The Regulatory Studies Program (RSP) of the Mercatus Center at George Mason University is dedicated to advancing knowledge of the impact of regulation on society. As part of its mission, RSP conducts careful and independent analyses employing contemporary economic scholarship to assess rulemaking proposals from the perspective of the public interest. Thus, this comment on the Environmental Protection Agency’s Proposed Rules for National Ambient Air Quality Standards for Particulate Matter does not represent the views of any particular affected party or special interest group, but are designed to evaluate the effect of the Agency’s proposals on overall consumer welfare.

I. Introduction: The Clean Air Act and the Proposed Rule

The original Clean Air Act of 1963 initially authorized the regulation of five “criteria pollutants:” sulfur oxides (SOx), particulate matter (PM), carbon monoxide (CO), photochemical oxidants (ozone), and hydrocarbons. The air quality criteria set for these pollutants was subsequently used to create their National Ambient Air Quality Standards (NAAQSs) under § 109(a)(1)(A) of the Clean Air Act of 1970, which is the particular clean air law commonly referred to as The Clean Air Act, or CAA. In addition to the

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1 Prepared by Alastair J. Walling J.D. LL.M., Legal Fellow, Regulatory Studies Program, Mercatus Center at George Mason University. This comment is one in a series of Public Interest Comments from Mercatus Center’s Regulatory Studies Program and does not represent an official position of George Mason University.


3 Section 109(a)(1)(A) of the CAA is codified at 42 U.S.C.A. § 7409(a)(1)(A).
original criteria pollutants listed in the 1963 act, the CAA added nitrogen dioxide, while the EPA used the authority granted it under the statute to create a NAAQS for lead in 1976. The EPA removed hydrocarbons from the list in 1983, after discovering that hydrocarbons did not directly affect human health and their contributions to ozone formation were already regulated under the ozone NAAQS.

Every five years the EPA is required by statute to review the NAAQSs and issue new standards if the current standards are deemed to reasonably endanger public health or welfare. There are currently two standards for levels of particulate matter with a width of 2.5 micrometers (µm) or less. The first is a 24-hour standard of 65 micrograms per square meter (µg/m²). The second is an annual average, which currently stands at 15µg/m³. The EPA has proposed new standards that would leave the annual average the same, while reducing the 24-hour or daily standard to 35µg/m³, although the EPA will accept comments on alternative daily standards of between 65µg/m³ and 25µg/m³. The EPA will also accept comments on reducing the annual standard to 14, 13, or 12µg/m³.

If the EPA finalizes the new daily standard, it will be in September of 2006. By April of 2010, the EPA will have made its final designations of which areas of the country are in attainment, which are not, and which are unlikely to be compliant in 2015. States would then begin the formulation of their state implementation plans (SIPs), which would have to be acceptable to EPA by April of 2013. The States would have until April of 2015 to bring their PM concentrations into compliance with the new standard.

By 2010, the States and the EPA will have taken stock of current and projected PM levels throughout the country, and the States will have begun planning on how to bring their non-attainment areas into compliance by 2015. Based upon the EPA’s monitors and projections, the States should start taking steps to limit PM emissions from point sources in 2010. However, these steps are likely to come at a high price and many jobs will be lost to factory closures, higher energy prices, or foregone economic development. Fortunately, these losses might be avoided if the EPA chooses to keep the current

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4 42 U.S.C.A. § 7409(c).
5 The EPA did not create a NAAQS for lead willingly. The Natural Resources Defense Council (NRDC) sued the EPA claiming that since EPA had previously acknowledged that lead posed a danger to human health and welfare that this classification had earned lead a spot on the on the NAAQSs list. The circuit court agreed and the Second Circuit Affirmed. The case is Natural Resources Defense Council v. Train, 545 F.2d 320 (2d Cir. 1976).
9 ENVIRONMENTAL PROTECTION AGENCY, FACT SHEET: PROPOSAL TO REVISE THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER, available at www.epa.gov/oar/particlepollution/fs20051220pm.html.
standards in place. The amount of particulate matter created by mobile sources should decline dramatically, as the nation’s automobile fleet turns over and modernizes. The American people are already paying for lower PM levels through higher prices for cars and trucks and transportation fuels. The adoption of new PM standards by the EPA raises the real possibility that Americans may pay twice for meeting the same air quality standard. A prudent approach would be for the EPA to maintain the current standards and to wait until the effects of current pollution reduction policies and turnover in the nation’s automobile fleet can be accurately ascertained.

II. What is PM and What Causes It?

Sometimes casually referred to as soot, particulate matter consists of natural and manmade circulations of small particles in the air. The smallest of these particles are classified as fine particles and technically known as PM2.5 because the particles themselves are less than 2.5 micrometers in diameter—about 1/30 the width of a human hair and so small that many thousands of them would fit in the period at the end of this sentence. Although the natural kicking up of dust generates some PM2.5, much of it starts out at emissions from manmade mobile and stationary sources. Major pollutants, such as sulfur dioxide, nitrogen oxide, and volatile or other organic compounds and carbonates react with the natural environment and all contribute to the formation of PM2.5.  

Particulate matter is said to result from a “primary source” when an otherwise naturally occurring very small physical object is picked up and suspended in the air, such as when wind or weather forces kick up the smallest pieces of the Earth’s crust. However, nearly all PM particles do not owe their origins to Earth and wind but result from so called “secondary sources.” Secondary sources of PM2.5 are many, varied, and listed below. Although they are called “secondary” sources, these chemicals are responsible for nearly all PM2.5 and are often referred to as “PM species.”

- Carbonates are the dominant PM2.5 species in the U.S. It is formed from reactive organic gas emissions from cars, trucks, industrial facilities, forest fires, and biogenic sources such as trees.

