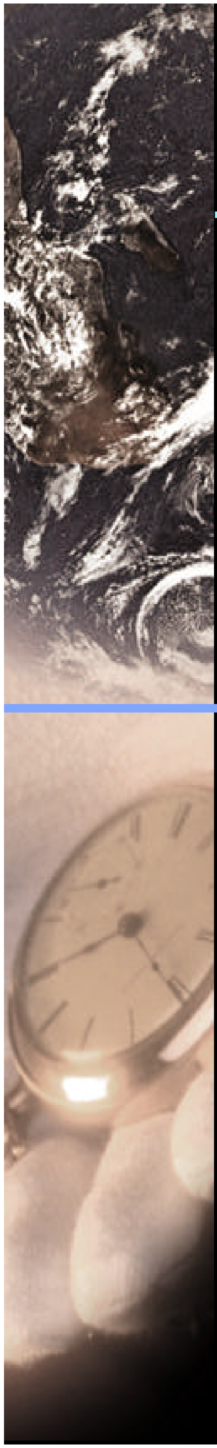


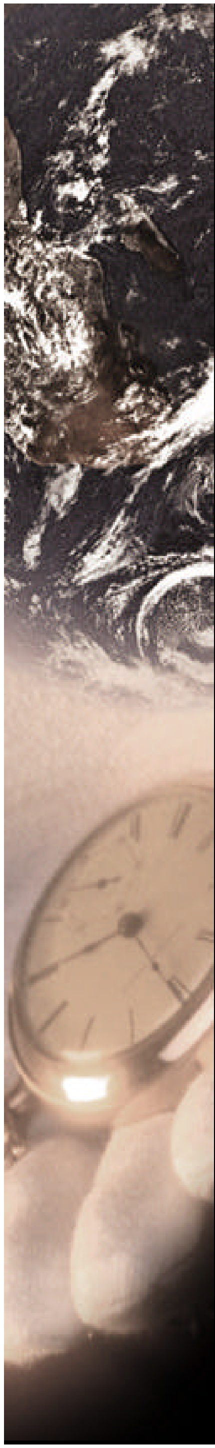
OTT
Office of Heavy Vehicle Technologies

The Environmental Safety & Health Program

Doug Lawson

March 17, 1999
Washington, D.C.

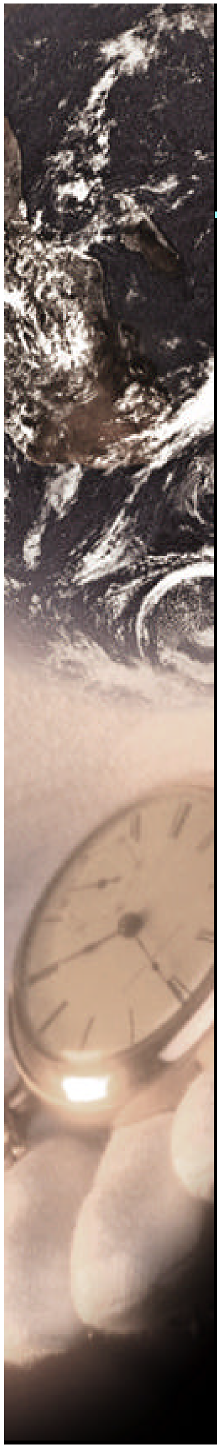
Environmental Safety & Health Program



PROGRAM MANAGER:
Michael Gurevich

Issues

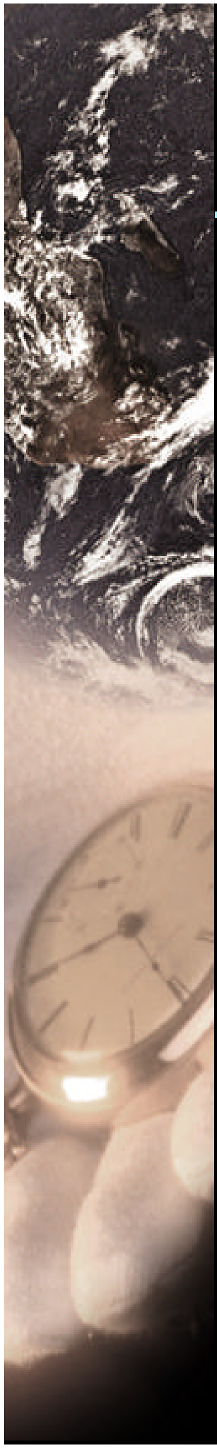
- ozone
- particles
- air toxics
- health effects



Environmental Safety & Health Program

PROGRAM GOAL

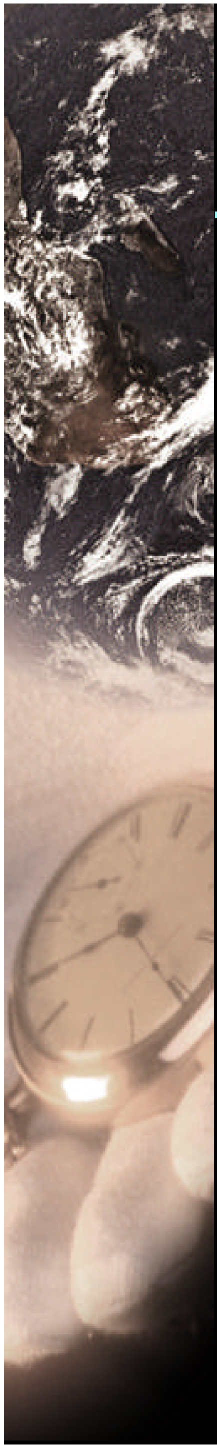
Understand atmospheric impacts and potential health effects that may be caused by the use of petroleum-based fuels and alternative transportation fuels from mobile sources.



