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Cost Effective Strategies for Conducting PM2.5 Model Attainment Demonstrations

Presentation at the Air & Waste Management Association Conference

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EPA's PM Standards: Old and New

	Previous Standards		2006 Standards	
	Annual	**24-hour**	**Annual**	**24-hour**
$PM_{2.5}$ (Fine Particles)	**15 µg/m³** Annual arithmetic mean, averaged over 3 years (established in 1997)	**65 µg/m³** 24- hour average, 98th percentile, averaged over 3 years (established in 1997)	**15 µg/m³** Annual arithmetic mean, averaged over 3 years	**35 µg/m³** 24- hour average, 98th percentile, averaged over 3 years
PM_{10} (Coarse Particles)	**50 µg/m³** Annual average (established in 1987)	**150 µg/m³** 24-hr average, not to be exceeded more than once per year on average over a three year period (established in 1987)	**Revoked**	**150 µg/m³** 24-hr average, not to be exceeded more than once per year on average over a three year period

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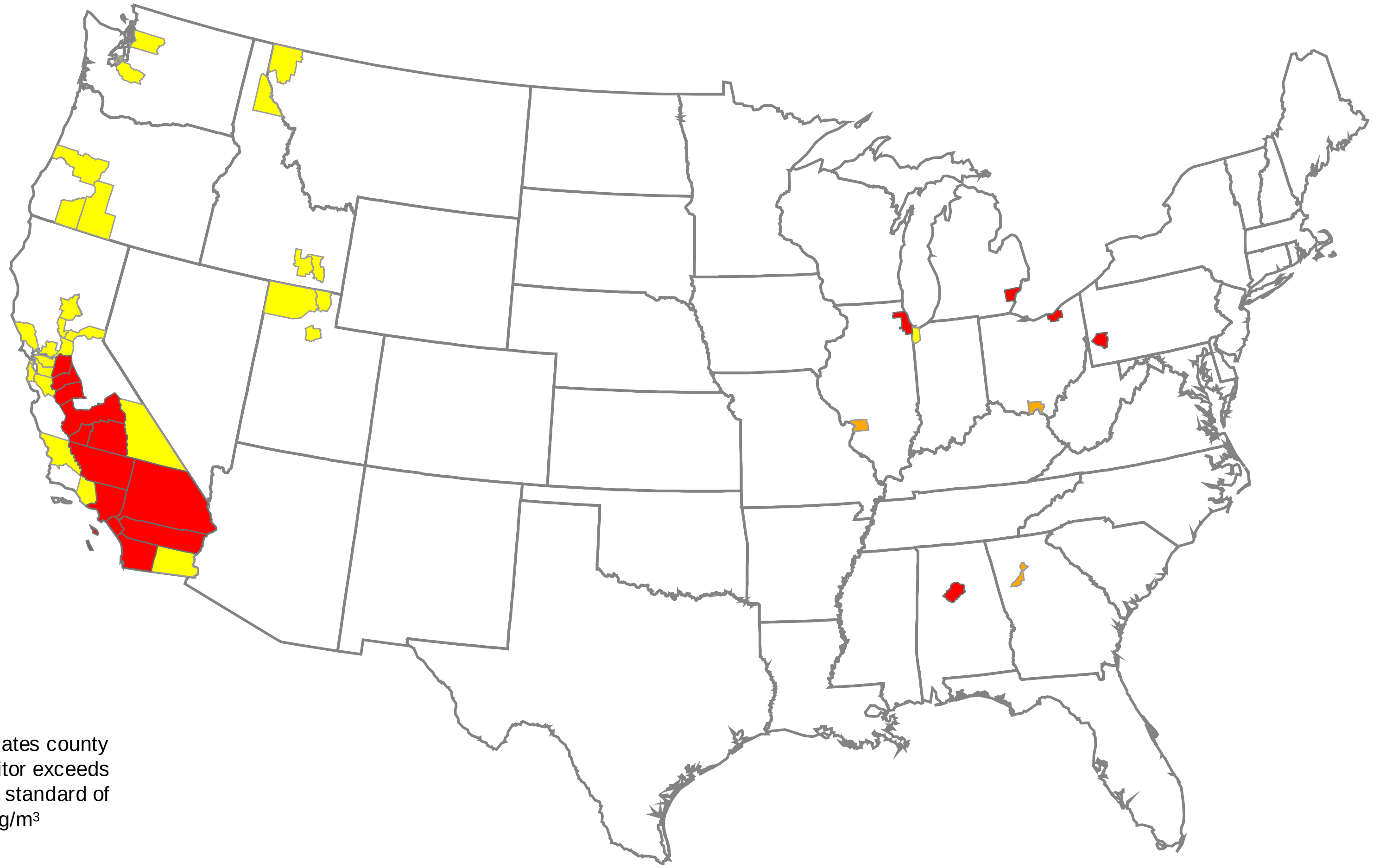
PM2.5 NAAQS Implementation Schedule