- Nitrates are typically the second most plentiful PM2.5 species in the Western U.S. and the third in the East. Nitrates are formed from nitrogen oxide gas emissions from cars, trucks, industrial facilities, forest fires, and biogenic sources such as trees.

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12 Id.
• Sulfates are often the second most plentiful PM2.5 species in the East and, in a few locations, are even slightly more plentiful than carbonates. They are less plentiful in the West and rank third behind nitrates,\(^\text{13}\) which is probably due to the dearth of coal-fired power plants in the West (California does not have a single coal-fired power plant).\(^\text{14}\) Most sulfate PM2.5 originates from atmospheric reactions of sulfur dioxide (SO₂). Near strong sources, directly emitted sulfates and sulfur trioxide can be significant (hence the ability of sulfates to rival carbonates in some locations). Direct (or primary) sulfate emissions can come from sources such as power generation facilities and industries which burn residual oil.\(^\text{15}\)

• Ammonia from sources such as fertilizer and animal feed operations contributes to the formations of sulfates and nitrates that exist in the atmosphere as ammonium sulfate and ammonium nitrate.\(^\text{16}\)

PM2.5 and their secondary sources are so small that wind and weather can transport them thousands of miles from their place of formation.\(^\text{17}\) However, PM2.5 concentrations throughout the country do vary according to the types of secondary sources contributing the PM2.5. Although carbon is a substantial component of fine particles everywhere,\(^\text{18}\) the concentration of sulfates and nitrates varies depending upon the region of the country. The concentration of sulfates is much higher on the East Coast, while nitrates are higher in the West. However, even in the East, sulfates comprise less than half of the PM2.5 species, while the combination of carbonates and nitrates almost always accounts for more than half of the PM2.5 species and often approaches two-thirds. EPA’s model for predicting the concentrations of future PM2.5 species enjoys varying levels of success depending upon the species. For example, the EPA is fairly confident that its model can accurately predict future sulfate concentrations, but freely admits that it cannot be so sure of future carbonate or nitrate levels.\(^\text{19}\) This should cause problems as the combination of carbonates and nitrates dominate species concentrations throughout the country, which leaves the EPA with a model that will be used to determine the extent of state implementation plans but might be able to accurately measure only a fraction of the problem.

\(^{13}\) Id.


\(^{15}\) EPA WHITE PAPER, at 16.

\(^{16}\) Id.

\(^{17}\) Id.

\(^{18}\) Id. at 17.

\(^{19}\) Id. at 3.
III. The PM Trend

The trend in PM concentrations, much like the trends of nearly all other pollutants, has been downwards. These are not recent trends but come on the heels of decades of dramatic reductions. For example, between 1970 and 2002, the total national emissions of the six principle pollutants tracked by the EPA have been cut 48 percent, even as energy generation (most of which came from burning fossil fuels) increased 42 percent, population increased 38 percent, the number of vehicle miles driven increased 155 percent, and GDP increased 164 percent.20 Between 1983 and 2002 sulfur-dioxide ambient concentrations (which can cause acid rain) fell 54 percent. Carbon-monoxide (CO) ambient concentrations (the main cause of wintertime smog) dropped by 65 percent. Emissions of volatile organic compounds (VOCs—a major contributor to urban smog) fell 40 percent. Ambient lead concentrations have fallen 94 percent, and emissions of large particulate matter (PM10—the main airborne cause of lung irritation) have dropped by 34 percent.21 These drops are dramatic, but the best news is that they have not stopped. The lowest hanging fruit may have been picked in the 1970s, but a steady stream of pollution reductions continues to fall from the tree. Thirty-nine percent of sulfur dioxide (SO2) reductions occurred between 1992 and 2003, as did 42 percent of carbon monoxide reductions and 25 percent of VOC reductions.22 Of the 34 percent reduction in large particulate matter (PM10) emissions, 25 percent occurred after 1988, while ambient concentrations fell 31 percent. Although these reductions occurred in every section of the country the sharpest declines were observed in areas with historically high concentrations: 39 percent in the northwest, 33 percent in the Southwest, and 35 percent in southern California.23

The EPA has only been measuring concentrations of very small particulate matter (PM2.5) since 1999, and thus can only confirm a 10 percent decline in concentrations between 1999 and 2003.24 Much like the reductions in PM10, the sharpest declines can be found in areas with historically high levels, with PM2.5 concentrations falling the most in the Southeast (20 percent) and southern California (16 percent).25 However, a comparison of modern figures to data collected by the Inhalable Particulate Monitoring Network, which operated from 1979 to 1983, reveals that since the early 1980s annual average PM2.5 levels have declined about 45 percent, while peak daily levels have declined


21 Id. The fall in PM10 concentrations is based on data collection that began in 1985, although unofficial estimates place it much higher.

22 Id.


24 Id.

25 Id.
nearly 50 percent.\textsuperscript{26} The declines are steady, but also appear to be increasing, as the 10 percent decline reported by the EPA between 1999 and 2003 had moved closer to 15 percent by 2004. In 1999, 35 percent of the nation’s PM2.5 monitors exceeded the annual standard, compared to about 14 percent today. At the same time, the EPA observed steep reductions in the production of PM2.5 species from power plants. Sulfur dioxide (SO2) emissions produced by electrical generation fell by 33 percent, while emissions of nitrogen oxides (NOx) from power plants dropped 30 percent between 1998 and 2004. Tough measures imposed on utilities during the pollution-prone summer months pushed their NOx emissions down a whopping 60 percent during the May-September 2005 ozone season. The reductions are far from finished.\textsuperscript{27} Future reductions under the EPA’s Clean Air Interstate Rule (CAIR) should push SO2 emissions from power plants down a further 40 percent by 2010 and 70 percent after 2020.\textsuperscript{28} CAIR’s objectives for NOx emissions are even more ambitious with planned reductions of 53 percent below 2003 levels by 2009 and 61 percent by 2015.\textsuperscript{29}

