

Health Impacts Program

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(Agreement No. 15071)

2008 Merit Review Meeting
Health Impacts Activity
February 26, 2008

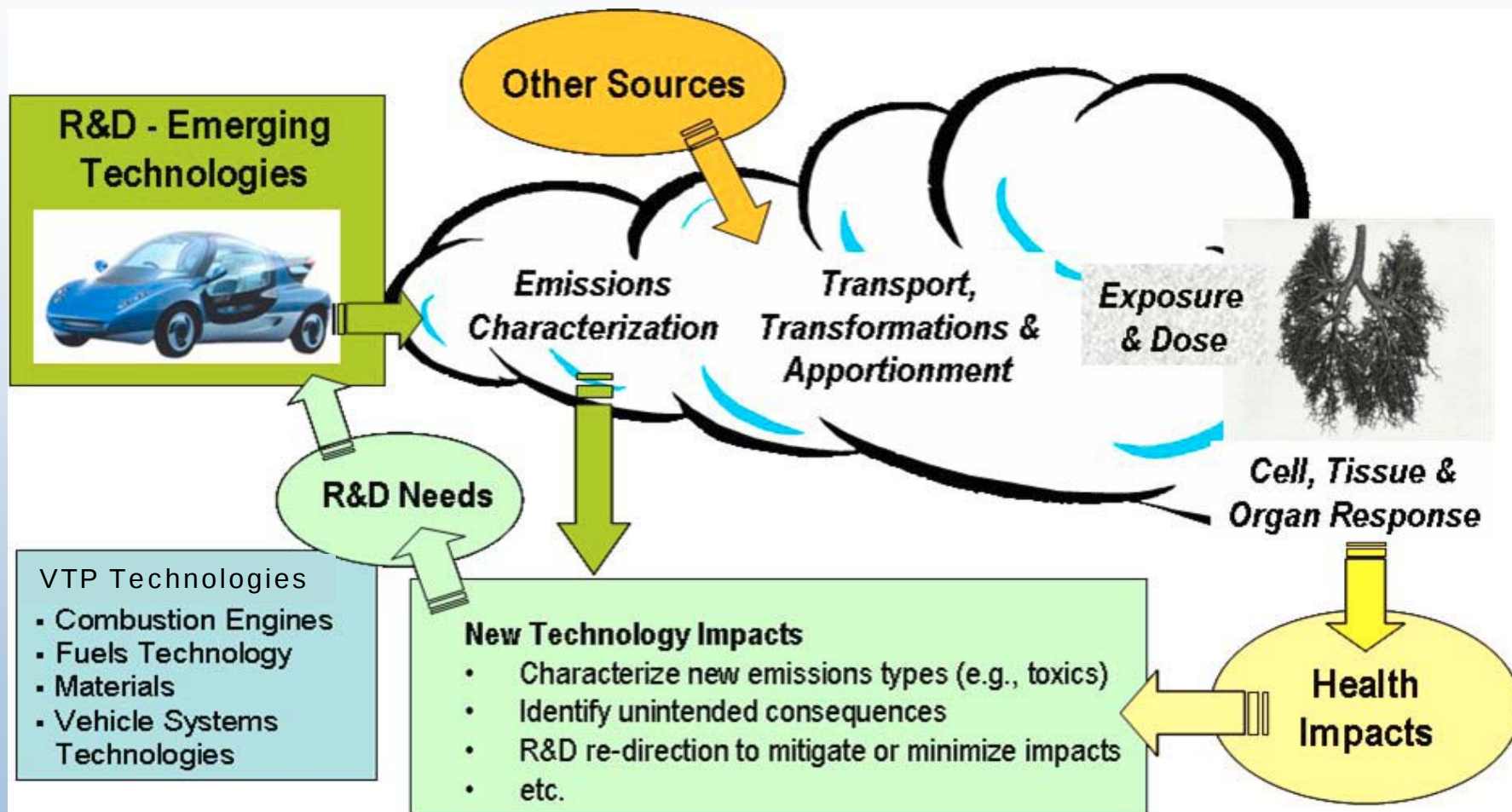
Dr. James Eberhardt, Program Manager

“This presentation does not contain any proprietary or confidential information”

OVT Health Impacts Program

- The goals of VT Health Impacts Program are:
 - To provide a sound scientific basis underlying any unanticipated potential health hazards associated with the use of new powertrain technologies, fuels and lubricants in transportation vehicles; and
 - To ensure that vehicle technologies being developed by VTP for commercialization by industry will not have adverse impacts on human health through exposure to toxic particles, gases, and other compounds generated by these new technologies.

