Diesel Regulations in California

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California Air Resources Board

California Environmental Protection Agency

Presentation Outline

- Emissions
- Policy Drivers
- Control Programs
  - New engines
  - Fuels
  - Existing engines
- Conclusions

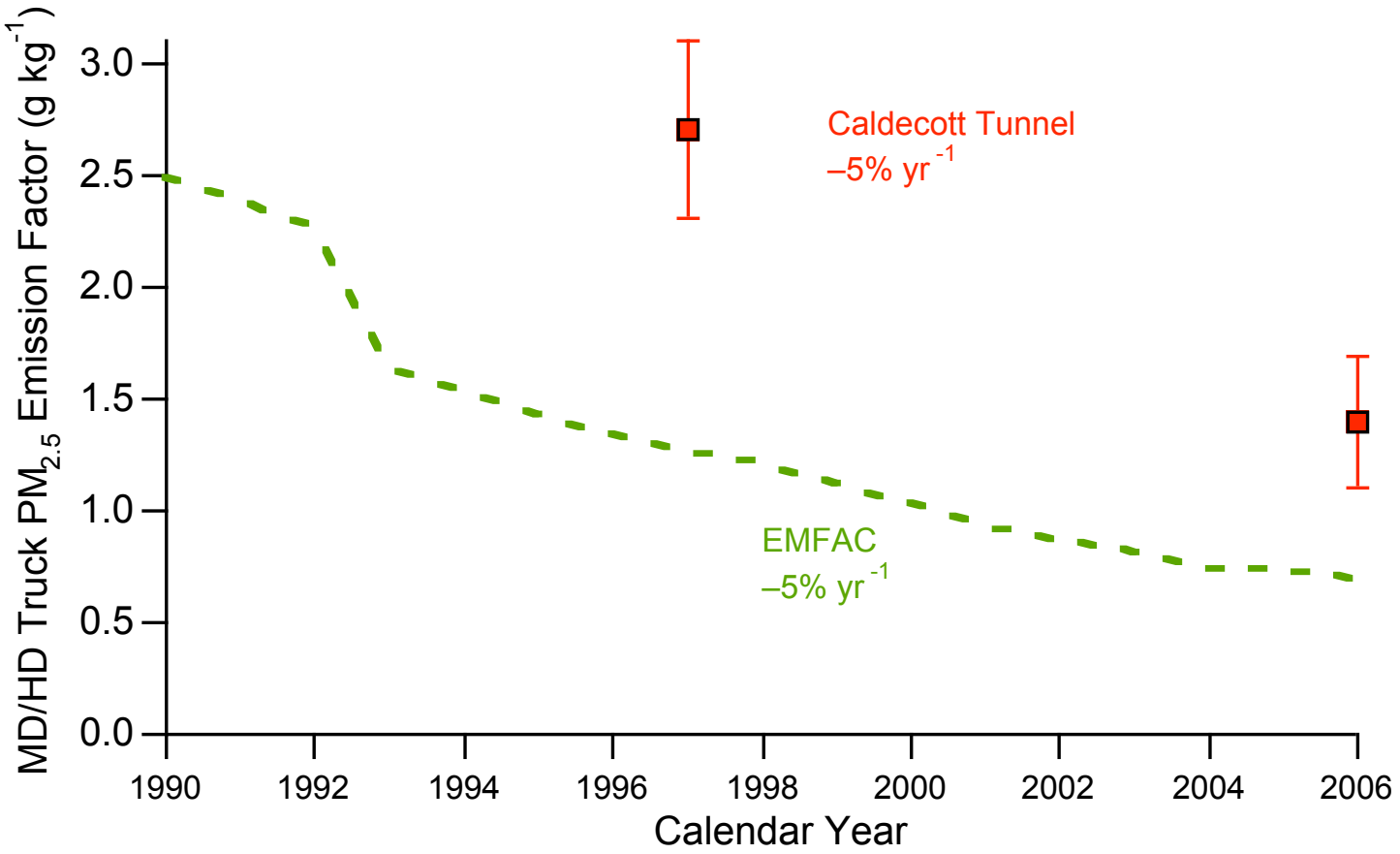
2006 Emissions in California

Emission Category	BC	OC
Total	52,000 tpy	108,000 tpy
On-Road Transport	20%	9%
Off-Road Transport	23%	13%
Residential	8%	16%
Managed Burning	14%	18%
Wildfires	29%	27%
Miscellaneous	6%	17%

Chow et al. (2008) Climate Change – Characterization of Black Carbon and Organic Carbon Air Pollution Emissions and Evaluation of Measurement Methods, Draft Final Report (Part 2), CARB Contract No. 04-307, November 7.