April 2005	Area designations for 1997 PM2.5 NAAQS
Dec. 2006	Effective date for revised 2006 PM2.5 NAAQS
Dec. 2007	States recommend designations for revised PM2.5 24-hour standard
April 2008	State plans due for PM2.5 annual std.
Dec. 2009	Final designations for revised PM2.5 24-hr std
April 2010	Effective date for revised PM2.5 24-hr std area designations
Apr 2010-15	Attainment date for 1997 PM2.5 annual std
April 2013	State plans due for revised PM2.5 24-hr std.
April 2015-20	Attainment date for revised PM2.5 24-hr std

Counties Projected to Violate the Revised $PM_{2.5}$ NAAQS in 2020

With CAIR/CAMR/CAVR and Some Current Rules** Absent Additional Local Controls



Indicates county monitor exceeds daily standard of 35 µg/m^3

Indicates county monitor exceeds annual standard of 15 µg/m^3

Indicates county monitor exceeds both the annual standard of 15 µg/m^3 and the daily standard of 35 µg/m^3

Counties Projected to Exceed Revised Standards

	Annual and Daily	*Annual Only*	*Daily Only*
2015	18	2	32
2020	17	3	28

* Projections as of September 2006.
**Current rules include Title IV of CAA, NOx SIP Call, and some existing State rules

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Future Changes in the PM2.5 NAAQS

Final Staff Paper to the EPA Administrator for the 9/06 PM2.5 NAAQS revision offered two options:

1)retain the current annual standard of **15** ug/m3, or

2) lower the annual NAAQS to **12 to 14** ug/m3

Future Changes in the PM2.5 NAAQS

EPA's Clean Air Scientific Advisory Committee recommended that the annual PM2.5 NAAQS be lowered to **12 to 14** ug/m3

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Future Changes in the PM2.5 NAAQS

The EPA Administrator in 9/06 chose to retain the current annual PM2.5 NAAQS of **15** ug/m3

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Future Changes in the PM2.5 NAAQS

THERE IS A SIGNIFICANT RISK THAT THE NEXT REVISION OF THE PM2.5 NAAQS WILL LOWER THE ANNUAL PM2.5 NAAQS BELOW 15 ug/m3

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•**How will EPA and States Decide What Additional Emission Controls from What Source Categories Are Needed to Attain the Current PM2.5 NAAQS?**

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EPA -454/B-07-002
April 2007

Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Air Quality Analysis Division
Air Quality Modeling Group
Research Triangle Park, North Carolina

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What is a Model Attainment Demonstration?

An air quality modeling analysis that demonstrates attainment of the NAAQS due to specified air pollution emission control scenarios to be included in the SIP

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EPA Model Attainment Demonstration for Choosing New Emission Controls

$$P = RRF \times M$$

P= Future Predicted Design Concentration

M= Base Year Monitored Design Concentration

RRF= Ratio of Predicted Future to Base Year Design Concentration for a Given Control Scenario

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What Can an Electric Power Company Do?

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What Can an Electric Power Company Do?

I. Make Sure the Emissions Inventory Data Used for Your Facilities is Accurate

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ACCURATE?

- **Actual fuel use and activity levels in Base Year**
- **Projected fuel use and activity levels in Future Year**

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ACCURATE?

- **Gram-moles per second emission rate for each of 18 vapor phase air pollutants from each stack**

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ACCURATE?

- **Total PM2.5 emissions from each stack**

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ACCURATE?

- **Total PM2.5 fugitive emissions from plant roads, storage piles, conveyors and other fugitive sources**

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ACCURATE?

Speciation of Primary PM2.5 Stack and Fugitive Emissions into Seven Components

1. sulfates
2. nitrates
3. ammonium
4. organic carbon
5. elemental carbon
6. particle bound water
7. other inorganics

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ACCURATE?

