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$PM_{2.5}$ Introduction

AWMA Meeting ♦ October 9, 2012

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Agenda

- Pollutant Description
- Current NAAQS/Designations
- Federal Modeling Requirements and Challenges
- State Modeling and Permitting Changes

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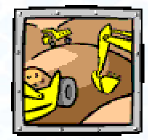
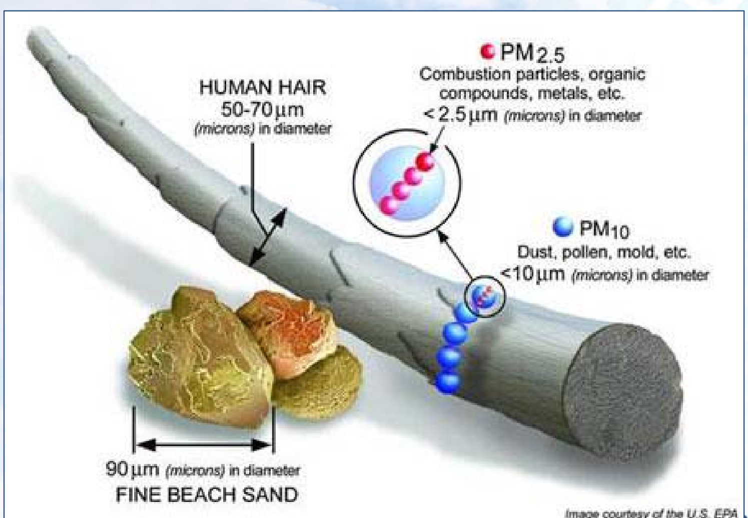
Particulate Matter

fraction	size range
PM_{10} (thoracic fraction)	<=10 µm
$PM_{2.5}$ (respirable fraction)	<=2.5 µm
PM_1	<=1 µm
Ultrafine (UFP or UP)	<=0.1 µm
PM_{10}-$PM_{2.5}$ (coarse fraction)	2.5 µm - 10 µm



Particle Sizes



Particulate Matter

- Solid and liquid airborne materials
- Dust from roads, steel mills, power plants, cotton gins, smelters, cement plants, diesel engines, grain elevators
- Aggravate respiratory conditions
- Major cause of reduced visibility
- PM_{10} (< 10 microns), $PM_{2.5}$ (< 2.5 microns)
- Primary vs. secondary

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$PM_{2.5}$ Precursors

- SO_2 – "Mandatory Precursor"
- NO_x – "Presumptive Precursor"
  - Unless a state can demonstrate that NO_x is not a significant contributor to $PM_{2.5}$ formation
- VOCs and NH_3 - "Candidate Precursors"
  - Not precursors, unless a state demonstrates that they are a significant contributor to $PM_{2.5}$ formation

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Characteristics of Particles

- Particulate matter can be emitted from various emission sources:
  - Stacks, quarries, stock piles, roads, combustion, …
  - With a variety of shapes, sizes, and chemical composition
- By size:
  - Total suspended particles (TSP) – all sizes
  - PM_{10} – 10 microns or less (aerodynamic diameter)
  - $PM_{2.5}$ – 2.5 microns or less
- Important characteristics for PM:
  - Size, Size Distribution, Shape, Density
  - Stickiness, Corrosivity, Reactivity, and Toxicity
  - Liquid droplets or dry dusts