Diesel Truck PM2.5 Emissions

Tunnel Measurements vs. Emission Model



Ban-Weiss, et al. (2008) Long-term changes in emissions of nitrogen oxides and particulate matter from on-road gasoline and diesel vehicles, AE, 42: 220-232.

High Emitters

- 226 heavy-duty truck plumes measured
  - Caldecott Tunnel (near San Francisco)
  - 4% grade
  - BC measured with single-wavelength aethalometer
- Convert >1% of fuel mass into black carbon
- 10% of heavy-duty trucks responsible for ~40% of total BC and particle number (PN) emissions
  - Share will increase as average fleet becomes cleaner
  - Little overlap between BC and PN high-emitters

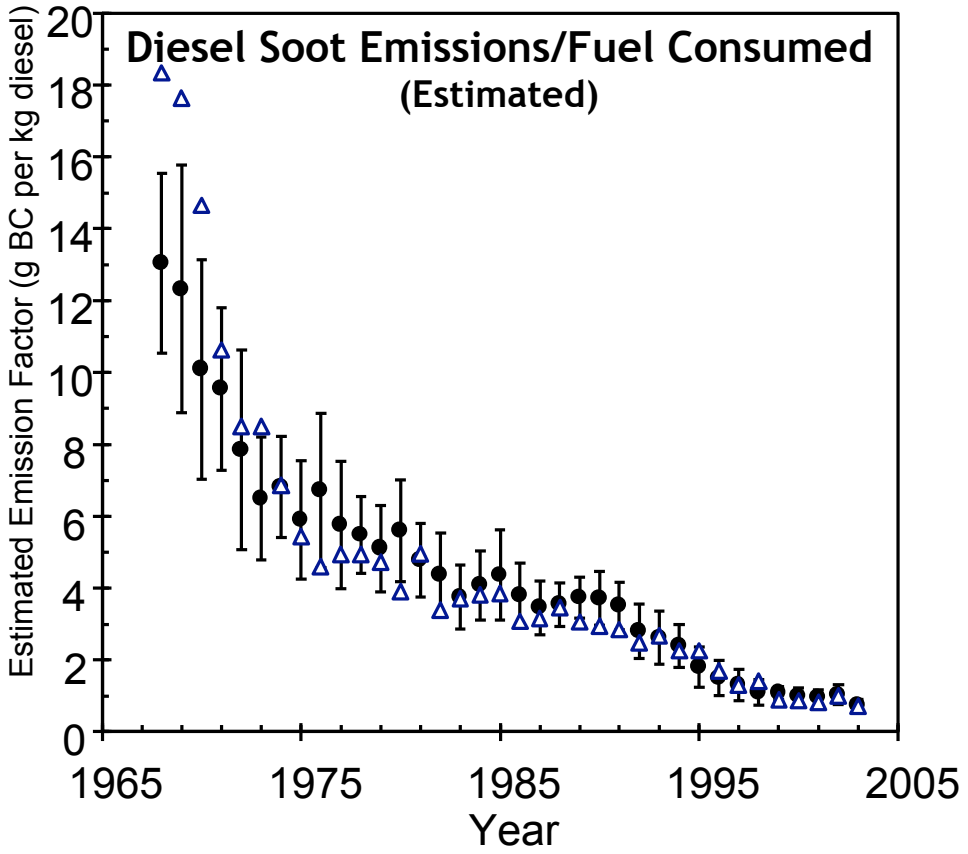
Harley (2008) On-Road Measurement of Light-Duty Gasoline and Heavy-Duty Diesel Vehicle Emissions, Draft Final Report, CARB Contract No. 05-309, August.

40 Years of Progress on Diesel PM

Engine diesel soot
⇩~18 fold

Fuel usage
⇧~6 fold

Ambient diesel soot
⇩~3 fold



Kirchstetter, et al. (2008) Black carbon concentrations and diesel vehicle emission factors derived from coefficient of haze measurements in California, AE, 42(3): 480-491.

