

Diesel Emission Control Technology Developments



***Tony Andreoni
& Dr. Alberto Ayala***

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California Environmental Protection Agency

Air Resources Board

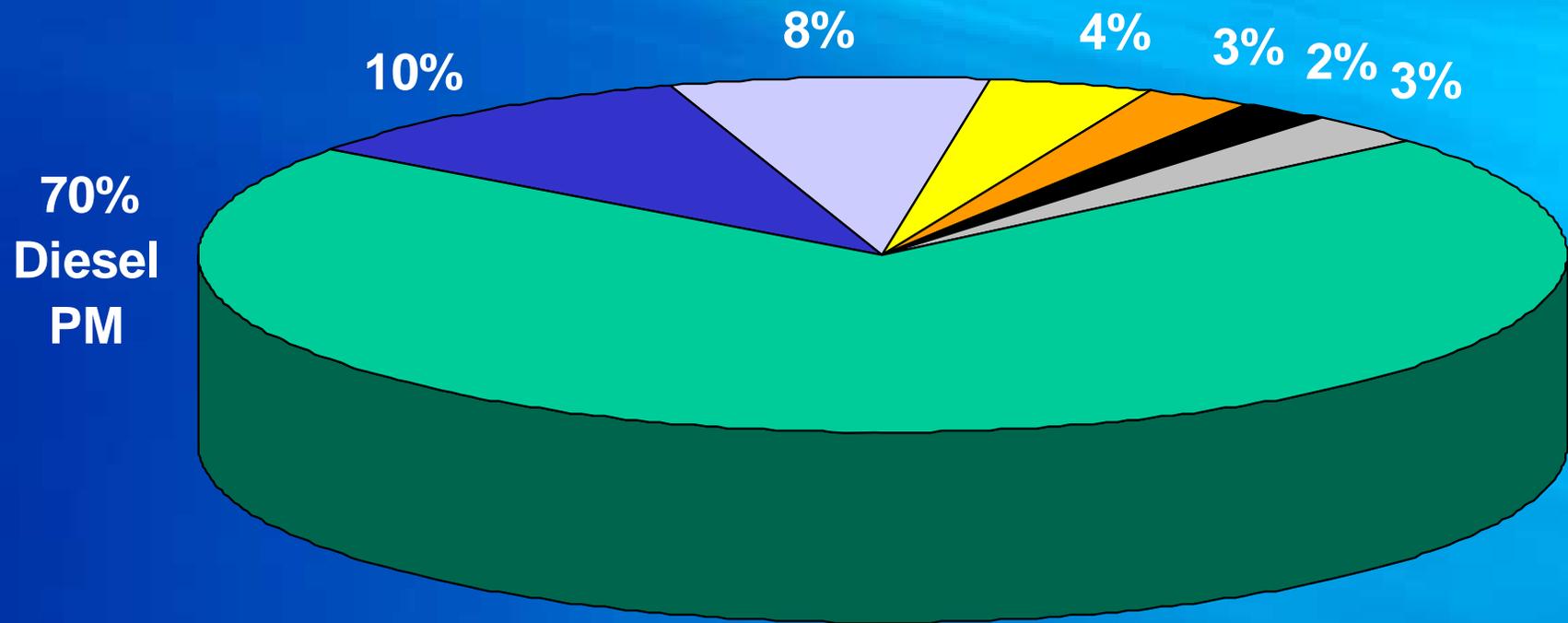


A Million plus.....

Category	Population (in 2000)
Trucks	700,000
Off-road equipment	500,000
Stationary and portable	65,000



Diesel PM Contribution to Risk



- Diesel Exhaust PM10 (70%)
- 1,3 Butadiene (10%)
- Benzene (8%)
- Carbon Tetrachloride (4%)
- Formaldehyde (3%)
- Hexavalent Chromium (2%)
- All Others (3%)



Significant Health Impacts

☆ **Reducing Health impacts is Program Corner Stone:**



- 2,900 premature deaths
- 2,500 cases of chronic bronchitis
- 600,000 lost work days



Diesel Risk Reduction Plan

☆ Goal: ↓ 85% by 2020

☆ Strategies:

- Cleaner fuel
- Stringent emission standards for new engines
- Aggressive reductions from in-use engines

