**ADDENDUM TO THE**

# *ASSESSMENT OF THE POTENTIAL COSTS, BENEFITS, & OTHER IMPACTS OF THE HAZARDOUS WASTE COMBUSTION MACT STANDARDS: FINAL RULE*

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## ACKNOWLEDGMENTS

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**(continued)**

## INTRODUCTION

The purpose of this Addendum is to provide revised final information on the costs, benefits, and economic impacts of EPA's final MACT standards for hazardous waste combustion facilities. The Addendum also evaluates the costs and benefits for the MACT floor[1], and a more stringent MACT option with "beyond-the-floor" (BTF) emission levels for mercury and dioxins/furans.[2] This Addendum is necessary because during the Office of Management and Budget (OMB) and Agency final review, EPA identified analytical issues that necessitated changes to the MACT standards, the engineering costing methodology, and the risk assessment. This document provides revised estimates of the costs, benefits, and other economic impacts of the rule, reflecting these changes.

The Addendum is organized into six sections. The first section discusses the major differences between the analysis in EPA's July 1999 Draft Final *Assessment of the Potential Costs, Benefits, and Other Impacts of the Hazardous Waste Combustion MACT Standards: Final Rule* (*"Assessment")* and the analysis provided in this Addendum. The second section summarizes the results contained in this document and highlights major differences in costs, benefits, and economic impacts between the Addendum and the Draft Final *Assessment.* The remaining four sections provide more detailed revised results for compliance costs; social costs and economic impacts; and benefits, corresponding to Chapters 4, 5, and 6, respectively, of the Draft Final *Assessment* document. The last section provides an updated comparison of the costs and benefits of the rule, focusing on the cost-effectiveness of the MACT standards, and corresponding to Chapter 8 of the Draft Final *Assessment* document.

Because methods and approaches for developing estimates in this Addendum are not presented in this document, the reader is advised to read this document in conjunction with the full July 1999 *Assessment* document. Detailed information on the methodologies applied for estimating the social costs, economic impacts, and benefits of the standards, are presented in the Draft Final *Assessment.*

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[1] The Final Standards include BTF emission levels for dioxins/furans (for certain incinerators and LWAKs), semi-volatile metals (SVM) (for cement kilns and LWAKs), and chlorine (for LWAKs); emission limits for the other pollutants are floor levels.

[2] Consistent with the Draft Final *Assessment,* we refer to this more stringent MACT option as the "BTF-ACI" MACT because the cost of controlling for mercury is based on activated carbon injection technology.

## MAJOR CHANGES REFLECTED IN THE ADDENDUM

This Addendum provides results that reflect changes to the standards, engineering costs, risk analysis, and minor changes to the economic impact model. We discuss the nature of these changes in more detail below.

### Changes in Standards

- **Final Standards:** For hazardous waste-burning lightweight aggregate kilns (LWAKs), the final MACT standard for total chlorine is changed from 150 ppmv to 230 ppmv. The 230 ppmv emissions standard still represents a BTF level (the floor level is unchanged at 1500 ppmv).

- **BTF-ACI MACT:** For incinerators, the mercury emissions limit is changed from 10 ug/dscm to 20 ug/dscm. This alternative regulatory option also includes the revised 230 ppmv chlorine BTF emissions limit for LWAKs.

The floor standards remain unchanged. In Exhibit 1, we provide the complete list of emission limits for the final revised MACT standards, as well as the Floor and BTF-ACI MACT.

### Changes to Engineering Costing

Results in this Addendum also reflect modifications to the engineering costing methodology. A more detailed description of the engineering cost methodology is provided in EPA's "Technical Support Document for HWC MACT Standards, Volume V Emission Estimates and Engineering Costs." While the overall approach remains largely the same (described in Chapter 4 of the Draft Final *Assessment),* cost estimates for feed control, high energy wet scrubbers, moderate design, operating, and maintenance changes for electrostatic precipitators (ESP-DOM), and monitoring costs have been updated[3]. The updated monitoring costs are presented in Exhibit ADD-2 below and include updated costs for PM continuous emission monitoring (PM CEMs are not, however, actually required in the final rule) and bag leak detector costs.[4]

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[3] U.S. EPA. July 1999. *Final Technical Support Document for HWC MACT Standards, Volume V: Emission Estimates and Engineering Costs*.

[4] Relative to cost estimates presented in the July 1999 Draft Final *Assessment,* the revised PM CEM costs have increased by about 25 percent.

**Exhibit ADD-1**

**REGULATORY ALTERNATIVES FOR EXISTING SOURCES**

| MACT | Source Category | D/F (ng TEQ/dscm) | PM | Hg ($\mu$g/dscm) | SVM ($\mu$g/dscm) | LVM ($\mu$g/dscm) | TCl (ppmv) | CO (ppmv) | HC (ppmv) |
|---|---|---|---|---|---|---|---|---|---|
| MACT Floor | Incinerators | WHB: 0.2; or 12 and temperature at inlet to PM control device < 400˚ F<br>Others: 0.2; or 0.4 and temperature at inlet to PM control device < 400˚ F | 0.015 gr/dscf | 130 | 240 | 97 | 77 | 100* or | 10 * |
| | Cement Kilns | 0.2; or 0.4 and temperature at inlet to PM control device < 400˚ F | 0.15 kg/Mg dry feed | 120 | 650 | 56 | 130 | 100 or<br>100 or | 10 (◆)<br>20 (◊) |
| | LWAKs | 0.2; or 4.1 and temperature at inlet to PM control device ≤ 400˚ F | 0.025 gr/dscf | 47 | 1700 | 110 | 1500 | 100 or | 20 |
| Final MACT | Incinerators | 0.2; or 0.4 and temperature at inlet to PM control device < 400˚ F or 0.4 for incinerators using wet PM control device | 0.015 gr/dscf | 130 | 240 | 97 | 77 | 100* or | 10* |
| | Cement Kilns | 0.2; or 0.4 and temperature at inlet to PM control device < 400˚ F | 0.15 kg/Mg dry feed | 120 | 240 | 56 | 130 | 100 or<br>100 or | 10 (◆)<br>20 (◊) |
| | LWAKs | 0.2; or 0.4 and rapid quench to PM control device ≤ 400˚ F at the exit of the kiln | 0.025 gr/dscf | 47 | 250 | 110 | 230 | 100 or | 20 |
| BTF-ACI MACT | Incinerators | **0.2** | 0.015 gr/dscf | **20** | 240 | 97 | 77 | 100* or | 10* |
| | Cement Kilns | **0.2** | 0.15 kg/Mg dry feed | **25** | 240 | 56 | 130 | 100 or<br>100 or | 10 (◆)<br>20 (◊) |
| | LWAKs | **0.2** | 0.025 gr/dscf | **10** | 250 | 110 | 230 | 100 or | 20 |

**Notes:**

1. Across all options, cement kilns sources have the option to continuously comply with a CO standard of 100 ppmv in lieu of complying with the HC standard. Cement kilns that choose to do this, however, must demonstrate compliance with the HC standard during the comprehensive performance test.
2. Incinerators and LWAKs may choose to comply with either the CO or the HC limit.
3. WHB are incinerators with waste heat boilers.
4. Shaded cells indicate that the standards represent BTF levels. Bold figures in the BTF-ACI option indicate that the pollutant is controlled with more stringency under the recommended MACT.

(*) Incinerators with high temperature rapid quench design can comply with the HC standard in lieu of the CO standard. Incinerators that use wet scrubbers can comply with the CO standard in lieu of the HC standard.

(◆) Cement kilns with bypass ducts have the option to comply with either a CO standard in the bypass duct of 100 ppmv, or an HC standard in the bypass duct of 10 ppmv (no main stack standard).

(◊) Cement kilns without bypass ducts have the option to comply with either a CO standard in the main stack of 100 ppmv, or an HC standard in the main stack of 20 ppmv.

**Exhibit ADD-2**

**AVERAGE TOTAL ANNUAL MONITORING COSTS**
**(per-system, in thousands of dollars)**

| Type of Monitoring | Cement Kilns | LWAKs | Commercial Incinerators | On-Site Incinerators | |
|---|---|---|---|---|---|
| PM CEMs | $51 | $52 | $56 | $101 govt. systems | $55 private systems |
| Opacity Monitors | $22 | N/A | N/A | N/A | |
| Fabric Filter Leak Detection Systems (BLDS) | N/A | $2 | $2 | $5 govt. systems | $2 private systems |
| HC/CO CEMs | 0 | 0 | 0 | 0 | |
| Oxygen Monitors | 0 | 0 | 0 | 0 | |

NOTES:

1. Monitoring compliance components based on Section 4, "MACT Compliance Costs" of the revised July 1999 *Technical Support Document: Volume V.*
2. Incremental costs for HC/CO CEMs are zero because all hazardous waste combustion systems are assumed to already have one or both of these components, thus satisfying the requirements of the regulation.
3. Opacity monitors apply only to cement kilns.
4. Incremental costs for oxygen monitors are zero because all HWC systems are assumed to already have these installed.
5. FF bag leak detection systems (BLDS) apply only to those LWAKs or incinerators with fabric filters (FF).

