



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

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OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Lists of Potential Control Measures for PM_{2.5} and Precursors
FROM: William T. Harnett *William Harnett*
Director, Air Quality Policy Division (C504-01)
TO: Air Division Directors, Regions I – X

The attached compilation of PM_{2.5}-related control measures, which was prepared by OAQPS, OTAQ, OAP and OPAR, is provided to you for your information and for you to share with the States in your regions that you determine would benefit. Please consider that the measures included in the lists have not been peer reviewed, and their appearance on these lists does not constitute EPA endorsement of any specific control measure.

Attachment

Lists of Potential Control Measures for PM_{2.5} and Precursors

These informational documents are intended to provide a broad, though not comprehensive, listing of potential emissions reduction measures for direct PM_{2.5} and precursors. The purpose is primarily to assist states in identifying and evaluating potential measures as States develop plans for attaining the PM_{2.5} NAAQS.

Before examining control measures, an important step for States is to identify the nature of the PM_{2.5} problem in their areas and the sources contributing to that problem. The severity, nature and sources of the PM_{2.5} problem vary in each nonattainment area, so the measures that are effective and cost-effective will also vary by area. Similarly, the geographic area in which measures are effectively applied will vary depending on the extent to which pollution sources outside the nonattainment area contribute to the area's PM_{2.5} problem.

Similarly, the costs of applying a given control measure will have case-specific considerations. While the tables here provide overall control costs and control efficiency estimates derived from the references, there is inherent uncertainty in any estimates of this nature. We do not attempt in these tables to provide any rigorous treatment of these uncertainties, but rather provide the control efficiency and cost estimates as a rough "ballpark" starting point. These documents also do not provide specific emissions monitoring and testing information, such as costs. We encourage the use of source-specific assessments which will be more reliable.

This document contains several tabular lists of PM_{2.5} control measures. For most measures, the tables provide an estimate of the control efficiency and the cost per ton of pollutant reduced. The tables also identify reference sources that the user may wish to consult for more information. In the interest of making the lists as relevant as possible, we have omitted some measures that we believe are already employed by virtually all sources. For example, for direct PM_{2.5} sources we did not include an encyclopedic listing of add-on controls such as baghouses, electrostatic precipitators, and venturi scrubbers, since these controls are generally well-known and widely implemented.

Note that this technical document is focused on identification of measures and does not address mechanisms for implementation, such as whether a measure would be implemented on a mandatory or voluntary basis, or whether state adoption of certain mobile measures on a mandatory basis would be pre-empted or require a fuels waiver under the Clean Air Act.

The following control measure lists are included:

- 1. Stationary Source Measures Lists.** Separate tables of measures are provided for three pollutants:

- PM2.5
- SO2
- NOx

In addition, for direct PM2.5, the table suggests a number of possible plant-specific engineering evaluations that may yield additional emissions reductions. We have also included a table of references.

2. On-road Mobile Source Measures Lists. Separate tables of measures are provided for three pollutants:

- PM2.5
- SO2
- NOx

We have also included a table of references.

3. Non-road Mobile Source Measures Lists. Separate tables of measures are provided for three pollutants:

- PM2.5
- SO2
- NOx

We have also included a table of references and a detailed control measures list.

4. Supplemental Appendix on On-road Ammonia and VOC Measures. In the notice of proposed rulemaking for PM2.5 implementation (Clean Air Fine Particle Implementation Rule), EPA proposed to make a legal presumption that VOC and ammonia would not be regulated precursors for purposes of a nonattainment area's PM2.5 plan, unless the state or EPA makes a determination to the contrary. In light of this, information on certain selected measures that reduce emissions of ammonia and/or VOC is provided in a separate, supplemental appendix. Tables are provided for:

- On-road VOC measures - measures that are listed in the on-road measures table for PM, SO2 and/or NOx, and that also reduce VOC.
- On-road ammonia measures - measures that are listed in the on-road measures table for PM, SO2 and/or NOx, and that also reduce ammonia.

We have also included a table of references.

5. Fugitive Dust Measures List. For completeness, we include a separate table of measures, including references, for sources of fugitive dust. Fugitive dust measures generally have a greater impact on reducing ambient concentrations of PM10 than PM2.5, because crustal material is usually a relatively small fraction of monitored PM2.5. However, dust measures might, in some circumstances, be helpful at reducing ambient PM2.5 concentrations.

Note that some emission reduction measures (e.g., many of the mobile source measures) are listed in more than one table of measures, because they reduce multiple pollutants. For example, a measure that reduces both direct PM and NOx appears once in the PM measures table, and once in the NOx measures table.

Draft, Version 1.0

EPA has developed a website, at <http://www.epa.gov/pm/measures.html>, intended to provide information on emissions reduction measures and programs for PM2.5 and precursors. It is our intent to include on this website the information in these tables, including weblinks to the references, in the near future.

