

Update on Vehicle Emissions Research

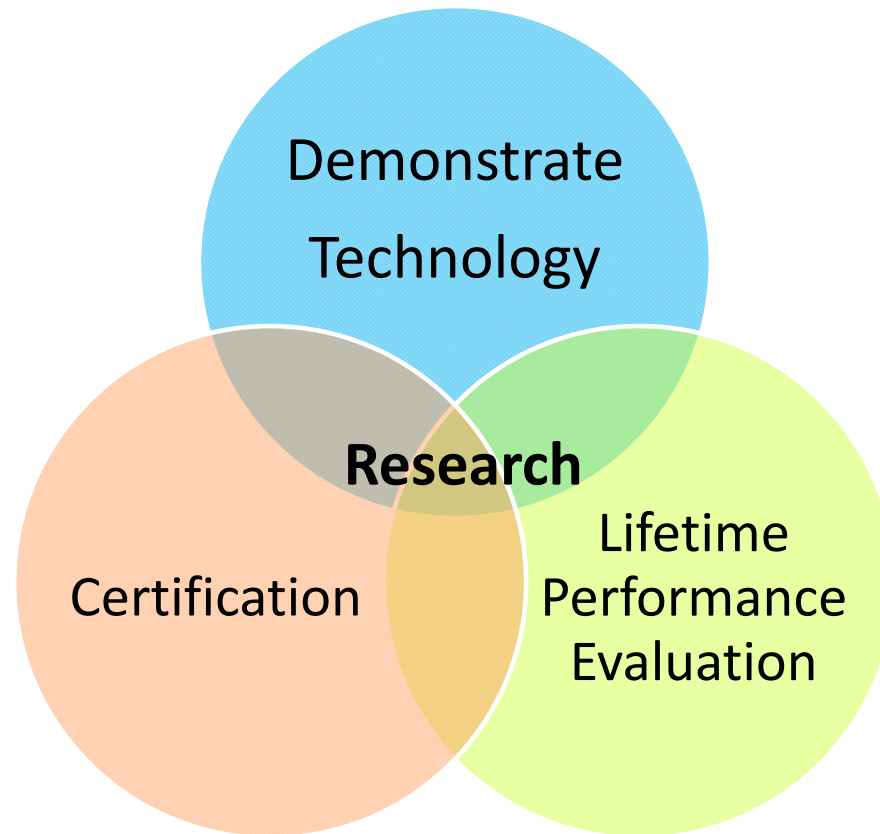
California Air Resources Board
Board Hearing, April 23rd 2015



Research Underpins ARB's Mobile Source Program



Emissions Testing at ARB



Research is critical and benefits all program areas

Resources

- Staff expertise
- In-house laboratories and field measurements
- Research contracts



Research Plan



PEMS



Mobile Measurements



Dynamometers

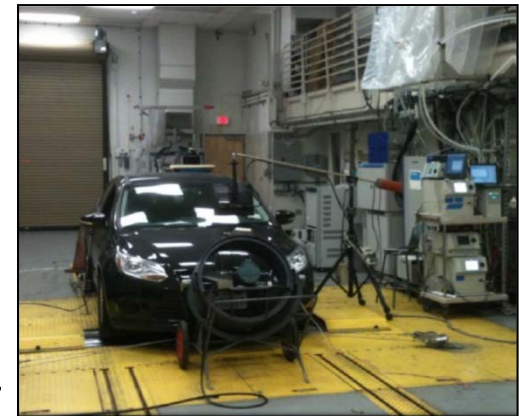
Determining Priorities

- 1. Identify ARB program priorities and develop appropriate research*
- 2. Investigate emerging issues*

- Annual meetings between research and program staff to develop annual research plan and research priorities
- Active in scientific community
- Meet with state and federal partners and major industry groups to understand research needs and emerging issues
- Respond to direct requests from program staff

Light Duty Research Priorities

- Guide the transition to zero emission vehicles
- Evaluate emissions of current fleet
- Expand understanding of emissions



Results will inform several important decisions by the Board on our light duty program

Research Focused on Transitioning to Zero Emission Technologies

Zero Emission Vehicles are here today:

- Factors affecting choice to purchase PHEV and ZEVs?
- PHEV usage patterns and emission implications?
- What happens to ZEVs and PHEVs in the secondary market?
- How to maximize the benefits of incentives?