**Changes to Economic Impact Modeling**

In addition to changes in the standards and the engineering cost methodology, social cost and economic impact results also reflect minor changes to the economic impact model.[5]

- We use revised figures in the employment impacts analysis to account for changes in the number of employees who fulfill facility-wide duties, and changes to wage rates associated with permitting activities.[6]

- In addition to the commercial sector, this Addendum also incorporates practical capacity constraints to the on-site consolidation routine (i.e., consolidation of waste burning across systems at a given facility is only allowed if there is adequate capacity).

- All dollar figures are converted to 1996 dollars using a revised GDP price deflator (from the February 1998 Economic Report of the President, Table B-3: Quantity and Price Indexes for Gross Domestic Product, and Percent Changes, 1959-1997).

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[5] The economic impact model is described in more detail in Chapter 5 of the Draft Final *Assessment* document.

[6] The new figure of $53.41 (revised from $38.29) is a weighted average of the following hourly wage rates: $93.97 for legal staff, $71.49 for managerial staff, $55.00 for technical staff, $26.48 for clerical staff, and $71.49 for consultant staff. The weighted average figure is calculated by dividing the total annual cost of permitting requirements (i.e., the sum of all staff type hour distributions multiplied by the appropriate wage rate) by the estimated total hours per year spent complying with these requirements (converted to 1996 dollars). Sources: Energy and Environmental Research Corporation, *Supporting Statement for EPA Information Collection Request #1773.02, "New and Amended Reporting and Recordkeeping Requirements for National Emissions Standards for Hazardous Air Pollutants from Hazardous Waste Combustion,"* prepared for the U.S. Environmental Protection Agency, September 1998 and Energy and Environmental Research Corporation, *Supporting Statement for EPA Information Collection Request #1361.08, "New and Amended RCRA Reporting and Recordkeeping Requirements for Boilers and Industrial Furnaces Burning Hazardous Waste,"* prepared for the U.S. Environmental Protection Agency, September 1998.

**Changes to Risk Assessment**

Benefit estimates provided in this Addendum are based on a revised risk assessment that incorporates changes described below. It is important to note that due to time and budget constraints, the risk assessment was ***not*** updated to reflect changes to the MACT Standards as described in this Addendum; the risk assessment is based on the Standards presented in the Draft Final *Assessment.*

- **Cancer risks:** The revised risk assessment includes minor changes to exposure factors for children age 6-11 and 12-19. These changes result in a decrease of less than 3 percent in cancer risks associated with the final standards.

- **Avoided asthma attacks associated with reduction in PM:** The revised risk assessment does not include quantified estimates of avoided asthma attacks due to limitations of the risk model.[7] EPA, nonetheless, believes that there will be reductions in the severity of asthma symptoms resulting from the PM controls in the rule.

- **Benefits from lead emission reductions:** The revised risk assessment uses a revised methodology for modeling risks associated with lead emissions that accounts for all relevant pathways of exposure to assess the overall impact of lead emissions on blood lead levels in children. In the previous analysis, a key pathway was inadvertently omitted from the lead analysis. Also, the previous analysis had errors in the background levels.

The benefit estimates presented in this Addendum also include decreased risks of premature mortality associated with reductions in short-term exposure to PM-2.5; the Draft Final *Assessment* only included benefits from reductions in long-term PM exposure. No changes were made to the ecological risk assessment.

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[7] Because asthma symptoms are related to the relative reduction in ambient PM levels, the risk assessment needs to explicitly account for ambient background PM on a site-specific basis, as well as incremental changes. While the Draft Final *Assessment* included estimates of avoided asthma attacks associated with the rule, because these estimates were based on the November 1998 risk assessment that did not include an explicit treatment of background PM levels, the asthma figures were likely overestimated by a factor of three.

The background document: *Human Health and Ecological Risk Assessment Support to the Development of Technical Standards for Emissions from Combustion Units Burning Hazardous Wastes: Background Document - Final Report*," July 1999, contains a full discussion of this issue.

**MAJOR FINDINGS**

- Social costs for the Final MACT standards are expected to be between $50 and $63 million per year, with an upper bound of $75 million. Overall, social cost estimates are about 20 percent lower than those presented in the Draft Final *Assessment.*

- Across all MACT options and combustion sectors, compliance costs have decreased. For the Final MACT standards, on average, we expect that each combustion system will spend between $160,000 and $720,000 annually to comply with the standards.

- As a result of the Final MACT standards, up to two cement kilns and 13 on-site incinerators are expected to stop burning waste entirely, rather than incur the rule's compliance costs.

- Market exit and waste consolidation activity is expected to result in between 14,000 and 42,000 tons of waste reallocated from combustion systems that stop burning as a result of the rule.

- Employment dislocations of approximately 100 to 200 FTEs are expected at combustion facilities that discontinue waste burning. Employment gains of about 300 FTEs are expected as new purchases of pollution control equipment stimulate additional hiring in the pollution control manufacturing sector and as additional staff are required at combustion facilities for various compliance activities.

- Annual human health benefits associated with emission reductions from the final MACT standards include between two and four avoided premature deaths, and reductions of six hospital admissions, 25 cases of chronic bronchitis, 224 avoided respiratory cases, and almost 20,000 days of work loss or mild restricted activity days (MRAD). The value of these benefits range from $10 to $84 million annually, with a best estimate of $19 million annually.

These findings are discussed in more detail in the sections that follow. The changes to the analysis presented in this Addendum will also affect the children's health analysis and the small business analysis, as presented in the Draft Final *Assessment*. Small business impacts are expected to decrease due to the reduced costs. Removal of the estimated reductions in asthma cases, however, may result in reduced incremental benefits to children’s health. EPA has not updated these analyses due to time and budget constraints.

## COMPLIANCE COST ANALYSIS

Across all MACT options and combustion sectors, compliance costs have decreased from those presented in the Draft Final *Assessment*. For the Final MACT standards, on average, we expect that each combustion system will spend between $160,000 and $720,000 annually to comply with the standards. This represents a decrease in costs of about 10 to 15 percent for on-site incinerators, 15 to 20 percent for commercial incinerators, 30 percent for cement kilns, and about 50 percent for LWAKs. The change for LWAKs reflects changes to the chlorine standards (from 150 ppmv to 230 ppmv) and changes to the engineering costing methodology. Exhibit ADD-3 presents the average total annual compliance costs per combustion system by MACT option and combustion sector. Exhibit ADD-4 shows the percentage of combustion systems requiring particular control measures under each MACT option. In Exhibit ADD-5, we provide a comparable set of results by showing the percentage of total compliance costs accounted for by each of the control measures under different MACT options and within each combustion sector.

## SOCIAL COST AND ECONOMIC IMPACT ANALYSIS

### Social Cost Results

The social cost analysis presented in this document uses the same economic framework described in the Draft Final *Assessment* document described in Chapter 5. We present results in Exhibits ADD-6 through ADD-9. Overall, social cost estimates are about 20 percent lower than those presented in the Draft Final *Assessment.* Social costs for the Final MACT standards are between $50 and $63 million, with an upper bound of $75 million.[8]

### Economic Impact Measures

- **Market Exits.** As a result of the Final MACT standards, over the long-term up to two cement kilns and an estimated 13 on-site incinerators are projected to exit the hazardous waste-burning market. This represents about 10 to 12 percent of the market in these sectors. In comparison to results presented in the Draft Final *Assessment*, an additional six market exits for on-site incinerators are expected; this change is likely due to the incorporation of on-site capacity constraints in the economic impact model. For other combustion sectors, market exit estimates for the final standards are comparable to those presented in the Draft Final *Assessment.* Exhibit ADD-10 presents the facility market exit estimates for the short-term and Exhibit

[8] The upper bound estimate for social costs applies engineering costs with design levels of 50 percent of the standards, and assumes that all facilities, including those non-viable in the baseline, continue to operate at current output levels and comply with the standards, passing 100 percent of the compliance costs to hazardous waste generators.

ADD-11 presents market exit results for the long-term (i.e., over the capital replacement cycle).