Environmental Safety & Health Program

Performance Objectives

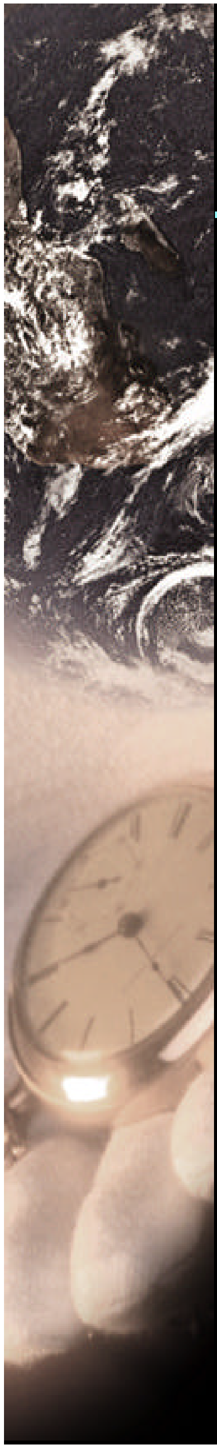
- Evaluate emissions from new and in-use vehicle technologies and fuels
- Determine impact of vehicle technologies and fuels on the atmosphere
- Determine the effects of technologies and fuels on health
- Communicate with other OHVT teams regarding findings and research needs on atmospheric impacts and health effects



Environmental Safety & Health Program

<u>Two Major Programs – Status Report</u>

- CRC E-43 Study with University of Minnesota
- Comparative Toxicity Study with Desert Research Institute, Southwest Research Institute, and Lovelace Respiratory Research Institute

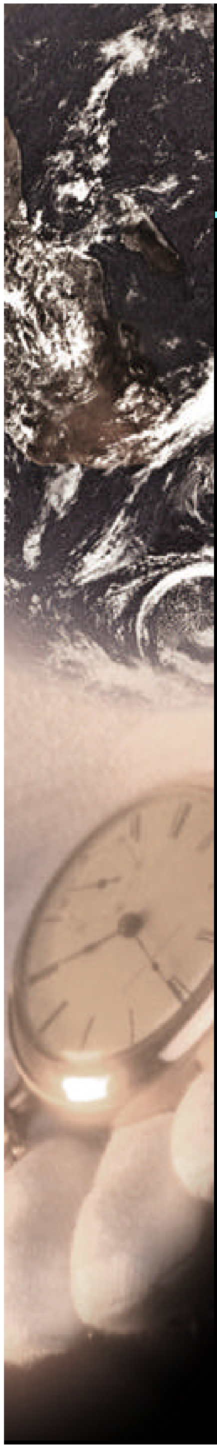


Diesel Aerosol Sampling Methodology
CRC Project E-43 – FY 99 Funds

- Program started September 1998
- $1.5MM project funded by DOE through NREL ($850K), CRC, AAM, API, EMA, SCAQMD
- In-kind contributions ($435K estimate) from Caterpillar and Cummins
- Investigators are University of Minnesota, West Virginia University, Carnegie Mellon University, and Paul Scherrer Institute (Switzerland)

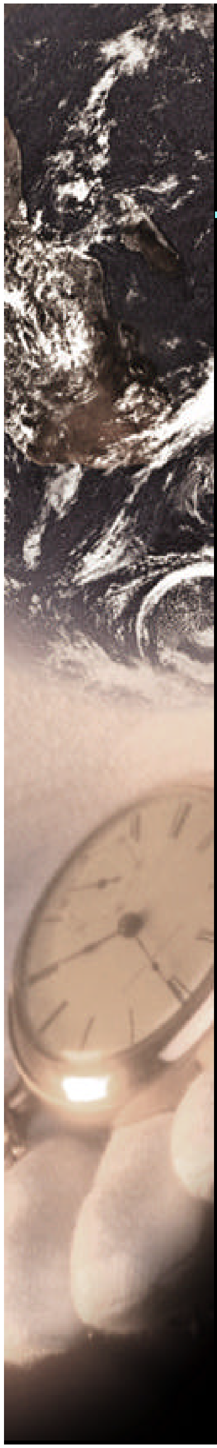
Diesel Aerosol Sampling Methodology
CRC Project E-43 – Progress Report

- Sampling equipment has been purchased: photoelectric aerosol sensor; diffusion charger, thermodenuder
- Cargo container for mounting on Volvo truck was received
- Contract to lease ELPI from Tampere University (Finland) was signed; contract signed with Carnegie Mellon for modeling task
- Planning meeting held at Cummins for testing program this summer



Comparative Toxicity Study

- NREL issued RFP on Exhaust Emissions Collection for Comparative Toxicity Testing in August 1998
- Completed peer review on three bids received in response to RFP
- NREL has negotiated contracts with DRI and SwRI team
- 2 Phases for collection of gas and diesel exhaust
  - Dynamometer testing to acquire 2 gr PM and associated semi-volatile compounds
  - Tunnel study testing to acquire 2 gr PM and associated semi-volatile compounds
- 14 samples will be selected by NREL and sent "blind" to Lovelace for comparative toxicity testing between gas and diesel emissions



Exhaust Samples for Comparative Toxicity Testing

- **Dynamometer Samples at 72 °F (PM and SVOC):**

  1) Ave. gasoline emitters
  2) High PM gasoline emitters
  3) Smoker gasoline emitter(s)
  4) Current technology diesel emitters
  5) High PM diesel emitters

- **Dynamometer Samples at 72 °F (SVOC only):**

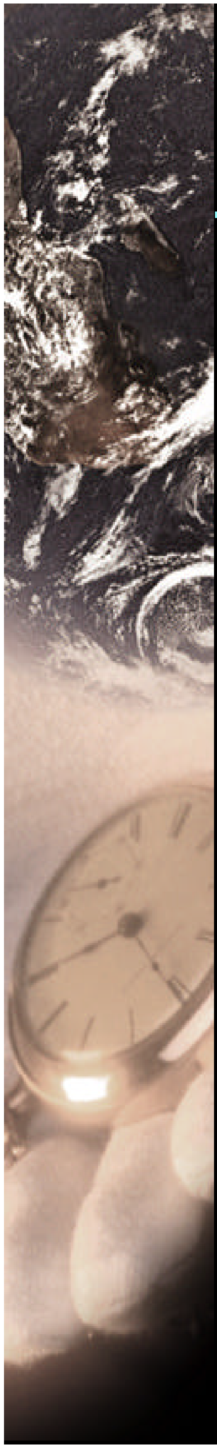
  6) Ave. gasoline emitters (same as 1)
  7) Current technology diesel emitters (same as 4)

- **Dynamometer Samples at 30 °F (PM and SVOC):**

  8) Ave. gasoline emitters
  9) Current technology diesel emitters

- **Samples from Fort McHenry Tunnel (PM and SVOC):**

  1) "Diesel" fleet sample plus "background" sample
  2) "Gasoline" fleet sample plus "background" sample