The effects of these emissions reductions have been observed in ambient air concentrations. Ambient levels of SO2, NOx, and sulfate PM all declined about 30 percent between 1989 and 2002.\textsuperscript{30} These more recent reductions are impressive, but they are only part of the story. Since 1983, ambient concentrations of carbon monoxide have fallen 63 percent, lead by 94 percent and PM2.5 by about 50 percent.\textsuperscript{31} Emissions of volatile organic compounds (VOCs), which are a major contributor to ozone, have nearly halved since 1983.\textsuperscript{32} In 1984, half of America’s cities violated federal summer smog standards with an average of 12 violations a year. By 2001, the number of cities in violation had been cut to 14 percent, and those caught only averaged four violations a year.\textsuperscript{33}

\begin{footnotesize}
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\item \textsuperscript{27} This reduction was due to a combination of the EPA’s NOx Budget Trading Program and the NOx SIP Call. \textit{Id.}
\item \textsuperscript{28} ENVIRONMENTAL PROTECTION AGENCY, \textbf{CLEAN AIR INTERSTATE RULE}, available at http://www.epa.gov/interstateairquality/.
\item \textsuperscript{29} ENVIRONMENTAL PROTECTION AGENCY, \textbf{CLEAN AIR INTERSTATE RULE: BASIC INFORMATION}, available at http://www.epa.gov/interstateairquality/basic.html.
\item \textsuperscript{30} Joel Schwartz, \textit{EPA’s Make-Work Project}, TECH CENTRAL STATION (July 1, 2004), available at http://www.tcsdaily.com/article.aspx?id=070104D.
\item \textsuperscript{31} ENVIRONMENTAL PROTECTION AGENCY, \textbf{SIX PRINCIPLE POLLUTANTS}, available at http://www.epa.gov/airtrends/sixpoll.html. The 50 percent reduction in PM2.5 is attributable to Joel Schwartz’s comparison to of modern reductions with measurements taken between 1979 and 1983 by the Inhalable Particulate Monitoring Network.
\item \textsuperscript{32} \textit{Id.}
\end{itemize}
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As previously mentioned, SO2, VOCs, carbon monoxide, and NOx, are all species that contribute to high PM2.5 levels. The across the board cuts in these major pollutants is reflected in lower PM2.5 concentrations. Had EPA’s current PM2.5 standard of 15µg/m³ been in place in 1980, then an estimated 80 percent of the nation’s pollution monitors would have registered non-attainment.34 Today, the number of monitors observing violations is only 14 percent.35 PM2.5 concentrations are down 40 percent in the last 20 years with 10 percent of that coming in just the last four years, and they are an estimated 80 percent below their 1900 levels. It may sound like hyperbole, but America’s PM levels are the lowest they have been since before the industrial revolution and appear to be heading lower.36

IV. Current and Projected Attainment and Affected Populations

The national trend in PM2.5 concentrations is clearly towards compliance with both the 15µg/m³ average annual standard and the 65µg/m³ 24 hour standard. In fact, 99.6 percent of the nation’s monitoring sites already achieve the daily standard and many do so with room to spare. Although non-attainment is primarily limited to annual levels reported by 14 percent of the EPA’s monitors,37 most of these areas are not far from compliance. As of 2004, a mere reduction of 10 percent or less in PM2.5 levels would have brought 60 percent of non-attainment areas into compliance, while reductions of 10 to 20 percent would have brought an additional 23 percent of areas into attainment.38

According to the EPA, 120 counties are in violation of the 15µg/m³ average annual standard. These counties are home to 58.7 million people, 21.8 million of who live in the 13 non-attainment counties in California. Of the 107 non-attainment counties not in California, 86 of them have annual PM2.5 concentrations of between 15-17µg/m³ — quite close to the standard. Outside of California, only one county, Allegheny, Pennsylvania has a designated level above 20µg/m³. The worst annual PM2.5 concentration is Riverside County, California with a maximum exposure level of 28.9µg/m³.39

While the number of counties seems small and the violations slight, the fact remains that 58.7 million Americans live in counties with monitors in violation of EPA PM2.5

39 Jones, supra note 14, at 14.
In some counts, the EPA adds in the occupants of neighboring counties and has placed the number of people exposed to high levels of PM2.5 at 99 million. However, not many people are exposed to high levels of PM2.5 as would appear. The fact that a county has been labeled “non-attainment,” does not mean that the entire county is in violation. It is fairly typical for about half of the PM monitors in “non-attainment” counties to register levels indicating compliance, as is true in Chicago, Pittsburgh, Washington, DC, and Baltimore. In the major cities in Tennessee—Knoxville, Chattanooga, and Nashville—the ratio was 55 percent. Even in the worst locations, such as Los Angeles, the percentage of monitors exceeding the threshold was 69 percent. Depending upon population concentrations, half of the people in a “non-attainment” county might not be living in a location experiencing greater than 15 µg/m³ concentrations of PM2.5. If an assumption that 60 percent of a county’s occupants are still exposed to higher PM2.5 levels is made, then the figure of 58.7 million drops to 35.2 million. Furthermore, if PM2.5 levels continue to drop at their current rate, then the number non-Californian counties in violation will fall to 12, while the number of Californian counties will only fall from 13 to 10 by 2010. This will reduce the number of people living in non-attainment counties outside of California to 14 million, or about 8.4 million if we consider that 60 percent of them probably live in a location actually in violation. While the continued inclusion of most of the California counties still leaves a large number of people living with higher PM2.5 levels, by 2010 the number of people actually living within locations in violation of current PM2.5 standards should be something like 20 million—a vast improvement over EPA’s estimate of 99 million.

