Reinhold Environmental Ltd.

2007 APC Round Table & Expo Presentation

July 8-10, 2007
Chattanooga, TN
Hosted by TVA

Primary $PM_{2.5}$ Emission Measurement and Control

Presented by
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2007 APC/PCVG Conference
7-10-07 Chattanooga, TN

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Presentation Overview

- Definitions
- Legislation
- Industries Impacted
- Emission Measurement Methods
- Control Alternatives
- Cost Considerations
- Performance
- Risks

Definitions

- Particulate matter – A mixture of solid particles and liquid droplets found in the air.
- $PM_{2.5}$ – “Fine” particles that are $\leq$ 2.5 µm in diameter.
- PM_{10} – All particles $\leq$ 10 µm in diameter.

Definitions

- $PM_{10\text{-}2.5}$ – “Coarse Fraction” Thoracic course particles that are > 2.5 < 10 µm.
- “Primary” particles – Are emitted directly into the atmosphere.
- “Secondary” particles – Formed in the atmosphere from primary gaseous emissions.

Generalizations

- The chemical composition of particles depends on location, time of year, and weather.
- Coarse PM is composed largely of primary particles
- Fine PM contains many more secondary particles.

PM Standards History

- **1971** --National Ambient Air Quality Standards (NAAQS) for particulate matter (PM) established TSP High Volume.
- **1987--** the EPA changed the Indicator for PM from TSP to PM_{10}.
- **1997--** the EPA revised the form of the 24-hour (daily) PM_{10} NAAQS and established $PM_{2.5}$ as a new fine PM Indicator.

September 21st, 2006

- GPA revised two categories of particle pollution:
  - Fine Particles ($PM_{2.5}$), which are 2.5 micrometers in diameter and smaller; and
  - Inhalable Coarse Particles, which are larger than 2.5 micrometers and smaller than 10 micrometers in diameter.

- For more information go to http://www.epa.gov/air/particles

PM Components: fine

- <u>Fine Particles</u>
  (Combustion, gases to particles)
  - Sulfates/acids
  - Nitrate
  - Ammonium
  - Organics
  - Carbon
  - Metals
  - Water

- <u>Sources</u>:
  - Coal, Oil, Gasoline, Diesel, Wood Combustion
  - Transformation of SO_x to NO_x
  - Organic gases including biogenics
  - High temperature industrial processes (Smelters, steel mills, Forest fire).
- <u>Exposure/Lifetime</u>:
  - Lifetime, days to weeks, regional distribution over urban scale to 1000s of km

PM Components: coarse

- <u>Inhalable Coarse Particles</u> *(Combustion, gases to particles)*
  - Resuspended dusts
    - (soil, street dust)
    - Coal, Oil, Fly ash
    - Aluminum Silica
    - Iron-Oxides
  - Tire and break-wear
  - Inhalable Biological materials (e.g. soils, plant fragments)
- <u>Sources</u>:
  - Resuspension of dust tracked onto roads
  - Suspension from disturbed soil (farms, mines, unpaved roads)
  - Construction/demolition
  - Industrial fugitives
  - Biological sources
- <u>Exposure/Lifetime</u>:
  - Coarse Fraction (2.5-10) lifetime of hours to days, distribution up to 100s km

EPA’s PM Standards: Old and New

	1997 Standards		**2006 Standards**	
	Annual	**24-hour**	**Annual**	**24-hour**
PM2.5 (Fine)	**15 μg/m^3** Annual arithmetic mean, averaged over 3 years	**65 μg/m^3** Annual arithmetic mean, averaged over 3 years	**15μg/m^3** Annual arithmetic mean, averaged over 3 years	**35μg/m^3** 24- hour average, 98th percentile, averaged over 3 years
PM10 (Coarse)	**50μg/m^3** Annual average	**150μg/m^3** 24-hr average 99th percentile	**Revoked**	**150μg/m^3** 24-hr average single expected exceedance averages over 3 years

Expected Timeline for Revised PM2.5 NAAQS

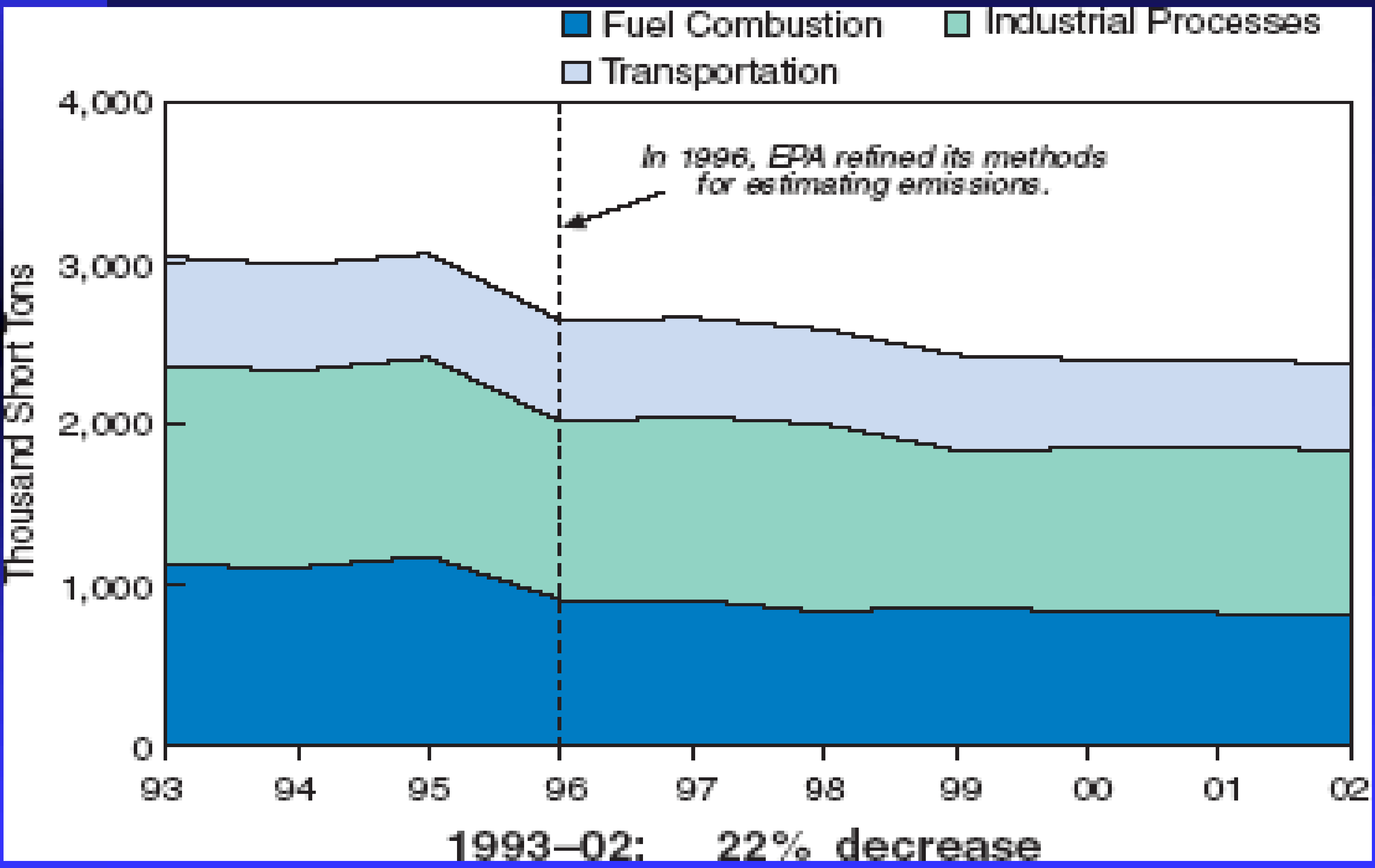
Milestone	**1997 $PM_{2.5}$ Primary NAAQS**	**2006 $PM_{2.5}$ Primary NAAQS**
Promulgation of Standard	July 1997	Sept. 2006
State Recommendations to EPA	Feb. 2004 (based on 2001-2003 monitoring data)	Dec. 2007 (based on 2004-2006 monitoring data)
Final Designations Signature	Dec. 2004	Dec. 2009
Effective Date of Designations	April 2005	April 2010
SIPs Due	April 2008	April 2013
Attainment Date	April 2010 (based on 2007-2009 monitoring data)	April 2015 (based on 2012-2014 monitoring data)
Attainment Date with Extension	Up to April 2015	April 2020

National PM_{10} Emission Trends

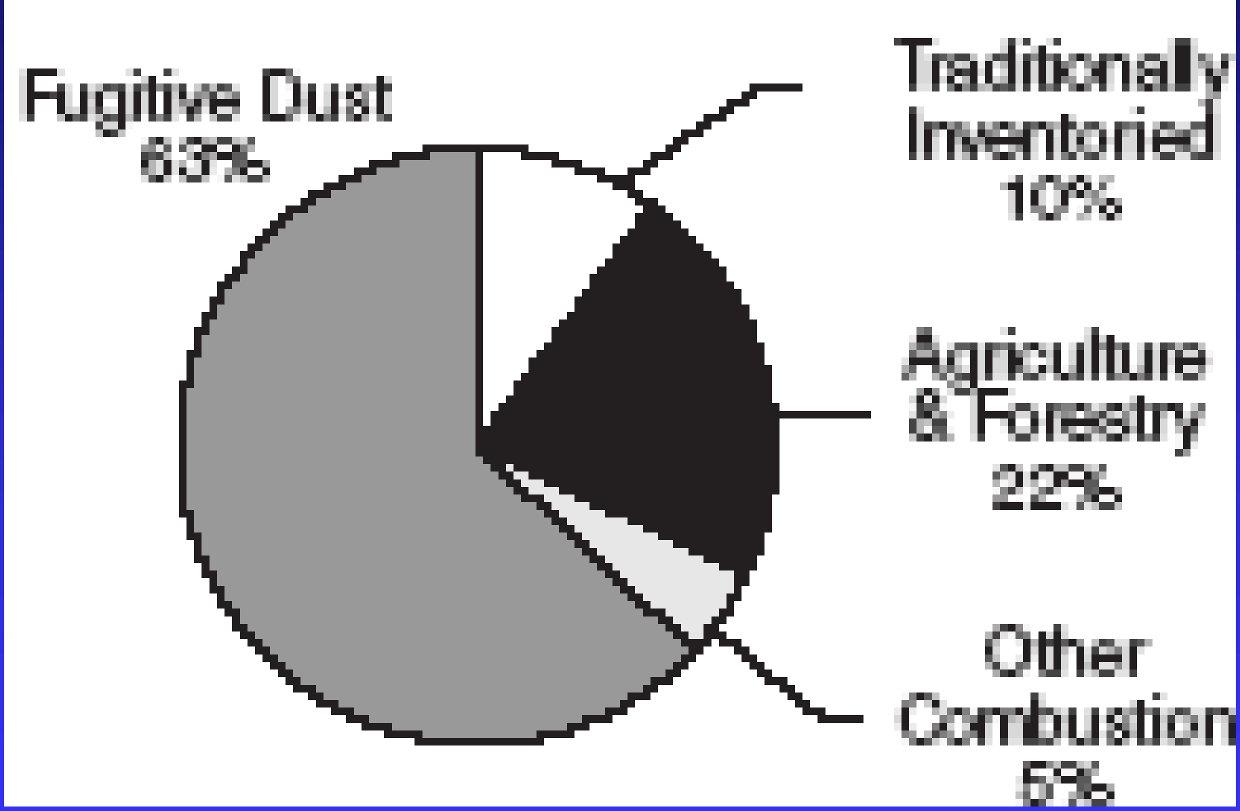
Group 1

- Direct PM_{10} emissions are generally examined in two separate groups.
- Emissions from the more traditionally inventoried sources, which decreased 22 % nationally between 1993 and 2002.
- These sources include fuel combustion, industrial processes, and transportation.
- Fuel combustion saw the largest decrease over the 10-yr period (27 %).

