Briefing Paper on the Costs and Benefits of EPA's Proposed Reduction in the $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS)

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EPA has proposed regulations to reduce the primary National Ambient Air Quality Standards (NAAQS) for fine particulate matter ($PM_{2.5}$, meaning particulate matter of diameter 2.5 microns or less) from an annual average of 15 ug/m^3 to somewhere in the range of 12 to 13 ug/m^3, a reduction of roughly 25%.[1] This proposed reduction in the annual average portion of the standard follows on EPA in 2006 having reduced the 24-hour portion of the NAAQS by about 50%, from 65 ug/m^3 to 35 ug/m^3.

EPA projects that the current standards of 15 ug/m^3 on an annual average basis and 35 ug/m^3 on a 24-hour basis will not be attained throughout the entire nation until the year 2020, if then. Efforts to attain the current 15/35 NAAQS by 2020 will involve large costs for all sectors of the U.S. economy and associated loss of jobs. Restrictions on economic growth will occur in both the counties that do not attain the standards while they pursue attainment (due to nonattainment New Source Review requirements), and also in the counties that do attain the standards as a result of PSD New Source Review requirements that limit emissions growth in areas with already-clean air. A reduced NAAQS such as EPA has proposed will increase the restrictions on economic growth beginning 60 days after promulgation of the new NAAQS.

Industry believes that the country should not now reduce the NAAQS for $PM_{2.5}$ at a time when there remains nearly a decade of hugely costly, difficult and technologically challenging work to be done in attempting to meet the current NAAQS.

The health benefits from further reductions in the NAAQS for $PM_{2.5}$ are highly uncertain, and could be near zero. Industry believes that the nation should continue the large and complex current effort to attain the existing standard for several more years and then assess progress, and only then might it be appropriate to consider further reducing the standard. No new NAAQS should be promulgated without EPA also having provided adequate and timely tools, guidance and rules for permitting and implementation of the new NAAQS.

Existing Regulations Require Huge Future Spending -- At Least $35 Billion per Year -- in an Attempt to Attain the Current NAAQS. Nearly 610,000 U.S. Jobs Will be Lost

From now through 2020 and beyond, we project based on EPA cost estimates that industry, households, vehicle owners, utilities and others will need to spend at a rate of more than $35.7 billion/year to comply with recent Federal "major" regulations whose benefits EPA estimates will consist largely in reductions in ambient levels of $PM_{2.5}$.[2] Additional spending pursuant to "non-major" Federal regulations, State and local requirements and a variety of non-regulatory programs could perhaps add a similar amount to the total, but the difficulty of estimating these

[1] The lowest measured design values for $PM_{2.5}$ are about 3.3 ug/m^3 on an annual average basis and 7 ug/m^3 on a 24-hour basis. The proposed maximum reduction from 15 to 12 ug/m^3 thus represents about 25% of the maximum total reduction (from 15 to 3.3 ug/m^3) that might potentially be achieved.

[2] "Major" regulations for the most part are those that will entail compliance costs exceeding $100 million in at least one year. Across the entire Federal government, there are roughly ten "non-major" regulations for every "major" regulation, though the average non-major regulation probably costs less than one-tenth the cost of the average major regulation.

costs lead us not to count any such costs beyond major Federal regulations in this analysis. (See Attachment A for a list of the major Federal regulations contributing to the $35.7 billion/year cost estimate and an explanation about how we derived this list. Attachment A also includes a discussion regarding the additional costs toward $PM_{2.5}$ attainment resulting from existing requirements other than major Federal regulations.)

Based on a recent macroeconomic analysis by NERA Economic Consulting focusing on the manufacturing sector,[3] we estimate that the nearly $36 billion/year in compliance costs toward attainment of the current NAAQS could reduce output in directly affected manufacturing sectors by up to 0.25 % to 1% each year. The value of shipments from the U.S. manufacturing sector could be reduced by $46 billion each year. Total gross domestic product, including all U.S. economic sectors in addition to manufacturing, might decline by $56 billion per year.

Using the widely respected IMPLAN® input-output model, we estimate that this loss in economic activity due to major $PM_{2.5}$-related regulations would cost about 83,000 U.S. jobs in directly affected sectors (mostly manufacturing), and about 254,000 additional jobs among suppliers to the directly affected sectors, including services, transportation, construction, raw materials, and more. The total eventual U.S. job losses due to existing $PM_{2.5}$-related requirements, including induced effects such as will result from reduced spending by those workers who retain their jobs but with less take-home pay, will total nearly 610,000.

Attachment B describes how we use the NERA study to estimate the macroeconomic impacts of $PM_{2.5}$-related compliance spending and summarizes the IMPLAN® modeling to project ensuing job losses.

The More Than $250 Billion in Yet-to-be-Spent Costs Through 2020 for Existing Major $PM_{2.5}$-Related Regulations Still Won't Get the Nation to Attaining the Current Standards. Further Regulations or Requirements and More Than a Billion Dollars per Year in Additional Compliance Spending Will be Needed

How close to attainment with the current NAAQS will we get in 2020 after industry, households and others have spent more than $250 billion between now and then for reducing ambient levels of particulate matter? (Nearly $36 billion per year for the next eight years amounts to more than $250 billion.) EPA terms the situation in 2020 after compliance with all existing requirements, and without any new requirements being added, as the "base case"; in a sense this represents the starting point from which EPA's Regulatory Impact Analysis (RIA) for the proposed revisions to the NAAQS begins. Will the nation attain the current standards in the 2020 base case?

- EPA's RIA in 2006 supporting the previous review of the NAAQS projected that 53 counties (accounting for 17% of the U.S. population) would not attain the current NAAQS in 2020 even after implementation of on-the-books-but-not-yet-fully-implemented regulations and requirements.

[3] NERA Economic Consulting. *Macroeconomic Impacts of Federal Regulation of the Manufacturing Sector*. Commissioned by Manufacturers Alliance for Productivity and Innovation. August 21, 2012.

- EPA's current, 2012 RIA now projects smaller figures: 14 counties (6% of the U.S. population) won't attain the current NAAQS by 2020 after implementation of existing regulations and other on-the-books requirements.

We think the answer is somewhere between EPA's two estimates. The Agency's recent estimate to the effect that the nation will come closer to attainment in 2020 reflects both the many additional requirements adopted in recent years and the progress the nation has made between 2006 and the present in controlling emissions and reducing the gap between actual air quality and the current NAAQS. But some of this emissions reduction is likely transitory and due to the recession. As the economy recovers, we will likely give back some of the emissions reductions that have occurred since 2006. And, we believe there are technical problems in EPA's current analysis that lead the Agency to overly-optimistic projections regarding air quality in 2020:

- EPA's current analysis takes credit for emissions reductions from some regulations that have not survived or likely will not survive legal challenge (e.g., the recent invalidation of EPA's Cross-State Air Pollution Rule);

- The current analysis appears to underestimate likely 2020 emissions from several important source categories (e.g., wildfires, Mexico);

- EPA's current analysis does not reflect any impact from expected growth through 2020 in various factors that have traditionally been thought to drive emissions (e.g., population growth, economic growth, growth in energy use); and

- The current analysis involves some simplifications or "short-cuts" that result in EPA underestimating the tonnage of emissions reductions that will be needed to achieve a sufficient improvement in ambient air quality at a nonattaining $PM_{2.5}$ monitoring site.

Despite the uncertainty about exactly what level of ambient air quality will prevail in 2020, it is clear that compliance with the present set of on-the-books regulations, requirements and programs will not suffice to yield nationwide attainment with the current $PM_{2.5}$ NAAQS in 2020. Despite the very large sums that have already been spent and the huge additional amounts that must be spent over the next eight years to meet requirements now on the books, some 20 - 50 million Americans will nevertheless likely find themselves in 2020 living in areas that have not yet attained the current NAAQS.[4] Full attainment will require further regulations and requirements that will elicit further emissions controls, likely costing an additional billion dollars per year or more:

- EPA's 2006 RIA did not estimate the full costs that will be needed to improve air quality from the projected 2020 base case to attainment of the current NAAQS, but the Agency estimated several quantities that in total would be close to this cost.[5] We judge that the Agency's estimate would have been roughly \$10 billion per year (in 1999 dollars).

[4] 6 to 17 percent of the projected 2020 U.S. population.

[5] The cost to obtain the air quality improvement from EPA's base case in 2020 to the current standard can be thought of as the sum of two costs: a) the cost to improve from the 2020 base case to the 1997 $PM_{2.5}$ NAAQS (15 ug/m3 on an annual basis and 65 ug/m3 on a daily basis); plus b) the cost to improve in 2020 from the 1997 NAAQS (15/65) to the current NAAQS (15/35). In the 2006 RIA, EPA estimated the cost of increment (b) at \$5.4 billion/year. EPA did not estimate the cost of increment (a), exactly; instead EPA estimated the annual cost in 2015

- Nor in the 2012 RIA did EPA estimate the full cost of improving air quality from the 2020 base case to attainment of the current 15/35 NAAQS. Using EPA's 2012 RIA data and calculation procedures, we estimate that the Agency would have calculated an incremental cost of roughly $90 million per year (in 2006 dollars) for attainment of the current NAAQS in 2020.[6] We believe such a cost estimate would be much too low primarily because, as we stated previously, EPA's projections regarding base case (after compliance with existing regulations and requirements) air quality in 2020 are too optimistic.

Based on several simplifying assumptions, we calculate the incremental cost as $1.25 billion per year to progress from "base case" air quality in 2020 to full compliance with the current NAAQS (15/35). In these calculations, we assume base case air quality in 2020 in each county in the U.S. at halfway between what EPA projects in the 2012 RIA (too optimistic, as argued previously) and what EPA projected in the 2006 RIA (too pessimistic, since many new regulations and requirements have been adopted since 2006 that will improve 2020 base case air quality relative to what was projected in 2006).[7]

And, as an added concern, EPA notes that control measures or strategies for obtaining the further emissions reductions needed for attainment of the current standard do not yet exist for some of the needed reductions. For some areas that are projected as not yet attaining the current NAAQS in 2020, the programs projected to be implemented in pursuit of attainment will exhaust all known controls and strategies. Further progress and full attainment will depend on new technological developments and innovative strategies that EPA simply assumes will emerge. Will these new control approaches develop and be capable of implementation sufficiently far in advance to yield attainment by 2020? No one knows. And if these unknown controls do in fact develop, what will they cost? No one knows this either, though EPA has assumed in the Agency's current RIA that unknown, yet-to-be-developed controls will become available in unlimited quantity at a cost of $15,000 per ton of emissions abated, about the same cost per ton

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to improve from the 2015 base case to attainment of the 1997 NAAQS. In effect, EPA estimated the cost to attain the 1997 NAAQS in 2015 instead of, as in increment (a), in 2020. Attaining the 1997 NAAQS by 2015 would cost more than attaining it by 2020, since by 2020 the various source control programs included in the base case would have five additional years to take effect, reducing the extent of improvement needed from additional controls. Whereas EPA estimated the incremental cost of attaining the 1997 NAAQS in 2015 at $6.7 billion/year (Appendix A of the 2006 RIA), EPA would have estimated the incremental cost of attaining the 1997 NAAQS in 2020 at a lower figure, perhaps roughly $5 billion per year. We guess that EPA would have estimated the combined costs of obtaining increments (a) and (b) at roughly $10 billion per year.

[6] We calculate this figure using the data on page 4.A-17 of the 2012 RIA for the counties projected as not attaining the current NAAQS in the base case in 2020, and assuming that all the necessary improvements in air quality for these counties can be obtained via reductions in direct emissions of $PM_{2.5}$ at an average cost that EPA would estimate of $5,000 per ton controlled.

[7] We make two other assumptions for these calculations. We assume "air quality ratios" -- the amount by which ambient $PM_{2.5}$ concentrations in a county are reduced per 1,000 tons of direct $PM_{2.5}$ emissions abated -- 25% lower than what EPA calculated in the 2012 RIA. We assume that all the emissions reductions needed for attainment in each nonattaining county can be obtained via within-county controls on direct emissions of $PM_{2.5}$ at a cost of $15,000 per ton. This assumed cost per ton may seem a bit high, but in our view this assumption compensates for the fact that nearly all nonattaining counties will not be able to rely for attainment on relatively cost-effective in-county controls of direct $PM_{2.5}$ emissions, but instead will need to obtain reductions also from regional sources of SO_2 and NOx, which are much less cost-effective.

as that which is paid now for relatively costly known controls. We believe, though, since "unknown" controls by definition exceed the limits of what is now technologically and economically feasible, that unknown controls (if in fact they emerge in time to help with attainment by 2020) will likely cost more than the more expensive currently known controls. Some indication of what additional controls may cost in areas that have already implemented extensive controls but still face severe nonattainment may be provided by current costs per ton for additional controls in areas like the South Coast Air Quality Management District (SCAQMD) in California,[8] or Houston, TX. In the SCAQMD, for example, median costs for offsets during 2009 and 2010 – the two most recent years for which the State has provided data – have been about $42,000 to $63,000 per ton for SO_2, $38,000 to $58,000 per ton for NOx, and $133,000 to $201,000 per ton for PM_{10}.[9] Costs per ton for $PM_{2.5}$ offsets would presumably be even higher than those for PM_{10}. In the Houston-Galveston area, perpetual NOx allowances traded at an average price of $5,700 to $8,700 per ton in the last half of 2011 and $8,300 to $12,500 per ton in the last half of 2012.[10]

In the 2006 RIA, EPA projected that speculative, theoretical, "unknown" controls will be needed for attainment of the current NAAQS in about 60% of the 53 counties throughout the country that were projected not to attain in the 2020 base case. Likewise, in the 2012 RIA, EPA projected that costly "unknown" controls will be needed for attainment of the current NAAQS in two of the 14 counties that won't attain -- though we believe this projection of only two counties is overly optimistic. These areas that likely won't attain and that would need substantial quantities of speculative "unknown" controls would become, using an Ozone analogy, "extreme" non-attainment areas. These areas could face decades of non-attainment costs and restrictions on economic development while exhausting all known controls and awaiting the emergence of a sufficient quantity of new control techniques and programs.

Whatever the exact figures, it is clear that existing, on-the-books requirements and some $250 billion in spending pursuant to these requirements (more than $36 billion per year, for the next eight years) will still not get us to attaining the current NAAQS in 2020. Additional control efforts beyond those currently required will be needed for attainment. We estimate that these additional controls might cost $1.25 billion/year.

Reducing the NAAQS Below the Current Standard as EPA Proposes Will Cost Even More, and Will Take the Nation Farther Into the Need for "Unknown" Emissions Controls

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8 EPA has not taken advantage in the $PM_{2.5}$ NAAQS RIA of the experience accumulating in the extreme ozone non-attainment areas of California. "Extreme" non-attainment areas under the Clean Air Act are allowed to complete an attainment demonstration SIP using speculative, theoretical or "unknown" controls to reduce emissions *on paper*. The high costs per ton prevailing for the most recent emissions reductions obtained in these extreme non-attainment areas provide some indication about what these unknown but hoped-for controls might cost, if they do in fact emerge.

9 California Environmental Protection Agency, Air Resources Board. Emission Reduction Offset Transaction Costs: Summary Reports for 2009 and 2010. February, 2012. We assumed that all transactions reported in these summary reports are for offsets that are valid for the lifetime of the permitted source. We annualized the one-time costs of these offset purchases by assuming a 10 to 20-year life and 7%/year interest rate, resulting in a "capital recovery factor" ranging from 0.0944 to 0.1424. Thus, the median reported cost for a NOx offset of $405,000/ton (one-time cost), for example, when annualized is equivalent to a cost of $38,000 to $58,000 per ton per year (e.g., $405,000 x 0.0944 = $38,000).

10 Houston-Galveston Area Emission Reduction Credit Organization. Meeting Summary, November 2, 2011. Also, Texas Commission on Environmental Quality. Mass Emissions Cap and Trade Program: "Trade Report". At: http://www.tceq.texas.gov/airquality/banking/mass_ect_prog.html.

In the 2006 RIA, EPA estimated that attaining a new NAAQS at 14/35 ug/m^3 would cost an additional $2.5 billion per year (1999 dollars) after the existing NAAQS at 15/35 ug/m^3 had been attained. EPA did not choose to estimate the undoubtedly much higher incremental costs to attain even tighter NAAQS.

In the 2012 RIA, EPA provides an entirely different picture. EPA now estimates that attaining a NAAQS at 14/35 ug/m^3 would be costless; that efforts to attain the current NAAQS at 15/35 would result in attaining 14/35 also. The costs to go further would be small. Attaining the upper end of EPA's proposed NAAQS range at 13/35 would cost only $3 million per year (2006 dollars), while attaining the lower end of the proposed range at 12/35 would cost only $69 million per year. Again, EPA's cost estimates in the 2012 RIA are much, much lower than in the 2006 RIA primarily because the 2012 RIA projects (over-optimistically, we believe) much better base case air quality in 2020 than did the 2006 RIA.