BACT: the four R's
Retrofit
Repower
Replace
Retire



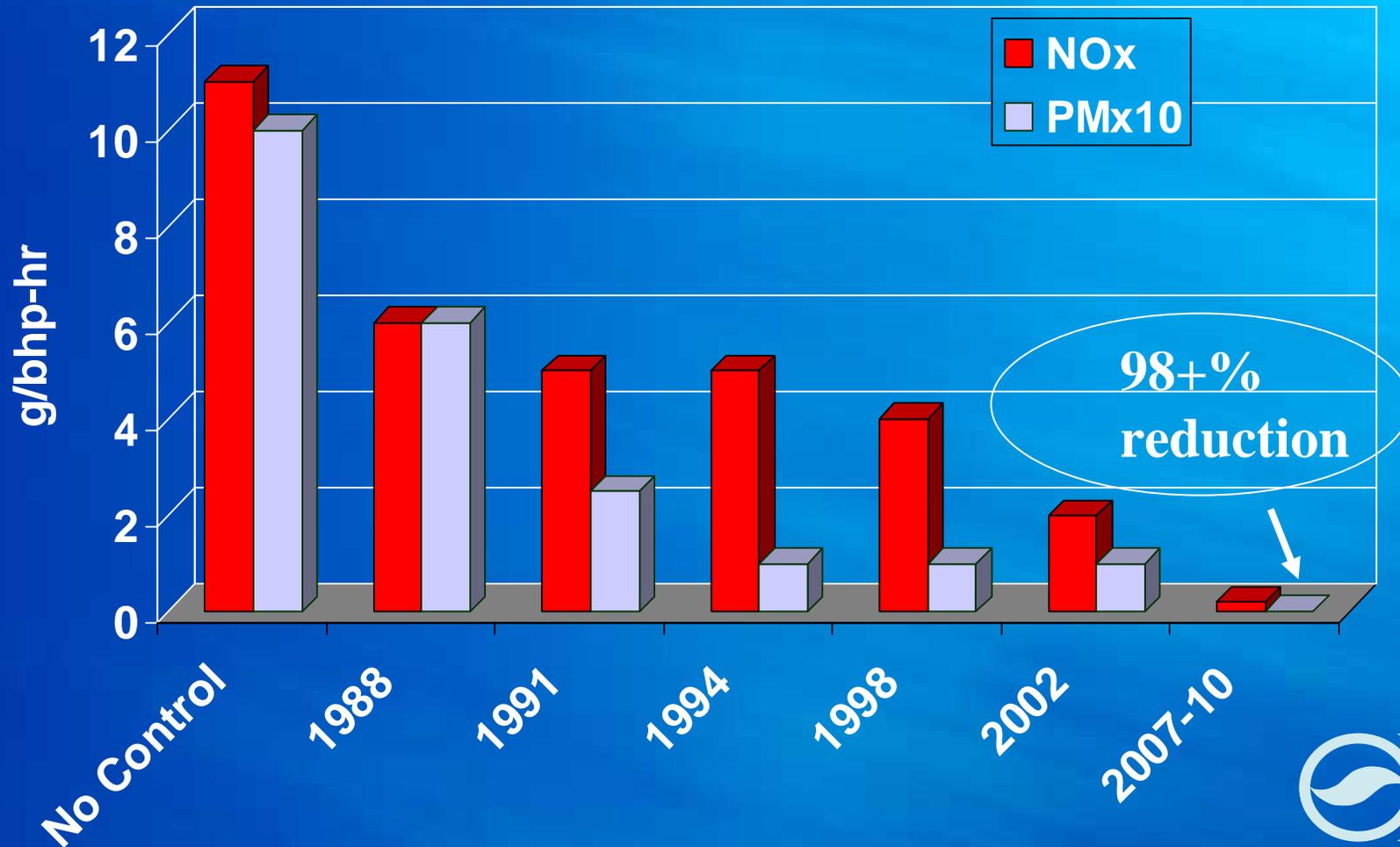
Cleaner Fuels

- ☆ **Reduces maximum diesel fuel sulfur content in 2006 from 500 to 15 ppmw**
- ☆ **Aligns with U.S. EPA for on-road**
- ☆ **Applies to off-road and stationary engines in California**
- ☆ **Enables use of control technologies**