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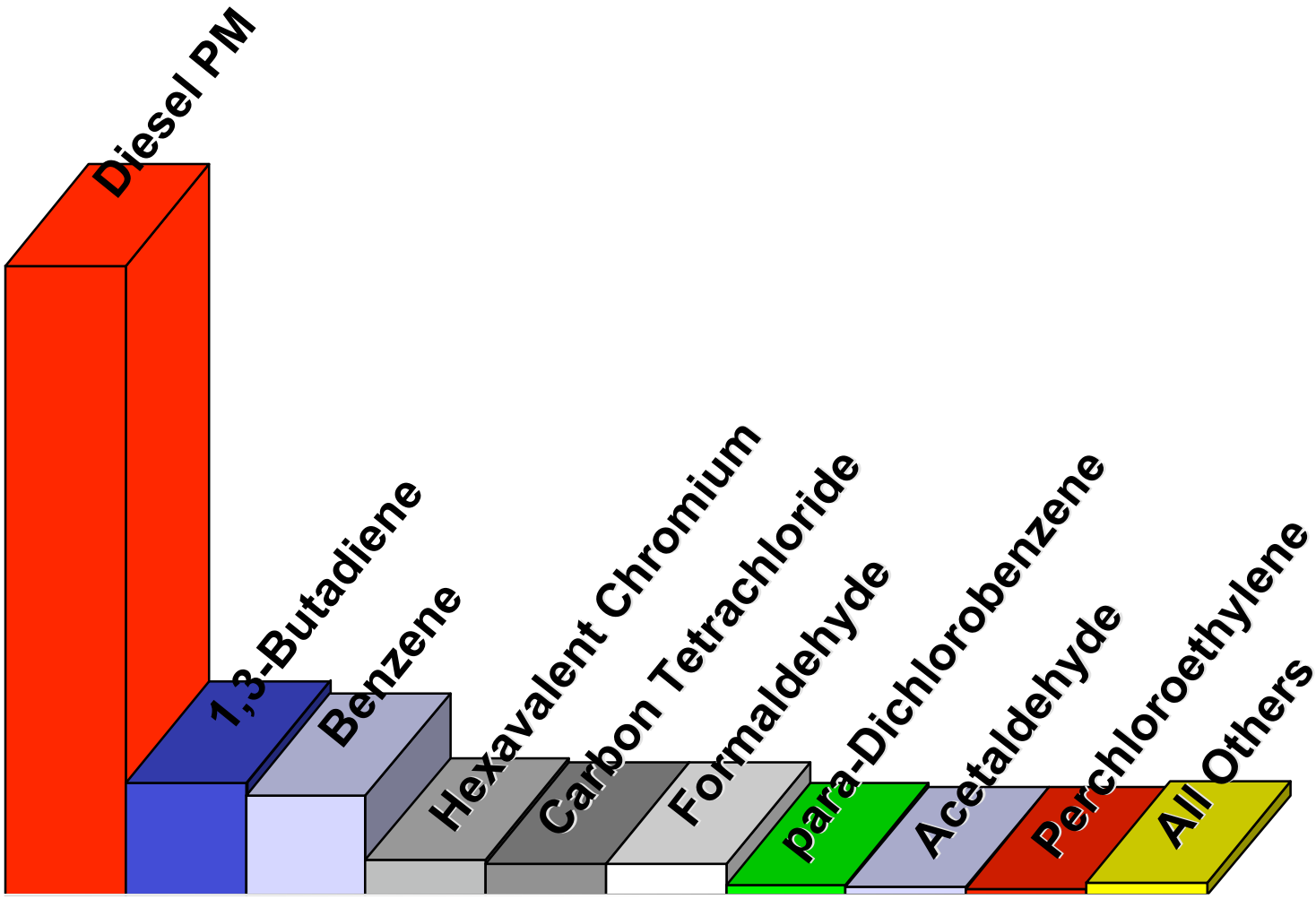
Cancer Risks from Airborne Toxics



* Estimated 400 cases/year in 2005 (dioxins not included).

Air Pollution and Premature Death

California estimates for 2005

Pollutant	Annual Deaths*
PM2.5	18,000
Ozone	540
Toxic Air Contaminants	400

* At least a factor of two uncertainty.

Impact of Diesel PM on California

Premature death (3500 per year*)

Lung cancer (250 per years)

Decreased lung function in children

Chronic bronchitis

Increased hospitalizations

Aggravated asthma

Increased respiratory symptoms

Lost work days

Reduction in visibility (10-75% of total)

Lloyd and Cackette (2001) JAWMA, 51: 809-847.

* www.arb.ca.gov/research/health/pm-mort/pm-mort.htm

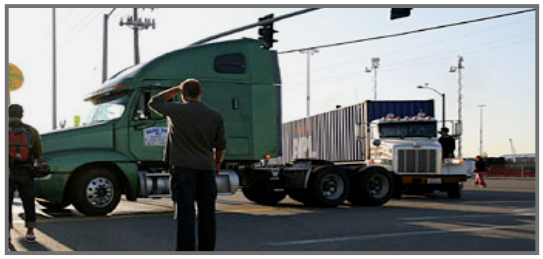
Study of U.S. Trucking Industry

Compared with general U.S. population:

- All-cause death rate:
  - 28% lower

However:

- Heart disease death rate:
  - Drivers 49% higher
  - Dockworkers 32% higher
- Lung cancer death rate:
  - Drivers 10% higher
  - Dockworkers 10% higher



Laden, et al. (2007) Cause-specific mortality in the unionized U.S. trucking industry, Environmental Health Perspectives, 115:1192-1196.