Health Impacts Program



Health Impacts Overview

Motivation

- ✓ Energy-efficient and vehicle technologies coupled with new fuels and lubricants must minimize air quality and health risks associated with emissions

Project Objective

- ✓ Link emissions measured in laboratory setting to air quality impact, and thereby, health impact

Approach

- ✓ Measure regulated pollutants, Mobile Source Air Toxics (MSATs) and other unregulated emissions from advanced fuels, lubricants, and technologies in laboratory on chassis and engine dynamometers
- ✓ Conduct laboratory studies of relevant health outcomes
- ✓ Conduct field studies of in-use emissions to link laboratory data to real-world air quality impact

Technical Barriers to be Addressed

- ✓ Actual emissions data on pre-commercial and future combustion engines
- ✓ Credible, validated models for emissions source apportionment
- ✓ Information on health impacts of new fuel and lubricant formulations
- ✓ Public understanding/knowledge of potential health impacts of new vehicle technologies

Input from Last Year's Merit Review Meeting

Strengths

- ✓ “Useful counterpoint to non-scientific attacks on the industry.”
- ✓ “Emission control is done to improve health; this work is key.”
- ✓ “...the most noteworthy aspect of the program is the general strategy and decisions of OFCVT to face potential health impacts as a critical, strategic concern in new vehicle technology deployment...”

Weaknesses

- ✓ “It is always hard to connect such studies to real human health in the presence of all other pollution and risk sources.”
- ✓ Need to “evaluate emissions from SCR systems and new catalyst systems.”
- ✓ Would like to see more linkage with health-based studies.

NREL Activities (Agreement 15071)

Key Accomplishments During FY07

- ✓ Our most important product is peer-reviewed publications (not gray literature/conference presentations):
 - 2007 scorecard: 5 papers published; 2 in press; 5 papers submitted.
- ✓ Demonstrated from our collaborative Weekend Ozone studies that NO_x emission reductions **do not** reduce ambient ozone levels in U.S. metropolitan areas, and in many cases, exacerbate the ambient ozone problem. Submitted paper that evaluates the weekend ozone effect in 23 states having high ozone.
- ✓ Submitted four papers to *Environmental Science & Technology* describing that **crankcase oil-derived emissions** contribute disproportionately to school bus in-cabin exposures.
- ✓ Showed that gasoline engine PM is **as important as** diesel PM in many portions of the Los Angeles Air Basin, and that high-emitting vehicles (“smokers”) are the largest culprits. Published these results in four papers in the *Journal of the Air & Waste Management Association*.
- ✓ Provided **technical guidance/input** to design of the Advanced Collaborative Emissions Study (ACES).
- ✓ Invited presentation at National Academy of Sciences roundtable on the influence of oxygenated fuels on vehicle emissions.

Most Significant FY07/08 Projects

- Collaborative Study on Lubricating Oil Emissions (CLOSE) Project
- EAct Program – Collaborative \$6 million study with EPA testing 22 vehicles and nearly 30 fuels to evaluate the influence of varying fuel properties on LD vehicle exhaust emissions
- Follow-on weekday/weekend ozone analyses in two regions: LA Basin and downwind of Detroit (minor efforts)
- New mobile source organic carbon source apportionment data analysis project in the Midwest (cosponsored with LADCO, MARAMA, and CRC)

FY06/FY07/FY08 Project: Collaborative Lubricating Oil Study on Emissions (CLOSE)

Study Objective

Understanding the relative contributions of fuel and engine lubricating oil to motor vehicle particulate matter (PM) emissions through extensive chemical and physical characterization of emissions under a variety of engine operating conditions

Why are we doing this?