National direct PM_{10} emissions, 1993–2002 (traditionally inventoried sources only).



National direct PM_{10} emissions by source category, 2002



$PM_{2.5}$ Program Objectives

- Method Development
- Establish 1200 monitoring sites
- Develop Speciation program
- Collect, measure & store data
- Develop Special Speciation studies (Supersites) program
    - Health effects
    - Emission source apportionment (SIPS)

Trends in $PM_{2.5}$

- Direct $PM_{2.5}$ emissions from man-made sources decreased 17 percent nationally between 1993 and 2002.
- Does not account for secondary particles, which typically account for a large percentage of $PM_{2.5}$.
- The principal secondary particles are Sulfates, Nitrates, and Organic Carbon.

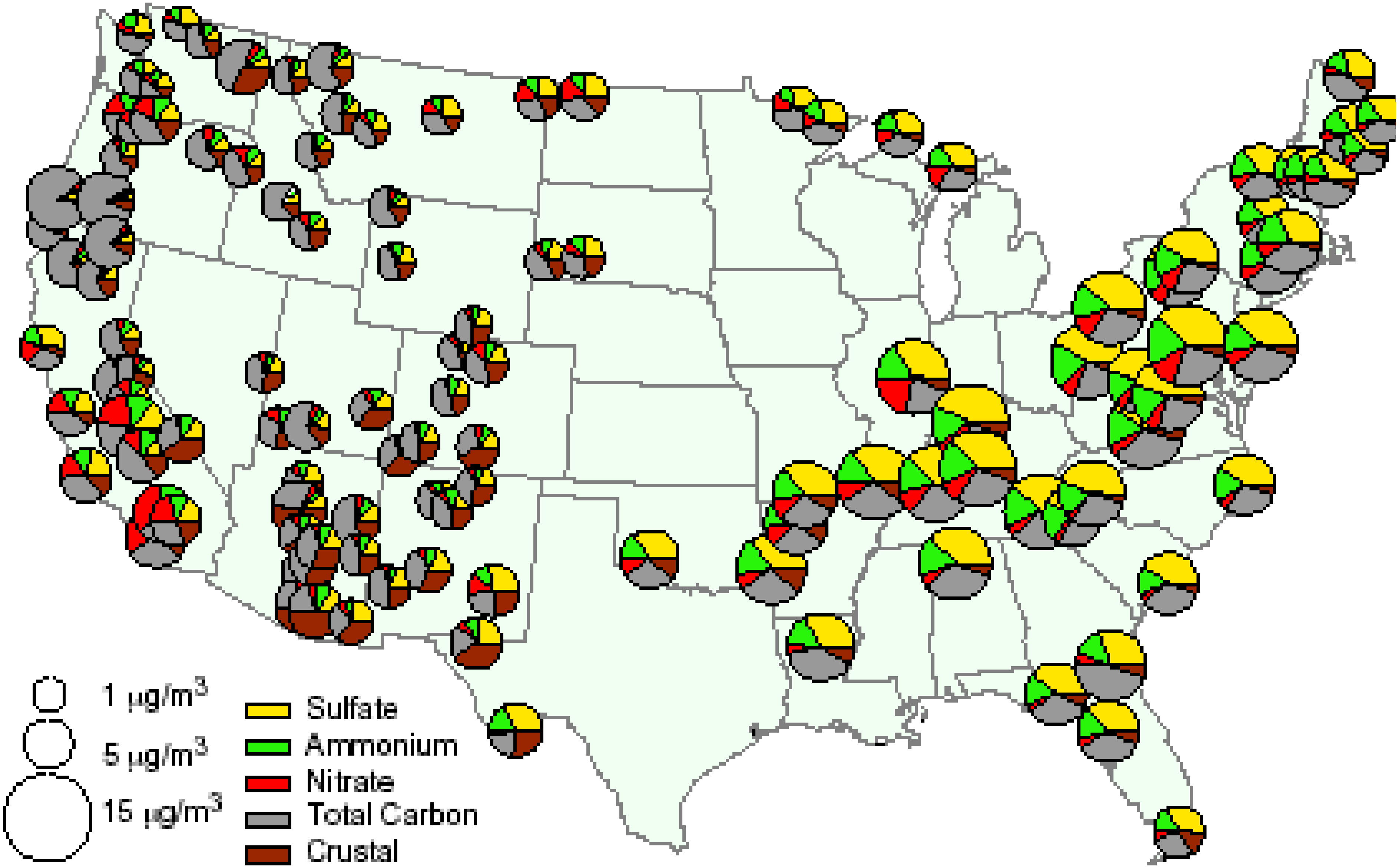
National Monitoring Network

- In 1999, EPA deployed a monitoring network to measure $PM_{2.5}$ concentrations nationwide.
- EPA has begun to examine trends at the national level.
- Annual average $PM_{2.5}$ concentrations decreased 8 percent nationally 1999 to 2002.

National Monitoring Network

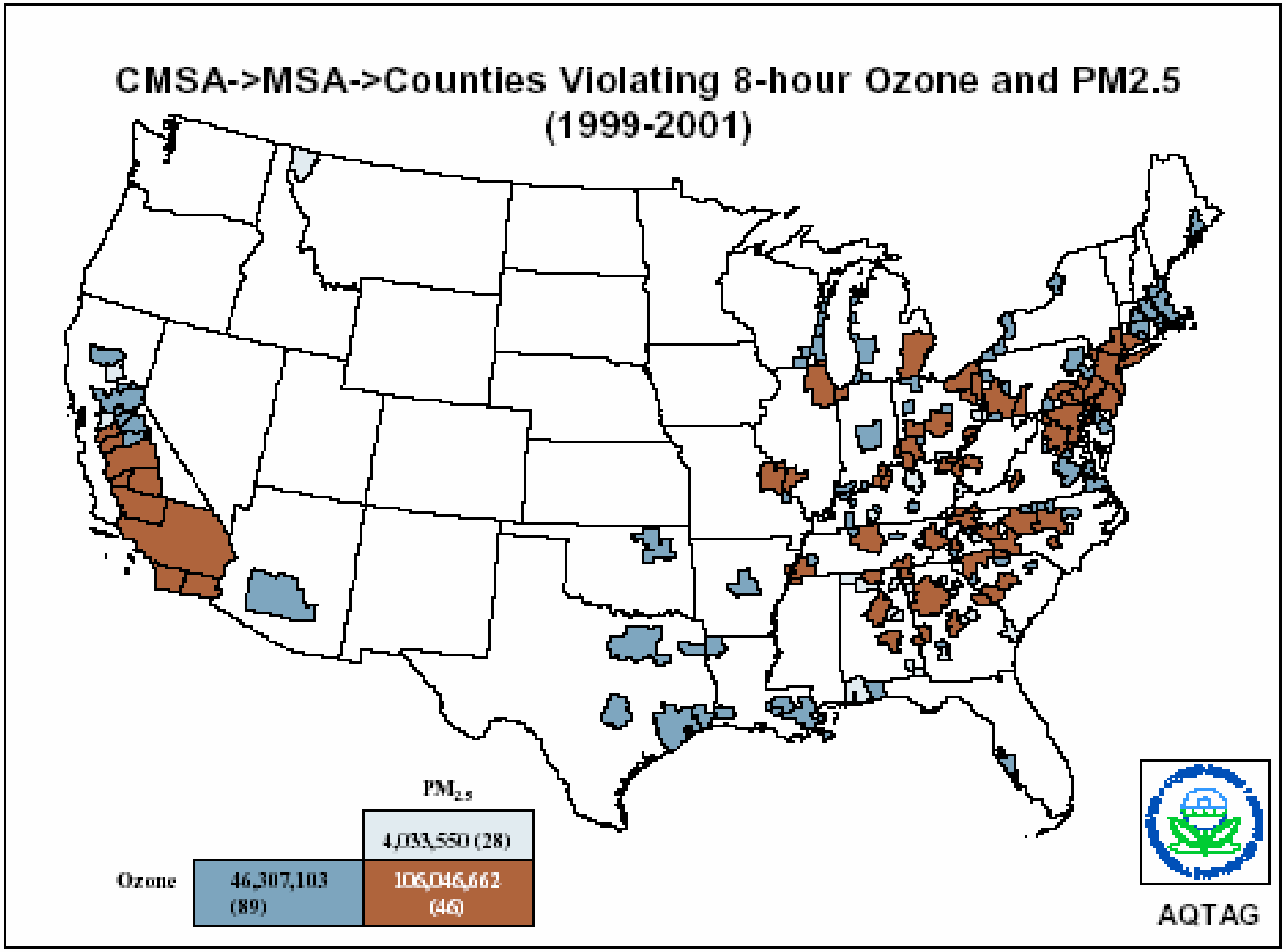
- Much of reduction occurred in Southeast where the monitored levels of $PM_{2.5}$ decreased 18 percent from 1999 to 2002.
- Lower annual average concentrations in the Southeast can be attributed, in part, to decreases in Sulfates, which largely result from power plant emissions of SO_2.

Annual Average PM$_{2.5}$ Concentrations ($\mu g/m^3$) and Particle Type in Rural Areas, 2002