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Diesel Risk Reduction Plan
(85% Less Diesel PM by 2020)

- New vehicle and engine standards (90% control)
- Low-sulfur (15 ppmw) diesel and alternative fuels
- Retrofit/re-power with incentives ($140M+ / year)
- International Diesel Retrofit Advisory Committee
- Anti-idling measures
- Enforcement programs

www.arb.ca.gov/diesel/dieselrrp.htm

DRRP Timeline

1998 – Cancer listing for diesel particles

2000 – Diesel Rick Reduction Plan adopted

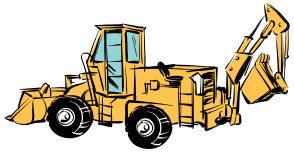
2006 – Ultra-low sulfur diesel required

2007-10 – New engine standards (on-road)

2011-15 – New engine standards (off-road)

2000-18 – Retrofits

Over 1.2 Million Diesels in California

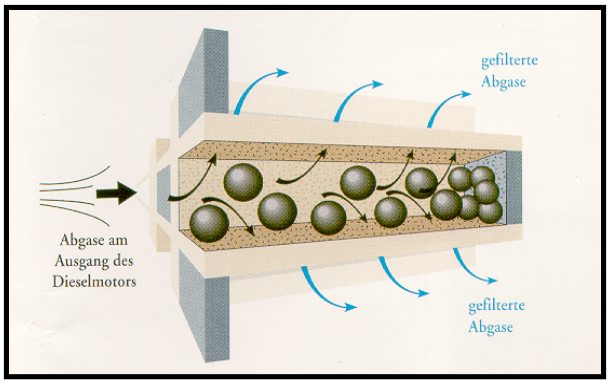
	Population 2010
Trucks 	940,000
Off-road equipment 	195,000
Stationary and portable	70,000

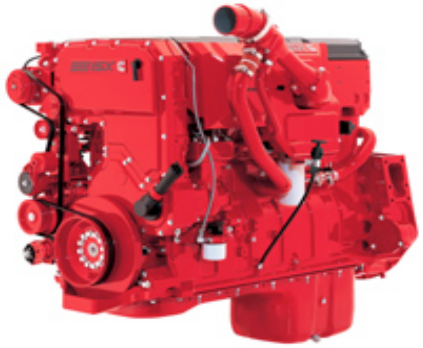
Progress: New Engines and Fuels

Major Task	Action	Adoption status
New engines	Truck standards reducing NO_X/PM by 90% (2007-10)	**Complete**
	Off-road equipment engine standards reducing NO_X/PM by 90% (2011-15)	**Complete**
	Locomotive/harbor craft standards	**Complete**
Fuels	15 ppmw sulfur diesel, on- and off-road	**Complete**
	Ship auxiliary engines	**Ongoing**
In-use compliance/ enforcement	OBD for heavy trucks	**Complete**
	In-use testing and recall program	**Complete**

Existing Engine Cleanup:
General Regulatory Approach

- Retrofit mid-aged engines
  - Filters 85% PM ↓
  - Catalysts 25% PM ↓
  - Other 50% PM ↓ typical
- Replace older engines
  - Re-power
  - New vehicle
- Compliance spread over 5+ years





Compliance Flexibility

- Additional time to repower engine if verified retrofit controls not available
- Special provisions for smaller fleets
- Special provisions for very low usage fleets
- Early compliance credit

