Memorandum

TO: Docket for rulemaking: "National Emission Standards for Hazardous Air Pollutants: Coal-and Oil-Fired Electric Utility Steam Generating Units -- Reconsideration of Supplemental Finding and Residual Risk and Technology Review" (EPA-HQ-OAR-2018-0794)

DATE: April 15, 2020

SUBJECT: Compliance Cost, HAP Benefits, and Ancillary Co-Pollutant Benefits for "National Emission Standards for Hazardous Air Pollutants: Coal-and Oil-Fired Electric Utility Steam Generating Units -- Reconsideration of Supplemental Finding and Residual Risk and Technology Review"

1. Introduction & Summary of Results

This memorandum provides information related to the estimated costs and benefits of controlling emissions from Coal and Oil-Fired Electric Utility Steam Generating Units (EGUs) for purposes of determining whether it is appropriate and necessary to regulate these sources under Clean Air Act (CAA) section 112. To evaluate these costs and benefits, the memo draws on the prior analysis of costs and benefits described in the 2011 Regulatory Impact Analysis (2011 RIA) for the Mercury and Air Toxics Standards (MATS) final rule (U.S. EPA, 2011a) as well as information reported in the Supplement to the Non-Hg Case Study Chronic Inhalation Risk Assessment In Support of the Appropriate and Necessary Finding for Coal- and Oil-Fired Electric Generating Units (U.S.EPA 2011b) for the MATS final rule. EPA refers readers to the 2011 RIA, 2011 Risk Assessment, and preamble for this Final Rule for full details of the results presented below, including the methods for estimating costs and benefits.

The 2011 RIA represented the best available information on the projected costs, benefits and impacts of the MATS rule at the time the Agency was making its regulatory decision. Thus, it provides the basis for assessing costs and benefits in the context of the section 112(n)(1)(A) determination of whether an appropriate and necessary finding was supportable as a prerequisite for the specific regulatory obligations imposed by the MATS rule.

Table 1 presents a summary of ex ante costs and the targeted pollutant benefits that EPA views as pertinent to the appropriate and necessary finding under section 112(n)(1)(A). Targeted pollutant benefits consist of the quantified and unquantified benefits from reducing hazardous air pollutants (HAP). EPA also estimated that the MATS rule would result in ancillary benefits from the concomitant reduction of non-targeted pollutants. These ancillary benefits include the monetized co-benefits associated with reductions in directly-emitted $PM_{2.5}$, SO_2, and CO_2 emissions and other unquantified co-benefits that occur as a result of reducing non-HAP emissions. However, for reasons described in the preamble, EPA views the HAP benefits, both quantified and unquantified, as the relevant portion of the analysis for purposes of the appropriate and necessary finding. Therefore, for the purposes of this final action, EPA focused on the targeted pollutant impacts. The quantifiable portion of the targeted HAP benefits are not commensurate with the compliance cost of the rule, as the difference between costs and HAP benefits is substantial using either discount rate. Focusing on the targeted pollutants reflects the purposes of the appropriate and necessary finding. However, for the purposes of analyses to comply with the requirements of OMB Circular A-4, a regulatory impact analysis should

estimate all benefits and costs as EPA did for the 2011 RIA. Thus, Section 3 of this memorandum presents all reasonably anticipated costs and benefits arising out of the MATS rule, including those arising out of co-benefits.

Table 1. Summary of 2015 Costs and Targeted HAP Benefits (billions of 2007$) as estimated in the 2011 RIA[a]

Description	Estimate (3% Discount Rate)	Estimate (7% Discount Rate)
Costs[b]	$9.6	$9.6
Targeted HAP Benefits[c]	$0.004 to $0.006 + B	$0.0005 to $0.001 + B
Net Targeted Benefits (targeted benefits-costs)	($9.6) to ($9.6) + B	($9.6) to ($9.6) + B

[a] All estimates represent annualized estimates of the benefits and costs of the final MATS in 2015.

[b] Total social costs are approximated by the compliance costs.

[c] B is the sum of all unquantified HAP benefits.