Source: Interagency Monitoring of Protected

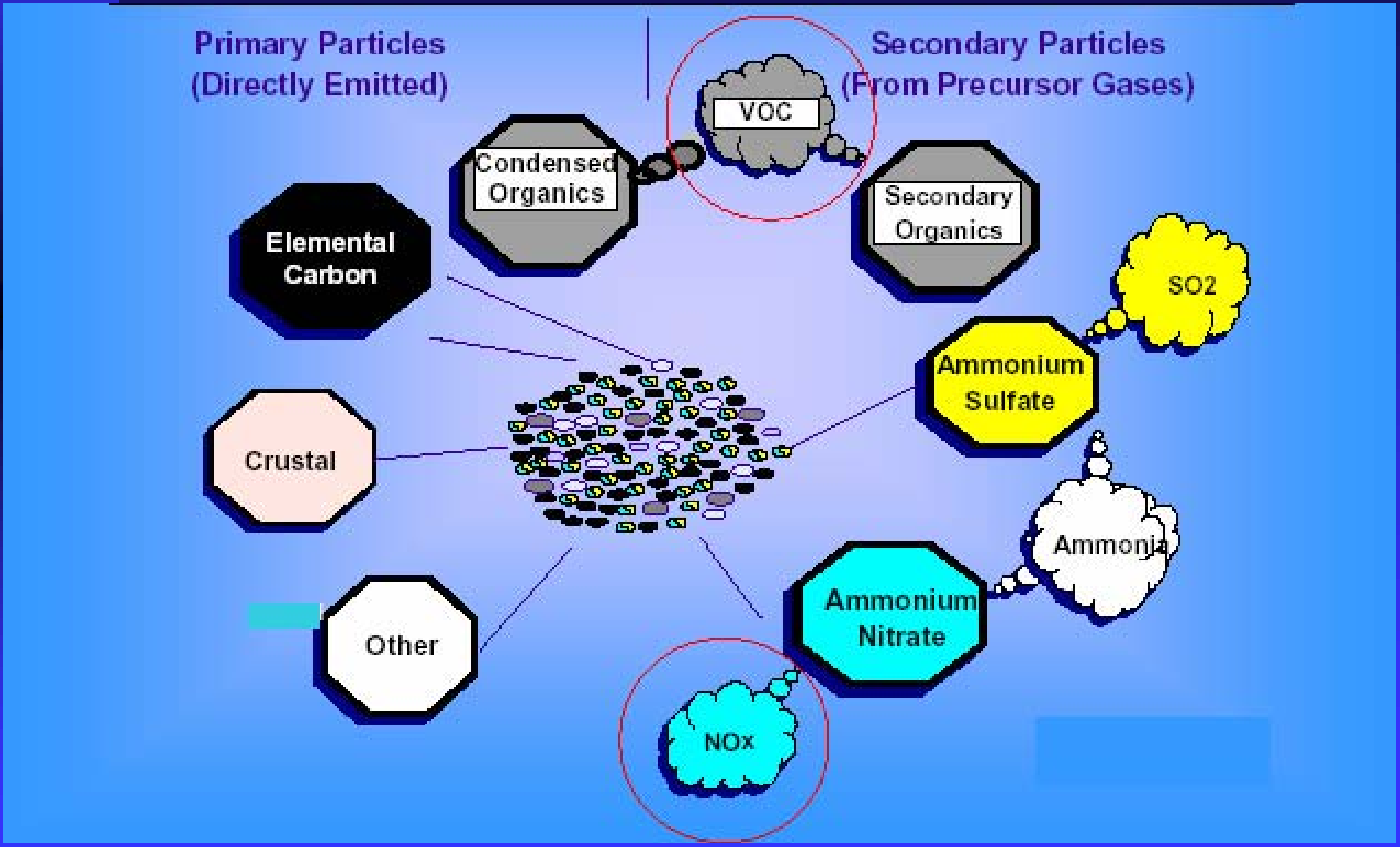
Together, Elevated Ozone and $PM_{2.5}$ Occur in Many Areas



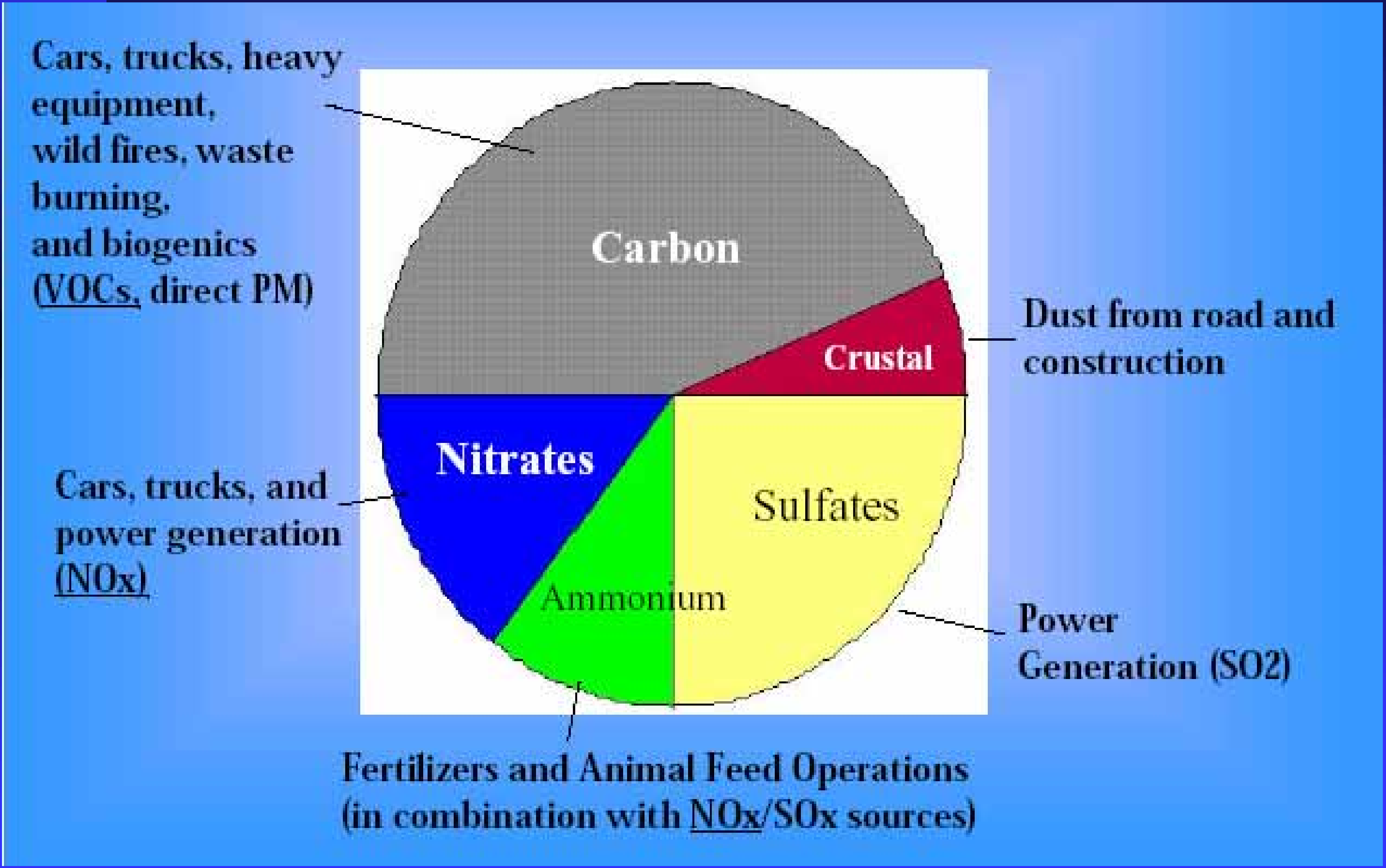
CMSA->MSA->Counties Violating 8-hour Ozone and PM2.5 (1999-2001)

Data from AQS (7/02)

What emissions sources are major contributors to Ozone and $PM_{2.5}$?



Automobiles, power generation, and other sources contribute to $PM_{2.5}$ levels



Cars, trucks, heavy equipment, wild fires, waste burning, and biogenics (VOCs, direct PM)

Dust from road and construction

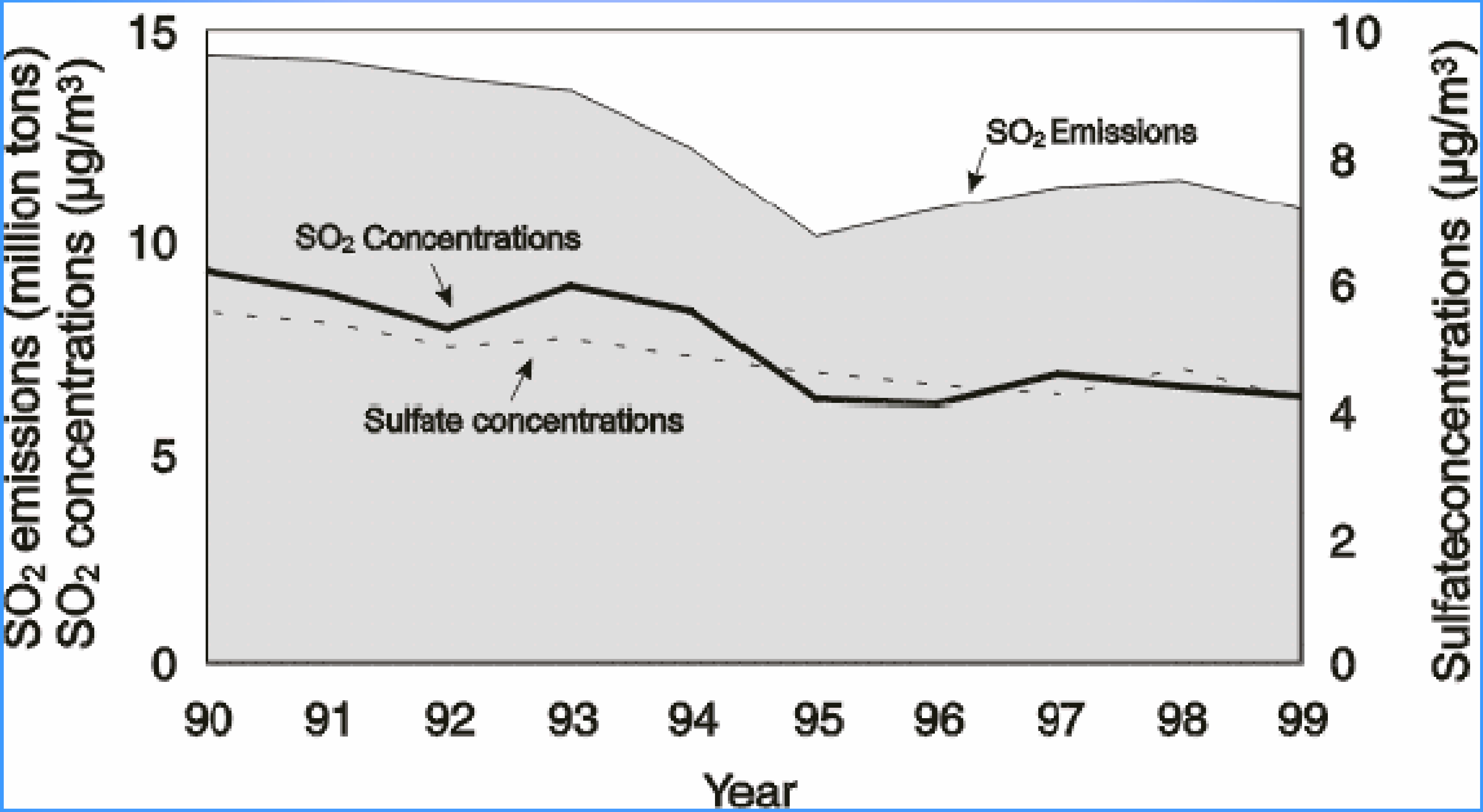
Cars, trucks, and power generation (NOx)

Power Generation (SO2)

Fertilizers and Animal Feed Operations (in combination with NOx/SOx sources)