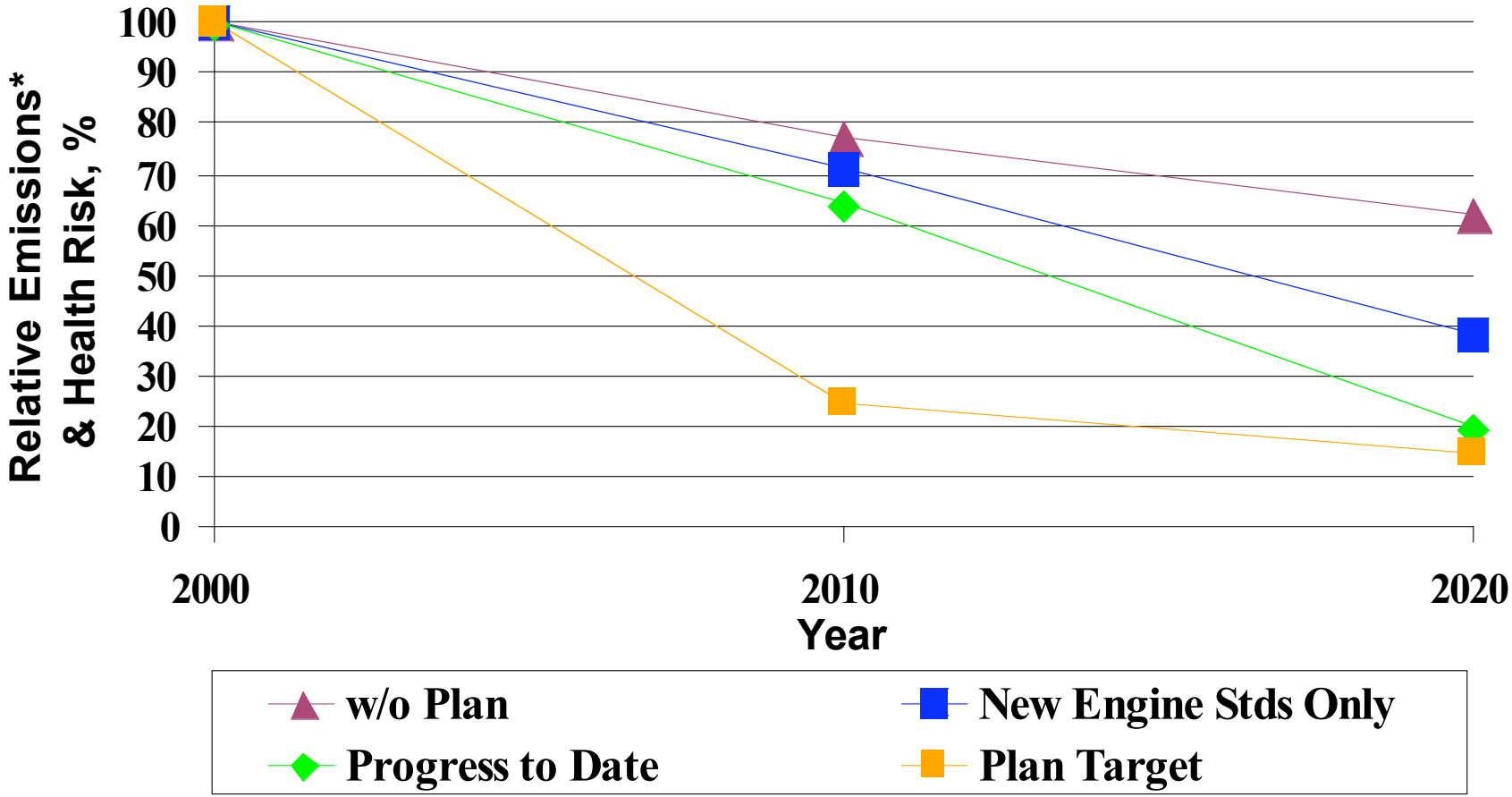
Progress: Existing Engines

Major Task	Action	% of PM	Cost (millions)	Adoption Status
Clean-up existing engines	Urban transit buses	<1	122	Complete
	Trash trucks	2	155	Complete
	Portable equipment	3	350-420	Complete
	Stationary engines	2	47	Complete
	Cargo handling equipment	<1	71	Complete
	Municipal fleets	<1	157	Complete

Progress: Existing Engines

Major Task	Action	% of PM	Cost (millions)	Adoption Status
Clean-up existing engines (cont.)	School buses	<1	101	Complete
	TRUs	2	87-156	Complete
	Idling limits	1	Savings	Complete
	Stationary ag. engines	1	34-42	Complete
	Aux. engines OGV	3	165-171	Complete
	Port trucks	9	1300	Complete
	Off-road non-ag.	30	3200	Complete
	Private trucks	37	5500	Complete
	Ag. equipment	8		2010