An excellent illustration of the problems associated with PM2.5 concentrations, the locations of monitors, and the population affected can be found in the EPA’s Interim Regulatory Impact Analysis (IRIA). The IRIA map represents what the EPA believes the PM2.5 concentrations will be in 2015 in Birmingham, Alabama. Birmingham is currently non-compliant with the existing rule and by EPA estimates, is unlikely to be so by 2015. However, two of the three PM2.5 monitors are placed very close to the city’s two largest clusters of major pollution sources and so, of course, register non-compliance. Furthermore, as EPA’s own map demonstrates, the vast majority of the 36 x 26 km area, which has been designated “non-attainment,” is well under the emissions threshold. Birmingham, Alabama may not meet the EPA’s standards, but the air that most people breathe there probably does.

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40 The EPA has put the estimate at 65 million, although the population of these counties is only 58.7 million. Id. The reasons for this discrepancy are unclear. The EPA could be compensating for “uncounted persons” or visitors, but the numbers are close enough.

41 The rational behind this move is that emissions from neighboring counties contribute to non-attainment in the named 120. Id.

42 Id. at 15.

43 ENVIRONMENTAL PROTECTION AGENCY, INTERIM REGULATORY IMPACT ANALYSIS FOR PM2.5 NATIONAL AMBIENT AIR QUALITY STANDARDS ch. 2, at 26, (Jan. 17, 2006) [hereinafter INTERIM REGULATORY IMPACT ANALYSIS].
Although PM can travel great distances, the highest concentrations appear to remain local to their source. For example, at its October 18, 2005 meeting, EPA’s Clean Air Act Advisory Committee (CAAAC) presented data collected from the highways of southern California. Sponsored by the EPA, a “Southern California PM Research center” had measured the concentrations of different PM particles at distance intervals from major highways. While the concentration of heavy particles stayed nearly constant as the distance from the highway increased, concentrations of lighter particles remained high near highways but dispersed rapidly. Starting at 1.0 relative concentration, levels of total light particles, black carbon, and carbon monoxide plummeted within the first 50 meters (to about 0.42). The rate of the declines of their relative concentrations then started slow and reached about 0.30 at 100 meters, before leveling off at 0.22-0.20 at 300 meters. The evidence from Birmingham, Alabama and the highways of southern California suggest that even when an area is not in attainment for PM2.5 levels, the scope of the violation is likely limited to the immediate vicinities of highways and major pollution sources. In retrospect, the assumption that the sensing of violations by 60 percent of an area’s pollution monitors corresponds to 60 percent of the population is, perhaps, too generous.

In addition to their limited exposure to PM2.5 within non-attainment counties, people living in these areas can take comfort in the fact that some PM2.5 species have been shown not to have detrimental health effects. Although carbonates typically dominate as the primary PM2.5 species, sulfates and nitrates vie for second, with sulfates making up 25 to 50 percent of PM2.5 on the East Coast, and nitrates comprising 25 to 50 percent in the West. Controlled studies have already shown nitrate PM2.5 to be without adverse health effects. As for sulfides, the main form of sulfate PM2.5, ammonium sulfate, is actually used as an inert control substance in studies of the health effects of acidic aerosols. It has been selected as a control for these studies, because it is a substance not expected to have any health effects on humans. Another form of sulfate, magnesium sulfate, is far from a lung irritant, and has found use as a means of therapeutically reducing airway constriction in asthmatics. Toxicology studies involving human volunteers have yet to find sulfates toxic—even at several times today’s peak levels. Not only are most people living in PM2.5 non-attainment areas unlikely to actually dwell in elevated PM2.5 levels, but, regardless of whether they live in the East or the West, about half of the PM2.5 they are ever likely to breathe are biologically known to either not be toxic or not produce adverse health effects in humans.


46 Id.
What Changing the Rules Will Do to the Number of Counties in Compliance

There are about 3,000 counties in the United States. About 1,000 of them have PM monitors. Most of these monitors are responsible for calculating annual average PM concentrations. Only 539 counties have valid data on 24 hour PM concentrations for 2001-2003. Relative reduction factors (RRFs), which are percentage reductions to individual particle components calculated into the model, are available in 385 of these counties located in the central and eastern U.S. Even taking into account RRF’s, the Electric Power Research Institute made the following projections on the impacts of various proposed rule changes on compliance for the 385 counties:

- Lowering the annual standard from 15µg/m³ to 14µg/m³ more than doubles the number of non-attainment counties from 19 to 44.
- Lowering the daily standards from 40µg/m³ to 35µg/m³ increases by more than a factor of 3 the number of non-attainment counties according to the daily standard from 10 to 34.
- Lowering the daily standard from 35µg/m³ to 30µg/m³ increases by nearly a factor of 4 the number of non-attainment counties due to the daily standard from 34 to 133.
- If the rules are not changed, only 19 counties will violate the annual standard, while only one county will violate the daily standard.

These numbers only cover a limited number of counties. John Bachmann, EPA’s Associate Director for Science/Policy, made a more thorough assessment in a December 20, 2005 conference call with reporters, Mr. Bachmann laid down the EPA’s estimates of what counties violate current standards and how they would fair under the proposed standards.

In any case, the numbers are 116 counties nationwide with monitors today would violate—do violate according to our most recent data, the current standards. Under these new standards, the proposed standards of 15 micrograms per cubic meter and 35, 191 would violate it.

48 Id. at 10.
49 Id. at 11.
Mr. Bachmann then proceeded to estimate what attainment would be like in 2015 under the current and proposed standards.