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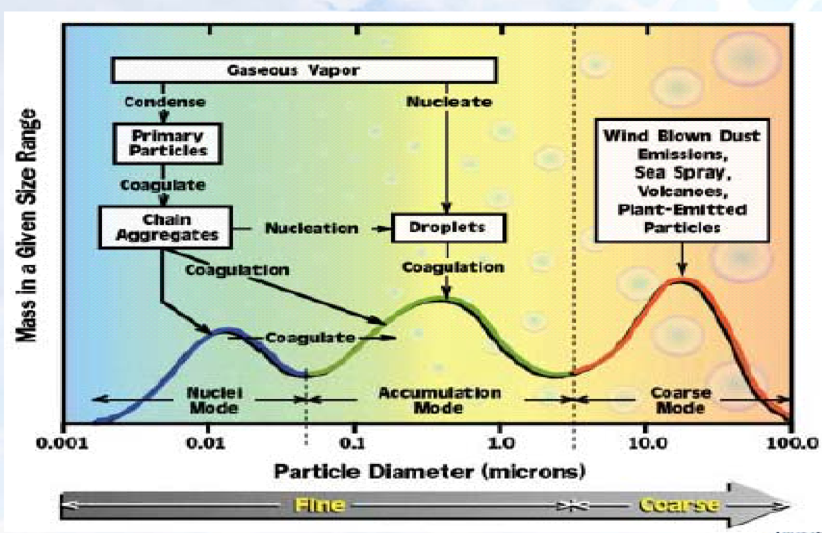
Typical Particle Size/Mass Distribution



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Typical Particle Distribution

- Particulate distributions are often skewed toward much higher numbers in the smaller size ranges.
- A typical plot of mass fraction of particles versus size is often shown a log-normal distribution (i.e., log(d) is a normal distribution).

Particulate Behavior

- Particles are separated from the surrounding fluids (e.g., gas streams) by the application of one or more physical forces in a way that
  - Particles move away from the direction of the mean fluid flow and
  - Are collected/removed from the gas stream.

Particulate Behavior

- When particles are present in a gaseous environment (gas stream, control device), they may be subject to various forces such as:
  - Gravitational force
  - Drag force
  - Centrifugal force
  - Electrostatic force
- A particle can be removed if the forces can cause the particle moving away from the gas stream.

Control of Particulate Matter

- **Typical Types of Equipment**
  - Mechanical Separators
    - Cyclones – by centrifugal force
    - Gravity Settler – by gravity
  - Fabric Filters (Baghouse) – by filtration
  - Electrostatic Precipitations (ESP) – by electrical force
  - Wet Scrubbers – by impaction and interception of particles with water droplets

Collection Mechanism for Particulate Pollutants

- Many factors influence the choice of a control device used to reduce industrial particulate emissions
  - If emitted material can be used or reused in the process, dry collection should be used
  - If the pollutant has little economic value, collection should be accomplished and the pollutant disposed of safely and economically
  - The industrial process and potential control devices must both be carefully reviewed
  - The conversion of an air pollution problem into a water pollution problem can create a more difficult disposal problem

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Comparison between Different PM Control Devices

Control Technology	Capital Investment	Maintenance and operating cost	Pressure drop (Energy use)	Collection efficiency	Limitation
Cyclone	Low (relatively cheap to buy and install)	Few maintenance requirements and low operating costs; Relatively small space requirements	Relatively low pressure drop (2-6 in water), compared to amount of PM removed	Low (esp. for small particles)	Limited to dry particles; Unable to handle sticky or tacky materials
Baghouse	Low	Few maintenance requirements and low operating costs; Take up a lot of space	Reasonable (2-6 in water) even for small PM	High	Harmed by high temperatures, corrosive chemicals or highly humid conditions; Potential for fire or explosion
ESP	High	Low operating costs except at very high efficiencies; take up a lot of space and cannot be easily redesigned	Can handle large volumes of gas flow with low pressure drop	Very High (>99.9%) Can handle a wide range of gas temperatures	Might not work on particulates with very high electrical resistivity

