The Particulate Matter and Ozone NAAQS

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Fine and Coarse PM

Fine particles (PM$_{2.5}$)
*Combustion, gases to particles*

**Major sources:**
- Coal, oil, gasoline, diesel, wood combustion;
- Transformation of SOx NOx, organic gases;
- High temperature industrial processes (smelters, steel mills); and
- Forest fires.

*Lifetime days to weeks, regional distribution over urban scale to 1000s of km*

Coarse particles (PM$_{10-2.5}$)
*Crushing, grinding, dust*

**Major sources:**
- Resuspension of dust tracked onto roads;
- Suspension from disturbed soil (farms, mines, unpaved roads);
- Construction/demolition; and
- Biological sources.

*Lifetime of hours to days, distribution up to 100s km*
### History of the PM NAAQS

<table>
<thead>
<tr>
<th>Year</th>
<th>Indicator</th>
<th>Ave. Time</th>
<th>Levela</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>TSP</td>
<td>24-hour</td>
<td>260 µg/m³ (primary) 150 µg/m³ (secondary)</td>
<td>Not to be exceeded more than once per year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annual</td>
<td>75 µg/m³ (primary)</td>
<td>Annual average</td>
</tr>
<tr>
<td>1987</td>
<td>PM₁₀</td>
<td>24-hour</td>
<td>150 µg/m³</td>
<td>Not to be exceeded more than once per year on average over a 3-year period</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annual</td>
<td>50 µg/m³</td>
<td>Annual arithmetic mean, averaged over 3 years</td>
</tr>
<tr>
<td>1997</td>
<td>PM₂.₅</td>
<td>24-hour</td>
<td>65 µg/m³</td>
<td>98th percentile, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annual</td>
<td>15 µg/m³</td>
<td>Annual arithmetic mean, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td>PM₁₀</td>
<td>24-hour</td>
<td>150 µg/m³</td>
<td>Initially promulgated 99th percentile, averaged over 3 years; when 1997 standards were vacated, the form of 1987 standards remained in place (not to be exceeded more than once per year on average over a 3-year period)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annual</td>
<td>50 µg/m³</td>
<td>Annual arithmetic mean, averaged over 3 years</td>
</tr>
<tr>
<td>2006</td>
<td>PM₂.₅</td>
<td>24-hour</td>
<td>35 µg/m³</td>
<td>98th percentile, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Annual</td>
<td>15 µg/m³</td>
<td>Annual arithmetic mean, averaged over 3 years</td>
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<td>24-hour</td>
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<td>Not to be exceeded more than once per year on average over a 3-year period</td>
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- First established in 1971.
- Not revised until 1987, and indicator changed from TSP to PM₁₀ (¼ of a grain of salt).
- Ten years later, added a standard for PM₂.₅ and retained but slightly revised standards for PM₁₀ (intended to regulate "inhalable coarse particles" from 2.5 to 10 micrometers).
- The 2006 standards lowered the 24-hour PM₂.₅ standard to 35 µg/m³, but retained the annual standard. The 24-hour PM₁₀ standard was retained, but the annual PM₁₀ standard was revoked.
## Current PM NAAQS Review

<table>
<thead>
<tr>
<th>Assessment/Comment Period</th>
<th>Date</th>
</tr>
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<tbody>
<tr>
<td>Final Integrated Science Assessment (ISA)</td>
<td>December 2009</td>
</tr>
<tr>
<td>Final Risk Assessment (RA)</td>
<td>June 2010</td>
</tr>
<tr>
<td>Final Urban-Focused Visibility Assessment (UFVA)</td>
<td>July 2010</td>
</tr>
<tr>
<td>Public Comment Period for Second Draft Policy</td>
<td>August 16, 2010</td>
</tr>
<tr>
<td>Assessment (PA)</td>
<td>(Extended to August 30 for Chapter 4)</td>
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<tr>
<td>Final Policy Assessment (PA)</td>
<td>September 2010</td>
</tr>
<tr>
<td>Proposed Rule</td>
<td>February 2011</td>
</tr>
<tr>
<td>Final Rule</td>
<td>October 2011</td>
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</tbody>
</table>
The PM Policy Assessment-2nd Draft