Cleaning Up Existing Diesels Necessary to Achieve Goal



* to 3 miles offshore

On-Road Vehicle Types Covered

Concrete Mixer

Dump Truck

Drill Rig

Water Truck

Hay Squeeze

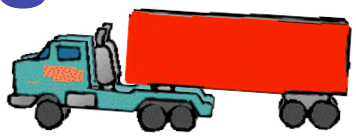
Tow Truck

Reefer Van

Fuel Tank Truck

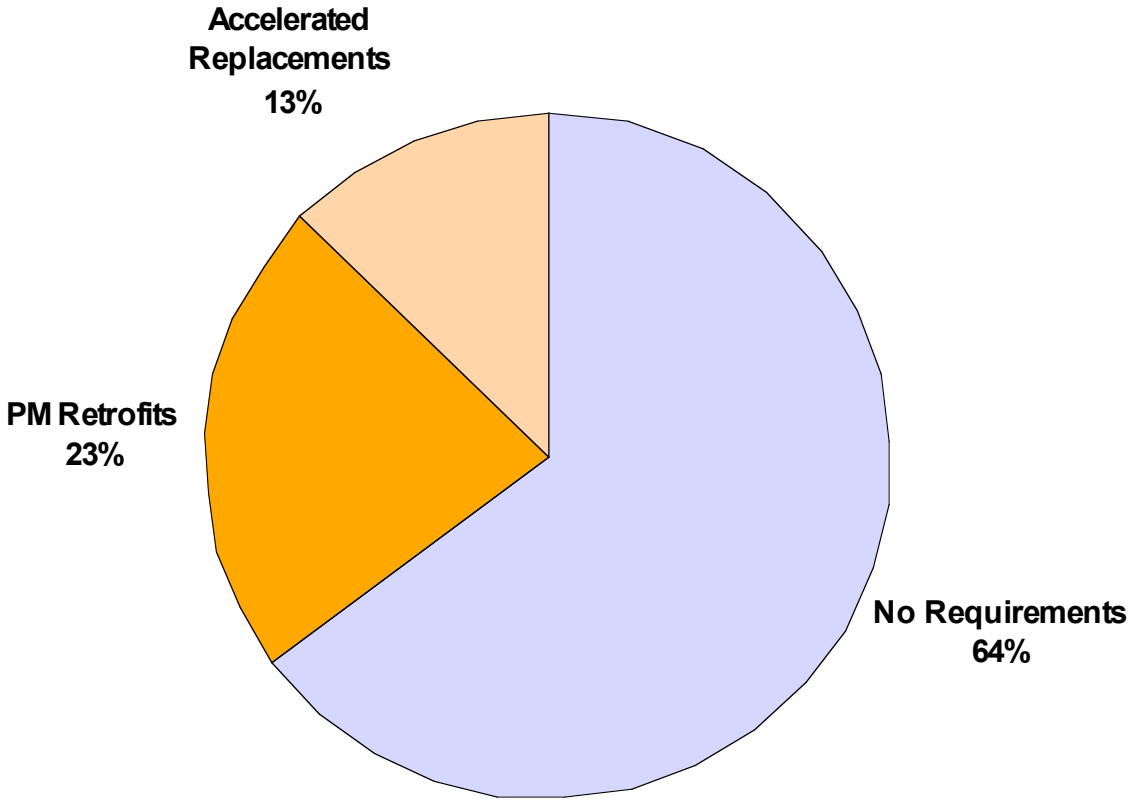
Passenger Bus

On-Road Truck Fleets – Approach



- Affects medium and heavy-duty diesel trucks operating in California
- Three Compliance Options
  - BACT, fleet average, percentage limits
  - Starts in 2009
- Includes out-of-state and international
  - Possible legal challenge
  - Mostly new trucks; would comply