Like the 2006 RIA, the 2012 RIA shows the nation to rely increasingly on rapid development and implementation of as-yet-unknown emissions control technologies to attain a reduced NAAQS. For the proposed NAAQS range of 12 to 13 ug/m^3, EPA estimates that "unknown" controls will provide more than 80% of the $PM_{2.5}$ emissions reductions and 100% of the SO_2 emissions reductions that will be needed incrementally for attainment of the reduced standards.[11]

We develop a rough estimate for the cost of attaining EPA's proposed lower NAAQS by again presuming air quality in the year 2020 that is halfway between EPA's projections in the 2006 RIA and those in the 2012 RIA. For each county in the U.S., we assume that air quality in 2020 after attainment of the current NAAQS at 15/35 ug/m^3 will be mid-way between what EPA projected for the county in the 2006 RIA and what EPA projected in the 2012 RIA. We estimate costs again assuming slightly lower responsiveness of air quality to emissions reductions than what EPA estimates in the 2012 RIA, and we assume that further emissions reductions can be obtained at a higher average cost of $20,000 per ton, recognizing the increasing reliance on "unknown" control measures. On this basis, we estimate the incremental costs to attain a lower NAAQS at 12/35 ug/m^{3}as about $1.15 billion per year, above and beyond the costs to be incurred to attain the current NAAQS at 15/35 ug/m^3.

We Estimate the Total (Not Incremental) Costs of Attaining EPA's Proposed Lower NAAQS at More Than $38 Billion per Year Through 2020. These Costs Will Result in More Than 680,000 Lost Jobs in the U.S.

The cost of current major Federal regulations that derive the majority of their benefits from reductions in ambient $PM_{2.5}$ is estimated at $35.7 billion per year. Multiple billions in additional costs that we are unable to quantify will be incurred to meet additional $PM_{2.5}$-related requirements that are now "on the books", including hundreds of relevant "non-major" Federal regulations, thousands of State and local requirements pursuant to SIPs, restrictions on growth pursuant to Federal New Source Review requirements, requirements pursuant to enforcement actions, and more. Unfortunately, neither we nor EPA believe that these existing requirements

[11] Note, though, that despite the high costs per ton projected for the "unknown" emissions reductions that will be needed to attain the proposed lower NAAQS, the 2012 RIA estimates relatively low total national costs to attain the lower NAAQS because EPA estimates a need for only a small quantity of emissions reductions. We believe that the quantity of reductions needed for attainment of a reduced NAAQS will be much larger than EPA estimates.

and at least $250 billion in projected compliance expenditures pursuant to these requirements will get the nation to attainment with the current NAAQS at 15/35 ug/m^3 by 2020. Despite this massive effort, some 20 - 50 million Americans will likely find themselves in 2020 living in areas that have not yet attained the current NAAQS. We estimate that $1.25 billion/year more in expenditures to reduce emissions of $PM_{2.5}$ and its precursors will be necessary to fully attain the current NAAQS in 2020.

But even if the nation sustains an effort at this large projected cost to reduce $PM_{2.5}$ over the next eight years, there is still great uncertainty about whether the nation will attain the current NAAQS. Will as-yet-unidentified and unknown new control technologies emerge as EPA assumes, will they be cost-effective, and can they be deployed sufficiently soon and in sufficient volume to make up for the shortfall in known opportunities for emissions reductions? Will all the regulations EPA is counting on to drive emissions controls survive legal challenge? Will U.S. emissions of $PM_{2.5}$ and precursors continue at their current recession-restrained level, or will they begin to grow as the economy recovers, the population increases, and energy usage perhaps increases also? And, to cite two examples of emissions projection uncertainties that don't involve the U.S. economy, will $PM_{2.5}$ emissions from wildfires in the U.S. hold at their average level that prevailed during the period from 1996 through 2002, and will emissions from Mexico hold at their 1999 levels?[12]

Industry believes that the country should not now reduce the NAAQS for $PM_{2.5}$ in the face of this uncertainty about how the effort to attain the current NAAQS will proceed. At a time when there remains nearly a decade of hugely costly, difficult and technologically challenging work to be done in attempting to meet the current NAAQS and the outcome remains uncertain, it seems inappropriate to add more challenge, more costs and more uncertainty by reducing the standard.

If the NAAQS were to be reduced as EPA proposes to the lower end of the 12 to 13 ug/m^3 range, the nation would incur incremental costs relative to the current NAAQS that we estimate at $1.15 billion per year. We estimate the total costs to attain the proposed reduced NAAQS in 2020 -- including the costs to comply with existing $PM_{2.5}$-related regulations and requirements, the incremental costs to attain the current standard, and then the incremental costs to progress from the current standard to the reduced NAAQS -- as a total of at least $38.1 billion per year. EPA estimates differing costs in the 2006 and 2012 RIAs. The table below shows our cost estimate and EPA's estimates from the two RIAs.

[12] In the 2012 RIA, we believe that EPA underestimates the effort and cost needed to attain the current NAAQS or a lower NAAQS in part because the Agency makes overly optimistic assumptions in projecting what base case air quality will be in 2020. EPA estimates that wildfires contributed about 15% of total U.S. emissions of $PM_{2.5}$ in 2005, making it a very important source, contributing more emissions than any of: a) Electricity generating units (EGUs); b) Non-EGU point sources; c) On-road vehicles; and d) Non-road vehicles and equipment. EPA assumes optimistically that wildfires will continue in 2020 to contribute the same quantity of annual emissions as they did on average over the period 1996 through 2002. However, wildfires have been occurring with increasing frequency and areal extent, such that the average over the 2003 through 2011 period is 41% higher than the average for the 1996 through 2002 period that EPA projects to remain unchanged through the year 2020. Will this increase continue? Similar issues exist for others of EPA's emissions projections. For example, EPA projects that $PM_{2.5}$ emissions from Mexico will remain unchanged at their 1999 level through 2020, while overlooking recent EPA-supported research to estimate future Mexican emissions that projects 29% growth by 2020.

Estimated Total Costs to Attain a Reduced $PM_{2.5}$ NAAQS
(in billions of dollars/year)

Activity That Entails Costs	Our Estimate (2006 $)*	EPA's Estimates	
		2006 RIA (1999 $)	2012 RIA (2006 $)
Comply with existing major Federal regulations that target $PM_{2.5}$	$35.7	---	---
Comply with other existing requirements that target $PM_{2.5}$	? Large ?	---	---
Incremental effort to attain the current NAAQS (15/35)	$1.25	$10**	$0.09**
Incremental effort after attaining the current NAAQS to attain the reduced NAAQS:			
to attain 14/35	---	$2.5	zero
to attain 12/35 (lower end of EPA's proposed range)	$1.15	---	$0.069
Total	**At least $38.1**	---	---

--- Not estimated
* Estimated using EPA data and methods, and some different assumptions
** Estimated using EPA data, methods and assumptions

We again use NERA's analysis and the IMPLAN® model to estimate the macroeconomic and jobs impacts of this total cost of at least $38.1 billion/year.

Based on interpolating the NERA analysis, we estimate that the minimum of $38.1 billion/year in compliance costs for attainment of the proposed lower NAAQS at 12/35 ug/m^3 could reduce output in directly affected manufacturing sectors by up to 0.25 % to 1% each year. The value of shipments from the U.S. manufacturing sector could be reduced by $49 billion each year. Total gross domestic product, including all U.S. economic sectors in addition to manufacturing, might decline by $60 billion per year.

Using the IMPLAN® input-output model, we estimate that this loss in economic activity due to compliance with a reduced $PM_{2.5}$ NAAQS at 12/35 ug/m^3 would cost about 108,000 U.S. jobs in directly affected sectors (mostly manufacturing), and about 272,000 additional jobs among suppliers to the directly affected sectors, including services, transportation, construction, raw materials, and more. The total eventual U.S. job losses due to the reduced NAAQS, including induced effects such as will result from reduced spending by those workers who retain their jobs but with less take-home pay, will total more than 680,000.

Attachment B further describes this analysis of the job impacts from $PM_{2.5}$ compliance spending.

EPA Should Not Revise This or Other NAAQS Until Permitting and Implementation Issues are Comprehensively Addressed

Sixty days after a NAAQS revision is published in the Federal Register, the newly revised NAAQS causes a change to the permitting requirements for projects undergoing permitting at that time, and for all future projects. EPA should stop further NAAQS revisions now. EPA should instead focus on providing adequate and timely tools (air quality models fit for purpose), guidance (to model users and to states for implementation), and implementation rules for the existing NAAQS. Future NAAQS revisions ($PM_{2.5}$, ozone, or others) should not occur without adequate and timely tools, guidance and implementation rules. Attachment C provides further detail on NAAQS revisions, permitting requirements and resulting slowing of economic growth.

The proposed lower NAAQS will make much more difficult the demonstration required of new sources and major modifications in attainment/PSD areas to the effect that they will not cause or contribute to a violation of a NAAQS or PSD increment. With current annual average air quality for $PM_{2.5}$ in attainment areas often in the range of 8 to 12 ug/m^3, tightening the annual standard from 15 ug/m^3 to 13 or 12 ug/m^3 will sharply reduce the margin above current air quality but below the standard within which a source's increased to-be-permitted emissions must fit. A variety of costs will result: proposed new projects or operational changes that would contribute to economic growth will be canceled, downscaled or deferred; limited capital will be spent for economically non-productive emissions controls; progress will be slowed by permitting delays; and substantial funds will be devoted to paperwork.

The proposed lower NAAQS will result in more areas being declared as in nonattainment than would occur with the current NAAQS. The cost to a community of being in nonattainment with a NAAQS includes not only the cost of the controls that must be implemented to attain the standard, but also the economic losses from being subject to nonattainment new source review and transportation conformity requirements while in nonattainment.

EPA Overestimates the Benefits of Reducing $PM_{2.5}$ Concentrations

In the 2012 RIA, EPA estimates monetized benefits from the proposed reduced NAAQS that substantially exceed the costs of the regulation. More than 98% of EPA's total estimated benefits consist of avoided premature mortality due to exposure to $PM_{2.5}$, with each avoided premature death valued at $8.9 million (in 2006 dollars). EPA's benefits methodology is generally similar to that employed in other recent Agency RIAs estimating the benefits from reductions in $PM_{2.5}$ exposure. We believe this methodology continues to produce implausibly high estimates of risk reductions and monetized benefits. We suggest several improvements to EPA's methodology that would substantially decrease the estimated benefits of $PM_{2.5}$ reductions to a range that does not clearly exceed the costs for EPA's proposed lower NAAQS.

EPA selects two studies to generate lower and upper bound risk estimates, ignoring many other published studies that find much lesser – and even zero – mortality risks from $PM_{2.5}$ exposure

EPA uses concentration response functions (CRFs) from selected results of the American Cancer Society (ACS) and the Harvard Six Cities air pollution studies to estimate how chronic mortality rates will change with changes in ambient levels of $PM_{2.5}$:

- EPA establishes a lower bound risk estimate using the Krewski, et. al. (2009) re-analysis of the American Cancer Society data. This CRF projects a 6% reduction in mortality per 10 ug/m^3 reduction in ambient $PM_{2.5}$.

- EPA establishes an upper bound risk estimate using the Laden, et. al. (2006) analysis of the Harvard Six Cities data. This CRF projects a 16% reduction in mortality per 10 ug/m3 reduction in ambient $PM_{2.5}$.

EPA ignores numerous problems in these studies and others analyzing the ACS and Harvard Six Cities data.[13] The range of risks associated with $PM_{2.5}$ exposure reported in these studies is unreasonably high. Other published studies have found no associations between long-term exposure to $PM_{2.5}$ and mortality risks (for example, Lipfert, et al. (2000) and Enstrom (2005)). In choosing particular CRFs from two studies that show a positive effect, EPA relies on selected model runs from those studies that do not adequately control for other possible explanations of the perceived effect. Other model results from these studies where greater statistical controls have been applied for other possible influences on mortality rates show less risk. For example, when Krewski, et al. (2000) includes SO_2 in the statistical model as well as $PM_{2.5}$ in analyzing the ACS data, the CRF for $PM_{2.5}$ exposure declines to 1 to 2% per 10 ug/m^3 (not statistically significant). Since this result was not statistically significant and several other studies have found no association between $PM_{2.5}$ and chronic mortality, we suggest that EPA present a lower

[13] See, for example, Attachment 11 to the comments submitted August 31, 2012 to the rulemaking docket for the PM NAAQS (EPA-HQ-OAR-2007-0492) by the American Petroleum Institute. Despite being Federally funded, the research data from the ACS and Harvard Six Cities studies has not been released to the public. Neither the public nor EPA has access to the data from these studies. Failure to release the underlying data prevents other researchers, including EPA, from being able independently to replicate and verify the results of the studies or to examine the data for possible errors or biases or for consistency with other hypotheses.

bound benefits estimate in the RIA based on the assumption that the chronic mortality association is not causal.

Neither these long-term epidemiology studies nor other short-term epidemiology studies cited by EPA demonstrate a "cause and effect" between $PM_{2.5}$ and mortality. Those studies that report associations could be an artifact of the statistical models used or the result of other factors that have either been poorly controlled or not controlled at all. The lower bound benefits estimate should reflect the possibility that exposure to $PM_{2.5}$ does not cause excess mortality.

EPA does not reflect the increasing uncertainty in claiming mortality benefits from reductions in $PM_{2.5}$ at lower ambient concentrations, where much of EPA's claimed mortality benefits occur

EPA calculates benefits from reductions in $PM_{2.5}$ exposure using the two selected CRFs, even when concentrations are below the level of proposed NAAQS or below the lowest levels observed in the epidemiology studies used to derive the CRFs. Although EPA states in the RIA that the Agency is much less certain in the validity of the mortality association at lower levels, this increased uncertainty is not reflected in any way in EPA's quantified benefits estimates. Mortality benefits calculated by applying the CRFs at lower ambient concentrations are simply added to those calculated by applying the same CRFs at higher levels. A substantial fraction of the mortality benefits that EPA estimates will result from the proposed standard in fact accrue at lower ambient concentrations of $PM_{2.5}$ where uncertainties increase.

The Clean Air Act requires the EPA Administrator to establish any primary NAAQS at a level that protects public health with an adequate margin of safety. EPA proposes to reduce the primary standard for $PM_{2.5}$ to an annual average somewhere in the range from 12 to 13 ug/m^3. Presumably, then, exposures to $PM_{2.5}$ that occur at concentrations below 12 or 13 ug/m^3, depending on the standard that is chosen, are therefore "safe", in EPA's view. However, for a NAAQS of 12 ug/m^3, approximately 75% of the mortality that EPA estimates would be avoided due to this standard occurs among populations that would have been exposed at "safe" $PM_{2.5}$ concentrations of less than 12 ug/m^3 in the absence of the new NAAQS. Likewise, for a NAAQS of 13 ug/m^3, approximately 80% of EPA's estimated avoided mortality occurs among populations exposed in the baseline to $PM_{2.5}$ concentrations below this alternative "safe" level of 13 ug/m^3.[14] One would think that EPA would somehow reflect in the Agency's benefits analysis the uncertainty of benefits estimates at lower ambient concentrations if 75 – 80% of EPA's total calculated benefits accrue to individuals who are exposed at levels deemed to be "safe".

There is another sort of uncertainty when EPA calculates mortality benefits at ambient $PM_{2.5}$ concentrations approaching the lower extreme of the concentrations analyzed in the epidemiological studies from which EPA selected the CRFs. The statistical uncertainty of a slope relationship (e.g., a CRF) estimated from a scatter of data points will typically widen substantially as one moves toward the extremes of the underlying data. Uncertainty about the magnitude of the CRFs estimated in the two selected studies increases as one approaches the lowest measured levels (LMLs) of ambient average $PM_{2.5}$ concentrations that prevailed in the cities comprising the datasets analyzed in the two studies. The confidence interval may even widen sufficiently so that the estimated CRF is not statistically significantly different from zero

[14] These two percentage figures are drawn from the graph on page 5-85 of the 2012 RIA.

at or near the LML, even though the average slope over the full range of the underlying data is statistically significant. EPA mentions this uncertainty in the RIA:

> "… the range from the 25th to 10th percentiles of the air quality data used in the epidemiology studies is a reasonable range below which we have appreciably less confidence in the associations observed in the epidemiological studies." (page 5-80)

But the Agency does nothing in any quantitative way in the benefits analysis to reflect this increasing uncertainty at lower concentration levels. EPA does not provide an analysis estimating the fraction of mortality benefits that the Agency calculates will occur below the 25th or 10th percentiles of the ACS or Harvard Six Cities data, and does not discount the certainty of this fraction of the mortality benefits in any way.[15]

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[15] EPA does provide an analysis that estimates the fraction of mortality benefits that accrues from exposures below the LMLs (somewhere near the zero-th percentiles) of the two studies' datasets. EPA asserts that the LML is 5.8 ug/m3 for the Krewski, et al. (2009) study and 10 ug/m3 for the Laden, et al. (2006) study. We have two reasons for not being particularly interested in this LML analysis. First, we are more concerned with the uncertainties that grow below the 25th or the 10th percentiles of the data, not those that occur below the lowest extreme, as it is below the 25th to the 10th percentiles at which, as EPA states "we have appreciably less confidence in the associations observed in the epidemiological studies." Second, Smith (2011) provides persuasive commentary to the effect that it is not the LML facing a study population at the time the study concludes that is of particular concern, but instead the lowest average level at which the study population has been exposed over their lifetimes. This latter quantity – the lowest average level at which the study population has been exposed over their lifetimes – is likely much higher than the LML as EPA defines it, and this latter quantity provides the lower limit below which extrapolation of the CRF is particularly problematic.