- Integrates evaluation of results from the ISA (evidence-based data) and from the RA (risk-based data).
- Recommends annual PM$_{2.5}$ concentrations in the range between 11 $\mu$g/m$^3$ (as precautionary level) and 13 $\mu$g/m$^3$ (a level just below that reported in select health effect studies).
- Recommends a 24-hr PM$_{2.5}$ between 30 $\mu$g/m$^3$ and 35 $\mu$g/m$^3$.
- Recommends lowering the PM$_{10}$ standard to be between 65 $\mu$g/m$^3$ and 85 $\mu$g/m$^3$, and change the form of the standard to be a 98$^{th}$ percentile.
Issues Associated with Recommendations Presented in the Policy Assessment

• US EPA continues to rely heavily on epidemiological studies of associations between ambient PM concentrations and various mortality and morbidity health outcomes to support lowering the PM$_{2.5}$ and PM$_{10}$ standards.

• Evidence of effects is uncertain due to confounding factors, results that vary with different model specifications, heterogeneity in PM concentrations and health effects, and measurement exposure error.

• Regardless, US EPA in the policy assessment is making recommendations to lower the standard based on air quality distributions at monitoring sites, not on the health effects literature.

• Recommendations for the 24-hr standard are based on having a “controlling” annual standard and a 24-hr standard that would provide additional protection.
PM$_{2.5}$ Emissions from Different Sources (2005)

National PM2.5 Emissions by Source Sector in 2005

- Road Dust: 964,877 tons
- Miscellaneous: 763,816 tons
- Industrial Processes: 541,284 tons
- Electricity Generation: 515,485 tons
- Fires: 411,470 tons
- Residential Wood Combustion: 382,126 tons
- Waste Disposal: 275,339 tons
- Non Road Equipment: 268,725 tons
- Fossil Fuel Combustion: 213,290 tons
- On Road Vehicles: 186,182 tons
- Solvent Use: 7,550 tons
- Fertilizer & Livestock: 1,523 tons

12%

National PM10 Emissions by Source Sector in 2005

- Road Dust: 10,506,374 tons
- Miscellaneous: 5,558,573 tons
- Industrial Processes: 12,359,980 tons
- Electricity Generation: 626,759 tons
- Fires: 485,602 tons
- Fossil Fuel Combustion: 400,251 tons
- Residential Wood Combustion: 389,421 tons
- Waste Disposal: 301,096 tons
- Non Road Equipment: 284,431 tons
- On Road Vehicles: 133,160 tons
- Fertilizer & Livestock: 15,230 tons
- Solvent Use: 8,442 tons

3%

Source: http://www.epa.gov/air/emissions/pm.htm
PM Air Quality Trends

Large implications to lowering the annual PM$_{2.5}$ standard – as many sites would be out of compliance!

PM$_{10}$ standard changes may also have an impact on power plants

Source: [http://www.epa.gov/airtrends.pm.html](http://www.epa.gov/airtrends.pm.html)
History of the Ozone NAAQS

- First established in 1971.
- First revision in 1979, when indicator changed from photochemical oxidants to ozone and the standards increased.
- In 1997, the standards changed form and were lowered to 0.08 ppm.
- The most recent revision in 2008 lowered the standards to 0.075 ppm, but this revision is currently under reconsideration.