Energy Efficiency and Renewable Energy Measures List. A list currently under development will include energy efficiency and renewable energy measures that can help reduce emissions of PM2.5 and precursors.

Agricultural Sources Measures List. Another separate list under development, being coordinated with the Department of Agriculture, will include control measures for agricultural sources, such as diesel engine retrofits and other measures that can help reduce emissions of PM2.5 and precursors.

Improved Source Monitoring. For many of the stationary source measures, it is fundamental to the effectiveness of the measure that implementation include appropriate source monitoring. Effective monitoring to assure ongoing compliance should include periodic emissions testing or other direct measures of compliance, as applicable, and less reliance on generic emissions factors (e.g., from AP-42) for estimating emissions or demonstrating compliance. Moreover, improvements to existing monitoring (e.g., use of fabric filter leak detectors, see EPA-454/R-98-015), or in the frequency of existing monitoring (see Barr and Schaffner, 2003, cited in Stationary Source reference table) will assure that control measures operate within compliance limits and may in fact increase the effectiveness of control measures already in place.

Contacts. These documents are a joint effort of EPA's Office of Air Quality Planning and Standards, Office of Transportation and Air Quality, Office of Atmospheric Programs, and Office of Policy Analysis and Review. Contractor assistance was provided by ICF Consulting and subcontractor E.H. Pechan. We regard these as "living documents" and have labeled them as "Draft" to indicate that as we use these documents, we expect to make ongoing revisions as we receive additional information. We invite users to provide suggestions for additional measures, or additional sources of information on measures, that they believe should be included. Please contact:

Tim Smith, Office of Air Quality Planning and Standards, 919-541-4718,
Smith.Tim@epa.gov, (stationary sources)

Rudolph Kapichak, Office of Transportation Air Quality, 734-214-4574
Kapichak.Rudolph@epa.gov (mobile sources)

Sam Waltzer, Office of Atmospheric Programs, 202-343-9175,
Waltzer.Sam@epa.gov (EGUs)

Tom Driscoll, Office of Air Quality Planning and Standards, 919-541-5135
driscoll.tom@epa.gov (emissions monitoring and testing)

Stationary Source Control Measures for PM2.5
See cover note for important notes and caveats on the use of these tables

| Source category | Emissions reduction measure | Control efficiency (%) | Cost effectiveness (\$/ton reduced) | Cost Year | Notes/caveats | Other pollutants controlled | References for more information |
|------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------------------------------|-----------|------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------------------------------------------------------------------------|
| Generally applicable measures: All industrial and commercial sources emitting direct PM2.5 | Review uncontrolled or under controlled stack sources for improvements | Variable | Variable | | | | EPA 2002, EPA 1998b, AWMA 2000, STAPPA/LAPCO 2006, Pechan and RTI 2005a, Pechan and RTI 2005b. |
| All industrial and commercial sources currently controlling PM with cyclones or multicyclones | Upgrade to high-efficiency collection device to collect fine fraction of PM | Variable | Variable | | | | EPA 1998b, AWMA 2000, EPA 2002 |
| All industrial and commercial sources currently controlled by electrostatic precipitators (ESPs) | Upgrade ESP to improve efficiency on fine fraction of PM, for example by increasing size/SCA, flue gas conditioning, use of hybrid technologies to improve performance, or replacement with fabric filter at time of rebuild. | Variable | Variable | | | | Pechan and RTI 2005b, EPA 1992, Southern Research Institute 1993. |
| Industrial process fugitives and open dust fugitive emissions sources | Improve fugitive emissions capture | Variable | Variable | | | | WRAP 2004, STAPPA/LAPCO 2006 |
| All sources of condensable PM2.5 | Evaluate whether can feasibly reduce temperature of gas stream and increase collection of condensables, and whether can collect with wet ESPs, afterburner, or other devices | Variable | Variable | | | | [We are looking for references on this topic] |
| Category specific: Cement Manufacturing | Process equipment vented to baghouse. Various controls for open storage piles, primary crushing operations, and conveying systems. | Not Available | Not available | | Process equipment limits: 0.01 gr/dscf for existing equipment; 0.005 gr/dscf for new equipment | | SCAQMD, 2005a |