- **Hazardous Waste Reallocated.** The total quantity of waste reallocated as a result of facilities that stop burning hazardous waste is between 14,000 and 42,000 tons, representing approximately one percent of all BRS combusted hazardous waste. Waste reallocation estimates for all MACT options and engineering design levels are presented in Exhibit ADD-12. These estimates are slightly less than those presented in the Draft Final *Assessment.* It is important to note that, like other economic impact estimates, the quantity of waste reallocated is sensitive to the quantity we expect will be reallocated even in the absence of the MACT standards (i.e., in the baseline). For the Final MACT standards, the waste reallocation estimate jumps to approximately 150,000 tons (about four percent of all BRS combusted hazardous waste) if we also include the reallocation of waste from facilities that we do not believe are viable even in the absence of the Final MACT standards.

- **Employment Impacts.** Employment shifts will occur in the combustion and pollution control industries as the market adjusts to new output levels post-MACT and combustion facilities invest in additional pollution control and monitoring equipment. As shown in Exhibit ADD-13, employment dislocations of approximately 100 to 200 FTEs are expected at combustion facilities that discontinue waste burning. As shown in Exhibit ADD-14, employment gains of about 300 FTEs are expected with the Final MACT standards as new purchases of pollution control equipment stimulate additional hiring in the pollution control manufacturing sector and as additional staff are required at combustion facilities for various compliance activities. Estimates for employment impacts are comparable to those presented in the Draft Final *Assessment.*

- **Combustion Price Increases.** Combustion price increases of between $5 and $15 per ton are expected with promulgation of the Final MACT standards, representing a combustion price increase of between one and seven percent. On a percentage basis, price increases at hazardous waste burning kilns are about 6 to 7 percent, whereas at incinerators, price increases are only about one percent of current combustion prices. Exhibit ADD-15 presents the expected combustion price increase across MACT options using different assumptions about the price elasticity for combustion services.

- **Non-Air Environmental Impacts.** While the primary environmental impact of the MACT standards are improvements in air quality resulting from emissions reductions at combustion facilities, other non-air environmental impacts may also result from the rule. Namely, use of some air pollution control equipment and shifts in waste burning could result in water, solid waste, and energy impacts.[9] We did not value these impacts because we expect the incremental environmental costs will be small relative to the total compliance costs of the rule. In addition, as a result of the combustion price increases stimulated by today's rule, generators may reduce the toxicity of wastes currently combusted, or use waste management alternatives such as solvent recycling. These waste minimization benefits are also discussed below.

  -- **Water Impacts.** Control of dioxins/furans also requires temperature control at some combustion systems. The use of rapid quench systems that control for temperature is expected to result in increased annual water consumption of 407 million gallons at incinerators, 845 million gallons at cement kilns, and 141 million gallons at LWAKs for the Final MACT Standards.

  -- **Solid Waste Impacts.** Facilities that install controls to meet particulate matter standards will generate about 6,500 tons of additional solid waste per year requiring disposal. Fabric filters, electrostatic precipitators, and ionizing wet scrubbers are considered to be MACT Floor control for particulate matter. In most cases, these devices can be added to the existing stack emissions control system to capture previously released particulate matter, which then needs to be disposed of as solid waste.[10]

  -- **Electricity and Natural Gas Usage.** As combustion facilities operate additional air pollution control devices to meet MACT standards, they will consume additional electricity -- approximately 95 million kilowatt hours per year. An additional 383,000 MBtu per year of natural gas will also be used at facilities that require afterburners or reheaters as a result of the MACT rule.

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9 The environmental impacts presented in this section were not previously evaluated in the Draft Final *Assessment.*

10 U.S. EPA. July 1999. *Final Technical Support Document for HWC MACT Standards, Volume V: Emission Estimates and Engineering Costs*.

-- **Other Energy Impacts.** Kilns that stop burning hazardous waste[11] to avoid complying with the HWC MACT standards will need to replace their hazardous waste derived fuel with alternative fuels -- mostly coal.[12] However, a large percentage of the hazardous waste displaced from these facilities will likely be sent to other kilns or incinerators. This is expected to decrease the quantity of fossil fuel used at these facilities and offset the increases at the kilns that stop burning.[13] Overall, therefore, we expect no significant net change in energy use (and corresponding criteria pollutants due to coal usage) associated with waste re-allocations.[14]

-- **Waste Minimization Benefits.** As discussed in Appendix F of the Draft Final *Assessment*, EPA's waste minimization analysis indicates that as much as 240,000 tons of hazardous waste might be reallocated from combustion to waste minimization alternatives in response to the price increases stimulated by today's final rule. While we believe that there would be some overlap between the waste quantity eligible for waste minimization and the quantity reallocated, we are not able to quantify this amount.

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[11] Up to one *additional* cement plant may stop burning hazardous waste due to the BTF SVM final standard. (We predict a *total* of 0 to 1 cement facilities may exit the market at the floor SVM standard; we predict a *total* of 0 to 2 cement facilities may exit the market under the final BTF SVM standard.)

[12] The average mix of conventional fuel used at cement kilns is 91.1 percent coal and 8.9 percent natural gas (Portland Cement Association, Economic Research Department, *U.S. Cement Industry Fact Sheet: 14th Edition, Table 24: Fossil Fuel Mix*, 1996, page 17.

[13] Wastes burned by cement kilns must be relatively clean and have a high heat value. According to the National Association of Chemical Recyclers (NACR), the 1994 weighted average heat value of fuels supplied to kilns by fuel blenders in NACR was 12,073 Btu/lb (see NACR, *NACR Waste Processing Survey*, August 1994, question 1). Commercial incinerators typically burn more contaminated wastes with heat values averaging 6,700 Btu/lb (from EER's combustion database), and often supplement wastes with conventional fuels to ensure temperatures high enough to destroy organic toxics. If incinerators burn waste with higher heat values (i.e., the waste displaced from cement kilns that stop burning due to the rule), the amount of fossil fuel needed to maintain required temperatures will be reduced, likely offsetting the increased fossil fuel use at the cement kilns exiting the hazardous waste-burning market.

[14] Some public commenters also noted that waste re-allocations may lead to increased risks associated with transport of hazardous waste. A preliminary screening analysis (see Exhibit 5-11 in the *Assessment*) suggests that increased transport distances will not increase significantly and therefore no significant environmental or health threats are likely.

**BENEFITS ASSESSMENT**

Annual human health benefits associated with emission reductions from the final MACT standards include between two and four avoided premature deaths, and reductions of six hospital admissions, 25 cases of chronic bronchitis, 224 avoided respiratory cases, and almost 20,000 days of work loss or mild restricted activity days (MRAD). Revised benefit results are summarized in Exhibits ADD-16 through ADD-19. Similar to the results presented in the Draft Final *Assessment*, benefits of the MACT standards are similar across the regulatory options evaluated.

The major changes to the human health benefits assessment are summarized below.

- Removal of 267,600 annual asthma cases avoided (due to revisions in the risk modeling).[15]

- An increase in upper bound mortality benefits due to inclusion of acute exposure to PM-2.5.

- An increase in the number of children with reductions in blood lead levels to below levels of concern (< 10 ug/dL) — from two children to 7 children. Similar to the results presented in the Final Draft *Assessment*, lead emission reductions at incinerators are primarily responsible for these potential health benefits to children.

- Finally, the revised cancer risk reductions are about three percent less than those presented in the Final Draft *Assessment.*

The monetized value of the human health benefits are approximately $19 million annually, about 35 percent less than the value estimate presented in the Draft Final *Assessment.* Removal of the estimated reductions in asthma cases (due to revisions in the risk modeling) is almost entirely responsible for this difference. The monetized value of the cancer risk estimates also are reduced slightly due to the change in exposure factors for two child population groups; however the change in the value of cancer risk reductions is only $30,000.

The benefit assessment is described in more detail below.

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[15] EPA believes, however, that there will be reductions in the severity of asthma symptoms resulting from the PM controls in the rule. These reductions have not been quantified.

- **Benefits from cancer risk reductions:** Across MACT standards, less than one cancer case per year is expected to be avoided due to reduced emissions from combustion facilities. In comparison to the cancer risk results presented in the Final Draft *Assessment*, the revised results (based on the revised exposure factors) are lower by about three percent.

- **Benefits from non-cancer risk reductions:**

  -- **Particulate matter.** The primary benefit from reduced PM exposure is a reduction in premature mortality of about 1.5 to 4.1 statistical cases per year, valued at about $8.4 million. Other health benefits from PM include reductions in hospital admissions (six cases), chronic bronchitis (25 cases), respiratory conditions (224 cases), and about 20,000 work loss days or mild restricted activity days (MRAD). As stated above, the major changes for PM from the Draft Final *Assessment* are the retraction of the avoided asthma cases and the inclusion of the upper bound estimate for PM-related mortality risks.