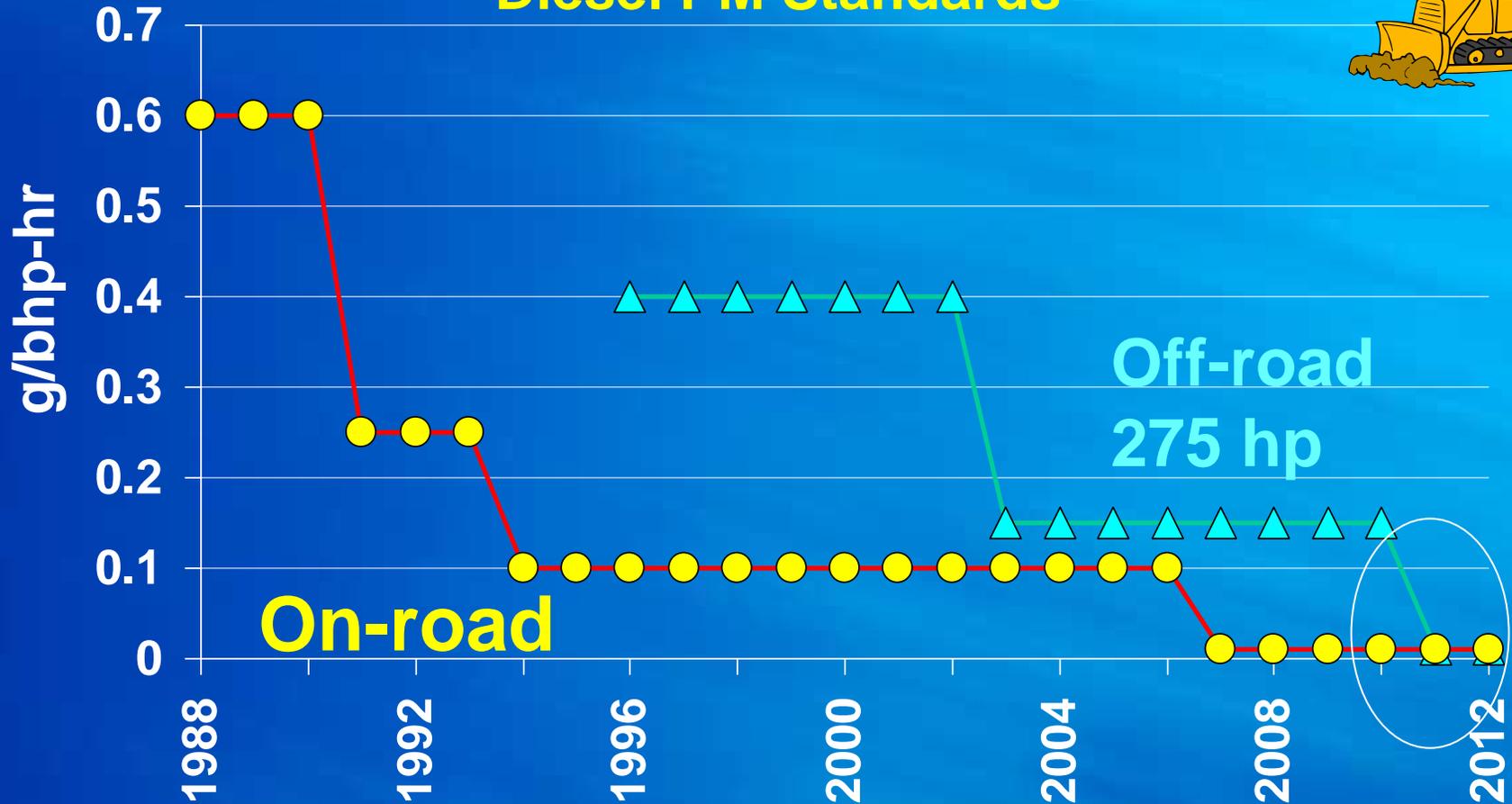
New Engine Standards

On-Road Engines



New Off-Road Standards Catching Up

Diesel PM Standards



In-Use Engine Regulations

☆ **Fleet Rule for Transit Agencies - Urban Buses & Refuse Trucks**

- Allows diesel or alternative path
- Ensures 85% reduction in PM
- Retrofit with Best Available Control Technology
- Over 2 million lbs of diesel PM reduced by 2020



In-Use Engine Regulations (Con't)

☆ **Stationary Engines**

- Establishes emission standards and operational requirements; engines to meet off-road standards for other pollutants
- Reduces diesel PM ~80% by 2020

☆ **Transport Refrigeration Units (TRUs)**

- Establishes performance standards and follows Tier 4 proposal
- Over 90% reduction by 2020



Future Actions

- ☆ **2005 and beyond :**
 - Public Fleets
 - Harbor Craft
 - Private on and off-road fleets
 - Ocean-going auxiliary engines
 - Ocean-going ships