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Summary of Wet Scrubbers

Relative advantages and disadvantages of wet scrubbers compared to other control devices	
Advantages	**Disadvantages**
Small space requirements Scrubbers reduce the temperature and volume of the unsaturated exhaust stream. Therefore, vessel sizes, including fans and ducts downstream, are smaller than those of other control devices. Smaller sizes result in lower capital costs and more flexibility in site location of the scrubber. **No secondary dust sources** Once particles are collected, they cannot escape from hoppers or during transport. **Handles high-temperature, high-humidity gas streams** No temperature limits or condensation problems can occur as in baghouses or ESPs. **Minimal fire and explosion hazards** Various dry dusts are flammable. Using water eliminates the possibility of explosions. **Ability to collect both gases and particles**	**Corrosion problems** Water and dissolved pollutants can form highly corrosive acid solutions. Proper construction materials are very important. Also, wet-dry interface areas can result in corrosion. **High power requirements** High collection efficiencies for particles are attainable only at high pressure drops, resulting in high operating costs. **Water-disposal problems** Settling ponds or sludge clarifiers may be needed to meet waste-water regulations. **Difficult product recovery** Dewatering and drying of scrubber sludge make recovery of any dust for reuse very expensive and difficult. **Meteorological problems** The saturated exhaust gases can produce a wet, visible steam plume. Fog and precipitation from the plume may cause local meteorological problems.

Current NAAQS/Designations

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Status of $PM_{2.5}$ NAAQS in IA

- 1997 Annual $PM_{2.5}$ NAAQS (15 $\mu g/m^3$)
  - All of state is currently designated attainment
- 2006 24-hour $PM_{2.5}$ NAAQS (35 $\mu g/m^3$)
  - All of state currently designated attainment
  - Muscatine County has violated the NAAQS
    - Area initially proposed as nonattainment based on 2005-2007 data
    - Designated as attainment in 2009 based on 2006-2008 data
    - Violated standard with 2007-2009 and 2008-2010 data
    - 2011 EPA SIP deficiency finding
    - IDNR revised SIP due in 2013
    - Modeling of area being conducted in support of SIP revisions
    - No nonattainment designation if the violations are resolved in a timely manner.

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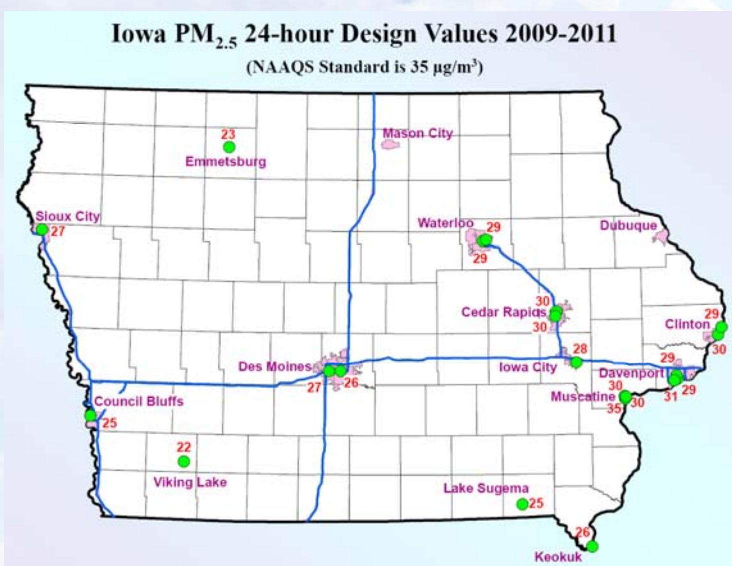
$PM_{2.5}$ - 24 hr NAAQS



Source: www.iowadnr.gov/InsideDNR/RegulatoryAir/MonitoringAmbientAir/TechnicalDocuments.aspx

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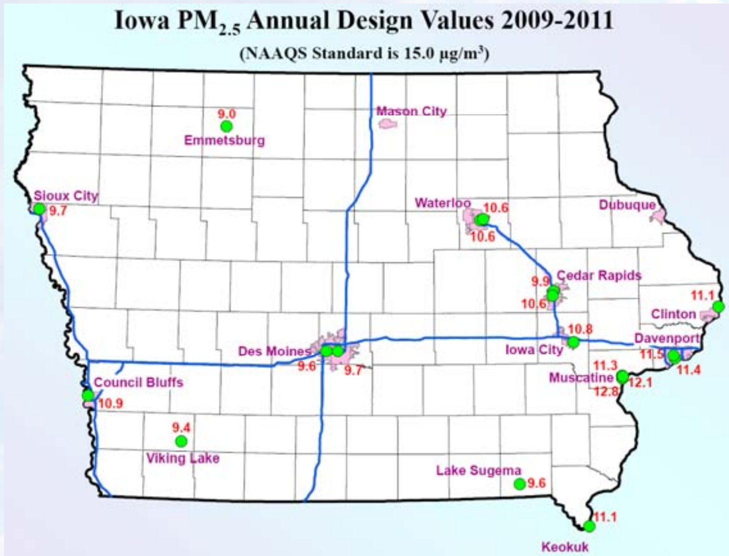
$PM_{2.5}$ - Annual NAAQS