And we—by 2015 which was one of the questions we project with some uncertainties that nationwide there would be 32 counties that would violate the current standards and 76 that would violate the proposed new standards if no additional actions are taken by states which they will.51

The EPA has been very busy since its inception in the early 1970s, but the gradual modernization of the economy and advent of cleaner technologies has played an important role in reducing emissions and ambient concentrations of all criteria pollutants even as energy consumption and the economy have expanded. According to Mr. Bachmann, even if the States and federal government take no additional actions, the number of non-attainment counties will fall from 116 to 32 by 2015. Even though the proposed reduction in the daily standard from 65µg/m³ to 35 µg/m³ pushes 191 counties into non-compliance, this number should be down to 76 by 2015. While this appears to be good news—no matter what standard is decided upon—Mr. Bachmann did mention that these predictions came with “some uncertainties.” As we shall see, these uncertainties are not trivial matters and could end up producing considerable hardships for the American people with little in the way of cleaner air in return. What is certain is that PM2.5 levels are declining, and the rate of decline has hastened over the past few years. However, the uncertainties present in the EPA’s model raise the real possibility that the EPA will underestimate future declines in PM2.5 levels. If this occurs, then, starting in 2010, States will start taking the “additional actions” Mr. Bachmann talked about. Additional actions in state implementation plans are never free and bound to cumulate in slower economic growth, lost jobs, and higher electricity prices. With this in mind, the EPA should consider keeping the current PM2.5 standards in place while waiting to assess the PM2.5 reductions already in the pipeline. Americans have already paid, and will continue to pay, for much of the clean air already on its way. But if the model underestimates the coming reductions in PM2.5, which it appears to do, then Americans will foot the same bill twice.

V. Problems with the EPA’s Estimates

The EPA has asked for comment on its proposal to reduce the maximum allowable daily PM2.5 concentrations from 65µg/m³ to 35µg/m³. Additionally, the agency has requested comment on the possibility of keeping the daily standard the same or reducing it as low as 25µg/m³, and either leaving annual concentrations at 15µg/m³ or lowering them to 14, 13, or 12µg/m³.52 Whatever new standard is decided, it will take effect in 2015, but States will have to start planning how to achieve these new goals in 2010. As a result, the EPA either directly or through the States will start ordering reductions in emissions in 2010,

51 Id. at 9-10.

even though EPA cannot accurately predict what PM2.5 levels will be in 2015. In an October 18, 2005 presentation to a subcommittee of the EPA’s Clean Air Act Advisory Committee (CAAAC), John Bachmann, the Associate Director for Science/Policy and New Programs of the Office of Air Quality Planning and Standards, admitted that predicting future emissions and ambient air quality is an inherently difficult undertaking.

The quantitative emissions and air quality forecasts summarized here were gathered from a variety of sources and projects. The numerous uncertainties inherent in such forecasts are documented elsewhere but are important to keep in mind here.\(^5\)

In some cases, forecasts are biased high because expected improvements in future controls can not be objectively determined. The lack of progress or increase in some categories over time may not be realistic. Direct PM emissions estimates for all categories are particularly uncertain, both in the base and future cases. While individual mobile source technologies are well characterized, significant uncertainties are suggested by comparisons between emissions and ambient measures.\(^4\)

Predicting future PM2.5 levels may be difficult, but according to the CAAAC presentation, while the EPA is predicting future declines in most major pollutants, it is not so sure about PM2.5. According to a chart entitled “Impacts of Current Control Measures,” which measures the projected impacts of existing clean air rules, the EPA projects SO2 emissions to fall from over 11 million tons in 2010 to about 10 million tons in 2020, and NOx emissions to fall from a little over 15 million tons in 2010 to just over 13 million in 2015 to about 12.5 million tons in 2020. However, PM2.5 emissions appear to hold steady at about 3.4 million tons in 2010 and 2015 before climbing to nearly 3.5 million tons in 2020.\(^5\)

Although PM2.5 levels have been falling over the years, the EPA does not seem to believe that they will fall much further. However, examination of some of the EPA’s other figures shows that PM2.5 levels are likely to fall. The CAAAC presentation included information on the species pollutants that make up PM2.5, and used a comparison between Birmingham, Alabama and nearby the Sipsey Wilderness to illustrate the difference between local and regional PM2.5.

In Birmingham proper, the contributions to PM2.5 come from the following: 48.2% carbon, 8.3% nitrate, 35.7% sulfate, and 7.7% crustal. In nearby the Sipsey Wilderness, PM2.5 is made up of 52.2% sulfate, 9.6% nitrate, 32.2% carbon, and 6.1% crustal. The urban excess, which is the urban minus regional concentrations equals 83.0% carbon, 5.7% nitrate, and 11.3% crustal. The total PM2.5 mass of Birmingham was an annual

\(^5\) CAAAC Meeting, *supra* note 44.

\(^4\) Id.

\(^5\) Id.
average of 17.6µg/m³, while the rural was 11.5µg/m³. While Birmingham exceeds the current standards and the Sipsey Wilderness does not, the starkest difference between the two areas is the composition of their PM2.5 concentrations. Nearly half of Birmingham’s PM2.5 owes its existence to carbon sources, which is representative of the overwhelming influence of automobile pollution. With fewer cars, the Sipsey Wilderness’s PM2.5 concentrations are dominated by sulfate and nitrate emissions, most likely transported from coal-fired power plants and other industrial sources.

With the Clean Air Interstate Rule (CAIR) already in place and expected to bring Birmingham down by about 1.5 µg/m³ in sulfate/nitrate reduction, an additional 1.0 will have to be found to bring Birmingham into compliance with existing standards. If this cannot be done, then either the State or EPA will have to take “additional actions” and impose regional controls.56

Since the Sipsey Wilderness owes more than 60 percent of its PM2.5 to either sulfates or nitrates, reductions in SO2 and NOx will presumably have a bigger impact on regional PM2.5 levels. However, the EPA can only hope for accurate measurements of sulfates, so they should accurately predict future levels of 35.7 percent of the pollutants contributing to PM2.5 in Birmingham. EPA’s model should have better luck with the Sipsey Wilderness and its 52.2 percent sulfate concentration, but an accurate prediction in the Sipsey Wilderness has little meaning, as the region is already in attainment and should remain so no matter what future standard is adopted.