- Stack gas exit parameters
- Fugitive emissions spatial geometry
- Other exit parameters

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ACCURATE?

Condensable PM2.5 (CPM)

- Lack of accurate emission factors in AP-42
- Stack test method 202 has sampling artifacts that overstate CPM
- New U.S. EPA stack test method under development for CPM

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ACCURATE?

Condensable PM2.5 (CPM)

Recommendation: For now use AP-42 emission factors to develop emissions inventory of total PM2.5 = filterable + CPM

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ACCURATE?

Condensable PM2.5 (CPM)

Recommendation: When new CPM stack test method is issued by EPA, test major sources of PM2.5 with new method and use results in the next PM2.5 SIP revision by 2013

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What Can an Electric Power Company Do?

II. Negotiate the Detailed Modeling Protocol Used to Predict Base Year and Future Year Concentrations

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Major Modeling Protocol Issues

1. Predict only at PM2.5 "Population-Oriented" Monitor Sites

2. Predict only 24-Hour Concentrations as Permitted for "Unique Population–Oriented Monitor Sites"

Major Modeling Protocol Issues

3. Exclude One or More of Your Power Plants from Local Scale Modeling

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Major Modeling Protocol Issues

HOW?

Demonstrate through local scale modeling that they are small contributors to the total PM2.5 concentration at each PM2.5 monitor site exceeding the NAAQS

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Major Modeling Protocol Issues

4. Increase the Organic Carbon (OC) and Other Particulate Matter (PM) Emissions from Motor Vehicles

- The current OC emission factor used for motor vehicles may be as much as a **factor of three low.**

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Major Modeling Protocol Issues

4. Increase the Organic Carbon (OC) and Other Particulate Matter (PM) Emissions from Motor Vehicles

New test results of OC emissions from motor vehicles will be available in the Fall of 2007

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Major Modeling Protocol Issues

4. Increase the OC and Other PM Emissions from Motor Vehicles

- Government/Industry test program of particulate emissions from 480 motor vehicles just completed
- EPA expects to revise the motor vehicle emission factors for OC and other PM emissions

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Major Modeling Protocol Issues

4. Increase the OC and Other PM Emissions from Motor Vehicles

   EPA's upward revisions in OC and other PM emissions from motor vehicles may not be in time to affect the PM Model Attainment Demonstrations due April 2008

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Major Modeling Protocol Issues

4. Increase the OC and Other PM Emissions from Motor Vehicles

- **Conclusion:** Negotiate with EPA, your Regional Planning Organization and State to increase the Motor Vehicle OC and other PM emission rates used in the Model Attainment Demonstrations

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Major Modeling Protocol Issues

5. Avoid Double Counting of Predictions from Regional and Local Scale Modeling

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What Can an Electric Power Company Do?

III. **Conduct Sensitivity Analyses to Determine the Impact on the Future Design Concentration (P) of ZEROING OUT Emissions from Your Plants and from Other Source Categories**

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Sensitivity Analyses

- PM Sensitivity Analysis work is underway
- Following example is from an ozone Sensitivity Analysis

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IMPACT ON HIGHEST OZONE CONCENTRATIONS OF ZEROING OUT NOX EMISSIONS FROM ELECTRIC GENERATING UNITS, MOTOR VEHICLES AND OFF-ROAD ENGINES IN NONATTAINMENT AREA

National Air Quality Standard (ppb)	**84.9**
2009 Emissions Inventory	**Highest 2009 Concentration**
On the Books Controls	**89.3**
Zero Out NOx Emissions from All **EGUs**	**89.3**
Zero Out Emissions from All **Non-Road Engines in Construction**	**86.8**
Zero Out Emissions from All **Motor Vehicles**	**86.3**

Sensitivity Analysis

Conclusions of Ozone Sensitivity Analyses:

1. Zeroing out NOx emissions from local power plants has no impact on highest ozone concentrations

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Sensitivity Analysis

Conclusions of Ozone Sensitivity Analyses:

2. Zeroing out local motor vehicle emissions or non-road engine emissions significantly lowers highest ozone concentrations

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Will Results for PM2.5 be Similar?

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Will Results for PM2.5 be Similar?