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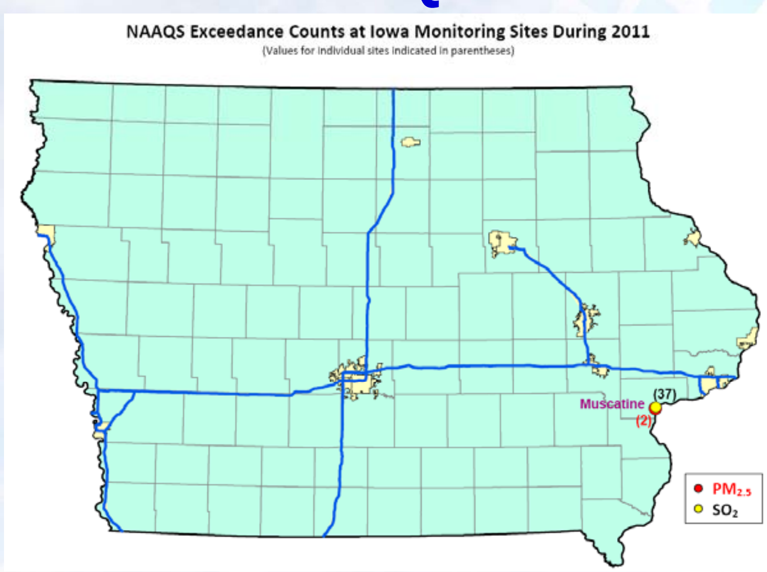
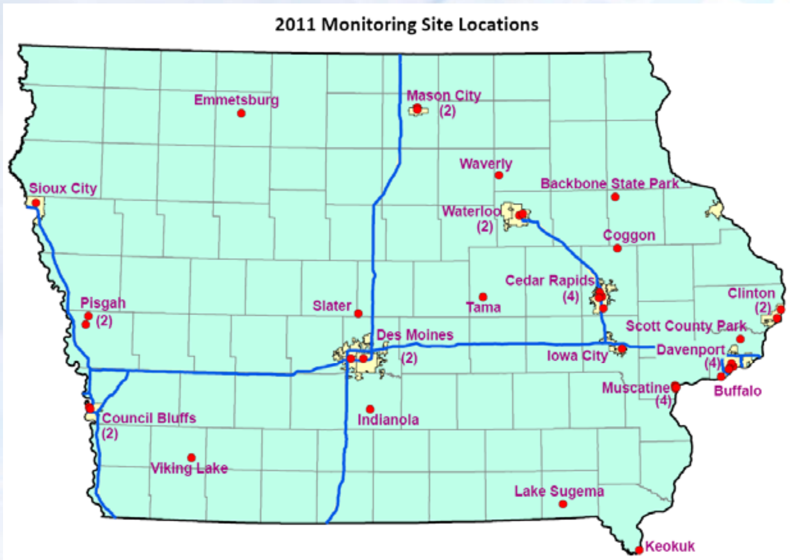
2011 Iowa NAAQS Exceedances