> "EPA now states that the LML for the ACS cohort is 7.5 [now 5.8] μg/m3, and 10 μg/m3 for the Six-Cities cohort. However, the LML for the ACS cohort averaged about 10 μg/m3 during 1979-1983, which spans the time that cohort was recruited (in 1982). The LML for the Six-Cities cohort averaged about 11 μg/m3 during 1979-1985, although that cohort was recruited earlier still, in 1974-1977. But even relying on these earlier, higher concentration levels as estimates of the levels that might account for observed differences in mortality risk levels is open to question. Recall that the estimates of differences in mortality risk across cities are built up by following the survival outcomes of the people in each city over many years. This means that the observations of their mortality risks at each age, if attributable to air pollution at all, could be a result of exposures they experienced many years in the past, or that they accumulated over a long period of time.
>
> Take the ACS cohort as an example. The ACS cohort was first established in 1982. At the time that the individuals were recruited for the ACS study, they had to be at least 30 years old and their average age in 1982 was 56 years. Thus all of the individuals in the ACS database had been exposed to US pollution levels since at least 1952 (*i.e.*, 30 years before 1982), and the average individual in the database experienced US pollution levels dating back to 1926. As researchers using the ACS database have stated "In the 1950s, levels of air pollution in most North American and European cities were 10 to 50 times higher than those found today." (Krewski, et al. 2000, p. 38) Since the mortality risk estimated for each city is based on many years of tracking these people, recent average $PM_{2.5}$ concentrations such as those in 2000 cannot be viewed as indicative of the $PM_{2.5}$ exposure level that most affected their observed survival outcomes. Those individuals who had not already died by 2000 would have already lived at least 44 years of their lives while being exposed to earlier, higher $PM_{2.5}$ levels. To say that the estimated mortality-risk relationship has been observed down to the level of the lowest $PM_{2.5}$ concentration most recently measured in any of these cities is close to assuming that recent lower levels of $PM_{2.5}$ accounted for the health outcomes of people who died as much as several decades ago. The same issues are present with the Six-Cities and all other cohorts being used in $PM_{2.5}$ epidemiological studies of risks due to chronic exposures to $PM_{2.5}$." (Smith, 2011, pages 19 and 20)

EPA's estimates of mortality due to $PM_{2.5}$ exposure are implausibly large when compared against other references

More than 98% of the monetized benefits that EPA estimates in the RIA will accrue from reducing exposures to $PM_{2.5}$ consist of avoided premature mortality. The CRFs that EPA uses in generating these estimates generate mortality projections that are implausibly large when compared against other references. We will present a series of comparisons for two years, 2005 and 2020, showing that EPA's estimates of mortality attributable to $PM_{2.5}$ are difficult to believe.

Comparisons for 2005:

A group of employees of EPA's Office of Air Quality, Planning and Standards recently published a paper titled: *Estimating the National Public Health Burden Associated with Exposure to Ambient $PM_{2.5}$ and Ozone* (Fann, et al. 2012).[16] The paper estimated the amounts of mortality and morbidity that would be avoided in the continental U.S. if 2005 ambient levels of $PM_{2.5}$ and ozone were reduced to natural background levels. The paper used identical data sources, assumptions and methods in estimating the risk reductions that would result from this improvement in $PM_{2.5}$ air quality as those that EPA used in the 2012 $PM_{2.5}$ NAAQS RIA to estimate the risk reductions that would resulting from other potential changes in $PM_{2.5}$ air quality. Most notably, the paper and the RIA used identical concentration-response functions (CRFs) for premature mortality and identical impact functions for all morbidity health endpoints.

Using Laden, et al.'s (2006) CRF to develop an upper estimate, Fann, et al. estimated that reducing 2005 $PM_{2.5}$ levels in the U.S. to natural background levels would result in 320,000 fewer premature deaths annually. We believe this estimate of mortality attributable to $PM_{2.5}$ is implausibly high when compared against aggregate national mortality statistics for 2005. This suggests that EPA's similarly derived benefits estimates in the 2012 $PM_{2.5}$ NAAQS RIA are also implausibly high. We will compare Fann's $PM_{2.5}$ mortality estimate against the U.S. government's official statistics on deaths in the U.S. in 2005 from the Center for Disease Control and Prevention's (CDC's) "National Vital Statistics" reports.[17]

Fann, et al.'s upper estimate to the effect that there would be 320,000 fewer premature deaths per year if $PM_{2.5}$ were reduced to natural background levels is not a complete estimate, using their methodology, for the number of premature deaths in the U.S. that would be "due to" 2005 levels of $PM_{2.5}$. To reflect the total nationwide reduction in premature mortality if $PM_{2.5}$ concentrations in 2005 were to be reduced to zero (i.e., the amount of premature mortality "due to" $PM_{2.5}$ in 2005), the 320,000 estimate should be adjusted upward to: a) Include Alaska and Hawaii as well as the lower 48 States; and b) include whatever reductions would ensue from reducing concentrations from natural background to zero.

[16] Fann, et al. (2012). Neal Fann, Amy D.Lamson, Susan C. Anenberg, Karen Wesson, David Risley, and Bryan J.Hubbell. "Estimating the National Public Health Burden Associated with Exposure to Ambient $PM_{2.5}$ and Ozone." *Risk Analysis*. 2012 Jan;32(1):81-95.
[17] Kung, et al. (2008). Hsiang-Ching Kung, Donna L.Hoyert, Jiaquan Xu and Sherry L. Murphy. "Deaths: Final Data for 2005." U.S. Department of Health and Human Services, Centers for Disease Control and Prevention: *National Vital Statistics Reports*. Volume 6, Number 10. April 24, 2008.

These adjustments would increase the Fann, et al and EPA RIA estimates of premature mortality due to $PM_{2.5}$ levels in 2005 to 362,000 deaths per year. (See Attachment D for detail on these adjustments and for further discussion.) We will compare this estimate for the number of deaths per year due to $PM_{2.5}$ against aggregate U.S. mortality statistics for the year 2005. In making this comparison, we note that the Laden, et al. (2006) CRF that EPA and Fann, et al. use in generating their upper estimate of $PM_{2.5}$ mortality applies specifically for individuals more than 24 years of age. We thus compare this estimate for the number of premature deaths due to $PM_{2.5}$ against mortality data for 2005 from the CDC for the identical U.S. population -- for all individuals more than 24 years old. The following table shows some specific comparisons.

Comparisons of EPA's Estimated Premature Mortality Due to $PM_{2.5}$
Against National Death Statistics

Cause of Death	Number of Deaths, 2005*
Due to $PM_{2.5}$ (EPA/Fann, et al. estimate, adjusted)	362,000
All Causes	2,373,985
Infectious and parasitic diseases (viral hepatitis, septicemia, TB, AIDS, etc.)	65,779
HIV/AIDS	*12,367*
Malignant neoplasms (cancer)	556,143
Diabetes melitus	74,876
Cardiovascular diseases	853,552
Acute myocardial infarction (heart attack)	*150,916*
Alzheimer's disease, Parkinson's disease	91,140
Accidents, suicide, homicide, events of undetermined intent, med/surg complications	143,631
Motor vehicle accidents	*32,225*
Nontransport accidents (falls, drowning, fires, poisoning, etc.)	*62,081*
Suicide	*28,153*
Homicide	*11,636*
All other	588,864

* Data for 2005, for age > 24 years. Source for all but the first row: CDC's "National Vital Statistics Reports"

The comparisons reveal the astonishing magnitude of the mortality impacts EPA projects for $PM_{2.5}$, despite the Agency's claims being subject to substantial scientific uncertainty. Indeed, commenters have noted EPA's failure to show that $PM_{2.5}$ causes death at concentrations close to U.S. ambient levels, either by a strong statistical association or a plausible biological mechanism. Arnett (2006). Yet, to accept Fann, et al.'s findings, as well as that of the 2012 $PM_{2.5}$ NAAQS which uses largely identical methodology and data, one would have to believe such propositions as:

- $PM_{2.5}$ results in the premature death of about thirty times as many people as does HIV/AIDS.

- $PM_{2.5}$ results in the premature death of about five times as many people as does diabetes.

- $PM_{2.5}$ results in the premature death of about four times as many people as Alzheimer's and Parkinson's diseases combined.

- $PM_{2.5}$ results in the premature death of more than ten times as many people as do motor vehicle accidents.

- $PM_{2.5}$ results in the premature death of about 2 ½ times as many people as all forms of accidents (motor vehicle; air, water, rail and other forms of transport; falls; drowning; fires; poisoning, etc.), suicides, homicides, and medical/surgical complications combined.

In another comparison, we estimate using EPA's methods the degree to which $PM_{2.5}$ contributes to cardiovascular deaths, and ask whether this contribution is plausible. The Laden, et al. (2006) study from which both Fann, et al. and the RIA draw the CRF used to estimate all-cause mortality also provides a CRF specifically for cardiovascular mortality -- cardiovascular mortality is estimated to decline by 28% for each 10 ug/m^3 reduction in annual average $PM_{2.5}$ concentration.[18] We estimate (see Attachment D) that the population-weighted average concentration of $PM_{2.5}$ in the U.S. in 2005 was perhaps about 9 ug/m^3. If this average concentration of $PM_{2.5}$ were reduced to zero, then by applying the Laden, et al. CRF for cardiovascular mortality, we would calculate that cardiovascular deaths would decline by 9 ug/m^3 x 28% ÷ 10 ug/m3 = 25.2%. Or, looking at this calculation in a different way, the Laden, et al. CRF implies that 25.2% of cardiovascular mortality is "due to" $PM_{2.5}$. There are many important and broadly agreed-upon risk factors for cardiovascular illness -- smoking, diet, obesity, heredity, lack of exercise, and other illnesses (e.g., diabetes), to name a few. To accept EPA's methods requires concluding that $PM_{2.5}$ outdoor air pollution is responsible for about 25% of all cardiovascular mortality, a larger share than most of these acknowledged important risk factors.

Comparisons for the year 2020:

EPA's estimates of the health and economic benefits of reducing ambient $PM_{2.5}$ are even more implausible when the reductions are carried forward to the year 2020, the year for which the RIA estimates costs and benefits.

In the Agency's most recent report on the Benefits and Costs of the Clean Air Act, EPA evaluated the scenario where the Clean Air Act and Amendments would reduce U.S. national average $PM_{2.5}$ levels from about 19 ug/m^3 to about 9 ug/m^3.[19] To estimate the resulting reductions in mortality and economic benefits, EPA used a similar methodology to that utilized in the $PM_{2.5}$ RIA and in Fann et al., (2012), relying on the CRFs from Pope, et al., (2002) and Laden, et al., (2006), extrapolating mortality well below the lowest levels in the underlying health studies, and using a valuation approach for mortality based on a very high VSL figure.

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[18] The impact coefficient of 1.28 per 10 ug/m3 that Laden, et al. (2006) estimated for cardiovascular mortality is much larger than the coefficient of 1.16 that the researchers estimated for all-cause mortality. As a result, these researchers project that a reduction in $PM_{2.5}$ levels will result in a much larger proportional reduction in cardiovascular mortality than in total mortality.

[19] U.S. Environmental Protection Agency, Office of Air and Radiation. The Benefits and Costs of the Clean Air Act from 1990 to 2020. Final Report. March, 2011.

In this report, EPA projected that by 2020, reductions in ambient $PM_{2.5}$ as a result of the Clean Air Act and Amendments will prevent 230,000 to 490,000 deaths, or 10-20% of all deaths estimated to occur in this year. In our view, again, these figures are not plausible.
By comparison, EPA's central and upper estimates of 230,000 or 490,000 deaths per year bracket the total number of deaths in the U.S. that CDC estimates occur each year from smoking, which was about 438,000 deaths annually over the 1997 – 2001 period.[20] It is not plausible that a 50% reduction in ambient levels of $PM_{2.5}$ has about the same public health impact as completely eliminating active smoking in the U.S. population.

EPA also projected that the economic value of mortality reductions attributed to reductions of $PM_{2.5}$ under the Clean Air Act would be $1,800 trillion/year (central estimate) to $5,100 trillion/year (upper estimate). Thus, in 2020:

- EPA's central estimate of the economic benefits of $PM_{2.5}$ reductions would exceed the projected GDPs of all but 10 countries in the world;[21]

- EPA's high estimate of the economic benefits of $PM_{2.5}$ reductions would exceed the total GDPs of all countries except the U.S. and China; and

- EPA's estimate of the economic benefits of $PM_{2.5}$ reductions is equal to 10-28% of the total projected U.S. GDP in the year 2020.

Again, for the year 2020 as well as for 2005, EPA's estimates of the reduction in mortality and the monetized value of the mortality benefits that could ensue from reductions in $PM_{2.5}$ concentrations are implausibly large.

From several perspectives, then, we believe that EPA's estimates of premature mortality due to $PM_{2.5}$ are so high as to be simply not credible.

> EPA's estimated mortality benefits would decline sharply, perhaps by as much as 95%, if the Agency were to improve the analysis by estimating and valuing "statistical life-years gained" rather than "statistical lives saved"

Most premature mortalities that EPA contends could be avoided as a result of a reduced $PM_{2.5}$ NAAQS would occur among older populations with many fewer average years of life expectancy remaining than the populations that have been assessed in the studies from which EPA draws the Agency's estimated value of a statistical life (VSL). EPA chooses the Agency's VSL by reference mostly to studies that have evaluated the wage premium paid to workers in hazardous occupations. When deaths occur in these occupations, the deaths usually cut the life expectancy of the deceased worker by 20, 30, 40, or even 50 or more years. In contrast, EPA finds that the premature mortality that the Agency believes may result from exposure to $PM_{2.5}$ occurs mostly among individuals with many fewer years of life expectancy remaining. In the $PM_{2.5}$ RIA, for example, EPA projects that half of the premature mortality that may be avoided

[20] Centers for Disease Control and Prevention. "Annual Smoking-Attributable Mortality, Years of Potential Life Lost, and Productivity Losses --- United States, 1997—2001." *Morbidity and Mortality Weekly Report*. July 1, 2005.
[21] GDP projections for the year 2020 for each of the world's larger economies are obtained from Goldman Sachs (2007). Goldman Sachs Group, Inc., Global Economics Group. BRICs and Beyond. 2007.

due to the proposed standard would occur among populations of age 75 to 99. We believe it is inappropriate for EPA to value the statistical lives at risk from $PM_{2.5}$ air pollution -- for populations for whom the potential loss in life expectancy is usually small -- by reference to studies on wholly different populations where deaths involve much greater loss in life expectancy.

In the $PM_{2.5}$ RIA, EPA estimates the value of mortality benefits by multiplying the projected number of *statistical deaths avoided* due the proposed rule by the Agency's (we believe wrongly) chosen VSL. A better approach for monetizing the benefits of avoiding premature mortality would be for EPA to estimate the number of *life-years gained* as a result of the regulation and then multiply by the value of a statistical life-year (VSLY). This alternative approach has been recommended for regulatory analysis by the Office of Management and Budget, it has been used occasionally in the past by EPA, it is often used by other Federal agencies and by other countries, and it is the preferred practice in valuing mortality benefits in the United Kingdom. Depending on the particular VSLY that is chosen, this different approach to valuation would reduce the monetized benefits that EPA estimates for the proposed NAAQS by between 47% and 95%.

In estimating the monetized value of the premature mortality projected as resulting from a reduced NAAQS for $PM_{2.5}$, EPA in the 2012 RIA values each avoided premature death at $8.9 million (in year 2006 dollars). For a reduced NAAQS at 12/35 ug/m^3, EPA projects that 280 premature deaths per year will be avoided when using a lower-estimate CRF drawn from Krewski, et al. (2009), and 730 premature deaths per year will be avoided when using an upper-estimate CRF drawn from Laden, et al. (2006). After multiplying these numbers of avoided premature deaths by the estimated $8.9 million value of a statistical life, EPA estimates mortality benefits for the lower end of the proposed NAAQS range at about $2.5 to $8.8 billion per year.[22] These estimated mortality benefits account for more than 98% of the total monetized benefits that EPA estimates for the proposed NAAQS.

EPA might alternatively have estimated the monetized value of the Agency's projected reduction in risk of premature mortality by calculating the number of life-years that would be saved or extended rather than the number of premature deaths avoided, and then by multiplying by the value of a statistical life-year (VSLY) rather than by the value of a statistical life (VSL). The VSLY approach would yield lower, and perhaps much lower, estimated benefits for the proposed rule than the VSL approach that EPA has applied.

There has been extensive discussion in recent years about whether VSL or VSLY may be the preferred metric to use in valuing health benefits, about which particular values for each might be assumed for regulatory analysis, and about the degree to which these values may vary with the age of the individuals receiving the health benefit and other characteristics of the risk reduction. We offer several comments:

- The Office of Management and Budget suggests in its "best practices" guidance for regulatory agency analyses pursuant to Executive Order 12866, that agencies present

[22] EPA subsequently discounts these estimated benefits somewhat to reflect an assumed "cessation lag". EPA presumes that the mortality rate will not decline immediately to its new level following a reduction in ambient $PM_{2.5}$ concentrations; instead there will be some lag in this adjustment process. EPA discounts the raw benefit values shown above to reflect the delay in realizing these benefits.

benefits estimates showing both statistical lives saved and statistical life-years saved.[23] In the 2012 RIA, EPA presents estimates for both the number of statistical lives saved and the number of statistical life-years that will be gained by the proposed regulation, but estimates the monetized value of these benefits using only the statistical lives saved approach. EPA does not estimate the lower monetized values that would result from using the life-years gained approach.