An accurate forecast of future carbonate concentrations is the key to predicting future PM2.5 levels in non-attainment areas such as Birmingham, while accurate measurements of sulfates are more likely to allow the EPA to make good predictions in rural areas that are also well within attainment levels. Reductions in PM2.5 levels in urban, non-attainment areas like Birmingham will hinge upon improvements in carbonate concentrations, which are dependent upon the number and quality of the area’s auto fleet. However, while autos contribute to most of the PM2.5 problem, the EPA does not know what improvements to expect as the quality of area cars and trucks improves:

At this time, it is not clear what current regulations and fleet turnover vs. growth in VMT (vehicle miles traveled) will do to affect these emerging concerns, although it is reasonable to expect some benefits.57

While the EPA cannot predict by how much carbonates will fall in Birmingham by 2015, they will most certainly fall. As reductions in sulfate and nitrate concentrations in nearby the Sipsey Wilderness contribute less to Birmingham’s PM2.5, the gradual modernization of the city’s stock of cars and trucks should push down concentrations of volatile organic compounds and other carbonates contributing the area’s PM2.5 problem.

56 Id.
57 Id., (parenthesis added).
Particular Problem’s with EPA’s Modeling

The EPA is refreshingly frank about the problems associated with its model and its ability to predict future PM2.5 emissions and concentrations.

In general, model performance is better for the eastern U.S. than for the West. The model performs well in predicting the formation of sulfates, which are the dominant species in the East. It does not perform as well for nitrates and carbon, which are the dominant species in the West. Therefore we have greater confidence in our projections in the East.\(^{58}\)

There are unknown uncertainties in the state of the science regarding the formation of secondary organic carbon, as well as with the techniques for measuring carbon and primary emissions of organic carbon. These uncertainties affect the model’s ability to properly predict organic carbon concentrations and the effectiveness of VOC controls for reducing carbon particles.\(^{59}\)

Although this has been discussed previously, its importance warrants continued emphasis. Carbonates are the dominant PM2.5 species.\(^{60}\) Nitrates come in second in the West, while sulfates are second in the East. Moreover, as observed in the comparison between Birmingham and the Sipsey Wilderness, higher concentrations of sulfate species are more likely to be found in regions that are already in attainment. Therefore, the EPA’s model should make the most accurate predictions in areas without PM2.5 problems, while the greatest inaccuracies will concern those areas most in need of accurate measurement. In addition to its difficulties with estimating the majority of PM2.5 species, the EPA’s model is also more geared towards predicting annual PM2.5 levels.

Overall, the model performs well in predicting monthly to seasonal concentrations, similar to other recent model applications for PM2.5. The model is less well suited to predicting 24-hour values.\(^{61}\)

For the proposal RIA, we used an interim projection methodology based on quarterly average species concentrations to calculate the projected daily average PM2.5 concentrations. The lack of a more refined peak concentration relative factor to predict changes in daily peaks may introduce additional uncertainty in the daily average projections. We intend to improve the methodology for the final RIA.\(^{62}\)

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\(^{58}\) EPA WHITE PAPER, supra note 11, at 3.

\(^{59}\) Id. at 4.

\(^{60}\) Id. at 17.

\(^{61}\) Id. at 3.

\(^{62}\) Id.
The EPA’s proposed rule change involves a reduction in daily PM2.5 levels from 65µg/m³ to 35µg/m³. Unfortunately, a model with problems estimating both the majority of PM2.5 species and daily PM2.5 concentrations is not appropriate for determining what reductions are needed when the primary issues are the daily concentration limits in areas where the problem is largely the problem species. Further, the potential for uncertainty, is far from limited to its problems with carbonates, nitrates, and predicting daily levels.

Additional uncertainty is introduced through our future year projections of emissions due to unrefined growth rates and limited information on the effectiveness of control programs.63

Modeling future emissions and air quality is difficult, but it becomes even more so when the success or failure of existing control problems become variables. For example, in its Interim Regulatory Impact Analysis, the EPA estimated that in three urban areas available controls on local sources could provide between 20 to 50 percent of the incremental reductions in concentrations of PM2.5 required to meet an annual standard of 15µg/m³ and between 5 to 50 percent of the incremental reductions in concentrations of PM2.5 required to meet a daily standard of 35µg/m³.64 The aforementioned problem predicting daily PM2.5 levels is apparent in these numbers, but the “more accurate” prediction for annual levels is not much better. Existing controls could reduce annual PM2.5 levels by 20 percent or they could reduce them by more than twice as much. Reductions in daily levels could be as low as five percent, or they could be ten times as high. The model already cannot be sure of carbonates, nitrates, and daily levels, and it cannot be so sure about the effectiveness of local existing controls either.

Lastly, but perhaps most importantly, the model is primarily focused upon emissions from point sources. Although the importance of mobile sources and their contribution to PM2.5 is recognized, the uncertainties and complexities inherent in any estimation of their future emissions has led the EPA to err on the side of caution:

Note that while we believe that the mobile sector is a substantial contributor to total PM 2.5 mass; our current mobile source inventory and control measures are limited in completeness. For this reason, we believe there are more mobile source reductions available than those that we model in our controls analysis.65

Further, existing emissions inventories appear to understate the extent of mobile source direct PM emissions and provide limited information on the extent of available controls that have already been applied to some categories.66

63 Id. at 4.
64 INTERIM REGULATORY IMPACT ANALYSIS, supra note 43, at ch. 2, p. 31.
65 Id. at ch. 2, p. 22 n. 11.
66 Id. at Executive Summary, p. 8.
AirControlNET is the EPA’s computer program designed to estimate the cost effectiveness of various pollution control strategies and their impact on PM2.5 concentrations. Although AirControlNET can provide a lengthy table of useful means of reducing PM2.5 emissions from point sources, it can provide little in the way of information regarding mobile sources.