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<th>Levela</th>
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<tr>
<td>1971</td>
<td>Photochemical oxidants</td>
<td>1-hour</td>
<td>0.08 ppm</td>
<td>Not to be exceeded more than once per year</td>
</tr>
<tr>
<td>1979</td>
<td>O₃</td>
<td>1-hour</td>
<td>0.12 ppm</td>
<td>Not to be exceeded more than once per year</td>
</tr>
<tr>
<td>1997</td>
<td>O₃</td>
<td>8-hour</td>
<td>0.08 ppm</td>
<td>Annual fourth-highest daily maximum, averaged over 3 years</td>
</tr>
<tr>
<td>2008</td>
<td>O₃</td>
<td>8-hour</td>
<td>0.075 ppm</td>
<td>Annual fourth-highest daily maximum, averaged over 3 years</td>
</tr>
</tbody>
</table>

*Levels are identical for primary and secondary ozone standards*
Reconsideration of the 2008 Ozone NAAQS

• In 2009, the US EPA Administrator re-evaluated the same scientific data used as the basis for the 2008 NAAQS, which was set under a different Administration, and decided to initiate a reconsideration of the standard.

• In Sept 2010, US EPA proposed new primary and secondary ozone standards:
  – The 8-hour primary standard should be lowered from 0.075 ppm to within the range of 0.06 – 0.07 ppm.
  – The secondary standard should be a cumulative, seasonal standard expressed as an annual index of the sum of weighted hourly concentrations, cumulated over 12 hours/day during the consecutive 3-month period within the ozone season with the maximum ozone index value, set within the range of 0.7 – 15 ppm-hours.

• US EPA has not issued their decision for reconsideration

• New review of ozone standards has begun, ISA to be released soon
Issues Associated with the Reconsideration of the 2008 Ozone NAAQS

- US EPA placed greater emphasis on an exposure study of lung function that did not show adverse effects at ozone levels below 0.08 ppm (Adams 2002, 2006).
- US EPA used inappropriate statistics to re-analyze this study and concluded that effects on lung function were observed at 0.06 ppm ozone.
- US EPA did not consider that the small effects observed on lung function were not adverse.
- Epidemiological studies relied on by US EPA were subject to major methodological limitations and do not support adverse effects below the 2008 standard.
Emissions of Ozone Precursors from Different Sources

National Nitrogen Oxides Emissions by Source Sector in 2005

- On Road Vehicles: 6,491,821 tons
- Non Road Equipment: 3,783,859 tons
- Electricity Generation: 2,394,297 tons
- Fossil Fuel Combustion: 1,163,635 tons
- Industrial Processes: 155,415 tons
- Waste Disposal: 94,372 tons
- Fires: 38,324 tons
- Residential Wood Combustion: 6,400 tons
- Solvent Use: 3,644 tons
- Miscellaneous: 2,098 tons

Total Emissions: 8,022,352 tons

Source: http://www.epa.gov/air/emissions/nox.htm

National Volatile Organic Compounds Emissions by Source Sector in 2005

- Solvent Use: 4,245,897 tons
- On Road Vehicles: 4,112,147 tons
- Non Road Equipment: 2,843,213 tons
- Industrial Processes: 1,645,584 tons
- Miscellaneous: 1,202,517 tons
- Fires: 681,309 tons
- Residential Wood Combustion: 543,463 tons
- Waste Disposal: 465,003 tons
- Fossil Fuel Combustion: 136,785 tons
- Electricity Generation: 47,395 tons
- Solvent & Livestock: 42,191 tons
- Road Dust: 1 ton

Total Emissions: 10,854,286 tons

Source: http://www.epa.gov/air/emissions/voc.htm
Ozone Air Quality Trends

Ozone Air Quality, 1990 - 2008
(Based on Annual 4th Maximum 8-Hour Average)
National Trend based on 547 Sites

1990 to 2008: 14% decrease in National Average

Source: http://www.epa.gov/airtrends/ozone.html
Conclusions

- About 10% of monitoring sites are currently out of compliance with the PM$_{2.5}$ standard. A lower standard would bring many more out of compliance. As a major contributor to emissions, this will significantly impact power plants. It is less certain how changes to the PM$_{10}$ standard will impact power plants.

- For ozone, many monitoring sites are currently out of compliance. Further reductions will bring many more out of compliance. As a major contributor to NOx emissions, this will have significant implications for power plants.