- EPA's $8.9 billion VSL figure derives ultimately from the Agency's analysis of twenty-six studies published between 1974 and 1991 that estimated the values that various populations placed on reductions in mortality risks. Twenty-one of the studies were wage-risk studies in which researchers had estimated the value of mortality risk reduction by examining the degree to which workers receive higher wages for performing more hazardous jobs. Five of the studies used other techniques. In general, the average age of the populations included in the 21 wage-risk studies is in the mid- to late-thirties. The occupationally-related fatalities that occurred among these populations and that the studies were evaluating might each entail an average of twenty to forty years of lost life expectancy. In contrast, most of the statistical deaths that EPA believes can be avoided by the proposed $PM_{2.5}$ NAAQS occur among older populations with fewer years of life expectancy remaining. EPA observes that about half of the avoided premature deaths would have occurred in populations age 75-99 (2012 RIA, page 5-75), and the average number of life years gained per premature fatality avoided is about 16 (2012 RIA, page 5-77). In our view, it is inappropriate for EPA to value the premature fatalities avoided by this proposed regulation at the same VSL as has been derived from a set of studies where each avoided premature fatality involves many more years of life expectancy. OMB suggests in Circular A-4:

  > "… when there are significant differences between the effect on life expectancy for the population affected by a particular health risk and the populations studied in the labor market studies, they prefer to adopt a VSLY approach to reflect those differences. You should consider providing estimates of both VSL and VSLY…" (page 30)

If EPA were to value mortality benefits for $PM_{2.5}$ using the VSLY approach, the results would depend upon the specific figure the Agency would choose for VSLY. A variety of VSLY estimates have been developed. For example:

- Aldy and Viscusi (2008) estimate a VSLY that varies with age. In one formulation, the VSLY is about $175,000 for workers in their late teens, then rises steadily to peak at $375,000 for workers in their late 40s, then declines rather sharply to near $100,000 at age 62. In another formulation the VSLY is about $50,000 lower than the first for individuals up to their mid-40s, but continues to rise to about $400,000 at age 54, then declines modestly to just below $350,000 at age 62.

- The Food and Drug Administration (FDA) typically use four different VSLY estimates for sensitivity analyses, ranging from about $100,000 at the low end (based usually on estimates in the health economics literature) to about $500,000 at the high end (based on

[23] U.S. Office of Management and Budget. Circular A-4. September 17, 2003.

a VSL value and then estimating the corresponding discounted value of the additional life years gained with the avoided premature deaths) (Robinson 2007). See FDA (2011) for a recent example.

- EPA often prepared VSLY estimates from about 1997 through 2003, when the "senior discount" controversy erupted after EPA used VSL values indicating that older individuals are willing to pay less for life-saving interventions than younger adults (Robinson 2007). One of EPA's VSLY values was $293,000 in 1990 dollars, used for the Clean Air Act Prospective Analysis (EPA 1999).

- First Great Britain (DEFRA 2004) and then the European Union (NEEDS 2006) conducted major contingent valuation surveys to develop an independent estimate of VSLY -- not derived by assuming a VSL value as a starting point -- that is intended to be used broadly in a variety of policy contexts. The EU ultimately in 2006 recommended a VSLY value of 40,000 euros for general use in benefit-cost analyses (NEEDS 2006).[24] Many European nations now value mortality benefits by using both the VSL and the VSLY approaches, with the VSL approach almost always providing a higher estimate of benefits (note that the European choice of VSL is usually less than EPA's VSL) and the VSLY approach, based on the 40,000 € figure, providing a much lower estimate (OECD, 2011). The United Kingdom uses the VSLY approach preferentially.

- The Australian Office of Best Practice Regulation provides guidance to other Australian Federal government agencies on procedures to apply in preparing cost-benefit analyses in Regulation Impact Statements. The Office recommends use of a VSLY of 151,000 AUD, roughly equivalent to U.S. $155,000 (OBPR 2008).

Each of these various VSLY estimates, if EPA were to use them, would lead to lower estimates of $PM_{2.5}$ mortality benefits than those EPA calculates in the 2012 $PM_{2.5}$ NAAQS RIA. Assuming that the average premature fatality avoided due to the proposed reduced NAAQS will result in 16 additional life years, as EPA estimates in the RIA, the VSLY would need to be $708,537 at a 3% discount rate or $942,133 at a 7% discount rate in order to yield a present value of benefits equal to EPA's assumed VSL of $8.9 million.[25] Assuming a 7% discount rate and the *highest* of the VSLY values cited above ($500,000, the high end of FDA's range), EPA's mortality benefits calculated in the RIA using a VSL of $8.9 million would decline by 47% if EPA were to switch to the (we think more appropriate) VSLY approach. Assuming instead a 7% discount rate and the *lowest* of the VSLY values cited above (40,000 € or $50,000, the European Union's recommended value for general application), EPA's mortality benefits calculated in the RIA using a VSL of $8.9 million would decline by 95% if EPA were to switch to the VSLY approach.[26]

[24] 40,000 euros at 2006 exchange rates is equivalent to approximately $50,000 in 2006 dollars.

[25] Note that individuals will discount the value of an additional year of life in the future relative to an additional year of life at present. Discounting means that the present value of 16 years of extended life, such as EPA estimates would result on average for each premature mortality avoided due to the proposed rule, is not simply 16 times the VSLY. At a 3% discount rate, the present value of 16 years of extended life is equal to 12.6 times the VSLY, while at a 7% discount rate the present value of 16 years of extended life is equal to only 9.4 times the VSLY.

[26] If the VSLY at a 7% discount rate needs to be $942,113 in order to yield a present value for 16 years of life extended that equals EPA's chosen VSL of $8.9 million, then a VSLY of $50,000 would yield only 5.3% as much mortality benefits for the 16 years of life extended as does EPA's VSL of $8.9 million ($50,000 ÷ $942,113 = 0.053). Estimated mortality benefits would decline by 94.7%.

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Attachment A: Costs of Existing Requirements Toward Attaining the Current NAAQS for $PM_{2.5}$

How much money will existing Federal, State and local regulations and programs require or induce the U.S. economy to spend in pursuing attainment of the existing NAAQS for $PM_{2.5}$?

This is a very difficult question to answer, for several reasons:

- It is not clear which particular regulations and programs should be counted as contributing to reducing the ambient concentration of $PM_{2.5}$. It would seem obviously correct to include the many regulations and programs that explicitly target and reduce emissions of $PM_{2.5}$ and/or its precursors (NOx, SO_2 and ammonia). It is not so obvious, though, whether or not to include other regulations and programs that target different pollutants (e.g., HAPs) or seek different goals (e.g., energy efficiency) but which nevertheless prompt controls that achieve significant reductions in ambient $PM_{2.5}$ as "co-benefits" (e.g., the utility MACT regulation). Some decision would have to be made about how far to go in including regulations or programs where reduction of $PM_{2.5}$ is a co-benefit. Should any $PM_{2.5}$ co-benefit suffice? Or perhaps one might require $PM_{2.5}$ to provide, let's say, at least one-half of a rule or program's estimated benefits in order to identify that action, regulation or program as significantly addressing $PM_{2.5}$.

- Even if one could settle on a definition of the sorts of regulations and programs that ought to be included, it would be exceedingly difficult to identify each of the specific regulations and programs of these sorts for which cost information would be sought. It would be relatively easy to list the particular Federal regulations that elicit $PM_{2.5}$-related spending, but much more difficult to list the other relevant Federal requirements and programs, such as consent decrees and other enforcement actions, transportation programs, etc.. The huge number of requirements under SIPs and other State and local programs (e.g. fuel content requirements, wood stove programs) would be nearly impossible to itemize.

- Even if one could identify the individual regulations and programs that require or induce spending toward attainment of the current NAAQS, estimating the amount of spending prompted by each would pose further difficulties. Cost estimates have been developed for most Federal regulations, but for relatively few State or local requirements. Cost estimates have been prepared for very few non-regulatory programs that induce private sector spending, whether they be incentive programs, enforcement actions, or informational efforts. And, whatever cost estimates exist for individual regulations or programs would be difficult to assemble into a total cost estimate, since individual cost estimates are prepared using a variety of often incompatible methodologies, assumptions and baselines.

EPA has not developed an estimate of the costs the economy will incur toward attainment of the current NAAQS for $PM_{2.5}$, though the Agency has done some of the work toward developing such an estimate. In both the 2006 and the 2012 RIAs for reconsideration of the $PM_{2.5}$ NAAQS, EPA listed existing regulations, requirements and programs that would have a significant impact on future ambient concentrations of $PM_{2.5}$. In the two RIAs, EPA estimated the impact of these initiatives on emissions of $PM_{2.5}$ and precursors and on air quality in the year 2020, but did not estimate the costs of these initiatives. We will use EPA's two RIA lists of existing regulations, requirements and programs that have a significant impact on future ambient concentrations of $PM_{2.5}$ as a starting point in developing our own estimate for the cost of these initiatives.

EPA's lists of $PM_{2.5}$-related initiatives in the two RIAs include programs (e.g., wood stove change-out, national low-emission vehicle program), enforcement actions (e.g., consent decrees for refineries and other companies, DOJ settlements), and other developments (e.g., actual or projected closures of individual industrial plants, projected growth in numbers of livestock and resulting growth in $PM_{2.5}$ and ammonia emissions) as well as regulations. The lists include numerous regional and State initiatives (e.g., Ozone Transport Commission LEV program; NY, CT and VA ozone SIP controls; State sulfur content rules for fuels; several States' controls regarding oil and gas emissions) as well as Federal initiatives, but the lists are undoubtedly very far from including all relevant requirements that have been or will be adopted pursuant to SIPs. Notably also, the list of regulations and programs that EPA assumes and analyzes as contributing to attainment of the current $PM_{2.5}$ standard does not include the several NAAQS for other criteria air pollutants that EPA has estimated in other RIAs will provide tens of billions of dollars per year in $PM_{2.5}$ co-benefits (i.e., the ozone, SO_2, NOx and lead NAAQS).[27] In our view, much or all of the costs estimated in EPA's previous RIAs for attainment of these other NAAQS could be regarded also as costs that will be incurred toward attainment of the $PM_{2.5}$ NAAQS, since $PM_{2.5}$ co-benefits comprise the vast majority of the benefits estimated for attainment of these other NAAQS.

In many respects, then, EPA's lists in the most recent two $PM_{2.5}$ NAAQS RIAs of existing regulations, programs and other requirements that will significantly affect future $PM_{2.5}$ ambient

[27] In the 2012 $PM_{2.5}$ RIA, after listing many regulations that the Agency does choose to reflect in estimating what $PM_{2.5}$ ambient concentrations will be in 2020, EPA states why the Agency has chosen not to include previous NAAQS in this list:

> "Note that we did not conduct this analysis incremental to controls applied as part of previous NAAQS analyses (e.g., O_2, NOx, or SO_2) because the data and modeling on which these previous analyses were based are now considered outdated and are not compatible with the current $PM_{2.5}$ NAAQS analysis. In addition, all control strategies analyzed in NAAQS RIAs are hypothetical." ($PM_{2.5}$ NAAQS RIA, page 4-4)

We do not believe this rationale is persuasive for not including the other NAAQS as among the set of existing regulations that will contribute importantly toward attainment of the existing $PM_{2.5}$ standard. We agree that all control strategies analyzed in NAAQS RIAs are "hypothetical" in the sense that an RIA control scenario represents only one of many possible ways that State and local governments might ultimately choose to pursue attainment, but this supposed shortcoming of the previous NAAQS RIAs is in fact unavoidable for any NAAQS RIA, including the 2012 RIA for the $PM_{2.5}$ NAAQS. The previous NAAQS RIA control scenarios that EPA declines to use as a part of the base case for the 2012 $PM_{2.5}$ RIA are no more hypothetical in how they simulate what SIPs perhaps might require than is the 2012 $PM_{2.5}$ RIA itself. Secondly, we agree that the data and modeling in the several NAAQS RIAs preceding the 2012 $PM_{2.5}$ RIA is somewhat outdated and difficult to integrate into the 2012 RIA analysis. However, the effort to resolve these data and methodology difficulties might be a small price to pay for the much better coverage of the controls that State and local governments may adopt in the future pursuant to existing Federal requirements than the incomplete list of State/local controls that EPA has otherwise been able to simulate in the 2012 $PM_{2.5}$ RIA.

EPA has chosen for other RIAs to include in the base case analysis the set of controls projected to be implemented for attainment of previously promulgated NAAQS. For example, EPA's RIA for the ozone NAAQS in 2008 included in the base case the set of controls projected as needed for attainment in the $PM_{2.5}$ NAAQS that was promulgated in 2006.

concentrations appear to be too short. The lists exclude other Federal NAAQS that will significantly reduce future $PM_{2.5}$ concentrations, as well as all but a few of the State and local activities under SIPs or other authorities that also reduce emissions of $PM_{2.5}$ and precursors. A reasonable argument might be made that Federal new source review (NSR) regulations, both for nonattainment and PSD areas, also have a significant impact in reducing $PM_{2.5}$ emissions, and they too are not included in EPA's lists.

On the other hand, EPA's lists in the RIAs of existing actions that will significantly reduce future $PM_{2.5}$ concentrations also include several Federal regulations that are neither intended to address nor appear to significantly affect emissions of $PM_{2.5}$ or precursors, for example, the renewable fuels standards and the light-duty greenhouse gas and CAFE standards.

Estimating the costs for affected entities to comply with each of the hundreds, if not thousands of existing regulations, programs and requirements that significantly affect future $PM_{2.5}$ concentrations would be a nearly impossible task. Compliance cost estimates exist for nearly all of the Federal regulations that might be cited, but obtaining these estimates can be difficult. Compliance cost estimates are typically developed in the RIA for a regulation, but: some regulations have no RIA, some RIAs are difficult to access (e.g., broken internet links), and drawing an appropriate cost estimate from an often voluminous RIA can be difficult (e.g., the RIA for a rule is frequently developed before the Agency has selected the final option and/or key details for a regulation, meaning that substantial effort is often needed to find and then adjust one of multiple cost estimates that may be in an RIA so as to match appropriately against the corresponding final rule). And, as we mentioned previously, cost estimates typically do not exist for most existing programs or requirements other than Federal regulations that may significantly affect future concentrations of $PM_{2.5}$, such as State and local regulations, enforcement actions, incentive programs, etc.

In our opinion, the best that can be done at a reasonable level of effort to estimate the future costs entailed by existing requirements relating to $PM_{2.5}$ is to develop a partial estimate addressing only the costs attributable to Federal regulations. Furthermore, in order to avoid the effort of combing through RIAs for cost estimates for the perhaps several hundred likely relevant Federal regulations, we will address only the regulations designated as "major" by the Office of Management and Budget (OMB) and for which compliance cost estimates are provided in OMB's annual compilations on the costs and benefits of Federal regulations.[28] For our purposes, OMB's reports have an important advantage in providing for each major regulation an estimate of annual compliance costs that can appropriately be summed across regulations. As a major advantage for our purposes, OMB has adjusted the cost and benefits estimates prepared by the sponsoring Agency for each major regulation to make the estimates appropriately comparable

[28] Major regulations for the most part are those that impose a cost exceeding $100 million on the economy in any single year. Annually since at least 1997, the Office of Information and Regulatory Affairs in OMB has published a list of the major Federal regulations issued during the preceding year, along with quantitative estimates of each major rule's costs and benefits. As a key advantage for our purposes, OMB has adjusted the cost and benefits estimates prepared by the sponsoring Agency for each major regulation to make the estimates appropriately comparable across regulations. In general, OMB has recalculated costs and benefits so as to convert the estimates from the form in which the Agency originally presented them (e.g., as a combination of capital and recurring annual costs, as a cost in some future benchmark year, as a one-time cost, as a present value cost, etc.) into an equivalent stream of equal annual payments, continuing forever. Each of the regulatory cost estimates provided in an OMB report thus represents an annualized cost that will be incurred each year from now through 2020 (the year on which our analysis focuses) and then continuing annually in years subsequent to 2020.

across regulations. In general, OMB has recalculated costs and benefits so as to convert the estimates from the form in which the Agency originally presented them (e.g., as a combination of capital and recurring annual costs, as a cost in some future benchmark year, as a one-time cost, as a present value cost, etc.) into an equivalent stream of equal annual payments, continuing forever. Each of the regulatory cost estimates provided in an OMB report thus represents an annualized cost that will be incurred each year from now through 2020 (the year on which our analysis focuses) and then continuing annually in years subsequent to 2020.

We used the following process in identifying a list of major Federal regulations for which costs will be incurred toward attainment of the existing NAAQS for $PM_{2.5}$.

1. Begin with the lists of existing final Federal regulations having an impact on $PM_{2.5}$ concentrations in the year 2020, as shown in EPA's 2006 and 2012 RIAs for the $PM_{2.5}$ NAAQS.