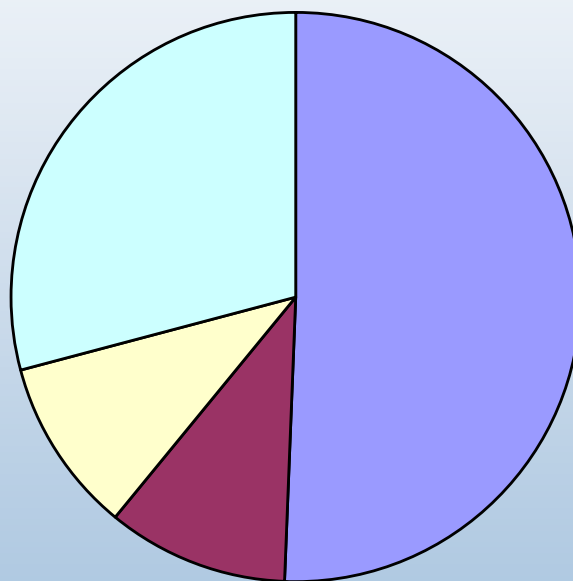
(We need to pass the “So What” Test)

- Source apportionment studies from past 10 years suggest that PM from gasoline engines in urban areas is generally a larger contributor to ambient PM than diesel engines
 - Denver area (1998, Fujita *et al.*, NFRAQS)
 - Phoenix area (2003, Lewis *et al.*, EPA)
 - Washington, DC (2004, Kim, Clarkson Univ.)
 - Los Angeles area (2007, Schauer, Fujita *et al.*)
 - Pittsburgh area (2007, Eatough *et al.* BYU)

CLOSE Financial Support

\$982,363 (thru 12/07)

Plus all fresh and aged lubricants provided by American Chemistry Council
PAPTG members



■ DOE/NREL ■ SCAQMD ■ CARB ■ CRC (AVFL-14)

Plus: Additional \$65,000 from DOE/NREL, CRC, and Lubrizol as of Jan. 2008

Test Matrix

Test Temperature	72°F (nominal)				20°F			
Test Lubricant	Fresh		Aged		Fresh		Aged	
Sample Number	1	2	1	2	1	2	1	2
LD gasoline (normal PM emitter)	✓	✓	✓	✓	✓	✓	✓	✓
LD gasoline (high PM emitter)	✓	✓	✓	✓	✓	✓	✓	✓
LD E10 (normal PM emitter)	✓	✓	✓	✓	✓	✓	✓	✓
LD E10 (high PM emitter)	✓	✓	✓	✓	✓	✓	✓	✓
MD diesel (normal PM emitter)	✓	✓	✓	✓	✓	✓	✓	✓
MD diesel (high PM emitter)	✓	✓	✓	✓	✓	✓	✓	✓
MD biodiesel (normal PM emitter)	✓	✓	✓	✓	✓	✓	✓	✓
MD biodiesel (high PM emitter)	✓	✓	✓	✓	✓	✓	✓	✓
HD CNG (normal PM emitter)	✓	✓	✓	✓				
HD CNG (high PM emitter)	✓	✓	✓	✓				
HD diesel (normal PM emitter)	✓	✓	✓	✓				
HD diesel (high PM emitter)	✓	✓	✓	✓				

Completed

Completed

LD Driving Cycle: California Unified Cycle (LA-92)

HD Driving Cycle: EPA HD Urban Dynamometer Driving Schedule (heavy duty chassis cycle)