2. Costs and benefits in the context of section 112(n)(1)(A)

The 2011 RIA estimated ex ante (prospective) costs and benefits attributable to compliance with the rule and described the unquantified benefits associated with reducing HAP and non-HAP air pollutants. A short summary of the key conclusions is provided below for costs, HAP benefits, and ancillary non-HAP benefits. These three components of the benefit-cost analysis are discussed more completely in Chapters 3, 4, and 5 of the 2011 RIA, respectively. As explained in section II.C.4 of the preamble to this rulemaking, we do not provide new ex post (retrospective) analysis that would theoretically examine the realized effects of the MATS rule. Such an analysis would be fraught with challenges, since it would require properly controlling for influential confounding factors in order to isolate the impact of MATS. For example, it would be difficult to account for how factors such as greater natural gas supply and lower electricity demand growth influenced the trajectory of MATS-regulated generation capacity. It would be similarly difficult to account for the impacts of other state and federal requirements, which changed since MATS was promulgated.

a. Costs

The compliance cost estimates were estimated using the Integrated Planning Model (IPM). IPM, developed by ICF International, is a state-of-the-art, peer-reviewed dynamic, deterministic linear programming model of the contiguous U.S. electric power sector. IPM provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies while meeting electricity demand and various environmental, transmission, dispatch, and reliability constraints. The model is designed to reflect electricity markets as accurately as possible using the best available information from utilities, industry experts, gas and coal market experts, financial institutions, and government statistics. Notably, the model includes state-of-the-art estimates of the cost and performance of air pollution control technologies, including those for control of mercury and other HAP emissions.

In the 2011 RIA, the power sector's "compliance costs" were estimated as the change in electric power generation costs between a base case without MATS and a policy case where the

sector complies with the HAP emissions limits in the final MATS. The base case provided a future projection of the power sector in 2015 in the absence of MATS and served as the baseline against which projections under policy cases were compared. The policy case examined in the 2011 RIA introduced the requirements of the rule as constraints on affected EGUs, which resulted in new projections of power sector outcomes under MATS. These compliance costs are an estimate of the increased expenditures in capital, fuel, and other inputs by the entire power sector to comply with MATS emissions requirements, while continuing to meet a given level of electricity demand. These costs were summarized in Table 3-16 of the 2011 RIA, which is included below as Table 2. The costs of MATS in 2015 were estimated to be $9.6 billion (2007$).

Table 2. Detailed Compliance Costs in 2015 under MATS (billions of 2007$) as estimated in 2011 RIA

Description	2015[a, b]
IPM Projection	$9.4
Monitoring/Reporting/Recordkeeping	$0.158
Oil-Fired Fleet[c]	$0.056
Total	$9.6

[a] The year 2016 is the compliance year for MATS, though the 2011 RIA used 2015 as a proxy for compliance in 2016 for IPM emissions and costs due to availability of modeling impacts in that year.
[b] Table 3-5 of the 2011 RIA shows annualized compliance costs for MATS in 2015, 2020 and 2030. Annualized compliance costs over the time frame range from $7.4 to $9.6 billion (2007$).
[c] EPA estimated the impacts of MATS on oil-fired units in a separate analysis, summarized in Appendix 3A of the 2011 RIA. These results are presented separately here because EPA did not model the impacts of MATS on oil-fired units using IPM. The IPM projection row reflects the change in all other electric power generation costs between the base case and policy case.

According to the commenters, costs of MATS compliance have been lower than the EPA estimated in 2011 and the EPA has not accounted for more recent studies of quantified HAP benefits. However, if the EPA updated its analysis, there is no reason to believe that the new data and analysis would change the overall conclusion of the 2011 analysis that costs outweighed the benefit attributed to reduction in mercury emissions.

However, while it is challenging to produce rigorous retrospective estimates of the benefits and costs of MATS, it is possible to demonstrate, using publicly available information, that it seems likely the compliance costs would continue to exceed quantified HAP benefits projected in the 2011 RIA ($9.6 billion versus $4 to $6 million annually in 2015).[1] Several commenters pointed to independent analyses that provided three estimates of the actual costs of MATS. While none of these estimates can be precisely compared against the EPA ex ante estimates because they use different cost metrics and dollar years, the independent analyses indicate that, if actual costs were to be estimated in a manner consistent with the EPA's 2011 RIA estimates, the compliance costs expenditures would still likely be in the billions of dollars.