2. Reduce these lists to include only the subset of these regulations that are "major" regulations with costs estimated in OMB's annual "Costs and Benefits of Federal Regulations" reports.

3. Add further final major regulations that have been promulgated since the 2012 RIA and/or the last available OMB report (draft report for 2012, with coverage of regulations for which OMB review concluded prior to September 30, 2011). One such regulation has been added, the Mercury and Air Toxics Standard ("MATS", or the utility MACT standard) promulgated in December, 2011.

4. Delete from the list any final regulations that have been vacated (e.g., the Cross-State Air Pollution Rule, or CSAPR) or that are not being implemented (e.g., the Industrial, Commercial and Institutional Boilers NESHAP or "Boiler MACT", and the New Source Performance Standards and Emission Guidelines for Commercial and Industrial Solid Waste Incineration Units, or "CISWI"). Make sure to include in the list any final regulations that are now effective because some other regulation has been vacated (i.e., CAIR is now being implemented because CSAPR has been vacated).

5. Add to the list all major regulations with cost estimates cited in an OMB report that appear likely to significantly affect $PM_{2.5}$ concentrations in the year 2020 and that appear not to have been cited in EPA's 2006 and 2012 RIA lists because of an oversight. (See the table below for identification of these "overlooked" regulations. EPA's RIA lists of regulations were not intended to be comprehensive. The lists omit, we believe unintentionally, several regulations very similar to regulations that were included in the lists.)

6. Reduce the resulting list of major regulations by eliminating any regulation for which EPA has not estimate at least 50% of monetized benefits to derive from reduction in ambient concentrations of $PM_{2.5}$. This benefits screen provides further assurance -- beyond simply being listed in EPA's $PM_{2.5}$ RIAs as affecting future $PM_{2.5}$ concentrations -- that the regulation can appropriately be counted as directed to a significant extent at $PM_{2.5}$ and/or its precursors. We believe that a regulation's costs can be fairly counted as

contributing toward attainment of the existing $PM_{2.5}$ NAAQS in 2020 if, as this screen provides:

a) The regulation is substantially directed at reduction of $PM_{2.5}$ or its precursors (i.e., half or more of the regulation's benefits involve $PM_{2.5}$); and

b) The regulation will impose costs at least through the year 2020. (In OMB's cost and benefits reports, the Office has adjusted and annualized the regulatory Agency's cost estimates for each major regulation so as to present the regulation's projected costs as a levelized stream of annual costs that continue each year, forever, including the year 2020. Any major regulation for which OMB has provided a cost estimate thus meets this second half of our benefits screen.)

The primary information source that we use for nearly all regulations in determining whether or not a minimum of 50% of the regulation's benefits derive from reductions in ambient $PM_{2.5}$ is Smith (2012).[29] Smith has reviewed EPA's RIAs for a large number of air quality regulations and determined which of these regulations have been estimated to have a majority of their estimated benefits or co-benefits stemming from reductions in $PM_{2.5}$. For a couple of regulations that have been promulgated since Smith's research for her report was completed, we have reviewed EPA's RIAs ourselves in order to make this 50 % determination.

Application of this benefits screen causes us to identify as *not* sufficiently focused on $PM_{2.5}$ several regulations that EPA had listed in EPA's 2012 $PM_{2.5}$ RIA as affecting ambient concentrations of $PM_{2.5}$ in 2020 -- the NOx SIP call, the GHG standards for light-duty vehicles/CAFE standards, the GHG standards for medium and heavy-duty vehicles, and the renewable fuels standards. A majority of the benefits that EPA estimated for these regulations do not involve $PM_{2.5}$, and hence we decline to count the costs of these regulations as contributing toward attainment of the current $PM_{2.5}$ NAAQS in 2020.

7. We also do not count any of EPA's NAAQS for criteria pollutants as directed significantly at reducing ambient concentrations of $PM_{2.5}$, even when the majority of EPA's estimated benefits for the NAAQS involve $PM_{2.5}$. Our reasoning for not including NAAQS as among the set of regulations imposing costs that contribute toward attainment of the current $PM_{2.5}$ NAAQS is different from EPA's. We seek to develop a conservative estimate for the costs of existing requirements that contribute significantly toward attainment of the current $PM_{2.5}$ NAAQS. The compliance costs that EPA estimates in the RIAs for NAAQS consist largely in costs to control various sorts of sources, and many of these source controls are identical to those that have their costs estimated also in the RIAs for various subsequent source-specific regulations. Thus, for example, the simulations in the 1998 and 2006 RIAs for reconsideration of the ozone NAAQS presumed that attainment would involve substantial additional control of NOx emissions from utility and industrial sources. The subsequently promulgated RICE NESHAPs and utility MACT regulations will elicit a significant share of these same NOx controls that

[29] Anne E. Smith, NERA Economic Consulting. *An Evaluation of the $PM_{2.5}$ Health Benefits Estimates in Regulatory Impact Analyses for Recent Air Regulations*. December, 2011.

previously were forecasted as needed for attainment of the ozone standard. If we were to count both the costs of the NOx controls that were thought necessary for attainment of the ozone NAAQS as well as the costs of the NOx controls needed for compliance with the subsequent source control regulations, we would be counting costs twice for many of the same controls. The controls and costs necessitated by subsequent source control regulations very frequently are the same as the controls and costs projected as necessary to attain a NAAQS that was promulgated earlier. In fact, subsequent national source control regulations are one of the primary means of moving toward attainment of a NAAQS. We want to develop a reasonably conservative estimate of the costs that existing requirements will elicit toward attainment of the current $PM_{2.5}$ NAAQS, and we will therefore avoid double-counting by including the costs estimated for compliance with source control regulations, but excluding the costs estimated for attainment of NAAQS. OMB takes a similar approach to avoid double-counting in the Office's reports totaling the costs and benefits of major Federal regulations over the preceding ten years. OMB excludes or adjusts downward the costs estimated for attainment of NAAQS as subsequent implementing (e.g., source control) regulations are adopted.[30]

We follow this set of seven steps to develop our list of major Federal regulations that are directed significantly at reducing ambient concentrations of $PM_{2.5}$ in 2020.

We estimate the costs for each of these regulations as follows:

1. As stated previously, we draw OMB's cost estimate for the regulation from the appropriate volume of OMB's annual report on "Costs and Benefits of Federal Regulations". For one regulation that was promulgated subsequent to the most recent of OMB's reports (utility MACT), we draw the cost estimate directly from EPA's RIA for this regulation.

1. We convert all of OMB's estimates to a common year's dollars so that the cost estimates can appropriately be summed across regulations. OMB's cost estimates are provided in different year's dollars for different regulations. We choose to express all costs in year 2006 dollars to match the manner in which EPA has expressed the costs estimated in the Agency's 2012 RIA supporting the proposed new $PM_{2.5}$ NAAQS. We convert to 2006 dollars by using the annual average Consumer Price Index for all urban consumers.

The following table shows the list of existing major Federal regulations that we have identified as directed significantly at reducing ambient concentrations of $PM_{2.5}$ in 2020, and the annual costs that these regulations are estimated to entail in each year from now through 2020. The table also shows additional regulations that might perhaps have been included in this list but that we excluded for one or another of the reasons that we have discussed. The 25 major regulations that we have identified as necessitating compliance expenditures toward attainment of the current $PM_{2.5}$ NAAQS in 2020 will cost more than $35.7 billion per year (2006 dollars) as estimated by OMB based on information from EPA.

[30] See, for example, the discussion on page 16 of OMB/OIRA: *Draft 2012 Report to Congress on the Benefits and Costs of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities*.

Major Federal Regulations Directed Toward Attainment of the Current NAAQS for $PM_{2.5}$, and Their Costs

Source for Cost Estimate: Yr of OIRA Report or Other	Final Rule	Cost/yr (millions of 2006 $)	Cited by EPA as Included in 2020 Base Case in 2102 RIA	Included in Our Estimated Costs Toward Attaining Existing PM NAAQS	Notes
1998	Emission standards for new locomotives	113	1	1	
1996	Emission standards for new highway heavy-duty engines	246	1	1	
1998	Medical waste incinerators	136	1	1	
1998	NAAQS for ozone	6,720	0	0	NAAQS not included in 2020 base case in EPA 2012 RIA
1998	NAAQS for particulate matter	28,639	0	0	NAAQS not included in 2020 base case in EPA 2012 RIA
1999	NOx SIP call	2,622	1	0	PM co-benefits not > 50% of total
1999	Non-road diesel engines	374	1	1	
1999	New non-road, non-handheld engines	166	0	1	Presumably included in 2012 RIA, but not explicitly cited
2000	Tier 2 and gasoline sulfur requirements	6,657	1	1	
2000	Regional haze rule	4,010	1	1	
2000	Section 126 petitions	1,444	0	1	Presumably included in 2012 RIA, but not explicitly cited
2001	Control of emissions from 2004 and later highway heavy duty engines	580	1	1	
2001	Heavy-duty engine and vehicle standards	5,203	1	1	
2002	Control of emissions from nonroad large spark-ignition engines	219	1	1	
2003	Revisions to regional haze regulations	82	1	1	
2004	Control of emissions from nonroad diesel engines and fuel	1,521	1	1	
2004	NESHAP for industrial boilers and process heaters	997	0	0	vacated
2004	NESHAP for stationary RICE	307	1	1	
2005	Clean Air Interstate Rule (CAIR)	2,055	0	1	2012 RIA included CSAPR as supplanting CAIR, but following the vacatur of CSAPR, CAIR remains in effect
2005	Clean Air Mercury Rule	569	0	0	vacated
2005	Clean Air Visibility Rule	660	0	1	Presumably included in 2012 RIA, but not explicitly cited
2006	NESHAP for stationary compression ignition ICE	64	0	1	Presumably included in 2012 RIA, but not explicitly cited
2006	NAAQS for particulate matter	3,087	0	0	NAAQS not included in 2020 base case in EPA 2012 RIA
2007	Control of HAPs from mobile sources	367	1	1	
2007	Clean air fine particle implementation	8,337	0	0	NAAQS not included in 2020 base case in EPA 2012 RIA
2008	Control of emissions from new locomotives and new marine diesel engines	391	1	1	
2008	Control of emissions from nonroad spark-ignition engines and eqpt	225	1	1	
2008	NAAQS for ozone	8,199	0	0	NAAQS not included in 2020 base case in EPA 2012 RIA
2008	Petroleum refineries NSPS	31	0	1	Presumably included in 2012 RIA, but not explicitly cited
2009	NAAQS for lead	1,340	0	0	NAAQS not included in 2020 base case in EPA 2012 RIA
2009	Passenger car & light truck CAFÉ, model year 2011	1,114	1	0	PM co-benefits not > 50% of total
2010	Portland cement NESHAP	968	1	1	
2010	NAAQS for sulfur dioxide	797	0	0	NAAQS not included in 2020 base case in EPA 2012 RIA
2010	NESHAP for RICE (Diesel)	342	1	1	
2010	NESHAP for RICE (Existing gas-fired)	228	1	1	
2010	Light-duty GHG standards & CAFÉ standards	3,757	1	0	PM co-benefits not > 50% of total
2011	Cross State Air Pollution Rule	797	1	0	vacated subsequent to 2012 $PM_{2.5}$ RIA
---	ICI boilers NESHAP, major sources	0	0	0	implementation is deferred
---	ICI boilers NESHAP, area sources	0	0	0	implementation is deferred
---	NSPS and emission guidelines for commercial/industrial solid waste incineration	0	0	0	implementation is deferred
EPA MATS RIA	Utility MACT (MATS)	9,336	1	1	
	Cost/yr ($ in millions) for the final rules included in our analysis:			**35,725**	

This estimated figure of $35.7 billion per year as the cost of existing major Federal regulations contributing significantly toward attainment of the current $PM_{2.5}$ NAAQS is undoubtedly a substantial underestimate of the total costs to the economy of seeking attainment with the current NAAQS. Other sorts of existing requirements will cost additional sums.

New Source Review (NSR) requirements

Federal NSR requirements have a substantial impact in reducing emissions of $PM_{2.5}$ and precursors well below the levels that would prevail without these requirements. NSR requirements restrain emissions in both attainment (PSD NSR) and non-attainment areas (nonattainment NSR). We do not know why, but NSR regulations are rarely designated as major regulations, and the costs to comply with them are rarely estimated. These costs are nevertheless substantial, involving cancellation, deferral or downsizing of many projects that would have contributed to economic growth, and/or requiring the installation of additional costly emission control equipment.

Appendix D in the final RIA for the 2006 $PM_{2.5}$ NAAQS revisions perhaps provides an indication of some of the costs attributable to $PM_{2.5}$-related NSR requirements. In this Appendix, EPA evaluated the impact of changing the Agency's methodology for projecting growth in emissions from non-EGU point and area sources with expected future growth in population, GNP and energy usage. Prior to the 2006 RIA, EPA had assumed that emissions from non-EGU point and area sources would grow in concert with projected growth in emissions "drivers" such as population and economic activity. For the 2006 RIA, though, EPA changed to a different assumption; assuming instead that future emissions from these source categories would remain unchanged despite any expected growth in emissions drivers. EPA justified this shift in methodology as consistent with several decades of history in which emissions from these source categories had been stable or declining. We have argued against this shift in EPA's methodology, believing instead that emissions from these source categories would tend to increase in concert with growth in emissions drivers, but for the impact of emissions control regulations that restrain this growth. EPA explicitly reflects in the 2006 and 2012 $PM_{2.5}$ NAAQS RIAs the projected reduction in future emissions from identifiable existing but not yet fully implemented regulations. We believe that when the Agency applies these projected regulation-required emissions reductions to emissions that are already flat-lined for future years because of the Agency's revised growth assumption, that the Agency is essentially "double-counting" the impact of regulations. Under the Agency's new approach adopted for the 2006 RIA, the Agency's emissions projections for non-EGU point and area sources reflect both the expected reductions from many identified individual existing but not fully implemented regulations, as well as the impact (via the "no growth" assumption) of regulations in general.

The reason we raise this issue at this point is not to criticize EPA's revised methodology. Instead, we believe that the regulations that most significantly restrain future growth in emissions, in addition to the source category-specific regulations that EPA enumerates and reflects in the RIA (e.g., NSPSs, MACTs, area source rules, etc.), are the New Source Review requirements. In our view, EPA's analysis in Appendix D suggests what the $PM_{2.5}$-related impact of the NSR requirements may be.

In Appendix D, EPA compares the impact in 2015, after accounting for the impact of source category-specific regulations, of two different growth assumptions:

- In "Case 1" (after accounting for the impact of source-category specific regulations), EPA assumes no growth from the 2001 inventory through 2015 in emissions from non-EGU point and area sources;

- In "Case 2" (again after accounting for the impact of source-category specific regulations), EPA assumes growth in emissions through 2015 consistent with projected growth in underlying emissions drivers.

We believe that much of the difference between Case 1 and Case 2 is the result of NSR requirements. In our view, it is largely the combination of NSR requirements and category-specific regulations that have held the growth of emissions well below what would otherwise be expected with growth over time in underlying emissions drivers. EPA's emissions inventory on which Case 1 and Case 2 are run already reflects the impact of many existing category-specific regulations. This leaves the difference between Case 1 and Case 2 as reflecting mostly the impact of NSR requirements. The following are the differences that EPA estimates between Case 1 and Case 2, which we believe represent roughly the impact of NSR requirements:

- In Case 1 relative to Case 2 in 2015, emissions of $PM_{2.5}$ are 423,000 tons/year lower (9%), emissions of SO_2 are 670,000 tons/year lower (7%), and emissions of NOx are 835,000 tons/year lower (7%).

- These reduced emissions have a substantial impact on projected air quality in 2015. For those counties that are projected to exceed 15 ug/m^3 annual average concentration of $PM_{2.5}$ in 2015 in either case, the annual average concentration in Case 2 averages 1.3 ug/m^3 higher than the annual average concentration in Case 1. 45% more counties are projected to be in nonattainment with the annual standard in Case 2 relative to Case 1. No analysis appears to have been conducted with respect to the 24-hour standard.

It is clear that EPA's methodology for projecting growth or, in our view, the NSR requirements, make a substantial difference in estimated future emissions and air quality. We can make a rough calculation of what the cost of compliance with the NSR requirements might be over the period from 2001 through 2015 by estimating the costs to implement emissions controls that would yield emissions reductions equivalent to those resulting from the NSR requirements. We assume that reductions in $PM_{2.5}$ emissions can be obtained at an average of \$5,000/ton and that reductions in SO_2 or NOx emissions can be obtained at an average of \$2,000/ton. If so, then the reduced emissions in Case 1 relative to Case 2, most of which reduction is due to NSR requirements, could be obtained at a cost that we estimate at roughly \$5.1 billion per year. NSR requirements applicable to non-EGU projects with potential increased emissions of $PM_{2.5}$ and/or precursors may cost roughly \$5.1 billion/year over the period from 2001 through 2015.