  -- **Lead.** The MACT standards are expected to reduce lead exposure below levels of concern (blood lead level of 10 ug/dl) for about seven children annually. The Draft Final *Assessment* projected reductions for only two children.

  -- **Mercury.** No changes were made to the mercury health risk analysis. Hazard quotients in the baseline are below levels of concern across all age groups and populations.

This Addendum does not present any results for ecological benefits or waste minimization benefits because no changes were made to these benefit components.

## COMPARISON OF COSTS, BENEFITS AND OTHER IMPACTS

This final section of the Addendum compares the costs and benefits of the rule. We use two metrics for this comparison. We first present cost-effectiveness measures which provide estimates of expenditures per unit reduction of emissions for each air pollutant. We then compare the total social costs of the rule with the total monetized benefits of the rule.

**Cost Effectiveness Analysis**

Using the same methodology (as discussed in the *Assessment*) we developed the cost per unit reduction of emissions for each air pollutant. These revised cost-effectiveness metrics for the Final Standards are shown in Exhibit ADD-20. We highlight the key differences in cost-effectiveness results from those presented in the Draft Final *Assessment* below.

- For the Final Standards, the cost-effectiveness for chlorine control improved across all combustion sectors, from $2,000/Mg to $1,100/Mg for LWAKs; from $1,800/Mg to $1,700/Mg for incinerators; and from $3,800/Mg to $3,600/Mg for cement kilns. Cost-effectiveness also improved for control of SVM emissions at incinerators (from $34,000 to $32,000 per Mg removed). For the Final Standards, the cost-effectiveness changed slightly for LVM emissions control at incinerators, from $256,000 to $273,000 per Mg removed.

- For other MACT options, the cost-effectiveness for chlorine control at LWAKs also improved, from $1,900/Mg to $700/Mg at the Floor, and from $2,000/Mg to $1,100/Mg for the BTF-ACI standards (which are the same levels as the Final standards).

- For the BTF-ACI option, the cost-effectiveness at incinerators improved slightly for control of mercury (from $25 million to $23 million per Mg of mercury removed). The improvement for BTF-ACI mercury cost effectiveness is likely due to the change in BTF-ACI standards.

- For the BTF-ACI MACT, the cost-effectiveness of control changed slightly for dioxins/furans at incinerators (from $762,000 to $827,000 per gram (TEQ) removed).

**Cost-Benefit Comparison**

Across all MACT regulatory scenarios, costs exceed monetized benefits more than two- fold, the same conclusion reached in the Draft Final *Assessment.* For both the final MACT, costs are about three times greater than monetized benefits. For the BTF-ACI option, costs are more than five times greater than monetized benefits. However, the HWC MACT standards are expected to provide other benefits that are not expressed in monetary terms. These benefits include health benefits to sensitive sub-populations such as subsistence anglers and improvements to terrestrial and aquatic ecological systems. When these benefits are taken into account, along with equity-enhancing effects such as environmental justice and impacts on children's health, the benefit-cost comparison becomes more complex. Consequently, the final regulatory decision becomes a policy judgment which takes into account efficiency as well as equity concerns.

**Exhibit ADD-3**

**AVERAGE TOTAL ANNUAL COMPLIANCE COSTS PER COMBUSTION SYSTEM**
**(Assuming No Market Exit)**

| MACT Option | Cement Kilns | LWAKs | Commercial Incinerators | On-site Incinerators | Government On-sites |
|---|---|---|---|---|---|
| Floor (50%) | $677,373 | $260,252 | $267,273 | $237,552 | $179,565 |
| Floor (70%) | $444,485 | $212,689 | $238,749 | $203,763 | $159,648 |
| Final (50%) | $723,010 | $341,613 | $267,634 | $265,811 | $179,565 |
| Final (70%) | $527,438 | $307,849 | $242,210 | $234,073 | $159,648 |
| BTF-ACI (50%) | $992,039 | $455,955 | $379,459 | $429,193 | $960,310 |
| BTF-ACI (70%) | $767,246 | $412,058 | $356,234 | $392,281 | $941,121 |

Notes:
1. No PM CEM costs included.
2. Averages based on all systems, and include those non-viable in the baseline.
3. Estimates taken from model exhibit "Average Total Annual Compliance Costs per Combustion System (Assuming no Market Exit)."

**Exhibit ADD-4**

**PERCENTAGE OF SYSTEMS REQUIRING CONTROL MEASURES (Before Consolidation)**

| Control Measure | Floor (50%) | Floor (70%) | Final (50%) | Final (70%) | BTF-ACI (50%) | BTF-ACI (70%) |
|---|---|---|---|---|---|---|
| **Cement Kilns** | | | | | | |
| New Fabric Filters | 33% | 27% | 33% | 27% | 61% | 52% |
| New Carbon Injection | 0% | 0% | 0% | 0% | 45% | 36% |
| New Quencher | 45% | 33% | 45% | 33% | 39% | 30% |
| Fabric Filter DOM | 12% | 9% | 12% | 9% | 6% | 6% |
| DESP DOM | 6% | 0% | 6% | 0% | 3% | 0% |
| Combination DOM | 3% | 3% | 3% | 3% | 3% | 3% |
| Feed Control | 55% | 42% | 64% | 52% | 73% | 55% |
| None | 12% | 27% | 3% | 21% | 3% | 18% |
| **LWAKS** | | | | | | |
| New Fabric Filters | 0% | 0% | 0% | 0% | 63% | 50% |
| New Carbon Injection | 0% | 0% | 0% | 0% | 63% | 50% |
| New Quencher | 88% | 88% | 88% | 88% | 50% | 50% |
| Fabric Filter DOM | 38% | 13% | 38% | 13% | 13% | 0% |
| Feed Control | 100% | 75% | 63% | 63% | 50% | 63% |
| None | 0% | 13% | 0% | 0% | 0% | 0% |
| **Commercial Incinerators** | | | | | | |
| New Fabric Filters | 15% | 10% | 15% | 15% | 40% | 40% |
| New Carbon Injection | 0% | 0% | 20% | 20% | 85% | 85% |
| New Quencher | 55% | 50% | 45% | 40% | 20% | 15% |
| New Reheater | 0% | 0% | 5% | 5% | 35% | 35% |
| Fabric Filter DOM | 15% | 10% | 15% | 10% | 15% | 10% |
| IWS DOM | 10% | 5% | 10% | 5% | 0% | 0% |
| HEWS DOM | 15% | 15% | 15% | 15% | 5% | 5% |
| Combination DOM | 5% | 0% | 5% | 0% | 5% | 0% |
| Feed Control | 85% | 80% | 80% | 75% | 70% | 65% |
| None | 5% | 5% | 5% | 5% | 5% | 5% |
| **Private On-Site Incinerators** | | | | | | |
| New Fabric Filters | 67% | 65% | 71% | 69% | 85% | 81% |
| New Carbon Injection | 0% | 0% | 15% | 15% | 71% | 60% |
| New Carbon Bed | 0% | 0% | 2% | 2% | 6% | 6% |
| New Quencher | 17% | 17% | 12% | 12% | 10% | 10% |
| New Afterburner | 6% | 2% | 6% | 2% | 6% | 2% |
| New Reheater | 0% | 0% | 8% | 8% | 60% | 48% |
| Fabric Filter DOM | 2% | 2% | 2% | 2% | 2% | 2% |
| WESP DOM | 2% | 2% | 2% | 2% | 0% | 0% |
| IWS DOM | 2% | 2% | 2% | 2% | 0% | 0% |
| HEWS DOM | 10% | 12% | 8% | 10% | 2% | 4% |
| Combination DOM | 2% | 4% | 2% | 4% | 2% | 4% |
| Feed Control | 46% | 40% | 42% | 37% | 42% | 52% |
| None | 6% | 8% | 4% | 6% | 2% | 2% |