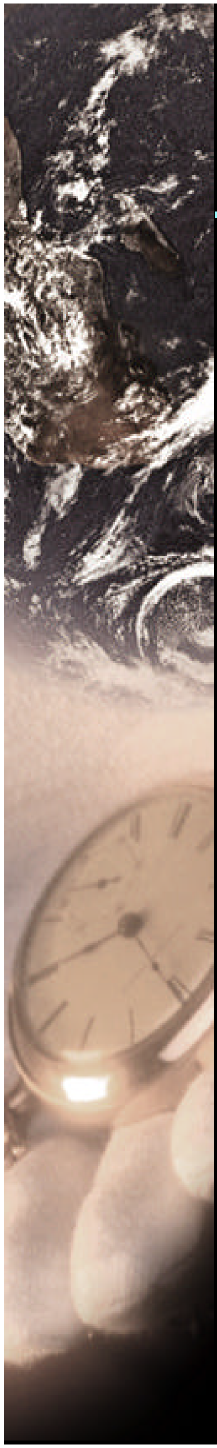
Exhaust Samples for Comparative Toxicity Testing

<u>14 samples (9-10 from dynamometer and 4-5 from tunnel):</u>

- Will be analyzed at DRI for mass, TC, EC, OC, elements by XRF, sulfate, nitrate, and ammonium ions plus organic speciation for PAH, hopanes, steranes, nitro-PAH, and oxy-PAH
- Will be sent to Lovelace Respiratory Research Institute for comparative toxicity testing

<u>Composited fuel and lube oil samples from vehicles</u>

- Composited fuel and lube oil from vehicles tested on the dynamometer will be chemically analyzed using standard methods and methods used for ambient measurements



Comparative Toxicity Testing at Lovelace Respiratory Research Institute

Three types of testing for comparing gasoline and diesel exhaust:

***In Vitro* (cell culture) testing:**

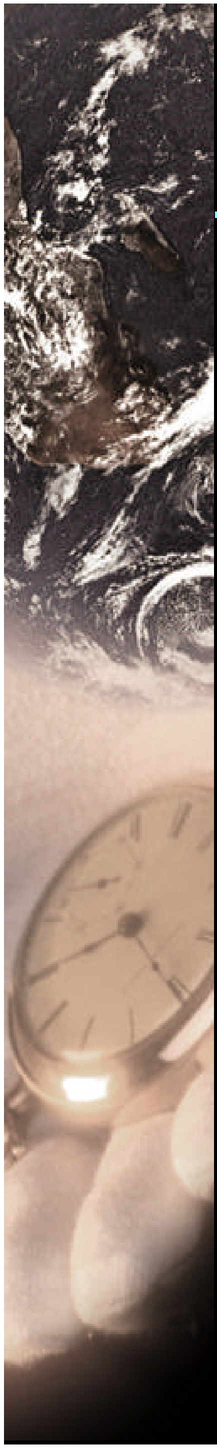
- Will use the A549 human lung epithelial cell line. Responses of these cells to PM *in vitro* may reflect responses of lung cells of humans
- Cells and media will be harvested and analyzed for a variety of parameters, including protein synthesis

***In Vivo* (animal) testing:**

- Rats will be instilled intratracheally with exhaust sample; groups of 5 rats per dose will be killed at several times ranging from immediately to 4 weeks after instillation; lung lavage fluid, cells, and lung tissue will be analyzed for a variety of parameters such as cell counts and proteins

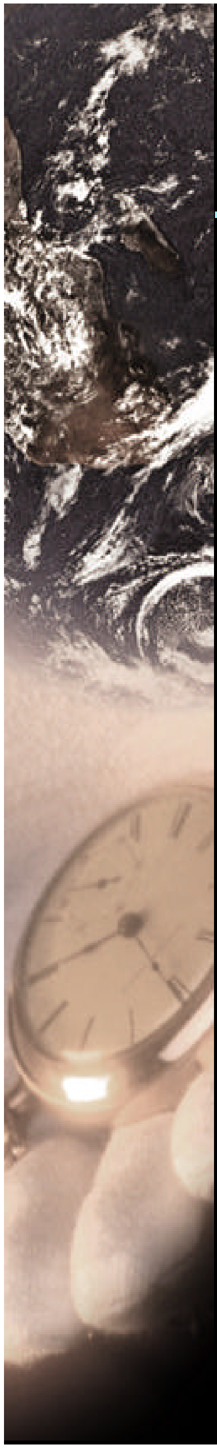
Ames Testing:

- Standard mutagenicity assay applied to PM and SVOC extracts; samples will be sent to outside laboratory



Comparative Toxicity Study – Update

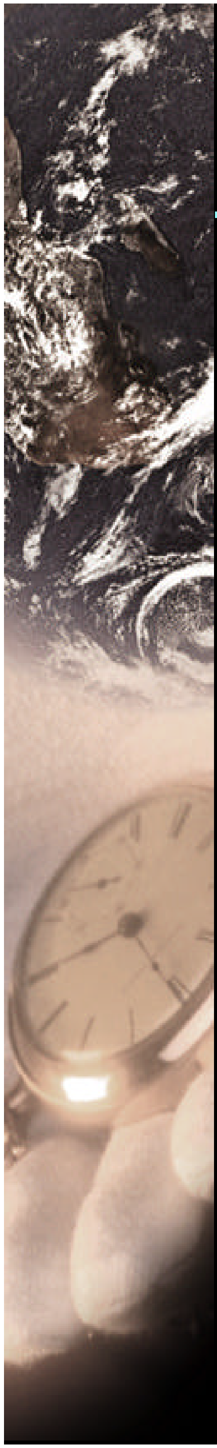
- Preliminary dyno PM exhaust sample was sent to DRI this week for extraction of PM from 20" x 20" filter
- Sample collected at SwRI from a 1968 Chevy run on two LA-92 cycles
- More than 3.5 grams were collected on filter
- Preliminary tunnel sample will be collected by DRI at the Fort McHenry tunnel around April 1



Environmental Safety & Health Program

New and Proposed Programs for FY99 Funding

- Enrollment in AEA Technologies Vehicle Particle Emissions Club
- Chemical measurement of $PM_{2.5}$ emissions from in-use vehicles in North Carolina
- Augmentation of U MN Diesel Aerosol Sampling Methodology Study to measure PM size and chemistry from SI vehicles (meeting yesterday)
- New weekday/weekend O_3/Mobile Source NO_x/PM inventory study