First, a 2015 analysis by Andover Technology Partners referred to by commenters

[1] The EPA's April 15, 2020, finalization of the subcategorization of Eastern Bituminous Coal Refuse-Fired EGUs could alter the benefits and costs of MATS. However, given that such subcategorization will affect only six units, we think it is reasonable to expect that any changes to the 2011 RIA's projected cost and benefits as a result of the potential subcategorization would not materially affect the EPA's conclusion that compliance costs of MATS disproportionately outweigh the HAP benefits associated with the standards.

estimated that the actual cost of compliance in the initial years of implementation was approximately $2 billion per year.[2,3] The second study referred to by commenters was a study performed by M.J. Bradley & Associates (MJB&A) using information from the U.S. Energy Information Administration.[4] MJB&A estimated that MATS-regulated facilities incurred total capital expenditures on environmental retrofits of $4.45 billion, an estimate that does not include ongoing operating and maintenance expenditures. Finally, as documented in a letter to the EPA and cited by several commenters, the Edison Electric Institute estimated that the power sector incurred total compliance costs of more than $18 billion, including both capital and operations and maintenance costs.[5] While these retrospective cost estimates are developed from bases that are dissimilar from one another and, in particular, from how the EPA developed the prospective cost estimates in the 2011 RIA, it is evident that the independent analyses each indicate that the industry costs of MATS are of a similar order of magnitude and in the billions of dollars.

In section 5 of the Executive Summary, the 2011 RIA discussed several factors that may have introduced uncertainties in the projected compliance cost estimates. First, the projected compliance costs as defined above were used to approximate the social costs of this rule. The projected social costs of the rule may have been higher or lower than the projected compliance costs because of pre-existing distortions in the economy. Second, the compliance cost projections did not capture possible costs associated with employment shifts as workers are retrained at the same company or re-employed elsewhere in the economy. Third, the analysis did not include permitting costs associated with updating Title V permits. Finally, technological innovation was not incorporated into these cost estimates. As a result of these factors, the 2011 RIA-based projected compliance cost estimates may be over- or under-estimated, with the direction of the potential bias being ambiguous.

b. Benefits

The 2011 RIA estimated benefits were broken out into two separate categories: HAP benefits and criteria pollutant co-benefits. Here, for this proposed action, EPA has further distinguished between these categories of benefits: the HAP reductions, as the explicit focus of regulations to reduce emissions under CAA section 112, are described as "targeted pollutant" benefits, while the simultaneous reduction of non-HAP pollutants (i.e., non-HAP $PM_{2.5}$, SO_2, and CO_2), which occur when the HAP compliance strategies are deployed, are considered "ancillary" co-benefits. These ancillary co-benefits are outside the direct regulatory focus of CAA section 112.

c. Targeted pollutant benefits

[2] Declaration of James E. Staudt, Ph.D., CFA, at 3, *White Stallion Energy Center v. EPA*, No. 12-1100 (D.C. Cir., December 24, 2015). Also available at Docket ID Item No. EPA-HQ-OAR-2009-0234-20549.

[3] In addition to the 2015 study, Andover Technology Partners produced two other analyses in 2017 and 2019, respectively, that estimated the ongoing costs of MATS. The 2017 report estimated that the total annual operating cost for MATS-related environmental controls was about $620 million, an estimate that does not include ongoing payments for installed environmental capital. The 2019 report estimates the total annual ongoing incremental costs of MATS to be about $200 million; again, this estimate does not include ongoing MATS-related capital payment. The 2017 report is available in Docket ID Item No. EPA-HQ-OAR-2018-0794-0794. The 2019 report is available in Docket ID Item No. EPA-HQ-OAR-2018-0794-1175.

[4] Available in Docket ID Item No. EPA-HQ-OAR-2018-0794-1145.

[5] Available in Docket ID Item No. EPA-HQ-OAR-2018-0794-2267.

Regulations under CAA section 112 are intended to reduce emissions of HAP. The EPA estimated mercury HAP benefits of this rule because mercury is the only HAP controlled by this rule for which there was sufficient information to conduct a national-scale benefits assessment. In particular, the 2011 RIA estimated the human health benefits associated with reducing maternal exposure to methylmercury among populations who consume self-caught freshwater fish. The monetized benefits from reductions in mercury emissions, calculated only for mercury exposure among children of mothers consuming recreationally caught freshwater fish, were expected to be $0.004 to $0.006 billion in 2015 using a 3 percent discount rate and $0.0005 to $0.001 billion using a 7 percent discount rate.

