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FINAL DRAFT: July 1999

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

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LIST OF ACRONYMS

ACFM	Actual Cubic Feet per Minute
APCD	Air Pollution Control Device
ATTIC	Alternative Technology Information Center
BDAT	Best Demonstrated Available Technology
BEQ	Breakeven Quantity
BIF	Boiler or Industrial Furnace
BRS	Biennial Reporting System
BTF	Beyond the Floor
CAA	Clean Air Act
CEM	Continuous Emissions Monitoring
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CETRED	Combustion Emissions Technical Resources Document
CIF	Cost, Insurance and Freight
CFR	Code of Federal Regulations
CK	Cement Kiln
CKD	Cement Kiln Dust
CKRC	Cement Kiln Recycling Coalition
Cl_2	Chlorine
CO	Carbon Monoxide
CRF	Capital Recovery Factor
CWA	Clean Water Act
D/F	Dioxin/Furan
DOM	Design, Operation, and Maintenance
DPRA	DPRA, Incorporated
DRE	Destruction and Removal Efficiency
EER	Energy and Environmental Research Corporation
EPA	Environmental Protection Agency
ESPs	Electrostatic Precipitators
GDP	Gross Domestic Product
GPM	Gallons per Minute
HAP	Hazardous Air Pollutant
HBL	Health Benchmark Level
HC	Hydrocarbons
HCl	Hydrochloric Acid
Hg	Mercury
HQ	Hazard Quotient
HSWA	Hazardous and Solid Waste Amendments
HWC	Hazardous Waste Combustion
HWIR	Hazardous Waste Identification Rule
ICR	Information Collection Request

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LIST OF ACRONYMS
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IWS	Ionizing Wet Scrubbers
LDR	Land Disposal Restrictions
LVM	Low Volatile Metals
LWA	Lightweight Aggregate
LWAK	Lightweight Aggregate Kilns
MACT	Maximum Achievable Control Technology
MTEC	Maximum Theoretical Emissions Concentration
NACR	National Association of Chemical Recyclers
NHWCS	National Hazardous Waste Constituent Survey
NSPS	New Source Performance Standards
O&M	Operating and Maintenance
OAQPS	Office of Air Quality Planning and Standards
OMB	Office of Management and Budget
OSW	Office of Solid Waste
PCDD	Polychlorinated Dibenzo-P-Dioxins
PCDF	Polychlorinated Dibenzo Furans
PCI	Pollution Control Industries
PIC	Products of Incomplete Combustion
PM	Particulate Matter
POTW	Publicly Owned Treatment Work
PSPD	Permits and State Programs Division
RCRA	Resource Conservation and Recovery Act
RFA	Regulatory Flexibility Act
RIA	Regulatory Impact Assessment
SBA	Small Business Administration
SQB	Small Quantity Burner
SVM	Semi-Volatile Metals
TCl	Total Chlorine
TEQ	Dioxin/Furan Toxic Equivalents
THC	Total Hydrocarbons
UMRA	Unfunded Mandates Reform Act
VISITT	Vendor Information System for Innovative Treatment Technologies

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EXECUTIVE SUMMARY

OVERVIEW

In May of 1993, the Environmental Protection Agency (EPA) introduced a draft Waste Minimization and Combustion Strategy to reduce reliance on the combustion of hazardous waste and encourage reduced generation of these wastes. Among the key objectives of the strategy is the reduction of health and ecological risks posed by the combustion of hazardous waste. As part of this strategy, EPA developed more stringent MACT emissions standards for hazardous waste combustion facilities. These final MACT standards address a variety of air pollutants, including dioxins/furans, particulate matter, mercury, semi-volatile and low-volatility metals, and chlorine. In addition, emissions of carbon monoxide and hydrocarbons will be regulated as proxies for non-dioxin, non-furan toxic organic emissions. The rule establishes emission levels for commercial incinerators, waste-burning cement kilns and lightweight aggregate kilns (LWAKs), and on-site incinerators. The final rule is scheduled for promulgation in July 1999.

As part of this Rulemaking, EPA considered multiple MACT alternatives for limiting emissions of hazardous and non-hazardous air pollutants at combustion facilities. On April 19, 1996, the Agency proposed MACT standards for hazardous waste combustion facilities. To support this proposal, EPA conducted a Regulatory Impact Assessment (RIA) that examined and compared the costs and benefits of the proposed standards, along with eleven additional regulatory alternatives. The RIA and two Addendums to the RIA are available in the RCRA docket established for the proposed rule.

This economic assessment (the *Assessment)*, which replaces the earlier RIA, analyzes the costs of the rule and the impacts that these costs would have on waste burning behavior, and compares these costs to the benefits of the regulation. In this document, we analyze the impacts of the final rule (referred to as the Recommended option in later chapters of the *Assessment*), as well as the MACT floor and a more stringent "beyond the floor" (BTF) MACT option for dioxins/furans and mercury based on activated carbon injection technology (the "BTF-ACI" MACT option). Exhibit ES-1 lists the emission standards by pollutant and combustion source category for the three MACT alternatives analyzed in this document.

The *Assessment* also seeks to satisfy OMB's requirements for regulatory review under Executive Order 12866, which applies to any significant regulatory action. This document also fulfills the requirements of the Regulatory Flexibility Act, as amended by the Small Business Regulatory Enforcement Fairness Act of 1996; Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations"; the Unfunded Mandates Reform Act of 1995; and

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Exhibit ES-1

REGULATORY ALTERNATIVES FOR EXISTING SOURCES

MACT	Source Category	Chlorinated D/F (ng TEQ/dscm)	PM	Hg (μg/dscm)	SVM (μg/dscm)	LVM (μg/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 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 100 or	10 (◆) 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
Recommended MACT (Final Standards)	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 100 or	10 (◆) 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	150	100 or	20
BTF-ACI MACT	Incinerators	**0.2**	0.015 gr/dscf	**10**	240	97	77	100 or	10
	Cement Kilns	**0.2**	0.15 kg/Mg dry feed	**25**	240	56	130	100 or 100 or	10 (◆) 20 (◊)
	LWAKs	**0.2**	0.025 gr/dscf	**10**	250	110	150	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.
5. Across all regulatory alternatives, a DRE of 99.99% is required (99.9999% for sources burning dioxin-listed wastes) to control emissions of non-dioxin/furan organic HAPs.

(*) 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.

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Executive Order 12630, "Government Action and Interference with Constitutionally Protected Property Rights"; and Executive Order 13084, "Consultation and Coordination with Indian Tribal Governments."

SUMMARY OF FINDINGS

This *Assessment* provides estimates of the costs and benefits of EPA's final MACT standards for hazardous waste combustion facilities. The total social costs of the final rule are estimated at between $65 and $73 million, with an upper bound of $95 million. Approximately $300,000 of the social costs are attributed to government administrative costs. As the cost of waste-burning increases, the market will adjust. These market responses will take the form of higher combustion prices, decisions to stop burning hazardous waste (these primarily take place in the on-site incinerator and cement kiln sectors), reallocation of waste from systems that stop burning, and employment shifts. Overall, we find that many of the marginal facilities are likely to exit the market even in the absence of the combustion MACT standards. Promulgation of the MACT standards will accelerate and slightly increase the consolidation that is already taking place in the combustion industry.

Human health benefits, and to a lesser extent ecological improvements, are also expected to result from decreased emissions associated with the MACT standards. EPA's multi-pathway risk assessment suggests that both mortality and morbidity risk reductions will result from the MACT standards. For the final rule, the mortality risk reductions translate into approximately two avoided premature deaths per year. Morbidity risk reductions (on an annual basis) include a small number of avoided hospital admissions associated with respiratory and heart conditions; 20,000 avoided restricted activity days; 25 avoided cases of chronic bronchitis; and over 250,000 avoided asthma attacks. Reductions in lead and mercury emissions may also provide some additional health benefits to children.

The remainder of this section summarizes the central conclusions of the *Assessment*.

- **Compliance costs for kilns are higher on average than those for incinerators.** Under the final MACT standards, average annual costs for incinerators are approximately $300,000 per system, while average annual compliance costs are $800,000 for cement kilns and $600,000 for LWAKs.

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- **Government administrative costs are estimated at $300,000 per year.** These government costs are associated with administering and enforcing the final MACT standards and related MACT requirements (e.g., notice of intent to comply).

- **Total social costs of the final rule are between $65 and $73 million annually, and are not expected to exceed $95 million.** Total social costs include about $300,000 in government administrative costs. At the Floor, total social costs decrease by about 10 percent to between $57 and $66 million annually. The increase in total costs for the BTF-ACI are more dramatic: relative to the final rule, costs increase by about 90 percent to between $124 and $140 million annually.

- **For the final rule, between one and two cement kilns and between 7 and 16 on-site incinerators will stop burning waste entirely, rather than incur the rule's compliance costs.** Additional waste consolidation will occur at other facilities where wastes are consolidated into fewer combustion systems.

- **Market exit and waste consolidation activity is expected to result in between 23,000 and 54,000 tons of waste that will be reallocated from combustion systems that stop burning.** This quantity corresponds to between 1 and 2 percent of total combusted wastes. If waste burned at baseline nonviable systems (i.e., systems we expect will exit the market in the baseline regardless of the MACT standards) is included in this total, the estimate increases to about 160,000 tons, or about 5 percent of total combusted wastes. Under the BTF-ACI MACT option, the quantity of reallocated wastes (incremental to the baseline) increases to between 55,000 and 90,000 tons. Reallocated wastes may be sent to other combustion facilities that remain open because there is currently adequate capacity in all combustion sectors and geographic regions to absorb these shifts.

- **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, employment shifts will occur. At facilities that consolidate waste burning or that stop burning altogether, employment dislocations of between 100 and 300 full time equivalent jobs are expected. Over half of these dislocations occur in the on-site sector and the remainder occur at kilns. Employment dislocations increase by almost 20 percent when going from the Recommended option to the BTF-ACI option. Employment gains of approximately 100 full time equivalent jobs are expected in the pollution control industry and gains of approximately 150 full time equivalent jobs are

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expected at combustion facilities that continue waste burning. Gains nearly double from the Recommended to the BTF-ACI option.

- **Combustion prices will likely increase by about $15 per ton for kilns (6 percent price increase) and $12 per ton for incinerators (2 percent price increase).** As combustion facilities incur compliance costs of the MACT rule, they have an incentive to increase prices for combustion. Our evaluation of waste management alternatives suggests that combustion demand is relatively inelastic, which will enable combustion facilities to pass through a significant share of the compliance costs to their customers.

- **Human health benefits will result from the MACT standards.** The MACT standards are expected to result in reduction of the following adverse health effects on an annual basis: approximately two premature deaths, six hospital admissions associated with respiratory ailments and heart conditions, 25 cases of chronic bronchitis, over 250,000 asthma attacks, and nearly 20,000 days of work loss or restricted activity. These human health benefits are valued at $30 million per year.

- **Potential ecological improvements.** Thirty-eight square kilometers of water may experience a decrease in potential risks to ecosystems. For terrestrial areas, the amount of land that may experience reductions in risk ranges between 115 and 147 square kilometers.

- **Waste minimization.** While a variety of waste minimization alternatives are available for managing those hazardous waste streams that are currently combusted, the costs of these alternatives generally exceeds the cost of combustion. When the additional costs of compliance are taken into account, waste minimization alternatives still tend to exceed the higher combustion costs.

Across regulatory options, costs exceed monetized benefits more than two-fold. For both the final and floor MACT options, costs are about three times greater than monetized benefits. For the BTF-ACI option, costs are almost four times greater than monetized benefits. However, the 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 to 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 and regulatory concerns.

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ENGINEERING AND COMPLIANCE COST ANALYSIS

We use engineering cost models based on system-specific parameters to estimate compliance costs for the MACT standards for hazardous waste combustion facilities. Under this approach, individual combustion systems are assigned air pollution control measures and corresponding cost estimates using engineering parameters such as gas flow rates, waste feed composition, and combustion chamber temperature. From this assignment of pollution control measures, we derive the capital, and fixed and variable operating costs that each combustion system in the economic analysis would incur in complying with the standards. The estimates of compliance costs also include the costs associated with permitting, testing and record keeping and reporting requirements. The compliance cost analysis is summarized in Exhibit ES-2.

- Cement kilns consistently have the highest average system compliance costs across MACT options. Average compliance costs for cement kilns under the final rule are approximately $800,000 per system. At the Floor, average costs for cement kilns are $670,000. Costs increase, on average, to over $1 million per cement kiln under the BTF-ACI option.

- Average system costs tend to be lower for incinerators than for kilns, although under the BTF-ACI option, costs escalate significantly for government incinerators (to $1 million per system), and are comparable to cement kiln costs. Under the final MACT standards, average system costs are $290,000 for commercial incinerators, $270,000 for privately-owned on-site systems, and $190,000 for government incinerators.

- Government administrative costs, borne primarily by EPA offices and state environmental agencies, total $300,000 per year.

Compliance costs vary significantly across individual combustion systems, due to the different air pollution controls the systems currently have in place and due to the differences in combustion systems and waste types handled. For the final MACT standards, the variation in compliance costs is summarized below.

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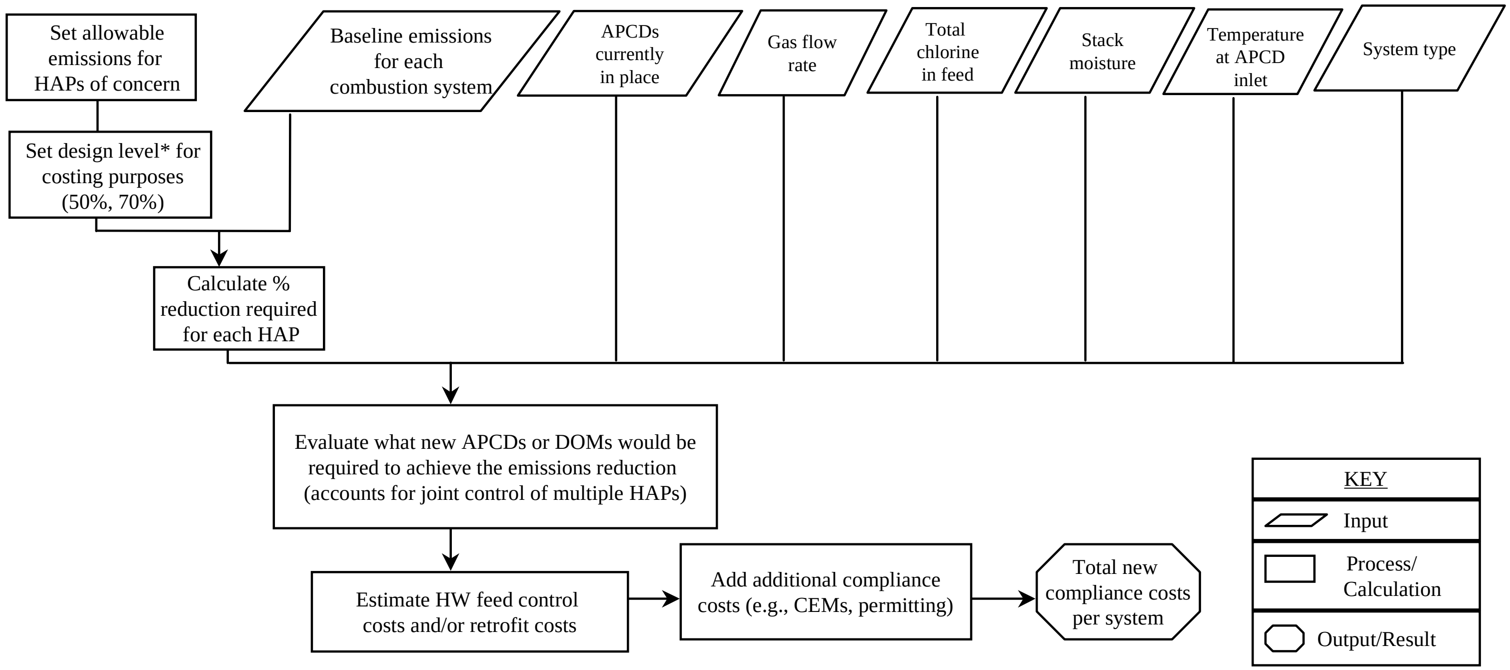
Exhibit ES-2

OVERVIEW OF SYSTEM-SPECIFIC COMPLIANCE COST ANALYSIS



NOTES

1. Setting of allowable emissions for hazardous air pollutants (HAPs) based on MACT analysis using Trial Burn Reports. Baseline emissions also determined using Trial Burn Reports (measured at the stack) and imputation. See U.S. EPA, *Draft Technical Support Document for HWC MACT Standards, Volume I: HWC Emissions Database*, March 1998.
2. All other data inputs from U.S. EPA, *Draft Technical Support Document for HWC MACT Standards, Volume I: HWC Emissions Database*, March 1998.
3. A DOM is a design, operation, or maintenance change to an existing Air Pollution Control Device (APCD). CEMs are continuous emission monitoring systems.

* The design-adjusted MACT emission requirement differs from the MACT standard by a factor that incorporates a design safety factor (50% or 70%). Engineering design levels are described more fully in Chapter 4.

- **Cement Kilns:** Annual system compliance costs range from $0 to $3.6 million, with an average cost of $800,000 per system.

- **Commercial Incinerators:** Annual system compliance costs range from $14,000 to $880,000, with an average cost of $290,000 per system.

- **LWAKs:** Annual system compliance costs range from $450,000 to $850,000, with an average cost of $640,000 per system.

- **Private On-Site Incinerators:** Annual system compliance costs range from $7,000 to $870,000, with an average cost of $270,000 per system.

- **Government On-Site Incinerators:** Annual system compliance costs range from $0 to $790,000, with an average cost of $190,000 per system.

SOCIAL COST AND ECONOMIC IMPACT ANALYSIS

Total social costs of the MACT standards include the value of resources used to comply with the standards by the private sector, the value of resources used to administer the regulation by the government, and the value of output lost due to shifts of resources to less productive uses. As explained in more detail in Chapter 5, we estimate the value of the private sector resource shifts using a simplified approach designed to bracket the welfare loss attributable to the MACT standards. The high end of the economic welfare loss range is based on a static market scenario in which all combustion facilities, excluding those we expect will exit the market in the baseline, continue to operate at current output levels and comply with the MACT standards. The low end of the economic welfare loss range is based on a dynamic market scenario and uses a lower output equilibrium estimated by modeling market adjustments in response to the increased costs associated with the rule (i.e., waste consolidation, market exits and price increases are incorporated in the model). We also develop a conservative upper bound estimate assuming that all facilities, including those we project will exit the market in the baseline, continue to operate at current output levels and comply with the MACT standards.

We develop social cost estimates by adding government cost estimates to the economic welfare loss estimates. (We estimate the value of government costs using results from an EPA Information Collection Request.) As shown in Exhibit ES-3, total annual social costs of the final rule are between $65 and $73 million, with an upper bound of $95 million. Almost half of the social costs are attributed to on-site incinerators; this is due to the large number of sources in this combustion sector. Total social costs increase by almost 90 percent to between $124 and $140 million for the BTF-ACI option due to the costly carbon injection and carbon bed equipment that is required to meet the BTF mercury levels. At the MACT Floor, total social costs of the rule are between $57 and $66 million, about 10 percent less than social costs of the Recommended option.

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Total incremental government costs represent less than 1 percent of total social costs across all MACT options.

Exhibit ES-3 SUMMARY OF SOCIAL COST ESTIMATES (millions of 1996 dollars)		
	Best Estimate	**Upper Bound**
Floor	$57 - $66	$90
Recommended	$65 - $73	$95
BTF-ACI	$124 - $140	$166

NOTES:
1. 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.
2. Because the government costs are small (less than 1 percent) relative to the compliance costs for affected sources, the social cost estimates do not change relative to compliance costs.
3. Cost ranges for best estimates reflect different combustion price elasticities and market adjustments (the static scenario assumes that 100 percent of compliance costs can be passed through to generators/fuel blenders; the dynamic scenario assumes 75 percent).
4. PM CEM costs not included.
5. 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/fuel blenders.
6. Costs for upper bound estimates reflect engineering design levels of 50%. Costs for best estimates reflect engineering design levels of 70%.

BENEFITS ASSESSMENT

Benefits from the rule include avoidance of premature mortality and a variety of other adverse human health effects. In addition, improvements to aquatic and terrestrial ecosystems may result from reduced emissions associated with the MACT standards. Finally, the MACT standards may also increase waste minimization practices by making these alternatives less expensive relative to combustion.

The basis for the benefits assessment is a multi-pathway risk assessment that estimates risks in the baseline and for the three final MACT options. A multi-pathway analysis that models both inhalation and ingestion pathways is used to estimate human health risks, whereas a less detailed screening-level analysis is used to identify the potential for ecological risks.

The risk modeling suggests that human health benefits will result from the MACT standards. Risk reductions are expected to result in approximately two fewer premature deaths per year.

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Particulate matter accounts for most of the avoided premature deaths; reductions in carcinogenic pollutants only account for the remainder of the avoided premature deaths. Reductions in particulate matter also contribute to many avoided nonfatal health effects. In particular, under the final rule, hospital admissions for heart and respiratory ailments are expected to be reduced by approximately six cases per year. In addition, over 250,000 asthma attacks, 25 cases of chronic bronchitis, and nearly 20,000 days of work loss or restricted activity will be avoided annually due to the MACT standards. Reductions in lead and mercury emissions may also provide some additional health benefits to children.

Ecological improvements may also result from the MACT standards. Thirty-eight square kilometers of water may experience a decrease in potential risks to ecosystems. For terrestrial areas, the amount of land that may experience reductions in risk ranges between 115 and 147 square kilometers.

To develop monetary values for the human health benefits, we use established economic valuation techniques for mortality and morbidity benefits. For mortality benefits, we apply the value of a statistical life (VSL) to the fatal risk reduction expected from the MACT standards. The VSL is based on an individual's willingness to pay (WTP) to reduce a risk of premature death. For morbidity benefits, we assign monetary values using a direct cost approach which focuses on the expenditures and opportunity costs averted by decreasing the occurrence of an illness or other health effect. While the WTP approach used for valuing the cancer risk reductions is conceptually superior to the direct cost approach, measurement difficulties, such as estimating the severity of various illnesses precludes us from using this approach. Applying these valuation techniques to the health benefit estimates yields a benefits value of about $30 million annually.

It is important to note that because certain sensitive sub-populations -- namely children, subsistence fishermen, and subsistence farmers -- who may face greater risks could not be enumerated in the risk assessment, the monetized benefit estimates do not include benefits to these individuals. We also do not include monetary estimates for the potential ecological improvements because we cannot translate the potential improvements into an end-point benefit measure, such as increased fish populations, for which a benefits transfer approach could assign monetary values. The monetized benefits, therefore, do not reflect the full spectrum of benefits expected from this rule. Any comparison of the costs with the benefits of the rule must account for this limitation.

OTHER REGULATORY ISSUES

Regulatory Flexibility Analysis

In general, the Combustion MACT standards will not have significant impacts on a substantial number of small entities. In particular, the direct impacts on small business combustion facilities and the indirect impacts on small business generators are minor. Only the indirect impacts

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on fuel blenders are notable; however, the absolute number of facilities affected is very small. Only six combustion facilities (about 3.5 percent) are classified as small businesses. With the exception of two facilities (both owned by a common parent company), compliance costs represent less than 1 percent of total sales for the combustion facilities. These two facilities are expected to incur costs associated with this final rule representing between 1 and 3 percent of total sales.

Environmental Justice Analysis

The HWC MACT Standards should not have any adverse environmental or health effects on minority populations and low-income populations. Any impacts the rule has on these populations are likely to be positive because the rule will potentially reduce emissions from combustion facilities near minority and low-income population groups. To assess whether the MACT Standards will have disproportionate effects on minority populations or low-income populations, we analyzed demographic data for areas nearby combustion facilities. The results from this analysis suggest that hazardous waste incinerators are not necessarily more likely to be located in areas with disproportionately high minority or low income populations. However, hazardous waste burning cement kilns are somewhat more likely to be located in areas where minority populations within one mile exceed county averages. Kilns are also more likely to be located in areas with low income populations. In addition, a small number of commercial hazardous waste incinerators located in highly urbanized areas are found to have disproportionately high concentrations of minorities and low-income populations within one and five mile radii. The reduced emission at these facilities due to the MACT Standards could represent environmental and health improvements for minorities and low-income populations in these areas.

Unfunded Federal Mandates

Executive Order 12875, "Enhancing the Intergovernmental Partnership" (October 26, 1993), calls on federal agencies to provide a statement supporting the need to issue any regulation containing an unfunded Federal mandate and describing prior consultation with representatives of affected state, local, and tribal governments. Signed into law on March 22, 1995, the Unfunded Mandates Reform Act (UMRA) supersedes Executive Order 12875, reiterating the previously established directives while also imposing additional requirements for federal agencies issuing any regulation containing an unfunded mandate. Federal rules are exempt from the UMRA requirements if the rule implements requirements specifically set forth in law, or, compliance with the rule is voluntary for state and local governmental entities.

Based on the criteria set forth by the UMRA and Executive Order 12875, the final HWC MACT rule does not contain a significant unfunded Federal mandate. Because the Agency is issuing today's final HWC MACT standards under the joint statutory authority of the Clean Air Act (CAA) and the Resource Conservation and Recovery Act (RCRA), the rule should be exempt from all

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relevant requirements of the UMRA. In addition, compliance with the rule is voluntary for non-federal governmental entities since state and local agencies choose whether or not to apply to EPA for the permitting authority necessary to implement the MACT standards.

Regulatory Takings

Executive Order 12630, "Government Actions and Interference with Constitutionally Protected Property Rights" (March 15, 1988), directs federal agencies to consider the private property takings implications of proposed regulation. Under the Fifth Amendment of the U.S. Constitution, the government may not take private property for public use without compensating the owner. Though the exact interpretation of this takings clause as applied to regulatory action is still subject to an ongoing debate, a framework for interpretation has been established by legal precedent through a series of prominent court cases.

Based on our review of relevant case law and mainstream legal interpretation, the final HWC MACT standards are not likely to result in any regulatory taking. Today's action will not require that private property be invaded or taken for public use. The rule also will not interfere with reasonable investor expectations because it does not ban hazardous waste combustion but merely authorizes operating parameters. Furthermore, these operating parameters and performance-based emissions standards originate in statutory authority established over the past twenty-eight years. The investment-backed expectations of anyone opening a hazardous waste combustion facility since then would include a recognition of the existence of impending regulatory requirements. Persons already engaged in combustion would have had more than eight years to adjust their expectations and to prepare for accommodation of the forthcoming regulation. As a result, no facility owner should be able to assert interference with reasonable investment expectations sufficient to support a taking.

Because the rule does not prohibit the burning of hazardous waste, it does not deny the facility owners all viable economic use of their property. Nor does the rule prevent owners from putting their property to other profitable uses should they decide to cease combustion in the face of the regulation. In the case of on-site incinerators, cement kilns, and LWAKs, the primary economic use of property comes from other activities not directly associated with hazardous waste combustion. Even if these facilities stop burning waste, they will still be able to manufacture their primary products, such as cement, lightweight aggregate, or chemicals. In terms of commercial incinerators, any facilities that may stop burning hazardous waste can still use their property for other industrial purposes.

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NOTE TO READERS:

This document does not contain the final standards and associated costs and benefits. We refer you to the Addendum to this document, also included in the EPA RCRA docket, for a copy of this document.

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INTRODUCTION AND REGULATORY OPTIONS — CHAPTER 1

BACKGROUND

In May 1993, the U.S. Environmental Protection Agency (EPA) introduced a draft Waste Minimization and Combustion Strategy designed to reduce reliance on the combustion of hazardous waste and encourage reduced generation of these wastes. Among the key objectives of the strategy is the reduction of the health and ecological risks posed by the combustion of hazardous waste. As part of this strategy, EPA is developing more stringent performance-based emissions standards based on the "maximum achievable control technology" (MACT) approach. These final MACT standards are being promulgated by EPA under Section 112 of the Clean Air Act, as amended (CAA).[1,2] Three categories of hazardous waste combustion facilities are subject to these revised standards:

- Hazardous waste incinerators, both commercial and on-site;
- Hazardous waste-burning cement kilns; and
- Hazardous waste-burning lightweight aggregate kilns.

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[1] Section 112 of the Clean Air Act requires EPA to promulgate MACT standards for major sources emitting hazardous air pollutants, including hazardous waste combustion facilities. While some hazardous waste combustion facilities may qualify as area sources, these sources must also be regulated under the MACT due to the Agency's finding that these sources present a potential threat of adverse effects to human health and the environment.

[2] In contrast to the proposed rule, this final rule eliminates the existing RCRA stack emissions national standards for hazardous waste combustion facilities because this would be duplicative. However, under the authority of RCRA's "Omnibus" provision (Section 3005(c)(3)), RCRA permit writers may still impose additional terms and conditions on a site-specific basis as may be necessary to protect human health and the environment.

After issuing several notices of data availability (NODA) and responding to peer review and public comments on MACT standards proposed in April 1996, EPA is issuing final standards for these facilities.

A Regulatory Impact Assessment (RIA) was prepared in November 1995 to support the analysis of various regulatory alternatives under consideration for the proposed rule (61 FR 17358). This *Assessment* reflects revisions to methodologies and assumptions employed in the RIA supporting the proposed rule. The revisions reflect public and peer review comments on the proposed rule, as well as refinements necessitated by changes in the rule. Below, we list the major revisions between the RIA at proposal and the *Assessment* for the final rule.

- **Improved benefits analysis.** We used results from an extensive multi-pathway risk assessment to develop human health and ecological benefit estimates. We determine the monetary value of the human health benefits using established economic valuation techniques.

- **Improved waste minimization analysis.** This document includes an expanded and significantly improved analysis of waste minimization alternatives. The refined analysis uses a more detailed decision framework for evaluating waste minimization investment decisions that captures the full inventory of costs, savings and revenues, including indirect, less tangible items typically omitted from waste minimization analysis, such as liability and corporate image.

- **Compliance costs more clearly distinguished from social costs.** We clarify the difference between compliance costs and social costs, and explain how the rule will likely affect producers and consumers. In Chapter 5, we describe the economic framework used for the social cost analysis and also explain how compliance costs are used as inputs for both the social cost analysis and the assessment of economic impacts.

- **Waste markets modeled to reflect segmentation across waste types.** The pricing approach used in this economic assessment assigns different prices to different types of wastes and uses actual data on waste characteristics to determine the type of waste burned at modeled combustion facilities.

- **Revised baseline and compliance costs.** Baseline and compliance costs were substantially revised. Instead of using a model plant approach for assigning compliance and baseline costs to modeled combustion facilities, costs for the final rulemaking have been estimated using combustion parameters specific to the actual combustion source, including gas flow rate, baseline emissions, APCDs currently in place, total chlorine in the feed, stack moisture and temperature at the APCD inlet.

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- **Data inputs updated to reflect most recent information.** The most recent available data were used in this analysis, including waste data from the 1995 BRS and supplemented with EPA's 1996 National Hazardous Waste Constituent Survey Database, plus 1996 and 1997 energy data from the Energy Information Administration and Portland Cement Association.

ANALYTICAL REQUIREMENTS

EPA's Office of Solid Waste prepared this *Assessment of the Potential Costs, Benefits, and Other Impacts of the Hazardous Waste Combustion MACT Standards*, (the *Assessment*) to evaluate the benefits and costs of the Hazardous Waste Combustion MACT standards, along with other economic, distributional, and equity impacts. This *Assessment* satisfies OMB's requirements for regulatory review under Executive Order 12866, which applies to any significant regulatory action. According to Executive Order 12866, the economic analysis should "provide information allowing decisionmakers to determine that:

- There is adequate information indicating the need for and consequences of the regulatory action;
- The potential benefits to society justify the potential costs, recognizing that not all benefits and costs can be described in monetary or even in quantitative terms, unless a statute requires another regulatory approach;
- The regulatory action will maximize net benefits to society (including potential economic, environmental, public health and safety, and other advantages; distributional impacts; and equity), unless a statute requires another regulatory approach;
- Where a statute requires a specific regulatory approach, the regulatory action will be the most cost-effective, including reliance on performance objectives to the extent feasible;
- Agency decisions are based on the best reasonably obtainable scientific, technical, economic, and other information."[3]

This document also fulfills the requirements of the Regulatory Flexibility Act, as amended by the Small Business Regulatory Enforcement Fairness Act of 1996; Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income

[3] Office of Management and Budget (OMB). January 1996. *Economic Analysis of Federal Regulations Under Executive Order 12866*, 1.

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Populations"; the Unfunded Mandates Reform Act of 1995; and Executive Order 12630, "Government Action and Interference with Constitutionally Protected Property Rights"; and Executive Order 13084, "Consultation and Coordination with Indian Tribal Governments."

NEED FOR REGULATORY ACTION

The Hazardous Waste Combustion MACT standards will reduce the level of hazardous air pollutants and other toxics currently emitted from combustion facilities. These pollutants include dioxins/furans, mercury, metals, particulate matter, chlorine gas, carbon monoxide, and hydrocarbons. As shown in Exhibit 1-1, carbon monoxide, particulate matter, and total chlorine are the pollutants with the highest total mass emission levels. With the exception of low volatility metals (LVMs) and chlorine, cement kilns emit the highest average levels of pollutants per combustion system.

While combustion facilities currently have some air pollution control devices in place, pollutants from combustion facilities still present both human health and ecological risks.[4] Human exposure to the combustion air toxics occurs both directly via inhalation of pollutants, as well as indirectly via ingestion of contaminated soil and food products. These exposures lead to cancer, respiratory diseases, and developmental abnormalities. A preliminary screening analysis also suggests that aquatic and terrestrial ecosystems may be at risk from these air pollutants.

Several combustion facilities have closed over the past several years and this trend may continue over the next few years, slightly reducing air pollution from hazardous waste combustion facilities. This trend in market consolidation should level off as supply comes into line with demand for hazardous waste combustion services and the market reaches equilibrium. Thus, EPA expects that the air pollution problem and the human health and ecological damages will continue to exist if MACT standards are not implemented.