Stationary Source Control Measures for PM2.5
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|---------------------------------------------------------------------------------|----------------------------------------------------------|------------------------|--------------------------------------------------------------------------------------------------|-----------|--------------------------------------------------------------------------------|-----------------------------|---------------------------------------|
| Ferrous Metals Processing - Iron and Steel Production - Blast Furnace Casthouse | Capture Hood Vented to a Baghouse | 85 | Not available | | Based on engineering judgments and data which for some plants may be outdated. | | EPA 2006a, Pechan 2006 |
| Ferrous Metals Processing - Iron and Steel Production - BOF | Secondary Capture and Control System | 85 | \$5,000 | | Based on engineering judgments and data which for some plants may be outdated. | | EPA 2006a, Pechan 2006 |
| Ferrous Metals Processing - Iron and Steel Production - Sinter Plant | Install baghouse to control emissions from sinter cooler | 99 | \$5,000 | 2001\$ | Based on engineering judgments and data which for some plants may be outdated. | | EPA 2006a, Pechan 2006 |
| Petroleum Refinery Catalytic and Thermal Cracking Units | Wet Scrubbing | 85 - 95 | Not Available | | | | MARAMA, 2006 |
| Petroleum Refinery Catalytic and Thermal Cracking Units | Electrostatic Precipitators | >95% | \$3,500 - \$6,600 | | | | MARAMA, 2006; SCAQMD, 2003 |
| Petroleum Refinery Catalytic and Thermal Cracking Units | Sodium bisulfite (SBS) injection | Not Available | Not Available | | | | MARAMA, 2006 |
| Stationary diesel engines including generators and other prime service engines | Diesel oxidation catalyst (where DPF not feasible) | 20 | \$1,000-\$2,000 | 2003\$ | Cost effectiveness is based on the combined CO, HC, NOx and PM reduction | | NESCAUM 2003, STAPPA and ALAPCO 2006 |
| Stationary diesel engines including generators and other prime service engines | Diesel particulate filter | 80-90 | \$2,000-\$19,000 | 2003\$ | Cost effectiveness is based on the combined CO, HC and PM reduction. | | NESCAUM 2003, STAPPA and ALAPCO 2006. |
| Coal-fired Utility Boiler currently controlled by ESPs | Indigo Agglomerator | 40 | Cost effectiveness is variable and based on plant size: the total capital cost of \$8 per kW | 2005\$ | | | Khan, EPA, August 21, 2006. |
| Coal-fired Utility Boiler currently controlled by ESPs | Add enough collection area to equal one field | 44 | Cost effectiveness is variable and based on plant size: the total capital cost of \$13.75 per kW | 2005\$ | | | Khan, EPA, August 21, 2006 |

Stationary Source Control Measures for PM2.5

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|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------|-----------|---------------------------------------------------------------|-----------------------------|----------------------------------|
| Coal-fired Utility Boiler currently controlled by ESPs | Add enough collection area to equal two fields | 67 | (Cost effectiveness is variable and based on plant size: the total capital cost of \$17.50 per KW | 2005\$ | CE is incremental to ESP controls | | Khan, EPA, August 21, 2006 |
| Residual Oil-Fired Utility and Industrial Boilers currently without add-on controls | ESP | Not Available | Not available | | | | EPA, 2006b. |
| Ferroalloy production | Improve capture on open furnaces | Not Available | Not available | | | | EPA, 2006b. |
| Ferroalloy production | Capture of fugitive emissions from pouring and casting | Not Available | Not available | | | | EPA, 2006b. |
| Refractory products manufacturing - non-clay with organic binders | thermal oxidizer on plants below MACT applicability cutoff | Not Available | Not available | | | | EPA, 2006b. |
| Refractory products manufacturing - non-clay with chromium | Fabric filter | Not Available | Not available | | | | EPA, 2006b. |
| Refractory products manufacturing - clay | Wet or dry lime scrubber for plants below MACT applicability limit | Not Available | Not available | | | | EPA, 2006b. |
| Commercial Cooking -- conveyORIZED charbroiler | Catalytic Oxidizer | 83 | \$3,000 | 2001\$ | | 90 % co-control of VOCs | Ventura County 2004, CE-ERT 2002 |
| Commercial Cooking -- large underfired grilling operations | Small ESP (e.g., SMOG-HOG) or scrubber | 99 | \$6,000 | 2003\$ | | | Sorrels 2006 |
| Open Burning of Land Clearing Debris | Substitution of landfilling for open burning | 50 to 100 | \$3,500 | 1999\$ | Development measure from PM NAAQS RIA | | EPA 2006a, Pechan 2006 |
| Residential Wood Combustion | Education and Advisory Program | 5-10 | Variable, depending on availability and effectiveness of resources allocated. | 1990\$ | Includes all programs other than woodstove changeout programs | | Pechan 1997 |
| Residential Wood Stoves | Woodstove Changeout Program, including financial incentives and information/encouragement when houses are sold | variable depending on outreach and incentives | \$2,000 | 1999\$ | Development measure from PM NAAQS RIA | | EPA Communication |
| Residential Wood Stoves | Mandatory changeout when houses are sold | 5-7% per year | Not available | | 5-7% is based on typical rates of housing turnover | | |
| Residential Fireplaces | Promote use of Gas Logs/elimination of wood burning | Not Available | Not available | | | | |
| Outdoor wood hydronic heaters | Emissions standards or siting requirements | Not Available | Not available | | | | NESCAUM 2007 |