**Exhibit ADD-4 (continued)**

**PERCENTAGE OF SYSTEMS REQUIRING CONTROL MEASURES (Before Consolidation)**

| Control Measure | Floor (50%) | Floor (70%) | Final (50%) | Final (70%) | BTF-ACI (50%) | BTF-ACI (70%) |
|---|---|---|---|---|---|---|
| **Govt. On-Site Incinerators** | | | | | | |
| New Fabric Filters | 29% | 24% | 29% | 24% | 38% | 33% |
| New Carbon Injection | 0% | 0% | 0% | 0% | 48% | 43% |
| New Quencher | 0% | 0% | 0% | 0% | 0% | 5% |
| New Afterburner | 5% | 5% | 5% | 5% | 5% | 5% |
| New Reheater | 0% | 0% | 0% | 0% | 19% | 19% |
| Fabric Filter DOM | 14% | 15% | 14% | 15% | 14% | 15% |
| IWS DOM | 5% | 5% | 5% | 5% | 5% | 5% |
| Combination DOM | 14% | 14% | 14% | 14% | 14% | 14% |
| Feed Control | 57% | 52% | 57% | 52% | 57% | 52% |
| None | 19% | 19% | 19% | 19% | 14% | 14% |

**Exhibit ADD-5**

**PERCENTAGE OF TOTAL NEW COMPLIANCE COSTS BY CONTROL MEASURE (Before Consolidation)**

| Control Measure | Floor (50%) | Floor (70%) | Final (50%) | Final (70%) | BTF-ACI (50%) | BTF-ACI (70%) |
|---|---|---|---|---|---|---|
| **Cement Kilns** | | | | | | |
| New Fabric Filters | 35% | 35% | 33% | 30% | 39% | 39% |
| New Carbon Injection | 0% | 0% | 0% | 0% | 24% | 24% |
| New Quencher | 24% | 32% | 23% | 27% | 13% | 15% |
| Fabric Filter DOM | 3% | 2% | 3% | 2% | 1% | 1% |
| DESP DOM | 4% | 0% | 4% | 0% | 1% | 0% |
| Feed Control | 33% | 30% | 37% | 40% | 22% | 21% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% |
| **LWAKS** | | | | | | |
| New Fabric Filters | 0% | 0% | 0% | 0% | 27% | 24% |
| New Carbon Injection | 0% | 0% | 0% | 0% | 31% | 27% |
| New Quencher | 38% | 47% | 28% | 29% | 10% | 11% |
| Fabric Filter DOM | 4% | 1% | 3% | 1% | 0% | 0% |
| Feed Control | 58% | 52% | 31% | 29% | 4% | 8% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% |
| **Commercial Incinerators** | | | | | | |
| New Fabric Filters | 10% | 8% | 9% | 11% | 19% | 20% |
| New Carbon Injection | 0% | 0% | 16% | 18% | 47% | 50% |
| New Quencher | 21% | 23% | 17% | 17% | 4% | 3% |
| New Reheater | 0% | 0% | 3% | 3% | 19% | 20% |
| Fabric Filter DOM | 3% | 2% | 3% | 2% | 2% | 0% |
| IWS DOM | 2% | 1% | 2% | 1% | 0% | 0% |
| HEWS DOM | 7% | 5% | 6% | 5% | 1% | 1% |
| Feed Control | 57% | 61% | 44% | 44% | 8% | 5% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% |
| **Private On-Site Incinerators** | | | | | | |
| New Fabric Filters | 39% | 54% | 36% | 48% | 28% | 33% |
| New Carbon Injection | 0% | 0% | 9% | 12% | 28% | 30% |
| New Carbon Bed | 0% | 0% | 0% | 1% | 1% | 1% |
| New Quencher | 5% | 7% | 3% | 4% | 2% | 2% |
| New Afterburner | 30% | 7% | 27% | 6% | 17% | 3% |
| New Reheater | 0% | 0% | 4% | 5% | 20% | 21% |
| HEWS DOM | 2% | 4% | 1% | 3% | 0% | 0% |
| Combination DOM | 0% | 1% | 0% | 0% | 0% | 0% |
| Feed Control | 23% | 26% | 18% | 20% | 4% | 8% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% |

**Exhibit ADD-5 (continued)**

**PERCENT OF TOTAL NEW COMPLIANCE COSTS BY CONTROL MEASURE (Before Consolidation)**

| Control Measure | Floor (50%) | Floor (70%) | Final (50%) | Final (70%) | BTF-ACI (50%) | BTF-ACI (70%) |
|---|---|---|---|---|---|---|
| **Govt. On-Site Incinerators** | | | | | | |
| New Fabric Filters | 22% | 21% | 22% | 21% | 22% | 21% |
| New Carbon Injection | 0% | 0% | 0% | 0% | 32% | 31% |
| New Quencher | 0% | 0% | 0% | 0% | 0% | 2% |
| New Afterburner | 6% | 7% | 6% | 7% | 4% | 4% |
| New Reheater | 0% | 0% | 0% | 0% | 12% | 13% |
| IWS DOM | 8% | 9% | 8% | 9% | 5% | 6% |
| Combination DOM | 2% | 2% | 2% | 2% | 1% | 1% |
| Feed Control | 62% | 61% | 62% | 61% | 24% | 22% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% |

**Exhibit ADD-6**

**TOTAL ANNUAL COMPLIANCE COSTS (millions)**
**(Assuming No Market Adjustments)**

| MACT Options | Cement Kilns | LWA Kilns | Commercial Incinerators | Private On-Site Incinerators | Government On-Site Incinerators | TOTAL |
|---|---|---|---|---|---|---|
| Floor (50%) | $22 | $3 | $7 | $33 | $4 | $69 |
| Floor (70%) | $15 | $2 | $6 | $28 | $4 | $55 |
| Final (50%) | $24 | $3 | $7 | $37 | $4 | $75 |
| Final (70%) | $17 | $3 | $6 | $32 | $4 | $63 |
| BTF-ACI (50%) | $33 | $5 | $10 | $59 | $24 | $130 |
| BTF-ACI (70%) | $25 | $4 | $9 | $54 | $24 | $116 |

Notes:
1. Estimates taken from model exhibit, "Total Annual Compliance Costs (millions) (Assuming No Market Exit)."
2. Costs of PM CEMs not included.
3. Estimates assume that all facilities comply. Facilities non-viable in the baseline are included.
4. Totals may not round due to rounding.

**Exhibit ADD-7**

**TOTAL ANNUAL COMPLIANCE COSTS (millions)**
**(Excludes Baseline Non-Viable, No System Consolidations or Market Exits)**

| MACT Options | Cement Kilns | LWA Kilns | Commercial Incinerators | Private On-Site Incinerators | Government On-Site Incinerators | TOTAL |
|---|---|---|---|---|---|---|
| Floor - 50% | $22 | $3 | $6 | $29 | $4 | **$ 63** |
| Floor - 70% | $15 | $2 | $5 | $24 | $4 | **$ 50** |
| Final - 50% | $24 | $3 | $6 | $30 | $4 | **$ 67** |
| Final - 70% | $17 | $3 | $5 | $25 | $4 | **$ 63** |
| BTF-ACI - 50% | $33 | $5 | $9 | $51 | $24 | **$130** |
| BTF-ACI - 70% | $25 | $4 | $8 | $46 | $24 | **$107** |

Notes:
1. Estimates adjusted from costs presented in model exhibit, "Total Annual Compliance Costs (millions) (Assuming No Market Exit)" by subtracting compliance costs of systems non-viable in the baseline.
2. Costs of PM CEMs not included.
3. Totals may not round due to rounding.

**Exhibit ADD-8**

**TOTAL ANNUAL PRE-TAX COMPLIANCE COSTS (millions)**
**AFTER COMBUSTION SYSTEM CONSOLIDATIONS**

| MACT Options | Cement Kilns | LWA Kilns | Commercial Incinerators | Private On-Site Incinerators | Government On-Site Incinerators | TOTAL |
|---|---|---|---|---|---|---|
| Floor (50%) | $22 | $3 | $6 | $22 | $4 | $57-$58 |
| Floor (70%) | $15 | $2 | $5 | $18 | $4 | $44 |
| Final (50%) | $24 | $3 | $6 | $23-$24 | $4 | $61 |
| Final (70%) | $17 | $3 | $5 | $20 | $4 | $50 |
| BTF-ACI (50%) | $33 | $5 | $9 | $41-$44 | $24 | $111-$114 |
| BTF-ACI (70%) | $25 | $4 | $8 | $37-$40 | $24 | $98-$101 |

Notes:

1. Costs for PM CEMs not included. Ranges reflect differences across 25% and 75% price pass-through scenarios.
2. Compliance costs after consolidation include the costs for those systems that will continue to burn waste, as well as the shipping and disposal costs (after the assumed price increase) for on-site incinerators that decide to stop burning wastes on-site. Other types of combustion systems that stop burning wastes do not incur compliance costs and therefore are excluded.
3. Because compliance costs are tax-deductible, the portion of pre-tax costs borne by the firm would be between 70 and 80 percent of the values shown above, depending on the specific firm's marginal tax bracket.
4. "Consolidation" allows for non-viable combustion systems, other than government on-site incinerators, to consolidate waste flows with other systems at the same facility, or to exit the waste burning market. As a result, the number of combustion systems incurring compliance costs is reduced. Government facilities are not included in the consolidation analysis because these facilities are not expected to close in response to the Hazardous Waste Combustion MACT standards (the costs for government on-site incinerators reported above are the same as those in the exhibit, "Total Annual Compliance Costs (Assuming no Market Exit)").
5. Totals may not add due to rounding.