SO4 in the east track SO2 emissions from power plants

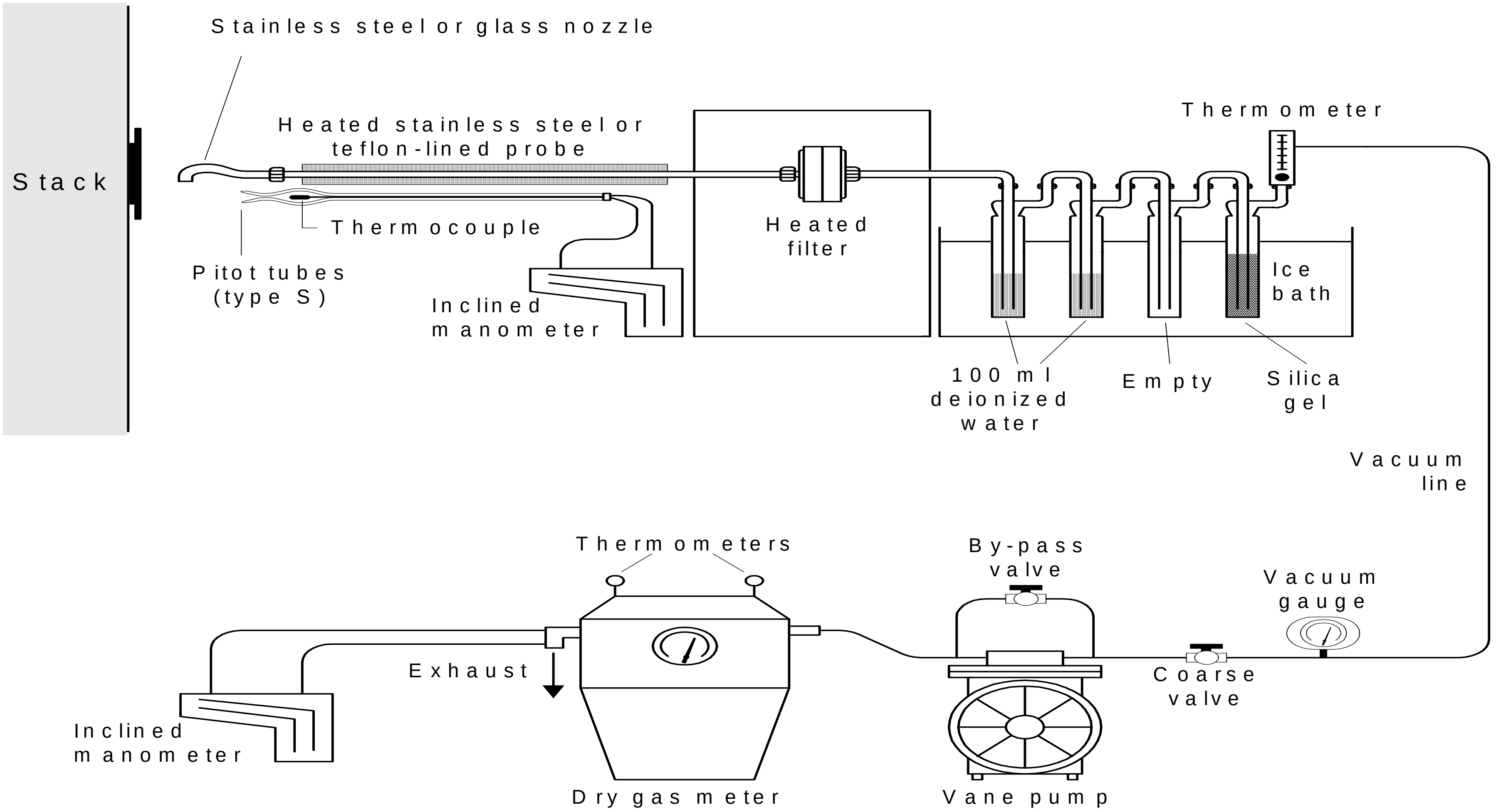
(sulfates are one of the largest component of PM2.5 in the East)



PM Emission Test Methods

Method 5	PM stationary sources
Method 17	In-stack filtration
Method 201	PM/PM$_{10}$ EGR procedure
Method 201A	PM/PM$_{10}$ CSR procedure
Method 202	Condensible particulate
CTM 39	Dilution Tunnel
CTM 40	No Condensibles

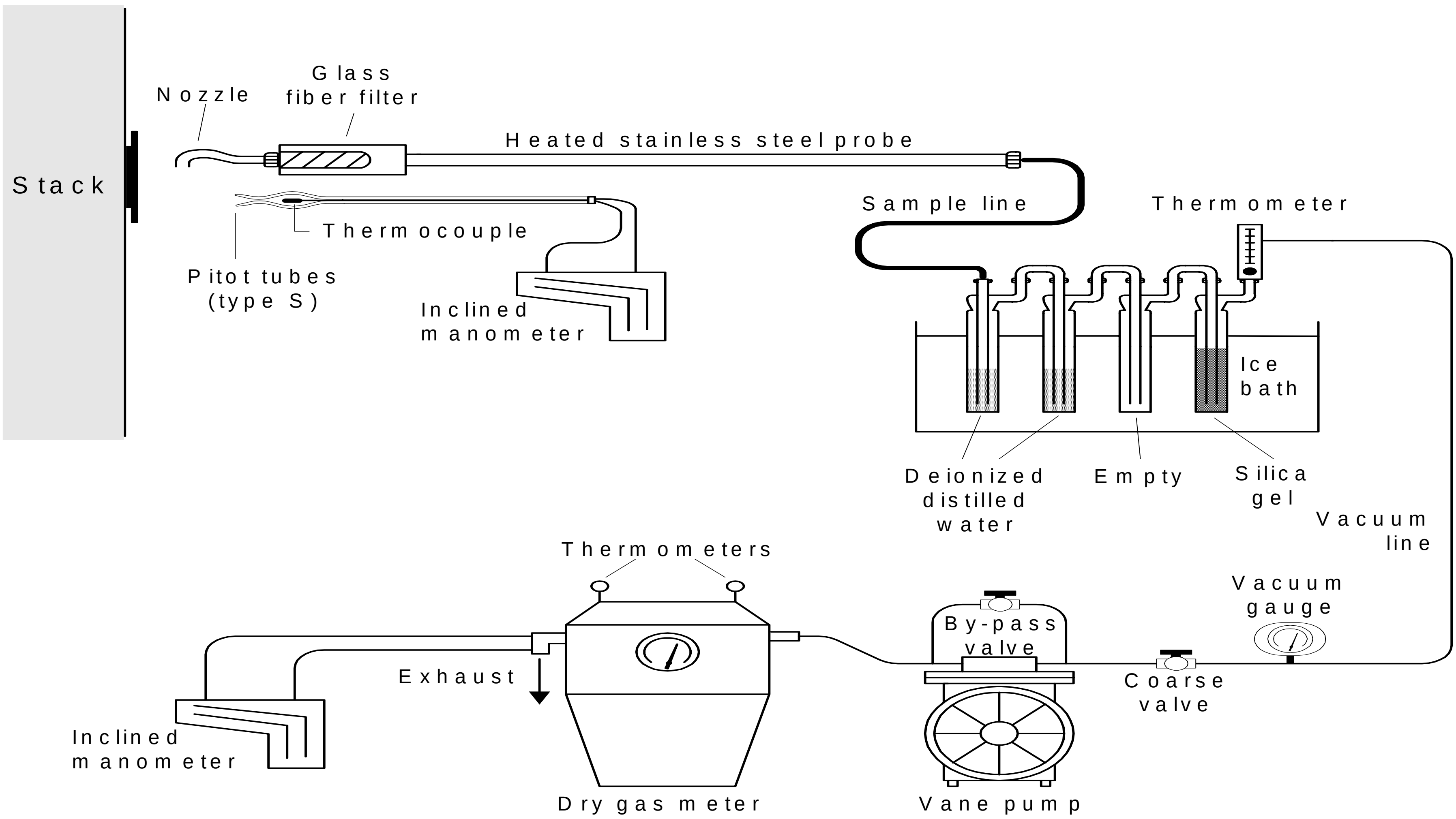
EPA Method 5 (*Sampling Train*)



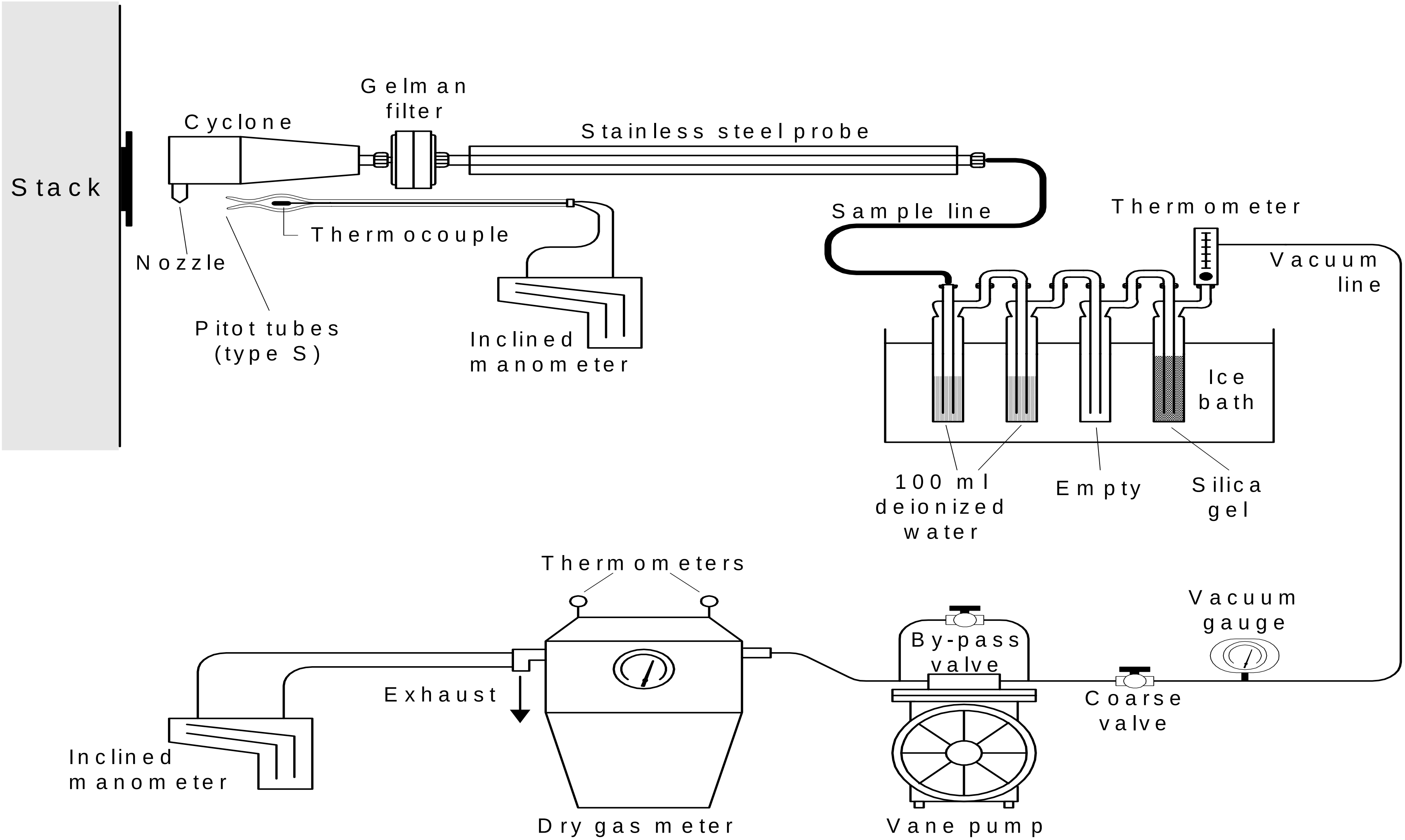
Method 5

- Measures ***total PM*** from stationary sources.
- Predominant test procedure used to measure PM mass emissions.
- Sampling train and isokinetic sampling procedures are the basis for many other EPA test methods.
- The sampling train and procedures have been adapted into other test methods.
- Relies on the use of EPA Test Methods 1 – 4.

