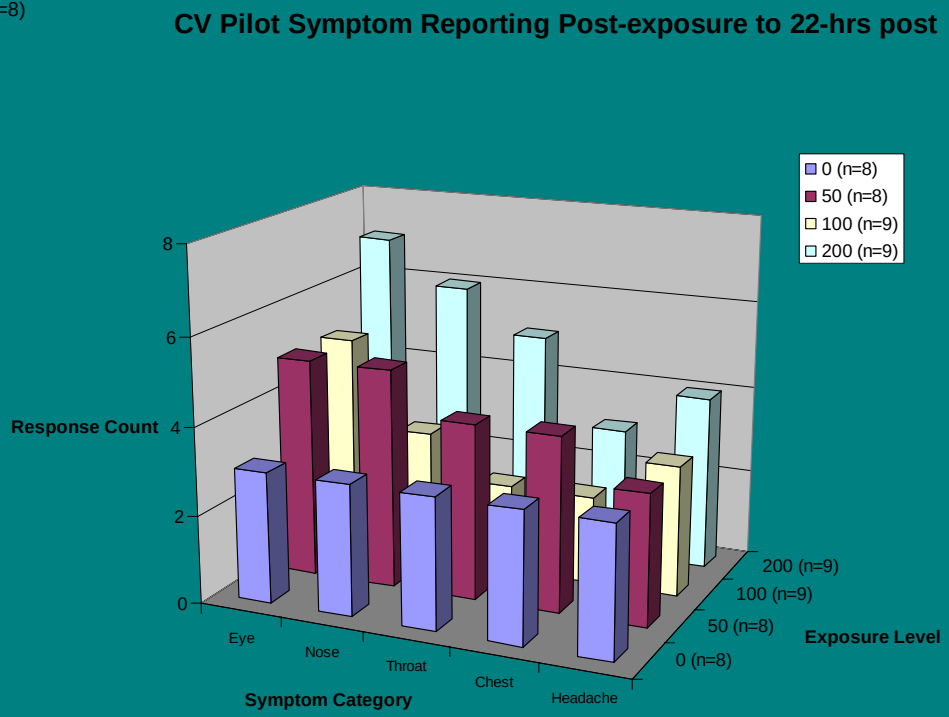
- **Pilot Study**: 9 healthy, non-smoking subjects, 18-49 yrs old; 4 exposure levels (0, 50, 100, 200 ug/m^3)
  - *Tolerability, blinding of exposure levels
  - *Symptoms
  - Microarray studies of gene expression in peripheral blood mononuclear cells
- **Ongoing Studies**:
  - Plasma markers of inflammation, oxidative stress, thrombosis, endothelial function
  - Flow-mediated dilation (FMD) of the brachial artery
  - Exhaled nitric oxide

Pilot Study Results
Perception of Exposure

Perceived Exposure	True Exposure	
	Diesel	Clean Air
Yes	22	4
No	4	4

Pilot Study Results
Symptoms





Diesel Exposure Facility: Proposed Studies

- Human studies in susceptible populations
  - metabolic syndrome (moderate obesity; elevated blood lipids, blood pressure, blood glucose)
  - asthma
- Mouse studies
- Particle-only studies
- Gas denuder studies

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