Opportunities

- ✧ **Cleaner engines**
- ✧ **CNG / LNG**
- ✧ **Hydrogen / natural gas blends**



Issues

- ✧ Availability & feasibility of technology
- ✧ Costs are high, small business impacted
- ✧ Retrofit support limited
- ✧ Lack of incentive funding
- ✧ Global climate change
- ✧ **Verification of after-treatment technologies -
Multi-media Assessment (MMA)**
- ✧ VERT compatibility with U.S. verification



Verification Procedure

- ☆ **Voluntary program**
 - ARB Regulations rely on verification program
 - Stationary diesel - verification is optional
- ☆ **Tests verify emission reduction**
 - Reliability, Durability, Applicability, Sec. Emissions, & NO₂
- ☆ **Diesel emission control systems (DECS) must be verified in CA to meet regulations**
- ☆ **Warranty and labeling requirements**
- ☆ **DECS using fuels and Fuel-Borne Catalysts (FBC) must**
 - Go through separate, but parallel verification
 - Go through MMA



Cal EPA Multi-media Assessment

- ✧ **One completed so far (Lubrizol)**
- ✧ **UC Regents under contract to develop MMA guidelines**
- ✧ **Environmental Policy Council includes Cal-EPA Boards**
 - Air & Water Resources - Integrated Waste - Toxic Substance Control - Office of Environmental Health Hazard Assessment



Technologies Verified

☆ **Level 3 (85+% PM Reduction)**

- 9 systems for On-Road engines
- 2 systems for Off-Road & Stationary engines

☆ **Level 2 (50 to 85% PM Reduction)**

- 2 systems for On-Road engines (1988-2003)
- 1 system for Off-Road engines (1996-2002)

☆ **Level 1 (25 to 50% PM Reduction)**

- 7 systems for On-Road engines (1988-2003)
- 4 systems for Off-Road engines (1996 & later)

☆ **More solutions needed for off-road**



Promising Technologies

☆ **Active Systems**

- Diesel Particulate Filter (DPF) with electric regeneration
- DPF using diesel fuel injected into filter for regeneration
- Non-catalyzed DPF with a FBC

☆ **Passive Systems**

- Catalyzed DPF (limited applications)
- Emulsified diesel fuel (limited applications)
- Alternative diesel fuel (such as Fischer-Tropshe)

☆ **Alternative Technologies**

- Hybrid-Electric
- Alternative fuels (such as hydrogen)



Promising Technologies (Con't)

☆ **Level 3 Systems used in Europe**

- FBC with DPF + Oxidation filter used in passenger cars
- Passive & Active DPFs used in mining equipment, and diesel transit busses

☆ **Level 3 Systems being demonstrated for TRUs**

- Active filter system with a FBC, intake air throttle valve and an ECU to monitor regeneration
- NREL/SCAQMD Fischer-Tropshe plus filter project



Choosing a Technology

- ☆ **Application dependent**
- ☆ **Cost considerations**
- ☆ **Useful life**
- ☆ **Regeneration issues**
 - Exhaust Temperature Profiles
 - Active vs. Passive systems
 - Lube oil consumption
- ☆ **Verified systems**
 - ARB vs. U.S. EPA
 - VERT approved systems



Technology Issues

☆ **Verification of FBC systems**

- MMA is costly & time-consuming
- Options for accelerating the process
- Independent labs needed for verification

☆ **Two different FBC systems are being demonstrated in California**

- 2 TRU Systems w/Euro technology
- 1 additional system being considered

☆ **Demonstration of low cost systems in small diesel engine applications**



Summary

- ☆ **Verification of emission control technologies continues - FBC's are progressing at a slower pace**
- ☆ **In-use diesel engine regulations depend on verified technologies**
- ☆ **Europe has shown that Active systems w/FBC is a key technology in some applications**
- ☆ **MMA is costly and time-consuming, and adds considerable complexity**
- ☆ **Need to consider all options**



Web Sites

☆ **Verification Procedure:**

- <http://www.arb.ca.gov/diesel/verdev/verdev.htm>

☆ **MMA:**

- <http://www.arb.ca.gov/fuels/multi/multi.htm>

☆ **Diesel Risk Reduction Plan:**

- <http://www.arb.ca.gov/diesel/dieselrrp.htm>

☆ **Marine Vessels and Cargo Handling Equipment:**

- <http://www.arb.ca.gov/msprog/offroad/marinevess/marinevess.htm>

- <http://www.arb.ca.gov/msprog/offroad/cargo/cargo.htm>

☆ **Off-Road In-use Control Measure:**

- <http://www.arb.ca.gov/msprog/ordiesel/ordiesel.htm>



Thank You