Research will inform the Midterm Review

Evaluate Emissions from the Current Fleet

Research confirms emissions continue to decline

- Portable Emissions Measurements Systems (PEMS) studies
- Roadside measurements
- Remote sensing

99% reduction in light duty emission rate over 20 years

Car exhaust control technology becoming increasingly durable



Expand our Understanding of Emissions

Use novel measurement techniques in the controlled laboratory environment

- Properties of light duty PM – implications for low mass measurements
- Emissions of air toxics and ultrafine PM reduced, often by more than 95%, over the last 25 years
- Newest control technology eliminate gases that condense to form secondary PM



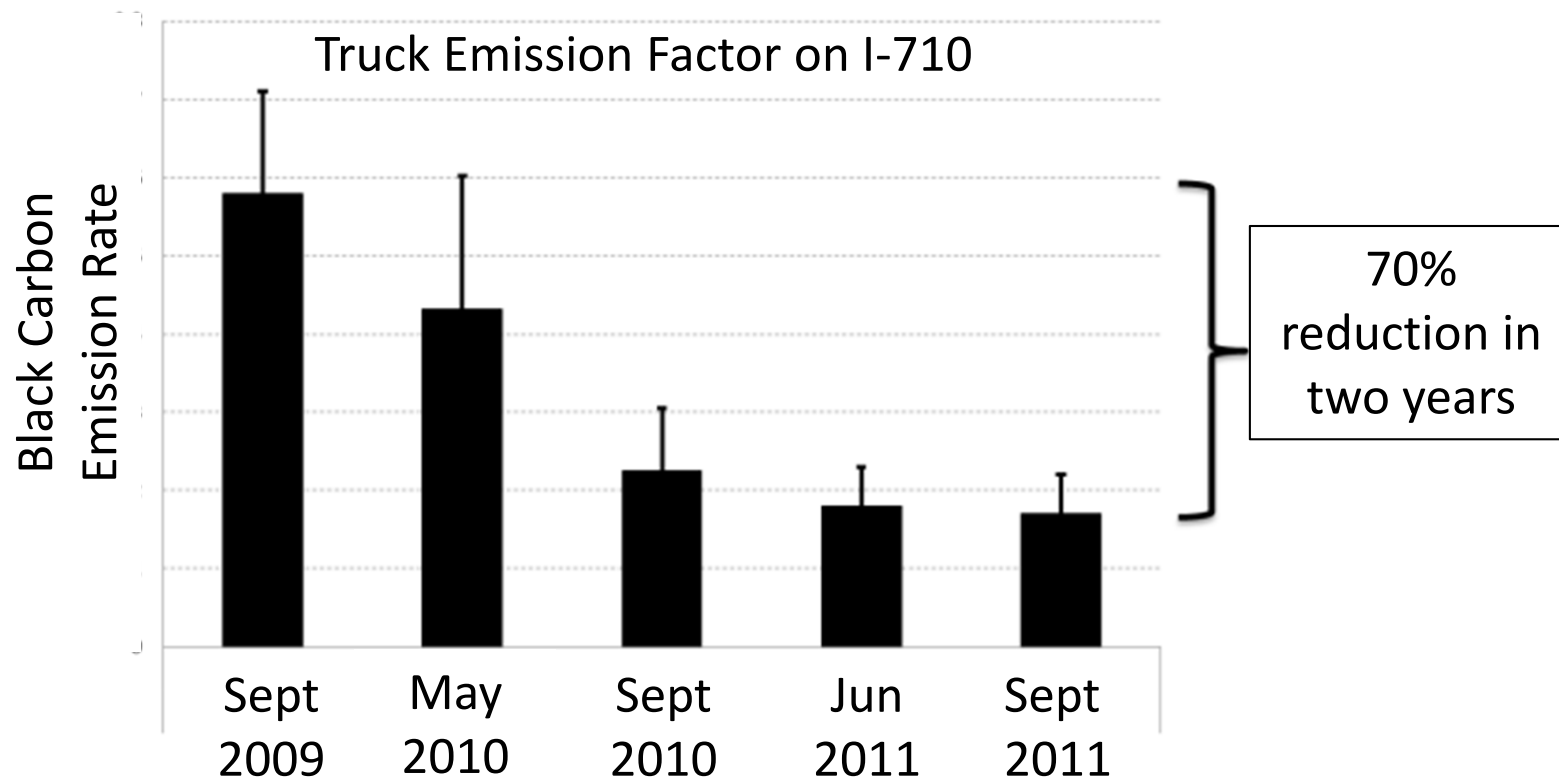
Heavy Duty Research Priorities

- Effect of Drayage and Truck and Bus rules for on-road emissions
- Support regulation to reduce on-road PM and NOx
- Expand understanding of emissions
- Inform the introduction of ZEVs in heavy duty applications