EPA Method 17 *(Sampling Train)*



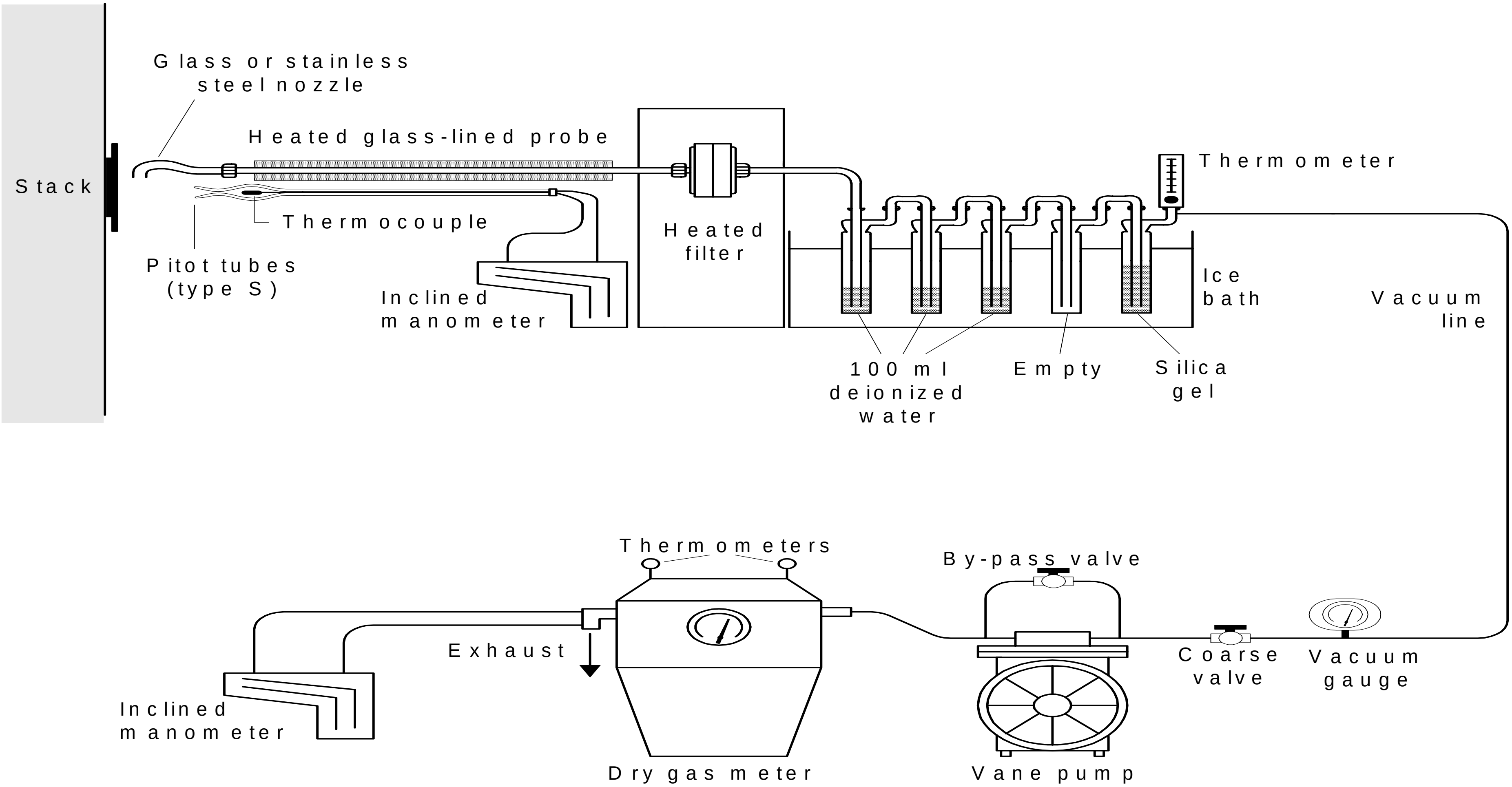
EPA Method 201A *(Sampling Train)*



Method 201A
Constant Sampling Rate Procedure

- A variation of Method 201, and may be used for the same purposes.
- Sample extracted at a constant flow rate via an in-stack sizing device, (separates PM greater than PM_{10}), attached to a PM sampling train.
- The sizing device can be either a specified cyclone or a calibrated cascade impactor.

EPA Method 202 Sampling Train



Method 202

- Determination of Condensible Particulate Matter (CPM) emissions from stationary sources.
- Represents condensible matter as material that condenses after passing through a filter.
- Condensible PM is collected in the impinger portion of a Method 17 type sampling train.
- The impinger contents are immediately purged after the run with Nitrogen gas to remove dissolved Sulfur Dioxide gases from the impinger contents.

Method 202

- The impinger solution is extracted with Methylene Chloride.
- The organic and aqueous fractions are taken to dryness and the residues weighed.
- The total of both fractions represents the condensible PM.
- There is the potential for low collection efficiency at oil-fired boilers with this method.
- To improve the collection efficiency at these sources, an additional filter should be placed between the second and third impinger.

Conditional Test Method 39

- Employs Ambient Analysis methods.
- Designed for Speciation.
- Calculations and setup same as 201A.
- Additional calculations for $PM_{2.5}$ sizer, the dilution setup and Venturi for monitoring sampling rate.

Project Goals

- Quantify Course & Fine PM
    - Use Dilution Sampling to Mimic Atmospheric Physics
    - Operationally Simple
    - Minimal Sample Location Limitations
- Speciation of Particulate
- Minimize Pseudo Particulate Formation

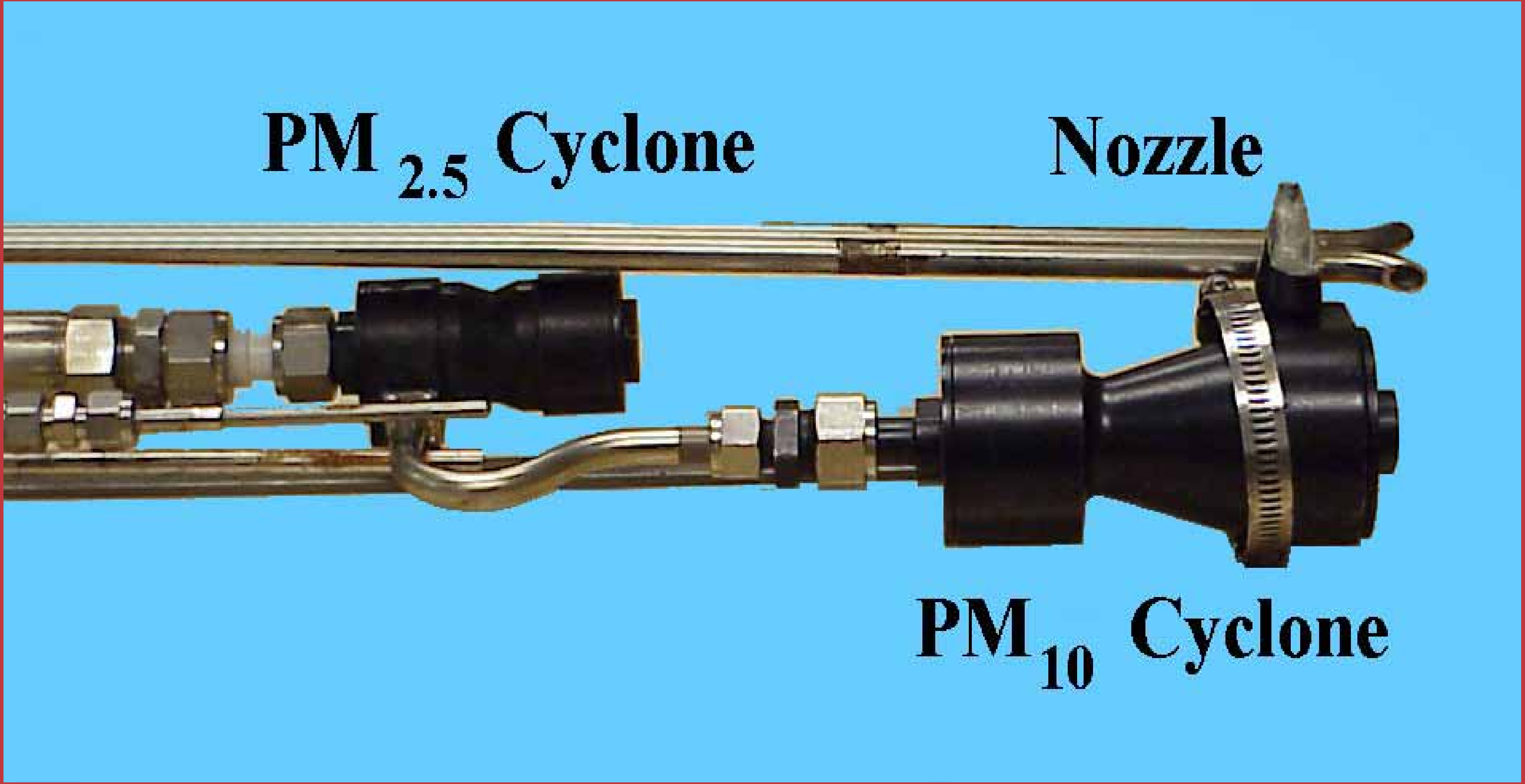
Description

- In Stack Particle Sizing
  - Large Cyclone Separates PM >10µM
  - Smaller Cyclone Separates PM >2.5µM
- Air Dilution Condenses Vaporous PM
  - Air is Filtered & Dehumidified
  - Sample is Diluted up to 40 to 1
- PM2.5 is collected on multiple filters