Absent from the table above is a summary of the mobile source and control information. AirControlNET currently contains a very limited array of mobile source controls. While the source apportionment data in chapter two suggests that this source sector is an important contributor to total PM2.5, for this analysis we are unable to simulate significant reductions in this sector with AirControlNET controls. We look to address this limitation in the final RIA.67

The combination of these many uncertainties has made it difficult for the EPA to accurately forecast future PM2.5 concentrations, but it has also had another effect—at present time, the EPA is unsure what reducing PM2.5 levels is going to cost:

We had planned to provide national cost and benefit estimates of illustrative control strategies to assess the nation’s ability to reach the proposed PM2.5 standards and alternative standards options. As we developed that analysis, we reached the conclusion that, at present, our available data and tools are insufficient to develop cost and benefit information that would accurately reflect the range of possible options that the States may choose to implement. Most significantly, we concluded that the national-scale analysis based on our current data and tools would not properly reflect the incremental costs and benefits of moving from the current standards to progressively more health-protective standards. We are taking steps to ensure that we will complete this national-scale analysis in time for publication with the final rule (September 2006).68

Modeling future emissions is difficult, and the accuracy of these predictions have serious implications. Based upon predictions made in 2010, States and the EPA will begin planning reductions in PM2.5 species in order to meet the 2015 targets. Unfortunately, it appears that it is quite possible that the EPA’s model will underestimate coming reductions in PM2.5 levels for the following reasons:

1. The model is good at predicting future sulfate concentrations but does not do as well with nitrates and carbonates. Unfortunately, carbonates and nitrates generally define the majority of PM2.5 species, and areas with high sulfate concentrations tend to already be compliant.

2. The proposed rule will affect the allowable daily concentrations of PM2.5, but the model has previously been more successful at predicting annual concentrations and is less suited to make accurate predictions of daily levels.

67 Id. at ch. 3, p. 10.
68 EPA WHITE PAPER, supra note 11, at 23.
3. The effectiveness of existing controls remains uncertain. The EPA estimated that local controls in three urban areas could contribute between 5 to 50 percent of the concentration reductions required to meet the new standards. The breath of this range is so wide that the forecast is almost rendered completely meaningless.

4. While mobile sources are recognized as major contributors to PM2.5, they receive scant consideration in the model. Emissions from mobile sources are likely to decline sharply, but the complexities and lack of data needed to accurately estimate their declines in emissions have caused them to largely escape consideration.

These uncertainties have the potential to multiply with one another and produce predictions of future daily PM2.5 concentrations that are wildly inaccurate. Furthermore, the lack of data for emissions for mobile sources ensures that the model will underestimate reductions in PM2.5 emissions and concentrations in 2015. These inaccurate predictions will cause the EPA and the States to plan for more drastic reductions in 2010 than are needed to achieve the 2015 standards. As a result, the American economy will pay considerably more to get below the same clean air threshold. In light of the high probability of this, and the looming, large, but unknown, improvements in vehicle emissions, the EPA should consider sticking to the existing standards until future PM2.5 levels can be accurately ascertained.

VI. The Coming Reduction in Auto Emissions

The contribution of automobiles to PM2.5 concentrations and pollution in general is considerable. According to statistics collected from the Los Angeles air basin, mobile sources (cars, trucks, etc.) were responsible for 28 percent of total organic gas emissions (which contribute to ozone formation), 82 percent of carbon monoxide, 80 percent of nitrogen dioxide, 48 percent of sulfur dioxide. While mobile sources are obviously contributing huge amounts of PM2.5, the majority of the blame falls on a very narrow subset of mobile sources. California state analysts believe that the oldest 10 percent of the State’s vehicle fleet is responsible for 90 percent of California’s mobile source emissions. California is famous for its strict emissions package requirements. While these emissions controls have raised the price of a car in Los Angeles by $1,000 to $2,000 and likely slowed fleet turnover, they have produced results. From 1988 to 1998, PM levels fell at an average rate of 5.6 percent per year. Between 1980 and 1998 carbon monoxide fell at an average annual rate of 3.4 percent, while nitrogen dioxide fell 2.9 percent, high ozone days fell 23.3 percent, and sulfur dioxide 8.9 percent.⁶⁹

These numbers reveal that much, if not a majority, of PM2.5 and PM2.5 species comes from mobile sources and the oldest of those mobile sources at that. Get rid of the oldest 10 percent and pollution and PM2.5 concentrations will plummet. Fortunately, not only are the oldest 10 percent likely to be replaced as they break down, but they, along with the remaining 90 percent, are going to be replaced by significantly cleaner automobiles.

⁶⁹ Matthew E. Kahn, The Beneficiaries of Clean Air Act Regulation, REGULATION, (Spring 2001), at 34.
In 2003, the EPA’s Tier 2 emissions standards took effect. Essentially, vehicles built after 2003 can be expected to be 75 to 95 percent cleaner than the average vehicle on the road.\textsuperscript{70} EPA has also ordered steep reductions in emissions from diesel trucks, which will have to achieve a 95 percent pollution reduction by 2007.\textsuperscript{71} In 2004, additional reductions were also mandated for construction, farm equipment, and other off-road diesel vehicles, which will have to lower their NOx and PM emissions by 90 percent.\textsuperscript{72} These new rules come on top of already adopted rules requiring large NOx and PM reductions for marine vessels, locomotives, and off-road gasoline engines as well.\textsuperscript{73}