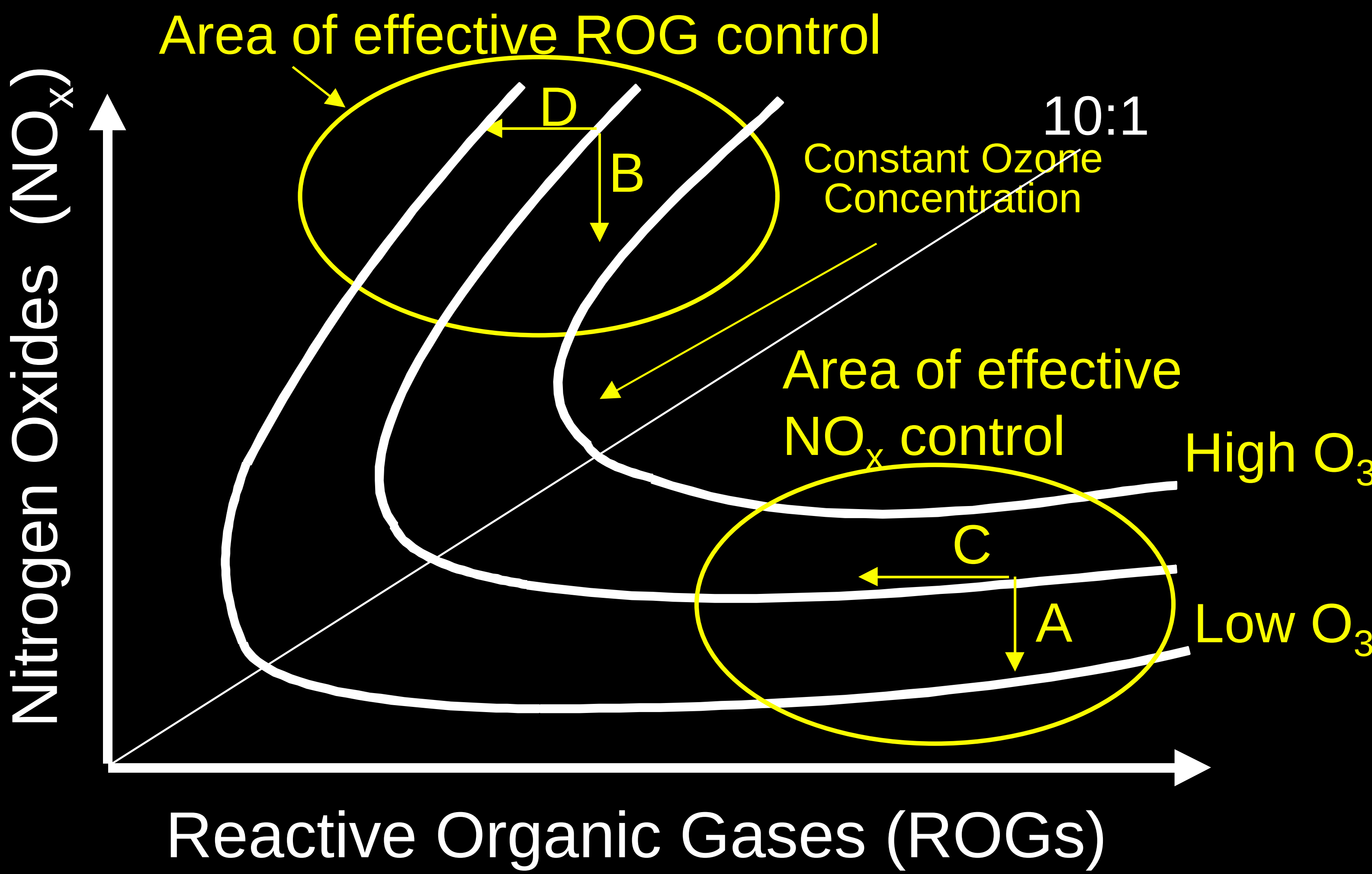


Weekday/Weekend O_3/Mobile Source NO_x/PM Study

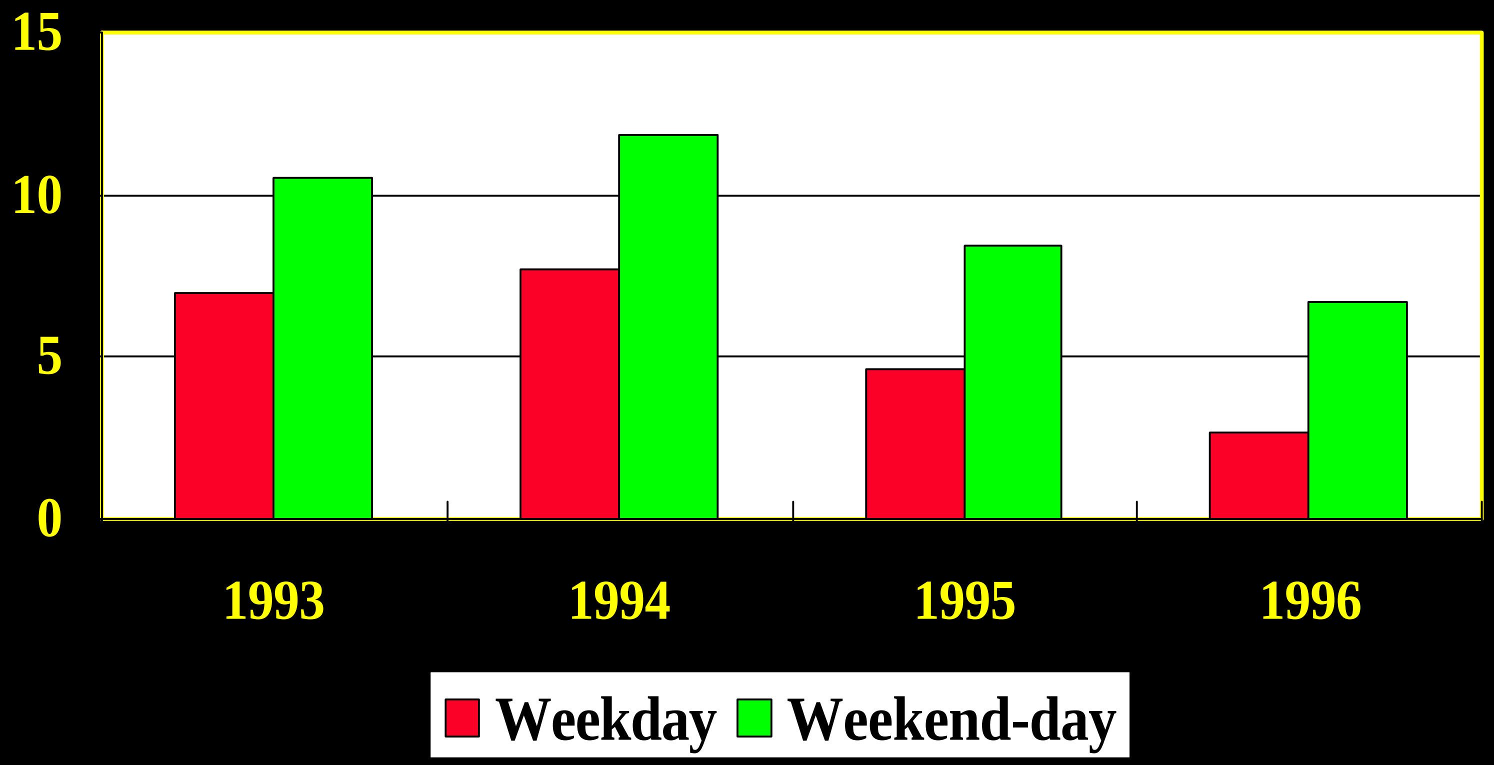
Why?