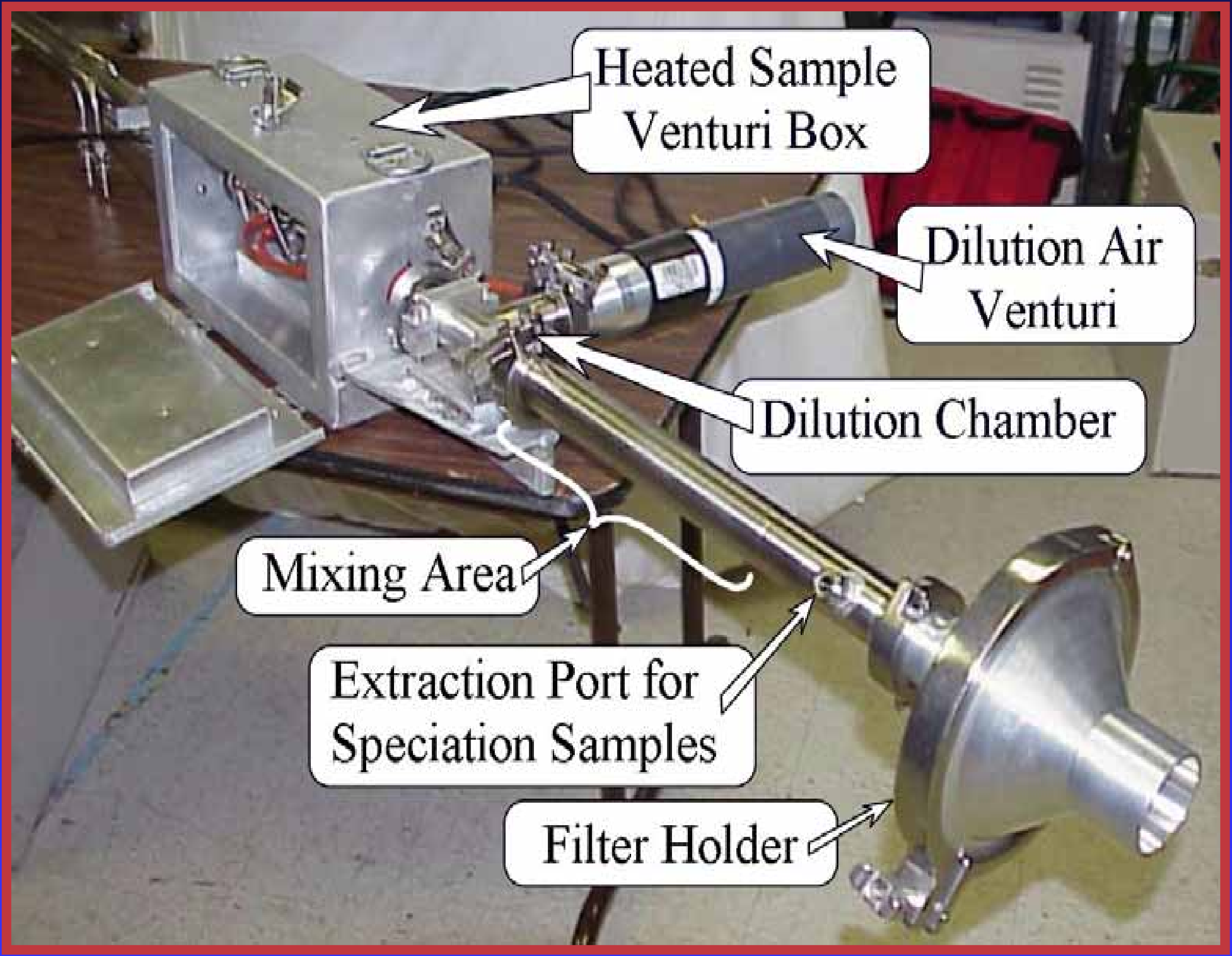
Competing Methodologies

- U.S. EPA Test Methods
    - Preliminary Method 004 (M201A +2.5)
    - Method 202
- State Test Methods
    - More Than Four Variants
    - Similar to Method 202
- Research Methods
    - More Than Six Variants
    - All Based on Dilution Sampling

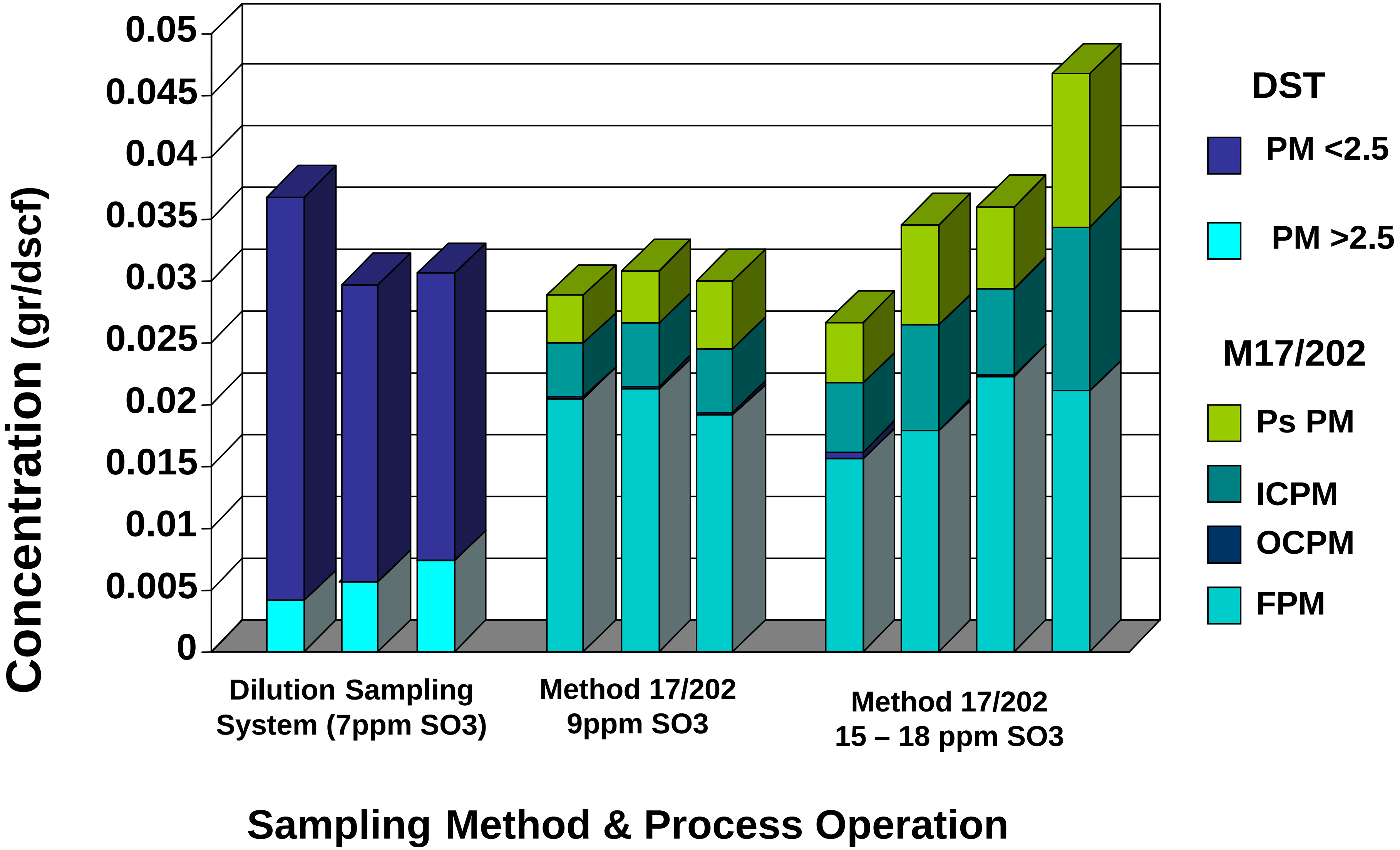
In Stack Particle Sizers



Major Components



Utility CFB Preliminary Results (2nd Test)



Ron Meyers Conclusions

- Many regions can use existing methods.
- Other regions need more comprehensive source methods.
- Depends on existing ambient levels.
- Choice can affect the future control decisions.
- CTM 40 plus Mtd 202 is suitable in some cases.
- Dilution Tunnel test can be the more prudent in other cases.

***EM April, 2006. p. 25**

Current* EPA Focus

- MTD 202 Revisions
- Reduce Sulfate Formation
  - i.e. Change Impinger Shape
- Reduce Options:
  - Nitrogen Purge – a must
- Promulgate 201A and 202 changes this year.
- 2008 Resume Work on CTM 39
- ASTM Progressing
  - i.e. CTM 39 consensus

***June 2007**

$PM_{2.5}$ Emission Control Options

- Commercial Candidates/Front Runners
  - ESP – Dry
  - ESP – Wet
  - FF – Pulse Jet
  - FF – Reverse Air
  - Sum Data
- Other Possible Options
  - Agglomerator
  - Panel Bed Filters
  - Scrubbers
  - Hybrids

Application vs. $PM_{2.5}$ Collection

ESP - Dry

APPLICATION, OUTLET EMISSION	TYPICAL ESP INLET % LESS THAN 2.5 MICRONS	TYPICAL PM-2.5 COLLECTION EFFICIENCY	TYPICAL ESP INLET MASS LOADING	TYPICAL PM-2.5 MASS LOADING COLLECTED
Utility - Eastern Bituminous Coal, 0.03 LB/MMBTU	11 %	98+ %	8.5LB/MMBTU	0.92 LB/MMBTU
Utility – PRB Coal 0.03 LB/MMBTU	50 %	99+%	6.0LB/MMBTU	2.53 LB/MMBTU
Biomass, 0.01 GR/SDCF	50 %	99+%	3 GR/SDCF	1.49 GR/SDCF
FCCU - Two stages of cyclones, 1 LB/KLB	60 %	85+%	20 pounds per 1000 pounds of coke burn-off	11.1 pounds per 1000 pounds of coke burn-off
FCCU – With third stage separator, 1 LB/KLB	90 %	50+%	2 pounds per 1000 pounds of coke burn-off	0.8 pound per 1000 pounds of coke burn-off
Rock Processing Kilns, 0.02 GR/SDCF	5 %	99.6+%	100 GR/SDCF	4.98 GR/SDCF
Recovery Boilers, 0.01 GR/SDCF	90 %	99.8+%	10 GR/SDCF	9.99 GR/SDCF
Oil-Fired Boilers, 0.03 LB/MMBTU	70 %	85+%	0.3LB/MMBTU	0.18 LB/MMBTU

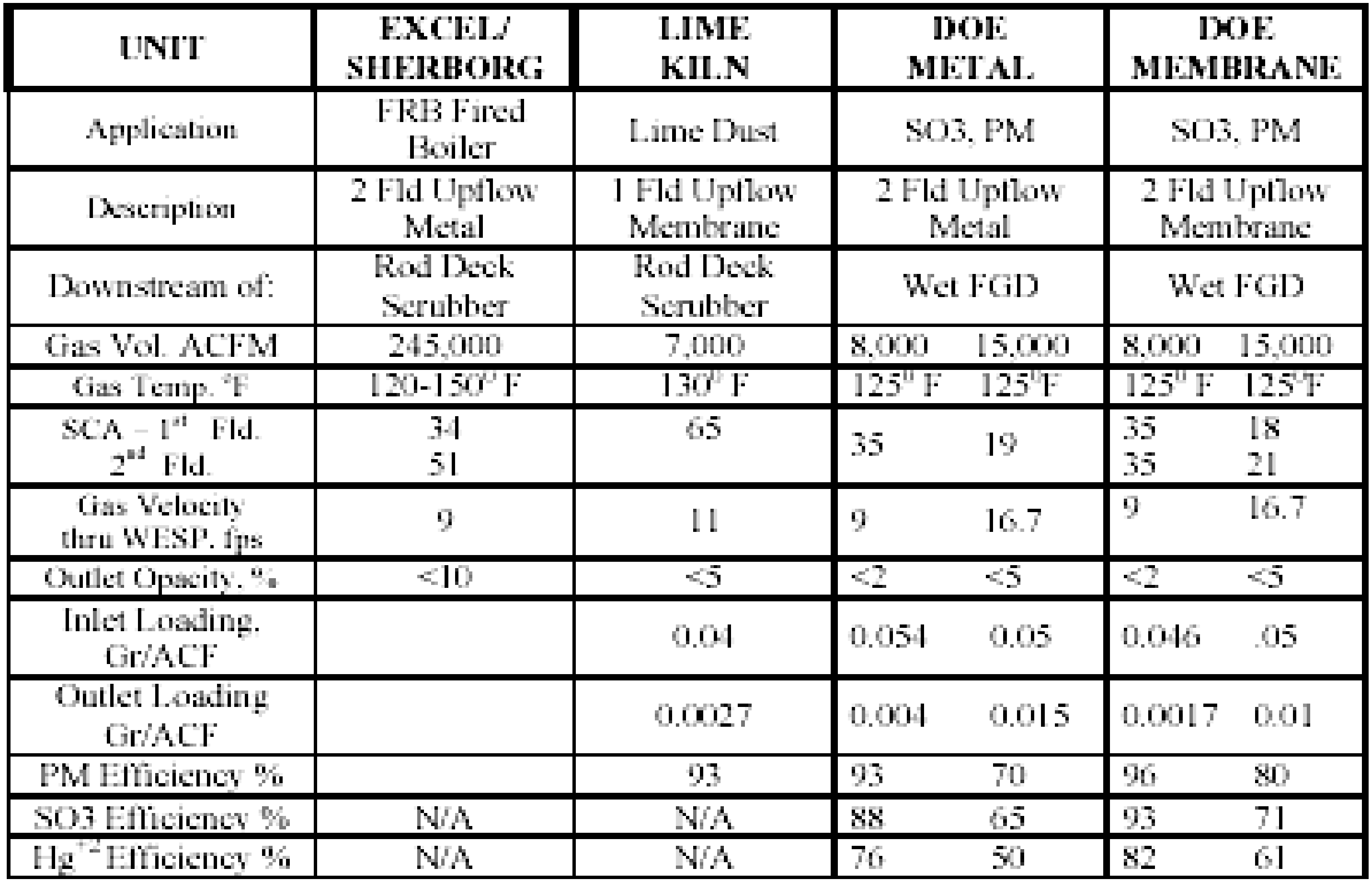
Mastropietro, R. 2007. Fine Particulate Collection Using Dry Electrostatic Precipitators. June 26-28. Presented at the 2007 A&WMA's 100th Annual Conference & Exhibition. Pittsburgh, PA.