**Exhibit ADD-9**

**SUMMARY OF SOCIAL COST ESTIMATES**
**(millions of 1996 dollars)**

| | Best Estimate | Upper Bound |
|---|---|---|
| Floor | $44-$50 | $69 |
| Final MACT | $50-$63 | $75 |
| BTF-ACI | $98-$107 | $130 |

Notes:
1. Cost ranges for best estimates reflect different combustion price elasticities (one scenario assumes that 25 percent of compliance costs can be passed through to generators/fuel blenders; the other scenario assumes 75 percent).
2. PM CEM costs not included.
3. Upper bound estimates assume that all facilities, including those nonviable in the baseline, continue to operate at current output levels and comply with the standards, passing 100% of the compliance costs to hazardous waste generators.
4. Costs for upper bound estimates reflect engineering design levels of 50%. Costs for best estimates reflect engineering design levels of 70%.
5. Government administrative costs of $300,000 annually are included in the social cost estimates. In order to simplify the analysis, we assume that government costs do not vary across MACT options or market adjustment scenarios.

**Exhibit ADD-10**

**SUMMARY OF FACILITY MARKET EXIT IMPACTS**
**(Short-Term)**

| | Facility Market Exits by Combustion Sectors | | | |
|---|---|---|---|---|
| | **Cement Kilns** | **LWAKs** | **Commercial Incinerators** | **Private On-site Incinerators** |
| **Baseline** | 0 (0%) | 0 (0%) | 3 (13%) | 26 (24%) |
| Floor (50%) | 0 (0%) | 0 (0%) | 0 (0%) | 16 (15%) |
| Floor (70%) | 0 (0%) | 0 (0%) | 0 (0%) | 16 (15%) |
| Final (50%) | 0 (0%) | 0 (0%) | 0 (0%) | 16 (15%) |
| Final (70%) | 0 (0%) | 0 (0%) | 0 (0%) | 16 (15%) |
| BTF-ACI (50%) | 0 (0%) | 0 (0%) | 0 (0%) | 16-20 (15%-18%) |
| BTF-ACI (70%) | 0 (0%) | 0 (0%) | 0 (0%) | 16-20 (15%-18%) |

Notes:
1. Market exit estimates taken from model exhibits,"Number of Combustion Facilities Likely to Stop Burning Hazardous Waste in the Short Term" and "Percentage of Facilities Likely to Stop Burning Waste in the Short Term" (without PM CEM costs).
2. Ranges reflect differences across 25% and 75% price pass-through scenarios.
3. For the MACT options, market exit estimates are incremental and include only those facilities likely to stop burning as a direct result of the Hazardous Waste MACT standards.
4. Government on-site incinerators are not expected to exit as a result of the Hazardous Waste Combustion MACT standards and therefore are not included in the market exit analysis.
5. Facility market exits only include those facilities at which all systems stop burning waste.
6. Numbers in parentheses indicate the percentage of facilities in a given sector that will exit the market.

**Exhibit ADD-11**

**SUMMARY OF FACILITY MARKET EXIT IMPACTS**
**(Long-Term)**

| | Facility Market Exits by Combustion Sectors | | | |
|---|---|---|---|---|
| | **Cement Kilns** | **LWAKs** | **Commercial Incinerators** | **Private On-site Incinerators** |
| **Baseline** | 0 (0%) | 0 (0%) | 3 (13%) | 42 (38%) |
| Floor (50%) | 1 (6%) | 0 (0%) | 0 (0%) | 13 (12%) |
| Floor (70%) | 0-1 (0%-6%) | 0 (0%) | 0 (0%) | 13 (12%) |
| Final (50%) | 1-2 (6%-11%) | 0 (0%) | 0 (0%) | 13 (12%) |
| Final (70%) | 0-1 (0%-6%) | 0 (0%) | 0 (0%) | 13 (12%) |
| BTF-ACI (50%) | 0-2 (0%-11%) | 0 (0%) | 0 (0%) | 10-16 (9%-15%) |
| BTF-ACI (70%) | 0-1 (0%-6%) | 0 (0%) | 0 (0%) | 10-16 (9%-15%) |

Notes:
1. Market exit estimates taken from model exhibits, "Number of Combustion Facilities Likely to Stop Burning Hazardous Waste in the Long Term" and "Percentage of Facilities Likely to Stop Burning Waste in the Long Term" (without PM CEM costs).
2. Ranges reflect differences across 25% and 75% price pass-through scenarios.
3. For the MACT options, market exit estimates are incremental and include only those facilities likely to stop burning as a direct result of the Hazardous Waste MACT standards.
4. Government on-site incinerators are not expected to exit as a result of the Hazardous Waste Combustion MACT standards and therefore are not included in the market exit analysis.
5. Facility market exits only include those facilities at which all systems stop burning waste.
6. Numbers in parentheses indicate the percentage of facilities in a given sector that will exit the market.

Note: Facility market exits for the final standards, and both options are incremental to the baseline.

**Exhibit ADD-12**

**SUMMARY OF QUANTITY OF HAZARDOUS WASTE THAT COULD BE REALLOCATED IN THE SHORT AND LONG TERM**

| MACT Option | Quantity of Hazardous Waste by Combustion Sector (tons) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cement Kilns | | LWAKs | | Commercial Incinerators | | Private On-site Incinerators | | TOTAL | | % of All BRS Combusted Hazardous Waste | |
| | Short Term | Long Term | Short Term | Long Term | Short Term | Long Term | Short Term | Long Term | Short Term | Long Term | Short Term | Long Term |
| Baseline | 0 | 0 | 0 | 0 | 3,170 | 3,170 | 45,770 | 97,760 | 48,940 | 100,930 | 1 | 3 |
| Floor (50%) | 0 | 11,530 | 0 | 0 | 0 | 0 | 440 | 13,570 | 440 | 25,100 | 0 | 1 |
| Floor (70%) | 0 | 0-11,530 | 0 | 0 | 0 | 0 | 440 | 13,570 | 440 | 13,570-25,100 | 0 | 0-1 |
| Final (50%) | 0 | 11,530-28,490 | 0 | 0 | 0 | 0 | 440 | 13,570 | 440 | 25,100-42,060 | 0 | 1 |
| Final (70%) | 0 | 0-11,530 | 0 | 0 | 0 | 0 | 440 | 13,570 | 440 | 13,570-25,100 | 0 | 0-1 |
| BTF-ACI (50%) | 0 | 0-28,490 | 0 | 0-7,380 | 0 | 0 | 0-5,270 | 8,510-25,450 | 0-5,270 | 8,510-61,320 | 0 | 0-2 |
| BTF-ACI (70%) | 0 | 0-16,960 | 0 | 0-2,730 | 0 | 0 | 440-5,270 | 8,510-25,450 | 440-5,270 | 8,510-45,140 | 0 | 0-1 |

Notes:
1. Estimates taken from model exhibits, "Quantity of Hazardous Waste that could be Diverted in the Short Term" and "Quantity of Hazardous Waste that could be Diverted in the Long Term" (PM CEM costs not included).
2. Ranges reflect differences across 25% and 75% price pass-through scenarios.
3. Combusted hazardous waste reported to BRS in 1995 excluding tonnage burned in on-site boilers: 3,300,000 tons.
4. These figures do not include waste diverted from systems that consolidate waste into other systems at the same facility.
5. Tons diverted are incremental to that resulting from consolidation and market exit likely to occur in the baseline (i.e., without the MACT standards).

Note: A portion of the waste reallocation quantity presented here may be addressed through waste minimization.