The market and other private sector institutions have failed to correct the air pollution problem from hazardous waste combustion facilities for several reasons. First, because individuals not responsible for the air pollution bear the costs in human health and ecological damages, no incentive exists for combustion facilities to incur the additional costs for implementing pollution control measures. In this case, the private industry costs of combustion do not fully reflect the human health and environmental costs of hazardous waste combustion. This situation, referred to as an "environmental externality," represents a type of market failure discussed in OMB's Guidelines.[5] Therefore, a non-regulatory approach, such as educational outreach programs, would

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[4] The *Assessment* provides a more detailed description of the current control technologies installed at combustion facilities in Chapter 2.

[5] Office of Management and Budget (OMB). January 1996. *Economic Analysis of Federal Regulations Under Executive Order 12866,* 3-5.

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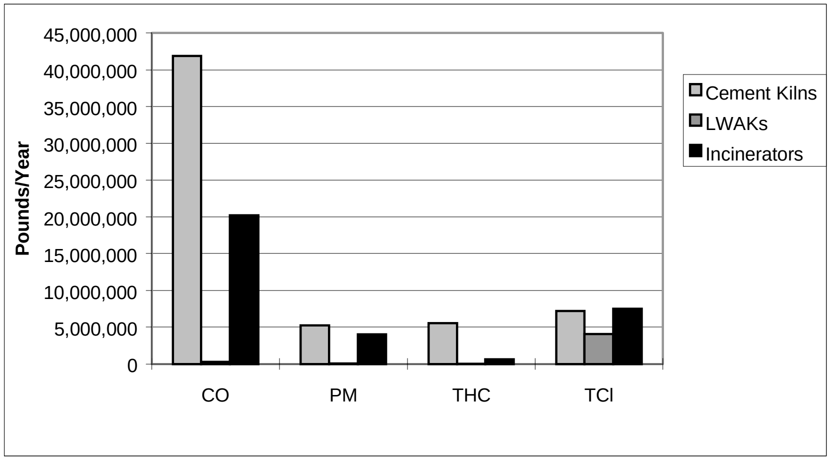
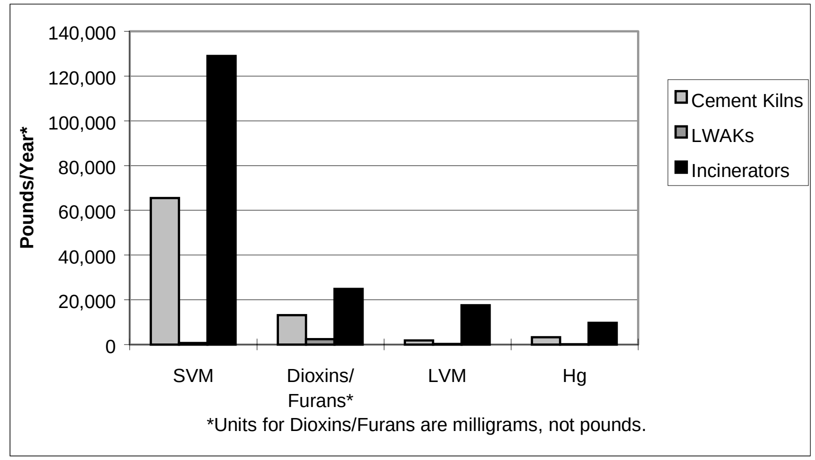
Exhibit 1-1

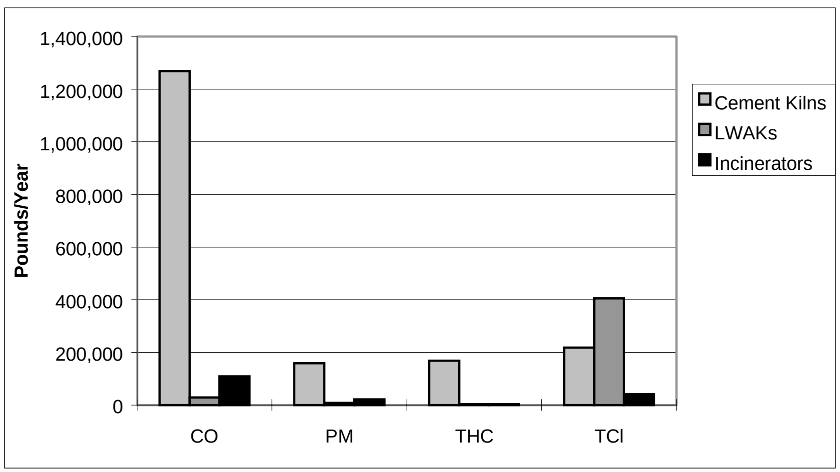
AGGREGATE AND SYSTEM AVERAGE BASELINE NATIONAL EMISSIONS

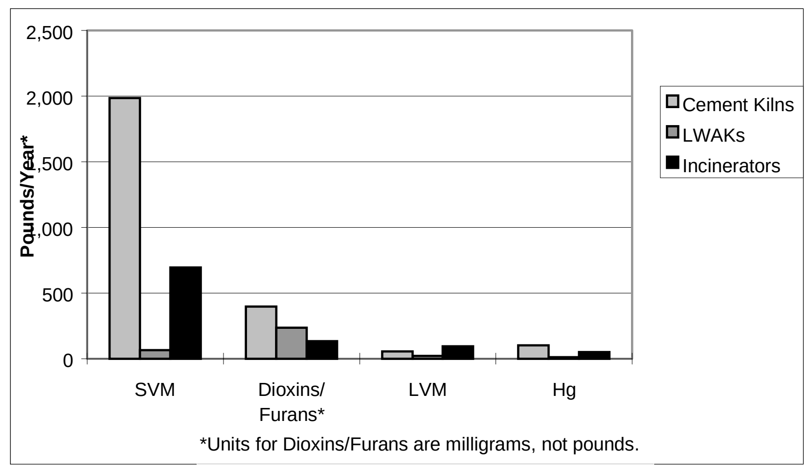
BASELINE NATIONAL EMISSIONS FROM COMBUSTION SYSTEMS (AGGREGATE)





AVERAGE BASELINE NATIONAL EMISSIONS PER SYSTEM





Note: Incinerators include commercial facilities and facilities with on-site systems.
Source: Energy and Environmental Research Corporation, May 5, 1998.

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be ineffective because the people who are made aware of the potential health risks (i.e., those people living nearby combustion facilities) have no power to reduce emissions without incurring significant costs.

Second, the parties injured by the combustion pollutants cannot obtain compensation from the damaging entity (the combustion facility) through legal or other means due to the high transaction costs involved and the difficulty in establishing a causal relationship between the damage incurred and activity at the combustion facility. Establishing a direct link between a specific combustion facility and human health and other damages incurred may be especially difficult because many combustion facilities are located in heavily industrialized areas, with multiple sources of pollutants; consequently, isolating the damaging effects from the combustion facility is difficult.

Lastly, emissions from hazardous waste combustion facilities directly affect the air, which is accessible to all people, and thus represents a "public good." Individuals who pay for reduced pollution cannot exclude others who have not paid from also enjoying the benefits of improved air quality. As a result, in the absence of government intervention, the free market will not provide public goods, such as clean air, at the optimal quantity and quality desired by the general public.

To internalize the environmental costs and to correct market distortions, government intervention is necessary. Consequently, EPA is issuing MACT standards for hazardous waste combustion facilities. EPA has selected this approach instead of a non-regulatory approach or another type of government intervention for three key reasons:

- First, due to the complex nature of pollutants, waste feeds, and the diverse nature of the regulated entities, alternative schemes (such as taxes, fees, or educational outreach programs) would be difficult to develop and implement;

- Second, Section 112 of the Clean Air Act requires the MACT standards;

- Third, the emission standards also satisfy EPA's obligation under RCRA to ensure that hazardous waste combustion is conducted in a manner adequately protective of human health and the environment; and

- Lastly, the MACT standards are generally consistent with the terms of the 1993 settlement agreement between the EPA and a number of groups who challenged EPA's final RCRA rule for cement kilns, "Burning of Hazardous Waste in Boilers and Industrial Furnaces."

Consequently, establishing the MACT standards is the most effective strategy for internalizing environmental costs and correcting market distortions.

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EXAMINATION OF ALTERNATIVE REGULATORY OPTIONS

As part of this Rulemaking, EPA considered multiple MACT alternatives for limiting emissions of hazardous and non-hazardous air pollutants at hazardous waste combustion facilities. On April 19, 1996, the Agency proposed MACT standards as specified in Exhibit 1-2. Since that time, EPA significantly expanded, updated, and revised the hazardous waste combustor database containing the emissions and ancillary data necessary for MACT standards development. After critically analyzing different methodologies for establishing the MACT floor and for evaluating the degree and cost of further reducing emissions "beyond the floor" (BTF), EPA has established its final recommended MACT. This economic assessment also evaluates two alternatives, the MACT floor for each source category, as well as a more stringent BTF MACT for dioxins/furans and mercury based on activated carbon injection technology. This more stringent option will be referred in the remainder of this document as the "BTF-ACI" MACT. These three options are summarized in Exhibit 1-3 and provide limits for the following air pollutants:

- **Dioxins/furans (D/F) —** chlorinated dioxin and furan emission standards are based on toxicity equivalents (TEQs).

- **Total Chlorine (TCl) —** the total chlorine jointly limits emissions of hydrochloric acid (HCl) and chlorine gas (Cl_2), both of which are designated HAPs. HCl and Cl_2 are controlled by a combined MACT standard because the test method used to determine HCl and Cl_2 emissions may not be able to distinguish between the compounds in all situations and because both of these HAPs can be controlled with the same type of pollution control measure.

- **Mercury (Hg) —** mercury is the only high-volatility metal for which emission limits are specified.

- **Semi-volatile Metals[6] (SVM) —** semi-volatile metals are comprised of lead and cadmium.

- **Low Volatile Metals (LVM) —** low volatile metals are comprised of arsenic, beryllium, and chromium.

- **Particulate Matter (PM) —** the particulate matter standard is a surrogate control for the following non-enumerated metal HAPs: antimony, cobalt, manganese, nickel, and selenium. These metals are not included in the volatility groups because of inadequate emissions data and the relatively low toxicity of antimony, cobalt and manganese.

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[6] Toxic metals are grouped by volatility because emission control strategies are determined by metal volatility.

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Exhibit 1-2

PROPOSED MACT STANDARDS (APRIL 1996)

Option	Source Category	D/F (ng/dscm TEQ)	PM (gr/dscf)	Hg (ug/dscm)	SVM (ug/dscm)	LVM (ug/dscm)	HCl (ppmv)	Cl_2 (ppmv)	CO (ppmv)	HC (ppmv)
Floor Levels	Incinerators	0.5	0.015	30	60	80	25	1	100	20
	Cement Kilns	0.5	0.03	40	60	80	60	1	NA	20
	LWAKs	0.5	0.015	30	60	80	1300	2.5	100	20
Proposed Standards	Incinerators	0.20	0.030	50	270	210	280	280	100	12
	Cement Kilns	0.20	0.030	50	57	130	630	630	100	20 (*) 6.7 (**)
	LWAKs	0.20	0.030	72	12	340	450	450	100	14

Notes:
(*) Main stack.
(**) By-pass.

Exhibit 1-3

REGULATORY ALTERNATIVES FOR EXISTING SOURCES

MACT	Source Category	Chlorinated D/F (ng TEQ/dscm)	PM	Hg (μg/dscm)	SVM (μg/dscm)	LVM (μg/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 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	100 100	or or	10 (◆) 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
Recommended MACT (Final Standards)	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	100 100	or or	10 (◆) 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	150	100	or	20
BTF-ACI MACT	Incinerators	**0.2**	0.015 gr/dscf	**10**	240	97	77	100	or	10
	Cement Kilns	**0.2**	0.15 kg/Mg dry feed	**25**	240	56	130	100 100	or or	10 (◆) 20 (◊)
	LWAKs	**0.2**	0.025 gr/dscf	**10**	250	110	150	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.
5. Across all regulatory alternatives, a DRE of 99.99% is required (99.9999% for sources burning dioxin-listed wastes) to control emissions of non-dioxin/furan organic HAPs.

(*) 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.

- **Carbon Monoxide (CO) and Hydrocarbons (HC) —** carbon monoxide and hydrocarbons are controlled as surrogates for non-dioxin, non-furan toxic organic emissions.[7]

In addition to control of these specific pollutants, EPA is also maintaining its current (baseline) RCRA destruction and removal efficiency (DRE) standard of at least 99.99 percent to ensure MACT control of nondioxin/furan organic hazardous air pollutants.[8] The 99.99 percent DRE standard, commonly referred to as "four-nines DRE," is the MACT floor (and final) standard.

Recommended MACT (Final Standards)

As indicated by the shading in Exhibit 1-3, the recommended MACT reduces emissions for certain pollutants below floor levels. Changes beyond the floor levels are specified for each of the combustion sectors below:

- **Incinerators:** The recommended MACT specifies beyond-the-floor control only for dioxins/furans at incinerators with waste heat boilers that also choose to implement temperature control. For these incinerator units, the BTF standard is reduced from 12 ng/dscm at the floor to 0.4 ng/dscm.

- **Cement Kilns:** The recommended MACT specifies beyond-the-floor control only for semi-volatile metals at cement kilns; the floor standard is reduced from 650 µg/dscm at the floor to 240 µg/dscm.

- **LWAKs:** The recommended MACT specifies beyond-the-floor control for dioxins/furans at LWAKs using temperature control; the standard is reduced from 4.1 ng/dscm at the floor to 0.4 ng/dscm. BTF control is also specified for semi-volatile metals, reducing emissions from 1700 µg/dscm at the floor to 250 µg/dscm; and for total chlorine, reducing emissions from 1500 ppmv at the floor to 150 ppmv.

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[7] Emission standards for municipal waste combustors and medical waste incinerators also limit emissions of CO to control non-D/F organic HAPs.

[8] A 99.9999 percent DRE is required for those hazardous waste combustors burning dioxin-listed wastes (i.e., F020-023 and F026-027); this is also a current (baseline) RCRA requirement.

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BTF for Mercury and D/F Based on Activated Carbon Injection

The BTF-ACI option would establish stricter standards than the recommended MACT for dioxins/furans and mercury. For dioxin/furan control, EPA sets uniform standards at 0.2 ng/dscm across all combustion sources. With regard to D/F control, unlike the Floor and the Recommended MACT, the BTF-ACI option does not allow facilities to use temperature control. With regard to mercury control, the BTF-ACI option sets beyond-the-floor levels at 25 µg/dscm for cement kilns and 10 µg/dscm for LWAKs and incinerators.

MACT Standards for New Sources

In addition to the regulatory options governing existing waste combustion facilities, this rule also establishes MACT standards for new sources. Exhibit 1-4 presents the specific standards for each HAP emitted by new sources. As shown, the basic option includes standards for dioxins/furans, PM, and CO/HC that are commensurate with the Recommended MACT for existing sources. The cement kiln standard for low-volatility metals and the cement kiln and LWAK standards for semi-volatile metals are more stringent than the Recommended MACT. In addition, for all combustion sectors, the mercury standard for new sources is more restrictive than the recommended MACT.

POTENTIAL ENVIRONMENTAL BENEFITS OF THE MACT STANDARDS

Following imposition of the Recommended MACT standards, emissions will decrease substantially, as shown in Exhibit 1-5. On average, incinerators will reduce their hazardous air emissions by the greatest percentage following the MACT standards. Across all pollutants for which MACT standards are established, the average total decrease is 64 percent for incinerators, 40 percent for LWAKs, and 26 percent for cement kilns. If all incinerators comply with the MACT standards, incinerators will reduce semi-volatile metals emissions by an average of 96 percent and both low-volatile metals and dioxin/furan emissions by 86 percent. LWAKs will reduce total chlorine by an average of 88 percent and dioxins/furans by 83 percent, while cement kilns will reduce semi-volatile metals by an average of 84 percent. None of the combustion sectors are expected to reduce carbon monoxide, and neither cement kilns nor LWAKs are expected to reduce total hydrocarbons.

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Exhibit 1-4

REGULATORY STANDARDS FOR NEW SOURCES

Source Category	D/F (ng TEQ/dscm)	PM	Hg (ug/dscm)	SVM (ug/dscm)	LVM (ug/dscm)	TCl (ppmv)	CO (ppmv)	HC (ppmv)
Incinerators	0.2	0.015 gr/dscf	45	240	97	21	100	10
Cement Kilns	0.2; or 0.4 and temperature at inlet to PM control device ≤ 400°F	0.15 kg/Mg dry feed	56	180	54	86	100 or 100 or	10 (◆) 20 (◊)
LWAKs	0.2; or 0.4 and rapid quench ≤ 400°F	0.025 gr/dscf	33	43	110	41	100 or	20

Notes:

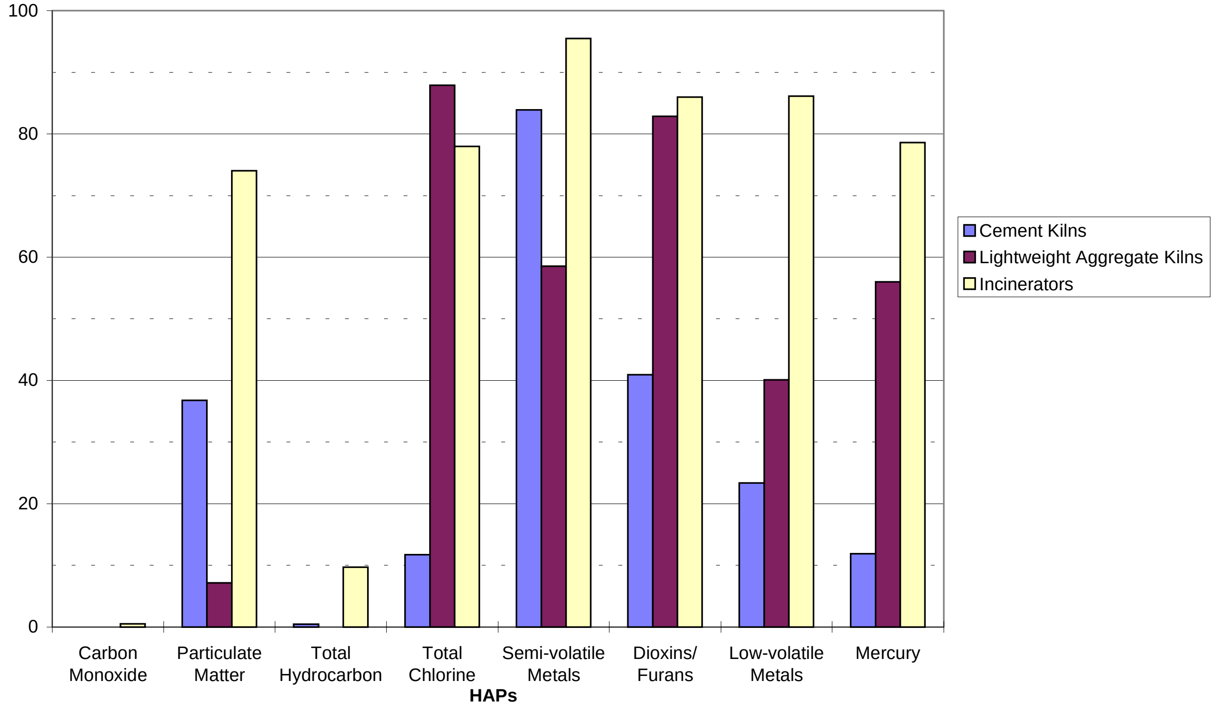
(◆) Cement kilns with bypass ducts can comply with either the CO standard in the bypass duct of 100 ppmv, or the HC standard in the bypass duct of 10 ppmv. However, new cement kilns at Greenfield sites must comply with the main-stack 50 ppmv standard for HC and do not have the option of complying with the CO standard of 100 ppmv in lieu of the HC standard. These new sources must also comply with the bypass duct standard of 10 ppmv for HC.

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

Shaded cells indicate that the standard is set at levels beyond the MACT floor for existing sources.

A DRE of 99.99% is also required (99.9999% for sources burning dioxin-listed wastes) to control emissions of non-dioxin/furan organic HAPs; this is the same DRE standard as for existing sources.

Exhibit 1-5
PERCENT DECREASE IN TOTAL EMISSIONS FROM THE BASELINE



Note: Emission estimates are based on the recommended MACT standards.

EPA anticipates that establishing MACT standards for hazardous waste combustion facilities will reduce human health and environmental risks from these facilities and may also lead to reduced generation of hazardous wastes. In particular, reductions in cancer risks are expected from decreased dioxin emissions, reductions in respiratory diseases are expected from decreased particulate matter emissions, and reductions in developmental abnormalities in children may result from decreased mercury emissions. In addition, dioxin and mercury reductions may also decrease risks to terrestrial and aquatic ecosystems.

TIMETABLE FOR MACT REQUIREMENTS

EPA allots three years for hazardous waste combustion facilities to come into full compliance with the MACT standards. A one-year extension may be granted to facilities for which complete system retrofits cannot be implemented within three years despite a good faith effort to do so. Exhibit 1-6 specifies other requirements that must be met during this three- or four-year time-frame. Within the first 10 months following the promulgation of the rule, facilities must hold public meetings to discuss the upgrades necessary for meeting the new standards. Within one year following the rule promulgation, combustion facilities must submit to EPA a notice of intent to

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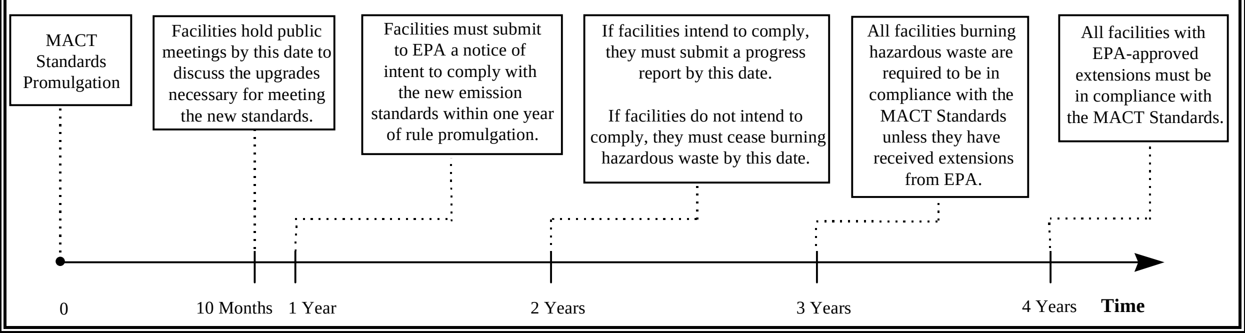
comply with the new emission standards. Two years after the rule promulgation, facilities that intend to meet the standards must submit a progress report and facilities that do not intend to comply must cease burning waste. Three years after the promulgation of the rule, all facilities must be in compliance with the MACT standards.

Exhibit 1-6
TIMELINE FOR HWC MACT REQUIREMENTS



ANALYTIC APPROACH AND ORGANIZATION

This *Assessment* evaluates the costs of the rule and impacts that these costs would have on waste burning behavior, and compares these costs to the benefits of the regulation. The *Assessment* analyzes the Final MACT standards along with two alternative MACT options that EPA also considered in development of the final rule. For statutory reasons under the CAA, one key metric used for evaluating decisions to go beyond the floor is a cost-effectiveness measure, which estimates compliance expenditures divided by emissions reduced for each pollutant. The *Assessment* evaluates cost-effectiveness from the baseline to the floor, and incrementally from the floor to beyond-the-floor.

The analysis discussed in the subsequent chapters of this report begins by establishing the baseline costs and waste management practices of the regulated facilities, and then determines the change in costs post-MACT and assesses the impacts of these increased costs on the combustion market. We also evaluate the benefits of the MACT standards and impacts to low-income and minority populations, small business, local governments, and private property owners. We discuss these analyses in seven subsequent chapters:

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Chapter 2: Overview of Combustion Practices and Markets
Presents background information on the combustion market and characterizes the industry and sectors affected by the MACT standards, examining current waste burning practices, types of hazardous waste managed by combustion sector, types of generating industries that use combustion services, and overall market trends.

Chapter 3: Defining the Regulatory Baseline
Describes the data used for specifying the baseline, which defines "the world absent the HWC MACT standards." We discuss current practices and future trends with regard to revenue and cost assumptions, future capacity projections, emission profiles, and pollution control practices.

Chapter 4: Compliance Cost Analysis
Explains how we develop compliance cost estimates for hazardous waste combustion facilities by using engineering cost models and examining other private sector compliance costs and government administrative and implementation costs.

Chapter 5: Social Cost and Economic Impact Analysis
Analyzes social costs and economic impacts of the MACT standards by examining the incentives and reactions of the regulated community. We analyze the following economic impacts: market exists, employment impacts, combustion prices changes, and the quantity of waste that may be diverted from combustion facilities that stop burning.

Chapter 6: Benefits Assessment
Evaluates human health and environmental benefits, including the number of cancer cases avoided and other mortality risk reductions, morbidity risk reductions, and risk reductions for terrestrial and aquatic ecosystems using a multiple pathway risk assessment.

Chapter 7: Equity Considerations and Other Impacts
Assesses distributional and equity impacts of the MACT standards, including small entity impacts, environmental justice implications, children's health, impacts to Tribal Governments, and assessments of the potential for unfunded mandates and regulatory takings resulting from the rule. Also analyzes the joint impacts of three other EPA rules on the cement industry.

Chapter 8: Comparison of Costs, Benefits, and Other Impacts
Compares the benefits with the costs of the rule, focusing on the cost-effectiveness of the final options under consideration.

OVERVIEW OF COMBUSTION PRACTICES AND MARKETS **CHAPTER 2**

This chapter presents an overview of the hazardous waste combustion industry to provide a context for assessing the costs and economic impacts of the rule. Various aspects of the combustion industry, from economic and technological issues to combustion facility relationships, can have a significant impact on the effects of the MACT standards. In this chapter, we first describe the types of facilities that combust hazardous waste and characterize the current market structure. We then discuss the quantity and characteristics of combusted hazardous wastes, and the industries that generate these wastes. Following this, we present an overview of waste burning services and the factors that underlie the demand for these services. We then describe the current regulatory framework and the types of pollution control devices currently in place at combustion facilities. Finally, we explore the current market and financial performance of the various combustion industry sectors.

COMBUSTION MARKET OVERVIEW

Three key segments constitute the hazardous waste combustion industry: hazardous waste generators, fuel blenders and other intermediaries (e.g. waste brokers), and commercial combustion facilities.[1] We illustrate the market structure and waste flows in Exhibit 2-1. As shown in the exhibit, some hazardous waste generators manage their wastes on-site and some send their wastes directly to commercial combustion facilities such as commercial incinerators and less often directly to waste-burning kilns.[2] Other generators manage their wastes through waste brokers or fuel blenders, who subsequently send the wastes to commercial combustion facilities.

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[1] Some generators also burn their hazardous wastes on-site in boilers. Because this rulemaking does not regulate on-site hazardous waste boilers and the boilers do not significantly affect market dynamics, we do not discuss them in the *Assessment*.

[2] The commercial/non-commercial division is not always clear-cut; a few generating facilities with on-site incinerators do accept some waste commercially even though most of the waste burned originates on-site.

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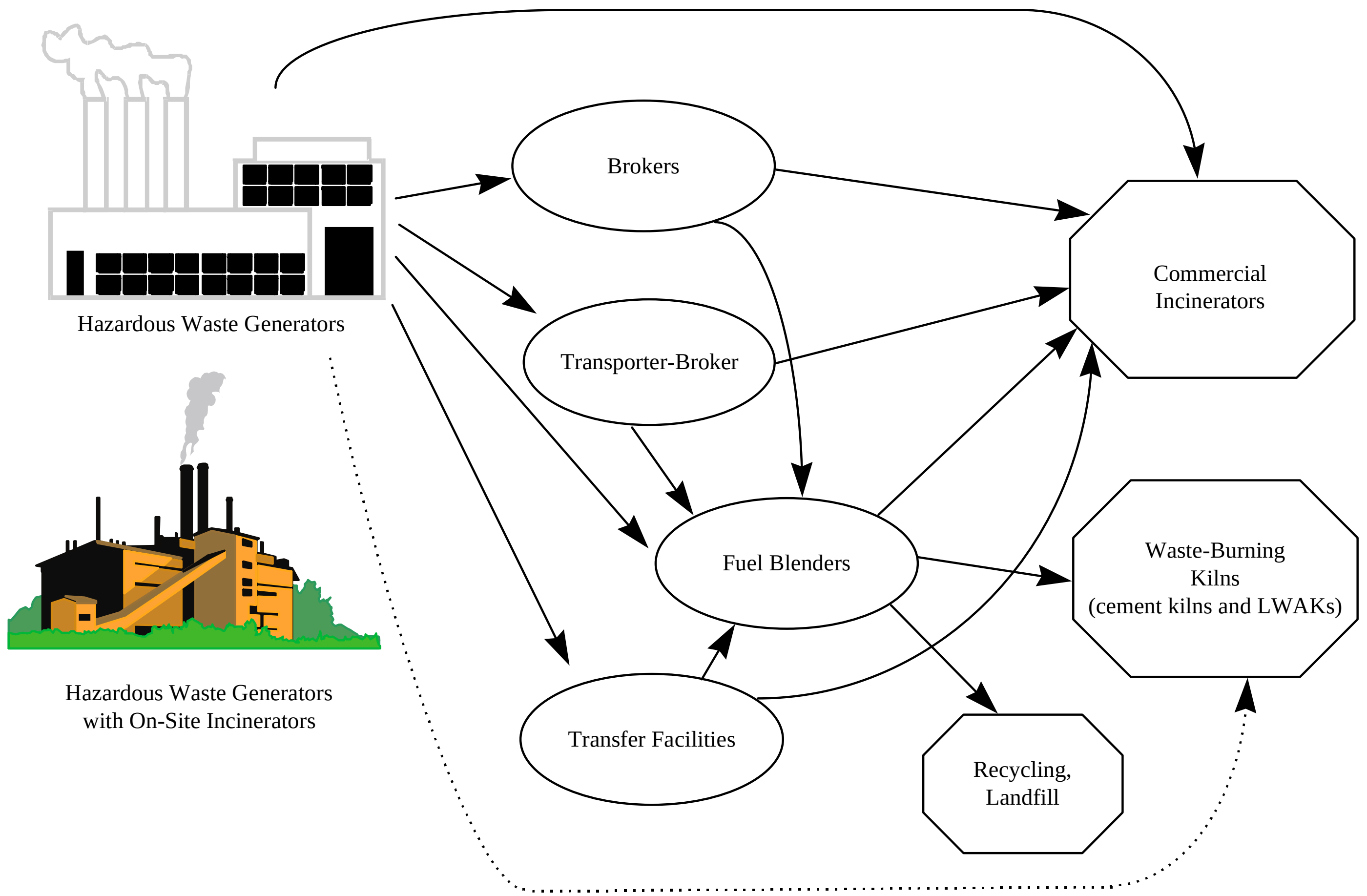
Exhibit 2-1

HAZARDOUS WASTE COMBUSTION MARKET STRUCTURE



Note: The dotted line indicates that few generators send wastes directly to kilns; most generators send wastes to some type of intermediary who in turn, send the wastes to kilns.

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Types of Combustion Facilities

Hazardous waste is combusted at three main types of facilities: commercial incinerators, on-site incinerators, and waste-burning kilns. In addition, the MACT standards also apply to mobile incinerators, which are used to treat soils and other contaminated media at Superfund sites.[3] These combustion units are called mobile incinerators because they are transported to hazardous waste sites as complete units or as parts which are later re-assembled. Because only a few mobile incinerators are currently operational, the incremental costs and resulting economic impacts of regulating mobile incinerators are expected to be small relative to the total national costs of the rule.[4] For this reason, this *Assessment* does not include mobile incinerators in the cost, economic impact, and benefit analyses.

Incinerators generally burn wastes to destroy toxic characteristics, although some also recover a portion of the energy contained in the wastes.[5] Commercial incineration facilities manage a wide variety of waste streams generated across a range of industries. On-site incinerators tend to manage waste streams with more uniform characteristics generated by certain product lines. Commercial incinerators, therefore, tend to be larger in size and are generally designed as rotary-kilns, which can manage solid wastes as well as liquid wastes. On-site incinerators may be designed as liquid-injection incinerators, which handle liquids and pumpable solids, or as rotary kilns, depending on the wastes generated and burned at these facilities.

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[3] Technically, mobile and transportable incinerators differ in that firms can move a mobile incinerator as a single unit but must disassemble, transport, and reassemble a transportable incinerator. The MACT standards, however, consider both types of incinerators as mobile incinerators.

[4] Using EPA's BRS database, the RCRA Corrective Action Information Database (RCAID), and the Resource Conservation and Recovery Information System (RCRIS), between six and 12 mobile incinerators are currently operational in the United States. (Gwen Fairweather et al, ICF Incorporated, "Memorandum: QRT #1, WAB-30, EPA Contract 68-W6-0061," prepared for Lyn Luben, U.S. EPA, June 12, 1998).

[5] Energy recovery is possible at incinerators if they burn the cleaner liquid solvent streams to fuel their afterburners. (Phil Retallick, Rollins Environmental Services, personal communication, September 13, 1994.)

In contrast, cement kilns and lightweight aggregate kilns (LWAKs) burn hazardous wastes to generate heat and/or power for manufacturing purposes. While kilns traditionally burned conventional fuels like coal and oil, the high energy requirements of manufacturing cement and lightweight aggregate motivated many firms to modify their kilns to burn hazardous wastes as well.[6] Using hazardous waste as fuel provides two primary benefits to kilns: reduced energy requirements and additional revenues from tipping fees paid by generators or fuel blenders to kilns for managing the hazardous waste. Cement kilns and lightweight aggregate kilns can also incorporate a portion of the residual ash from combustion (of both hazardous and non-hazardous fuels) in their products, slightly reducing raw material requirements.

Number of Combustion Facilities

One hundred seventy two facilities are currently permitted to burn hazardous waste in the United States.[7] As shown in Exhibit 2-2, on-site incinerators comprise the greatest percentage of combustion facilities, with 129 on-site incinerators.[8] The commercial sector includes a relatively small number of facilities, with only 20 commercial incineration facilities, 18 cement kiln facilities, and five lightweight aggregate kiln facilities.

[6] However, due to limitations on the quantities of hazardous waste that facilities can burn without affecting product quality, conventional fuels still provide the majority of the energy needed to produce cement. (Portland Cement Association. June 1994. *U.S. Cement Industry Fact Sheet Twelfth Edition*, 17.)