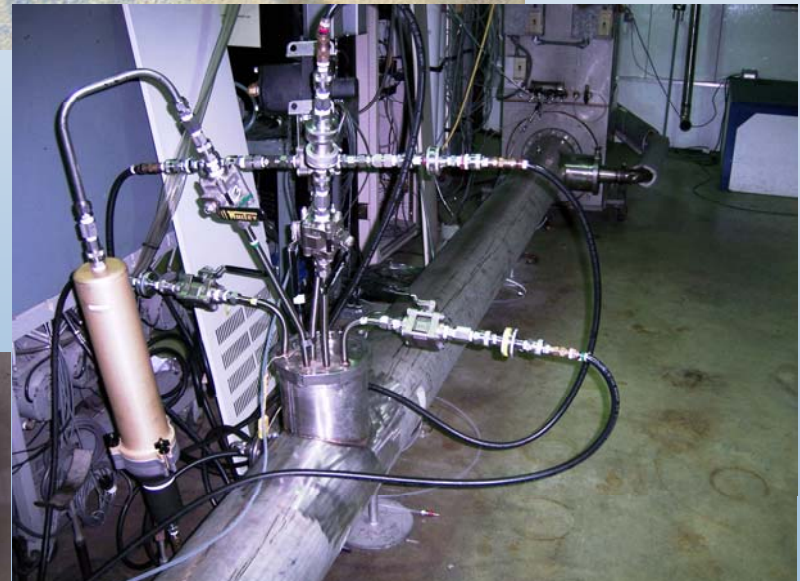
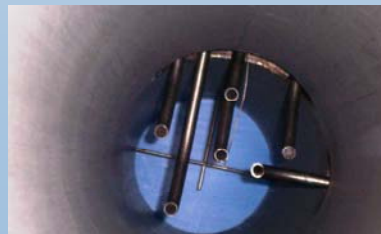
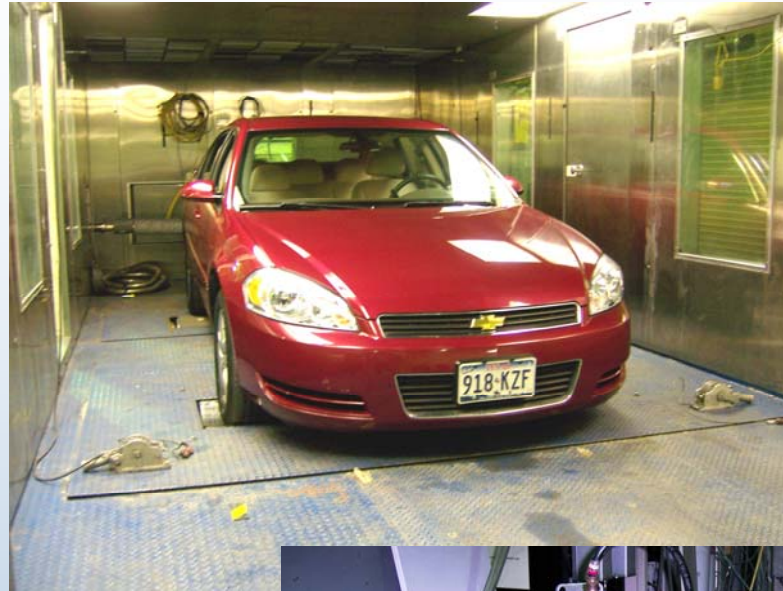
Test Oils for CLOSE Study – Oil Performance and Aging

- American Chemistry Council Petroleum Additives Product Approval Protocol Task Group (PAPTG) and Coordinating Research Council Lubricant Panel developed test oil matrix
- Lubricants supplied by ACC PAPTG members
- Each lubricant doped with $C_{36}D_{74}$ tracer to label lubricant contribution to emissions

	LD Gasoline / E10 Oil	MD Diesel / Biodiesel Oil	HD CNG Oil	HD Diesel Oil
Performance Level	APISM/ ILSAC GF-4	Cummins CES 20074/DDC 7SE272	API CJ-4/SM	API CJ-4
Viscosity Grade	5W20	15W40	15W40	15W40
How Aged Oil Is Generated	2.7 L to 4.6 L Detroit OEM vehicles with oil drain interval of 7.5K and 10K miles	CNG City Bus Service, ~ 60K mi/yr, 6K drain interval. Engines are DDC Series 50s and John Deere CNG	HD diesel line service running 50% of the time at 80,000 GVW. Drain interval is 25K mi. Engines are 2006 CAT C-15s and Cummins ISX	HD Mack Class 8 trucks over the road 80,000 GVW max. Drain intervals 20K- 30K mi.

LD Vehicle Testing

- LD normal emitter testing completed
 - 2006 Chevrolet Impala with 3.5L V6 engine
 - 30,695 miles on odometer
 - 5th highest passenger car sales in CY2006
 - Based on previous experience, expected PM emission rate > 0.6 mg/mi
- Performed follow-on testing with E0 at room temperature to check for vehicle and system drift; also collected ultrafine particles by size for chemical analysis