Results will inform several important decisions by the Board on our heavy duty program



Black Carbon Emissions from Trucks in California

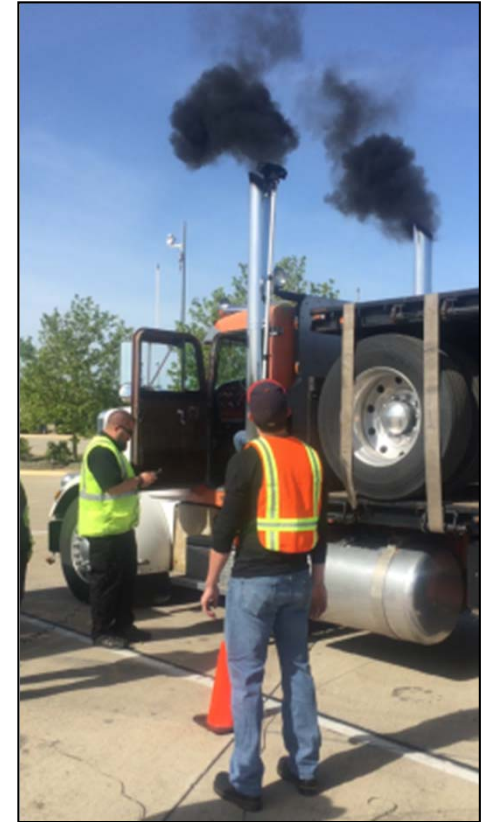


Kozawa et al. (2014) Verifying Emissions Reductions from Heavy-Duty Diesel Trucks Operating on Southern California Freeways, *Environmental Science and Technology*, 48(3), 1475-1483.

On-Road PM Emissions

ARB funded research measures on-road emission factors:

- PM filters, or DPFs, virtually eliminate PM
 - Thousands of trucks measured
 - Multiple locations statewide
 - Several different techniques used
 - Multi-year studies
- Small fraction of on-road PM filters not well maintained or tampered with



April 2015

Improving Compliance for Filters

Develop ability to quickly identify compromised DPFs

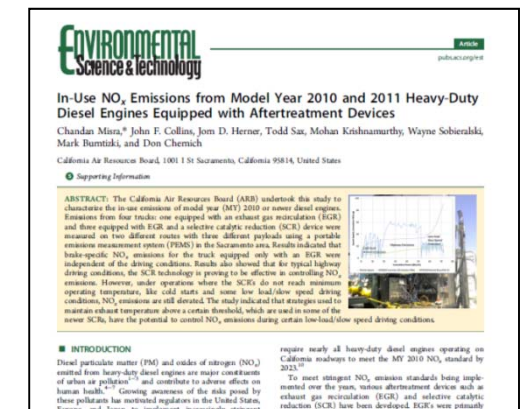
Detailed testing and repair of high-emitting trucks

Design Inspection & Maintenance program to improve compliance



NO_x Emissions

- ARB research identified off-cycle NO_x from modern diesel engines as a possible concern in 2009
- Subsequent research has provided additional insight
- Working with engine manufacturers – improvements have been made



ARB's Freight Strategy includes actions to address these issues

NO_x Research Informing How Low New Engine and In-Use Standards Can Be Set



Demonstrate ability to meet a 90% reduction in NO_x standard



Lower engine NO_x standards

Remote sensing to understand in-use emissions

Measure NO_x from real world driving using PEMS

Activity as a function of vocation



Improve in-use certification

Expand Understanding of Emissions

- Diesel PM from modern trucks is reduced by 99%, but is still diesel PM
- Emissions of toxic compounds and ultrafine diesel soot PM reduced by 95-99% over the last 20 years
- Toxicity screening also show major reductions



Inform the Introduction of Hybrids, Battery and Fuel Cells in Heavy Duty

- Research to record duty cycle of trucks in various vocations:
 - Determine the right technology for the right use
 - Develop test procedures and certification programs for new technologies
- Data collection and analysis to evaluate performance of ARB funded demonstrations

Next Steps



- Support conversion to zero emission light duty vehicles
- Emulate light duty success and transition heavy duty fleet to zero emissions
- Quantify the rate of on-road emission reductions as lower emitting vehicles enter the fleet and control technology becomes more durable

Continue to provide the scientific underpinnings of programmatic goals