New regulations will also have a substantial effect on Volatile Organic Compounds (VOC’s). VOCs are a major contributor to ozone and PM2.5, and new cars will produce 90 percent less of them. Since mobile sources account for two-thirds of all manmade VOCs, the effects of automobile fleet modernization should have a significant impact on VOC levels and PM2.5.\textsuperscript{74} Diesel particles regularly contribute between 5 to 10 percent of urban and suburban PM, and as much as 30 percent in the densest urban settings, but by 2007 new diesel trucks will emit 90 percent less soot, while off-road diesel vehicles will have to meet similar standards by 2010.\textsuperscript{75}

In addition to reductions in NOx, VOCs, and soot, the introduction of low sulfur gasoline should further depress emissions of SO2, which are already being pushed lower by new restrictions on power plant emissions. Gaseous VOCs can contribute between 20 to 40 percent to urban PM levels. In the eastern U.S., about 25 to 40 percent of PM is attributable to SO2, while NOx defines a similar proportion in the West.\textsuperscript{76} Between new regulations on automobiles and diesel engines, combined with the introduction of cleaner low-sulfur gasoline, concentrations of PM2.5 and PM2.5 species attributable to mobile sources look set to decline significantly.

According to the Federal Highway Administration, the average age of a car on the road today is about nine years, while the average pickup is aged 10.\textsuperscript{77} While it is true that

\textsuperscript{70} \textsc{Environmental Protection Agency, Tier 2 Vehicle & Gasoline Sulfur Program: Basic Information}, available at http://www.epa.gov/tier2basicinfo.htm.

\textsuperscript{71} \textsc{Environmental Protection Agency, Clean Diesel Trucks and Buses Rule}, available at http://www.epa.gov/otaq/diesel.htm#regs.

\textsuperscript{72} \textsc{Environmental Protection Agency, Nonroad Diesel Equipment}, available at http://www.epa.gov/nonroad-diesel.

\textsuperscript{73} \textsc{Environmental Protection Agency, Nonroad Engines, Equipment, and Vehicles}, available at http://www.epa.gov/nonroad/.


\textsuperscript{75} \textit{Id.}

\textsuperscript{76} \textit{See Interim Regulatory Impact Analysis, supra note 43, at Executive Summary, p. 7.}

\textsuperscript{77} \textsc{Federal Highway Information Administration, Department of Transportation, Highway Information Quarterly Newsletter} (April 2003), available at http://www.fhwa.dot.gov/ohim/hiq/hiqapr03.htm.
modern cars and trucks do indeed last longer, much of the U.S. vehicle fleet appears long overdue for turnover. Although the EPA is uncertain about the growth in the vehicle fleet and vehicle turnover, it is highly probably that not only will nearly all of the 10 percent very oldest vehicles be off the road by 2015, but, considering the nine year old average, most of the remaining 90 percent will be as well. As the retirement of one old car makes room for pollution from ten new ones, any growth in the vehicle fleet is unlikely to impede the forces of modernization. While it received little attention in the EPA’s model, the modernization of the vehicle fleet should have a substantial impact on future PM2.5 levels. Despite the uncertainty, considering the high quality cars and fuels now being produced, it would not be unreasonable to see automobile pollution fall by more than half by 2015 simply from modernization of the fleet.

VII. Likely Effects, Recommendations, and Conclusion

The EPA’s proposal to reduce daily PM2.5 levels from 65 µg/m³ to 35 µg/m³ is likely to cause much more harm than good. PM2.5 levels, as well as emissions and ambient concentrations of all other criteria pollutants, have been falling for decades and are set to fall further. While this trend is most fortunate, attempting to quicken its pace can only lead to lost jobs, higher energy prices, and billions in lost economic opportunities. Furthermore, it would appear that the EPA’s model has difficulties predicting future daily PM2.5 concentrations and, considering its shortcomings in dealing with mobile sources, is likely to dramatically underestimate future reductions in PM2.5 and other criteria pollutants.

The good news is that the United States appears to be heading towards a new age of exceptional environmental cleanliness. As unbelievable as it sounds, air quality may soon attain levels of cleanliness not seen since before the industrial revolution. Unfortunately, by adopting the proposed daily standard of 35µg/m³ and combining it with a model with a tendency to underestimate future reduction in PM2.5, the EPA will set in motion numerous unnecessary and costly control measures across the country. Americans will endure job losses, higher electricity prices, and billions in lost GDP, at the same time as they are paying the additional environmental costs built into their new Tier 2 complaint automobiles. There is little doubt that the air will be significantly cleaner in 2015, the question is how many times the American people will pay for it. If the current PM2.5 NAAQS is kept in place, then Americans will pay for tomorrow’s cleaner air only once—through higher vehicle costs. However, if the PM2.5 standard is lowered to 35µg/m³, then the plans made in 2010 to reach these levels in 2015 will likely be based on overestimated pollution levels, and costs generated by the state implementation plans will come on top of the higher vehicle costs already being paid by consumers.

Reaching a clean air threshold is important, but, as lives, livelihoods, and billions of dollars are at stake, it would be wisest to take both the benefits of reaching the threshold and the considerable discount. The uncertainties inherent in the EPA’s model have created the real possibility that future pollution reductions will be underestimated. The effects on PM2.5 of CAIR, vehicle fleet modernization, or even seemingly unrelated programs such as the Healthy Forests Initiative may be uncertain, but they are likely to be
considerable. The uncertainties are significant, and the costs of ordering additional reductions will be huge. With these two factors in mind, EPA should consider maintaining the current standard and taking more time to assess the impacts of its current programs and vehicle fleet turnover. The current control programs and vehicle fleet turnover are likely to produce impressive results, but, if they fail to do so, the EPA can always reissue the proposed standard or decide on a stricter one. However, at present, the high stakes and potential for a promising, and already paid for, future warrant a wait and see approach.

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