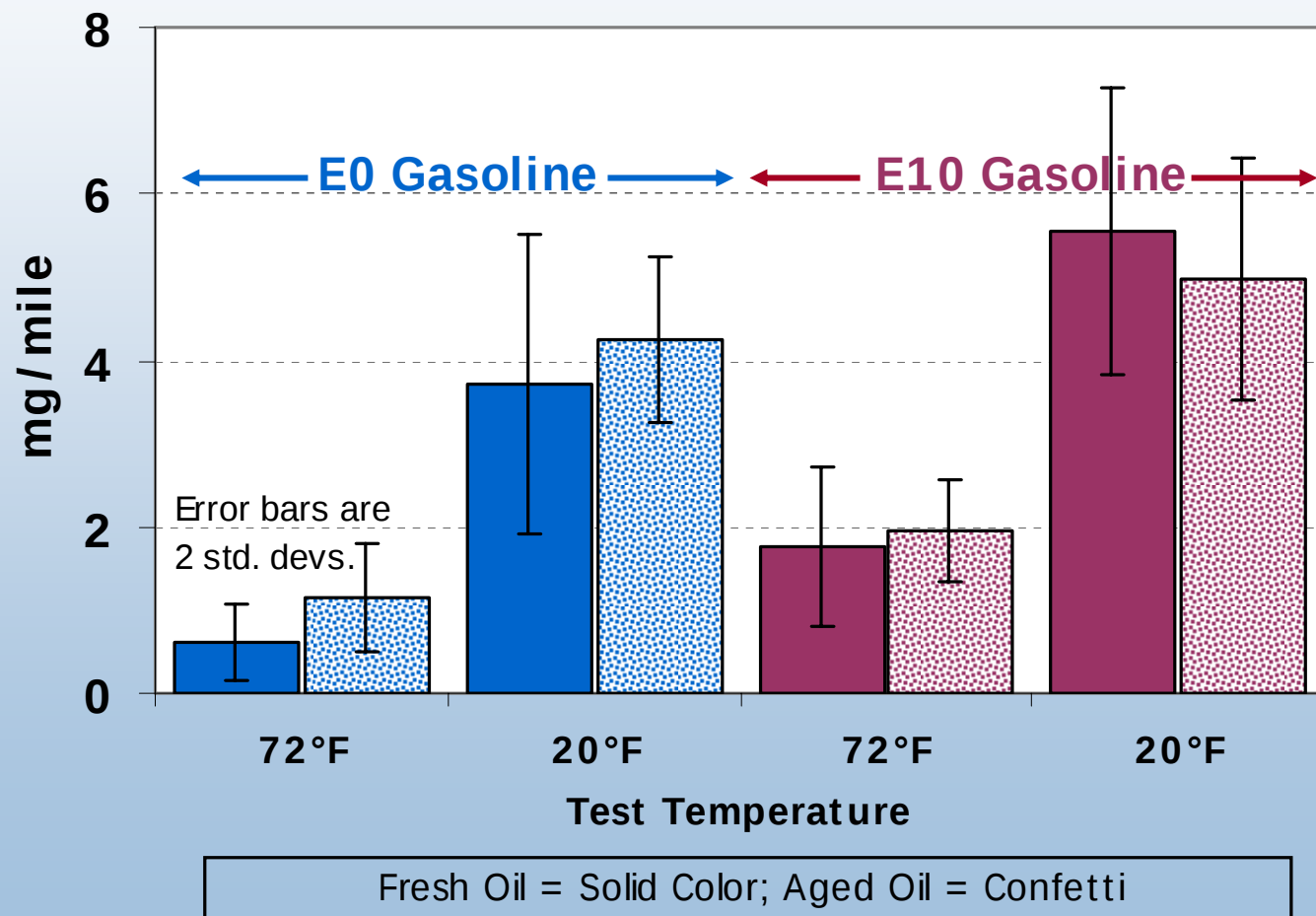
Preliminary Data/Testing in Progress

Data shown are for one vehicle only,
may change before final analyses, and
may not represent the fleet at large!