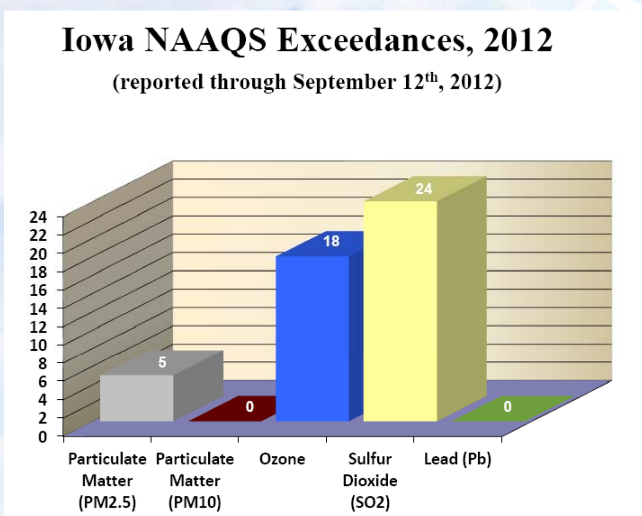
Source: www.iowadnr.gov/InsideDNR/RegulatoryAir/MonitoringAmbientAir/TechnicalDocuments.aspx

2011 Iowa NAAQS Monitors



Source: www.iowadnr.gov/InsideDNR/RegulatoryAir/MonitoringAmbientAir/TechnicalDocuments.aspx

2012 Iowa NAAQS Exceedances



Source:
www.iowadnr.gov/portals/idnr/uploads/air/insidednr/monitoring/tech/Exceedances%20of%20Health%20Standards/iowa_naaqs_2012.pdf

Proposed $PM_{2.5}$ NAAQS Revisions

- June 29, 2012 EPA proposal (77 FR 38890)
  - New Annual Standard: **12 - 13 μg/m³**
  - 24-hr Standard (35 μg/m³) Unchanged
  - New Secondary (Visibility) Standard
    - Primarily affects urban areas
    - Standard: 28 to 30 deciviews
  - No "additional actions" required to meet attainment
    - Upcoming EGU regulations will provide sufficient reductions
- Impacts on Iowa
  - IDNR thinks state would be in attainment with 13 μg/m³
  - 12 μg/m³ will likely result in nonattainment for Muscatine County
  - Recommendations may change as design values are updated
- Revisions are to be finalized by December 14, 2012

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Federal $PM_{2.5}$ Modeling

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$PM_{2.5}$ Increment, SIL, and SMC

- EPA finalized $PM_{2.5}$ Increments, SILs, and SMCs on September 29, 2010
- Opted to treat $PM_{2.5}$ as a new pollutant
  - No impact to the existing annual and 24-hour Increments for PM, measured as PM_{10}
  - New baseline date for $PM_{2.5}$
    - Major Source Baseline Date = October 20, 2010
    - Trigger date = October 20, 2011
  - Sites may be NAAQS limited rather than Increment (in the near term)

	NAAQS (ug/m3)	Class II Increment (ug/m3)	Class II SIL (ug/m3)	SMC (ug/m3)
Annual	15	4	0.3	-
24-Hour	35	9	1.2	4

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$PM_{2.5}$ vs. PM_{10} Modeling

- NAAQS 24-hour thresholds
  - 35 $\mu g/m^3$ for $PM_{2.5}$ vs. 150 $\mu g/m^3$ for PM_{10}
  - Form of the standard is different
    - PM_{10} is highest second high concentration over 5 years of meteorological data (modeled H6H)
    - $PM_{2.5}$ is based on the eighth highest daily max concentration averaged over 3 years (modeled 8^{th} highest daily concentration from over 5 years of meteorological data)
    - Form of $PM_{2.5}$ standard makes it difficult to assess which sources have the highest concentrations for an event (use MAXDCONT output)
- NAAQS annual threshold
  - 15 $\mu g/m^3$ for $PM_{2.5}$ vs. former standard of 50 $\mu g/m^3$ for PM_{10}

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$PM_{2.5}$ Modeling Considerations

- $PM_{2.5}$ NAAQS Compliance Modeling
  - Direct $PM_{2.5}$ emissions including condensable emissions
- Lack of $PM_{2.5}$ emissions data
- Nearby stationary sources explicitly modeled in the analysis
  - Reliability of nearby source inventory an important factor
- Modeled compliance will be extremely challenging for new and existing sources
  - Background concentrations are high – above the standard in some places.