[7] Using additional information, we updated the 1997 list of combustion facilities to establish this universe of 172 combustion facilities.

[8] As previously discussed, between six to twelve mobile incinerators are currently in operation, but we do not include them in our analysis because they represent a small portion of the total incinerators currently burning hazardous waste.

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Exhibit 2-2

UNIVERSE OF REGULATED ENTITIES

Type of Combustion Device	Estimated Number of Systems	Number of Facilities	Average Waste Burning Systems/Facility
Cement kilns	33	18	1.83
Lightweight aggregate kilns	10	5	2.00
Commercial incinerators	26	20	1.30
On-site incinerators	163	129	1.24
Total	**232**	**172**	**1.35**

Notes:
(1) The analysis includes facilities that are currently burning hazardous waste, as well as facilities that are no longer burning but have not commenced formal closure procedures.
(2) We do not include mobile incinerators in this analysis.

Sources:
(1) U.S. EPA, PSPD, List of Permitted Hazardous Waste Combustion Facilities, February 1996.
(2) Update of OSW Hazardous Waste Combustion Database (Revised Technical Standards for Hazardous Waste Combustion Facilities, NODA, January 7, 1997 (62 FR 960.)

As shown in Exhibit 2-3, at a given location, a facility may have more than one combustion system. In general, a combustion system has one combustion unit connected to a single stack. However, some systems have multiple units connected to a shared single stack. Because most systems comprise only one unit and because this distinction is not critical to the analysis and presentation of the *Assessment*, we use the terms "system" and "unit" interchangeably.

The number of systems per facility ranges from one to four. On average, cement kilns and lightweight aggregate kilns have more waste burning combustion systems per facility than do incinerators. On-site facilities have the lowest average number of systems per facility.

On-Site Versus Commercial Combustion

Companies that generate large quantities of hazardous waste typically choose to combust the waste themselves. These non-commercial facilities are usually located at the generator's production site, and are referred to throughout this report as "on-site" incinerators. Generators choose to burn their wastes on-site rather than sending wastes off-site for several reasons:

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- The costs of on-site combustion are often less than the costs of managing wastes at commercial facilities, especially for large quantity generators.

- Generators remain somewhat insulated from price fluctuations in the commercial sector.

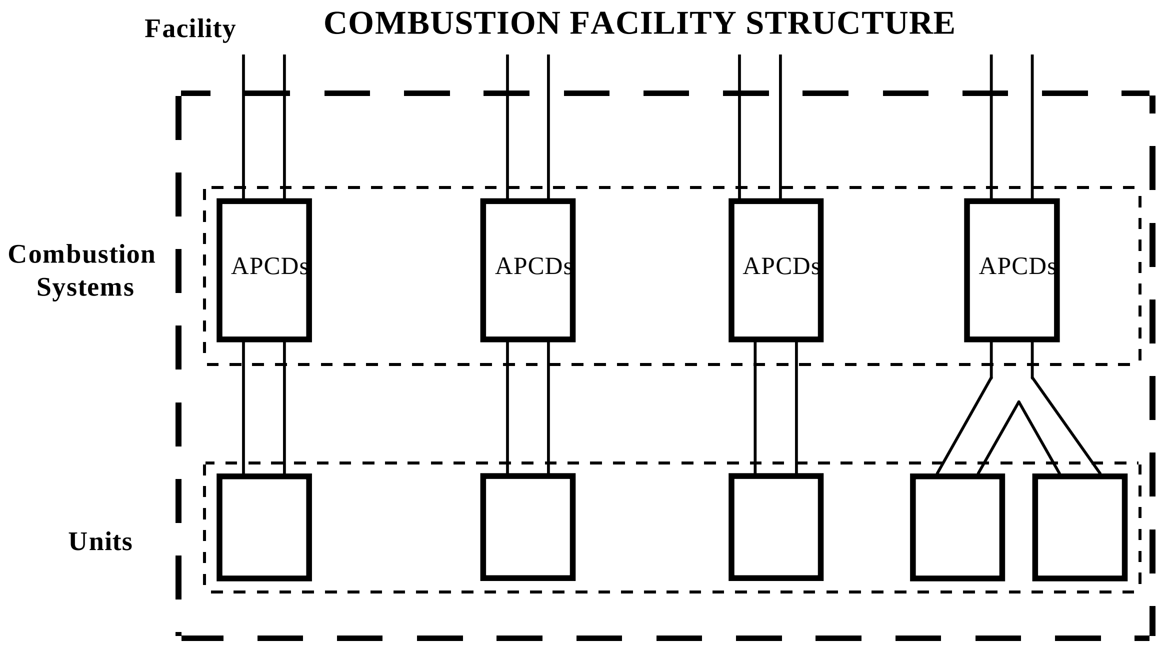
- Generators of specialized wastes may not be able to send their wastes off-site because commercial incinerators will not accept certain wastes (e.g., explosives) or because transportation is too risky or difficult (e.g., gaseous wastes).

- Finally, generators limit liability risks by controlling the entire treatment process. For many firms, cradle-to-grave internal waste management is a corporate policy.

For facilities that generate small to medium quantities of waste and do not already have an incinerator, paying a commercial facility to burn the waste is usually less costly than constructing and maintaining an on-site incinerator.

Exhibit 2-3

COMBUSTION FACILITY STRUCTURE



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Fuel Blenders and Other Intermediaries

Hazardous waste combustion intermediaries include waste brokers and fuel blenders. Waste brokers arrange the movement of wastes from the generator to the combustion facility without additional processing. In contrast, fuel blenders collect waste from a number of generators and process it to meet the requirements of their customers in the commercial combustion market, primarily cement kilns.[9] As of March 1997, 92 active fuel blenders were in operation, compared to 58 in 1996, 73 in 1993, and 74 in 1994.[10] Many of these fuel blenders are vertically integrated with kilns, and may be located on-site or adjacent to the cement facility.[11] The National Association of Chemical Recyclers (NACR) estimates that 55 percent of the waste received by its membership is recycled (often at solvent recovery facilities), while kilns use 45 percent as fuel.[12]

Fuel blenders mix wastes used as fuels to meet customer requirements for energy content, viscosity, and acceptable concentrations of hazardous constituents. A consistent energy content is important for both kilns and incinerators. For kilns, the waste fuels replace conventional fuels in a production process with specific energy requirements. For incinerators, a variable thermal loading can reduce efficiency and potentially damage the combustion unit. Viscosity affects the ability to pump wastes into the combustion chamber in a uniform manner. Criteria for hazardous constituent concentrations are important both for controlling emissions and for protecting the stability of the production process and the quality of the product (in the case of cement kilns and LWAKs). Fuel blenders have continually worked to improve their blending abilities, and have had a large impact on hazardous waste combustion markets. We discuss activity of fuel blenders in more detail below.

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[9] See Daphne McMurrer, Bob Black, and Tom Walker, Industrial Economics, Inc., "Memorandum: The Processing and Use of Waste Fuels," prepared for Lisa Harris, Office of Solid Waste, U.S. EPA, December 13, 1994.

[10] These figures were derived from the U.S. EPA, 1993 Biennial Reporting System (BRS); the U.S. EPA, 1995 Biennial Reporting System (BRS); and Allen White and David Miller, Tellus Institute, "Economic Analysis of Waste Minimization Alternatives to Hazardous Waste Combustion," prepared for U.S. EPA, July 24, 1997.

[11] In a CKRC survey of 21 cement companies, 17 facilities reported having fuel blending done on-site or adjacent to the facility. Cement Kiln Recycling Coalition. Fall 1994. "CKRC Cement Facility Questions on Hazardous Waste Fuel Blending and Burning."

[12] Chris Goebel, National Association of Chemical Recyclers, personal communication, May 20, 1997.

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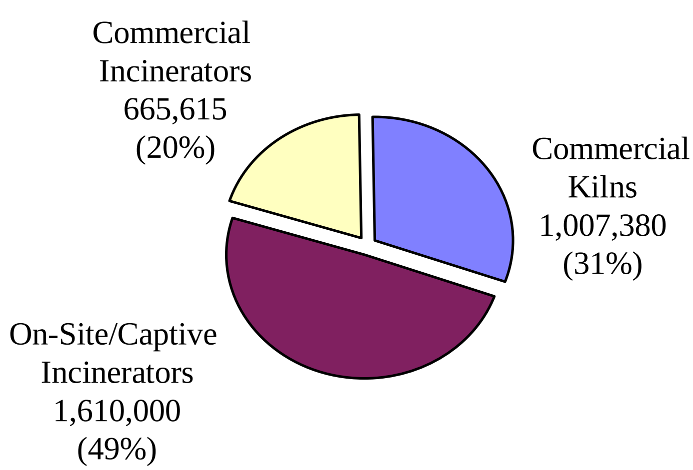
CHARACTERISTICS OF COMBUSTED WASTE

Waste quantities burned at combustion facilities are a function of industrial activities in generating industries (e.g., chemicals, pharmaceuticals), regulatory requirements, remedial activity, and available waste management substitutes. In 1995 combustion facilities burned about three million tons of hazardous waste annually. As shown in Exhibit 2-4, on-site incinerators burned about 49 percent of the total combusted wastes. Commercial kilns burned approximately 31 percent, and commercial incinerators burned the remainder.[13]

Exhibit 2-4

WASTE QUANTITIES MANAGED BY COMBUSTION SYSTEMS (Tons)



Total Demand: 3,282,995

Source: EPA Biennial Reporting System.

Notes:

1) We adjusted the on-site/captive incinerator tons data to account for a data entry error involving the Dow facility in Plaquemine, L.A. While available 1995 BRS data indicate that the facility combusted 2,099,059 tons of waste, the facility actually combusted 22,639 tons.

2) This analysis excludes wastes burned at mobile incinerators.

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[13] U.S. EPA. 1995. Biennial Reporting System (BRS).

In general, hazardous waste used for fuel in cement kilns and LWAKs differs from the waste burned at commercial facilities. Waste burned in kilns tends to be liquid, high-Btu waste (e.g., solvents and organic liquids) that is most suitable for use as fuels. This type of waste is easy to pump, burns cleanly, and results in a relatively small amount of solid residue. Under the Boiler and Industrial Furnace (BIF) rule,[14] the waste burned for energy recovery must have a minimum heat value of 5,000 Btu/lb. In practice, the blended waste burned by cement kilns has an average heat value of 12,000 Btu/lb.[15]

Wastes burned in incinerators include streams that kilns cannot accept, such as highly contaminated solids with low heating value. In addition, incinerators also burn liquid wastes and solids with low levels of contaminants. Unlike kilns, incinerators burn waste that typically has a low heat value; the average is only 6,700 Btu/lb.[16] Incinerators often supplement wastes with conventional fuels to ensure temperatures high enough to destroy organic toxics.

Increasingly, improvements in blending technologies and storage units are allowing kilns to handle more solids and other wastes that have historically been sent to commercial incinerators.[17] Fuel blenders can mix solids and other wastes together with high Btu liquid wastes to create a slurry suitable for use as fuel. According to industry representatives, in 1997 hazardous wastes used as fuel typically contained between 20-25 percent suspended solids.[18] Blending also ensures that contaminants, such as metals and chlorine, do not exceed allowable levels in fuels sent to combustion units.

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[14] The final rule was published on February 21, 1991 (56 FR 7134).

[15] The 1994 weighted average heat value of fuels supplied to kilns by fuel blenders in the National Association of Chemical Recyclers (NACR) was 12,073 Btu/lb., with a minimum value of 8,800 Btu/lb. and a maximum of 14,000 Btu/lb. See NACR, *NACR Waste Processing Survey*, August 1994, question 1. Values vary by type of waste; see Appendix B for heat content values assumed in the EPA economic impact model.

[16] Average heat content of waste at medium and large commercial rotary kiln incinerators from Energy and Environmental Research Corporation combustion database.

[17] Technology improvements in storage units include improved dispersion tanker with agitators and storage tanks with pulverizers. These technologies keep the solids mixed with the liquids and ensure that the slurry is pumpable.

[18] Personal communication with fuel blender, May 29, 1997.

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MAJOR SOURCES OF COMBUSTED HAZARDOUS WASTES

Most of the waste managed by combustion comes from a relatively narrow set of industries as shown in Exhibit 2-5. The entire chemical industry in 1995 generated 74 percent of combusted waste.[19] Within this sector, the organic chemicals subsector was the largest source of waste sent to combustion, providing about 32 percent of all combusted waste. The pesticide and agricultural chemical industry generated 12 percent of the total. No other single sector generated more than 10 percent of the total.

MARKET AND REGULATORY FORCES INFLUENCING COMBUSTION INDUSTRY

Regulatory requirements, liability concerns, and economics affect the demand for combustion services. Regulatory forces influence the demand for combustion by mandating certain hazardous waste treatment standards and by establishing technical requirements for the combustion systems. Liability concerns of waste generators affect combustion demand because combustion, by destroying organic wastes, greatly reduces the risk of future environmental problems.[20] Finally, if alternative management options are more expensive, hazardous waste generators will likely choose to combust their wastes to increase their overall profitability. However, this industry is not a fluid market and changes in waste management practices often present logistical and regulatory challenges. For example, a firm that wants to burn its own wastes faces many barriers, mostly regulatory, and typically require very long lead times.

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[19] We exclude industries with SICs corresponding to refuse systems from our analysis because they are likely to be fuel blenders.

[20] Note that some, albeit much reduced, liability exposure remains in the form of residual incinerator ash that must be disposed of in a hazardous waste landfill. With some cement kilns and LWAKs, even this problem is minimal because much of the combustion residuals are integrated into the product.

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Exhibit 2-5

INDUSTRIAL SECTORS GENERATING COMBUSTED WASTE, 1995

	SIC Code	Corresponding NAIC Codes	Volume (tons)	% of Volume
Industrial Organic Chemicals, N.E.C.	2869	32511, 325188, 325193, 32512, 325199	853,216	31.82
Pesticides and Agricultural Chemicals, N.E.C.	2879	32532	321,869	12.00
Business Services, N.E.C.	7389	51224, 51229, 541199, 81299, 54137, 54141, 54142, 54134, 54149, 54189, 54193, 54135, 54199, 71141, 561421, 561422, 561439, 561431, 561491, 56191, 56179, 561599, 56192, 561591, 52232, 561499, 56199	245,241	9.15
Organic Fibers, noncellulosic	2824	325222	190,209	7.09
Medicinal Chemicals and Botanical Products	2833	325411	157,520	5.87
Pharmaceutical Preparations	2834	325412	105,881	3.95
Plastics Materials and Resins	2821	325211	93,043	3.47
Petroleum Refining	2911	32411	92,023	3.43
Industrial Inorganic Chemicals, N.E.C.	2819	325998, 331311, 325131, 325188	64,826	2.42
Unknown			61,487	2.29
Nonclassifiable Establishments	9999		46,108	1.72
Services, N.E.C.	8999	71151, 51221, 54169, 51223, 541612, 514199, 54162	30,585	1.14
Paints, Varnishes, Lacquers, Enamels	2851	32551	29,837	1.11
Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	2865	32511, 325132, 325192	29,667	1.11

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Exhibit 2-5 (cont.)

INDUSTRIAL SECTORS GENERATING COMBUSTED WASTE, 1995

	SIC Code	Corresponding NAIC Codes	Volume (tons)	% of Volume
Air, Water, and Solid Waste Management	9511	92411	28,033	1.05
Photographic Equipment and Supplies	3861	333315, 325992	27,356	1.02
Scrap and Waste Materials	5093	42193	18,768	0.70
Synthetic Rubber (Vulcanizable Elastomers)	2822	325212	17,025	0.63
Special Warehousing and Storage, N.E.C.	4226	49312, 49311, 49319	14,914	0.56
Primary Aluminum	3334	331312	12,648	0.47
Chemicals and Chemical Preparations, N.E.C.	2899	32551, 311942, 325199, 325998	10,303	0.38
Sanitary Services, N.E.C.	4959	48819, 56291, 56171, 562998	10,089	0.38
Alkalies and Chlorine	2812	325181	9,567	0.36
Local and Suburban Transit	4111	485111, 485112, 485113, 485119, 485999	9,471	0.35
Chemicals and Allied Products, N.E.C.	5169	42269	7,337	0.27
All Other SIC Codes			201,826	7.53
Total:			2,681,509	100.00

Notes:

1) We exclude refuse systems (SIC code 4953) from the analysis because they are likely to be fuel blenders; our intent was to characterize the original sources of hazardous waste.

2) We adjusted the tons data to account for a data entry error involving the Dow facility in Plaquemine, LA. While the state-reported data used in the 1995 BRS indicate that the facility combusted 2,099,059 tons of waste, the facility actually combusted 22,639 tons.

3) The total tons listed does not equal the total in Exhibit 2-4 because only the 1995 BRS GM forms contained SIC codes, yet the GM forms do not capture data from small quantity generators. (To obtain the information in Exhibit 2-4 we were able to use the 1995 BRS WR forms, which list the wastes received from small and large quantity generators.) In addition, reporting errors on the part of generators and data entry errors on the part of EPA affect the accuracy of the tons combusted.

Source: 1995 BRS data.

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Regulatory Requirements Encouraging Combustion

While industry began incinerating some of their hazardous wastes as early as the late 1950s, the current market for hazardous waste combustion emerged largely from EPA regulation of hazardous waste disposal. Two major regulatory forces directly encouraging combustion are the land disposal restrictions under the Hazardous and Solid Waste Amendments (HSWA) of 1984 and the "Records of Decision (RODs)" documenting clean-up agreements for Superfund sites.[21]

EPA's Land Disposal Restrictions (LDRs) prohibit hazardous waste generators from sending untreated wastes directly to landfills and mandate alternative waste treatments, known as Best Demonstrated Available Technologies (BDATs). Many of these standards are based on the performance of combustion technology.

The Records of Decision establish the cleanup plan for contaminated sites under the Comprehensive Environmental Reclamation, Compensation, and Liability Act (CERCLA). Since contaminated soil at Superfund sites is subject to the LDRs, incineration is sometimes a technology chosen during remediation. Between 1982 and 1991, incineration was the single source control remedy selected most often (in 28 percent of the RODs issued).[22] In more recent years, however, use of incineration as the cleanup method at Superfund sites has been declining. Through fiscal year 1995, EPA chose incineration as the cleanup method in only 6 percent (43 times) of the RODs issued.[23]

The percentage of source control RODs stipulating *mobile* incinerators as the management technology started at about 6 percent in 1986 and increased to about 11 percent in 1987. In recent years, however, the use of mobile incinerators to treat hazardous waste at Superfund sites has also declined. Since Superfund cleanups create the majority of the demand for mobile thermal treatment units, the demand for mobile incinerators has decreased significantly. In 1994 and 1995, for example, treatment remedies at Superfund sites declined as containment-only remedies increased; in addition, *within* the category of treatment remedies selected by EPA, mobile incinerators' share decreased steadily. By 1995 mobile incinerators constituted only 4 percent of the treatment technologies selected by EPA.[24]

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[21] Robert Graff and Thomas Walker, Industrial Economics, Inc., "Factors that Require, Encourage, or Promote Combustion of Hazardous Waste," memorandum to Walter Walsh, Office of Policy Analysis, U.S. EPA, November 11, 1993, 12.

[22] Graff and Walker, op. cit., p. 10.

[23] US General Accounting Office. 1997. *Superfund: EPA Could Further Ensure the Safe Operation of On-Site Incinerators.*

[24] US EPA, Solid Waste and Emergency Response, Technology Innovation Office. 1997. "Clean Up the Nation's Waste Sites: Markets and Technology Trends: 1996 Edition."

Other pending EPA rules could also affect the combustion industry. For example, the Hazardous Waste Identification Rule (HWIR) could potentially reduce the quantity of waste sent to combustion facilities as some treated hazardous wastes could exit the RCRA Subtitle C regulatory system. The HWIR media rule would have a similar effect on the combustion industry because the rule gives generators of clean-up wastes greater flexibility in managing their wastes on-site.[25]

Liability Concerns

Remediation regulations also affect generators' hazardous waste management policies by increasing firms' liability. For example, CERCLA created a liability system in which a generator that ships waste to a licensed disposal site can be liable for up to the entire cost to clean the site if environmental damages occur. With such large potential costs, generators found combustion's ability to destroy the wastes, rather than simply dispose of them, extremely attractive.

Fears of product liability exposure through the courts have also increased demand for combustion. In addition, many manufacturers want to be certain that off-specification products (e.g., pharmaceuticals) are destroyed so they do not illegally enter the market. The Hazardous Waste Treatment Council estimated that 15 to 30 percent of waste handled by destructive incineration is not classified as hazardous by any agency.[26]

Economic Forces Encouraging Combustion

Economic forces can encourage combustion over alternative treatment in various ways. For example, combustion can treat a wide variety of waste streams and may be cheaper than segregating and managing streams with different methods.[27]

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[25] "Redefining Hazardous Waste." 1996. *Environmental Business Journal*, 5.

[26] However, this non-hazardous waste helps combustion units cover their fixed costs of operation, an important attribute during periods of excess combustion capacity. (Graff and Walker, op. cit, pp. 15-16.)

[27] For larger waste streams, however, waste segregation can often lead to large cost savings because it allows facilities to handle less toxic fractions less expensively.

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CURRENT REGULATORY FRAMEWORK

A number of regulations govern emissions from combustion units and the processes by which residuals must be managed. Because different sets of regulations apply to different segments of the combustion market, they influence the relative costs across different combustion sectors. Below, we discuss the regulatory framework separately for waste-burning kilns and hazardous waste incinerators (both commercial and on-site units). We then explain the regulations that govern ash disposal from combustion facilities. Finally, we explain how the regulations may affect the nature of competition across sectors of the combustion market.

Regulations Governing Hazardous Waste-Burning Kilns

Currently, emissions from hazardous waste-burning kilns are regulated under the 1991 Boiler and Industrial Furnace Rule.[28] This rule establishes destruction and removal efficiency requirements (DREs) for dioxin-listed wastes and other organic hazardous wastes. In addition, the rule establishes emission limits for toxic metals, hydrogen chloride, chlorine, and particulate matter. The rule also controls products of incomplete combustion (PICs) by limiting flue gas concentrations of carbon monoxide and hydrocarbons. In addition, the rule establishes Part B RCRA permit requirements to ensure that kilns are operating within the specifications of the rule. Although several waste-burning kilns have applied for final Part B RCRA permits, as of mid-1997 only one of these facilities has actually obtained a final permit. Hazardous waste-burning kilns that do not have RCRA permits operate under "interim status," which requires compliance with the substantive emission controls for metals, chlorine, particulates, and carbon monoxide (and, where applicable, HC and dioxins and furans).

The BIF rule conditionally exempts from regulation kilns that burn small quantities of hazardous waste fuel. This exemption is known as the "small quantity burner exemption." The small quantity burner exemption is a risk-based exemption mentioned in the statute. The exemption is provided only to hazardous waste fuels generated on-site and is conditioned on a number of requirements, including a one-time notification and recordkeeeping.

[28] Emissions from cement kilns that do *not* burn waste will be regulated under the Portland Cement MACT (proposed March 13, 1998). Cost estimates in the *Assessment* are incremental to the current baseline and do not account for the proposed Portland Cement MACT (see Chapter 4).

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Regulations Governing Hazardous Waste Incinerators

Title 40 in the *Code of Federal Regulations,* Parts 264 and 265, regulate hazardous waste incinerators.[29] This rule establishes performance standards for dioxins and other organic pollutants, particulate matter, and hydrogen chloride. In general, standards for these pollutants are more stringent than those set for kilns. However, the existing regulations for incinerators do not directly control either toxic metal emissions or products of incomplete combustion (PICs).

Unlike RCRA combustion units, incinerators used for CERCLA cleanups must comply with the *substantive* requirements of the RCRA and Title VI CAA regulations (e.g., emission levels) but not with the *administrative* requirements (e.g., reporting).[30] In fact, CERCLA units do not require Title V permits to operate; they must simply meet applicable, relevant, and appropriate requirements (ARARs).[31]

Ash Disposal

Ash from hazardous waste incinerators is also considered a hazardous waste. Facilities must dispose of the material in a permitted hazardous waste landfill at a cost of $74 to $147 per ton.[32] By comparison, ash from cement kilns or LWAKs is often integrated into their products. Even when ash cannot be used in their products, the kilns can sell the ash or deposit it on-site as a non-hazardous material at a cost of slightly over $3 per ton.[33] This ash from kilns can be treated as non-hazardous because it is exempt under RCRA Subtitle C, as discussed in Section 3001(b)(3)(A), the so-called Bevill Amendment.

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[29] 40 CFR 264.343 (1997)

[30] Robin Anderson, U.S. EPA, OSWER, personal communication, May 21, 1998.

[31] Andrew Opalko, U.S. EPA, personal communication, May 8, 1998.

[32] Mohsen Zadeh, Energy and Environmental Research Corporation, personal communication, March 11, 1997.

[33] U.S. EPA, 1993. *Report to Congress on Cement Kiln Dust*, 9-10.

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EPA regulatory initiatives are likely to change this balance within a few years. Future regulation of cement kiln dust (CKD), the ash from cement production, will likely increase the cost of managing residuals at kilns that combust hazardous wastes.[34] The impact of this change on hazardous waste markets is unclear. To the extent that waste-burning and non-waste burning kilns face the same CKD management costs, it is likely that cement markets rather than waste-burning markets will change as a result.

Effect of Regulatory Differences on Market Competition

Differences in the requirements for fully permitted facilities can create economic advantages for one sector over another. In addition, interim status under the BIF rule can create temporary benefits for BIFs that disappear once a unit is fully permitted. In reality, these temporary benefits can sometimes last many years.[35] Representatives from each industry claim that their facility type is more stringently regulated than the other, and thus subject to higher costs. In addition to differences in the disposal requirements for combustion residuals, already discussed above, industry representatives claim that waste-burning kilns have lax standards for metal emissions relative to commercial incinerators. These representatives also argue that the destruction and removal efficiency (DRE) verification does not need to occur for BIFs until a full permit is issued.

Conversely, the cement kiln industry asserts that incinerators have an advantage under current regulations. For example, Subpart O regulations do not require extensive feed rate analysis on a continuous basis and do not establish metal-specific emission limits.[36]

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[34] In January 1995 EPA published a regulatory determination which stated that additional control of the cement kiln dust from hazardous waste-burning kilns and non-hazardous waste burning kilns is warranted. In the regulatory determination EPA agreed to develop additional regulations under RCRA Subtitle C and, if necessary, the Clean Air Act. Currently, RCRA does not regulate cement kiln dust, which the 1980 Bevill amendment excluded from regulation pending EPA study.

[35] As of June 1995, for example, all waste burning cement kilns were operating under interim status. (Karen Randolph, U.S. EPA, personal communication, June 13, 1995.)

[36] The incinerator regulations do not require metal emissions standards, but limit particulate matter emissions. Since low particulate matter emissions do not necessarily correspond with low toxic metals emissions, opponents view the controls as inadequate. (Bureau of National Affairs. 1995. “Cement Industry ‘Enforceable Agreement’ Would Replace Agency’s Plan for Kiln Dust.” *Environmental Reporter*, 1645).

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The validity of these claims is difficult to gauge. Baseline emissions (described in Chapter 1) suggest that BIFs have higher average emissions of mercury and semi-volatile metals than do incinerators. Incinerators emit more low volatility metals. However, these data cannot be used to compare emissions per ton of waste burned across sectors. Nor do they provide insights into the cost savings to any sector attributable to higher emissions. The MACT will alleviate some of these cost advantages because the standards are likely to ensure that human health and the environment are protected equally across combustion sectors and on a nationwide basis.

COMBUSTION MARKET PERFORMANCE

Historical Performance

Throughout much of the 1980s, hazardous waste combustors enjoyed a strong competitive position. In spite of their high capital costs, incinerators were extremely profitable. EPA regulations requiring combustion greatly expanded the waste tonnage requiring treatment. Federal permitting rules, as well as powerful local opposition to incinerator siting, constrained the entry of new combustion units. As a result, combustion prices rose steadily, reaching nearly $640/ton for clean high-Btu liquids and $1,680/ton for sludges and solids in 1987.[37] Profits were equally high. For example, after-tax profits earned by Rollins Environmental Services, a firm operating primarily in the incineration sector, peaked at 16.4 percent that year.[38] The high profits induced many firms to enter the permitting and siting process for new combustion units, despite the inevitable delays in obtaining the required operating permits.

Hazardous waste combustion markets have changed significantly since the 1980s. In the early 1990s, the industry entered a period of substantial overcapacity, resulting in fierce competition, declining prices, poor financial performance, numerous new project cancellations, and some facility closures. Within the past few years, several additional combustion facilities have closed; many of those that remain open have combined with other combustion facilities and then further consolidated their operations.[39]

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[37] Midpoint values from industry survey data presented in ICF Incorporated, *1990 Survey of Selected Firms in the Hazardous Waste Management Industry*, prepared for the U.S. Environmental Protection Agency, Office of Policy Analysis, July 1992, 2-5.

[38] Wayne Nef. June 24, 1994. “Rollins Environmental Services.” *Value Line*, 352.

[39] EPA's List of Permitted Hazardous Waste Combustion facilities indicates that some commercial facilities have retracted pending permits and others have exited the market. (See: Shaye Hokinson, Alice Yates, Alexi Lownie, and Doug Koplow, "Core Combustion Data Update," memorandum prepared by Industrial Economics, Incorporated for U.S. EPA, 23 August 1996.

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The demand for combustion at mobile incinerators has also decreased in the 1990s. Two factors are largely responsible for the decline: the high cost of incineration and the public and governmental opposition to high-temperature incinerators, due to potential human health risks.[40] As a result, several mobile incinerators have ceased operating or have merged with other companies. In addition, some of these firms have moved a portion or all of their processes overseas.[41]

Overcapacity and Effects on Poor Market Performance

Despite the recent consolidation activity in the combustion industry, overcapacity remains. According to surveys of the combustion industry, capacity utilization estimates have decreased significantly from 1980 levels, which were in the 80 percent range. By 1995, the capacity utilization rates dropped to rates of around 50 percent. As shown in Exhibit 2-6, commercial incinerators have the lowest capacity utilization, at an average of 42 percent.[42]

Although EPA-promulgated land disposal restrictions (LDRs) increased waste quantities managed across combustion sectors, these increased quantities were insufficient to offset the following factors:

- **New Combustion Supply**. Most of the new combustion supply came on-line in the 1980s. The new supply came both from new and expanded combustion units. In recent years, however, companies have canceled many projects with the price declines of the past few years. The closing of certain facilities, however, has prompted others to expand so that they can attract the new waste streams in the market. In addition, the elimination of waste processing bottlenecks (e.g., waste storage capacity) has also expanded the capacity of some facilities already in operation. New combustion capacity is also expected to come on-line in the near future; the Louisiana Department of Environmental Quality is issuing a permit that will allow an additional 550,000 tons per year of capacity at a GTX incinerator.

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[40] US EPA, Solid Waste and Emergency Response, Technology Innovation Office. April 1997. "Clean Up the Nation's Waste Sites: Markets and Technology Trends: 1996 Edition"; Gwen Fairweather, Steven Brown, and Michael Berg, ICF, "Memorandum: QRT #1, WA B-30, EPA Contract 68-W6-0061," prepared for Lyn Luben, OSW/EPA, and Kevin Brady, IEc, June 13, 1998.

[41] Gwen Fairweather, Steven Brown, and Michael Berg, ICF, "Memorandum: QRT #1, WA B-30, EPA Contract 68-W6-0061," prepared for Lyn Luben, OSW/EPA, and Kevin Brady, IEc, June 13, 1998.

[42] Actual tons figures are from 1995 BRS; capacity estimates are converted from trial burn feed rate data and assume operating rates of 8,000 hours per year.

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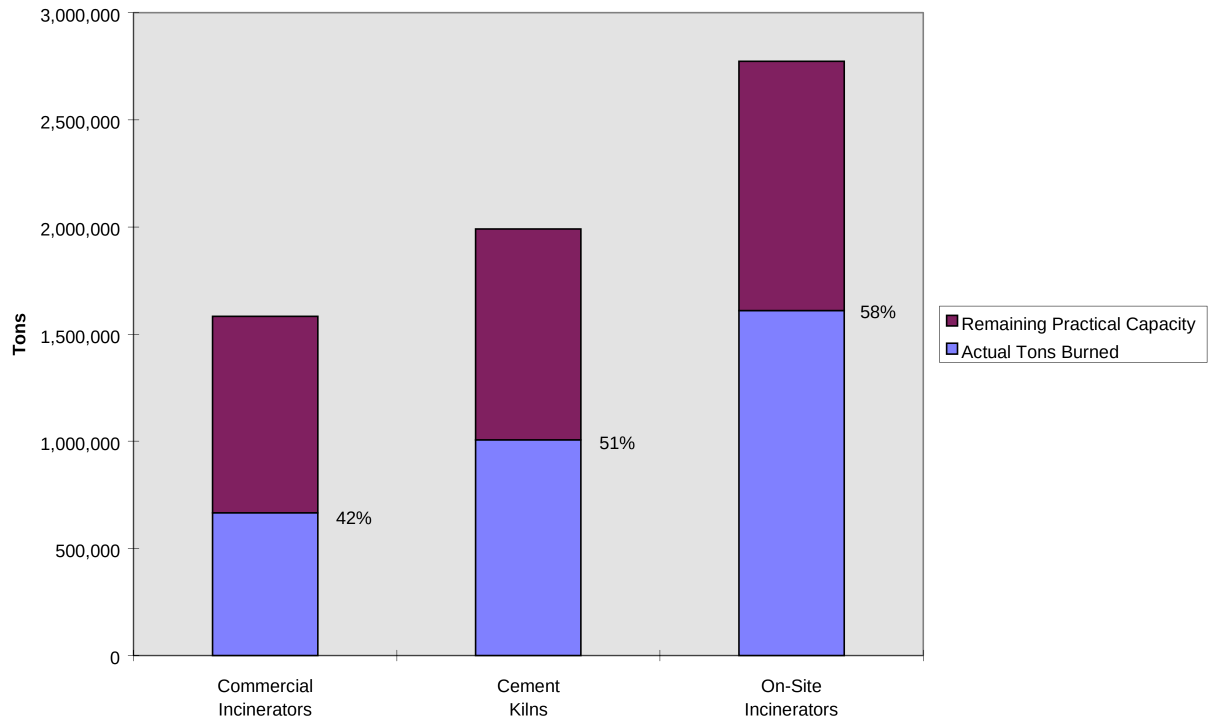
Exhibit 2-6
AVERAGE CAPACITY UTILIZATION AT HAZARDOUS WASTE-BURNING FACILITIES



Source: 1995 BRS; "HW Feed Data Update" (Electronic communication from EER), July 14, 1998.