EPA also identified a number of unquantified mercury-related benefits of MATS in the 2011 RIA. There are other neurologic, cardiovascular, genotoxic, and immunotoxic effects potentially associated with exposures to mercury, including impacts on motor skills and attention/behavior, for which it was not possible to quantify the estimated monetized benefits of the MATS rule. There is also the potential for mercury released from U.S. EGUs to impact commercially consumed fish more broadly as part of a global Hg pool; however, technical challenges in modeling these health impacts prevents them from being incorporated into the benefits analysis at this time. Additionally, deposition of mercury to waterbodies can also have an impact on ecosystems and wildlife; however, more research is required to link these ecological effects to ecosystem services and estimate an economic value of mercury reductions.

Data and methodological limitations also prevented us from estimating the economic value of impacts from reductions in other HAP such as arsenic, benzene, cadmium, chlorine, formaldehyde, lead, manganese, nickel, and selenium that may be emitted from coal- and oil-fired EGUs. These unquantified HAP benefits are represented by the letter “B” in Table 1.

Comments received on the 2019 Proposal (84 FR 2670) addressed unquantified and unmonetized HAP-related benefits including those associated both with mercury and non-mercury HAPs. In response to those comments, EPA reevaluated information from a non-Hg chronic inhalation risk assessment for 16 EGUs conducted for the 2012 MATS rule that was not described in the 2011 RIA (U.S.EPA 2011b) and also evaluated literature cited by these commenters. The results of those evaluations, which are presented in the Final Reconsideration of Supplemental Finding Rule preamble, sections II.C.3 and II.C.4, address the following topics: (a) potential for cardiovascular-related mortality associated with methylmercury exposure in adults, (b) additional neurocognitive endpoints besides IQ, (c) additional exposure pathways for methylmercury exposure (e.g., consumption by U.S. residents of commercial fish sourced globally), and (d) the potential for non-mercury HAP-related benefits. However, the EPA did not identify any additional endpoints that could be quantified and monetized for purposes of more fully characterizing the targeted pollutant benefits of the MATS rulemaking beyond those included in the 2011 RIA.

d. Ancillary co-pollutant benefits

The $PM_{2.5}$ attributable benefits quantified in the 2011 RIA are comprised almost entirely of non-HAP emissions of direct $PM_{2.5}$ and SO_2.[6]. The Agency estimated these benefits using a benefit-per-ton methodology derived from air quality model simulations of the MATS rule, as described in section 5.2.3 of the 2011 RIA. As reported in Table 5-19 of the 2011 RIA, EPA estimated ancillary co-pollutant benefits of the MATS rule ranging between $37 and $90 billion with a 3 percent discount rate or between $33 and $81 billion with a 7 percent discount rate; a small portion of these co-benefits are attributable to reducing CO_2. The 2011 RIA also considered an array of potential $PM_{2.5}$ and ozone-related effects in qualitative terms, because sufficient data was not available to estimate these benefits. Such endpoints included $PM_{2.5}$-related reproductive and developmental effects, the incidence of $PM_{2.5}$-related cancer and cardiovascular endpoints including cerebrovascular events. Ozone-related effects not quantified included premature mortality, respiratory hospital admissions and emergency department visits, school absences, changes in outdoor worker productivity, cardiovascular, reproductive and developmental effects.

The estimated and quantified non-HAP co-benefits ($PM_{2.5}$ and CO_2 in particular) are subject to important uncertainties related to data gaps, model capabilities and scientific uncertainty. Table 5.4 of the 2011 RIA summarizes a number of these key assumptions and uncertainties relevant to the analysis of criteria pollutant benefits. A number of these assumptions and uncertainties greatly affect the estimated size and distribution PM-related benefits and include: assumptions about the causal relationship between PM exposure and the risk of adverse health effects; the shape of the concentration-response relationship for long-term exposure-related $PM_{2.5}$ and the risk of premature death; the toxicity of individual $PM_{2.5}$ particle components; the levels of future $PM_{2.5}$; the validity of the reduced-form technique used to relate $PM_{2.5}$ emission precursors to the number and value of $PM_{2.5}$ adverse health effects; and the approach used to assign a dollar value to adverse health effects.