WET ESP

- Used for 100 years in some industries
- Difficult applications (Sulfuric Acid mist)
- Utilities in Europe & Japan
- Possible ESP efficiency improvement
- Locate as the last field in dry ESP
- Avg collection eff. 95% (EPRI Pilot)
- 67% Sulfuric Acid & 30% Mercury

Performance Comparisons of One Full-size & 3 Pilot Units

ESP - Wet



UNIT	EXCEL/ SHERBORG	LIME KILN	DOE METAL		DOE MEMBRANE	
Application	FRB Fired Boiler	Lime Dust	SO3, PM		SO3, PM	
Description	2 Fld Upflow Metal	1 Fld Upflow Membrane	2 Fld Upflow Metal		2 Fld Upflow Membrane	
Downstream of:	Rod Deck Scrubber	Rod Deck Scrubber	Wet FGD		Wet FGD	
Gas Vol. ACFM	245,000	7,000	8,000	15,000	8,000	15,000
Gas Temp. °F	120-150° F	130° F	125° F	125°F	125° F	125°F
SCA – 1st Fld. 2nd Fld.	34 51	65	35	19	35 35	18 21
Gas Velocity thru WESP, fps	9	11	9	16.7	9	16.7
Outlet Opacity, %	<10	<5	<2	<5	<2	<5
Inlet Loading, Gr/ACF		0.04	0.054	0.05	0.046	.05
Outlet Loading Gr/ACF		0.0027	0.004	0.015	0.0017	0.01
PM Efficiency %		93	93	70	96	80
SO3 Efficiency %	N/A	N/A	88	65	93	71
Hg^{+2} Efficiency %	N/A	N/A	76	50	82	61

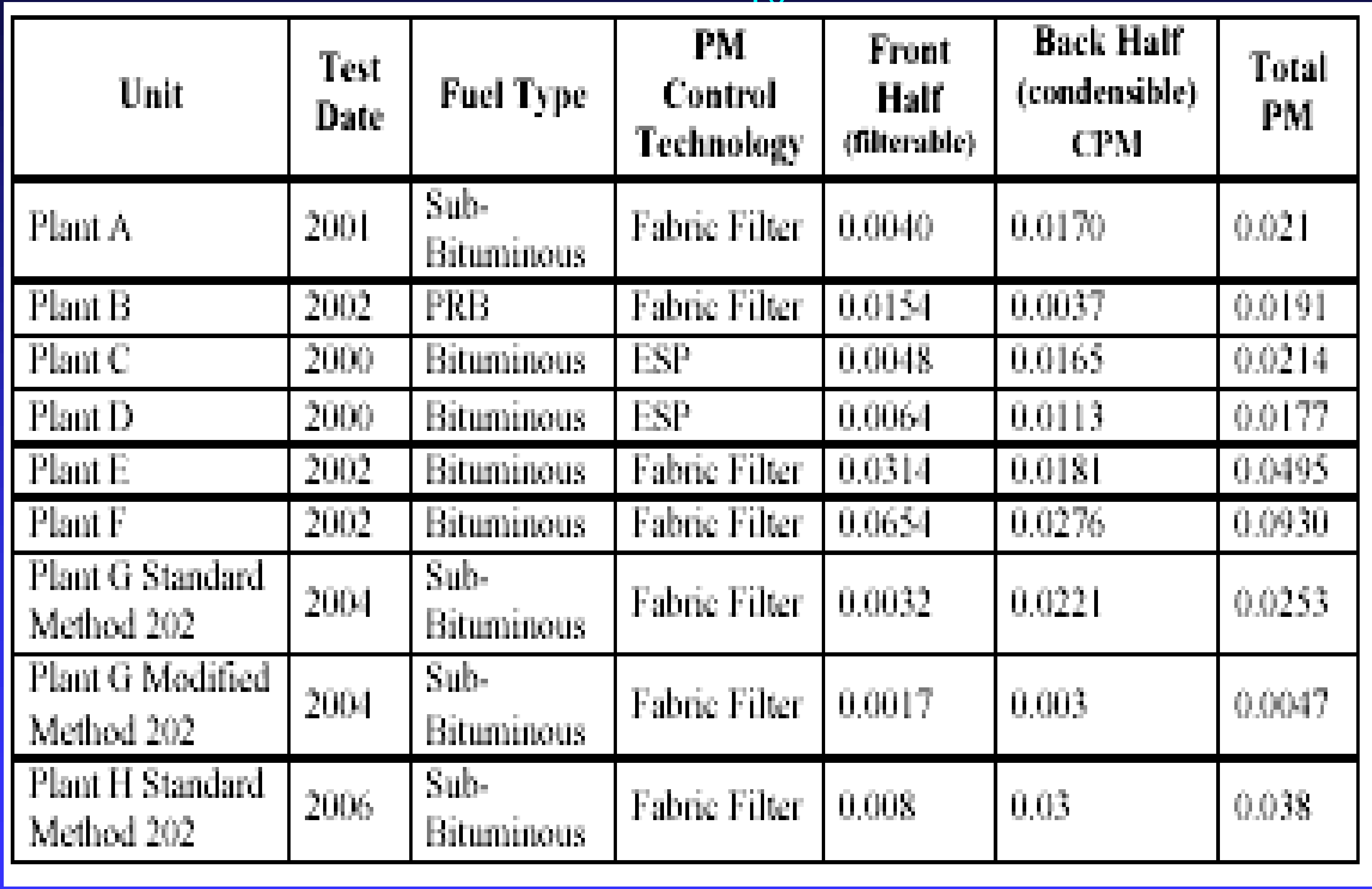
Caine, J. 2007. Membrane WESP-A Lower Cost Technology for Multi-Pollutant Control. June 26-28. Presented at the 2007 A&WMA's 100th Annual Conference & Exhibition., Pittsburgh, PA.

ETV/BFP Filtration Performance

Vendor	$PM_{2.5}$ Outlet (gr/dscf)	Total PM (gr/dscf)	Average Residual P (in w.g.)	# Cleaning Cycles
1. **Donaldson Co.**	0.0000034	3.4×10^{-6}	1.56	162
2. **S. Filter Media**	0.000022	2.5×10^{-5}	1.89	309
3. **Gore & Assoc.**	< 0.000007	$< 0.7 \times 10^{-5}$	0.96	87
4. **BWF America**	0.0000086	8.6×10^{-6}	1.61	252

Summary of the Available Filterable Condensible Contributions for Total PM_{10} Measurements.

Summary Data



Unit	Test Date	Fuel Type	PM Control Technology	Front Half (filterable)	Back Half (condensible) CPM	Total PM
Plant A	2001	Sub-Bituminous	Fabric Filter	0.0040	0.0170	0.021
Plant B	2002	PRB	Fabric Filter	0.0154	0.0037	0.0191
Plant C	2000	Bituminous	ESP	0.0048	0.0165	0.0214
Plant D	2000	Bituminous	ESP	0.0064	0.0113	0.0177
Plant E	2002	Bituminous	Fabric Filter	0.0314	0.0181	0.0495
Plant F	2002	Bituminous	Fabric Filter	0.0654	0.0276	0.0930
Plant G Standard Method 202	2004	Sub-Bituminous	Fabric Filter	0.0032	0.0221	0.0253
Plant G Modified Method 202	2004	Sub-Bituminous	Fabric Filter	0.0017	0.003	0.0047
Plant H Standard Method 202	2006	Sub-Bituminous	Fabric Filter	0.008	0.03	0.038

Nicolo, R. 2007. Fine Particle Measurement and Control. June 26-28. Presented at the 2007 A&WMA's 100th Annual Conference & Exhibition., Pittsburgh, PA.

ESP & FFBH
Size & Cost Comparisons 2006

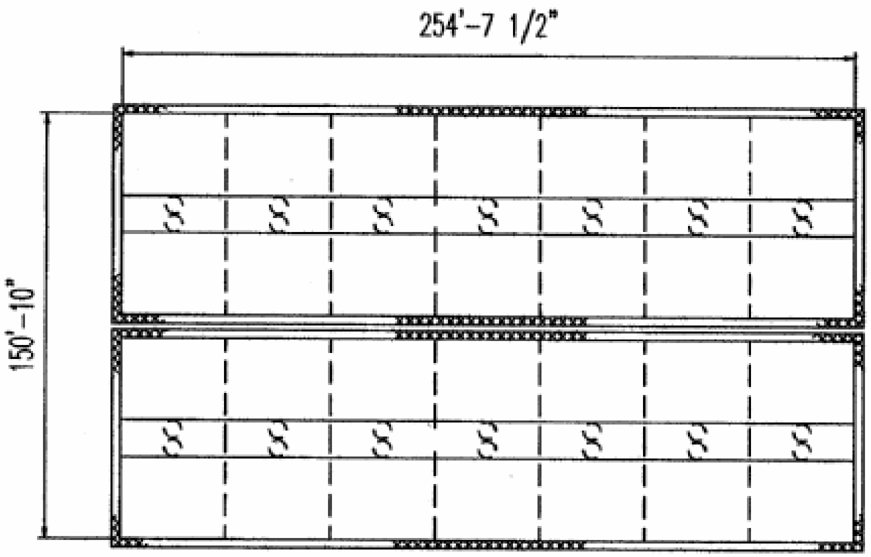
Assumptions

- Inlet Volume to Baghouse/ESP = 3,000,000 ACFM
- Normal Operating Temperature = 280 °F
- Coal Sulfur Content = 3.0%
- Outlet Particulate from Baghouse/ESP = 0.02 lb/MMBtu