- **Increased Solids-Burning Capability in Kilns**. Fuel blenders have improved their ability to suspend solids in liquid wastes. One fuel blender, for example, estimates that suspended solids comprise 20 to 25 percent of the facility's hazardous waste-derived fuel.[43] Suspending solids in liquid waste has greatly expanded the effective solids burning capacity among kilns that could previously only burn liquids and has driven down prices in this formerly high-profit segment. This practice has also improved the financial performance of fuel blenders. As discussed in the April/May 1995 issue of *Hazardous Materials Management*, "To improve margins, fuel blenders have recently increased the solid content of the mixtures they send to the kilns."

[43] Fuel blender, personal communication, May 29, 1997.

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- **Waste Minimization Efforts**. Industry efforts to minimize hazardous waste generation have reduced the quantity of wastes requiring treatment.

- **Substitution of Alternative Technologies in Remediation Market**. On-site units are likely to handle much of the future combustion demand for remedial wastes. In addition, new alternative technologies, such as thermal desorbers, have further weakened demand.

Structural Advantages for Waste-Burning Kilns

Kilns possess two major structural advantages in the combustion of hazardous wastes that will remain regardless of federal regulatory actions. First, they are able to recover the energy content of the wastes in their production process. Second, they can use existing production capital equipment to combust hazardous wastes.

- **Energy Recovery.** Waste-burning kilns can use the heating value of hazardous waste fuels to offset purchases of virgin fuels that would otherwise be necessary to achieve required heating temperatures to a much greater extent than can incinerators.[44] A commercial incinerator uses process heat to break down and destroy hazardous organic wastes, while a cement kiln uses the heat both to break down wastes and to manufacture cement, a saleable end product.

- **Shared Capital.** Even in the absence of energy recovery advantages, cement kilns still enjoy an advantage based on their ability to produce a saleable product. A commercial incinerator must purchase all of its capital equipment to combust hazardous wastes and control emissions from the process. In contrast, a cement kiln purchases capital equipment to manufacture cement, and this equipment can also destroy hazardous wastes. While there are some incremental capital purchases required for a kiln to burn hazardous wastes, these are small relative to the overall cost of an incineration unit.

---

[44] Incinerators can use some cleaner solvent streams to fuel their afterburners. However, while some broader energy recovery is done at European incinerators, it is unlikely to be done in the United States. When the heat recovery process runs hot gas through a heat exchanger, the temperature of the gas flow drops, increasing the likelihood that chlorine PICs can re-form dioxins. This increases the dioxin emissions from the stack. (Retallick, op. cit.)

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The result is that the incremental cost of burning a ton of hazardous waste in a kiln is lower than the cost of burning it in an incinerator.

Market Performance Across Combustion Sectors

While the hazardous waste combustion sector overall has experienced declining prices, such a decline has affected commercial incinerators more than kilns until recently.[45] In the commercial incineration sector, industry representatives report that average prices for liquid organics fell by about 10 percent and solid prices declined by almost 20 percent between 1991 and 1993. From 1994 to 1996, prices began to level off, although for some waste categories, such as cleaner liquid streams, prices declined slightly. Prices in the cement kiln sector remained mostly stable from 1991 to 1993, as measured by the prices that fuel blenders paid to cement kilns. However, the prices have declined slightly in 1994 through 1996. Kilns continued to accept wastes at lower prices than incinerators. This is due, in part, to the kilns' lower costs and in part to the higher heat content of the waste streams they receive.

Financial Performance and Profitability

Financial performance indicators help contrast the condition of incinerators and cement kilns but are subject to two caveats. First, financial data for Rollins Environmental Services, which has recently merged with Laidlaw Environmental Services, Inc., serves as a proxy for the entire commercial incinerator sector because data on other firms include substantial non-incinerator assets and because Rollins was a large portion of the industry. Performance of incinerators owned by other firms may be somewhat different from Rollins, though we have no reason to believe that these differences are large. Second, cement markets heavily influence financial performance for cement kilns. Nonetheless, the baseline costs of hazardous waste combustion in the kilns (detailed in Appendix B) suggest strong returns on waste burning.

[45] As demand for mobile incineration diminishes and firms introduce new remediation technologies, prices for mobile incineration have also declined.

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Examining financial returns for Rollins Environmental Services provides some insights into the economics of the incineration segment of the market because Rollins derived nearly 80 percent of revenues from incineration. The firm's net profit margin peaked at 16.4 percent in 1987, and remained quite high until 1992. The net profit margin dropped to 5.6 percent in 1993, and the firm lost money in 1994, 1995, and 1996.[46]

Cement industry profits, which are presently stronger than in the commercial incineration segment, have followed an upward trend over the past few years. Net profit margins were 2.8 percent in 1993, 5.7 percent in 1994, and 8.1 percent in 1995. Net profits continued to increase to 9.5 percent in 1996 and 10.4 percent in 1997.[47]

The return-on-equity ratio (ROE) measures the financial returns to investors in a firm or industry. As these returns fall, it becomes more difficult for firms to raise new funds in capital markets. Rollins' ROE between 1985 and 1988 was above 20 percent, a better performance than the environmental services sector overall. With the increase in incineration overcapacity, Rollins' ROE declined steadily to only 5.6 percent in 1993 and turned negative in 1994.

Average returns to shareholders in the cement industry dropped from 8.6 percent in 1990 to only 0.1 percent in 1991 as a result of the recession. The ROE had recovered to 6.8 percent in 1993, and 10.3 percent in 1994.[48] By 1997 the ROE was 16.9 percent.[49] This implies that the cement industry may be able to raise investment capital more readily than the commercial incineration sector over the next few years.

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[46] Wayne Nef. March 24, 1995. "Rollins Environmental Services." *Value Line*, 350; SEC's Edgar Database - Internet Address: www.sec.gov/archives/edgar/data.

[47] Thomas Mulle. January 20, 1995. "Cement and Aggregates." *Value Line*, 891; Christopher Coyle. April 17, 1998. "Cement and Aggregates." *Value Line*, 894.

[48] Mulle, op. cit., p. 891; Christopher M. Coyle. April 17, 1998. "Cement and Aggregates." *Value Line*, 894.

[49] Christopher M. Coyle. April 17, 1998. "Cement and Aggregates." *Value Line*, 894.

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This chapter provides the necessary information for specifying the regulatory "baseline," which describes the world absent the hazardous waste combustion MACT standards. Specifying the baseline is necessary for accurately estimating incremental MACT compliance costs and risk-reduction benefits, as well as for evaluating economic and distributional effects of the MACT standards (e.g., market exits, employment shifts). According to the Office of Management and Budget, "the baseline should be the best assessment of the way the world would look absent the proposed regulation. That assessment may consider a wide range of factors, including the likely evolution of the market, likely changes in exogenous factors affecting benefits and costs, likely changes in regulations promulgated by the agency or other government entities, and the likely degree of compliance by regulated entities with other regulations."[1] While Chapter 2 provides a general description of the market, regulations, and other exogenous factors (i.e., energy price fluctuations), this chapter summarizes conclusions from Chapter 2 critical for the baseline specification. We organize this chapter into two main sections -- a baseline profitability analysis and a discussion of emissions and pollution control practices. Each section describes the assumptions and data sources for the baseline elements identified below.

The "Baseline Economic Assumptions" section presents our assumptions about key characteristics of hazardous waste combustion markets in the absence of the MACT rule. This includes characterization of the following elements:

- **Hazardous Waste Combustion Prices —** the price that combustion facilities charge for their services affects the facilities' ability to cover operating costs and any additional costs imposed by the MACT standards. This section describes our assumptions about the anticipated evolution of combustion prices and the prices we use in the economic impact analysis.

[1] Office of Management and Budget (OMB). 1996. *Economic Analysis of Federal Regulations Under Executive Order 12866*, p. 9.

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- **Quantities of Combusted Hazardous Wastes —** like prices, changes in hazardous waste quantities managed by combustion affect the degree to which combustion facilities cover operating costs. Due to the high fixed costs of certain types of hazardous waste combustion, waste quantities are especially important to a firm's profitability. This section describes our source for hazardous waste quantity estimates and how market changes will affect quantities combusted over time.

- **Energy Savings —** for waste-burning kilns, the decision to burn also depends on savings from avoided energy purchases. This section includes information on the conventional fuel mix at kilns and fuel prices.

- **Transportation Costs —** for on-site incinerators, avoided costs also include shipping costs. This section describes our data assumptions for transportation costs.

- **Baseline Costs of Waste-Burning —** we require baseline cost estimates to assess baseline profitability and to identify marginal facilities that may exit the market even in the absence of the MACT standards. This section summarizes the approach and results from the baseline cost analysis.

- **Future Capacity —** after developing data assumptions for the revenue and cost components above, we then project longer term capacity trends in light of current profitability.

The "Emissions and Pollution Control Practices" section establishes baseline emission profiles and current pollution control practices in the industry. We describe the following baseline elements in this section:

- **Baseline Emissions —** we characterize baseline emissions so that emission reduction projections and subsequent human health and ecological benefit estimates are incremental to the baseline.

- **Pollution Control Practices —** we define baseline pollution control practices to assess the type of engineering retrofits and other pollution control measures needed at specific combustion facilities. Characterizing this baseline element ensures that compliance cost estimates are incremental to the baseline (i.e., we do not assign pollution control costs if a facility currently employs this particular control).

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BASELINE ECONOMIC ASSUMPTIONS

We evaluate baseline economics of hazardous waste combustion facilities to assess whether facilities will continue waste burning, even in the absence of the increased costs associated with the MACT standards. This information is then used to assess other economic impacts, such as employment shifts and waste quantities diverted, on an incremental basis. As described in Chapter 2, current overcapacity in the combustion market has resulted in poor financial performance across the combustion industry (e.g., declining and even negative operating profits). By identifying the combustion facilities that are non-viable in the baseline, we can avoid attributing the market exit of these facilities to the MACT standards. Given market performance, we do not expect any significant activity in terms of new entry to the market.

We assess baseline profitability of each modeled system by determining whether a combustion system is burning enough waste to adequately cover the costs of operation and realize a reasonable return on capital.[2] Operating profits are calculated as follows:

Operating Profits = Waste Burning Revenues - Waste Burning Costs

Where:

Waste Burning Revenues = Combustion revenues + Avoided energy costs (for cement kilns and LWAKs) + Avoided transportation costs (for on-site incinerators)

Waste Burning Costs = Baseline costs of hazardous waste burning

Operating profits are calculated before tax and deductions for plant and corporate overhead. After-tax profits would be lower. We describe each of the baseline revenue and cost components in more detail below.

As shown in the equations above, we require a number of data inputs to calculate baseline revenues and costs for each modeled combustion system. We describe our assumptions for each of the revenue and cost components below, in light of the current and future expected activity in the combustion market.

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[2] Because baseline costs of burning also include a capital recovery factor, at breakeven, facilities also realize a reasonable return on capital.

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Hazardous Waste Combustion Prices

The combination of decreasing demand and overcapacity in the hazardous waste market has contributed first to declining prices, then to fairly constant, low prices, which we assume will approximate the hazardous waste combustion prices at the end of the 1990s. In the *Assessment* we specify prices for seven waste categories, reflecting differences in waste form (liquid, sludge, or solid), as well as other waste characteristics, such as contaminant concentrations (e.g., metals, mercury), heat content, and water content. Pricing data are shown in Exhibit 3-1 and represent average market prices.[3]

Exhibit 3-1

WASTE PRICES FOR FINAL ECONOMIC IMPACT MODEL
(price per ton in 1996 dollars)

Liquids			Sludges		Solids	
Comparable Fuels	**With Suspended Solids**	**Highly Contaminated**	**Less Contaminated**	**Highly Contaminated**	**Less Contaminated**	**Highly Contaminated**
$20 (Baseline) $0 (post-MACT)	$70	$301	$320	$630	$683	$1,281

Notes:

1. We base the prices on information obtained from industry representatives in 1997. We use the GDP implicit price deflator to convert these values to 1996 dollars.
2. Contaminants evaluated include halogen, mercury, lead, cadmium, and water. (Lauren Fusfeld, Alice Yates, Tom Walker, Industrial Economics, Inc., November 17, 1997. "Preliminary Findings from NHWCS Database to Inform Distribution of Waste Types Across Combustion Systems," Memorandum prepared for Lyn Luben, U.S. EPA.)
3. We expect that combustion facilities will not charge a tipping fee for comparable fuels, and thus the price drops to $0 post-MACT.
4. CKRC, the hazardous waste burning cement kiln industry group, reported revenue estimates for wastes burned by cement kilns of about $67 per ton (cement kilns generally burn liquids with lower-contaminant levels than commercial incinerators). This difference may be a result of pricing arrangements between cement kilns and fuel blenders. EPA conducted a sensitivity analysis to assess the impact of this pricing difference and found that market exit estimates did not change. (For more information, see: "Evaluation and Use of Data Submitted by the Cement Kiln Recycling Coalition," 30 June 1999 (Docket Number F-97-CS4A-FFFFF).

[3] We incorporate price changes associated with the comparable fuel exclusion to project prices post-MACT. The comparable fuel exclusion is one component of the "Fast-Track" rulemaking that allows a conditional exclusion from RCRA Subtitle C for wastes that are similar to conventional fossil fuels (verified by testing and analysis). We expect that combustion facilities will not charge a tipping fee for comparable fuels, and thus the price drops to $0 post-MACT.

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The price estimates we use in this document represent the prices received by combustion facilities, and not intermediaries (e.g., we use tipping fees paid to cement kilns, and not to fuel blenders).[4]

With the exception of a few on-site facilities handling specialized wastes, we apply the prices in Exhibit 3-1 to estimate waste-burning revenues. However, for those few facilities known to burn specialized waste such as explosives and low-Btu aqueous wastes, we adjust prices upward to reflect the actual market prices for these waste types.[5]

Hazardous Waste Quantities

The total quantity of waste combusted for destruction and energy recovery has varied slightly over the 1990s, as shown in Exhibit 3-2. In total, combustion facilities managed about three million tons in 1995.[6] From 1991 to 1993, the quantity of waste combusted increased approximately 1 percent; from 1993 to 1995, combusted waste quantities increased by 9 percent. From 1991 to 1993, the greatest increase occurred in the on-site incinerator sector. From 1993 to 1995, the greatest increase in tonnage combusted occurred in the commercial incineration sector. In more recent years, the growth rate of combusted hazardous waste quantities has slowly decreased in both the commercial incineration and on-site incineration sectors. In fact, industry representatives note that the absolute quantities of waste combusted by commercial energy recovery facilities decreased in 1995 and 1996. As discussed in Chapter 2, several factors contributed to the diminished growth rate of demand for hazardous waste in the 1990s. These include waste minimization, source reduction, and the substitution of alternative remediation treatment technologies, such as thermal desorbers.[7]

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[4] This practice is consistent with public comments. For example, one industry trade group, CKRC, points out, "the revenues that accrue to the cement kilns are far more relevant to assessing the impact of the proposed MACT rule than are revenues received by the fuels managers," (Susel and Sessions 1997, 10).

[5] We adjust prices for two of the 34 private on-site incinerators and one of the 15 commercial incinerators in the economic model.

[6] Note that our waste analysis does not include wastes handled by mobile incinerators.

[7] Maureen M. Cromling. December 1996. "A Year of Challenges and Achievements." *Environmental Business Journal*, 11; "Redefining Hazardous Waste." June 1996. *Environmental Business Journal*, 5; "Commercial Hazardous Waste Management Facilities: 1997 Survey of North America." March/April 1997. *Hazardous Waste Consultant*, 4.2, 4.6.

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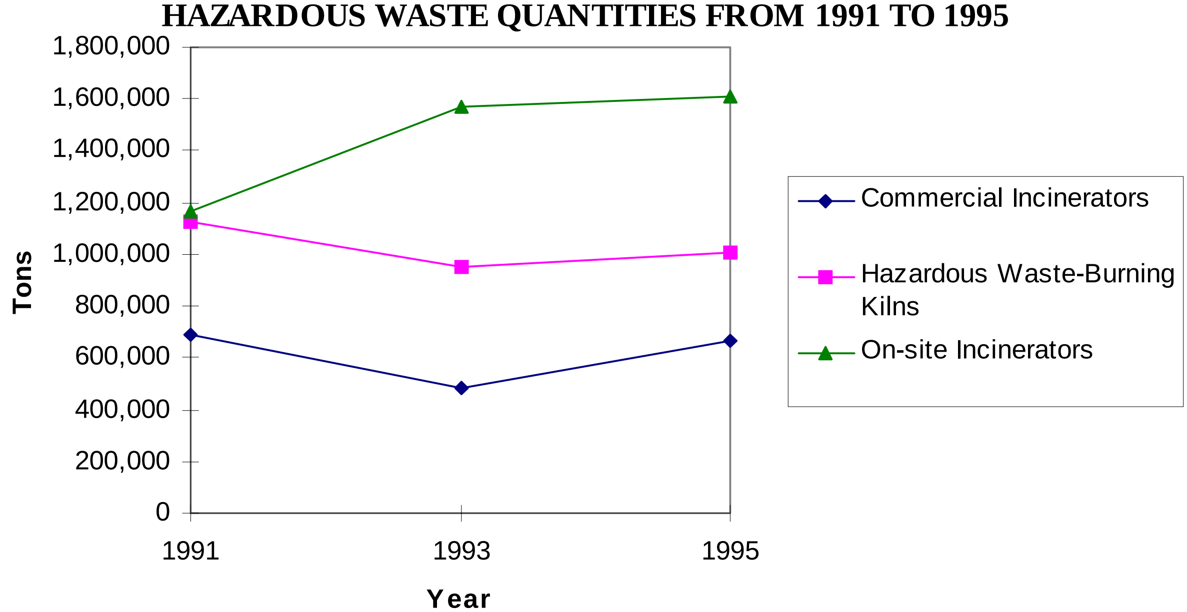
As indicated in Exhibit 3-2, our primary data source for hazardous waste quantities managed at combustion facilities is EPA's Biennial Reporting System, a national system that collects data on the generation and management of hazardous waste. The BRS captures data on two groups of RCRA-regulated hazardous waste handlers: non-household Large Quantity Generators and Treatment, Storage, and Disposal facilities (TSDs). These facilities must submit a report every other year detailing the quantities and composition of the waste, along with the management method used for handling the waste. BRS data exist for odd-numbered years; 1995 is the latest year for which final BRS data are currently available.[8] Thus, while prices are from 1997, because we do not expect any significant changes in total hazardous waste quantities combusted from 1995 to 1997, this difference in years should not bias the results.

Exhibit 3-2

HAZARDOUS WASTE QUANTITIES FROM 1991 TO 1995



Sources: 1991, 1993, and 1995 Biennial Reporting Systems.

Note: The analysis does not include wastes managed at mobile incinerators.

We use facility-specific tons burned data from the 1995 BRS in the economic assessment model. To match the waste streams with the available pricing data, we group wastes by BRS form code (i.e., wastes are categorized as liquids, solids, or sludges) for each facility and then further characterize the wastes using sector averages from EPA's National Hazardous Waste Constituent

[8] The U.S. EPA, 1997, Biennial Reporting System (BRS) data are expected in late 1998 or early 1999.

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Survey (NHWCS) which provides more detailed constituent concentration data. For facilities for which there was no form code information, we use sector averages to distribute the waste across the seven waste categories. For facilities that have more than one combustion system, we evenly distribute waste quantities across systems.

While total waste quantities combusted have not changed significantly over the past several years, for particular facilities, tons burned may vary significantly from year to year. This may make certain facilities appear non-profitable in the baseline or post-MACT, where in fact, these facilities are willing to operate at a loss for a single year, with the expectation that in the following year they will more than regain their losses. Year-to-year variability may also make certain facilities appear more economic if the quantities from 1995 are high-volume due to special circumstances. On the whole, these factors should cancel out each other, such that the economic impact results presented in Chapter 5 are not biased either upward or downward, particularly given the relatively constant level of overall demand for combustion services.

Because the demand for hazardous waste combustion has leveled off over the past few years and we do not foresee any significant changes in the factors contributing to decreased demand, using facility-specific information from 1995 should be adequate for the purposes of this analysis. It is important to note, however, that economic impact results are sensitive to the tons burned assumptions. The economic analysis would need to be revisited if waste generation or management behavior change markedly.

Energy Savings

In addition to the revenues facilities earn from combustion fees, we estimate the savings to cement and lightweight aggregate kilns from avoided energy purchases. To calculate energy savings, we first convert the waste quantities burned into an energy equivalent (in million Btus per pound).[9] We compare the energy content of the waste fuels to the energy content of conventional fuels displaced by waste burning. Then we calculate the quantity of conventional fuel the cement kilns would have to buy if they were unable to obtain hazardous waste. We assume that conventional fuel for cement kilns is 91.1 percent coal and 8.9 percent natural gas.[10]

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[9] We used the average Btu/lb estimates used in the baseline cost models. These models assumed 13,111 Btu/lb for liquids burned by cement kilns and 10,767 Btu/lb for liquids burned by lightweight aggregate kilns. For sludges and solids burned by both types of kilns, we used an average heat content of 9,733 Btu/lb. *See Appendix B for more information.*

[10] Portland Cement Association, Economic Research Department. 1996. *U.S. Cement Industry Fact Sheet: 14th Edition*, *Table 24: Fossil Fuel Mix*, 17.

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Avoided Transportation Costs

We also account for transportation costs in the avoided costs of on-site incinerators. Assuming an average distance of 200 miles, the cost of transporting liquid waste to a commercial incinerator was estimated to be $53/ton in 1996 dollars. The cost of transporting sludges and solids was estimated to be $50/ton in 1996 dollars.[11]

Baseline Waste-Burning Costs

To evaluate baseline profitability we also need estimates of the baseline costs of combustion for each modeled facility. Baseline costs suggest important differences across combustion segments that significantly influence competitiveness. The results of the baseline cost analysis provide a core input to the combustion cost model. Below, we summarize how these baseline costs are estimated. A more detailed description of the approach, as well as detailed results, can be found in Appendix B.

The objective of the baseline cost analysis is to estimate the total costs (variable and fixed) of burning a ton of hazardous waste in combustion units of different types. In the case of incinerators, this baseline cost is simply the variable and fixed costs of the facility (prior to new pollution control requirements), since incineration is the sole function of the facility. For cement kilns and LWAKs, the decision is whether to burn hazardous waste or some other fuel. In this case, we need to know the incremental costs introduced by the decision to burn hazardous waste rather than conventional fuel; this is the cost that would be avoided if the facility chose to burn conventional fuel. These incremental costs might include permitting costs, the cost of insurance, and the cost of special hazardous waste handling procedures and equipment. Because the same kiln is required for cement production regardless of hazardous waste combustion activities, no kiln capital costs are included in the baseline cost estimates for cement kilns.

The baseline cost analysis involved three key tasks:

- Identification and classification of combustion cost components;
- Quantification of combustion cost components; and
- Development of annualized baseline combustion cost estimates for each combustion system in the cost model.

[11] DPRA, Incorporated, September 1994, "Estimating Costs for the Economic Benefit of RCRA Non Compliance," Prepared for U.S. EPA, Office of Regulatory Enforcement. 5-4. Data were inflated to 1996 prices using the GDP implicit price deflator.

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EPA first identified the key elements of baseline costs for kilns and incinerators. For cement kilns, key cost components include waste storage, waste sampling and analysis, and waste-specific labor. For incinerators, key components include the cost of the combustion system and air pollution control device (APCD) units already installed, labor, and incinerator ash disposal. Both cement kilns and incinerators incur permitting costs. These costs are also included in the baseline costs.

We then classified the baseline cost components into three categories: fixed annual capital; fixed operating and maintenance costs (O&M); and variable costs. Fixed annual capital costs refer to expenditures lasting multiple years. This includes capital equipment and operating permits. Costs have been annualized using a 10 percent interest rate to convert the total capital cost to a series of equal annual payments over the estimated life of the capital.[12] Fixed O&M costs include items such as annual machine repairs. These costs recur every year, but do not vary significantly in proportion to the quantity of hazardous waste burned. Variable costs include items such as supplemental fuel and some labor costs that increase in proportion to the amount of waste burned. Annual variable costs are derived by multiplying variable costs per ton of waste burned by the number of tons burned.

After identifying the key cost components to include in the baseline analysis, engineering cost models were developed separately for incinerators and kilns to estimate baseline costs for each combustion system.[13] The engineering cost models use combustion system-specific parameters such as the size and type of the unit (e.g., wet vs. dry, rotary vs. liquid injection) to calculate costs for each combustion system. The cost components for each system were divided into fixed and variable costs of hazardous waste combusted. We separated annual capital recovery figures from the other annual fixed costs because annual fixed O&M costs would cease if a unit stopped combusting hazardous waste, while capital costs apply to equipment already purchased and therefore could not be recovered.[14] We relied on a number of sources, including trade journals, discussions with

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[12] A 10 percent real rate of return was used to calculate a capital recovery factor (CRF) using the following equation:

$$CRF = \frac{i\,(1+i)^n}{(1+i)^n - 1}, \textit{where } i = 10\% \textit{ and } n = 10, 15, \textit{or } 20 \textit{ years}.$$

The 10 percent annualization factor matches the rate of return recommendation for private investment in the OAQPS Control Cost Manual, January 1990.

[13] Energy and Environmental Research Corporation, *Revised Estimation of Baseline Costs for Hazardous Waste Combustors for Final MACT Rule*, Prepared for Industrial Economics, Inc. and US EPA, Office of Solid Waste Management Division, August 20, 1998.

[14] The distinction between fixed O&M and fixed capital is important in our calculation of short-run breakeven quantities. While fixed capital is sunk and need not be recovered for a unit to continue burning waste, fixed O&M is a recurring cost and must be recovered through revenues.

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facilities, and engineering judgment, to quantify the baseline cost components. The sources for each component along with more detailed information about the baseline cost methodology are provided in Appendix B.

Based on the judgment of engineering experts, the baseline cost estimates assume continuous operation for every combustion sector, except on-site incinerators. We assume on-site incinerators operate in batch mode because they are generally small, combust relatively small quantities of hazardous waste, and would consume a great deal of energy if they were to be operated continuously.[15] On-site incinerators are also assumed to burn only hazardous wastes. To the extent that non-hazardous wastes are also burned, the fixed costs per ton of hazardous waste burned would decline. (This issue, along with other factors affecting the economics of on-site burning is discussed further in Chapter 2.)

Baseline combustion costs for the different combustion sectors are summarized in Exhibit 3-3. As shown, baseline costs for incinerators differ dramatically from those for kilns. We expect this difference because baseline costs for kilns do not include capital costs. Baseline costs vary most widely across on-site incinerators. This is a product of the different types and sizes of on-site incinerators. Across all sectors, larger systems have a lower fixed costs per ton of capacity. These economies of scale illustrate the importance of capacity utilization; a large facility can have extremely high costs per ton of waste actually burned if much of its combustion capacity is not being utilized.

Future Capacity

We project future capacity in the combustion industry by assessing the baseline profitability of each system in the model. We first determine if the combustion system is covering its short-term costs (which include both fixed and variable operating and maintenance costs). We then assess longer term future capacity by evaluating profitability over the capital replacement cycle. We use future capacity projections so that costs and economic impacts are incremental to the baseline. In other words, if a facility is not currently covering its long-term costs, we do not attribute market exit to the MACT rule because we expect that over the longer term, this facility will exit the market even in the absence of the MACT standards. To reflect the uncertainty of the data assumptions, we also estimate costs and economic impacts assuming constant capacity.

[15] This assumption leads to lower annual O&M costs, reducing the cost per ton combusted.

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Exhibit 3-3

ANNUAL BASELINE COSTS FOR EXISTING COMBUSTION SYSTEMS

Sector	Average Tons Per System	Average Capital (Annualized) Costs	Average Fixed O&M Costs	Average Variable O&M Costs	Total Costs (Capital Costs + O&M)	Median Total Cost Per Ton
Cement Kilns	26,567 (11,526 - 96,012)	$389,075 ($262,828 - $601,529)	$503,959 (409,690 - 677,138)	$832,076 (338,773 - 2,728,03)	$1,725,110 ($1,152,352 -$3,696,451)	$67 ($35 - $121)
LWAKs	331,397 (102,248 - 675,620)	$242,574 ($189,363 - $314,260)	$461,803 ($410,004 - $565,880)	$184,473 ($126,491 - $246,312)	$888,849 ($766,155 - $1,073,878)	$4 ($1 - $10)
Commercial Incinerators	25,034 (206 - 96,080)	$1,669,073 ($437,841 - $3,141,895)	$1,306,425 ($864,210 -$1,874,319)	$2,606,140 ($77,533 - $7,403,559)	$5,581,639 ($1,379,584 - $11,587,124)	$278 ($76 - $6,697)
Private Incinerators	16,703 (0 - 113,217)	$678,926 ($191,292 - $1,780,392)	$320,416 ($110,771 - $812,304)	$1,572,833 ($21 - $13,078,031)	$2,568,183 ($421,287 - $14,294,148)	$303 ($23 - $1,381,339)

Notes:

1. Baseline costs not included for government incinerators because we assume these systems remain operational regardless of cost. While this assumption may overstate costs and understate closures post-MACT, EPA believes this is a reasonable assumption because in general these systems burn specialized wastes.
2. Cost averages appear at the top of each cell, except the "Total Cost per Ton" column which presents the median values. Minimum and maximum values appear in parentheses.

In the short term, most combustion systems are adequately covering their baseline waste-burning costs. Exhibit 3-4 shows the results of the short-term profitability analysis. Every cement kiln and LWAK in the model is currently burning enough waste to cover its operating and maintenance costs. Most incinerators, both commercial and on-site units, are also meeting their short-term costs. As shown in the exhibit, with the exception of one on-site incinerator, the systems not covering their short term costs are burning waste quantities significantly below the median tons burned in that sector. This result is due to the fact that the quantity of wastes burned at a facility is the most important determinant of whether a combustion system is profitable.

In the long term, over the capital replacement cycle, the total number of systems that are not covering their baseline waste-burning costs increases by a factor of five. We assess baseline profitability over the longer term by determining whether a combustion system is burning enough waste to cover the costs of operation and capital replacement and to realize a reasonable return on capital.[16] Exhibit 3-5 summarizes our results. In comparison with the short term results, one additional commercial incinerator and 40 additional on-site incinerators cannot cover waste-burning costs over the longer term capital replacement cycle. We expect these facilities will exit the combustion market over the longer term because there is no incentive for these facilities to invest in new equipment if growth for combustion services remains stagnant (i.e., we expect these facilities will leave the market regardless of the MACT standards).

Based on the profitability analysis, we expect some additional consolidation in the commercial incinerator sector and no changes in future capacity of the kiln sectors. We expect a significant number of on-site incinerators will discontinue burning over the capital replacement cycle, as they find it less expensive to ship wastes off-site to a commercial incinerator or to other waste management alternatives. Future capacity over the longer term in the on-site sector is expected to decrease by approximately 35 percent.

The profitability analysis also provides us with insights regarding the economic performance across combustion sectors. In general, kilns have lower operating profits per ton on an absolute dollar basis than commercial incinerators, reflecting the fact that they burn lower-priced liquid wastes. However, the kilns' lower baseline costs of waste burning keep all kilns operating within healthy profit margins. As noted earlier, on-site incinerators appear to be the worst performers and have many unprofitable systems.

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[16] Because baseline costs of burning also include a capital recovery factor, at breakeven, facilities also realize a reasonable return on capital.

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Exhibit 3-4

SYSTEMS THAT APPEAR NON-VIABLE IN THE SHORT TERM BASELINE

Site ID	Hazardous Waste Quantity Burned (Tons)	Breakeven Quantity (Tons)
Commercial Incinerators		
324	206	4,601
359	2,234	5,017
Total Number of Non-Viable Commercial Incinerator Systems: 2 systems (10%)		
Private On-Site Incinerators		
708	6,492	13,886
711	205	3,189
504	0	1,943
904	0	436
340	44	526
342	211	629
229	860	1,748
725	269	-
Total Number of Non-Viable Private On-Site Incinerator Systems: 8 systems (15%)		

Notes:
1. All cement kilns and LWAKs in the model appear viable in the short run baseline.
2. The source of the hazardous waste quantities data is the 1995 BRS.
3. We do not include government incinerators in this analysis because we assume that they will continue burning wastes post-MACT and will not affect future capacity projections.
4. The average and median tons per system for commercial incinerators are 25,034 and 17,092 tons, respectively. The average and median tons per system are 16,703 and 5,746 tons, respectively, for on-site incinerators.
5. Number in parenthesis represents the percent of systems non-viable in the short term baseline.
6. Where there is no breakeven quantity reported, the variable costs are significant enough to prevent the facility from being profitable.

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Exhibit 3-5

LONG TERM BASELINE OPERATING PROFITS PER TON OF HAZARDOUS WASTE BURNED (Number of Systems Falling in Profit Range)

	<$0	**$0-$50**	**$51-$100**	**$101-$150**	**>$150**
Cement Kilns	0	0	8	15	10
LWAKs	0	0	8	3	0
Commercial Incinerators	3	1	1	1	20
On-Site Incinerators	48	13	11	11	56

Notes:
1. Estimates taken from model exhibit "Baseline Operating Profits Per Ton of Hazardous Waste Burned."
2. Baseline operating profits = weighted average price per ton + weighted average energy savings per ton - total annual baseline costs per ton. Total annual baseline costs include fixed annual capital costs, fixed annual operating and maintenance costs, and annual variable costs.

This analysis is subject to numerous uncertainties. In particular, profitability calculations are sensitive to waste quantity data, which are not fully up-to-date and vary from year to year. The calculations are also sensitive to combustion prices. We rely on national average prices, and therefore may understate or overstate waste burning revenues. In addition, declining combustion profits over the past several years may reduce the ability of some kilns to cross subsidize marginal cement operations with hazardous waste revenues. EPA does not expect this to be a major issue because cement markets are extremely healthy now and because most kilns do not subsidize cement production with waste-burning profits.[17]

In the on-site incinerator sector, uncertainties may lead us to understate future capacity and overstate consolidation in the baseline. Four key factors may lead to overestimates of the number of incinerators likely to stop burning hazardous wastes in the baseline:

- Waste quantity burned data for on-site incinerators are three years old and are self-reported by combustion facilities. Inaccuracies could be substantial.