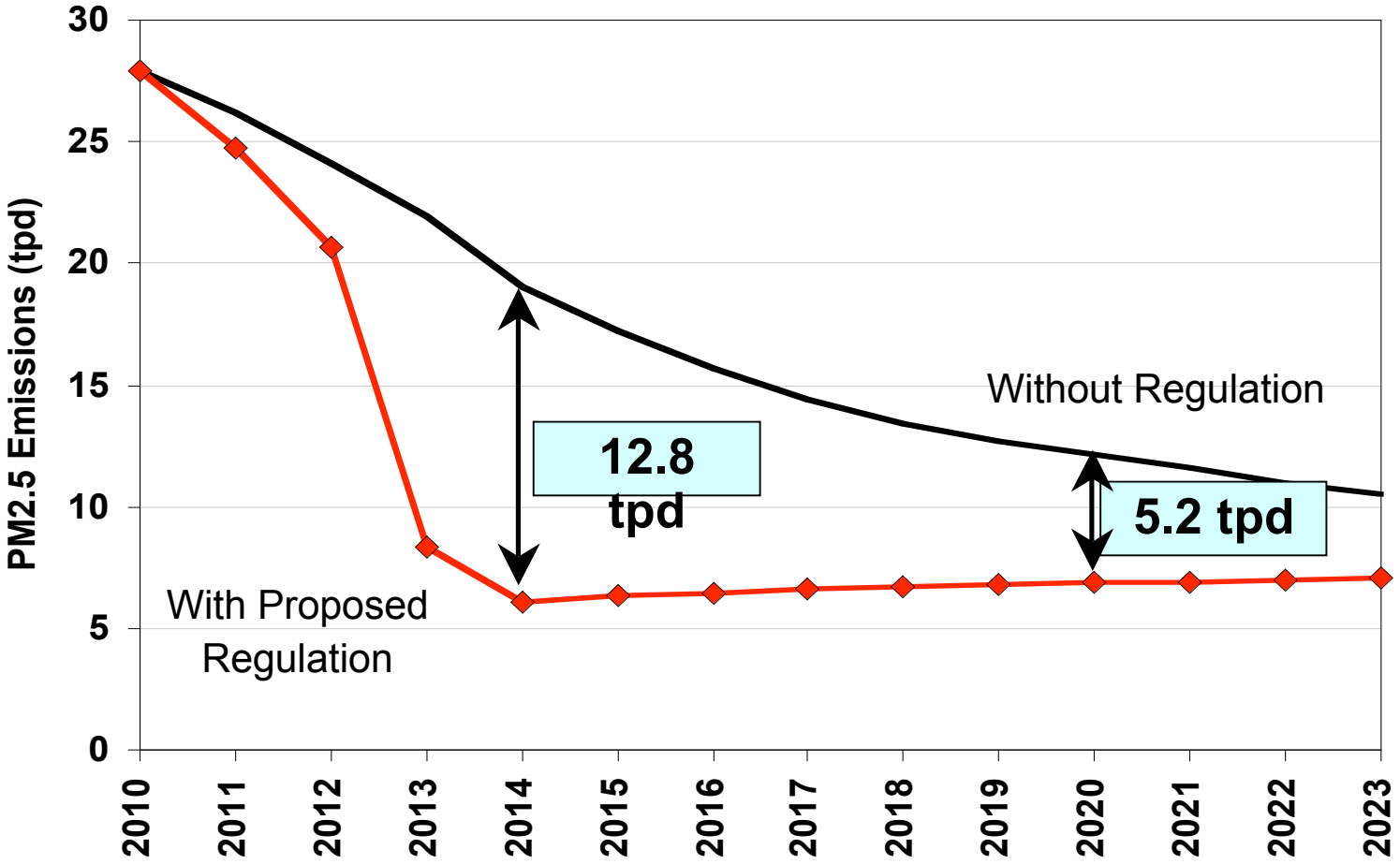
Accelerated Replacement Not Required for Every Truck