- EPA's new ozone standard means more parts of the country will be in nonattainment
- Heavy-duty vehicles are a significant source of NO_x, a precursor of ozone
- The $NO_x/HC/O_3$ system is nonlinear
- NFRAQS HD emissions results show that HD contributions to emission inventory are uncertain
- Ozone has higher concentrations on weekdays than weekends in California

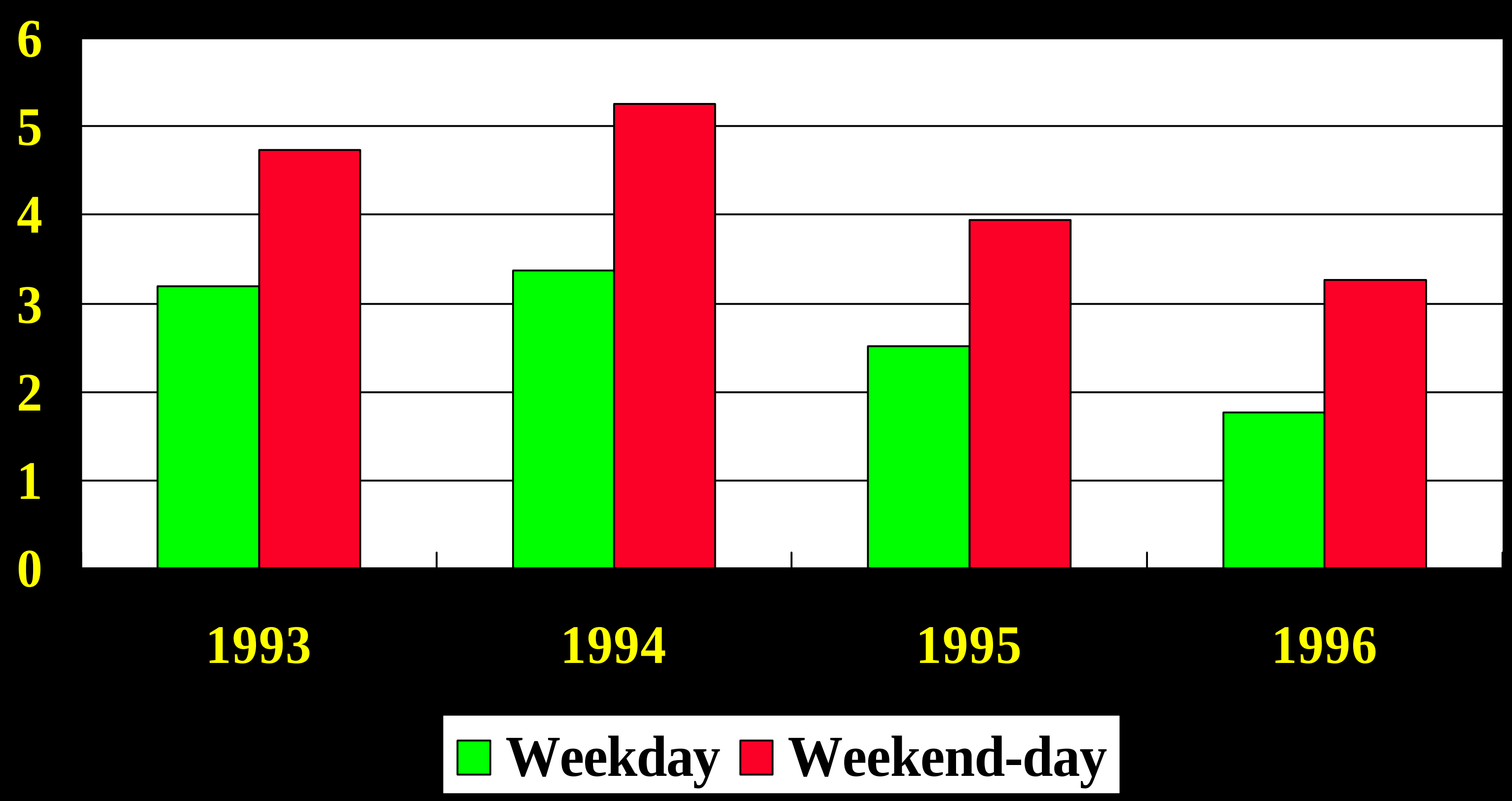
Ozone Isopleth

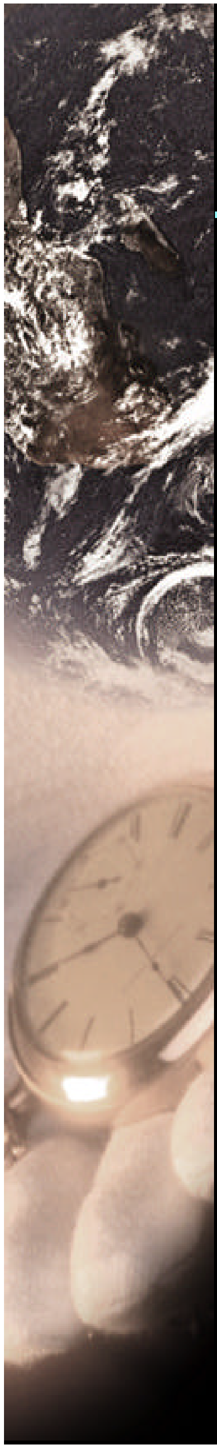


South Coast Air Basin Station-Hours per Day Above 1-Hr Ozone Standard



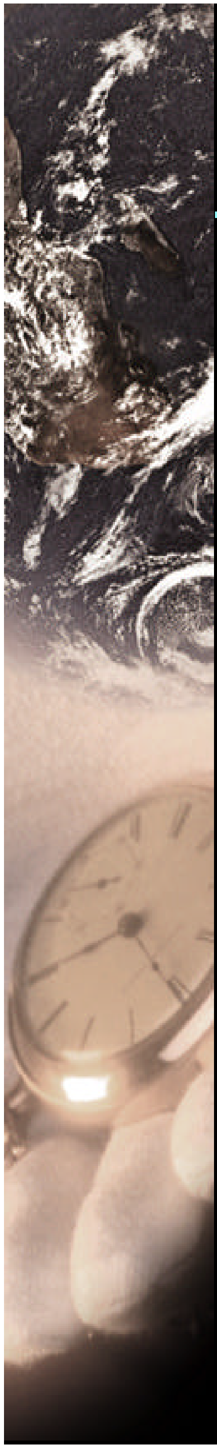
South Coast Air Basin Station-Hours per Day Above 8-Hr Ozone Standard