- In Urban Areas in the East and Midwest at Population-Oriented Monitor Sites, **Organic Carbon** and **Sulfates** are Typically the Largest Contributors to the Total Annual Average PM2.5 Concentration with **Nitrates** being a smaller contributor

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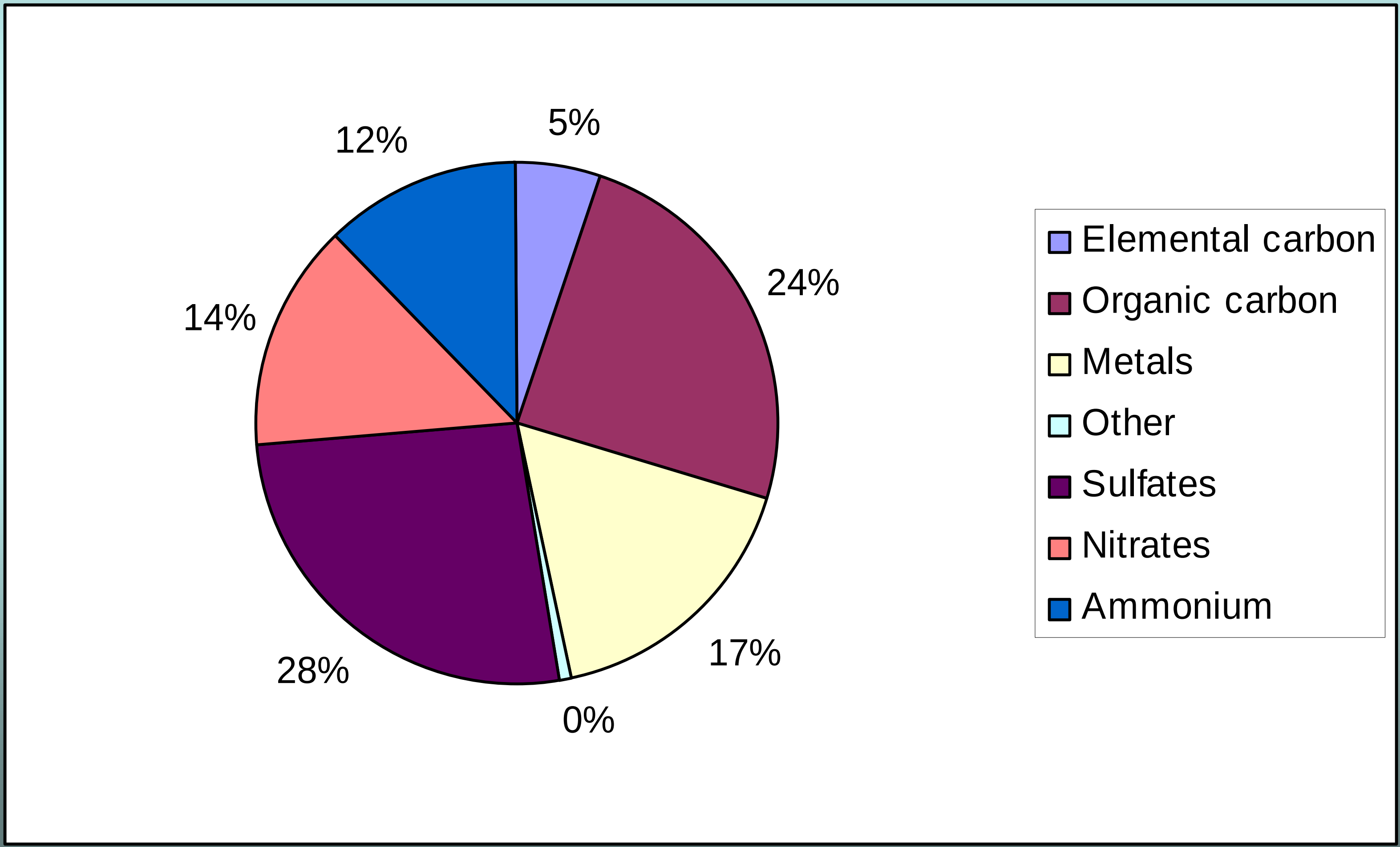
Typical Annual Average PM2.5 Concentration Speciation in Urban Areas of Eastern Half of the U.S.



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Will Results for PM2.5 be Similar?

- The dominant portion of the PM2.5 **organic carbon** concentrations typically are from local motor vehicle and off-road engine emissions **within the Nonattainment Area**

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Will Results for PM2.5 be Similar?