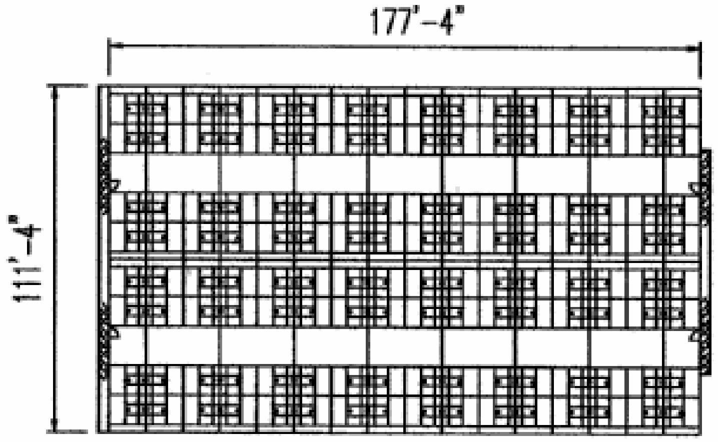
Introduction
Technical Comparison

Cleaning Mtd.	**Reverse Air**	**Pulse Jet**	**ESP**
Air Pressure	Low	Compressed	NA
Filter Media	Woven	Felt	NA
Bag Diameter/Plate ga	12 inch	5 inch	18 ga
Bag Length/Plate Ht.	31.5 feet	26 ft	48 ft
Plate Spacing	NA	NA	16 in
Collect dust	Inside tube	Outside Tube	NA
Filtration via	Dust Cake	Felt + Dust	NA
No. of Casings	2	2	2
No. of Fields	NA	NA	4
No. of Chambers	NA	NA	3
Experience	30 years	15 years	>50 years

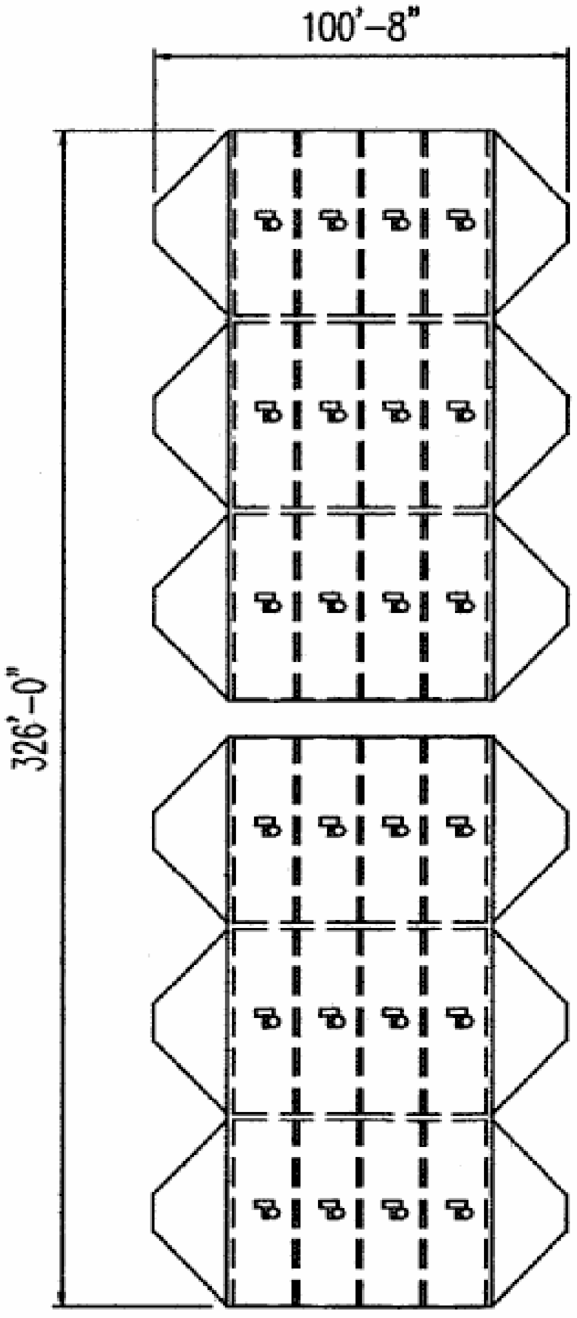
Size Comparison



PLAN VIEW
(Reverse Air Collector)



PLAN VIEW
(Pulse Jet Collector)



PLAN VIEW
(Electrostatic Precipitator)

Parts Comparison

- REVERSE AIR
- 13.5 oz. FG +Teflon B
- 35 ft L x 12 in D
- $125/bag
- 16,128 bags
- $2,016,000/bag set
- $225,792 labor
- $2,241,792 bag set+labor
- 9 yr life
  - $249,088/yr bags+labor

- PULSE JET
- 18 oz. PPS
- 26 ft L x 6 in D
- $70/bag
- 23,296 bags
- $1,630,720/bag set
- $163,072 labor
- $1,793,792 bag set+labor
- 6 yr life
  - $298,965/yr bags+labor

- ESP
- $340/insulator
- 192 insulators
- $65,280/192
- $35,000/other
- 5 yr life
- $4,400/TR set
- 24 TR sets
- $105,600/24 sets
- 5 yr life
  - $82,352/yr parts +labor

Annual Costs-ESP & Baghouse Fifteen Year Straight Line

Baglife: RA= 9 yr, PJ = 6 yr, ESP Insulators/TR = 5 yr

For comparison only & not for budgetary purposes

Interest charges not included

REVERSE AIR	PULSE JET- Mod.	ESP
$43,000,000 (house)	$25,000,000 (house)	$28,000,000 (stacked)
$2,867,000/yr (house)	$1,667,000/yr (house)	$1,867,000/yr (house)
$249,000/yr (bags)	$298,000/yr (bags)	$82,000/yr (insul./TR)
$3,116,000/yr	$1,966,000/yr	$1,949,000/yr

ESP Pros & Cons

- Advantages
  - 1- Low pressure drop
  - 2- High experience
  - 3- High temperature capability
- Disadvantages
  - 1- Very sensitive to fluctuations in gas stream conditions : flow, temperature, particulate & gas composition, dust loading
  - 2- Not effective in capturing some contaminants: heavy metals, dioxins

Baghouse Pros & Cons

- Advantages
  - Extremely high efficiency on both course & fine particulate
  - Relatively insensitive to gas stream fluctuations including flow, dust loading and particulate and gas composition
  - Future Issues
  - In the case of pulse jet relatively small “footprint”
- Disadvantages
  - Temperature limited by bag selection (500F max)
  - Relatively high flange to flange pressure drop
  - Bag change might require respiratory protection

Future Issues Favor Baghouse

- Control of Fine Particles-$PM_{2.5}$
- Mercury Control
- Coal Fluctuations
- Multi-pollutant Control

Summary Comparison

	RA	PJ	ESP
Initial Capital Cost Annual O&M Expense Total Annual Cost	$39 mil $231,000/yr $2,831,000/yr	$23 mil $280,000/yr $1,813,000/yr	$25 mil $77,000/yr $1,744,000/yr
SIZE (ft) Ht W L	84 151 255	81 111 177	85 326 101
Reliability yrs experience reported	30 Very Good/Excellent	15 Very Good	50+ Excellent
Flexibility - gas volume coal characteristics	Very Good Excellent	Very Good Excellent	Fair Fair/Poor
Future- Fine Particle Mercury	99.99% 90%* $1.5 mil/yr**	99.99% 90%* $1.5 mil/yr**	98% 60%* >$10 mil/yr**

* Sorbent efficiency **Carbon Injection comparative cost for mercury capture

Typical Guarantees

- Bag Life
- Emissions
- Pressure Drop
- Temperature Loss

Bag Life Guarantees & Emission Guarantees

- Bag Life Guarantees
  - 2 – 3 Year
  - Evergreen
- Emission Guarantees
  - Measured Concentration
  - Opacity

Pressure Loss Guarantees

- All Cells Active
- One Cell Cleaning
- One Cell Cleaning, One Cell Out for Maintenance

“Aggressive” States

- Florida
- Minnesota
- New Hampshire
- Wisconsin

Status Overview

- No states found with $PM_{2.5}$ emission limits
- No states are ahead of EPA on regulations re $PM_{2.5}$ from emission sources
- Exception - NM has a PM_2 emission reg.
- Some states are using the permitting process to require inclusion of condensibles
- Test methodology varies

Florida

- Does not set $PM_{2.5}$ emission limits
- Enforces PM_{10}
- Employs Method 5
- In attainment for $PM_{2.5}$

Minnesota

- No limit for $PM_{2.5}$
- No $PM_{2.5}$ predictive model yet
- PM test generally require condensibles
- Used to gauge permit limit compliance
- Also for emission inventory purposes
- Employs Mtd 5 “backend” or Mtd 202

Minnesota Publication

- Air Quality in Minnesota – Problems & Approaches.
- Particulate matter – “especially very small particles from combustion sources such as power plants…..are creating public health & ecological concerns now, at outdoor concentrations.
- “Fine particles …..estimated to be responsible for at least 70,000 deaths each year in the US……”

Minnesota Publication

- “vital to go beyond merely meeting federal air quality standards.”
- Goals: “By 2010 reduce emissions of pollutants that contribute to fine particles & ozone by 20 % from 2000 levels.
- Re-examine indirect source permitting program to help achieve reductions.

New Hampshire

- Does not require $PM_{2.5}$ permit limitations
- When PM_{10} testing required Methods 201A and 202 employed
- If older NSPS apply (asphalt plants) then employ Method 5 without “back-end”

NHDES Environmental News May/June 2000

- “We need to undertake an integrated approach to reducing emissions from the electric utility sector.”
- “From New Hampshire’s perspective , ensuring that EPA aggressively addresses $PM_{2.5}$ and Regional Haze issues will help improve not only public health , but also our tourist economy.”

Wisconsin

- Presently do not have $PM_{2.5}$ standards.
- PM limits include the “back-half.”
- Employ either 202 or “back-half.”
- Done to determine emission limit compliance.
- Adoption of federal 8-hr ozone & $PM_{2.5}$ ambient air standards – January 2005.

State Enforcement Issues

- Condensible Method Selection
- Condensible Method Application
- Data base significance
- Modeling emissions/ambient relationship
- CTM 39 adoption
- Court challenges

Risks Considerations

More Questions than Answers

“Performance” Risks

- It is becoming more and more common to include the condensibles in the total weight of the measured particulate emission.
- Performance guarantees in some cases include condensibles.
- For the provider of such a performance guarantee there is little relevant data available upon which to base a risk assessment of the guarantee.
- The technical issues include a number of yet unanswered questions.

Risks/Questions

- What is the impact on the condensible results of:
  - differences in the air pollution control equipment?
  - the application?
  - process or fuel changes? (e.g. Sulfur content of coal)
  - differences in the Air Pollution Control equipment train on the condensibles?

More Risk/Questions

- Which components of the condensibles {e.g. Nitrates, Sulfates, Hydrocarbons etc.} are the primary contributors?
- What modifications or additions to the control equipment and/or process/boiler operating conditions can significantly mitigate the amount of condensable particulate?

Data/Questions

- What data exists?
- Is it useful?
- What data is needed?
- How much will it cost?
- Who will pay—vendors, government?

Method/Questions

- **Vendor's Choice**

  Mtd 5 + "back-end", Mtd 201A + 202, CTM 39, Mtd 202 + CTM 40

- **Buyer's Choice**

  Compliance Today vs. Tomorrow's Method

Mercury/Toxics & Risks

- Control methods not yet final
- Leaning towards FF over ESP
- Selecting APCT today, maximize flexibility