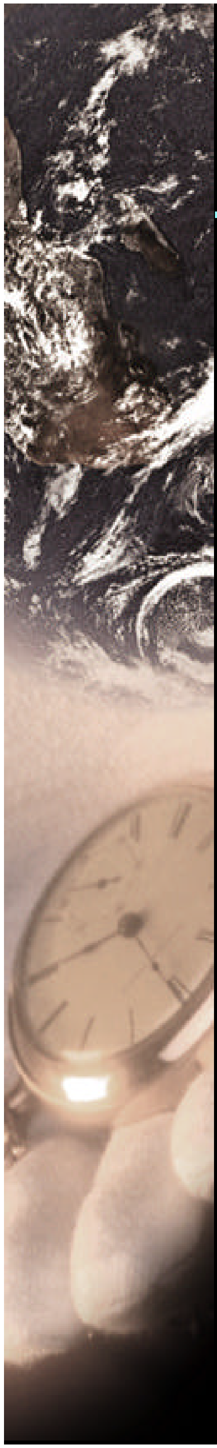


Weekday/Weekend O_3/Mobile Source NO_x/PM Study

- Program is in planning stages
- Funding will be provided by NREL, CRC, and possibly others
- March 24 meeting at CARB with NREL, CARB, CRC, and SCAQMD
- Possible merging of new CRC projects A-36 and E-53, with NREL funds over at least one and up to three FYs support
- Want to issue RFP late this spring



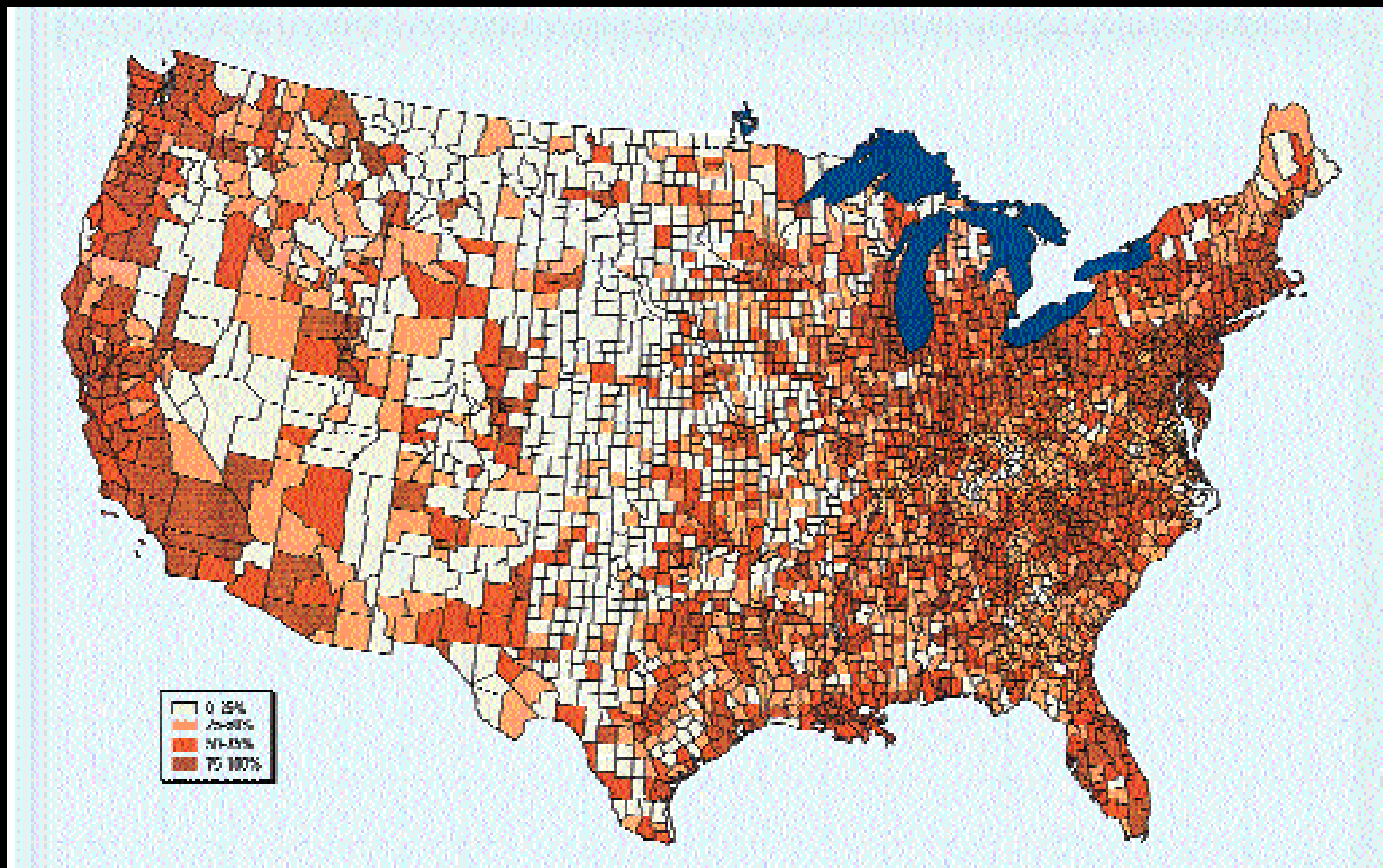
New Area of Focus:
Air Toxics (HAPs)