Number of Different Trucks Operating in California in 2008 = 941,000

Statewide PM2.5 Emissions

On-Road Truck Rule



Off-Road Vehicle Types Covered

Dozer

Loader

Belt Loader

Aerial Lift

Backhoe Loader

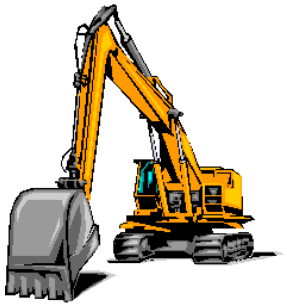
Telescopic Forklift

Ground support equipment

Skid Steer

Mast Forklift

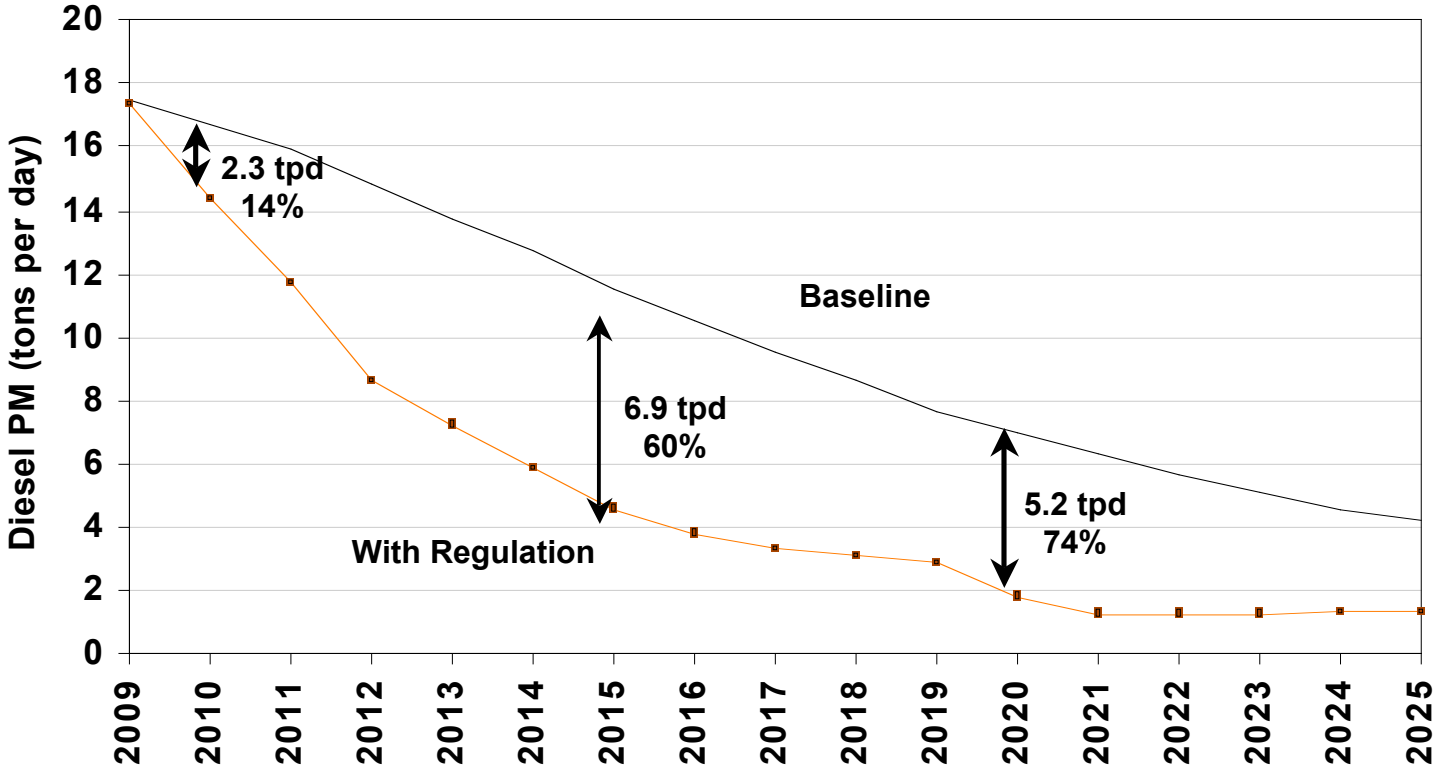
Off-Road Equipment – Approach



- Affects mainly construction and industrial equipment
  - ~200,000 units (over 25 hp)
  - Non-agricultural (separate rulemaking)
  - Exemptions for specialty equipment, low use
- PM requirements, lesser of
  - Install PM retrofits (20% of hp per year) or
  - Meet PM fleet average
  - Starts in 2009

Statewide PM2.5 Emissions

Off-Road Equipment Rule



Overall Health Benefits

- On-Road Truck Rule
  - About 9,400 fewer premature deaths
  - Value estimated at $48 to $68 billion
- Off-Road Equipment Rule
  - About 4,000 fewer premature deaths
  - Value estimated at $18 to $26 billion
- Health Benefit to Cost Ratios
  - Range of 4:1 to 20:1 for all regulations

Technological Feasibility and Costs

Catalyst based NOx and PM exhaust retrofit systems

Exhaust Retrofits

- Requirements already in place
  - New York City
  - Los Angeles Airport
  - Europe
  - US underground mining requirements
- Significant number of retrofits in service
  - Over 130,000 retrofits on heavy-duty vehicles
  - 35,000 DPFs retrofit on construction vehicles in Switzerland and Germany

Cost of Retrofits

		PM ↓
• Passive filter	$11-15,000	85%
• Flow through filter	$5,000	50%
• Catalyst	$2,000	25%

Off-Road Engine Size	Total Price
Less than 50 hp	$8,000
50 to 175 hp	$12,000
175 to 300 hp	$18,000
Greater than 300 hp	$30,000

Incentives Portfolio

- Carl Moyer Program
  - About $140 million per year
  - Funds available for grants and vouchers
- Proposition 1B
  - $1 billion over several years
  - Funds available for grants and loan guarantees
- Assembly Bill (AB) 118
  - $350+ million for low interest loans
- Lower Emission School Bus Program
  - About $200 million for replacements and retrofits

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Conclusions

- Large diesel PM reductions over past 40 years and next 20 years
- Reducing in-use diesel emissions has large public health benefits
- Costs are high, but benefits are higher
- Incentives help tremendously

Where to Find More Information

ARB's Diesel Portal
www.arb.ca.gov/diesel/diesel.htm

Diesel Control Device Verification
www.arb.ca.gov/diesel/verdev/vt/cvt.htm

ARB's Goods Movement, Port's and Rail Web Portal
www.arb.ca.gov/html/gmpr.htm

ARB's Climate Change Portal
www.arb.ca.gov/cc/cc.htm