<u>Additional Federal regulations that are not "major"</u>

In addition to the 25 major existing Federal regulations that we identified and for which OMB estimated costs, there are hundreds of existing non-major Federal regulations that will also reduce emissions of $PM_{2.5}$ and/or its precursors and that also have $PM_{2.5}$ benefits or co-benefits that comprise half or more of their total benefits. Many of the more than 200 NSPS, NESHAP and MACT regulations for specific source categories target or co-control $PM_{2.5}$ and its precursors. There are additionally dozens of other relevant existing regulations addressing mobile sources (on-road and non-road), fuels, area sources, new source review, GACT/RACT/BACT/LAER and other topics that will have a meaningful impact on $PM_{2.5}$ concentrations. We would estimate that there are likely at least 10 existing non-major EPA regulations that importantly affect $PM_{2.5}$ and its precursors for every existing major regulation that does so.

OMB has investigated the question of how the total costs of all rules subject to OMB review compare against the costs of major rules alone. OMB reviewed cost information for a sample of regulations promulgated by three Federal agencies (OSHA, FDA, and NHTSA), and found that non-major regulations (those with an annual cost of less than $100 million) accounted for roughly 5 – 15% of the total cost of all the regulations that OMB reviewed from these agencies. OMB concluded that major rules account for the "vast majority of the total costs … of all rules subject to OMB review."[31]

The consulting firm NERA Economic Consulting recently also considered the same issue. NERA suggested that major regulations might perhaps account for only about half of the total costs entailed by all regulations:

> "Based on the 5,756 non-major regulations issued from 1993 to 2011, the total estimated cost of non-major regulations would equal that of major regulations if their average cost was approximately $40 million per regulation … [and that] this is close to the average cost of the non-major regulations for which cost estimates were available."[32]

With respect to regulations that contribute to reducing future ambient concentrations of $PM_{2.5}$, we suspect that the picture in reality is more like the one suggested by OMB than the one suggested by NERA. In our judgment, the non-major EPA regulations addressing $PM_{2.5}$ or its precursors have an average cost well short of $40 million per year, and the average major EPA regulation addressing $PM_{2.5}$ has an average cost well above the average for all the major regulations that NERA considered. We might guess that all existing non-major regulations addressing $PM_{2.5}$ would add perhaps 5 – 20% to the cost of all existing major regulations addressing $PM_{2.5}$.

> <u>Requirements other than Federal regulations that will also contribute significantly in reducing future ambient concentrations of $PM_{2.5}$.</u>

Costs toward attainment of the current $PM_{2.5}$ NAAQS will be required or elicited by a wide variety of measures in addition to Federal regulations: State and local regulations and SIP requirements, enforcement actions, incentive programs, informational programs, and more. We do not know how to estimate the costs that may be entailed by these other sorts of requirements in comparison to the costs that may be entailed by Federal regulations. Some impression about the possible magnitude of the costs that will be entailed by Federal source control regulations

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[31] OMB/OIRA: *Progress in Regulatory Reform: 2004 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities*, page 26.

[32] NERA Economic Consulting. *Macroeconomic Impacts of Federal Regulation of the Manufacturing Sector*. August 21, 2012. Page 49.

relative to the costs that will be entailed by other requirements (State and local requirements, enforcement actions, etc.) can be gained by considering the list of controls that EPA presumes in the RIAs will be implemented by 2020 in an attempt to attain the current NAAQS.

EPA provides more information in the 2006 RIA than in the 2012 RIA on the nature of the controls to be applied in pursuing attainment of the current NAAQS and on their costs. Table 6-1 in the 2006 RIA lists the controls and their corresponding costs that may be applied to improve ambient air quality from the 1997 NAAQS (15/65 ug/m^3) to the 2006 NAAQS (15/35 ug/m^3). We reproduce this table below, and we also add a final column to the table suggesting whether each sort of controls is likely to be mandated by Federal regulations, by State and local SIPs, or by a combination of these authorities.

Controls, Costs and Authority for the Controls – Additional Controls Needed to Attain Current NAAQS After Attaining 1997 NAAQS (Table 6-1 of 2006 RIA, adapted)

Source Category and Controls	Cost (million $/yr)	Comments on Authority for Controls: Federal Reg or SIP
I. Modeled Partial Attainment		
A. Electric Generating Units (EGU) Sector		
Local Controls on direct PM	$340	Likely mostly Federal regs: MATS, etc.
Local Controls for NOx	$59	Likely mostly Federal regs: MATS, etc.
Regional EGU program (equivalent to a Phase III of CAIR)	n/a	---
Subtotal	$400	
B. Mobile Source Sector		
Local Measures -- direct PM	$30	Likely mostly Federal regs
Local Measures – NOx	$31	Likely mostly SIPs
Subtotal	$60	
C. Non-EGU Sector		
Point Sources (Ex: Pulp & Paper, Iron & Steel, Cement, Chemical Manufacturing.)	n/a	---
SO_2 Regional Program for Industrial Sources	n/a	---
Local Known Controls	$300	Federal regs may contribute, but mostly SIPs
Area Sources (Ex: Residential Woodstoves, Agriculture)	$44	Likely SIPs only
Developmental Controls (Point & Area Sources)	$32	SIPs only; developmental controls unlikely to be Federal
Subtotal	$380	
II. Incremental Cost of Residual Nonattainment		
East	$3	SIPs only: developmental and extrapolated controls
West	$300	SIPs only: developmental and extrapolated controls
California	$4,000	SIPs only: developmental and extrapolated controls
Subtotal	$4,300	
III. Full Attainment (Partial, plus Residual Nonattainment)	$5,100	Summary: about 10% Federal, 90% SIPs

We conclude that about $4.5 billion/year of the $5.1 billion/year in costs to attain the current NAAQS will be pursuant to requirements mandated by State and local SIPs, whereas only about 10% of this total cost will be mandated by Federal regulations (see the rightmost column in the table). A factor contributing significantly to the substantial share of total costs that will be driven by State/local requirements is that State and local governments will be the ones to mandate whatever ”developmental” or “extrapolated” or “unknown” controls are needed. These sorts of advanced and unproven controls cannot reasonably be required by Federal regulations on a uniform national basis; they must be required on a highly site-specific basis by individual State or local jurisdictions. Although such developmental or extrapolated controls may not provide a large share of the emissions reductions needed for attainment, their costs per ton are much higher than for known controls and their costs can thus be significant.

In sum, we believe it is likely that as areas get closer to attainment of the 1997 NAAQS, the 2006 NAAQS, or any future more stringent NAAQS, the controls needed for attainment will increasingly be required via site-specific State and local SIPs, rather than by uniform Federal regulations. We would not be surprised if State and local SIPs drove perhaps $5 billion or more in annual costs toward attainment of the current NAAQS (as in the table above), plus the great bulk of the $1.15 billion/year that we estimate as the incremental cost to attain EPA's proposed new NAAQS subsequent to having attained the current NAAQS. It is not clear how much of this $5 billion-plus per year spending amount has already been required by State and local governments, between 2001 (the base year for the emissions inventory for EPA's 2006 RIA) and the present.

Summary of potential total costs of existing requirements toward attainment of the current $PM_{2.5}$ NAAQS

We estimate the total cost of existing requirements toward attainment of the current NAAQS very roughly as follows:

- Cost of existing $PM_{2.5}$-related major Federal regulations — $35.7 billion/yr
- Cost of existing $PM_{2.5}$-related non-major Federal regulations (5 to 15% of cost of all $PM_{2.5}$-related Federal regulations) — $4 billion/yr
- Cost of $PM_{2.5}$-related NSR requirements — $5 billion/yr
- Cost of State/local $PM_{2.5}$ SIP requirements — $5 billion/yr

Total cost of existing requirements toward attainment of current NAAQS — $50 billion/yr

Because of the high uncertainty about each of these figures other than the cost of major Federal regulations and our desire for a conservative analysis (i.e., not likely to overestimate costs), we will use only the $35.7 billion/year figure in our further analyses.

Attachment B: Analysis and Modeling to Estimate the Macroeconomic and Jobs Impacts of $PM_{2.5}$ NAAQS Compliance Costs

The compliance costs that we estimate various entities will incur to attain the current or alternative potential $PM_{2.5}$ NAAQS will have macroeconomic impacts. Production costs will increase for the affected sectors, their output and value of shipments will fall, and total gross domestic product (GDP) will decline as the entire U.S. economy adjusts. Employment will decline in the affected sectors and throughout the economy as a whole.

We will estimate and quantify the macroeconomic and jobs impacts of the costs to attain alternative NAAQS in two steps:

1. We use the results of a recent study by NERA Economic Consulting to project the impact of the $PM_{2.5}$ NAAQS compliance costs that we estimate in this paper on the physical output of affected sectors, on the value of shipments by these sectors, and on U.S. GDP in total.[33]

2. We then use these macroeconomic projections as inputs to the IMPLAN® input-output model, and we run the model to estimate the impact of the macroeconomic changes on employment (jobs) in the U.S. economy.[34]

We will describe this analysis in more detail.

Using the NERA study to estimate the macroeconomic impacts from the NAAQS compliance costs

NERA summarizes the overall approach of their study as follows:

> In the study "*Macroeconomic Impacts of Federal Regulation of the Manufacturing Sector*," commissioned by Manufacturers Alliance for Productivity and Innovation (MAPI), economists from NERA Economic Consulting examined qualitative and quantitative impacts of federal regulations on the U.S. economy as a whole and the manufacturing sector in particular. NERA applied its general equilibrium model of the U.S. economy (the NewERA Model) to evaluate the macroeconomic consequences of major regulations based on cost estimates of federal regulations developed from the qualitative part of this study. The modeling framework captures the direct and indirect effects of increases in the cost of production in the manufacturing sector because the model accounts for interactions among all parts of the economy. (NERA, 2012, page 5)

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[33] NERA Economic Consulting. *Macroeconomic Impacts of Federal Regulation of the Manufacturing Sector*. Commissioned by Manufacturers Alliance for Productivity and Innovation. August 21, 2012.

[34] IMPLAN® is a widely used and widely respected input-output model of the U.S. economy. It is used to trace and estimate the economic impacts, and often particularly the employment impacts, that will result from a change in final demand or output for one or more sectors of the economy. IMPLAN® is an acronym for "Impact Analysis for Planning", and the model is maintained and marketed by the Minnesota IMPLAN® Group, Inc. See www.IMPLAN.com. IMPLAN® is a proprietary model; we purchased a copy of it and ran it for this analysis.

NERA used various methods to develop several lists of Federal regulations affecting the U.S. manufacturing sector and to estimate the likely compliance costs for these different lists of regulations. For each list of regulations and corresponding set of projected compliance costs, NERA then used the compliance costs as input to their general equilibrium model, ran the model and recorded the resulting estimated macroeconomic impacts. NERA referred to the various lists of regulations and corresponding estimates of compliance costs as "scenarios"

One scenario that NERA ran through their model was termed the "COST" scenario. This scenario included all "major" Federal regulations identified by NERA as significantly affecting the U.S. manufacturing sector, with these regulations' corresponding annualized cost estimates as reported by the Office of Management and Budget (OMB) in OMB's annual reports to Congress on the costs and benefits of Federal regulations. The set of particular regulations and corresponding cost estimates included in NERA's COST scenario is in several ways very similar to the set of major Federal regulations and cost estimates that we listed in Attachment A to this paper as contributing significantly toward attainment of the $PM_{2.5}$ NAAQS. We thus use NERA's results from modeling the COST scenario to represent also the macroeconomic impacts that might ensue from our list of regulations, after appropriately scaling down NERA's results to reflect the relative total costs of NERA's and our lists of regulations.

But there are also some differences between our list of regulations and NERA's list for their COST scenario:

- Both lists include only major Federal regulations identified in OMB's annual reports and for which OMB provides a cost estimate.

- The compliance cost estimate for each regulation on both our list and NERA's COST scenario list is identical. We and NERA drew the same cost estimates from the same source, the OMB reports. NERA converted OMB's cost estimates for the various major Federal regulations consistently to 2010 dollars, we converted OMB's cost estimates consistently to 2006 dollars.

- For the COST list, NERA selected from the OMB reports all those major Federal regulations with cost estimates, beginning in 1992, that were judged to significantly affect manufacturing. The list thus included many environmental regulations, but also other financial, labor, transportation, and energy regulations. NERA identified for the COST list a set of regulations with summed annualized costs of $164 billion per year in 2010 dollars. Rules issued by EPA accounted for 64% of this total, with air quality regulations accounting for more than 85% of the Agency total. Several CAFE standard regulations issued by the Department of Transportation and included in the COST scenario also might reasonably be counted as air quality regulations, bringing air quality regulations' share of NERA's COST scenario total to 60% or so.

- For our list, we selected from the OMB reports all those major Federal regulations with cost estimates, but we further screened these regulations to include only those for which EPA had estimated reductions in $PM_{2.5}$ concentrations to provide half or more of the monetized benefits. We aimed to select regulations that were in some sense directed significantly at $PM_{2.5}$. Since EPA did not begin quantifying $PM_{2.5}$ mortality benefits in the RIAs for Agency regulations until 1997, our list thus does not include any of those regulations included in NERA's COST list that were issued between 1992 and 1997. We also excluded from our list any NAAQS regulations, because including such regulations as well as source control regulations might involve some double-counting and result in a total cost estimate that was not clearly conservative. NERA, in contrast, included NAAQS regulations in the COST scenario, thus including such very high cost regulations as the 1997 and 2006 revisions to the particulate matter NAAQS, the 1997 and 2008 revisions to the ozone standard, and more.

- In total, the regulations on our list that also appear on NERA's COST scenario list account for \$30.4 billion/year (85%) out of the \$36.7 billion/year (2006 dollars) in total estimated costs for the regulations on our list. The remaining regulations on our list (totaling \$6.3 billion/year in costs) would, in our judgment, also appear on NERA's COST list but for the fact that they individually are sufficiently small in cost that they were not selected by NERA as "significantly" affecting manufacturing. Some of these regulations included on our list but not NERA's include, for example, the 1997 emission standards for new locomotives, the 2000 regulation on control of emissions from 2004 and later highway heavy duty engines, and the 2010 NESHAPs for reciprocating internal combustion engines (RICE). All these and the other regulations on our list are of a sort that we believe will substantially affect manufacturing.

In sum, we believe that all of the major Federal regulations on our list that we identify as directed significantly at $PM_{2.5}$ are similar in important respects to the great majority of regulations and costs comprising NERA's COST scenario. The two lists of regulations overlap to a large degree, and the two lists of regulations directly regulate the same sectors: mostly manufacturers, electric utilities, vehicle and equipment owners and fuels producers. The cost estimates for the two lists of regulations are drawn from the same source, and are expressed identically as a stream of levelized annual costs, continuing forever.

An important characteristic of NERA's macroeconomic modeling of their various regulatory cost scenarios (the COST scenario as well as additional COSTREG, COSTPLUS and more scenarios) is that the magnitudes of the macroeconomic impacts resulting from the model runs are roughly proportional to the total annualized costs for the lists of regulations comprising each scenario. Thus, for example, NERA's COSTPLUS scenario involves cumulative annual regulatory costs about 2 ½ times those for the COST scenario, and all the macroeconomic impacts that NERA's model projects for the COSTPLUS scenario are about 2 ½ times larger than those for the COST scenario. Each of NERA's scenarios involves roughly similar sorts of regulations affecting a roughly similar mix of economic sectors, so it is perhaps not surprising that the model results are roughly proportional to the magnitude of regulatory costs with which the model is loaded.

At \$164 billion per year in 2010 dollars, NERA's COST scenario is the lowest cost of the various scenarios NERA analyzes and the closest in cost to the \$35.7 billion per year cost (2006 dollars) for our set of major existing Federal regulations directed significantly at $PM_{2.5}$. Since:

a) The NERA model yields predicted macroeconomic impacts that are roughly proportional to the regulatory cost burden that is loaded into the model; and

b) The mix of regulations included in our list is qualitatively very similar in type and incidence to the list for NERA's COST scenario, we believe it is reasonable to use NERA's results from modeling the COST scenario to represent also the macroeconomic impacts that might ensue from our list of regulations, after appropriately scaling down NERA's results to reflect the relative total costs of NERA's and our lists of regulations.

When we inflate to 2010 dollars our estimate of $35.7 billion per year for the cost in 2006 dollars for existing regulations directed significantly at $PM_{2.5}$, we obtain an annual cost of $38.6 billion in 2010 dollars. This figure represents 23.5% of the regulatory costs that NERA estimates for the COST scenario ($164 billion per year, in 2010 dollars). We thus project the macroeconomic impacts from the set of $PM_{2.5}$-related regulations that we have identified as 23.5% of the impacts that NERA estimates will ensue from the COST scenario when using their model. We likewise adjust NERA's COST scenario macroeconomic estimates downward to reflect the different level of impacts that might ensue from our larger set of costs representing the total annualized costs to attain EPA's lower end of the Agency's proposed range for a reduced NAAQS (i.e, 12/35 ug/m^3, which we estimate to cost $38.1 billion/year in 2006 dollars, or $41.2 billion in 2010 dollars, or 25.1% of NERA's COST scenario costs). The tables below show NERA's projected macroeconomic impacts for the COST scenario, the scaling factors we use to convert NERA's COST scenario estimates to reflect our different sets of compliance costs, and the macroeconomic impacts that we estimate for our two scenarios using NERA's results.