- Almost all of the PM2.5 **sulfate** concentrations and a portion of the **nitrate** concentrations are from distant sources of SO_2 and NO_x emissions **outside the Nonattainment Area**

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Will Results for PM2.5 be Similar?

Conclusion: YES

- Additional controls on PM2.5 and PM2.5 precursor emissions from local power plants are **not expected to help much** in lowering the highest PM2.5 concentrations in the Nonattainment Area

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Will Results for PM2.5 be Similar?

Conclusion: BUT

- Additional controls on SO_2 and possibly NO_x from distant power plants outside the Nonattainment Area are **expected to help more** in lowering the highest PM2.5 concentrations in the Nonattainment Area

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WHAT TO DO?

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What to Do?

1. If Annul PM2.5 concentrations are decreasing over time, consider changing the Base Year in the Model Attainment Demonstration to a more recent year

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What to Do?

2. Select a group of economically and politically feasible control scenarios to evaluate

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What to Do?

3. Determine the Cost Effectiveness of Different Control Scenarios by Calculating for each the Reduction in PM2.5 Annual Average Design Concentration per Unit Cost (ug/m3 per $ cost)

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What to Do?

4. Select the most cost effective control scenarios that are economically and politically feasible

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IV. Control Scenarios

- **Focus on Local Control Scenarios for Motor Vehicles**

- **Focus on Local Control Scenarios for Off-Road Engines**

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Control Scenarios for Heavy Duty Diesel Motor Vehicles (HDDVs)

PM Emission Standards for On-Road Heavy-Duty Diesel Vehicles	
Model Year	**Emission Rates (grams/bhp-hr)**
1989 and Earlier	0.60
1990	0.60
1991 - 1993	0.25
1994 - 2006	0.10
2007	0.01

Source: Emission Standards Reference Guide for Heavy-Duty and Nonroad Engines, US EPA, (http://www.epa.gov/otaq/cert/hd-cert/stds-eng.pdf)

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Control Scenarios for HDDVs

- The large majority of PM emissions from HDDVs is PM2.5
- More than 50% of PM emissions from on-road mobile sources in 2009 typically will be from HDDVs

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Control Scenarios for HDDVs

- **Control Option 1:** Modernize Private Sector HDDV Fleets with incentives to replace older vehicles/engines with ones meeting the 2007 PM emission standards

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Control Scenarios for HDDVs

- **Control Option 2:** Modernize Government Sector HDDV Fleets with incentives to replace older vehicles/engines with ones meeting the 2007 PM emission standard:
  - School buses
  - Refuse collection trucks
  - Other HDDVs

Control Scenarios for HDDVs

- **Control Option 3:** Speed limit and idling restrictions for HDDVs

Control Scenarios for Light Duty Gasoline Vehicles (LGVs)

- **Control Option 1:** Expand Inspection and Maintenance Programs

- **Control Option 2:** Implement Vehicle Scrappage Program Incentives for Oldest Government and Private Sector Vehicles

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Local Control Scenarios for Non-Road Engines

- About **55%** of 2009 Non-Road PM emissions are from the Non-Road diesel equipment

- **Over 90%** of Non-Road Diesel Engine PM emissions are PM2.5

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Local Control Scenarios for Non-Road Engines

PM Emission Standards for Non-Road Diesel Engines		
Engine Size (hp)	**Model Year**	**Emission Rates (grams/bhp-hr)**
175-750	1996+	0.40
750+	2000+	0.40
175-300	2003+	**0.15**
300-600	2001+	**0.15**
600-750	2002+	**0.15**
750+	2006+	**0.15**

Source: Emission Standards Reference Guide for Heavy-Duty and Nonroad Engines, US EPA, (http://w w w .epa.gov/otaq/cert/hd-cert/stds-eng.pdf)

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Local Control Scenarios for Non-Road Engines

Control Option 1. Modernize Non-Road Engines in Construction and Agricultural Sectors

Provide incentives to replace pre-2001engines having **0.4 or higher** gms/bhp with ones meeting the **0.15** gms/bhp standard

Local Control Scenarios for Non-Road Engines

Control Option 2. PM2.5 After Treatment Device Retrofits for Non-Road Engines

CONCLUSION

- Finding economically and politically feasible PM2.5 Control Scenarios that attain the PM2.5 annual NAAQS cost effectively may be difficult.

- The above approach provides ways that will help government and the electric power industry realize this goal.

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