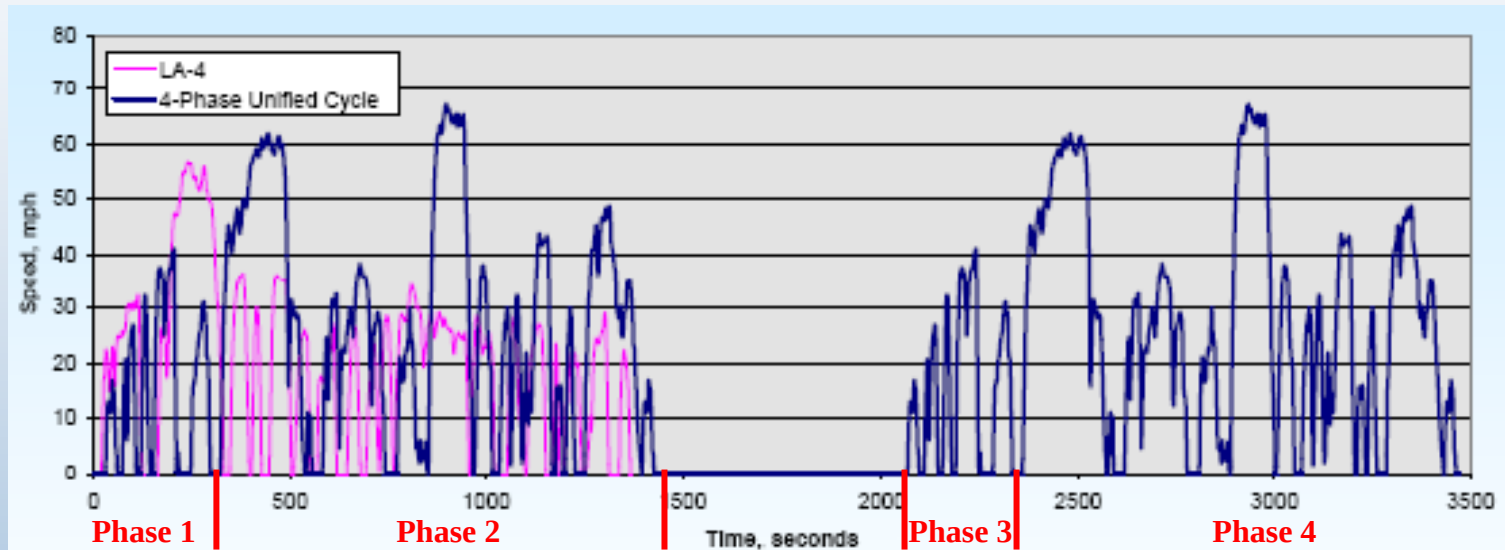


PM Emissions from “Normal” Gasoline LD Vehicle

Unified Driving Cycle (Ave. of 16 UDCs at 72°F and 4 UDCs at 20°F)