- Operators of some on-site incinerators may continue to operate units at a loss to avoid liabilities associated with off-site shipments.

[17] For a more detailed discussion on this issue, see the "Joint Impacts Analysis" for cement kilns in Chapter 5.

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- Some on-site incinerators may spread the fixed costs of combustion over both hazardous and non-hazardous wastes burned at the incinerators, reducing the total costs of hazardous waste combustion.

- Finally, avoided costs of off-site treatment for on-site incinerators that burn specialized wastes are higher than our average commercial prices suggest. While we adjust avoided costs for two on-site incinerators that burn specialized waste streams, we may not account for all such on-site incinerators.[18]

To further evaluate the economics of waste burning at on-site combustion systems, we conducted interviews with plant managers and other staff at eight facilities with on-site incinerators.[19] In this research, we found that several factors contribute to firms' decisions to incinerate waste on-site, including economic issues, self-sufficiency goals, liability issues, specialized waste treatment, and non-hazardous waste combustion. Energy recovery, which we thought might be an important consideration for firms with on-site incinerators, does not appear to affect decisions regarding the continued operation of the incinerators in any significant manner. In addition, we found that technical and other physical limitations constrain waste consolidation at on-site facilities.

As shown in Exhibit 3-6, industry staff reported economic and liability issues as the main factors for burning waste on-site, rather than sending it to an off-site combustion facility such as a commercial incinerator or waste-burning kiln. With the exception of one on-site facility, all the facilities noted that the current costs of burning their hazardous wastes off-site exceed the costs of burning their wastes on-site. These economic issues should be adequately captured in the economic impacts model. Unlike economic concerns, we were not able to quantify liability issues for incorporation into the economic impact model. Avoiding liability risks associated with off-site disposal liability is often driven by corporate policy, regardless of costs. By managing wastes on-site, the facilities limit the risks posed by the transportation of dangerous materials and by the handling of these materials in commercial facilities that are not as familiar with the wastes.

[18] We might not have identified all such facilities in the model and/or the facilities included in the model may not be representative of all on-site facilities in the universe.

[19] A summary of our findings can be found in "Summary of On-Site Incinerator Analysis," Memorandum Prepared for Lyn Luben, U.S. EPA, Prepared by Lauren Fusfeld and Alice Yates, Industrial Economics, Incorporated, 20 February 1998.

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Exhibit 3-6

FACTORS INFLUENCING VIABILITY OF COMBUSTION

Company	Economic Issues	Liability	Specialized Wastes	Energy Recovery	Self-Sufficiency	Combustion of Non-Hazardous Wastes
American Cyanamid	★	★	★		★	●
Ashland Chemical	★	●	★			★
Bayer	★	●		●		●
Dupont	★			●	●	
Eastman Kodak	★	★		❍		
Novartis Pharmaceuticals	❍	●		❍	★	●
Olin Chemicals	●	★	★	●		●
Vulcan	★	❍		●		

Note: ★ Factor is very important to facility.
● Factor is somewhat important to facility.
❍ Factor is not important to facility.
A blank cell indicates that the facility did not mention the factor.

EMISSIONS AND POLLUTION CONTROL PRACTICES

This section establishes baseline emission profiles and current pollution control practices in the industry. We characterize baseline emissions so that emission reduction projections and subsequent human health and ecological benefit estimates are incremental to the baseline. We define baseline pollution control practices to assess the type of engineering retrofits and other pollution control measures needed at specific combustion facilities. Characterizing this baseline element ensures that compliance cost estimates are incremental to the baseline (i.e., we do not assign pollution control costs if a facility currently employs this particular control).

Emissions

The risk assessment for the hazardous waste combustion MACT rule uses baseline emissions as the starting point for estimating the health and ecological benefits of the rule (see Exhibit 3-6 and Exhibit 3-7). These emissions are based on trial burn test and certification of compliance testing

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data, and are a product of the type of waste fed, pollution controls in place, and other operational conditions during the tests.[20] (See Chapter 1 for a graphical depiction of the emissions profiles across combustion sectors and pollutants.) The characteristics of waste fed during normal operations may differ significantly from that fed during trial burns. In particular, facilities often "spike" the waste feed at the trial burns with high levels of metals, chlorine, and mercury. During testing, facilities operate under worst-case conditions to give operators a wide allowable envelope of operating limits needed to burn a wide array of wastes.

This situation results in emission estimates that likely exceed "typical" emissions. Therefore, the risk reductions and benefit estimates in Chapter 6 are likely overestimates. We do not expect that cost estimates will be biased in the same way, however, because EPA expects that sources will likely operate under the same worst-case conditions for the HWC MACT performance tests as they did during trial burns (for incinerators) and certification of compliance testing (for kilns). Thus, if sources want to maintain operational flexibility, they will still need to implement additional pollution control measures, even if under *typical* operating conditions, they meet the MACT standards.

Exhibit 3-7

BASELINE NATIONAL EMISSIONS FROM COMBUSTION SYSTEMS (AGGREGATE)

	Cement Kilns (pounds per year)	LWAKs (pounds per year)	Incinerators (pounds per year)
CO	41,866,939	290,469	20,222,247
TCl	7,211,308	4,051,105	7,513,779
THC	5,543,943	32,882	643,141
PM	5,235,808	82,637	4,008,097
SVM	65,497	636	128,963
Hg	3,324	118	9,708
LVM	1,810	223	17,548
Dioxins/ Furans	0.029	0.005	0.055

Note: Incinerators include commercial facilities and facilities with on-site systems.
Source: Energy and Environmental Research Corporation, May 5, 1998.

[20] These emissions data are based on an updated and significantly expanded database of emissions and ancillary information. A detailed description of this update can be found in the January 7, 1997 Federal Register (62 FR 960).

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Exhibit 3-8

AVERAGE BASELINE NATIONAL EMISSIONS PER SYSTEM

	Cement Kilns (pounds per year)	LWAKs (pounds per year)	Incinerators (pounds per year)
CO	1,268,695	29,047	108,722
TCl	218,524	405,110	40,397
THC	167,998	3,288	3,458
PM	158,661	8,264	21,549
SVM	1,985	64	693
Hg	101	12	52
LVM	55	22	94
Dioxins/ Furans	0.0009	0.0005	0.0003

Note: Incinerators include commercial facilities and facilities with on-site systems.
Source: Energy and Environmental Research Corporation, May 5, 1998.

Air Pollution Control Practices

The baseline assumes the same pollution controls and operational conditions as during the trial burn or certification of compliance testing. Combustion facilities already control at least some of the emissions targeted by the MACT standards.[21] This baseline pollution control information is used in the compliance costing analysis of Chapter 3. We require information on baseline pollution controls so that we do not assign pollution control measures to facilities that already have this equipment installed. At the same time, baseline pollution control information is important because a facility may be able to implement a design or operational change to an existing control to meet the MACT standard at lower cost than installing a completely new air pollution control device.

Although nearly all facilities have installed some air pollution control devices, there are distinct differences in the types of controls installed by various types of combustion facilities. Exhibit 3-8 lists the APCDs that control pollutants, as well as the prevalence of those APCDs by facility type. The majority of cement kilns (79 percent) already have dry electrostatic precipitators, which control particulate matter. A significant number of commercial incinerators have quenches, which control flue gas temperature to reduce formation and emissions of dioxins and furans; low energy wet scrubbers, which control acid gas and chlorine; and fabric filters, which control particulate matter and metals. A significant number of private on-site incinerators also have quenches (76 percent) and low energy wet scrubbers (57 percent). For government incinerators, 88

[21] Mobile incinerators, which we exclude from the general baseline pollution control analysis, often use comprehensive APCD systems, including fabric filters and wet scrubbers (Bruce Springsteen, EER, personal communication, May 15, 1998).

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Exhibit 3-9

BASELINE APCDS BY COMBUSTION SECTOR

Control Device	Emissions Controlled	Number (Percentage) of Sample Systems Currently Using Device				
		Cement Kilns	Commercial Incinerators	Private On-Site Incinerators	Lightweight Aggregate Kilns	Government Incinerators
Fabric Filter	Particulate matter, metals	21%	54%	12%	100%	42%
Dry Electrostatic Precipitators (ESPs)	Particulate matter	79%	4%	1%	0%	0%
Wet Electrostatic Precipitators (ESPs)	Particulate matter	0%	12%	7%	0%	0%
Ionizing Wet Scrubber	Acid gas and particulate matter	0%	15%	3%	0%	4%
High Energy Wet Scrubber	Particulate matter, acid gas, and chlorine	0%	23%	43%	20%	46%
Low Energy Wet Scrubber	Acid gas and chlorine	0%	73%	57%	0%	63%
Carbon Injection	Mercury and dioxin/furan	0%	4%	0%	0%	0%
Quench	Flue gas temperature control	3%	77%	76%	20%	88%
Dry Scrubber	Acid gas and chlorine	0%	46%	5%	0%	8%
Carbon Absorber	Mercury and dioxin/furan	0%	0%	2%	0%	8%
Afterburner	Carbon monoxide and hydrocarbons	0%	0%	0%	0%	0%
High Efficiency Particulate Air Filter	Particulate matter	0%	0%	3%	0%	8%
No Control Devices	N/A	0%	0%	13%	0%	4%
Number of Systems in Sample	N/A	33	26	136	10	24

Notes:
1. This analysis excludes one government facility for which no data were available.
2. This exhibit includes imputed data.
3. Sum of percentages will not be 100 percent because a single system may use more than one APCD.

Source: OSW Hazardous Waste Combustion Database prepared by EER, April 23, 1998. This database includes both actual and imputed system information.

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percent have quenches and 63 percent have low energy wet scrubbers. In addition, all the lightweight aggregate kilns have fabric filters. Other interesting issues regarding APCDs include the following:

- Only one facility currently uses carbon injection, a control technology which under the BTF-ACI MACT option will frequently be necessary for dioxin/mercury control.

- Lightweight aggregate kilns rely almost entirely on fabric filters for emission control.

SUMMARY

Establishing the baseline scenario provides the necessary foundation for the assessment of combustion facilities' responses to the Hazardous Waste Combustion MACT Standards. The subsequent chapters rely on the following baseline components:

- **Chapter 4 (Compliance Cost Analysis)** requires baseline pollution control equipment data and emission profiles to project engineering system costs of the MACT standards.

- **Chapter 5 (Social Cost and Economic Impact Analysis)** requires information on baseline revenues, costs, and future capacity.

- **Chapter 6 (Benefits Assessment)** requires baseline emission profiles to determine risk reductions and corresponding benefits.

The key issue addressed in this chapter is future combustion capacity. For on-site incinerators, future capacity could decrease by almost 35 percent over the longer term as on-site incinerators discontinue burning. We expect these economically marginal incinerators will find it less expensive to manage wastes off-site. In the baseline, commercial incinerator capacity is also expected to decrease, by approximately 10 percent. Projecting future capacity allows us to adjust post-MACT costs and economic impacts, such as market exits, so that results are incremental to the baseline. If baseline future capacity estimates are understated, then incremental costs and economic impacts will be overstated. Likewise, if future capacity estimates are overstated, then incremental rule impacts will be understated. To address this uncertainty, we also provide cost and economic impact estimates that do not account for baseline market adjustments.

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INTRODUCTION

Hazardous waste combustion facilities complying with the maximum achievable control technology (MACT) standards will likely achieve the required emission reductions by installing pollution control devices, limiting toxics in the waste feed, or through some combination of the two. In addition, facilities will need to comply with monitoring, reporting, and record keeping requirements that are part of the standards. This chapter of the *Assessment* focuses on the costs associated with all compliance activities for both existing combustion facilities as well as for potential new sources. We analyze costs incurred by combustion facilities, as well as costs incurred by various government entities as they administer compliance activities. The chapter is organized into six sections:

- **Costing Methodology for Existing Combustion Systems.** In the first section, we discuss the methodology used to estimate compliance costs borne by combustion facilities, which involves assigning pollution control measures to individual combustion systems and estimating costs for these control measures. This section also describes other compliance cost components such as continuous emission monitors, permit modifications, testing and analysis, and other reporting and record keeping requirements.

- **Results of Compliance Cost Analysis for Existing Sources.** The results section provides compliance cost estimates for combustion systems and shows how these costs vary across combustion sectors, assuming all sources choose to come into compliance with the rule.

- **Compliance Costs for New Combustion Sources.** This section describes the compliance cost methodology and results for new combustion sources. While market performance suggests that additional market entry is unlikely in the near-term, we include this section to illustrate the additional costs potential entrants to the market would need to consider.

- **Caveats and Limitations of Compliance Cost Analysis.** This section describes data limitations and uncertainties that are important to highlight as caveats to the compliance cost analysis.

- **Government Costs.** This section reviews the incremental costs for government entities as they administer and enforce the new emission standards and related MACT requirements.

- **Summary.** We conclude the chapter with a brief review of key findings from the cost analysis.

This chapter is designed to provide a summary of the costs that would be faced by combustion facilities. Based on these costs, combustion facilities must decide whether or not to continue burning waste. We discuss the market response of combustion facilities to the rule in Chapter 5.

COSTING METHODOLOGY FOR EXISTING COMBUSTION SYSTEMS

Total compliance costs for existing hazardous waste combustion facilities are developed using engineering models that assign pollution control measures and their costs to each modeled combustion system.[1] Included along with these pollution control costs are other compliance costs associated with monitoring requirements, sampling and analysis, permit modifications, and other record keeping and reporting requirements. Exhibit 4-1 provides an overview of the procedure used in this system-specific compliance cost analysis.

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[1] These engineering models are different from the models plants approach used to estimate costs for the originally proposed MACT rule. For this final rulemaking, the engineering models account for system-specific parameters and thus the engineering costs should better reflect actual costs the industry will incur. That is, we estimate costs for actual affected sources included in the economic impact model.

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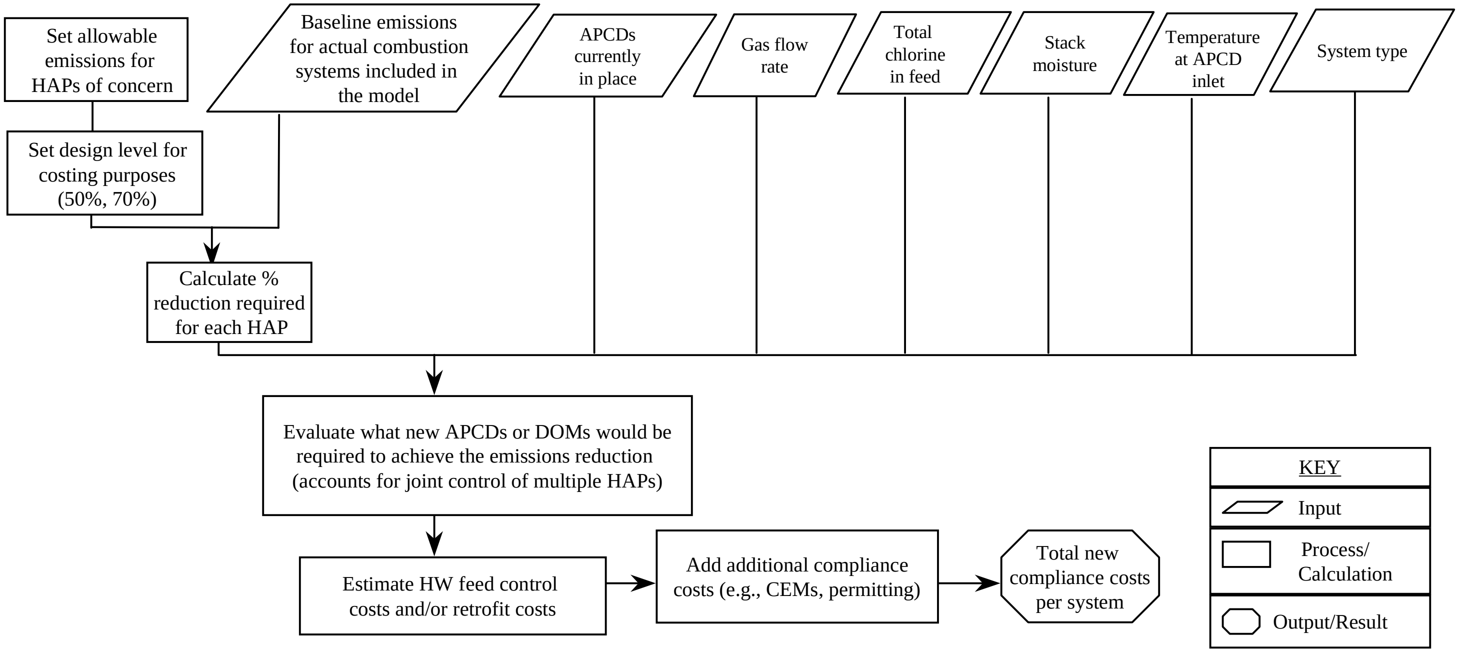
Exhibit 4-1

OVERVIEW OF SYSTEM-SPECIFIC COMPLIANCE COST ANALYSIS



NOTES
1. Setting of allowable emissions for hazardous air pollutants (HAPs) based on MACT analysis using Trial Burn Reports. Baseline emissions also determined using Trial Burn Reports (measured at the stack) and imputation. See U.S. EPA, *Draft Technical Support Document for HWC MACT Standards, Volume I: HWC Emissions Database,* March 1998.
2. All other data inputs from U.S. EPA, *Draft Technical Support Document for HWC MACT Standards, Volume I: HWC Emissions Database,* March 1998.
3. Compliance costs are estimated for design levels at 50 percent and 70 percent of a standard. The 50 percent level is more conservative because it incorporates more stringent design safety factors.
4. A DOM is a design, operation, or maintenance change to an existing Air Pollution Control Device (APCD). CEMs are continuous emission monitoring systems.

Compliance cost components include those that are estimated using combustion system-specific parameters and those that are consistent across a particular combustion sector (e.g., cement kilns) or across the entire regulated universe of hazardous waste combustion facilities. As we discuss below, cost estimates include the following components:

- Pollution control measures;
- Continuous emissions monitors[2] (CEMs); and
- Other compliance costs:
  - Permitting and other record keeping and reporting requirements,
  - Testing requirements, and
  - Shutdown costs.

<u>Air Pollution Control Measures</u>

We developed pollution control costs using engineering models that assign controls and associated costs to individual combustion systems based on a variety of system-specific parameters, including system type (e.g., liquid injection, rotary kiln, wet/dry system), gas flow rate, and kiln temperature. Pollution control systems may include both end-of-pipe controls, which are listed in Exhibit 4-2, as well as controlling the waste feed, both with regard to total volume fed as well as limiting toxics in the waste feed.[3]

As shown in Exhibit 4-1, the engineering cost model uses baseline emission estimates for each system, and compares these with the design-adjusted emission requirements. The design-adjusted MACT emission requirement differs from the MACT emission standard by a factor that

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[2] The cost and economic impact analyses were conducted both with and without PM CEMs. However, because PM CEMs are not required in the final rule, we focus on results without PM CEM costs.

[3] Feed control costs are upper bound costs based on the cost of technology retrofit that would potentially be required to control the pollutant. We also considered estimating feed control costs based on lost revenues (which are a function of both waste quantities and waste type); however, because detailed waste specifications are not available for each combustion facility, EPA developed conservative cost estimates for feed control using retrofit costs. A more detailed discussion of the feed control cost analysis is found in U.S. EPA, *Draft Technical Support Document for HWC MACT Standards, Volume V: Emission Estimates and Engineering Costs,* July 1998.

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incorporates a design safety factor. For example, a MACT standard for mercury of 120µg/dscm corresponds to an emission requirement of 84µg/dscm at the 70 percent design level (0.7 x 120 = 84) and an emissions requirement of 60µg/dscm at the 50 percent design level (0.5 x 120 = 60).

For each combustion system, the system-specific design-adjusted MACT emission requirement is subtracted from the system-specific baseline emission level to determine the percentage reduction required for each pollutant. For example, a cement kiln with a baseline mercury emission level of 210µg/dscm would need a 60 percent mercury emission reduction to meet the MACT floor standard of 120µg/dscm, at the 70 percent design level.

$$\textit{Emissions Reduction} = \frac{\textit{Baseline Emission Level - (MACT Standard x Design Level)}}{\textit{Baseline Emission Level}}$$

$$= [210 - (120 \times 0.7)] / 210$$

$$= 0.6 = 60\%.$$

The engineering cost model then compares the percentage emission reduction with a variety of controls that achieve certain emission reductions, assigns the least-cost control that can attain the necessary level of control, and then assigns retrofit costs associated with the selected control measure. This procedure is done for all MACT options and pollutants.

Exhibit 4-2

AIR POLLUTION CONTROL MEASURES ASSIGNED IN COMPLIANCE COST ANALYSIS

Pollutant	Pollution Control Measures	Comments
PM, Low-Volatile Metals, Semi-Volatile Metals	— Fabric Filter — Feed Control	Depending on flue gas temperature and other site-specific factors, additional flue gas cooling equipment (e.g., water quench) may be required to integrate the fabric filter into any existing wet scrubbing systems.
HCl and Chlorine	— Packed Tower Scrubber — Spray Tower Scrubber — Feed Control	
Mercury	— Carbon Injection/Carbon Bed — Feed Control	Carbon injection must be accompanied by a dry particulate matter (PM) control device; Carbon injection and carbon bed is assigned only under the BTF-ACI MACT option.

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Exhibit 4-2 (continued)

AIR POLLUTION CONTROL MEASURES ASSIGNED IN COMPLIANCE COST ANALYSIS

Pollutant	Pollution Control Measures	Comments
Dioxin/Furan	— Temperature Control — Carbon Injection/Carbon Bed	Temperature control applicable only at systems operating at higher temperatures.
Hydrocarbons and CO	— Afterburner — Design, Operation, Maintenance (DOM)	

Notes:
1. U.S. EPA, *Draft Technical Support Document for HWC MACT Standards, Volume V: Emission Estimates and Engineering Costs*, July 1998.
2. Control measures assigned in compliance cost analysis include installation of new devices, changes in design, operation, and maintenance (DOM) to existing devices, or adoption of waste feed control for particular constituents.

If the emissions reduction required for a particular air pollutant is modest and can be achieved with devices already existing at the facility, the assigned control measure will involve changing the design, operation, and maintenance (DOM) of the existing equipment. For example, a modest particulate matter (PM) reduction may be achievable by optimizing the cleaning cycles and test procedures on an existing fabric filter system.

Continuous Emissions Monitoring Costs

The MACT rulemaking effort has also considered requiring hazardous waste combustion facilities to install continuous emissions monitoring (CEM) systems for some hazardous air pollutants (HAPs). As the name implies, CEMs allow regulators to track emissions from combustion facilities on a continuous real-time basis. Emissions data can either be transmitted from the facility to data-receiving points at EPA and state agencies, or it can be stored on-site for review during inspection.

This technology represents an alternative to the current system whereby most types of emissions are regulated on the basis of trial burn data gathered for permit applications and renewals and routine measurement of indicator operating parameters. CEMs would allow EPA to enforce the MACT standards more closely and help ensure that violations do not occur between periodic emissions testing.

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EPA has estimated the cost of implementing CEM requirements for individual combustion systems. The costs depend directly on the set of air pollutants to be monitored by CEMs as well as the types of combustion facilities required to install the systems. For the final MACT standards, EPA considered CEM requirements addressing two different groups of pollutants: CO/HC and particulate matter (PM).[4] With regard to the first group of pollutants, all regulated combustion facilities will be required to install either CO or HC CEMs. However, because it is likely that all existing waste combustion facilities already have either a CO or HC CEM in place, no incremental cost will be associated with the CO/HC requirements of the final MACT standards.[5] In addition, regulated combustion facilities that have either CO or HC CEMs in place also generally have oxygen monitors installed to comply with current RCRA requirements. Therefore, no incremental costs are associated with oxygen monitors.

For particulate matter CEMs, the EPA considered two different options. Under one option, PM monitors would be required for all regulated combustion facilities. As shown in Exhibit 4-3, the total annualized cost of this monitoring is approximately $41,000 to $51,000 per combustion system. Under the other option, PM continuous monitors would not be required for any facility. The cost associated with this option is zero. Under the Final Standards, EPA will not require PM CEMs. Thus, we focus on results without PM CEM costs. Cost and economic impact results that include PM CEMs are included in Appendix C.

Exhibit 4-3

AVERAGE PER-SYSTEM TOTAL ANNUAL COSTS OF CONTINUOUS EMISSIONS MONITORING FOR PM
($ thousands)

CK	LWAK	Commercial Incinerators	On-Site Incinerators
$41	$43	$46	$51

Source: U.S. EPA, *Draft Technical Support Document for HWC MACT Standards, Volume V: Emission Estimates and Engineering Costs*, July 1998.
Note: No incremental costs are associated with the CO/HC CEM requirements of the final MACT standards.

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[4] The proposed MACT rule also called for the use of CEMs to monitor mercury. However, due to various factors including the developmental stage of these particular monitors, mercury CEM requirements will not be incorporated into the final standards.

[5] U.S. EPA. July 1998. *Draft Technical Support Document for HWC MACT Standards, Volume V: Emission Estimates and Engineering Costs*.

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Other Compliance Costs

In addition to the CEM and pollution control costs that are detailed above, regulated hazardous waste combustion facilities also will incur costs associated with other compliance components of the MACT standards. A brief description of these components follows. We provide a summary of the costs associated with them in Exhibit 4-4.

- **Permitting and Other Reporting and Recordkeeping Requirements:** The HWC MACT standards require a number of facility record keeping and reporting procedures that are associated with permitting and other compliance activities. These record keeping and reporting procedures are related to both new compliance activities as well as to modifications of existing CAA and RCRA permitting and compliance schemes. New requirements include preparing a Notice of Intent to Comply (NIC) with the MACT standards and holding public meetings. The incremental permitting, reporting and record keeping requirements total approximately $5.7 million annually across all combustion facilities.[6]

- **Performance Testing Requirements:** Incremental compliance testing requirements associated with the MACT standards would cost the existing 172 combustion facilities approximately $441,000 per year in total.[7] The incremental costs are associated with two levels of performance testing of the pollution control equipment used to comply with the MACT standards: the Comprehensive Performance Test and the Confirmatory Performance Assessment. The Comprehensive Performance Test includes stack sampling for metals, PM, dioxins/furans, total chlorine and organics at two worst-case operating conditions and is to be performed once every five years for all types of combustion systems.[8] The Confirmatory Performance Assessment includes sampling for dioxins/furans at normal operating conditions and is to be performed once every five years for all combustion systems, halfway between Comprehensive Performance Tests.

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[6] As part of the "fast track" component of this rule, EPA promulgated a streamlined process for modifying the RCRA permit, so that affected sources can make necessary changes to their RCRA permits that may be required during the three year compliance period as sources transition to MACT compliance and CAA Title V permitting. However, we do not include the cost savings from this permit streamlining because these impacts are accounted for in an earlier analysis (see U.S. Environmental Protection Agency, *Economic Analysis Report for the Combustion MACT Fast-Track Rulemaking*, March 1998).

[7] U.S. EPA. July 1998. *Draft Technical Support Document for HWC MACT Standards, Volume V: Emission Estimates and Engineering Costs*.

[8] There will be an additional costs for “problematic” sources, those facilities currently not demonstrating compliance with RCRA destruction and reduction efficiency (DRE) standards. These additional costs are not included in our estimates.

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Exhibit 4-4

SUMMARY OF OTHER COMPLIANCE COST COMPONENTS

Compliance Component	Annual Cost per Respondent/Activity	Annual Estimated Number of Respondents/Activities	Estimated Total Annual Costs
Requirements Related to CAA Provisions:			
Reading of the Regulations (See Note 5)	$600	57	$34,000
Construction/Reconstruction Application Requirements	$7,000	2-3	$15,000
Compliance with Standards and General Requirements (e.g., weekly testing of the automatic waste feed cutoff (AWFCO) system)	$61,000	0-128	$1,958,000
Performance Testing Requirements	$4,800	0-172	$1,113,600
Monitoring Requirements (e.g., development of feedstream analysis plan)	$8,000	0-6	$47,000
Notification and General Reporting and Record Keeping Requirements (e.g., Notice of Intent to Comply (NIC) with standards)	$40,000	0-57	$2,219,000
Application for Extension for Pollution Prevention or Waste Minimization Measures	$3,000	23	$75,000
Requirements Related to RCRA Provisions:			
Reading of the Regulations	$200	84	$18,000
Regulation of Residues (i.e., for chlorinated dioxins and furans)	$200	1,488	$223,000
ESTIMATED TOTAL ANNUAL INCREMENTAL IMPACT =		**$5,700,000**	

Notes:
1. Sources: U.S. EPA, *Supporting Statement for EPA ICR #1773.02 "New and Amended Reporting and Recordkeeping Requirements for National Emissions Standards for Hazardous Air Pollutants from Hazardous Waste Combustors*," September 1998; U.S. EPA, *Supporting Statement for EPA ICR #1361.08 "New and Amended RCRA Reporting and Recordkeeping Requirements for Boilers and, Industrial Furnaces Burning Hazardous Waste*," September 1998; U.S. EPA, *Draft Technical Support Document for HWC MACT Standards, Volume V: Emission Estimates and Engineering Costs*, July 1998.
2. Estimated total annual costs are calculated based on the cost per respondent or activity multiplied by the estimated number of respondents or activities per year. Each type of component has a number of sub-components (not listed) associated with it, all varying in the number of estimated respondents or activities per year. Depending on the sub-component, no facilities may comply in a given year, or the same facility might respond multiple times per year (e.g., testing of AWFCO system of multiple combustion systems each week). Therefore, the total annual costs per component reflect variability in the number of respondents or activities for each sub-component.
3. With the exception of those for performance testing, estimates reflect only the first three years following the promulgation of the rule, the time period covered by the Information Collection Requests (ICRs). The total costs of performance testing, a component that will probably not occur until the fourth year of the rule, are calculated based on the number of estimated systems in the universe multiplied by the median annual costs for the testing procedures at the system level.
4. Estimates reflect a universe of approximately 172 HWC facilities. Totals may not add due to rounding.
5. Hour and cost estimates for reading the regulations are optimistic (i.e., they may be underestimates of the true costs). Because these costs ($34,000 annually) are small relative to the total costs of the rule (between $65 and $73 million), even if these costs are significantly underestimated, this should not affect our estimates of the overall cost and economic impacts of the rule.

- **Shutdown Costs:** We also investigated the significance of shutdown costs to facilities associated with the installation of equipment or implementation of other pollution control measures assigned in the compliance cost analysis. Examination of shutdown periods suggests that virtually all of the installations could be coordinated along with routine maintenance shutdowns (which we assume require at least three weeks per year). Because virtually all technologies have installation times of three weeks or less, we assume that all retrofits could be made simultaneously during a single facility shutdown, suggesting that no significant incremental shutdown time is necessary.

RESULTS OF COMPLIANCE COST ANALYSIS FOR EXISTING SOURCES

On average, we expect that each combustion system will spend between approximately $244,000 and $1,500,000 annually to comply with the MACT requirements, as shown in Exhibit 4-5. The wide range across these average cost estimates is largely a result of the significant cost variations of different control measures for different systems. For example, design, operation and maintenance modifications of existing equipment have annual costs of around $20,000, whereas the annualized costs of a new quench is about $270,000, and annualized costs for new carbon injection units can be as high as $1.7 million for larger combustion systems.[9] From the MACT Floor to the BTF-ACI option, average system costs increase by over $200,000 for privately-owned systems and by almost $1 million for government systems. This cost increase is due to the greater number of systems assigned costly carbon injection equipment for control of mercury under the BTF-ACI option. These results are supported by Exhibit 4-6, which shows the percentage of combustion systems requiring particular control measures under each MACT option. Under the Floor (50 and 70 percent) options, no combustion systems are assigned carbon injection, but this figure jumps to approximately 50 percent across all sectors under the BTF-ACI (50 and 70 percent) options. In Exhibit 4-7, 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.

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[9] Average annualized costs for carbon injection units, however, are around $200,000 per combustion system.

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Exhibit 4-5

AVERAGE TOTAL COMPLIANCE COSTS PER COMBUSTION SYSTEM[10]
(Assuming No Market Exit)

MACT Option	Cement Kilns	LWAKs	Commercial Incinerators	On-site Incinerators	Government On-sites
Floor (50%)	$944,126	$572,964	$346,569	$279,131	$210,317
Floor (70%)	$670,373	$456,109	$300,518	$240,717	$187,072
Rec (50%)	$1,004,297	$651,900	$341,734	$302,125	$210,317
Rec (70%)	$795,888	$637,584	$288,152	$267,289	$187,072
BTF-ACI (50%)	$1,453,081	$787,451	$515,027	$506,121	$1,064,641
BTF-ACI (70%)	$1,157,206	$788,205	$462,965	$482,848	$1,024,053

Notes:
1. No PM CEM costs included.
2. 75% price pass-through scenario assumed.
3. Estimates calculated assuming all facilities comply. Facilities non-viable in the baseline are reflected in the average total annual compliance costs.

[10] The engineering costs are currently being refined and will provide better cost estimates for feed control; the refined cost estimates will be slightly less than those presented in the exhibit.