$PM_{2.5}$ Modeling – Making it Work

- Base emission limits on source tests of similar sources or conduct source-specific testing to obtain speciation data
- Stack height changes
- Particle size distributions wherever possible (e.g., California's CEIDARS) to limit $PM_{2.5}$ emission rates
- Care with temperature and air flow profiles
- Separate modeling of conceivable scenarios
- For haul road fugitives the use of revised AP-42 Paved Haul Road Equation

$PM_{2.5}$ Modeling Strategy

- Refine facility inventory
- Refine state inventories (neighbors)
- Ambient monitoring for background values
- Make use of SILs

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Implications of Current and Pending $PM_{2.5}$ NAAQS Changes

- Using $PM_{2.5}$=PM_{10} emissions calculation strategies for sources with a significant fraction of coarse PM no longer advisable, especially for fugitive material handling and storage activities
- Monitored $PM_{2.5}$ concentrations are close to the 24-hr and annual $PM_{2.5}$ NAAQS complicating NAAQS modeling for PSD permitting
  - For many sources, triggering PSD for $PM_{2.5}$ is no longer a viable option because modeling unworkable
- Stay apprised of $PM_{2.5}$ PSD permitting activity in your area
  - Your source may be considered as a regional inventory source in a $PM_{2.5}$ NAAQS modeling study without your knowledge
  - High impacts may be attributed to your source if $PM_{2.5}$ emissions and source characterization data available in permits or emission inventories is not accurate

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Draft $PM_{2.5}$ Modeling Guidance

- Draft guidance originally expected to be released by EPA in fall 2011
- Delay in release pushed 10th Modeling Conference back to March 2012
- Guidance discussed at that meeting, but still not officially released
- Latest estimate of anticipated release data is late 2012
  - EPA taking comments, suggestions, and feedback into account

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Draft $PM_{2.5}$ Modeling Guidance

- One issue addressed is consideration of secondary formation of $PM_{2.5}$
- Considering 4-tiered modeling approach

Model Requirement	Tier	Approach
Single-source screening analysis to compare with SILs	Tier I	**Primary & Secondary:** AERMOD with region- (or state-) specific offset ratios
Cumulative-source analysis to compare with NAAQS and PSD increments	Tier II	**Primary & Secondary:** AERMOD with region- (or state-) specific offset ratios
	Tier III	**Primary:** AERMOD **Secondary:** Use of a chemistry plume model (e.g., SCICHEM)
	Tier IV	**Primary:** AERMOD **Secondary:** CAMx (or CMAQ) with fine grid and PiG for new source

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State $PM_{2.5}$ Modeling and Permitting Updates

$PM_{2.5}$ Modeling for Minor Sources

- Will begin in January 2013
- IDNR expects to significantly revise the Modeling Determination form (simplify it to remove many of the requirements that trigger modeling)
- IDNR (or local agency) permit engineer has discretion to request modeling even if the MD form indicates it is not needed

2013 $PM_{2.5}$ Permitting Exemptions

- IDNR has proposed changes to certain construction permitting exemptions and Title V insignificant activities (IA) to protect the new $PM_{2.5}$ NAAQS
  - Will apply to new or modified sources only (existing units grandfathered) as of January 1, 2013 (permit issuance date)
  - Proposals:
    - Fuel burning equipment exemption will no longer include coal units and will set limits for used oil and untreated biomass
    - Removal of exemption for incinerators and pyrolysis cleaning furnaces with capacity < 25 lb/hr
    - Removal of 1 lb/hr exemption (generally no longer used)
    - Expand small unit exemption and Title V IA thresholds
      - $PM_{2.5}$ at 0.52 tpy for SU and Title V IA; 0.4 tpy for SSU; 10 tpy SUE notification
    - New usage thresholds for welding and soldering
    - Add same SU thresholds for $PM_{2.5}$ to the R&D exemption
  - Expect an official public comment period soon

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Questions?

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