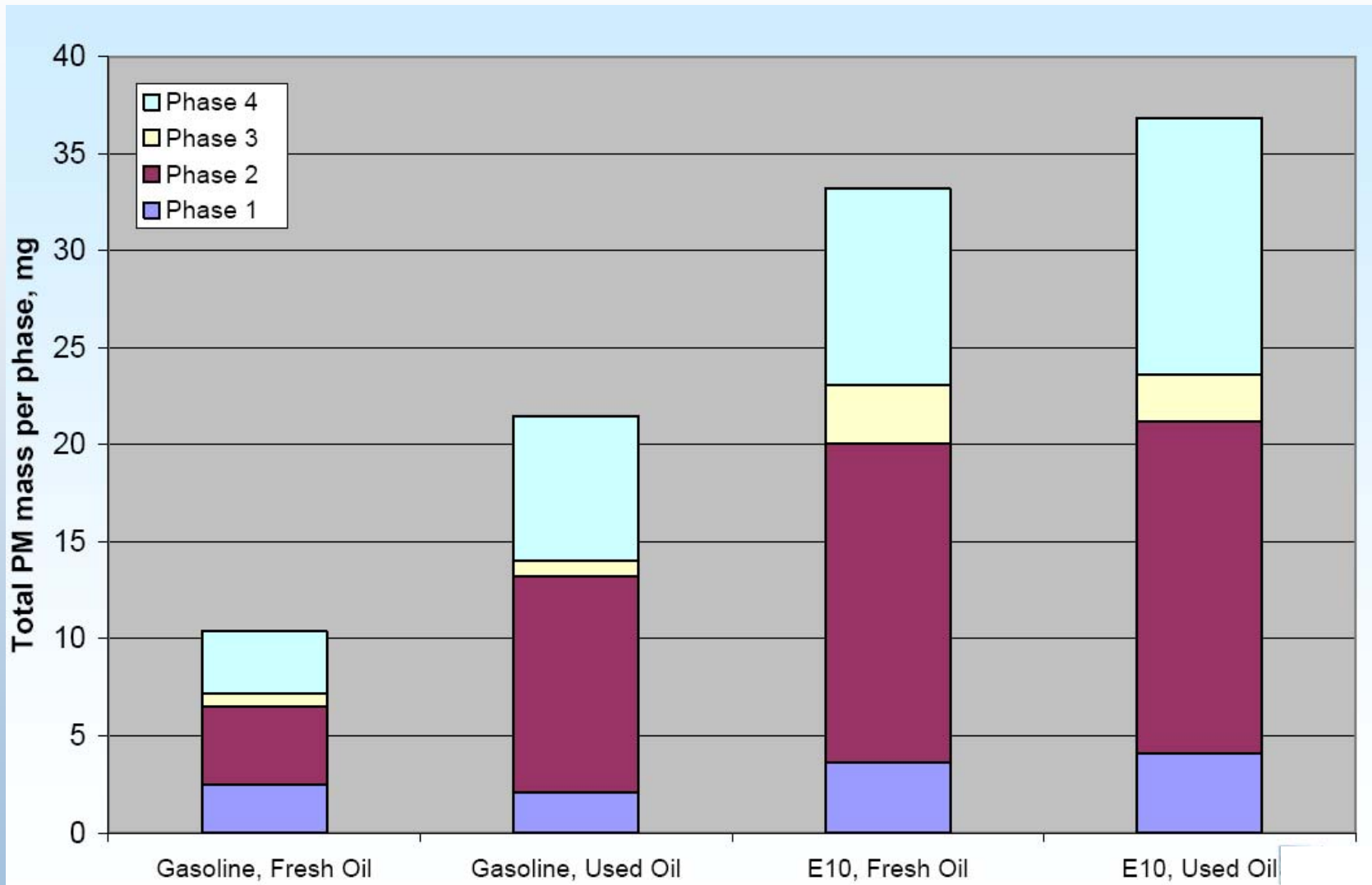


Four-Phase Unified Driving Cycle vs. LA-4 Test Cycle



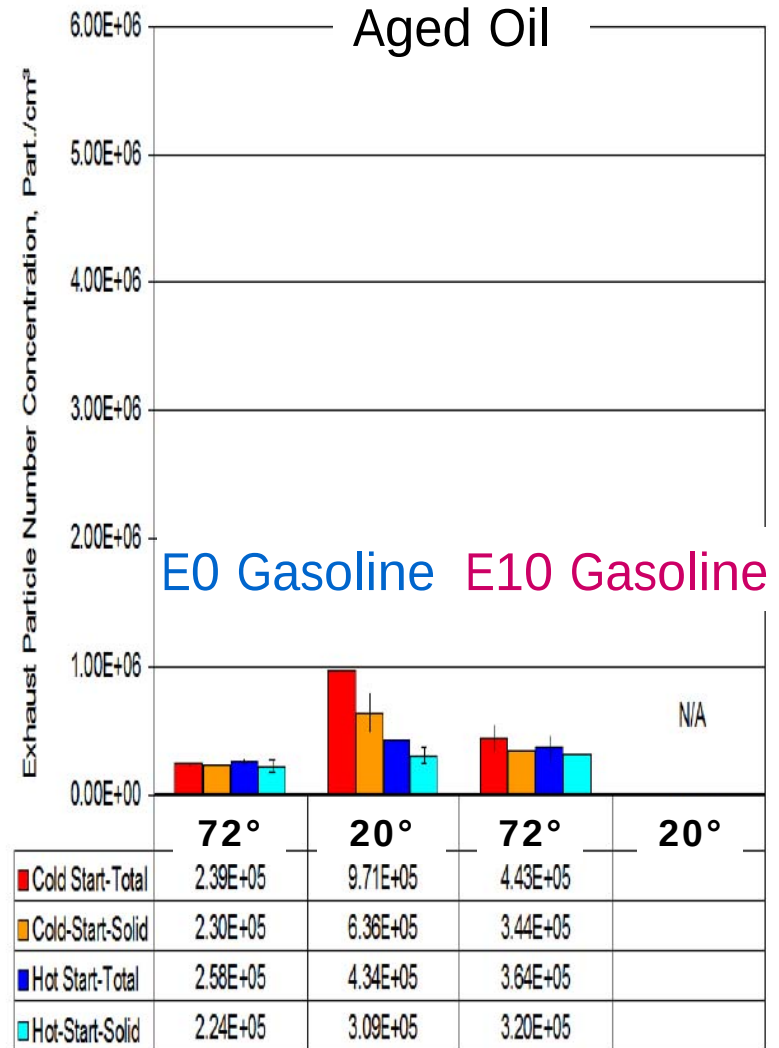
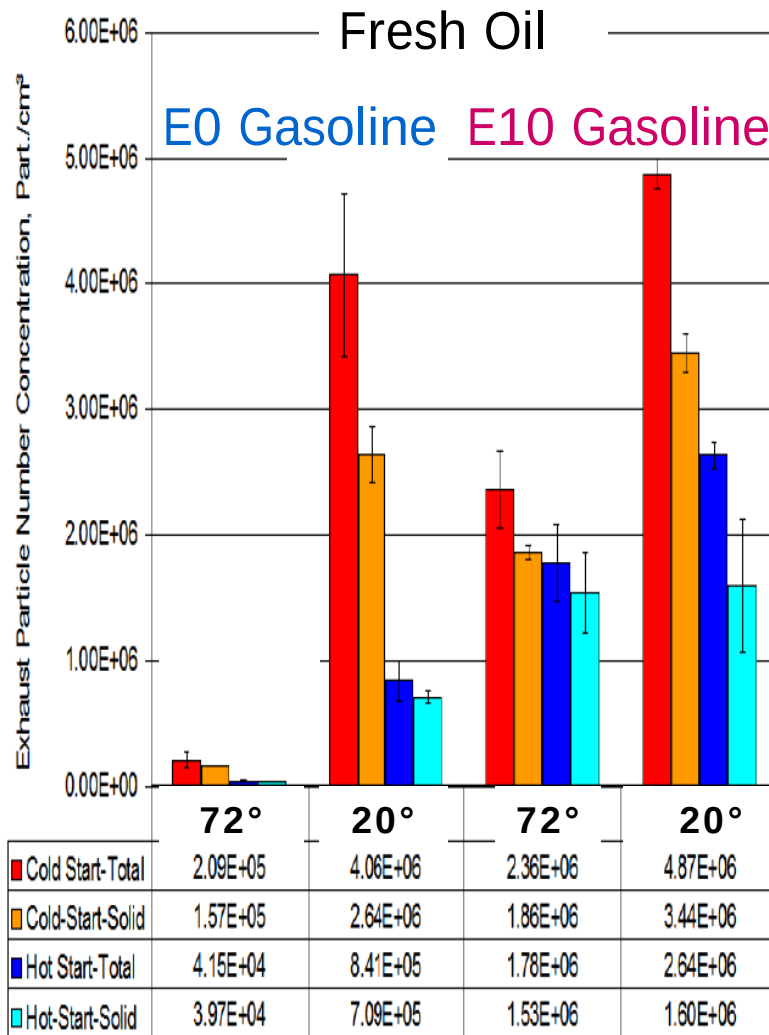
- 72°F: 8 consecutive cold-start tests per sample
- 20°F: 2 consecutive cold-start tests per sample

Average PM Distribution by UDC Phase at 72°F



PM Number Distribution –

“Normal” Emitter Gasoline LD Vehicle



Conclusions from CLOSE Project

- None today; study in progress at present time; data from only one “normal” gasoline LD vehicle presented; testing from “normal” emitter completed; high emitter gasoline LD vehicle has been recruited and preliminary testing is being done this week. Come back next year for CLOSE Project Conclusions!

Summary – Health Impacts Program

- Guidance from last year's Merit Review Meeting has improved the quality of FY08 Health Impacts Activity
- Relevance: Influence of fuels, lubricants, and new technologies on emissions, air quality, and health hazards is being investigated
- Approach: The research conducted in laboratory settings, using engine and chassis dynamometer measurements to produce emissions for characterization and health hazards investigations
- Technical Accomplishments: Results are being published in peer-reviewed literature, in addition to being presented at technical meetings
- Collaborations: Coordination and collaboration with project cosponsors, including the California Air Resources Board, South Coast Air Quality Management District, U.S. Environmental Protection Agency, Coordinating Research Council, and American Chemistry Council
- Direction of FY08/09 research will be guided by Merit Review Meeting input