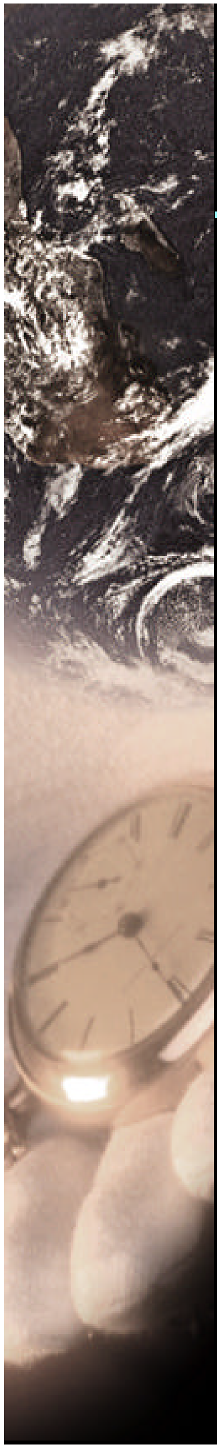


EPA's Cumulative Exposure Project and HAPs

- Under the 1990 Clean Air Act, EPA has issued standards that are to reduce air toxics (HAPs) emissions by over 10^6 tons/year
- EPA performed Cumulative Exposure Project
- Used $1/10^6$ excess risk of cancer ($1/10^6$ would contract cancer if exposed continuously for 70 yr)
- 56 HAPs estimated to have $>1/10^6$ cancer risk in at least once census tract
- HAPs with highest modeled concentrations are toluene, xylene, methyl chloroform, benzene, formaldehyde, methyl chloride, carbonyl sulfide, hydrochloric acid, methanol

Distribution of Total Modeled Air Toxic Concentrations by County in the US in 1990, (in quartiles) – Woodruff *et al*. 1998.

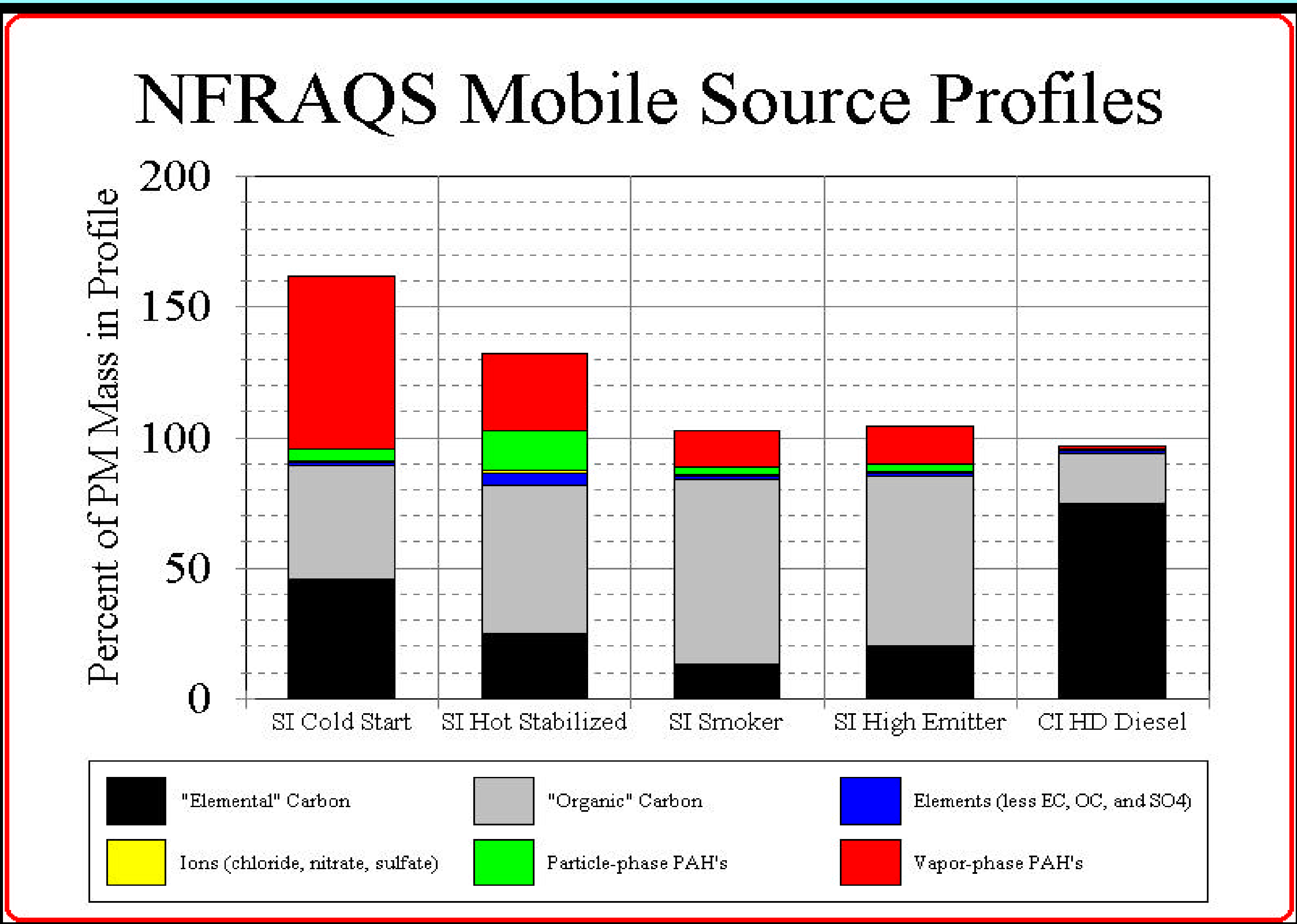


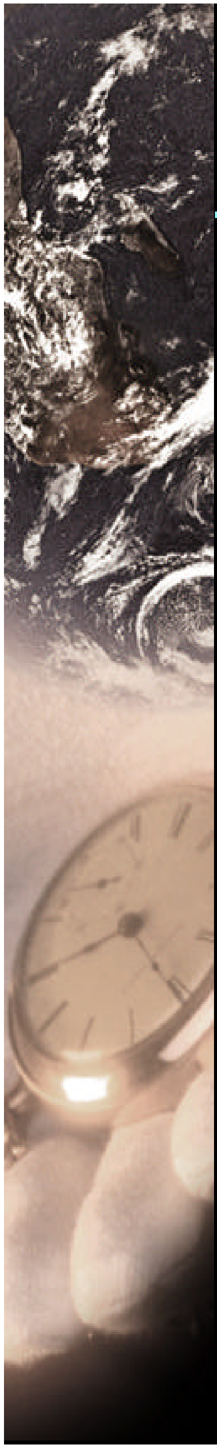


EPA's Hazardous Air Pollutants List (188 "Air Toxics" – Mobile/Fuel Species in Red)