The Agency has also noted that it is less confident in risk and benefits estimated to occur at very low $PM_{2.5}$ concentrations, particularly those that fall below the bulk of the observed data in underlying epidemiologic studies used to quantify PM-related risks of premature death. These uncertainties are particularly important because air quality has improved over time due to federal and state pollution control efforts, reducing the fraction of the U.S. population experiencing elevated $PM_{2.5}$ exposures. Furthermore, the air quality data informing the two long-term exposure epidemiologic studies (Laden et al. (2006), Pope et al. (2002)) defining the concentration-response relationships used in the 2011 RIA did not reflect fully the lower levels of exposure the U.S. population experienced in the MATS analytical year (2016). We are more confident in the magnitude of the risks estimated from simulated $PM_{2.5}$ concentrations that coincide with the bulk of the observed PM concentrations in the epidemiological studies that are used to estimate the benefits. Likewise, we are less confident in the risk estimated from simulated $PM_{2.5}$ concentrations that fall below the bulk of the observed data in these studies.

To provide insight to the potential uncertainty in the estimated $PM_{2.5}$ mortality benefits at lower levels, in the 2011 RIA EPA quantified the proportion of the benefits associated with

[6] Based on analysis of available data, the EPA expects non-mercury metal HAP to represent no more than 0.8 percent of filterable PM. For more detail, see memorandum titled *Non-mercury Metals Content of Filterable Particulate Matter* in the docket for this action.

concentrations below the lowest measured levels (LML) observed in the epidemiological studies used to quantify the concentration-response relationships. The LMLs for the studies used to quantify the premature mortality relationship in the MATS rule were 7.5 $\mu g/m^3$ (Pope et al. 2002) and 10.0 $\mu g/m^3$ (Laden et al. 2006); in 2011 the annual primary NAAQS for $PM_{2.5}$ was 15.0 $\mu g/m^3$. In 2011, we estimated that between 73 percent of the benefits of the original regulation were *at or above* the LML of the Pope et al. 2002 study and 11 percent *at or above* the LML of the Laden et al. (2006) study. More information on these analyses are available in the 2011 RIA.

3. Total Costs and Benefits

The total costs and benefits of MATS monetized in the 2011 RIA can be summarized as shown in Table 3. As noted, EPA believes that for purposes of the appropriate and necessary finding, the most appropriate basis for comparison is the relative size of the targeted pollutant benefits, both quantified and unquantified, relative to the costs imposed by the rule. Thus, net targeted pollutant benefits here are calculated as HAP benefits minus costs of the rule. To perform this assessment, EPA used the results presented in 2011 RIA as this RIA contained the best available information on the projected costs, benefits and impacts of the MATS rule at the time the Agency was making its regulatory decision.[7]

Table 3. Summary of Costs and Benefits in 2015 (billions of 2007$) as estimated in the 2011 RIA[a]

Description	Estimate (3% Discount Rate)	Estimate (7% Discount Rate)
Costs[b]	$9.6	$9.6
Targeted HAP Benefits[c]	$0.004 to $0.006 + B	$0.0005 to $0.001 + B
Net Targeted Pollutant Benefits (HAP benefits-costs)	($9.6) to ($9.6) + B	($9.6) to ($9.6) + B
Ancillary Co-benefits[d]	$37 to $90 + CB	$33 to $81 + CB

[a] All estimates represent annualized estimates of the benefits and costs of the final MATS in 2015.

[b] Total social costs are approximated by the compliance costs.

[c] B is the sum of all unquantified targeted benefits.

[d] CB is the sum of all unquantified co-benefits. Co-benefits are composed primarily of monetized PM-related health benefits. The value of the avoided premature air pollution deaths each year accounts for over 90 percent of total monetized co-benefits. Benefits in this table are nationwide and are associated with reducing directly emitted $PM_{2.5}$ and SO_2. The estimate of social benefits also includes CO_2-related benefits calculated using the social cost of carbon, discussed further in Chapter 5 of the 2011 RIA. CB is the sum of all unquantified co-benefits and disbenefits.

4. References

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[7] The EPA's April 15, 2020, finalization of the subcategorization of Eastern Bituminous Coal Refuse-Fired EGUs could alter the benefits and costs of MATS. However, given that such subcategorization will affect only six units, we think it is reasonable to expect that any changes to the 2011 RIA's projected cost and benefits as a result of the potential subcategorization would not materially affect the EPA's conclusion that compliance costs of MATS disproportionately outweigh the HAP benefits associated with the standards.

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