Scaling Factors Used to Develop Our Estimates from NERA's Results

	Costs per Year in Billions		
	in 2006$	in 2010$	Scale Factor
NERA estimated cost for COST scenario regulations		$164	
Our estimated cost for $PM_{2.5}$-related regulations	$35.7	$38.6	23.5%
Our estimated (total) cost to attain proposed NAAQS at 12/35	$38.1	$41.2	25.1%

NERA's Estimated Macroeconomic Impacts and Estimates for Our Two Scenarios

Type of Impact	For NERA COST Scenario	For Our PM2.5-Related Regulations	For Full Compliance With Proposed 12/35 NAAQS
Scale Factor Applied to NERA COST Scenario		*23.5%*	*25.1%*
Reduction in physical output for manufacturing sectors	1% to 4%	0.25% to 1%	0.25% to 1%
Reduction in value of shipments by manufacturing sectors	$195 billion/yr	$45.9 billion/yr	$49.0 billion/yr
Distribution of this reduction by mfg sector:			
Chemicals	25.9%	25.9%	25.9%
Petroleum products	18.7%	18.7%	18.7%
Other manufacturing	10.8%	10.8%	10.8%
Food products	10.8%	10.8%	10.8%
Transportation equipment	7.2%	7.2%	7.2%
etc.	...	...	...
Total	100%	100%	100%
Reduction in GDP	$238 billion/yr	$56.0 billion/yr	$59.8 billion/yr

Here is an example of how these tables can be read. NERA estimated that the regulations comprising their COST scenario would entail total compliance costs of $164 billion per year in 2010 dollars. Our estimated total cost for existing major Federal $PM_{2.5}$-related regulations is $35.7 billion per year in 2006 dollars, or $38.6 billion/year in 2010 dollars. Our $PM_{2.5}$-related regulations are thus projected to cost 23.5% as much as NERA's COST scenario regulations, and we use this figure as a scale factor to adjust NERA's macroeconomic impact estimates to yield appropriate estimates for our $PM_{2.5}$-related regulations. NERA estimated that the $164 billion per year in compliance costs entailed by regulations comprising their COST scenario would reduce the value of shipments by manufacturers by $195 billion per year. This $195 billion per year reduction in value of shipments is distributed among specific manufacturing sectors of the U.S. economy as follows: 25.9% of this loss will be incurred by chemicals manufacturers, 18.7% will be incurred by petroleum product manufacturers, etc. To estimate the macroeconomic impacts from our list of major Federal $PM_{2.5}$-related regulations (total cost of $38.6 billion in 2010 dollars), we scale NERA's estimates down by multiplying by the factor of 0.235. The result is that we estimate a reduction in value of shipments of $45.9 billion per year as a result of major Federal $PM_{2.5}$-related regulations, and this reduction will be distributed across specific manufacturing sectors in the same proportions as NERA estimated (e.g., chemicals manufacturers will incur a reduction of $11.9 billion per year in value of shipments, equal to 25.9% of the $45.9 billion per year total for all manufacturing sectors).

<u>Using the IMPLAN® model to estimate the employment impacts associated with these macroeconomic effects</u>

IMPLAN® is a widely respected and used input-output model of the U.S. economy. It is used to trace and estimate the economic impacts, and often particularly the employment impacts, that will result from a change in final demand or output for one or more sectors of the economy. For example, it was selected by the Federal government as one of the preferred models that State and local governments might use to develop their required estimates of the employment impact of stimulus spending.

An input-output model such as IMPLAN® simulates the flows of goods and services necessary to produce each economic sector's output. A very large system of multipliers within the model describes the change of output for each and every regional industry caused by a one-dollar change in final demand for any given industry. Input-output models are geographically based, and can usually be run to simulate the impacts of a change in final demand on economic flows within a locality, within a region, within a state, within the entire nation, or within many other sorts of geographies. In our application, the regulation-induced projected annual change in revenues (value of shipments) for each industrial sector (mostly for manufacturing sectors), as shown in the table above, is the change in final demand that drives the model.

In addition to the inherent advantages of IMPLAN® (i.e., well respected, easy to use, relatively low cost to purchase), the NERA analysis has an important feature that makes IMPLAN® the preferred input-output model to use in generating employment impact estimates from the NERA model results. NERA provides a table identifying in detail the composition of all the industry sectors into which the U.S. economy is divided in the firm's general equilibrium model, thus showing, for example, which specific subsectors are included within the model's "chemicals" sector and which are included within the "other manufacturing" sector. This table provides two crosswalks: one that shows how the NERA model's sector structure is organized relative to the thousands of NAICS industry subcodes, and another that shows how the NERA model's subsectors correspond to the IMPLAN® model's 440 industrial sectors.[35] In effect, NERA provides a table that shows how the sector-by-sector outputs of their general equilibrium model can be translated into the differently organized sector-by-sector inputs for the IMPLAN® model. NERA does not provide any such table or crosswalk that would translate their model outputs into the input format required to drive any other input-output model that could estimate employment impacts. In effect, NERA provides the information needed to use their model in conjunction with IMPLAN® but does not provide the parallel information that would be needed to use input-output models other than IMPLAN®.

We loaded the sector-by-sector estimates for loss in value of shipments produced by the NERA model into IMPLAN® using NERA's crosswalk table, and then ran IMPLAN® to estimate the resulting employment impacts. IMPLAN® calculates the total national employment impact of the regulation-induced loss of revenues for each affected industry sector and indicates how this effect has arisen:

- Direct effects include impacts on employment in the particular industries that directly bear the regulatory compliance costs;
- Indirect effects include the employment impacts on suppliers to the directly affected industries;
- Induced effects are the impacts resulting from reduced spending by employees of the directly and indirectly affected industries, as a result of reduced earnings by these employees; and
- The total effect is the sum of direct, indirect and induced effects.

The following table shows the loss of employment/jobs that IMPLAN® projects will result from our two scenarios: from the projected (minimum of) $35.7 billion per year in compliance costs for existing $PM_{2.5}$-related regulations and requirements, and from the projected (minimum of) $38.1 billion per year in compliance costs to attain the lower end of EPA's proposed NAAQS range.

Projected Employment Losses Due to $PM_{2.5}$ Requirements

	Due to Costs for Existing $PM_{2.5}$-Related Regulations and Requirements	Due to Costs to Attain Lower End of Proposed NAAQS
Direct effects	82,767	107,841
Indirect effects	254,373	271,734
Induced effects	272,424	303,979
Total effects	609,564	683,555

[35] NERA (2012) op cit., page 97.

Attachment C: NAAQS Revisions, Permitting Requirements, and Resulting Slower Economic Growth

Economic development projects with emissions increases must obtain an air permit in order to begin construction. The requirements for the project's air permit depend on whether the measured concentration of air pollutants in the local area meets (attainment area) or exceeds (non-attainment area) each of the 6 NAAQS. An individual NAAQS can have multiple elements (e.g., a 24-hour standard as well as an annual standard) which a project is required to meet. NAAQS exist for six air pollutants: Carbon Monoxide, Lead, Nitrogen Dioxide, Ozone, Particle Pollution, and Sulfur Dioxide

Air permits in attainment areas

Economic development projects in areas where the measured air quality meets the NAAQS (attainment areas) can increase emissions a limited amount. The project first must employ the best available control technology considering cost (BACT). The project then must assure that its increased emissions will not cause a significant deterioration in local air quality. This limited growth in emissions growth is permitted in order to accommodate economic growth with only an insignificant decline in air quality in the attainment area. Economic development projects in attainment areas must also show through air quality analysis (either modeling or air quality monitoring) that the specific project does not cause or contribute to an exceedance of the NAAQS.

When a NAAQS is revised, all areas with air quality better than the revised NAAQS are attainment areas for 2-3 years. EPA 2-3 years after a NAAQS revision divides the U.S. into attainment and non-attainment areas. This step is called an air quality designation. In areas subsequently designated as non-attainment, new non-attainment permitting is required.

Air permits in non-attainment areas

An economic development project in an area where the measured air quality does not meet the NAAQS (a non-attainment area) must reduce total emissions within the non-attainment area in order to receive a permit. The project first must employ the lowest achievable emissions rate (LAER) control technology that has been demonstrated by a similar emission source. LAER technology is much more expensive than BACT as control cost is not a consideration in determining whether or not to apply LAER. After applying LAER, the project must also reduce emissions from other sources in the non-attainment area in order to offset the new emissions contributed by the project, resulting in a net emissions decrease in the non-attainment area. Offsets can be generated by the project owner or purchased from other emissions sources in the non-attainment area. This approach is described as non-attainment permitting.

A NAAQS revision quickly affects economic development projects undergoing permitting, and effects may continue for decades

Sixty days after a NAAQS revision is published in the Federal Register, the newly revised NAAQS causes a change to the permitting requirements facing all projects undergoing permitting at that time and all future projects. A revised NAAQS (whether a lower level of the NAAQS or a decrease in the NAAQS averaging time) will thus complicate permitting for any project that has begun but not completed permitting at the point when a revised NAAQS takes effect for permitting purposes, sixty days after promulgation. In the worst case, a project can be stopped because of a NAAQS change that makes an economic project unable to pass the test imposed by the new NAAQS. In a better-than-worst case, the project can progress but at a slower pace (permitting takes longer) or increased permitting cost (for new modeling and new analyses) or at a higher cost for controls or restrictions on operating practices, thus reducing the project's economic return to the owner.

A reduction in the level of the NAAQS or a shorter averaging time will reduce the amount of emissions increase potential or margin available in the averaging time window (for example, tons of emissions in a year, or tons of emissions in an hour) for an economic development project. If the lower NAAQS sufficiently reduces the allowable amount of emission increase, then the project may be terminated, even if LAER controls were to be installed.

The costs for new projects in a non-attainment area to reduce emissions to attain a NAAQS will continue until the area's air quality improves and it is re-designated to attainment. It may take a decade or more subsequent to a NAAQS revision for a non-attainment area to attain and then secure a re-designation to attainment, during which time all new projects will need to install LAER controls and obtain offsets. In attainment areas, the tighter permitting requirements resulting from a lower level or shorter averaging time for the NAAQS will continue forever. The following table shows the timelines for the consequential actions that will occur subsequent to recent or potential near-future NAAQS revisions.

Pollutant	Final NAAQS revision date or projection	Initial impact on permits for economic growth projects	Effective date for non-attainment designation	State sends EPA "Good neighbor" plan	States submit plan to attain	Deadline for attaining the revised NAAQS
$PM_{2.5}$ (2006)	Oct. 2006	Dec. 2006	Dec. 2009	Oct. 2009	Dec. 2012	Dec. 2014/2019
Ozone (2008)	Mar. 2008	May 2008	Aug. 2012	Mar. 2011	Aug. 2015	2015-2032
NO_2 (Primary)	Feb. 2010	Apr. 2010	Feb. 2012	Jan. 2013	NONE	NONE
SO_2 (Primary)	Jun. 2010	Aug. 2010	Jun. 2013	Jun. 2013	Dec. 2014	Jun. 2018
$PM_{2.5}$ (current review)	Dec. 2012	Mar. 2013	Mar. 2015	Dec. 2015	Mar. 2018	2020/2025
Ozone (2014)	Sep. 2014	Nov. 2014	Nov. 2016	Sep. 2017	Nov. 2019	2019-2036

Notes: There were no NO_2 non-attainment areas at the time for initial designation. There may be NO_2 non-attainment areas after 3 years of new near-road monitor data is available around 2017. The deadline years for attainment of the 2008 Ozone NAAQS depend on the degree of non-attainment: 2015 (marginal), 2018 (moderate), 2021 (serious), 2027 (severe-15), and 2032 (extreme).

Sixty days after promulgation, each of these NAAQS revisions affects all economic development projects undergoing permitting at that time. The effects of the NAAQS revisions on permitting can then continue for all existing and future projects in non-attainment areas for up to 24 years (in the case of the 2008 Ozone NAAQS and extreme non-attainment areas) and forever in attainment areas.

Current air quality with respect to the NAAQS changes since the 1990 CAA Amendments

This discussion is limited to the Ozone and PM NAAQS as these two NAAQS:

- are most relevant to economic growth and have contributed the most to permitting complications;
- have been and will continue to be responsible for very high costs incurred by all sectors of the U.S. economy to reduce emissions; and
- have taken longer than CAA deadline time frames to reduce emissions sufficiently to attain the NAAQS.

During the CAA policy-relevant time frames for attainment of current and future NAAQS (5 to 10 years for $PM_{2.5}$, 3 to 20 years for Ozone), the nation has funded and will continue to fund large costs toward attainment of the NAAQS, including capital and operating costs to reduce emissions, costs and delays associated with permitting, and reduced opportunities for economic growth. Economic theory and practical decisions indicate these emission reduction costs, permit costs and permitting complications and restrictions have contributed to past, present, and future potential job losses during recessionary economic periods as well as restricting the rate of job growth during time periods when the overall U.S. economy grew. These costs are particularly worrisome at present, when the U.S. has the opportunity for a renaissance of our manufacturing sector renaissance due to changes in the supply and demand of natural gas (methane) and natural gas liquids (such as ethane and propane).

Has the U.S. attained the current Ozone and $PM_{2.5}$ NAAQS yet?

The current $PM_{2.5}$ and Ozone standards have not yet been achieved nationwide. The initial standard-setting year and the most recent final CAA attainment deadline year are shown below:

Standard and year	Latest attainment date	Achieved nationwide? (Yes or No)
1979 1-hour ozone 0.12 ppm	1989	No
1990 1-hour ozone 0.12 ppm	2010	No
1997 8-hour ozone 0.08 ppm	2024	No, time remains
1997 annual $PM_{2.5}$ 15 ug/m^3	2014	No, time remains
2006 24-hr $PM_{2.5}$ 35 ug/m^3	2020	No, time remains
2008 8-hour ozone 0.075 ppm	2032	No, time remains

EPA annually publishes trends in PM and Ozone design values at http://www.epa.gov/airtrends/values.html . An inspection of the most recent data indicates that:

- the 1997 $PM_{2.5}$ annual NAAQS is not met in the San Joaquin Valley and the Los Angeles area. (Table 1A: Annual non-attainment status)

- the 1997 24 –hour NAAQS is not met nationwide and some areas have just barely improved air quality to attain after passing the first 5 year deadline in 2009 and being two years of five into the second 5-year period. (Table 1b: 24-hour non-attainment area status)

- for the 2006 24-hour $PM_{2.5}$ NAAQS there are 9 non-attainment areas that have just completed plans for the first attainment period ending in 2014 with gaps to close of 3 to 27 ug/m^3. (Table 1b: 24-hour non-attainment area status)

NAAQS revisions since 2006 are affecting economic growth project permitting

Permitting related restrictions on economic growth have been in place since the 2004 designation for the 1997 NAAQS and remain in place for areas not yet re-designated to attainment. New permitting-related restrictions on economic growth occurred when the 24-hour $PM_{2.5}$ NAAQS became effective late in 2006, and additional non-attainment-related permitting restrictions on economic growth began for 24-hour non-attainment areas in December, 2009. This occurred again for the 2008 Ozone NAAQS in the summer of 2008 and again at designations in summer 2012.

1997 Ozone NAAQS revision

Before 1997

1-hour	0.12 ppm	Attainment is defined when the expected number of days per calendar year, with maximum hourly average concentration greater than 0.12 ppm, is equal to or less than 1

After

0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years

EPA in 1997 changed the 1990 1-hour 0.12 ppm (effectively 124 ppb) Ozone NAAQS to a new averaging time of 8-hours. EPA set the level of the new 8-hour standard at 0.08 ppm (in effect 84 ppb). Neither the 1990 1-hour Ozone standard nor the 1997 8-hour ozone standard have been attained nationwide at this time. Permitting-related restrictions on economic growth for the 1990 and 1997 Ozone standards in non-attainment areas remain in place for areas in the U.S. not yet re-designated to attainment.

2006 $PM_{2.5}$ NAAQS revision

Before 2006

24-hour	65 $\mu g/m^3$	98th percentile, averaged over 3 years
Annual	15.0 $\mu g/m^3$	Annual arithmetic mean, averaged over 3 years

After

24-hour	35 $\mu g/m^3$	98th percentile, averaged over 3 years
Annual	15.0 $\mu g/m^3$	Annual arithmetic mean, averaged over 3 years

EPA revised the $PM_{2.5}$ NAAQS in 2006. EPA left unchanged the annual $PM_{2.5}$ NAAQS at15 ug/m^3. EPA reduced the 65 ug/m^3 24-hour $PM_{2.5}$ NAAQS level by about 50% to 35 ug/m^3 in October, 2006. In attainment areas nationwide, new permitting-related restrictions on economic growth for this NAAQS revision began by the end of 2006. These continue in the "legacy non-attainment areas" for the 1997 NAAQS (a "legacy non-attainment" area is one that has retained a prior non-attainment designation at the time when a NAAQS revision is made). In December, 2009, non-attainment permitting restrictions were extended to new geographic areas in addition to the "legacy non-attainment" areas. Permitting-related restrictions on economic growth for the 2006 NAAQS revision remain in place for numerous areas in the U.S. not yet re-designated to attainment as well as for the "legacy non-attainment" areas.