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Exhibit 4-6

PERCENTAGE OF SYSTEMS REQUIRING CONTROL MEASURES (Before Consolidation)

Control Measure	Floor (50%)	Floor (70%)	Rec (50%)	Rec (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%	100%	100%	100%	100%
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	65%	63%	69%	67%	85%	83%
New Carbon Injection	0%	0%	15%	15%	71%	71%
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%	60%
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	48%	42%	44%	38%	52%	50%
None	6%	8%	4%	6%	2%	2%

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Exhibit 4-6 (continued)

PERCENTAGE OF SYSTEMS REQUIRING CONTROL MEASURES (Before Consolidation)

Control Measure	Floor (50%)	Floor (70%)	Rec (50%)	Rec (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%	67%	62%
None	19%	19%	19%	19%	5%	10%

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Exhibit 4-7

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

Control Measure	Floor (50%)	Floor (70%)	Rec (50%)	Rec (70%)	BTF-ACI (50%)	BTF-ACI (70%)
Cement Kilns						
New Fabric Filters	26%	23%	24%	20%	28%	27%
New Carbon Injection	0%	0%	0%	0%	17%	17%
New Quencher	18%	21%	17%	18%	9%	10%
Fabric Filter DOM	2%	2%	2%	1%	1%	1%
DESP DOM	3%	0%	3%	0%	1%	0%
Feed Control	51%	53%	54%	60%	44%	45%
Total	100%	100%	100%	100%	100%	100%
LWAKS						
New Fabric Filters	0%	0%	0%	0%	18%	14%
New Carbon Injection	0%	0%	0%	0%	20%	16%
New Quencher	17%	21%	17%	16%	7%	7%
Fabric Filter DOM	2%	0%	2%	0%	0%	0%
Feed Control	81%	78%	82%	84%	55%	63%
Total	100%	100%	100%	100%	100%	100%
Commercial Incinerators						
New Fabric Filters	8%	7%	7%	9%	15%	16%
New Carbon Injection	0%	0%	13%	15%	37%	40%
New Quencher	17%	18%	13%	14%	3%	3%
New Reheater	0%	0%	2%	3%	15%	16%
Fabric Filter DOM	2%	1%	2%	1%	1%	0%
IWS DOM	2%	1%	2%	1%	0%	0%
HEWS DOM	5%	6%	5%	6%	1%	1%
Feed Control	66%	68%	55%	51%	28%	24%
Total	100%	100%	100%	100%	100%	100%
Private On-Site Incinerators						
New Fabric Filters	33%	45%	32%	41%	24%	27%
New Carbon Injection	0%	0%	8%	11%	25%	28%
New Carbon Bed	0%	0%	0%	1%	1%	1%
New Quencher	5%	6%	3%	4%	1%	2%
New Afterburner	27%	6%	24%	5%	15%	3%
New Reheater	0%	0%	3%	5%	18%	20%
HEWS DOM	2%	4%	1%	2%	0%	0%
Feed Control	32%	38%	27%	30%	16%	18%
Total	100%	100%	100%	100%	100%	100%

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Exhibit 4-7 (continued)

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

Control Measure	Floor (50%)	Floor (70%)	Rec (50%)	Rec (70%)	BTF-ACI (50%)	BTF-ACI (70%)
Govt. On-Site Incinerators						
New Fabric Filters	18%	17%	18%	17%	15%	15%
New Carbon Injection	0%	0%	0%	0%	22%	23%
New Quencher	0%	0%	0%	0%	0%	1%
New Afterburner	5%	6%	5%	6%	3%	3%
New Reheater	0%	0%	0%	0%	8%	9%
IWS DOM	7%	8%	7%	8%	4%	4%
Combination DOM	1%	1%	1%	1%	1%	1%
Feed Control	69%	68%	69%	68%	47%	43%
Total	100%	100%	100%	100%	100%	100%

Compliance costs vary even more markedly when comparing across individual systems within a given combustion sector. The following compliance cost results for the MACT Recommended option (at the 70 percent design level) illustrate the wide variability across specific combustion systems:

- **Cement Kilns** -- Annual per-system compliance costs range from $0 to $3,579,000, with an average cost of $800,000 per system.[11]

- **Commercial Incinerators** -- Annual per-system compliance costs range from $13,823 to $882,842, with an average cost of $290,000 per system.

- **LWAKs** -- Annual per-system compliance costs range from $450,175 to $846,248, with an average cost of $640,000 per system.

- **Private On-Sites** -- Annual per-system compliance costs range from $7,267 to $871,962, with an average cost of $270,000 per system.

- **Government On-Sites** -- Annual per-system compliance costs range from $0 to $793,466, with an average cost of $190,000 per system.

COMPLIANCE COSTS FOR NEW COMBUSTION SOURCES

While most of this analysis focuses on MACT standards for existing sources, the rule also finalizes MACT requirements for new facilities entering the hazardous waste combustion market. The standards would apply to both newly constructed facilities (e.g., a new commercial incinerator) as well as to cement or lightweight aggregate kilns that choose to begin burning hazardous waste.[12]

EPA applied the same basic approach in developing compliance costs for new sources as was used for existing sources. Specifically, EPA determined the set of pollution control measures that would be needed to meet the MACT standards and then used the cost models discussed above to estimate engineering costs. These estimates were developed for each category of combustion facility

[11] The compliance cost estimates for cement kilns do not take into account the Portland Cement MACT, which addresses non-hazardous cement kilns. If the Portland Cement MACT is accounted for in these estimates, the compliance costs for cement kilns under combustion MACT would likely be lower.

[12] Rebuilding a facility can also trigger new MACT standards if the renovation effort requires over one-half of the capital expenditures associated with constructing an entirely new facility.

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as well as for different size classes. Estimation of the new MACT costs differs from that for existing sources in that we must first assume a set of baseline pollution controls for each system in order to meet current regulatory standards (e.g., requirements of the *Resource Conservation and Recovery Act* (*RCRA*) and the *Boiler or Industrial Furnace* (*BIF*) rule). For all kilns, the baseline control is assumed to be a fabric filter system, while the baseline control for incinerators is assumed to include a water quench cooling tower, a packed tower scrubber, and a venturi scrubber. The net annual costs of the new MACT standards are then calculated as the incremental pollution control expenditures beyond these baseline control costs.[13] The results of this analysis are provided in Exhibit 4-8.

Exhibit 4-8

TOTAL ANNUALIZED SYSTEM COSTS FOR NEW COMBUSTION SOURCES

Source Category	Size	Baseline	Floor	Incremental
CK	Large	$1,114,316	$3,929,891	$2,815,575
CK	Small	$489,334	$1,613,829	$1,124,495
INC	Large	$1,166,935	$1,834,197	$667,262
INC	Small	$454,320	$827,616	$373,296
LWAK	Medium	$217,225	$1,259,482	$1,042,257

Notes: 1. Estimates from Energy and Environmental Research Corporation, July 1998.
2. Size classification for sources based on waste feed flow rates.
3. Incinerators include private and government on-site incinerators as well as commercial incinerators.

CAVEATS AND LIMITATIONS OF COMPLIANCE COST ANALYSIS

The analysis of private sector compliance costs for the MACT standards contains a variety of uncertainties. The most significant include the following:

- Available emissions data are limited for many facilities. Emissions data are the product of trial burns required for combustion facilities, but information for some pollutants often is not available. In these cases, the emissions

[13] A more detailed explanation of the analysis used to determine costs for new sources can be found in U.S. EPA, *Final Technical Support Document for HWC MACT Standards, Volume V: Emission Estimates and Engineering Costs.*

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reduction requirements are assigned to facilities according to the underlying statistical distribution for each pollutant (which is based on emissions of the pollutant at facilities where data are available).[14]

- Information on existing APCDs is not available for a number of systems in the national universe of combustion facilities. Existing APCD data are projected for approximately 23 percent of commercial incinerators and approximately 40 percent of on-site incinerators.[15]

- Due to data limitations with respect to waste feed characteristics, it is difficult to determine the extent to which feed control may be used as a feasible alternative method of compliance with the MACT standards.

As a result of these limitations, individual combustion system decision-making may result in actual compliance behavior different from the pollution control measures assigned using the engineering cost models. While uncertainty exists, we do not believe that compliance costs are systematically biased either upward or downward.

GOVERNMENT COSTS

In addition to costs incurred by the private sector, the MACT standards also will affect EPA and other government entities. The rulemaking will result in incremental costs to government entities as they administer and enforce the new emissions standards and related MACT requirements. This section reviews these incremental costs for government entities associated with revised permitting and reporting requirements.

The incremental HWC MACT government costs are mainly associated with the review of permits and other combustion facility documents required by provisions of RCRA and the CAA. Facility documents that require agency review include the following: performance test plans, emergency safety valve (ESV) and automatic waste feed cutoff (AWFCO) violation reports, and

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[14] For more information on the approach taken for estimating emissions reduction requirements, see U.S. EPA, *Draft Technical Support Document for HWC MACT Standards, Volume V: Emissions Estimates and Engineering Costs*, July 1998.

[15] See Energy and Environmental Research Corporation, *Revised Estimation of Baseline Costs for Hazardous Waste Combustors for Final MACT Rule*, Prepared for Industrial Economics, Incorporated and U.S. EPA, August 1998.

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notices of intent to comply (NIC) with the standards. Exhibit 4-9 presents the total annual government costs for reviewing these documents.[16] These figures represent annual costs expended over the first three years following rule promulgation. Overall, incremental government costs are projected to be approximately $330,000 per year. Government costs will be assumed by U.S. EPA Offices as well as by state and local agencies that hold relevant permitting responsibilities. The distribution of these costs across different government entities depends on which agencies have responsibility for permitting as well as on the number of combustion facilities in specific permitting jurisdictions and the current permitting status and other site-specific characteristics of the facilities.

SUMMARY

We use engineering cost models based on system-specific parameters to estimate compliance costs for the MACT standards for hazardous waste combustion facilities. Under this approach, individual combustion systems are assigned air pollution control measures and corresponding cost estimates using engineering parameters, such as gas flow rates, waste feed composition, and combustion chamber temperature. From this assignment of pollution control measures, we derive the capital, and fixed and variable operating costs that each combustion system in the economic analysis would incur in complying with the standards. The estimates of compliance costs also include the costs associated with permitting, testing, and record keeping and reporting requirements. Key insights from the compliance cost analysis include the following:

- Average system costs tend to be lower for incinerators than for kilns, although under the BTF-ACI option, costs escalate significantly for government incinerators and are comparable to costs for cement kilns.

- Cement kilns consistently have the highest average system compliance costs across MACT options.

- In general, average system cost estimates under the 50 percent design level are approximately 10 to 20 percent higher than at the 70 percent design level. Under the BTF-ACI option, however, costs do not vary as significantly across design levels. The reason for the smaller cost range is that the

[16] Sources: U.S. EPA, *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 Combustors*, September 1998; U.S. EPA, *Supporting Statement for EPA Information Collection Request #1361.08 for "New and Amended RCRA Reporting and Recordkeeping Requirements for Boilers and Industrial Furnaces Burning Hazardous Waste,"* September 1998.

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activated carbon injection system, the major pollution control measure required under the BTF-ACI option, constitutes a significant portion of the costs for both of the design levels.

- Government administrative costs, borne primarily by EPA offices and state environmental agencies, total approximately $330,000 per year.

- Changes in record keeping and reporting activities associated with new compliance requirements and permit modifications result in total costs of about $5.7 million across all combustion facilities per year.

These cost estimates, along with cost estimates for government administration of the rule, form the basis for assessing the social costs and other economic impacts of the rule provided in the following chapter.

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Exhibit 4-9

SUMMARY OF HWC MACT INCREMENTAL COSTS TO GOVERNMENT

HWC MACT Component	Annual Cost per Respondent/Activity	Annual Estimated Number of Respondents/Activities	Estimated Total Annual Costs
Review of Construction/Reconstruction Applications	$100	0-3	$200
Review of Compliance with Standards and General Requirements (e.g., review of emergency safety valve (ESV) violation reports)	$1,000	0-191	$9,000
Review of Performance Testing Requirements	$4,000	0-46	$111,000
Review of Monitoring Requirements (e.g., review of feedstream analysis plans)	$1,000	0-342	$91,000
Review of Notification, General Reporting and Record Keeping Requirements (e.g., review of Notice of Intent to Comply (NIC))	$2,000	43-57	$112,000
Review of Requests for Pollution Prevention or Waste Minimization Control Extensions	$200	46	$7,000
ESTIMATED TOTAL ANNUAL INCREMENTAL IMPACT =			**$330,000**

Notes:
1. Estimates from U.S. EPA, *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 Combustors*," September 1998 and *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*," September 1998.
2. Estimated total annual costs for government review activities are calculated using the annual cost per facility respondent or activity (e.g., review of reconstruction application) multiplied by the estimated number of respondents or activities per year. Each type of component has a number of sub-components (not listed) associated with it, all varying in the number of estimated respondents per year. Depending on the sub-component, no facilities may comply in a given year, or the same facility might respond multiple times per year (e.g., submitting performance test plans for multiple systems). Therefore, the total annual government costs per component vary depending on the number of facility respondents or activities for each sub-component; total annual costs cannot be derived by multiplying the average cost by the average number of respondents/activities.
3. Estimates reflect only the first three years following the promulgation of the MACT standards, the time period covered by the Information Collection Requests (ICRs), and are based on a universe of approximately 172 HWC potential respondents or facilities. Totals may not add due to rounding.

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SOCIAL COST AND ECONOMIC IMPACT ANALYSIS — CHAPTER 5

This chapter analyzes social costs and economic impacts of the Hazardous Waste Combustion MACT standards. Throughout this chapter, we focus on results that do not include the costs of PM CEMs.[1] While Chapter 4 is limited to the modeling of government administrative costs and potential compliance costs to hazardous waste combustors, this chapter examines the responses of the regulated community. To model market adjustments, we use data from the baseline specification to characterize the economics of hazardous waste combustion. This modeling allows us to estimate how increased compliance costs will affect incentives for hazardous waste combustion facilities to continue burning and the competitive balance in combustion market segments. We organize the discussion into five parts:

- **Overview of Results --** We first present a summary of results from the social cost and economic impact analyses presented in this chapter.

- **Social Cost Methodological Framework --** This section presents the economic theory used for analyzing social costs. The social costs of the rule describe the total value of resources used to comply with the standards and the total value of lost output resulting from the standards.

- **Modeling Market Dynamics --** This section introduces the approach we used to model market dynamics and calculate social costs and economic impacts.

- **Social Cost Results --** This section presents results from the social cost analysis, which are made up of economic welfare losses and government costs.

[1] The final rule requires that particulate matter CEMs be installed, but defers the effective date of the requirement to install, calibrate, maintain, and operate PM CEMs until these actions can be completed. Model results with PM CEM costs are included in Appendix C.

- **Economic Impact Measures --** Finally, we describe estimates of several economic impact measures: market exit estimates, the quantity of waste reallocated from combustion facilities that stop burning, employment impacts, potential combustion price increases, and other industry impacts, including potential changes in the cost structure of the combustion sector and in the profits for hazardous waste combustion facilities and APCD manufacturers. The economic impact measures are distinct from the social cost estimates in that they provide insights into the distributional effects of the rule, impacts that may not represent net costs to society.

OVERVIEW OF RESULTS

The four sections of this chapter present social cost and economic impact results, as well as a detailed explanation of the approach taken in both of these analyses. The list below summarizes some of the key results presented in the chapter:

Social Cost Results

- Total annual social costs of the final rule (Recommended MACT) are between $65 and $73 million, with an upper bound of $95 million.

- Total annualized compliance costs under the dynamic scenario (for which pricing increases and waste consolidation are incorporated into the economic model) are about 20 percent lower than total compliance costs in the static scenario (i.e., without any market adjustments). The decrease in compliance costs is due to market exits expected in the baseline as well as market exits attributed to the MACT standards.

- Almost half of the social costs are attributed to on-site incinerators due to the large number of sources in this combustion sector.

- Total incremental government costs are less than 1 percent of total social costs across all MACT options.

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<u>**Economic Impact Measure Results**</u>

- **Market exits.** Across MACT options, between one and three cement plants and between seven and 23 on-site incinerators will stop burning hazardous waste entirely, rather than incur the rule's compliance costs. We do not expect any commercial incinerators or LWAKs will exit the waste-burning market as a direct result of the MACT standards.

- **Hazardous waste reallocated.** Market exit and waste consolidation activity is expected to result in approximately 50,000 tons (90,000 tons under the BTF-ACI option) tons of waste being reallocated from combustion systems that stop burning. Adequate capacity currently exists in the hazardous waste combustion industry to absorb this quantity of waste, which corresponds to approximately 3 percent of total currently combusted wastes.

- **Employment impacts.** At facilities that consolidate waste burning or stop waste burning altogether, employment dislocations of between 100 and 300 full-time equivalent employees are expected. At the same time, employment gains of about 100 full-time equivalent employees are expected in the pollution control industry, and gains of approximately 150 full-time equivalent employees are expected at combustion facilities as they invest in new pollution control equipment.

- **Combustion price changes.** Prices will likely increase by almost 15 percent (corresponding to increase of about $20 per ton) as combustion facilities face increased costs under the MACT standards.

- **Other industry impacts.** MACT compliance costs represent less than 2 percent of current total pollution control expenditures in industries with on-site incinerators but more than 60 percent of current pollution control expenditures for cement kilns. MACT compliance costs will increase the total costs of burning hazardous waste by approximately 50 percent for cement kilns and about 20 percent for commercial incinerators, though overall waste-burning costs still remain significantly lower for cement kilns when compared to commercial incinerators. Also, we expect that profits will decrease by 2 percent for commercial incinerators and by 11 percent for cement kilns, as these facilities incur the costs of rule compliance. Total profits for the pollution control industry are expected to increase in total by about three million dollars.

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SOCIAL COST METHODOLOGICAL FRAMEWORK

Total social costs of the MACT standards include the value of resources used to comply with the standards by the private sector, the value of government resources used to administer the regulation, and the value of output lost due to shifts of resources to less productive uses. To evaluate these shifts in resources and changes in output requires predicting changes in behavior by all affected parties in response to the regulation, including responses of directly-affected entities (combustion facilities) as well as indirectly affected private parties (e.g., hazardous waste generators who incur potential changes in combustion service availability or prices). We group these components of social costs into two basic elements:

- Economic welfare changes, which include shifts in consumer and producer surplus, and
- Government administrative costs.

Below, we discuss the market structure we assume for our social cost and economic modeling of the rule. We then present our approach to analyzing economic welfare changes and government costs associated with the rule.

<u>Combustion Market Structure Used for Modeling</u>

We assume a competitive market structure for modeling cost and economic impacts associated with the rule. While the hazardous waste combustion market is not purely competitive (i.e., individual firms act as price takers), given the extremely competitive nature of the industry (see Chapter 2), we believe this assumption better reflects the true nature of the market than other market structures (e.g., oligopolistic).[2]

The best indicator of the competitiveness of this market is the behavior of prices for waste combustion. Over the course of the past decade, as cement kilns have entered the market for waste combustion services, downward pressure on pricing has been intense. Competition for wastes exists across combustion sectors, and as noted in a June 1996 *Environmental Business Journal* article, "[i]ncinerators continue to face competition from cement kilns that burn hazardous waste derived fuel." (Environmental Business Journal 1996, 4). Given the competitive nature of the waste

[2] Note that while the Portland cement manufacturing market itself might be characterized as oligopolistic, our analysis focuses on the *hazardous waste-burning* component of the cement manufacturing operations. The olipoloistic nature of the cement industry would only be relevant to this rule if waste burning is used to cross-subsidize cement manufacture. Our understanding, based on public comments and other documents, is that such cross subsidization is not a significant practice in the industry. As such, the assumption that waste burning is a separate profit center subject to independent decision making is appropriate.

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management market, particularly for wastes that can be burned by both kilns and incinerators, we have adopted the competitive market structure for our modeling. We believe that this approach provides the most supportable framework for assessment of the impacts of the rule.

To determine the market structure for the industry, we also assessed whether barriers to entry (due to logistical and regulatory challenges faced by waste management facilities) would tend to make this industry less competitive. Barriers to entry do not appear to be a significant factor, as demonstrated by the significant number of players entering the market in the 1980s when prices were high. In addition, industries considering entry into, or expanding their presence in the hazardous waste burning market are well financed and highly sophisticated in their understanding of regulatory issues. As a result, we do not view barriers to entry playing a major role in reducing the competitiveness of the industry.

Economic Welfare Changes

This *Assessment* uses a simplified partial equilibrium analysis to estimate social costs. In the analysis, changes in economic welfare are measured by summing the changes in consumer and in producer surplus. For competitive markets, supply and demand can be illustrated graphically as shown in Exhibit 5-1.[3] As shown in the exhibit, the additional costs associated with the MACT standards will move the supply curve upward (from S_0 to S_1). This movement results in lost consumer and producer surplus, represented by the shaded trapezoid (the sum of areas A and B).[4] To calculate the area of the trapezoid (the economic welfare loss), economists typically use econometric techniques to estimate the supply and demand curves. This estimation procedure relies on historical price and output information. Because hazardous waste combustion markets have changed rapidly over the last several years, using historical data to construct these curves does not provide an accurate picture of the current combustion market. In addition, the hazardous waste

[3] The demand curve is drawn with a fairly steep slope, indicating a relatively inelastic demand for combustion services. Our analysis of the elasticity of demand for hazardous waste combustion services is discussed more fully in Appendix F, which analyzes waste minimization alternatives as substitutes for combustion.

[4] In simplest terms, the producer surplus refers to the amount of income individuals receive in excess of what they would require in order to supply a given number of units of a product or service. The consumer surplus is the benefit consumers receive from consumption of a product or service in excess of what they pay for it (i.e., the difference between what a consumer is willing to pay and what a consumer has to pay for a given product or service).

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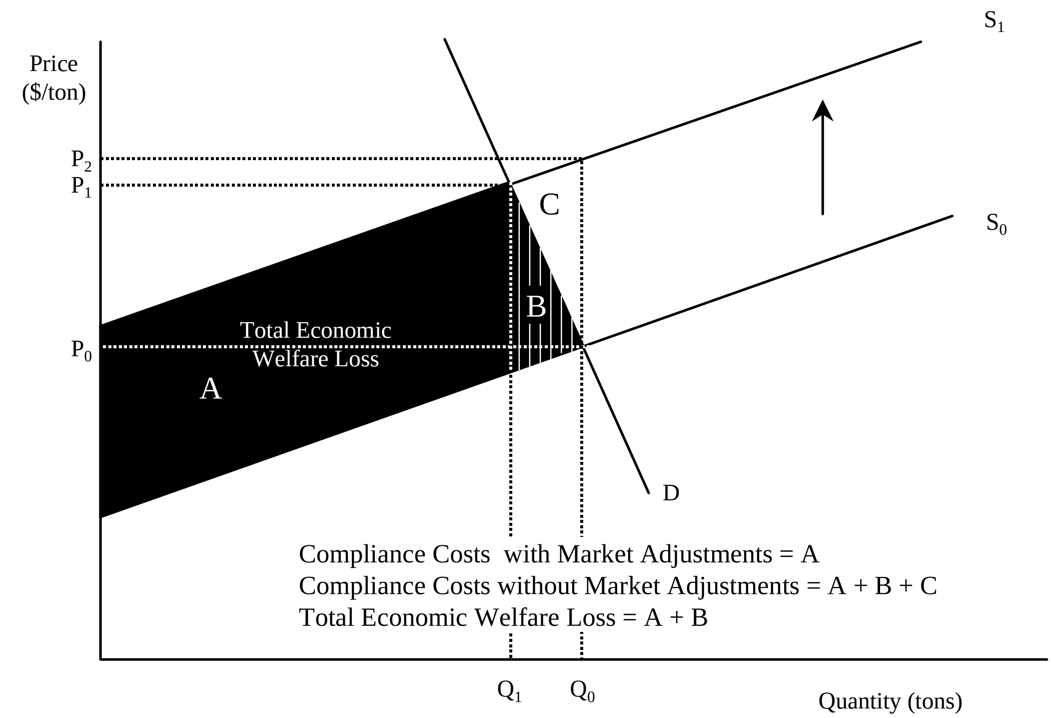
Exhibit 5-1

FRAMEWORK FOR ANALYZING ECONOMIC WELFARE LOSS



combustion market is somewhat segmented, with different sectors providing different types of combustion services. Data are not adequate to support econometric analysis at this level of complexity.

As an alternative to an econometric model, we have developed a simplified approach designed to bracket the welfare loss attributable to the MACT standards. This approach bounds potential economic welfare losses associated with the rule by considering two scenarios:

Static Scenario —

- **Compliance costs assuming no market adjustments.**[5] In this first scenario, we calculate an upper bound estimate of economic welfare losses by assuming that all combustion facilities continue to operate at current output levels and comply with the MACT standards. Facilities pass 100 percent of the compliance costs to the hazardous waste generators. Total compliance cost estimates for this static scenario are represented by the sum of the shaded areas A, B, and C in Exhibit 5-1.

Dynamic Scenario —

- **Market adjusted compliance costs.** In the second scenario, we assess market adjusted private costs by allowing only a portion of costs to be passed through. As a result, market exits occur as the market adjusts to a lower output equilibrium. Market-adjusted compliance costs are represented by shaded area A in Exhibit 5-1. These costs will be borne by both producers and consumers of combustion services. The extent to which these costs can be passed through to hazardous waste generators in the form of higher combustion prices depends primarily on the availability and costs of alternative waste management options. If substitutes are readily available, the slope of the demand curve will decrease, thus limiting the extent of combustion prices increases, and the resulting magnitude of consumer surplus losses. If the slope is zero, combustion facilities pass 0 percent of the compliance costs to hazardous waste generators.

The true economic welfare loss of the rule is indicated by shaded areas A and B in Exhibit 5-1. As shown in the exhibit, the true economic welfare loss lies somewhere between market adjusted compliance cost estimate (A) from the dynamic scenario and total compliance costs with no market adjustments (A+B+C) from the static scenario.

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[5] The static scenario also does not account for baseline adjustments. The framework illustrated in Exhibit 5-1 assumes market equilibrium. In reality, the hazardous waste combustion market is currently not in equilibrium. The dynamic scenario makes an additional adjustment to account for the current market over capacity. Thus, results under the static scenario are not the same as results under the dynamic scenario with 100 percent price pass-through (in which demand is completely inelastic).

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Government Costs

The final MACT standards also result in costs to government entities which administer and enforce the new emission standards. The costs for EPA and state environmental agencies to review permit modification applications and other industry documents and to implement modifications to their programs and practices following the final HWC MACT standards form the basis of the government cost estimates. The *Assessment* analyzes these costs directly in Chapter 4; we use the results from the Chapter 4 analysis in calculating the contribution of government costs to total social costs.

Social Cost Framework Summary

While the hazardous waste combustion industry's dynamic, segmented nature prevent us from estimating demand and supply curves, we are able to approximate the social costs of the MACT standards by summing total compliance costs and government administrative cost estimates. To bound the social costs, we use total compliance cost estimates under a static scenario (i.e., constant output, no market adjustments) and total compliance cost estimates that account for market adjustments.

HAZARDOUS WASTE COMBUSTION MARKET MODELING

To depict the two scenarios described above, we constructed a spreadsheet model that incorporates numerous baseline input parameters and compliance cost estimates specific to each combustion system included in the model. The economic model calculates total compliance cost estimates necessary for the social cost analysis, as well as a variety of economic impact measures. Because the economic model includes only a subset of combustion facilities, we use linear scaling factors for each combustion sector to project total costs and economic impacts. These scaling factors are shown in Exhibit 5-2 and assume that the facilities in the model are representative of the combustion universe.[6]

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[6] Some uncertainty exists about the number of facilities in the combustion universe that are actually operating. For instance, facilities may be included in the analysis that are still permitted but that have actually ceased operation, causing us to overstate the costs of the MACT standards. Also, the relatively low coverage (38 percent) for private on-site incinerators in the modeling effort may cause us to over- or under-estimate the impacts of the MACT standards on this combustion sector.

This section describes the economic model in more detail. We first explain how we estimate total compliance costs under the static scenario. Next, we describe how we model market dynamics by allowing combustion facilities to increase prices and by allowing consolidation of wastes across multiple combustion systems at a given facility. We then explain how we estimate total compliance costs for the dynamic scenario. We end the section by summarizing how the total compliance cost estimates relate to economic welfare losses in the context of social costs.

Exhibit 5-2

SCALING FACTORS FOR NATIONAL COST ESTIMATES

Sector	Number of Facilities in Universe	Number of Facilities in Model	Number of Systems in Universe	Number of Systems in Model	Scaling Factors
Cement kilns	18	18	33	33	1.00
Lightweight aggregate kilns	5	4	10	8	1.25
Commercial incinerators	20	15	26	20	1.30
All on-site incinerators	129	49	163	73	2.23
Government on-site incinerators	18	15	25	21	1.19
Private on-site incinerators	111	34	138	52	2.65

Notes:

1. We base scaling factors on system-level information because system-level economics drive plant costs, compliance costs, and decisions to cease burning.
2. Systems and facilities modeled are considered representative of the combustion universe, allowing for the use of linear scaling factors (see footnote on the previous page).

Total Compliance Costs Under Static Assumptions

The first social cost scenario assumes constant output and full compliance. We calculate total compliance cost estimates under this scenario as follows:

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1. Assign MACT compliance costs to each combustion system in the model.

2. Sum compliance costs across all systems for each combustion sector (e.g., cement kilns).

3. Multiply sector totals by the appropriate linear scaling factor.

4. Sum scaled sector totals across combustion sectors.

The result from these calculations may represent an upper bound estimate of total economic welfare loss which assumes that all facilities decide to continue waste burning post-MACT. Because a number of facilities appear to be currently operating at levels that do not cover the costs of waste-burning, we also execute the above calculations only for the facilities that currently appear viable. (See baseline viability projections described in Chapter 3.)

<u>Modeling Market Dynamics</u>

While the static scenario estimates total compliance costs for all existing combustion facilities, actual costs depend on the incentives and reactions of the regulated community and its customers. Increased compliance costs affect the incentives for combustion facilities to continue burning and the competitive balance in different combustion sectors. Combustion facilities may try to recover these increased costs by charging higher prices to generators and fuel blenders. To characterize post-MACT scenarios more accurately, we first evaluate the profitability of each combustion system in the absence of the MACT standards (i.e., baseline profitability).[7] Under the dynamic scenario, we do not include costs for, or economic impacts from, combustion systems that are not profitable in the baseline. For systems that are profitable in the baseline, we evaluate their economic viability post-MACT by introducing two dynamic market elements to the economic model. First, the post-MACT scenario also allows combustion facilities to pass through portions of the cost increase to generators in the form of higher prices. Secondly, we allow combustion facilities to consolidate waste burning among multiple combustion systems at the same facility, enabling them to increase throughput and reducing total facility compliance costs. We discuss these two dynamic elements below.

[7] See page 3-3 for an explanation of the profitability analysis.

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Combustion Price Increases

All combustion facilities that remain in operation will experience increased costs under the MACT standards. To protect their profits, combustion facilities will have an incentive to pass these increased costs on to their customers in the form of higher combustion prices. Price increases will be capped by the availability of substitutes for combustion (i.e., the waste minimization and non-combustion treatment alternatives discussed in Chapter 6). Characterizing the availability of waste minimization options allows us to assess the elasticity of demand for combustion services. That is, if lower cost waste minimization options are readily available for large quantities of combusted waste, combustion facilities will be less able to pass compliance costs along to generators in the form of higher combustion prices.

We conducted a waste minimization analysis to inform the expected price change.[8] The analysis considers in-process recycling, out-of-process recycling, and source reduction as alternatives to hazardous waste combustion. The analysis shows that, while a variety of waste minimization alternatives are available for managing hazardous waste streams that are currently combusted, the costs of these alternatives generally exceed the cost of combustion. When the additional costs of compliance with the MACT standards are taken into account, waste minimization alternatives still tend to exceed the higher combustion costs. This translates into a demand for combustion that is relatively inelastic, as indicated by the steep angle of the curve in Exhibit 5-3.[9]

Due to the variance of price elasticity across different priced waste types and the uncertainties and limitations of the waste management alternatives analysis, we conducted a sensitivity analysis by evaluating the impact of the proposed rule under four different price increase assumptions:

1. Combustion prices do not change (i.e., a 0 percent price pass through in which demand for hazardous waste incineration is completely elastic and compliance costs are fully borne by the combustion facilities).

2. Combustion prices increase slightly (i.e., combustion price demand elasticity is nearly constant). Under this price assumption, we assume that combustion

[8] The report is included as Appendix F: Allen White and David Miller, Tellus Institute, "Economic Analysis of Waste Minimization Alternatives to Hazardous Waste Combustion," July 24, 1997.

[9] Overall, demand is relatively inelastic. However, demand elasticity varies with (base) combustion prices: at higher combustion prices, demand is more inelastic than at lower combustion starting prices.

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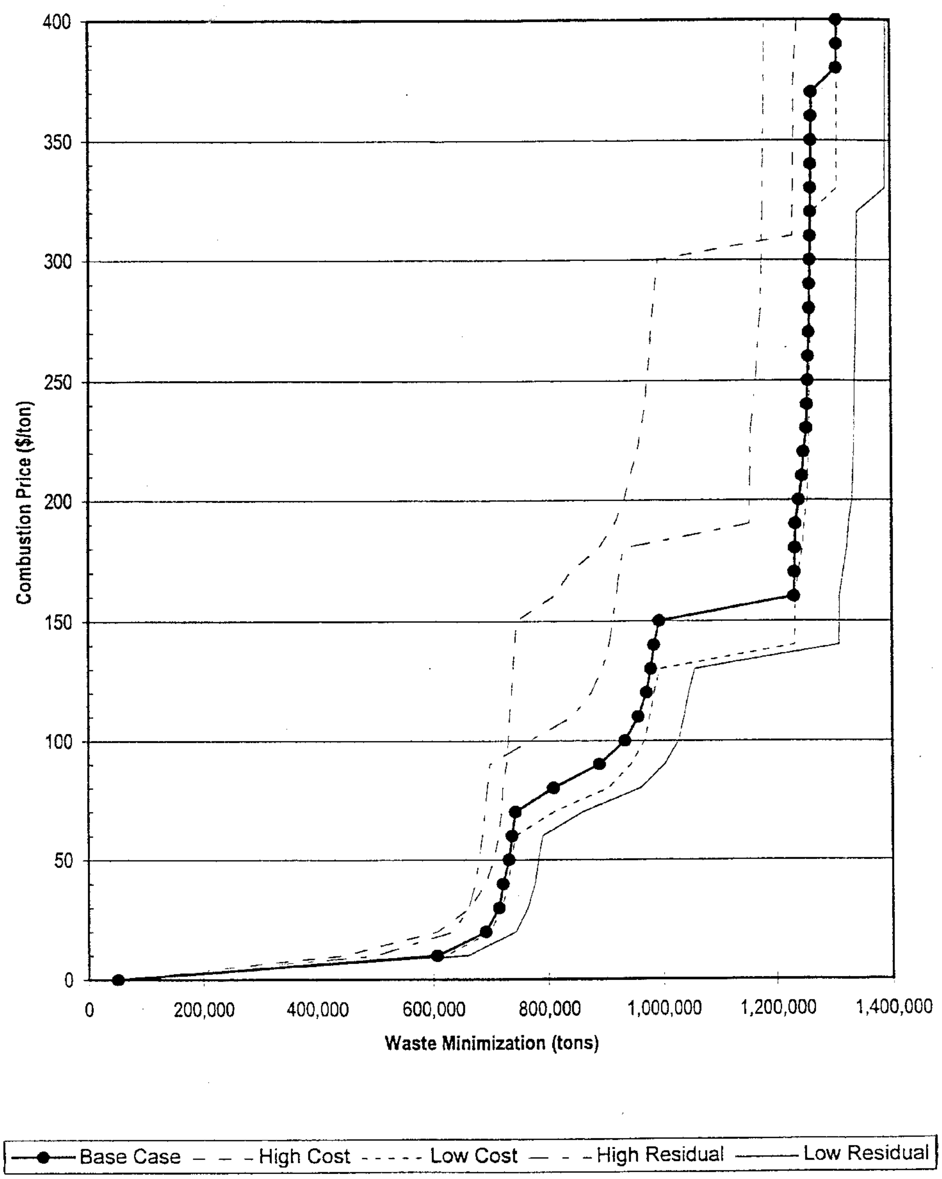
Exhibit 5-3

DEMAND FOR COMBUSTION ALTERNATIVES



Notes:
1. Graph excludes potential source reduction activities because the rate of source reduction is not expected to be sensitive to changes in combustion prices.
2. See Appendix F for more information on source reduction and waste minimization alternatives.