Acetaldehyde	Diazomethane	Hydrochloric acid	Quinoline
Acetamide	Dibenzofurans	Hydrogen fluoride	Quinone
Acetonitrile	1,2-Dibromo-3-chloropropane	Hydrogen sulfide	Styrene
Acetophenone	Dibutylphthalate	Hydroquinone	Styrene oxide
2-Acetylaminofluorene	1,4-Dichlorobenzene(p)	Isophorone	2,3,7,8-Tetrachlorodibenzo-p-dioxin
Acrolein	3,3-Dichlorobenzidene	Lindane (all isomers)	1,1,2,2-Tetrachloroethane
Acrylamide	Dichloroethyl ether	Maleic anhydride	Tetrachloroethylene
Acrylic acid	1,3-Dichloropropene	Methanol	Titanium tetrachloride
Acrylonitrile	Dichlorvos	Methoxychlor	Toluene
Allyl chloride	Diethanolamine	Methyl bromide	2,4-Toluene diamine
4-Aminobiphenyl	N,N-Diethyl aniline	Methyl chloride	2,4-Toluene diisocyanate
Aniline	Diethyl sulfate	Methyl chloroform	o-Toluidine
o-Anisidine	3,3-Dimethoxybenzidine	Methyl ethyl ketone	Toxaphene
Asbestos	Dimethyl aminoazobenzene	Methyl hydrazine	1,2,4-Trichlorobenzene
Benzene	3,3¬-Dimethyl benzidine	Methyl iodide	1,1,2-Trichloroethane
Benzidine	Dimethyl carbamoyl chloride	Methyl isobutyl ketone	Trichloroethylene
Benzotrichloride	Dimethyl formamide	Methyl isocyanate	2,4,5-Trichlorophenol
Benzyl chloride	1,1-Dimethyl hydrazine	Methyl methacrylate	2,4,6-Trichlorophenol
Biphenyl	Dimethyl phthalate	Methyl tert butyl ether	Triethylamine
Bis(2-ethylhexyl)phthalate	Dimethyl sulfate	4,4-Methylene bis(2-chloroaniline)	Trifluralin
Bis(chloromethyl)ether	4,6-Dinitro-o-cresol, and salts	Methylene chloride	2,2,4-Trimethylpentane
Bromoform	2,4-Dinitrophenol	Methylene diphenyl diisocyanate	Vinyl acetate
1,3-Butadiene	2,4-Dinitrotoluene	4,4¬-Methylenedianiline	Vinyl bromide
Calcium cyanamide	1,4-Dioxane	Naphthalene	Vinyl chloride
Caprolactam	1,2-Diphenylhydrazine	Nitrobenzene	Vinylidene chloride
Captan	Epichlorohydrin	4-Nitrobiphenyl	Xylenes
Carbaryl	1,2-Epoxybutane	4-Nitrophenol	o-Xylenes
Carbon disulfide	Ethyl acrylate	2-Nitropropane	m-Xylenes
Carbon tetrachloride	Ethyl benzene	N-Nitroso-N-methylurea	p-Xylenes
Carbonyl sulfide	Ethyl carbamate (Urethane)	N-Nitrosodimethylamine	Antimony Compounds
Catechol	Ethyl chloride (Chloroethane)	N-Nitrosomorpholine	Arsenic Compounds
Chloramben	Ethylene dibromide	Parathion	Beryllium Compounds
Chlordane	Ethylene dichloride	Pentachloronitrobenzene	Cadmium Compounds
Chlorine	Ethylene glycol	Pentachlorophenol	Chromium Compounds
Chloroacetic acid	Ethylene imine (Aziridine)	Phenol	Cobalt Compounds
2-Chloroacetophenone	Ethylene oxide	p-Phenylenediamine	Coke Oven Emissions
Chlorobenzene	Ethylene thiourea	Phosgene	Cyanide Compounds
Chlorobenzilate	Ethylidene dichloride	Phosphine	Glycol ethers
Chloroform	Formaldehyde	Phosphorus	Lead Compounds
Chloromethyl methyl ether	Heptachlor	Phthalic anhydride	Manganese Compounds
Chloroprene	Hexachlorobenzene	Polychlorinated biphenyls	Mercury Compounds
Cresols/Cresylic acid	Hexachlorobutadiene	1,3-Propane sultone	Fine mineral fibers
o-Cresol	Hexachlorocyclopentadiene	beta-Propiolactone	Nickel Compounds
m-Cresol	Hexachloroethane	Propionaldehyde	Polycylic Organic Matter
p-Cresol	Hexamethylene-1,6-diisocyanate	Propoxur (Baygon)	Radionuclides (including radon)
Cumene	Hexamethylphosphoramide	Propylene dichloride	Selenium Compounds
2,4-D, salts and esters	Hexane	Propylene oxide	
DDE	Hydrazine	1,2-Propylenimine	

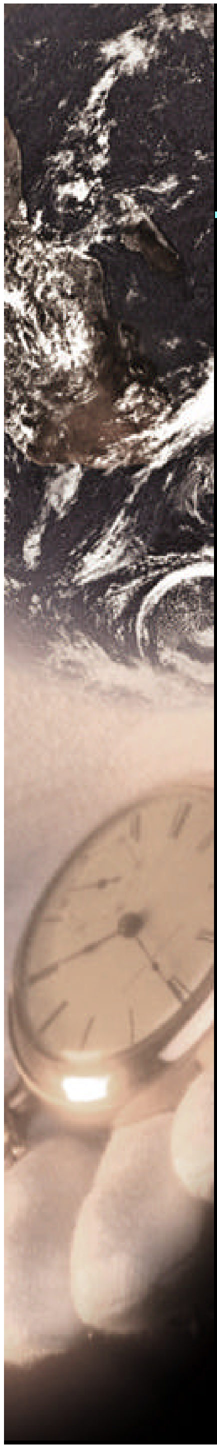
Mobile Source Profiles Used in Receptor Modeling by Composition Class





NFRAQS Observations and Future Work

- Hot stabilized, normal SI vehicles have little PM emissions
- Cold start SI vehicles have ~50/50 split between EC and OC. What fraction is fuel and what is from lube oil?
- Smoking and high emitter SI vehicles have large OC/EC ratio; presumably from lube oil.
- Questions/recommendations:
  - Can lube oil retain its current properties and be made "ashless"?
  - If lube oil is 1.5% S, and lube oil consumption is 0.2% of fuel consumption, then S from lube oil is equivalent to 30 ppm in fuel.
  - Chlorine may need to be removed because of dioxin considerations.



Environmental Health & Safety Program

Summary

- New ES&H programs are focus of much national interest
- The focus of these programs is to address policy-relevant regulatory issues
- We are coordinating OHVT's ES&H Program with other interested sponsors