2008 Ozone NAAQS revision

Before

0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years

After

0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years

EPA revised the Ozone NAAQS in March, 2008, revising the prior 0.08 ppm (effectively 0.084) standard to 0.075 ppm (75 ppb). This effectively reduced the level of the ozone standard by about 40%, assuming as many people believe that the uncontrollable background level of ozone is around 60 ppb. Uncontrollable ozone is due to natural sources and international sources of ozone and ozone-generating substances as well as a minimal level of U.S. emissions at low-emitting sources as necessary for the U.S. economy to function normally.

In attainment areas throughout the country, new permitting-related restrictions on economic growth for this NAAQS revision began in the late spring of 2008. In "legacy non-attainment areas" economic growth project restrictions continued for the 1997 Ozone NAAQS. In the summer of 2012 when EPA designated non-attainment areas, new permitting-related restrictions on economic project growth began.

2010 NO_2 NAAQS revision

Prior to April, 2010, these were the elements of the NO_2 NAAQS that a project had to meet for successful permitting.

Before

Annual	53 ppb	Annual arithmetic average

After

Annual	53 ppb	Annual arithmetic average
1-hour	100 ppb	98th percentile, averaged over 3 years

EPA in February, 2010, added a 1-hour standard at 100 ppb to the historical annual average standard at 53 ppb. A 100 ppb 1-hour NAAQS is a much more difficult standard for an emissions-increasing project to meet. This change added significantly to the challenges of air permitting for many projects.

2010 SO_2 NAAQS revision

Prior to June, 2010, these were the elements of the SO_2 NAAQS that a project had to meet for successful permitting.

Before

3-Hour	0.5 ppm	Not to be exceeded more than once per year
24-Hour	0.14 ppm	Not to be exceeded more than once per year
Annual	0.03 ppm	Annual arithmetic average

After

1-hour	75 ppb	99th percentile, averaged over 3 years
3-Hour	0.5 ppm	Not to be exceeded more than once per year

EPA in June, 2010, revoked the existing primary annual and 24-hour standards and replaced them with a 1-hour standard at 75 ppb.

EPA should not revise a NAAQS until permitting and implementation issues are comprehensively addressed

For most of these NAAQS revisions, EPA was not ready at the time of their promulgation with a corresponding package of permitting and implementation procedures. Sixty days after a NAAQS revision is published in the Federal Register, the newly revised NAAQS causes a change to the permitting requirements for projects undergoing permitting at that time, and for all future projects. Confusion and delays occur if EPA is not ready with clear, workable methods for permitting under the new NAAQS at that time. EPA should stop further NAAQS revisions now. EPA should instead focus on providing adequate and timely tools (air quality models fit for purpose), guidance (to model users and to states for implementation), and implementation rules for the existing NAAQS. Future NAAQS revisions ($PM_{2.5}$, ozone, or others) should not occur without adequate and timely tools, guidance and implementation rules.

New Source Review (NSR) costs of EPA's proposed reduced NAAQS for $PM_{2.5}$

A reduced NAAQS will entail substantial costs via the NSR requirements in both attainment and nonattainment areas. EPA has not estimated these costs. We developed a rough, partial estimate for these costs in Attachment A.

<u>NSR impacts of a reduced $PM_{2.5}$ NAAQS in attainment areas</u>

In contrast to most other obligations associated with a new NAAQS (e.g., identification of nonattainment areas, SIPs, implementation of controls to attain standards in nonattainment areas), PSD requirements become effective for a new NAAQS very quickly -- upon the effective date of the NAAAQS, which is generally sixty days after publication of the final rule in the *Federal Register*. New sources and major modifications in an attainment area must conduct a cumulative air quality analysis (PSD modeling) that demonstrates that the proposed activity will not cause or contribute to a violation of any NAAQS or PSD increments. At least eight States also apply the PSD modeling requirements to minor modifications and/or renewal of operating permits. PSD modeling that demonstrates compliance will thus be required of many sources, even when minor or perhaps no new activities are undertaken, shortly after promulgation of a new NAAQS.

EPA's PSD modeling guidance for $PM_{2.5}$ is very conservative and the tools available for making the required compliance demonstration are limited. The result is a very conservative, screening-type modeling regime. See the comments submitted June 15, 2012 by the American Forest & Paper Association (AF&PA) and the American Wood Council (AWC) on EPA's 10th Modeling Conference. Member companies have conducted preliminary modeling analyses following current EPA guidance to assess $PM_{2.5}$ impacts using EPA's prescribed screening techniques. These analyses suggest that many sources cannot demonstrate compliance with the current $PM_{2.5}$ NAAQS under current EPA guidance despite operating with state-of-the-art controls.

Sources find that they cannot simulate compliance for modest new activities or even sometimes for existing activities unless they: a) implement substantial additional capital improvements and emission controls; and/or b) commit to restricted operational practices and onerous permit conditions; and/or c) find internal or external offsets. A variety of costs result: proposed new projects or operational changes that would contribute to economic growth are canceled, downscaled or deferred; limited capital must be spent for economically non-productive emissions controls; progress is slowed by permitting delays; and substantial funds are devoted to paperwork.

This already-difficult situation regarding PSD permitting for $PM_{2.5}$ will be exacerbated if the NAAQS is tightened. With current annual average air quality for $PM_{2.5}$ in attainment areas often in the range of 8 to 12 ug/m^3, tightening the annual standard from 15 ug/m^3 to 13 or 12 ug/m^3 will sharply reduce the margin above current air quality but below the standard within which a source's to-be-permitted emissions must fit. Where the current annual average concentration is 10 ug/m^3, for example, reducing the annual standard from 15 to 12 ug/m^3 will cut by 60% the margin within which a source must demonstrate compliance. The reduction of the margin for growth will be even greater if other sources within the area have already been permitted to increase their emissions subsequent to the applicable baseline date.

If EPA again applies the approaches for establishing increments, SERs, and SILs utilized in the 2008 $PM_{2.5}$ NSR Implementation Rule, adopting a tighter NAAQS now will likely eventually lead the Agency to tighten these other elements of the PSD program, further increasing costs for sources in PSD areas.

Reducing the NAAQS at this time without provision of reasonable permitting models, guidance, rules and processes will (again, as with the previous revision) significantly complicate the permitting of new or modified sources and hinder economic growth.

<u>NSR impacts of a reduced $PM_{2.5}$ NAAQS in nonattainment areas</u>

The proposed lower NAAQS will result in more areas being declared as in nonattainment than would occur with the current NAAQS.

The cost to a community of being in nonattainment with a NAAQS includes not only the cost of the controls that must be implemented to attain the standard, but also the economic losses from being subject to nonattainment new source review and transportation conformity requirements while in nonattainment. EPA's *New Source Review: Report to the President* (June 2002) concluded that NSR requirements applied to existing power plants, refineries and other industrial facilities impede or result in the cancellation of a variety of projects that would provide needed capacity or efficiency or reliability improvements. The impediments to growth, investment and modernization from application of nonattainment NSR have been among the primary concerns cited by state and local officials contesting EPA's designation of broad $PM_{2.5}$ nonattainment areas, including counties with non-attaining monitors and the additional areas with sources thought to be contributing to nonattainment.

Attachment D: Comparison of EPA Mortality Estimates for $PM_{2.5}$ Against Aggregate National Mortality Statistics

A group of employees of EPA's Office of Air Quality, Planning and Standards published in 2012 the paper *Estimating the National Public Health Burden Associated with Exposure to Ambient $PM_{2.5}$ and Ozone*.[36] The paper estimated the amounts of mortality and morbidity that would be avoided in the continental U.S. if 2005 ambient levels of $PM_{2.5}$ and ozone were reduced to natural background levels. The paper used identical data sources, assumptions and methods in estimating the risk reductions that would result from this improvement in $PM_{2.5}$ air quality as those that EPA used in the 2012 $PM_{2.5}$ NAAQS RIA to estimate the risk reductions that would resulting from other potential changes in $PM_{2.5}$ air quality. Most notably, the paper used the same concentration-response functions (CRFs) for premature mortality as were used in the RIA to develop an upper and a lower estimate for the mortality risk reductions that will ensue for the various NAAQS alternatives. Both Fann, et al. (2012) and the RIA used an upper estimate CRF of 1.16 per 10 ug/m^3 increase in $PM_{2.5}$ from Laden, et al. (2006) and a lower estimate CRF of 1.06 per 10 ug/m^3 from Krewski, et al. (2009). The paper also used the same impact functions as did the RIA for all morbidity health endpoints.

Using Laden, et al.'s CRF to develop an upper estimate, Fann, et al. estimated that reducing 2005 $PM_{2.5}$ levels in the U.S. to natural background levels would result in 320,000 fewer premature deaths annually. We believe this estimate of mortality attributable to $PM_{2.5}$ is implausibly high when compared against aggregate national mortality statistics for 2005. This suggests that EPA's similarly derived benefits estimates in the 2012 $PM_{2.5}$ NAAQS RIA are also implausibly high. We will compare Fann, et al.'s $PM_{2.5}$ mortality estimate against data on deaths in the U.S. in 2005 from the Center for Disease Control and Prevention's "National Vital Statistics" reports.[37]

Fann, et al.'s upper estimate to the effect that there would be 320,000 fewer premature deaths per year if $PM_{2.5}$ were reduced to background levels is not a complete estimate for the number of premature deaths in the U.S. "due to" 2005 levels of $PM_{2.5}$. Fann, et al.'s estimate:

- Addresses the continental U.S., and not Alaska or Hawaii, which were not modeled or considered in either Fann, et al.'s analysis or the RIA.

- Pertains to a reduction in ambient $PM_{2.5}$ levels from those prevailing in 2005 to natural background levels, but does not reflect what would occur if $PM_{2.5}$ were completely eliminated. Under Fann, et al.'s assumptions, some additional premature mortalities would presumably be avoided if $PM_{2.5}$ were reduced from natural background levels to zero, and zero is the appropriate end-point if Fann, et al. were to estimate the amount of premature mortality "due to" $PM_{2.5}$.

[36] Fann, et al. (2012). Neal Fann, Amy D.Lamson, Susan C. Anenberg, Karen Wesson, David Risley, and Bryan J.Hubbell. "Estimating the National Public Health Burden Associated with Exposure to Ambient $PM_{2.5}$ and Ozone." *Risk Analysis*. 2012 Jan;32(1):81-95.

[37] Kung, et al. (2008). Hsiang-Ching Kung, Donna L.Hoyert, Jiaquan Xu and Sherry L. Murphy. "Deaths: Final Data for 2005." U.S. Department of Health and Human Services, Centers for Disease Control and Prevention: *National Vital Statistics Reports*. Volume 6, Number 10. April 24, 2008.

- Includes only premature mortality among individuals more than 24 years of age. The Laden, et al. CRF was estimated specifically for individuals more than 24 years of age, and it appears that Fann, et al. applied it only to individuals of this age in developing the 320,000 estimate (see page 8 of Fann, et al.).

Before comparing Fann, et al.'s estimate against the national data for 2005, we make several adjustments to reflect these observations:

- We increase Fann, et al.'s estimate by 0.5% to account roughly for Alaska and Hawaii. Alaska and Hawaii comprised 0.7% of the U.S. population in 2005. We presume that population-weighted annual average $PM_{2.5}$ concentrations in Alaska and Hawaii in 2005 were somewhat lower than equivalent figures for the lower 48, and so we increase Fann, et al's estimate by only 0.5% to account roughly for Alaska and Hawaii.

- Fann, et al. indicate that they assumed the following natural background concentrations of $PM_{2.5}$, in ug/m^3: Northeast, 0.74; Southeast, 1.72; Industrial Midwest, 0.86; Upper Midwest, 0.84; Southwest, 0.62, Northwest ,1.01; Southern California, 0.84. They also indicate that the mean annual average $PM_{2.5}$ concentration across the U.S. in 2005 was 7.8 ug/m^3, while the median was 7.48 ug/m^3. We guess that the population-weighted mean concentration across the U.S. would be somewhat higher than the simple mean ($PM_{2.5}$ concentrations are, we would guess, somewhat higher in more populated areas than in less populated areas); we guess perhaps about 9 ug/m^3 in 2005. The average reduction in population-weighted $PM_{2.5}$ concentration that Fann et al. analyzed in reducing concentrations to background was thus perhaps about 8 ug/m^3 – from about 9 ug/m^3 down to about 1 ug/m^3 as an average background level across the seven regions. A complete elimination of $PM_{2.5}$ (reduction to zero ug/m^3) would add about 1 ug/m^3 more to the 8 ug/m^3 average reduction that Fann et al analyzed in developing their mortality estimate. We thus increase Fann, et al's estimate by 1/8, or by 12.5%.

- The two adjustments to Fann, et al.'s estimate – 0.5% to reflect Alaska and Hawaii, and 12.5% to reflect elimination of $PM_{2.5}$ instead of only reduction to background – result in increasing the estimate to 362,000.

Fann, et al, or EPA using the $PM_{2.5}$ RIA's upper estimate methodology, would estimate that $PM_{2.5}$ at 2005 levels is responsible for approximately 362,000 premature deaths per year among individuals more than 24 year old in the U.S. We will compare this estimate for the number of premature deaths due to $PM_{2.5}$ against mortality data for 2005 from the Centers for Disease Control and Prevention (CDC) for the identical U.S. population – for all individuals more than 24 years old.

The following table shows the number of premature deaths per year that EPA would attribute to $PM_{2.5}$, based on the upper estimate CRF drawn from Laden, et al. (2006), and compares this EPA mortality estimate against national death statistics for the year 2005 as reported by CDC (Kung, et al., 2008).

Comparisons of EPA's Estimated Premature Mortality Due to $PM_{2.5}$
Against National Death Statistics

Cause of Death	Number of Deaths, 2005*
Due to $PM_{2.5}$ (EPA/Fann, et al. estimate, adjusted)	362,000
All Causes	2,373,985
Infectious and parasitic diseases (viral hepatitis, septicemia, TB, AIDS, etc.)	65,779
HIV/AIDS	*12,367*
Malignant neoplasms (cancer)	556,143
Diabetes melitus	74,876
Cardiovascular diseases	853,552
Acute myocardial infarction (heart attack)	*150,916*
Alzheimer's disease, Parkinson's disease	91,140
Accidents, suicide, homicide, events of undetermined intent, med/surg complications	143,631
Motor vehicle accidents	*32,225*
Nontransport accidents (falls, drowning, fires, poisoning, etc.)	*62,081*
Suicide	*28,153*
Homicide	*11,636*
All other	588,864

* Data for 2005, for age > 24 years. Source for all but the first row: CDC's "National Vital Statistics Reports"

The comparisons reveal the astonishing magnitude of the mortality impacts EPA projects for $PM_{2.5}$, despite the Agency's claims being subject to substantial scientific uncertainty. Indeed, commenters have noted EPA's failure to show that $PM_{2.5}$ causes death at concentrations close to U.S. ambient levels, either by a strong statistical association or a plausible biological mechanism. Arnett (2006). Yet, to accept Fann, et al.'s findings, as well as that of the 2012 $PM_{2.5}$ NAAQS which uses largely identical methodology and data, one would have to believe such propositions as:

- $PM_{2.5}$ results in the premature death of about thirty times as many people as does HIV/AIDS.
- $PM_{2.5}$ results in the premature death of about five times as many people as does diabetes.
- $PM_{2.5}$ results in the premature death of about four times as many people as Alzheimer's and Parkinson's diseases combined.
- $PM_{2.5}$ results in the premature death of more than ten times as many people as do motor vehicle accidents.
- $PM_{2.5}$ results in the premature death of about 2 ½ times as many people as all forms of accidents (motor vehicle; air, water, rail and other forms of transport; falls; drowning; fires; poisoning, etc.), suicides, homicides, and medical/surgical complications combined.

In another comparison, we estimate using EPA's methods the degree to which $PM_{2.5}$ contributes to cardiovascular deaths, and ask whether this contribution is plausible. The Laden, et al. (2006) study from which both Fann, et al. and the RIA draw the CRF used to estimate all-cause mortality also provides a CRF specifically for cardiovascular mortality -- cardiovascular mortality is estimated to decline by 28% for each 10 ug/m^3 reduction in annual average $PM_{2.5}$ concentration.[38] We estimate (see Attachment D) that the population-weighted average concentration of $PM_{2.5}$ in the U.S. in 2005 was perhaps about 9 ug/m^3. If this average concentration of $PM_{2.5}$ were reduced to zero, then by applying the Laden, et al. CRF for cardiovascular mortality, we would calculate that cardiovascular deaths would decline by 9 ug/m^3 x 28% ÷ 10 ug/m3 = 25.2%. Or, looking at this calculation in a different way, the Laden, et al. CRF implies that 25.2% of cardiovascular mortality is "due to" $PM_{2.5}$. There are many important and broadly agreed-upon risk factors for cardiovascular illness -- smoking, diet, obesity, heredity, lack of exercise, and other illnesses (e.g., diabetes), to name a few. To accept EPA's methods requires concluding that $PM_{2.5}$ outdoor air pollution is responsible for about 25% of all cardiovascular mortality, a larger share than most of these acknowledged important risk factors.

[38] The impact coefficient of 1.28 per 10 ug/m3 that Laden, et al. (2006) estimated for cardiovascular mortality is much larger than the coefficient of 1.16 that the researchers estimated for all-cause mortality. As a result, these researchers project that a reduction in $PM_{2.5}$ levels will result in a much larger proportional reduction in cardiovascular mortality than in total mortality.