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facilities can pass through 25 percent of the median compliance costs in the lowest-cost commercial combustion sector.[10]

3. Combustion prices increase moderately (i.e., combustion demand is relatively inelastic). Under this price assumption, we assume that combustion facilities can pass through 75 percent of the median compliance costs in the lowest-cost commercial combustion sector.

4. Maximum price increase (i.e., no waste management alternatives are economically available, making demand for hazardous waste incineration completely inelastic). The maximum price increase corresponds to 100 percent of the median compliance costs in the lowest-cost commercial combustion sector.[11]

Waste Consolidation

In a further attempt to model industry behavior more accurately, we allow for consolidation of waste burning across systems at a given facility. The logic behind this is that many hazardous waste combustion facilities have more than one permitted combustion system at the same site. Each system may burn too little waste to cover its costs. However, the facility may be able to consolidate waste among systems, offering two benefits to the combustion facility. First, consolidation reduces compliance expenditures because not all systems are brought into compliance for hazardous waste burning. Second, it increases the throughput at the systems that remain in operation. As a result, the systems remaining in operation are more likely to cover their costs.[12] As shown in Exhibit 5-4,

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[10] Price increases for kilns and incinerators are somewhat different because kilns and incinerators do not compete for some waste stream types. We assume, based on what occurs in the actual marketplace, that kilns and incinerators compete with each other only for liquids and less contaminated sludges and solids and that only commercial incinerators compete for highly contaminated solids and sludges.

[11] This pricing case differs from the static scenario because in the static scenario every system (including those non-viable in the baseline) is able to pass through *its own* full compliance costs. In contrast, in dynamic scenario 100 percent pass-through pricing case, we only include systems viable in the baseline, and price increases are uniform across particular wastes and do not vary across facilities managing the same basic waste types (because we assume markets are competitive).

[12] A number of facilities report tons burned at the facility, rather than the system, level. This method of reporting hides possible variances in tons burned across the systems that would illustrate that some systems may be able to cover their costs while others are not. The consolidation routine helps overcome this gap by evaluating how many systems would need to close in order to bring the remaining systems to levels that cover their costs.

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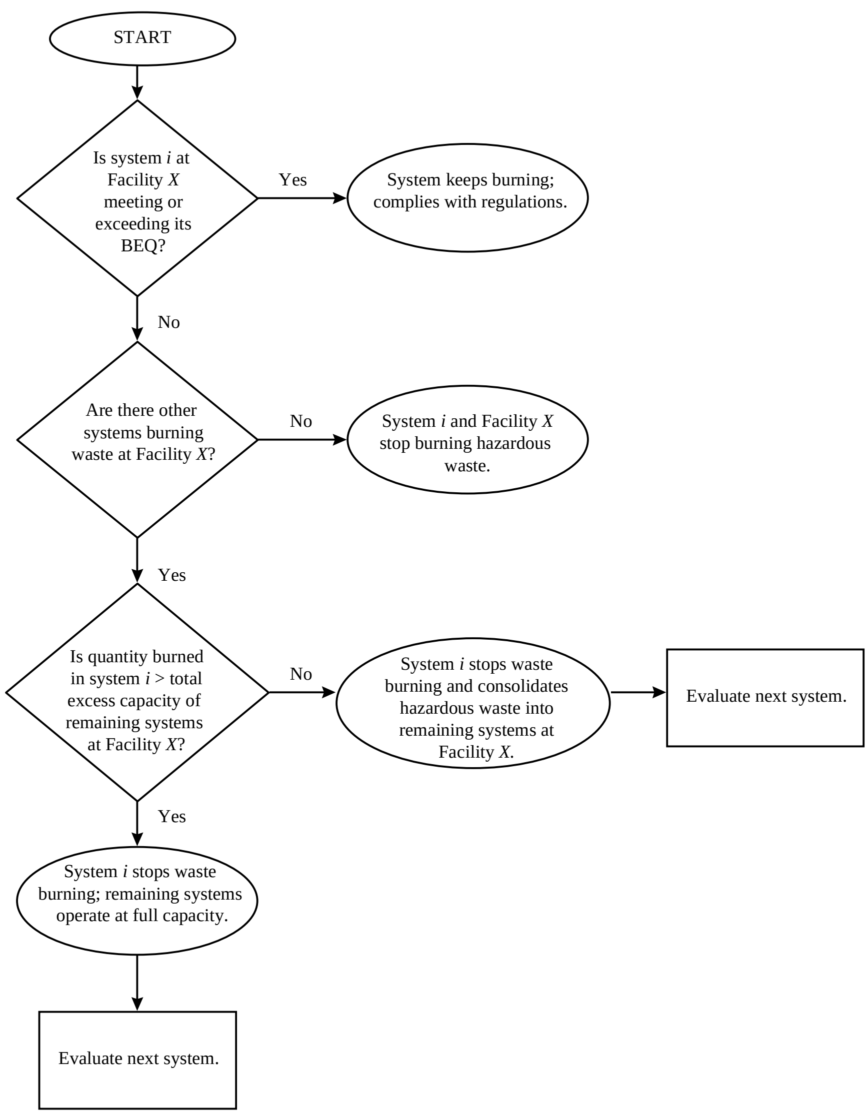
the consolidation routine closes one system at multi-system facilities and distributes the waste from the closed system equally among the remaining open systems. We only allow wastes to be shifted to another system at the same facility if there is adequate capacity. If the open systems still do not cover costs, the process is repeated until either the systems remaining open are able to cover costs or there is only a single system left. If the single open system does not cover costs, we assume that the entire facility will cease burning hazardous wastes, and the waste will be reallocated to other combustion facilities or waste management alternatives.

Exhibit 5-4

COMBUSTION SYSTEM CONSOLIDATION MODULE



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Total Compliance Costs Under Dynamic Assumptions

We calculate total compliance costs under this dynamic scenario by assessing the post-MACT profitability of each system in the model and by allowing combustion price increases as well as waste consolidation. To assess profitability, we use the same approach for assessing profitability post-MACT as in the baseline (see Chapter 3), except in the post-MACT scenario, the costs of burning are adjusted upward to account for compliance costs. Thus, the basic formula is adjusted as follows:

Operating Profits = Total Revenues - Total Baseline Costs - Total Compliance Costs

Where:

Total Revenues = *[Combustion market price per ton + Energy savings per ton + Avoided transportation costs per ton] * Tons burned]*

= $P * Q$

Total Costs = *{Total fixed costs + [(Variable baseline costs per ton + Variable compliance costs per ton)* Tons burned)] + Fixed compliance costs}*

= $\{FC + [(VC + C_{VC}) * Q] + C_{FC}\}$

As shown in the formula above, compliance costs are broken down into fixed and variable components. While pollution control costs are primarily comprised of fixed costs, the cost of operating some technologies also vary by the amount of hazardous waste burned.

To assess profitability, we determine whether revenues are adequately covering the costs of waste burning by comparing the tons burned at each combustion system with the breakeven quantity (BEQ) for that combustion system. The BEQ measures the quantity of waste that a combustion system would have to burn for prices to cover the costs of operation.[13] We use estimates of breakeven quantity to assess the likelihood that combustion facilities will stop burning waste in the face of increased compliance costs and constant hazardous waste prices. We calculate two BEQ measures -- short-run and long-run. Combustion systems will continue to operate in the short run if they can burn enough waste to cover their variable and fixed O&M costs. Systems must cover

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[13] For additional information on breakeven analyses, see Eugene Brigham and Louis Gapenski, *Financial Management Theory and Practice*, 6th Edition, 1991, The Dryden Press, Chicago, 483; or Leopold Bernstein, *Financial Statement Analysis: Theory, Application and Interpretation*, 1983, Irwin, Howewood, IL, 640-652.

their fixed capital costs as well if they are to continue operating in the long run. In both the long and short run, a combustor will not choose to invest in new capital (i.e., pollution control equipment) unless it is confident that it can burn enough waste to cover the cost of that new equipment.[14]

Thus, at breakeven, profit equals zero and we can solve for the BEQ using the formula specified above:

$$0 = \text{Total Revenues} - \text{Total Costs}$$

$$0 = P*Q - [\, FC + [(VC + C_{VC}) * Q] + C_{FC}]$$

$$C_{FC} + FC = Q[P - VC - C_{VC}]$$

$$\mathbf{Q} = \frac{\mathbf{FC + C_{FC}}}{\mathbf{P - VC - C_{VC}}} = \textbf{Breakeven Quantity} = \mathbf{BEQ}$$

Note that in the *short term*, FC includes only the new fixed costs of the rule, such as new pollution control devices plus baseline fixed O&M costs. All of these fixed costs would be avoided if the facility chose not to continue burning hazardous waste prior to investing in compliance. In the *long term*, the company's old equipment will wear out and require replacement. Therefore, FC for the long-term BEQ includes both the new fixed costs of the rule and the baseline fixed O&M and capital costs.

The BEQ analysis provides a more precise indication of whether a combustion system is likely to continue burning waste. To assess whether a combustion system is likely to be able to meet its breakeven quantity, we can compare the BEQ to the quantity of waste currently burned at the system. If the BEQ significantly exceeds current tons burned, the system is likely to cease waste burning. For instance, the lower quantities burned at on-site incinerators will result in more of these facilities being unable to meet BEQ.

The BEQ analysis is affected by many of the same uncertainties discussed in the baseline profitability section. Most significantly, inaccuracies in the quantity and type of hazardous waste burned at each system affect our evaluation of each system's ability to meet the BEQ.

[14] As noted in Chapter 3, some firms could decide to operate their combustion systems at a loss. We anticipate that the vast majority of combustion firms will shut loss-making operations, however.

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Summary

We use the BEQ analysis to predict which combustion facilities in the model are expected to stop burning in the face of increased costs. The facilities that exit the market will, of course, not need to implement any of the MACT requirements. Total compliance costs under the market-adjusted scenario therefore are less than total compliance costs in the static scenario and provide a lower bound on welfare losses. The true economic welfare loss lies somewhere between the market adjusted compliance cost estimates and total compliance costs with no market adjustments.[15]

SOCIAL COST RESULTS

As described in the methodological framework section, social costs are comprised of economic welfare losses and government costs. We bound the economic welfare loss estimates by estimating total compliance costs under the two market scenarios described above (i.e., static and dynamic scenarios). We also provide an upper bound of total social costs that includes all combustion systems, even those non-viable in the baseline.[16] Below, we present compliance cost results for the static and dynamic scenarios.[17] We then present social cost results that also incorporate the government cost estimates from Chapter 4.

Compliance Cost Results for the Static Scenario

For the final recommended MACT, annualized compliance costs under the static scenario, in which all baseline viable combustion facilities comply with the MACT standards, range from $73 to $86 million, depending on the engineering design level (i.e., controls designed for emission reductions at 70 percent versus 50 percent of the standards). At the Floor, total annualized compliance costs are about 10 percent lower than costs for the final standards and range from $66 to $83 million, depending on the engineering design level. For the BTF standards, costs almost double (relative to the final standards), and range from $140 to $155 million. Again, this range reflects different assumptions about the engineering design levels. For the static scenario, our best estimate is at the 70 percent engineering design level for the final recommended MACT: $73 million.

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[15] EPA expects that compliance costs with market adjustments assuming moderate price increases (i.e., 75 percent price pass-through) is a closer approximation of total economic welfare loss because demand for hazardous waste combustion services is relatively inelastic, and assuming the additional costs of output adjustments are minimal.

[16] This upper bound analysis is essentially a sensitivity analysis of our baseline viability analysis (see Chapter 3).

[17] Results with PM CEM costs are included in Appendix C.

As shown in Exhibit 5-5, the MACT standards will introduce aggregate cost impacts that differ greatly across combustion sectors and across regulatory options (i.e., from Floor and Recommended to the BTF-ACI option). Looking across combustion sectors shows that cement kilns and private on-site incinerators make up the majority of the national costs under any given MACT option. For cement kilns, this significant share of the impact is due primarily to the high costs per system. For on-site incinerators, the high aggregate costs are primarily due to the large number of combustion systems within this sector. Total costs are less for commercial incinerators (because of relative limited costs per system) and for LWAKs (because of the limited number of systems).

Exhibit 5-5

TOTAL ANNUAL COMPLIANCE COSTS (millions)
(Excludes baseline non-viable systems, no system consolidation or market exits)

MACT Options	Cement Kilns	LWA Kilns	Commercial Incinerators	Private On-Site Incinerators	Government On-Site Incinerators	TOTAL
Floor	$22-$31	$5-$6	$6-$8	$28-$34	$5	$66-$83
Recommended	$26-$33	$6-$7	$6-$8	$30-$34	$5	$73-$86
BTF-ACI	$38-$48	$8	$10-$11	$58-$61	$26-$27	$140-$155

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. Ranges reflect design levels of 50% and 70% of the MACT standards.
3. Costs of PM CEMs not included.
4. Totals may not add due to rounding.

To assess the sensitivity of these results to our baseline viability assumptions, we also estimated the compliance costs for all combustion systems, including those non-viable in the baseline. The results from this sensitivity analysis are shown in Exhibit 5-6. As shown in the exhibit, total costs increase by about 10 percent across all options (relative to total costs excluding baseline non-viable systems). Depending on whether controls are designed to 50 percent or 70 percent of the standards, total annual costs for the Final standards range from $82 to $95 million. For the Floor standards, costs range from $72 to $90 million. For the BTF-ACI standards, costs range from $150 to $166 million. These results provide an upper bound on total compliance costs.

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Exhibit 5-6

TOTAL ANNUAL COMPLIANCE COSTS (millions)
(No market adjustments; total costs for all facilities, including baseline nonviable systems)

MACT Options	Cement Kilns	LWA Kilns	Commercial Incinerators	Private On-Site Incinerators	Government On-Site Incinerators	TOTAL
Floor	$22-$31	$5-$6	$8-$9	$33-$39	$5	$72-$90
Recommended	$26-$33	$6-$7	$7-$9	$37-$42	$5	$82-$95
BTF-ACI	$38-$48	$8	$12-$13	$67-$70	$26-$27	$150-$166

Notes:
1. Estimates taken from model exhibit, "Total Annual Compliance Costs (millions) (Assuming No Market Exit)."
2. Ranges reflect design levels of 50% and 70% of the MACT standards.
3. Costs of PM CEMs not included.
4. Estimates assume that all facilities comply, including those non-viable in the baseline.
5. Totals may not add due to rounding.

Compliance Cost Results for the Dynamic Scenario

Total annualized compliance costs under the dynamic scenario, for which baseline exits, pricing increases, and waste consolidation are incorporated into the economic model, are approximately 20 percent lower than total compliance costs in the static scenario which includes baseline non-viable systems. This change in total costs results from market exits expected in the baseline and market exits attributed to the MACT standards. Facilities that exit the market will not invest in pollution control equipment or incur other MACT-related costs, thus reducing total compliance cost estimates.

Under the dynamic scenario, total annual compliance costs range from $57 million under the MACT Floor (70% design level) to $139 for the MACT BTF-ACI (50% design level). These results are presented in Exhibit 5-7. Our best estimate for compliance costs are provided by this dynamic scenario. Best estimates for costs also use the 70 percent engineering design level and assume relatively inelastic demand (modeling using the 75 percent price pass-through assumption). Using these assumptions, our best estimate of total annual compliance costs for the recommended MACT is $65 million annually.

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Exhibit 5-7

**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%)	$30	$5-$6	$8	$26	$5	$73-$74
Floor (70%)	$21	$4	$6	$22	$5	$57
Rec (50%)	$32	$5-$7	$7	$27	$5	$76-78
Rec (70%)	$25	$5	$6	$23-$24	$5	$64-$65
BTF-ACI (50%)	$42-$43	$7	$12	$48-$51	$27	$135-$139
BTF-ACI (70%)	$34	$7	$10	$47-$48	$26	$123-$124

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 independent rounding.

Summary

We develop total social cost estimates by adding government cost estimates to the economic welfare loss estimates. As discussed in the "Social Cost Methodological Framework" section earlier in this chapter, our simplified approach for estimating economic welfare losses uses compliance cost estimates under two scenarios (i.e., static and dynamic). We take the results from these scenarios (discussed in the sections above) to develop our economic welfare loss estimates.[18]

[18] Economic welfare losses include changes in consumer and producer surplus; we do not, however, estimate these changes independently.

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We present estimates of total social costs in Exhibit 5-8. This exhibit uses the best estimates from the static scenario (70% engineering design level, excluding baseline non-viable systems) and the dynamic scenario (70% engineering design level and relatively inelastic demand (i.e., 75% price pass through). For the upper bound estimates, we use the static scenario which includes baseline non-viable systems with pollution systems designed to achieve control at 50 percent of the MACT standards. For the final rule (Recommended MACT), total annual social costs are between $65 and $73 million, with an upper bound of $95 million.[19, 20] Almost half of the social costs are attributed to on-site incinerators; this result is due to the large number of systems in this combustion sector. Total social costs increase by about 90 percent to between $124 and $140 million for the BTF-ACI option due to the costly carbon injection and carbon bed equipment that is required to meet the BTF mercury levels. At the Floor, total social cost estimates are between $57 and $66 million, about 10 percent less than costs for the Recommended option. Total incremental government costs are less than 1 percent of total social costs across all MACT options.

Exhibit 5-8
SUMMARY OF SOCIAL COST ESTIMATES
(millions of 1996 dollars)

	Best Estimate	Upper Bound
Floor	$57 - $66	$90
Recommended	$65 - $73	$95
BTF-ACI	$124 - $140	$166

NOTES:
1. 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.
2. Because the government costs are small (less than 1 percent) relative to the compliance costs for affected sources, the social cost estimates do not change relative to compliance costs.
3. Cost ranges for best estimates reflect different combustion price elasticities and market adjustments (the static scenario assumes that 100 percent of compliance costs can be passed through to generators/fuel blenders; the dynamic scenario assumes 75 percent).
4. PM CEM costs not included.
5. 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/fuel blenders.
6. Costs for upper bound estimates reflect engineering design levels of 50%. Costs for best estimates reflect engineering design levels of 70%.

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[19] Our best estimate takes into account baseline output adjustments that we expect will occur as baseline non-viable facilities exit the market and output is adjusted to a new capacity level.

[20] The compliance cost portion of the lower end of our best estimate range is $65 million, which is based on the dynamic market scenario assuming moderate price increases (i.e., 75% price pass-through scenario).

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ECONOMIC IMPACT MEASURES

In addition to providing compliance cost estimates under the static and dynamic market scenarios, the model also calculates several economic impact measures which describe at a more detailed level how the market responses change the shape of the combustion industry and affect the APCD industry. This section describes the approach and findings for each of the following economic impact measures:[21]

- **Market exits.** With the MACT standards, total costs of combustion increase, making it unprofitable for some facilities to continue burning hazardous waste. In this section, we estimate the incremental number of facilities that may exit the market as a direct result of the MACT standards.

- **Hazardous waste reallocated.** As certain combustion systems stop burning, waste is reallocated from these systems to other combustion facilities or to alternative waste management options. In this section, we estimate the quantity of hazardous waste reallocated under different MACT options.

- **Employment impacts.** As specific combustion facilities find it is no longer economically feasible to continue to burn hazardous wastes and therefore exit the market, workers at these locations may be displaced. At the same time, the rule may result in employment gains 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. In this section, we project employment shifts across these sectors.

- **Combustion price changes.** Combustion prices will likely increase with the higher costs of waste burning. In this section, we estimate price increases for each of the MACT alternatives.

- **Other industry impacts.** The MACT standards will also affect the cost structure of the combustion industry and the profits for hazardous waste combustion facilities and APCD manufacturers. In this section, we estimate the increase in profits for the APCD industry, the change in overall costs for combustion sectors and decrease in profits for hazardous waste combustion firms, and the relationship between MACT compliance costs and current pollution control expenditures.

[21] We also present economic impact results that include PM CEM costs in Appendix C.

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Market Exits

Based on the dynamic breakeven quantity (BEQ) analysis, we calculate the number of systems and facilities, likely to exit the hazardous waste combustion market in response to the MACT standards. Because the hazardous waste combustion market is a dynamic industry, with a number of facilities dropping out of the market in the past few years, we present market exit estimates incremental to those projected in the baseline. Incremental exits are those we expect to result from the MACT standards; baseline exits, on the other hand, are those that we expect to occur even without the MACT standards.[22]

The analysis from Chapter 4 provides the information needed to assess whether a particular combustion *system* is viable. However, evaluating market dislocations must also incorporate *facility-level* impacts. The BEQ analysis feeds directly into this evaluation; where no system at a facility can meet BEQ (even after wastes are consolidated), we assume the facility will cease burning hazardous waste completely.[23]

Facility-level impacts provide the best measure of regional economic dislocations. A cement plant that consolidates hazardous waste burning in two systems at a single location rather than the previous three will generate smaller economic impacts than if the plant stops burning waste altogether. One important caveat is that, for most sectors, exiting the hazardous waste combustion market is fundamentally different from closing a plant. Cement kilns or LWAKs that stop burning hazardous fuels do not stop making cement and aggregate. Similarly, on-site incinerators are generally located at large industrial facilities such as chemical plants or refineries. Production is likely to continue even if the wastes are sent off-site for management. Only in the case of a commercial incinerator would exit from hazardous waste combustion markets most likely signal the actual closure of the plant.

Short Term

In the short term, we expect a relatively small percentage of facilities to stop burning hazardous waste as a result of the Combustion MACT standards, incremental to baseline exit estimates. These particular facilities are marginally profitable at present and burn low quantities of hazardous waste over which they can spread their compliance costs. The consolidation routine

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[22] Our market exit estimates are a function of several assumptions, including the following: engineering cost data on the baseline costs of waste burning; cost estimates for pollution control devices; prices for combustion services; and assumptions about the waste quantities burned at these facilities. Due to the uncertainty surrounding these data assumptions, we also provide baseline exit estimates in Appendix K as part of our economic impact assessment sensitivity analysis.

[23] Since some systems will stop burning hazardous wastes at facilities that continue to burn wastes in other systems, facility exit estimates will be lower than system-level exit estimates.

suggests that for the final recommended standards, the following number of combustion facilities will cease burning hazardous waste in the short term, with the high-end estimates including facilities that appear non-viable in the baseline:[24]

- **Cement Kilns** -- one out of 18 facilities.
- **LWAKs** -- zero out of five facilities.
- **Commercial Incinerators** -- between zero and three out of 20 facilities.
- **Private On-Site Incinerators** -- between 16 and 42 out of 111 facilities.

Long Term

In general, the number of anticipated market exits increases in the long term due to capital replacement costs.[25] However, because this also holds true in the baseline, an increased number of projected long-term baseline market exits can decrease the number of incremental long-term exits. The consolidation routine estimates that for the recommended MACT standards, the following number of combustion facilities will cease burning hazardous waste in the long term as a direct result of the MACT standards, with high-end estimates including facilities that appear non-viable in the baseline:

- **Cement Kilns** -- between one and two out of 18 facilities.
- **LWAKs** -- zero out of five facilities.
- **Commercial Incinerators** -- between zero and three out of 20 facilities.
- **Private On-Site Incinerators** -- between seven and 55 out of 111 facilities.

[24] These high-end estimates, unlike those in Exhibit 5-8, include facilities that appear to be non-viable in the baseline regardless of the MACT standards. We include these potential baseline exits in the ranges presented above to capture the uncertainty surrounding estimates of incremental market exits.

[25] Long term market exits are **not** incremental to short-term exits (i.e., they are **not** over and above exits projected for the short term.

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Summary

Market exits are summarized across the short term and long term in Exhibits 5-9 and 5-10. As shown, the MACT standards have the greatest impact on on-site incinerators. Market exits are not significant for any of the commercial sectors.

Exhibit 5-9

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%)	1 (6%)	0 (0%)	0 (0%)	16 (15%)
Floor (70%)	1 (6%)	0 (0%)	0 (0%)	16 (15%)
Rec (50%)	1 (6%)	0 (0%)	0 (0%)	16 (15%)
Rec (70%)	1 (6%)	0 (0%)	0 (0%)	16 (15%)
BTF-ACI (50%)	1-2 (6%-11%)	0 (0%)	0 (0%)	20 (18%)
BTF-ACI (70%)	2 (11%)	0 (0%)	0 (0%)	20-23 (18%-21%)

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 relative to the baseline 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.

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Exhibit 5-10

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%)	1-2 (6%-11%)	0 (0%)	0 (0%)	7-13 (6%-12%)
Floor (70%)	2 (11%)	0 (0%)	0 (0%)	13 (12%)
Rec (50%)	1-2 (6%-11%)	0 (0%)	0 (0%)	7-13 (6%-12%)
Rec (70%)	1-2 (6%-11%)	0 (0%)	0 (0%)	13 (12%)
BTF-ACI (50%)	2-3 (11%-17%)	0 (0%)	0 (0%)	13-20 (12%-18%)
BTF-ACI (70%)	2- 3 (11%-17%)	0 (0%)	0 (0%)	13-20 (12%-18%)

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 relative to the baseline 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.

Hazardous Waste Reallocated

Combustion systems that can no longer cover their costs will stop burning hazardous waste. As such, waste from these systems will be reallocated to one of the following alternatives:

- Other viable combustion systems at the same facility if there is sufficient capacity,

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- Other combustion facilities that continue burning, or
- Waste management alternatives (e.g., solvent reclamation).

Because combustion is likely to remain the lowest cost option, we expect a large proportion of the reallocated wastes will continue to be managed at combustion facilities.[26]

Waste is reallocated from non-viable systems (i.e., those below BEQ) at both facilities that exit the market and at facilities that continue waste burning in other combustion units. Exhibit 5-11 summarizes the approach for estimating quantities of reallocated wastes. Wastes are only consolidated into fewer systems at the same facility if there is sufficient capacity.

As a result of the predicted market exits, we estimate that between 23,000 and 54,000 tons of currently burned hazardous waste will be potentially reallocated in the long term to other waste management facilities as a result of the final standards.[27] This corresponds to between approximately 1 and 2 percent of the total waste combusted in 1995. These estimates are for the final recommended MACT at the 70 percent engineering design level, over the long term. This estimate increases to about 160,000 tons (5 percent) if we include the waste burned in combustion systems non-viable in the baseline. Exhibit 5-12 summarizes incremental waste reallocated quantity estimates across MACT options and combustion sectors. Currently there is sufficient capacity across the combustion market to accommodate managing this reallocated waste, even at the high-end of the waste quantity estimates.

We also examined the geographic distribution of reallocated wastes to determine whether market exits and wastes reallocated from these facilities are concentrated in certain areas of the country. We then determined the amount of remaining combustion capacity at the regional level that could handle the reallocated wastes. For this analysis, we assume that wastes could be managed at other combustion facilities located within 200 miles of the systems we predict will stop burning.[28] The results of this analysis are shown in Exhibit 5-13.

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[26] One industry trade association submitted comments to EPA expressing concern that conditionally exempt small quantity generators (CESQGs) may discontinue sending their hazardous waste to kilns for use as fuel pos-MACT due to the anticipated price increases and due to the anticipated exits of kilns from the hazardous waste-burning market. Given the small number of expected kiln market exits, and the relatively inelastic demand for combustion services, EPA believes that CESQGs will continue to send their wastes to combustion facilities.

[27] We include in this range waste from systems that appear non-viable in the baseline to capture the uncertainty surrounding estimates of incremental market exits.

[28] We examined waste reallocated from facilities where all systems close as well as waste reallocated due to capacity constraints at facilities with consolidating systems.

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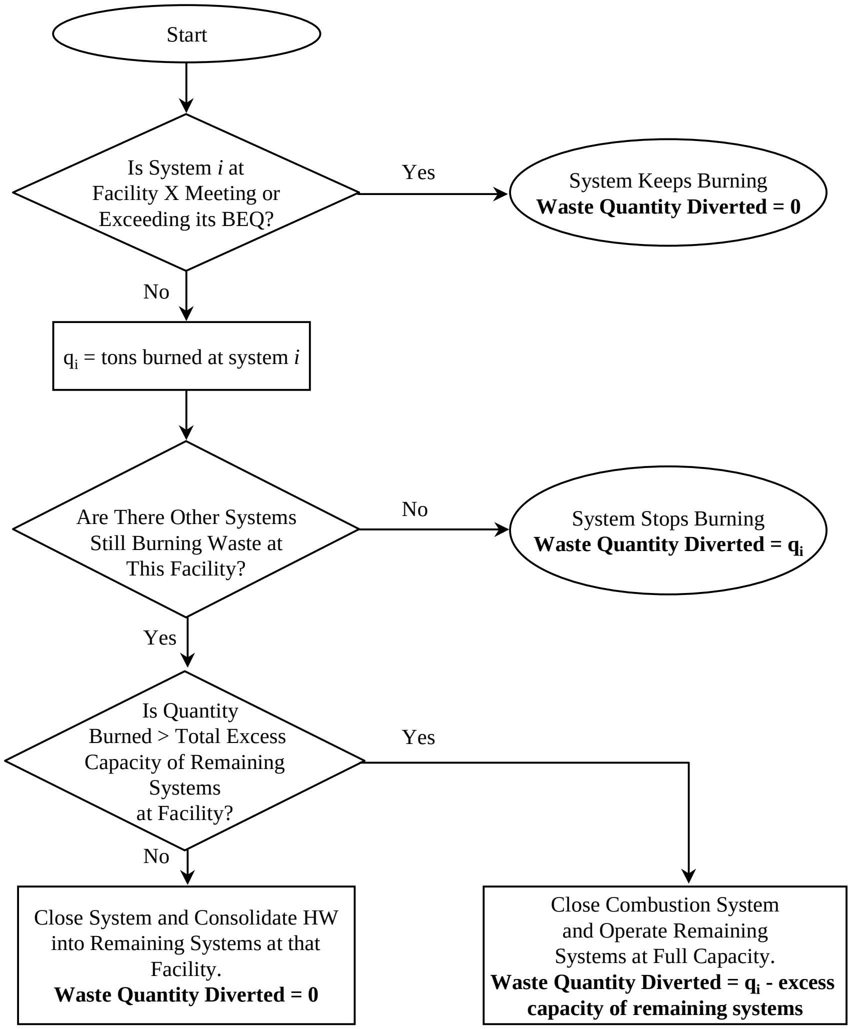
Exhibit 5-11

ROUTINE FOR CALCULATING QUANTITY OF WASTE DIVERTED



The hazardous waste combustion systems that we expect will stop burning and reallocate waste post-MACT are scattered across the Eastern and Central regions of the United States, with the exception of one system on the West Coast. (This pattern is consistent with the baseline geographic distribution of combustion systems.) The combustion systems that remain open in the Eastern and Central regions are sufficiently dispersed to handle the types and quantities of waste reallocated in their areas. However, there are no other combustion facilities nearby the system that we expect will stop burning on the West Coast.[29] Thus, we expect that wastes reallocated from this system, generated by both large and small quantity generators, have a higher likelihood of being managed by alternatives to combustion (e.g., pollution prevention).

[29] In this geographic analysis, we only examine combustion systems that are included in our economic model. It is possible that there exists a commercial system on the West Coast not included in the economic model that could handle the reallocated wastes in this region.