**Exhibit ADD-13**

**SUMMARY OF ESTIMATED EMPLOYMENT DISLOCATIONS**

| MACT Option | Combustion Sectors | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cement Kilns | | LWAKs | | Commercial Incinerators | | Private On-site Incinerators | | TOTAL | |
| | Low End | High End | Low End | High End | Low End | High End | Low End | High End | Low End | High End |
| Baseline | 0 | 0 | 0 | 0 | 80 | 80 | 182-345 | 182-408 | 262-425 | 262-488 |
| Floor (50%) | 0-21 | 0-21 | 0 | 0 | 0 | 0 | 98-131 | 116-231 | 119-131 | 137-231 |
| Floor (70%) | 0-21 | 0-21 | 0 | 0 | 0 | 0 | 98-131 | 116-231 | 98-131 | 116-231 |
| Final (50%) | 0-42 | 0-42 | 0 | 0 | 0 | 0 | 98-131 | 116-231 | 119-140 | 137-231 |
| Final (70%) | 0-21 | 0-21 | 0 | 0 | 0 | 0 | 98-131 | 116-231 | 98-131 | 116-231 |
| BTF-ACI (50%) | 0-42 | 0-42 | 0 | 0-5 | 0 | 0 | 90-139 | 108-252 | 90-148 | 111-252 |
| BTF-ACI (70%) | 0-21 | 0-21 | 0 | 0-3 | 0 | 0 | 90-139 | 108-252 | 90-139 | 108-252 |

Notes:

1. Estimates taken from model exhibits, “Estimated Long-Term Employment Losses at Combustion Systems” and "Estimated Short-Term Employment Losses at Combustion Systems" (without PM CEM costs).
2. Low-end estimates include employment losses associated only with those systems located at facilities where all systems stop burning. High-end estimates reflect all employment losses, including those associated with closing systems located at facilities where at least one system remains open. The low-end estimate assumes that employees associated with closing systems will be reassigned within a facility where other remaining systems are still burning.
3. Ranges reflect differences across 25% and 75% price pass-through scenarios.
4. Employment loss estimates are incremental, or directly attributable to the Hazardous Waste Combustion MACT standards.
5. Employment impacts are national estimates and are based on primary impacts only. They ignore any secondary spill-over effects.
6. Numbers between this exhibit and the ones listed above may not add exactly due to rounding.

**Exhibit ADD-14**

**SUMMARY OF ESTIMATED EMPLOYMENT GAINS**

| MACT Option | Labor Within Pollution Control Equipment Sector | Labor within Hazardous Waste Combustion Sectors | | TOTAL |
|---|---|---|---|---|
| | | O&M | Permitting | |
| Floor (50%) | 136-137 | 156-157 | 7 | 300-302 |
| Floor (70%) | 104 | 130 | 7 | 242 |
| Final (50%) | 146-147 | 175-176 | 7 | 329-331 |
| Final (70%) | 114 | 149 | 7 | 270 |
| BTF-ACI (50%) | 238-246 | 353-369 | 8 | 600-623 |
| BTF-ACI (70%) | 202-209 | 308-322 | 8 | 518-538 |

Notes:
1. Estimates taken from model exhibits, "Estimated Employment Increases Associated with Compliance Requirements" (PM CEM not costs included).
2. Ranges reflect differences across 25% and 75% price pass-through scenarios.
3. Estimates are sensitive to a number of assumptions, including the wage rates associated with compliance requirements and the percent of revenues generated due to each of the compliance requirements.
4. Estimates are national and based on primary employment impacts only, ignoring any secondary spill-over effects. Therefore, they do not account for job displacement across sectors as investment funds are diverted from other areas of the larger economy and should not be interpreted as net gains.
5. Estimates are based on long-term annual averages because these provide an upper-bound estimate of primary employment losses and gains associated with the rule.
6. Numbers between this exhibit and the one listed above may not add exactly due to rounding.

**Exhibit ADD-15**

**WEIGHTED AVERAGE COMBUSTION PRICE PER TON AND INCREASE IN PRICES DUE TO ASSUMED PRICE PASS THROUGH**

| MACT Options | Cement Kilns | LWA Kilns | Commercial Incinerators | On-Site Incinerators |
|---|---|---|---|---|
| Current Weighted Average Price | $172 | $136 | $689 | $729 |
| Increase in price due to compliance costs passed through | | | | |
| Floor (50%) | $5-$15 | $5-$15 | $4-$13 | $5-$14 |
| Floor (70%) | $3-$10 | $3-$10 | $3-$9 | $3-$9 |
| Final (50%) | $5-$15 | $5-$15 | $4-$13 | $5-$14 |
| Final (70%) | $4-$11 | $4-$11 | $3-$10 | $3-$10 |
| BTF-ACI (50%) | $11-$34 | $11-$34 | $8-$25 | $9-$28 |
| BTF-ACI (70%) | $8-$25 | $8-$25 | $7-$20 | $7-$22 |

Notes:
1. Estimate taken from model exhibit, "Weighted Average Combustion Price Per Ton and Increase in Prices Due to Assumed Price Pass Through."
2. Ranges reflect 25% and 75% price pass-through scenarios.
3. Compliance costs do not include PM CEM costs.
4. Median compliance costs per ton exclude systems currently not burning hazardous waste.
5. The commercial sector with the lowest total cost per ton (baseline + compliance cost) drives the assumed increase in combustion prices of waste categories managed by that sector.
6. Prices for on-site incinerators reflect the cost per ton of off-site treatment that generators avoid by burning the waste on-site.
7. Weighted average price per ton = (solids percentage of total waste burned in each sector x solids price) + (liquids percentage of total waste burned in each sector x liquids price) + (sludges percentage of total waste burned in each sector x sludges price).

**Exhibit ADD-16**

**BENEFITS SUMMARY: BASELINE TO MACT FLOOR**

| Type of Benefit | Reduction in Number of Cases per Year | Annual Undiscounted Value (1996 $ millions) |
|---|---|---|
| Human Health Benefits | | |
| Cancer premature deaths avoided | 0.12<br>(0.09 - 0.25) | $ 0.67<br>($0.06 - $4.0) |
| PM premature deaths avoided | 1.5<br>1.5 - 4.1 | $ 8.4<br>($1.05 - $65) |
| PM-related disease avoided | | $ 8.8 |
| hospital admissions | 6 | $ 0.05 |
| chronic bronchitis | 25 | $ 7.76 |
| respiratory conditions | 224 | $ 0.00 |
| work loss days/ MRAD | 19,766 | $ 1.00 |
| Recreational anglers potentially at risk for having offspring with developmental abnormalities | 0 | $ 0.00 |
| Children age 0-5 with blood lead > 10$\mu$g/dL | 7 | -- |
| **Total Annual Monetized Benefits** | | **$ 17.89<br>($9.93 - $77.98)** |

Notes:
1. The average value of a statistical life is $5.6 million, with a low-end estimate of $0.7 million, and a high-end estimate of $15.9 million.
2. Benefits associated with changes in children's blood lead levels are not monetized.
3. We use cost of illness approach for valuing noncancer health effects. This method tends to understate the benefits, because it does not account for some indirect costs (*i.e.*, pain and suffering of the affected individuals).
4. The best estimate (which is also the low-end estimate) for the PM-related cancer mortality uses the long-term PM concentration-response (CR) function from Pope *et al.* (1995) because EPA's Science Advisory Board, Health and Ecological Effects Subcommittee (HEES) recommends using this CR function.
5. Valuation of cancer mortality:
   - lowest estimate reflects lower bound of 90% confidence interval & VSL = $0.7 million.
   - highest estimate reflects upper bound of 90% confidence interval & VSL = $15.9 million.
   - best estimate reflects central estimate & VSL = $5.6 million.
6. Valuation of PM-related mortality:
   - low-end estimate reflects long-term PM CR function & VSL = $0.7 million.
   - high-end estimate reflects short-term PM2.5 CR function & VSL= $15.6 million
   - best estimate reflects long-term PM CR function & VSL = $5.6 million.

**Exhibit ADD-17**

**BENEFITS SUMMARY: BASELINE TO RECOMMENDED MACT (FINAL STANDARDS)**

| Type of Benefit | Reduction in Number of Cases per Year | Annual Undiscounted Value (1996 $ millions) |
|---|---|---|
| Human Health Benefits | | |
| Cancer premature deaths avoided | 0.36<br>(0.19 - 0.62) | $ 2.02<br>($0.13 - $9.9) |
| PM premature deaths avoided | 1.5<br>1.5 - 4.1 | $ 8.4<br>($1.05 - $65) |
| PM-related disease avoided | | $ 8.8 |
| hospital admissions | 6 | $ 0.05 |
| chronic bronchitis | 25 | $ 7.76 |
| respiratory conditions | 224 | $ 0.00 |
| work loss days/ MRAD | 19,767 | $ 1.00 |
| Recreational anglers potentially at risk for having offspring with developmental abnormalities | 0 | $0.00 |
| Children age 0-5 with blood lead > 10$\mu$g/dL | 7 | -- |
| **Total Annual Monetized Benefits** | | **$19.24<br>($10.00 - $83.87)** |

Notes:

1. The average value of a statistical life is $5.6 million, with a low-end estimate of $0.7 million, and a high-end estimate of $15.9 million.
2. Benefits associated with changes in children's blood lead levels are not monetized.
3. We use cost of illness approach for valuing noncancer health effects. This method tends to understate the benefits, because it does not account for some indirect costs (*i.e.*, pain and suffering of the affected individuals).
4. The best estimate (which is also the low-end estimate) for the PM-related cancer mortality uses the long-term PM concentration-response (CR) function from Pope *et al.* (1995) because EPA's Science Advisory Board, Health and Ecological Effects Subcommittee (HEES) recommends using this CR function.
5. Valuation of cancer mortality:
   - lowest estimate reflects lower bound of 90% confidence interval & VSL = $0.7 million.
   - highest estimate reflects upper bound of 90% confidence interval & VSL = $15.9 million.
   - best estimate reflects central estimate & VSL = $5.6 million.
6. Valuation of PM-related mortality:
   - low-end estimate reflects long-term PM CR function & VSL = $0.7 million.
   - high-end estimate reflects short-term PM2.5 CR function & VSL= $15.6 million
   - best estimate reflects long-term PM CR function & VSL = $5.6 million.

**Exhibit ADD-18**

**BENEFITS SUMMARY: BASELINE TO BTF-ACI MACT**

| Type of Benefit | Reduction in Number of Cases per Year | Annual Undiscounted Value (1996 $ millions) |
|---|---|---|
| Human Health Benefits | | |
| Cancer premature deaths avoided | 0.40<br>(0.22 - 0.66) | $ 2.2<br>($0.15 - $10.5) |
| PM premature deaths avoided | 1.5<br>1.5 - 4.1 | $ 8.4<br>($1.05 - $65) |
| PM-related disease avoided | | $ 8.8 |
| hospital admissions | 6 | $ 0.05 |
| chronic bronchitis | 25 | $ 7.76 |
| respiratory conditions | 224 | $ 0.00 |
| work loss days/ MRAD | 19,766 | $ 1.00 |
| Recreational anglers potentially at risk for having offspring with developmental abnormalities | 0 | $0.00 |
| Children age 0-5 with blood lead > 10$\mu$g/dL | 7 | -- |
| **Total Annual Monetized Benefits** | | **$ 19.46<br>($10.02 - $84.50)** |

Notes:

1. The average value of a statistical life is $5.6 million, with a low-end estimate of $0.7 million, and a high-end estimate of $15.9 million.
2. Benefits associated with changes in children's blood lead levels are not monetized.
3. We use cost of illness approach for valuing noncancer health effects. This method tends to understate the benefits, because it does not account for some indirect costs (*i.e.*, pain and suffering of the affected individuals).
4. The best estimate (which is also the low-end estimate) for the PM-related cancer mortality uses the long-term PM concentration-response (CR) function from Pope *et al.* (1995) because EPA's Science Advisory Board, Health and Ecological Effects Subcommittee (HEES) recommends using this CR function.
5. Valuation of cancer mortality:
   - lowest estimate reflects lower bound of 90% confidence interval & VSL = $0.7 million.
   - highest estimate reflects upper bound of 90% confidence interval & VSL = $15.9 million.
   - best estimate reflects central estimate & VSL = $5.6 million.
6. Valuation of PM-related mortality:
   - low-end estimate reflects long-term PM CR function & VSL = $0.7 million.
   - high-end estimate reflects short-term PM2.5 CR function & VSL= $15.6 million
   - best estimate reflects long-term PM CR function & VSL = $5.6 million.

**Exhibit ADD-19**

**BENEFITS SUMMARY: CASES AVOIDED BY SOURCE, BASELINE TO MACT STANDARD**

| LWAK/Human Health Benefits | Floor | Final | BTF-ACI |
|---|---|---|---|
| Cancer premature deaths avoided | 0.00 | 0.06 | 0.06 |
| PM premature deaths avoided | 0.0 - 0.01 | 0.0 - 0.01 | 0.0 - 0.01 |
| PM-related disease avoided | | | |
| hospital admissions | 0.0 | 0 | 0 |
| chronic bronchitis | 0.0 | 0 | 0 |
| respiratory conditions | 1 | 1 | 1 |
| work loss days/ MRAD | 37 | 37 | 37 |
| Recreational anglers potentially at risk for having offspring with developmental abnormalities | 0 | 0 | 0 |
| Children age 0-5 with blood lead > 10$\mu$g/dL | 0 | 0 | 0 |
| **Cement Kilns/Human Health Benefits** | **Floor** | **Final** | **BTF-ACI** |
| Cancer premature deaths avoided | 0.01 | 0.01 | 0.03 |
| PM premature deaths avoided | 0.0-0.02 | 0.0-0.02 | 0.0-0.02 |
| PM-related disease avoided | | | |
| hospital admissions | 0 | 0 | 0 |
| chronic bronchitis | 0 | 0 | 0 |
| respiratory conditions | 1 | 1 | 1 |
| work loss days/ MRAD | 71 | 71 | 71 |
| Recreational anglers potentially at risk for having offspring with developmental abnormalities | 0 | 0 | 0 |
| Children age 0-5 with blood lead > 10$\mu$g/dL | 0.4 | 0.4 | 0.4 |
| **All Incinerators/Human Health Benefits** | **Floor** | **Final** | **BTF-ACI** |
| Cancer premature deaths avoided | 0.11 | 0.29 | 0.31 |
| PM premature deaths avoided | 1.5 - 4.1 | 1.5 - 4.1 | 1.5 - 4.1 |
| PM-related disease avoided | | | |
| hospital admissions | 6 | 6 | 6 |
| chronic bronchitis | 25 | 25 | 25 |
| respiratory conditions | 222 | 222 | 222 |
| work loss days/ MRAD | 19,659 | 19,659 | 19,659 |
| Recreational anglers potentially at risk for having offspring with developmental abnormalities | 0 | 0 | 0 |
| Children age 0-5 with blood lead > 10$\mu$g/dL | 6.8 | 6.8 | 6.8 |

Notes:

1. Hospital admissions include all respiratory, congestive heart failure, and ischemic heart disease.
2. Respiratory conditions include acute bronchitis, lower, respiratory symptoms, and upper respiratory symptoms.
3. With avoided PM-related premature mortality, the range reflects application of two CR functions, Pope et al. 1995 and Schwartz et al. 1996.
4. With reduced cancer-related mortality, the range reflects a 90 percent confidence interval around the central estimate.

**Exhibit ADD-20**

**COST-EFFECTIVENESS RESULTS**

| Source | Options | Pollutant | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **TEQ, $1,000/g[1]** | **Hg, $1,000/Mg[2]** | **SVM, $1,000/Mg** | **LVM, $1,000/Mg** | **PM, $1,000/Mg** | **CO, $1,000/Mg** | **THC, $1,000/Mg** | **TCl, $1,000/Mg** |
| LWAK | Baseline to FLR | - | $27,144 | - | $1,271 | $6.7 | - | - | $0.7 |
| | FLR to FINAL | $ 25 | - | $532 | - | - | - | - | $1.1 |
| | FLR to BTF-ACI | $535 | $34,327 | $316 | - | - | - | - | $1.1 |
| INC | Baseline to FLR | $903 | $ 3,537 | $ 32 | $ 273 | $12.9 | $19.6 | $12.3 | $1.7 |
| | FLR to FINAL | $368 | - | - | - | - | - | - | - |
| | FLR to BTF-ACI | $827 | $ 22,768 | - | - | - | - | - | - |
| CK | Baseline to FLR | $898 | $6,274 | $ 67 | $4,234 | $ 7.1 | - | $ 3.3 | $3.6 |
| | FLR to FINAL | - | - | $502 | - | - | - | - | - |
| | FLR to BTF-ACI | $661 | $16,207 | $414 | - | - | - | - | - |

Note: This table includes pollutants where more than one option was under consideration. Cost-effectiveness is calculated at the 70% design level.
g = gram
Mg = megagram

DETAILED COST MODEL RESULTS

FOR THE:

***ADDENDUM***

TO THE:

# *ASSESSMENT OF THE POTENTIAL COSTS, BENEFITS, & OTHER IMPACTS OF THE HAZARDOUS WASTE COMBUSTION MACT STANDARDS: FINAL RULE*

July 23, 1999

# ADDENDUM

**TO THE:**

***ASSESSMENT OF THE POTENTIAL COSTS, BENEFITS, & OTHER IMPACTS OF THE HAZARDOUS WASTE COMBUSTION MACT STANDARDS: FINAL RULE***

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*** ADDENDUM plus DETAILED COST MODEL RESULTS ***

July 23, 1999