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Exhibit 5-12

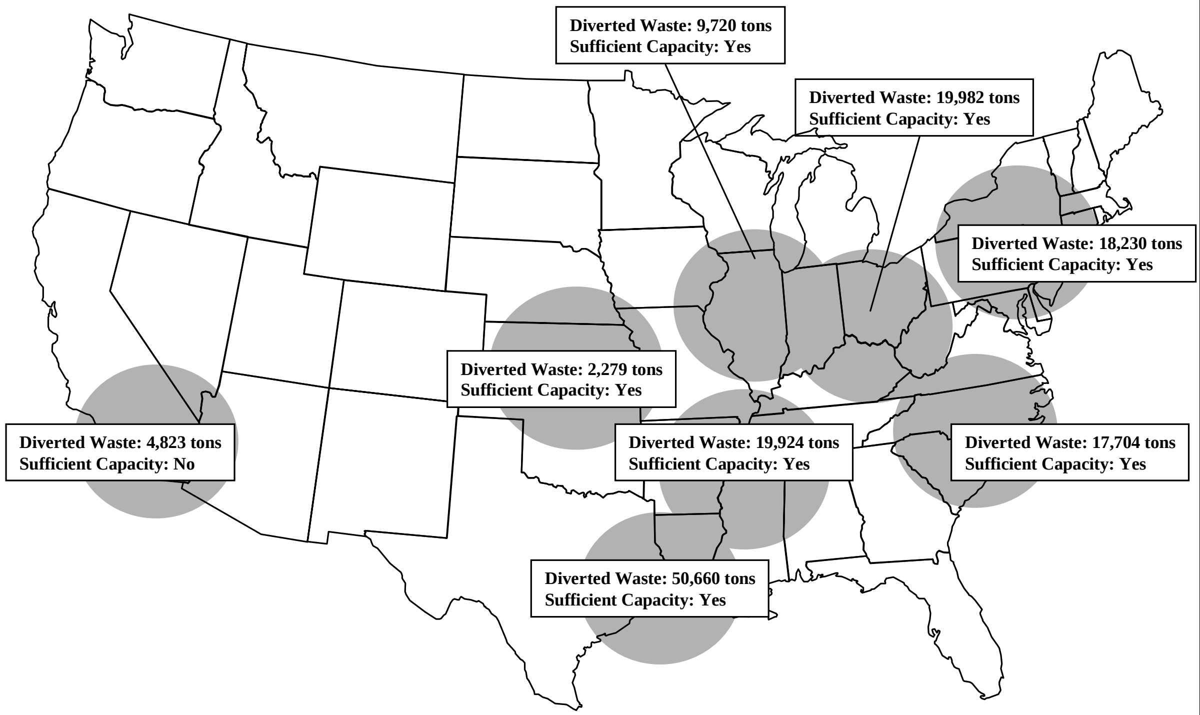
SUMMARY OF QUANTITY OF HAZARDOUS WASTE THAT COULD BE REALLOCATED IN THE SHORT AND LONG TERM

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	102,050	48,940	105,220	1	3
Floor (50%)	11,530	11,530-28,490	0	0	0	0	1,870	0-10,700	13,400	0-39,190	0	0-1
Floor (70%)	11,530	28,490-42,550	0	0	0	0	1,870	10,700	13,400	39,190-53,250	0	1-2
Rec (50%)	11,530	11,530-28,490	0	0-500	0	0	1,870	0-10,700	13,400	0-39,690	0	0-1
Rec (70%)	11,530	11,530-42,550	0	500	0	0	1,870	10,700	13,400	22,730-53,750	0	1-2
BTF-ACI (50%)	26,060-37,590	37,590-54,550	0	0-500	0	0	10,600	17,080-34,020	36,660-48,190	54,670-89,070	1-2	2-3
BTF-ACI (70%)	37,590	37,590-54,550	0	0-500	0	0	10,600-15,430	17,080-34,020	48,190-53,020	54,670-89,070	2	2-3

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 reallocated from systems that consolidate waste into other systems at the same facility.
5. Tons reallocated are incremental to that resulting from consolidation and market exit likely to occur in the baseline (i.e., without the MACT standards).

Exhibit 5-13

REGIONAL ANALYSIS OF DIVERTED WASTE AND REMAINING CAPACITY



Note: Regions are defined by a radius of 200 miles, the average distance hazardous waste is typically shipped by generators. (Source: DPRA, Inc., "Estimating Costs for the Economic Benefit of RCRA Noncompliance," prepared for U.S. EPA, Office of Regulatory Enforcement, September 1994, p. 5-10.) Some generators ship hazardous waste beyond 200 miles for treatment meaning that further capacity exists outside the regions drawn above for handling the diverted waste. Regions on map not drawn to scale.

Employment Impacts

The proposed MACT standards are likely to cause employment shifts across all of the hazardous waste combustion sectors. As specific combustion facilities find it no longer economic to keep all of their systems running or to stay in operation at all, workers at these locations may be displaced. At the same time, the rule may result in employment gains 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. In the section below, we describe the approach for analyzing employment shifts.[30] We then describe the results from this analysis for both employment gains and dislocations.

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[30] See Appendix E for a more detailed discussion of the methodology for the employment impacts analysis.

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Primary employment dislocations in the combustion industry are likely to occur when combustion systems consolidate the waste they are burning into fewer systems or when a facility exits the hazardous waste combustion market altogether. As shown in Exhibit 5-14, for each system that stops burning, employment dislocations include operating and maintenance labor. For each *facility* that exits the market, employment dislocations also include supervisory and administrative labor.

In addition to employment dislocations, the proposed rule will also lead to job gains as firms invest to comply with the various requirements of the MACT standards. Employment gains will occur in the pollution control equipment manufacturing industry, which produces devices to be used to achieve compliance with the standards.[31] We also anticipate employment increases at combustion facilities as additional operation and maintenance will be required for the new pollution equipment and as more staff will be needed for other compliance activities, such as new reporting and record-keeping requirements. Our approach for estimating these gains is illustrated in Exhibit 5-15.

[31] This industry also includes the manufacturers of PM continuous emissions monitoring systems (CEMs), which EPA has considered requiring as part of the standards. Because PM CEMs are not required in this phase of the rulemaking, we do not include employment gains associated with PM CEMs in the results presented in this chapter. However, we do include estimates of gains associated with PM CEMs in the full set of economic impact results presented in Appendix C.

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Exhibit 5-14

PROCEDURE USED TO ESTIMATE EMPLOYMENT DISLOCATIONS

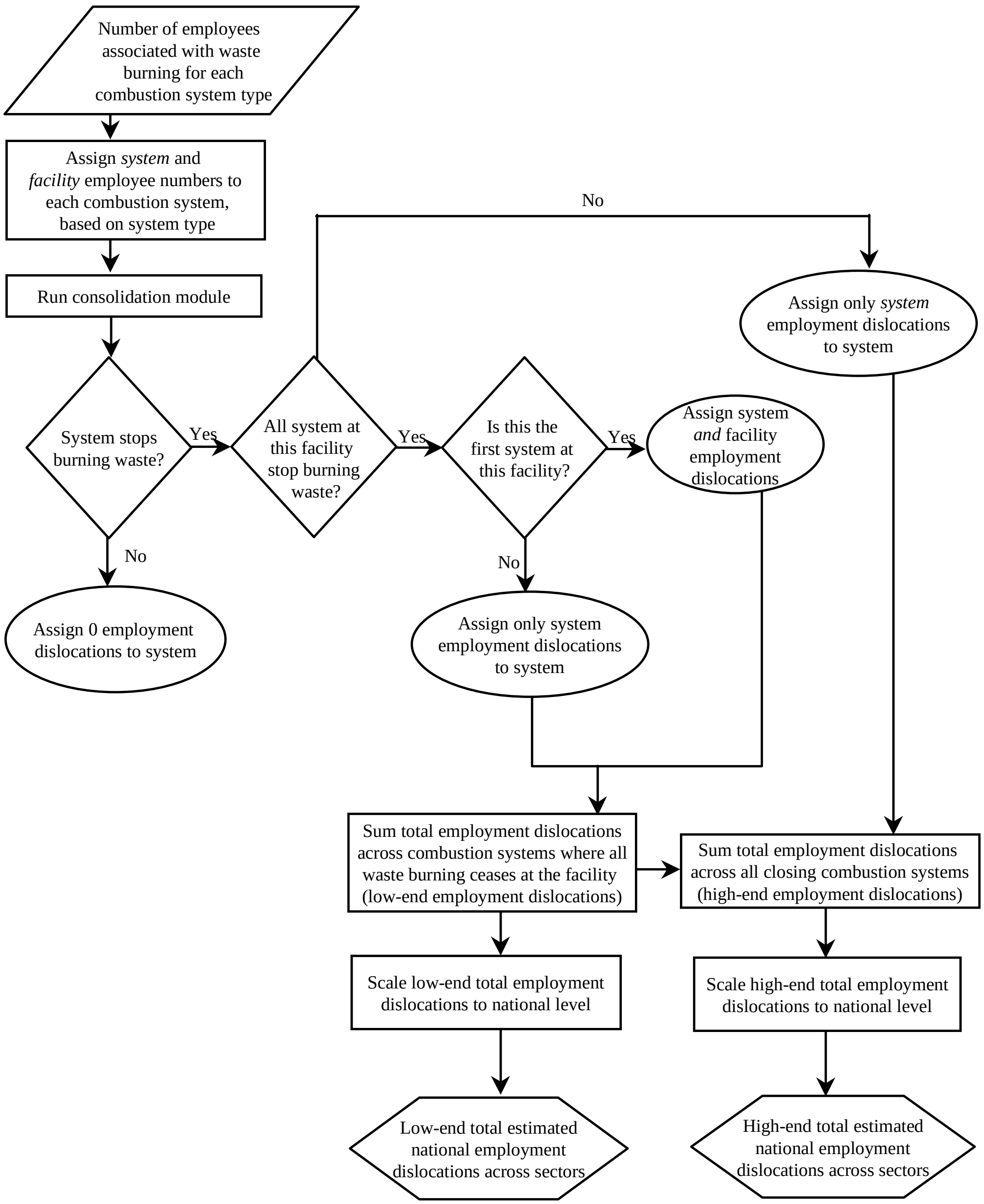

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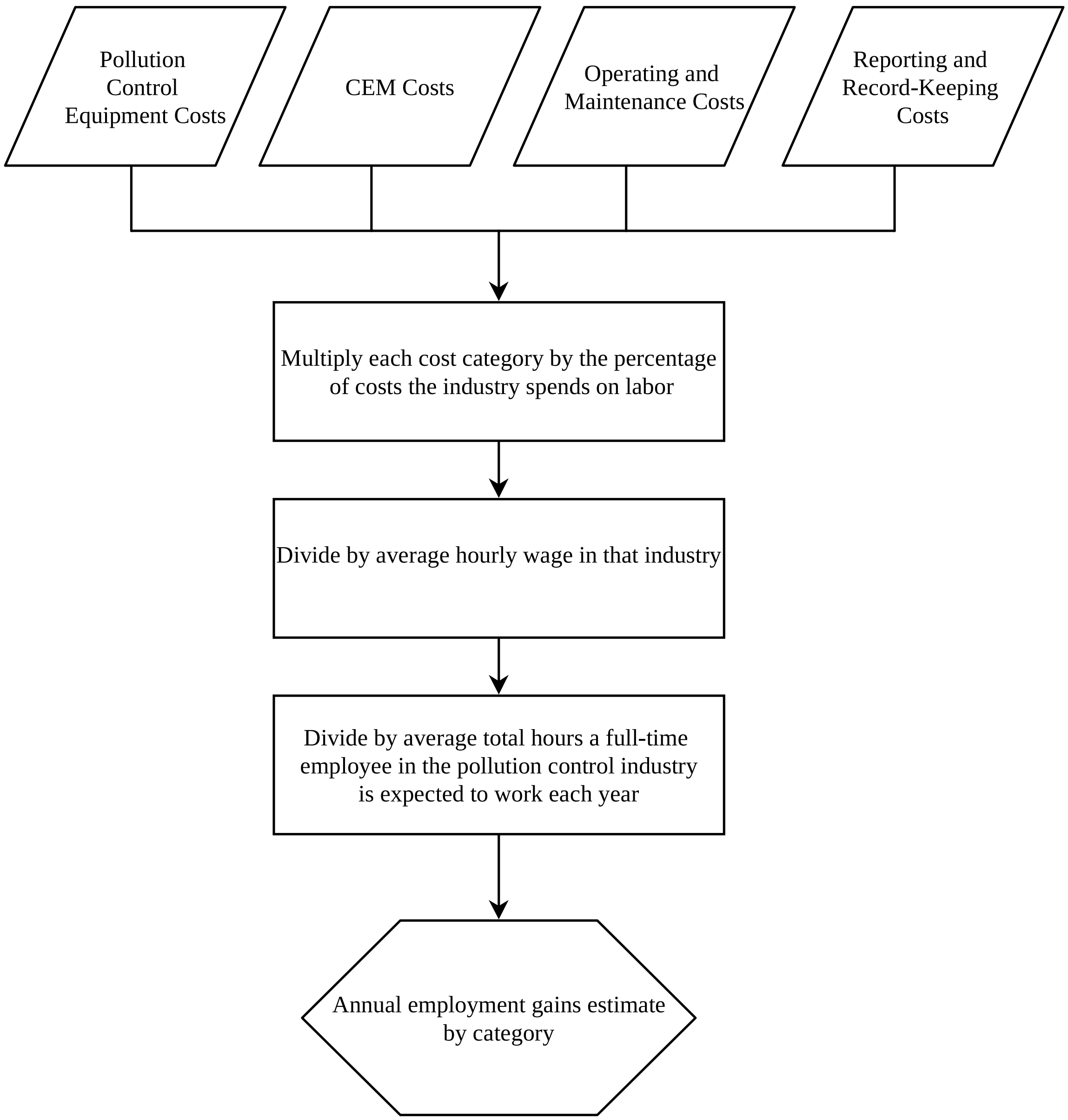
Exhibit 5-15

PROCEDURE USED TO ESTIMATE EMPLOYMENT GAINS



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We normalize both gain and dislocation estimates as full-time equivalent (FTE) employees on an annual basis. That is, short-term employment surges may occur in the pollution control equipment industry as combustion facilities make their initial equipment purchases. We average these surges over the lifetime of the pollution control equipment so that gain and dislocation estimates are presented in consistent terms. Results from the employment impact analysis are summarized in Exhibits 5-16 and 5-17. We also describe these results in more detail below.

Employment Dislocation Results

In general, employment dislocations do not vary a great deal across the MACT options. Total incremental long-term employment dislocations associated with exiting combustion facilities range from 80 to 170 FTE jobs under the Floor and the Recommended options.[32] Under the BTF-ACI option, employment dislocations increase by almost 20 percent to approximately 150 to 200 FTEs. Among the different sectors, on-site incinerators are responsible for most of the total estimated number of job dislocations. Their significant share of the dislocations is a function of both the large number of on-site incinerators in the universe as well as the relatively high number of expected exits within this sector. Cement kilns are responsible for the second largest number of expected employment dislocations due to the number of systems that consolidate waste-burning at these facilities.

It is important to note that the employment dislocation estimates are subject to the same uncertainties characterizing the market exit estimates. To address uncertainties with the baseline market exit projections, we also estimated employment dislocations that assume constant future combustion capacity in the baseline (i.e., the static scenario). (See Appendix K.) This sensitivity analysis estimates conservative upper-bound employment dislocations of up to 580 FTEs in the combustion industry.

Employment Gain Results

Total annual employment gains associated with the Combustion MACT range from 200 to 500 FTEs. Almost half of the estimated job gains occur in the pollution control equipment industry, and the other half occurs at the combustion facilities as additional operators and maintenance workers are needed to manage the pollution control equipment. Additional staff needed for permitting requirements of the rule are relatively insignificant in comparison.

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[32] The dislocation estimates are likely to change in the next draft of the report to reflect corrections to the facility employment requirements. This correction will increase employment loss estimates moderately.

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Overall, a more stringent regulatory option will lead to both slightly higher job dislocations, as more systems are expected to stop burning, as well as to more job gains, as the compliance requirements stimulate additional hiring. While it may appear that this analysis suggests overall net job creation under particular options and within particular combustion sectors, such a conclusion is inaccurate. Because the gains and dislocations occur in different sectors of the economy, they should not be added together; doing so would mask important distributional effects of the rule. In addition, the employment gain estimates reflect sectoral impacts only and therefore do not account for job displacement across sectors as investment funds are diverted from other areas of the larger economy.

Exhibit 5-16

SUMMARY OF ESTIMATED EMPLOYMENT DISLOCATIONS

	Combustion Sectors									
	Cement Kilns		**LWAKs**		**Commercial Incinerators**		**Private On-site Incinerators**		**TOTAL**	
MACT Option	**Low End**	**High End**	**Low End**	**High End**	**Low End**	**High End**	**Low End**	**High End**	**Low End**	**High End**
Floor (50%)	21-42	21-42	0	0-3	0	0	49-129	68-229	70-150	91-252
Floor (70%)	21-42	21-49	0	3	0	0	96-129	115-229	138-150	159-252
Rec (50%)	21-42	21-42	0	0-7	0	0	49-129	68-229	70-150	91-252
Rec (70%)	21-42	21-49	0	3-7	0	0	96-129	115-229	117-150	142-252
BTF-ACI (50%)	21-62	21-70	0	3-7	0	0	88-137	107-266	130-179	151-310
BTF-ACI (70%)	42-62	42-70	0	3-7	0	0	88-145	107-274	130-187	151-318

Notes:
1. Estimates taken from model exhibits, "Estimated Short-Term Employment Losses at Combustion Systems" and "Estimated Long-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.

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Exhibit 5-17

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%)	124-125	148-150	10	282-286
Floor (70%)	92	122-123	10	223-225
Rec (50%)	133-135	167-169	10	310-314
Rec (70%)	101-102	142-144	10	253-255
BTF-ACI (50%)	207-214	320-334	10	537-558
BTF-ACI (70%)	181-187	290-304	9-10	481-501

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.

Combustion Price Increases

All combustion facilities that remain in operation will experience increased costs under the MACT standards. To protect their profits, combustion facilities will have an incentive to pass these increased costs on to their customers in the form of higher combustion prices. Generators potentially will have to pay higher prices unless they can obtain less expensive waste management alternatives.

Exhibit 5-18 (below) illustrates how price pass-through would work in theory. This exhibit illustrates a number of important principles about hazardous waste combustion markets.

- Waste will be sent to the least expensive alternatives first, all else being equal.[33]

- Both baseline costs of hazardous waste combustion and new compliance costs vary significantly across combustion systems, even within the same sector. Thus, regulatory changes can affect different systems in very different ways.

- Prices will rise to the point at which all demand for waste management is met. In Exhibit 5-18, the last tons are managed in the non-combustion/waste minimization alternative at a cost of $230 per ton. This would become the market price. Combustion systems A, B, and C would each set their prices at about $230 per ton in order to maximize their profits. The least efficient management option would earn just enough to stay in business, but would not recover capital costs. In this example, combustion system D would exit the market.

Exhibit 5-18

SIMPLIFIED EXAMPLE OF DETERMINATION OF NEW MARKET PRICE FOR COMBUSTION

Assume 100 Tons Require Management	Combustion System A	Combustion System B	Combustion System C	Alternative Management/ Waste Min	Combustion System D
Cost/ton of Waste	$145	$175	$220	$230	$240
Tons of capacity	35	25	35	100	300
Remaining tons requiring treatment	100-35=65	65-25=40	40-35=5	5-5=0	0

[33] In fact, other factors such as transportation costs will affect which facilities are the least expensive to particular generators. In addition, the price of combustion will vary by the method of delivery (e.g., bulk versus drum), the form of the waste (e.g., liquid versus solid), and the contamination level (e.g., metals or chlorine content). These factors make it more difficult to compare various waste management options.

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The real hazardous waste combustion marketplace is much more complex than the five options shown above. Estimating the cost of combustion at which the last ton of waste would be combusted is difficult due to pricing variations by region, waste stream, and individual combustion service providers. Instead, we have adopted some simplifying assumptions that should provide a reasonable approximation of these markets:

- To calculate the price increase for waste for which all sectors compete, we first determine which commercial sector has the lowest median total costs per ton (baseline plus compliance costs). The industry sector with the lowest costs is the most efficient and will have the greatest power to pass through compliance costs in the form of higher prices.

- To determine the price increase for more highly contaminated solids and sludges, we calculate the median cost per ton for commercial incinerators since commercial incinerators burn the majority of these more highly contaminated waste streams.

The availability of substitutes for combustion (i.e. waste minimization and non-combustion treatment alternatives) will cap price increases. These alternatives will constrain both price increases by the lowest cost sector and the ability of higher cost sectors to match these increases. Given an absence of good data on the price at which these alternatives are viable, we evaluate the impact of the proposed rule under both a low and a high price pass through scenario. The low scenario evaluates market impacts if alternatives are available at close to the current market price of combustion.

Using the median compliance costs for the lowest cost sector as the basis for a price increase is a conservative assumption. As Exhibit 5-18 illustrated, the most expensive facility needed to manage the remaining supply of waste will set the new market price. The capacity that exists at facilities in the least cost segment with compliance costs at or below the median for that segment will not be sufficient to manage all the wastes requiring combustion. We believe that the actual price increase will most likely be higher than the median compliance costs for the lowest cost sector. We further assume that other combustion sectors will match the dollar value of this increase, even if it exceeds their new compliance costs, in an effort to maximize profits. We assume that the market share of each combustion sector will not change because the price differential (in dollars) between sectors will remain constant.

Available economic data on the cost of waste management alternatives, including source reduction and other waste minimization options, are not precise enough for us to pinpoint the maximum price increase that combustors could pass through to generators and fuel blenders. However, based on an analysis of waste management alternatives (summarized in Chapter 6), we believe that demand for combustion is relatively inelastic and combustion facilities are likely to pass

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through 75 percent of compliance costs in the least-cost sector. Exhibit 5-19 shows the price increase estimated across MACT options at both 25- and 75-percent price pass-through scenarios. As shown in the exhibit, the price increase ranges from one to 30 percent across all MACT options. Price increases for the Recommended MACT (70% design level) range from between 3 and 9 percent for waste burning cement kilns, 4 and 11 percent for LWAKs, and 1 and 2 percent for incinerators, depending on assumptions about the elasticity of demand for combustion services. Based on our analysis of waste management alternatives, EPA believes that demand is relatively inelastic; thus, price increases of about $15 per ton (6 percent) are expected for kilns and increases of about $12 per ton (2 percent) are expected for incinerators.

Exhibit 5-19

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	$728
Increase in price due to compliance costs passed through				
Floor (50%)	$9-$28	$9-$28	$7-$20	$7-$22
Floor (70%)	$4-$11	$4-$11	$3-$10	$4-11
Rec (50%)	$10-$29	$10-$29	$7-$20	$8-$23
Rec (70%)	$5-$15	$5-$15	$4-$12	$4-$13
BTF-ACI (50%)	$13-$40	$13-$40	$10-$29	$11-$33
BTF-ACI (70%)	$12-$35	$12-$35	$9-$27	$10-$29

Notes:
1. Ranges reflect 25% and 75% price pass-through scenarios.
2. Compliance costs do not include PM CEM costs.
3. Median compliance costs per ton exclude systems currently not burning hazardous waste.
4. 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.
5. Prices for on-site incinerators reflect the cost per ton of off-site treatment that generators avoid by burning the waste on-site.
6. 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).

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Other Industry Impacts

Combustion Profit Decreases. On average, hazardous waste-burning profits for all combustion sectors will decline post-MACT, yet the decline will not be consistent across sectors. We expect that hazardous waste-burning profits for cement kilns will decrease by about 11 percent, while profits for commercial incinerators may decrease by about 2 percent. Our profit margin estimates are based on a simple calculation that subtracts operating costs from revenues. These estimates provide relative measures of profit changes and should not be used to predict absolute profit margins in these industries.

Cost Structure of the Combustion Industry. Incremental MACT compliance costs represent less than 2 percent of the total pollution control expenditures in industries that contain facilities with on-site incinerators.[34] (See Exhibit 5-20.) For cement kilns, MACT compliance costs are expected to increase total pollution control expenditures by about 60 percent at hazardous waste-burning facilities.[35] Total costs of waste-burning increase by about 50 percent for cement kilns after the addition of MACT compliance costs, while total costs increase by about 20 percent for commercial incinerators. However, overall costs still remain significantly lower for hazardous waste burning cement kilns when compared to commercial incinerators.

APCD Profit Increases. To comply with the MACT standards, many facilities will need to purchase additional pollution control equipment. From the perspective of the pollution control industry, these expenditures are translated into additional revenues and profits. We estimate that additional profits for the APCD industry will total approximately $2.8 million, or about $300,000 annually (undiscounted). This total figure represents about 14 percent of the average annual profits of three of the largest APCD manufacturers.[36]

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[34] We did not include commercial incinerators in this cost structure analysis because the *Pollution Abatement Costs and Expenditures* reports do not provide data on service industries, which is the industry category for commercial incinerators.

[35] According to *Pollution Abatement Costs and Expenditures: 1994*, the total pollution expenditures for the cement industry in 1994 were $207.50 million, which is $217.61 million in 1996 dollars using the GDP implicit price deflator from the *1998 Economic Report of the President*. Because only 19 percent of cement kilns burn hazardous waste, we use $41.35 million in 1996 dollars (0.19 * $217.61) as the base pollution control figure.

[36] To estimate additional profits for APCD manufacturers, we multiply total capital costs post-MACT by the average profit percentage of net sales for three major APCD manufacturers. (We calculate the average profit percentage of net sales (after all costs and taxes) for the APCD manufacturers with data from the firms' 401k forms.)

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Exhibit 5-20

MACT COMPLIANCE COSTS AS A PERCENTAGE OF TOTAL POLLUTION CONTROL EXPENDITURES FOR INDUSTRIES WITH ON-SITE INCINERATORS

Industry	SIC	Percentage of Hazardous Waste Combusted On-Site	Total Pollution Control (Capital and Operating) Costs (millions)	Total Annual Compliance Costs for On-Site Incinerators (weighted by SIC) (hundreds of thousands)	Compliance Cost Percentage of Total Pollution Control Expenditures
Industrial Organic Chemicals, N.E.C.	2869	38.25%	$2,455	$142	0.58%
Pesticides and Agricultural Chemicals, N.E.C.	2879	19.00%	$280	$70	2.51%
Medicinal Chemicals and Botanical Products	2833	7.10%	$170	$26	1.55%
Industrial Inorganic Chemicals, N.E.C.	2819	3.60%	$443	$13	0.30%
Pharmaceutical Preparations	2834	2.86%	$366	$11	0.29%
Plastics Materials and Resins	2821	2.65%	$993	$10	0.10%
Petroleum Refining	2911	1.73%	$5,664	$6	0.01%
Photographic Equipment and Supplies	3861	1.51%	$179	$6	0.31%
Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	2865	0.93%	$397	$3	0.09%
Secondary Nonferrous Metals	3341	0.42%	$115	$2	0.14%
Synthetic Rubber (Vulcanizable Elastomers)	2822	0.36%	$168	$1	0.08%
TOTAL			**$11,231**	$290	
MINIMUM			**$115**	**$1**	**0.01%**
MAXIMUM			**$5,664**	**$142**	**2.51%**
AVERAGE			**$1,021**	**$26**	**0.54%**

Sources:
1. U.S. Department of Commerce, *Pollution Abatement Costs and Expenditures: 1994* (MA200(94)-1), Tables 3 and 7, May 1996, 20-24, 34-40.
2. Model Exhibit," Total Annual Compliance Costs (Assuming No Market Exit)."
3. *1998 Economic Report of the President* (used to convert total pollution control costs to 1996 dollars).

Notes:
1. Total pollution control expenditures cover all environmental media (e.g., air, water, solid waste).
2. Statistics cover manufacturing establishments with 20 or more employees.
3. Statistics do not include industries with pollution abatement costs and expenditures less than $1.0 million.
4. Percentages of hazardous waste combusted on-site do not add to 100% because we exclude industries with percentages lower than 0.36% and we exclude industries omitted from *Pollution Abatement Costs and Expenditures: 1994*.

Economic Impact Summary

In this chapter, we presented analyses of and results for several different economic impacts expected to result from the MACT standards. We summarize the findings in Exhibit 5-21 and describe major results below:

- Across MACT options, between one and three cement kilns and between seven and 23 on-site incinerators will stop burning hazardous waste entirely, rather than incur the rule's compliance costs. For the Recommended MACT, between one and two cement kilns and seven and 16 incinerators are expected to exit the market. Additional waste consolidation will occur at other facilities where wastes are consolidated into fewer combustion systems.

- For the Recommended MACT, market exit and waste consolidation activity is expected to result in up to 54,000 tons of waste that will be reallocated from combustion systems that stop burning (this incremental quantity corresponds to 2 percent of total combusted wastes). Under the BTF-ACI MACT option, the quantity of reallocated wastes increases to 90,000 tons (about 3 percent of total combusted wastes). Across MACT options, the reallocated wastes come primarily from cement kilns and on-site incinerators that stop burning. Reallocated wastes may be sent to other combustion facilities that remain open because there is currently adequate capacity in all sectors to absorb these shifts.

- As the market adjusts to new output levels post-MACT and combustion facilities invest in additional pollution control and monitoring equipment, employment shifts will occur. At facilities that consolidate waste burning activities or that stop burning altogether, employment dislocations of between 100 and 300 full-time equivalent employees are expected. Over half of these dislocations occur in the on-site sector and the remainder occur at cement kilns. Employment dislocations increase by almost 20 percent when going from the Recommended option to the BTF-ACI option. Employment gains of approximately 100 full-time equivalent employees are expected in the pollution control industry, and gains of approximately 150 full-time equivalent employees are expected at combustion facilities that continue waste burning as facilities invest in new pollution control equipment. Gains similarly increase by almost 70 percent from the Recommended to the BTF-ACI option.

- As combustion facilities incur compliance costs of the MACT rule, they have an incentive to increase prices for combustion. Our evaluation of waste management alternatives suggests that combustion demand is relatively

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inelastic and prices will likely increase as a result of the final rule by about $15 per ton for kilns (6 percent) and $12 per ton for incinerators (2 percent).

- MACT compliance costs increase the total costs of burning hazardous waste by approximately 50 percent for cement kilns and about 20 percent for commercial incinerators, though overall costs remain much lower for cement kilns. MACT compliance costs represent less than 2 percent of total pollution control expenditures in industries that contain facilities with on-site incinerators. Total pollution control expenditures for cement kilns, however, increase by approximately 60 percent when MACT compliance costs are added. On the whole, these compliance costs translate into decreased profits for hazardous waste combustion facilities and increased profits for APCD manufacturers. We expect profits will decrease by 2 percent for commercial incinerators and by 11 percent for cement kilns, as these facilities incur the additional costs of rule compliance. Total profits for the pollution control industry are expected to increase by about three million dollars.

Exhibit 5-21

SUMMARY OF ECONOMIC IMPACT ANALYSIS

	MACT Option		
Economic Impact Measure	**Floor**	**Recommended**	**BTF-ACI**
Market Exits			
Cement Kilns	1-2	1-2	1-3
Commercial Incinerators	0	0	0
LWAKs	0	0	0
Private On-Site Incinerators	7-16	7-16	13-23
Quantity of Wastes Reallocated	0-53,250	0-53,750	36,660-89,070
Employment Impacts			
Annual Gains	223-286	253-314	481-558
Annual Dislocations	70-252	70-252	130-318
Expected Combustion Price Change	$3-$28	$4-$29	$9-$40

Notes:
1. Estimates taken from the following model exhibits, "Number of Combustion Facilities Likely to Stop Burning Hazardous Waste in the Short Term" and "Number of Combustion Facilities Likely to Stop Burning Hazardous Waste in the Long Term;" "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;" "Estimated Short-Term Employment Losses at Combustion Systems" and "Estimated Long-Term Employment Losses at Combustion Systems;" "Estimated Employment Increases Associated with Compliance Requirements;" and "Weighted Average Combustion Prices per Ton and Increase in Prices due to Assumed Price Pass Through."
2. PM CEM costs not included.
3. Ranges reflect 25% and 75% price pass-through scenarios and different engineering design levels (i.e., 50% and 70% of the standards). Ranges for market exits and quantity of waste diverted also reflect short and long term estimates.

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This chapter presents the benefits assessment for the hazardous waste combustion MACT standards. We use results from EPA's multiple pathway human health and ecological risk assessment to evaluate incremental benefits to society of emission reductions at hazardous waste combustion facilities.[1] This chapter also assesses how the MACT standards may potentially lead to changes in the types and quantities of wastes generated and managed at combustion facilities through increased waste minimization.

The chapter is organized into five sections:

- **Risk Assessment Overview:** Provides a brief summary of the methodology from the multiple pathway risk assessment which forms the basis for the human health and ecological benefits assessment.

- **Human Health Benefits Analysis:** Describes the approach and presents results for characterizing human health benefits from the risk results. Where possible, we assign monetary values to these risk reductions using different economic valuation techniques. We also describe benefits to sensitive sub-populations in quantitative, non-monetary terms.

[1] At Proposal, we also included results from a screening analysis to assess the potential magnitude of property value benefits caused by the MACT standards. We did not expand this analysis in the Economic Assessment of the Final Rule due to limitations of the benefits transfer approach and because property value benefits likely overlap with human health and ecological benefits; including property value benefits would result in double-counting. The benefits assessment also does not examine how secondary impacts such as emissions from increased coal use at combustion sources that stop burning hazardous waste as fuel may result in human health and ecological damages. EPA believes that other air regulations under the Clean Air Act governing these emissions should provide adequate protection to prevent adverse impacts on human health and the environment ecological factors.

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- **Ecological Benefits Analysis:** Describes the methodology and results for the ecological benefits assessment. Ecological benefits results are described in qualitative terms due to the screening level nature of the ecological risk analysis.

- **Waste Minimization Benefits:** Describes the benefits that the MACT standards may have on increasing waste minimization practices.

- **Conclusions:** Summarizes key findings from the benefits assessment.

It is important to note that the benefits analysis assumes a baseline scenario with constant future capacity and with combustion facilities operating at levels corresponding to trial burn performance. As explained in the "Regulatory Baseline" chapter, the characteristics of waste fed during normal operations may differ significantly from that fed during trial burns. In particular, facilities often "spike" the waste feed at the trial burns with high levels of metals, chlorine, and mercury. This situation results in emission estimates that likely exceed "typical" emissions. Therefore, the risk reductions and benefits estimates are likely to overstate true benefits.

RISK ASSESSMENT OVERVIEW

The basis for the benefits assessment is a multi-pathway risk assessment developed by the Economics, Methods and Risk Analysis Division in EPA's Office of Solid Waste, to estimate baseline risks from hazardous waste combustion emissions, as well as expected risks after the MACT standards are implemented.[2] This section provides an overview of the risk assessment, which analyzes both human health and ecological risks that result from direct and indirect exposure to emissions from facilities that burn hazardous waste.[3] A multi-pathway analysis that models both inhalation and ingestion pathways is used to estimate human health risks, whereas a less detailed screening-level analysis is used to identify the potential for ecological risks. In most cases, the risk assessment is carried out for four major scenarios: baseline (no regulation), the MACT Floor, EPA's Recommended BTF Standard, and the more stringent BTF-ACI Standard (which tightens the dioxin and mercury levels across combustion sources). The *Assessment* uses a case study approach in

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[2] "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," November 1998.

[3] EPA expects that hazardous waste-burning kilns that use feed control to achieve emissions reductions will also generate cement kiln dust (CKD) with a lower toxicity than prior to feed control (in particular, lower SVM content) (USEPA "Selection of MACT Standards and Technology," Chapter 12 of Volume 3 Technical Support Document for HWC MACT Standards, July 1999.) The risk assessment did not address the potential human health and ecological benefits associated with reduced toxicity CKD.

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which 76 hazardous waste combustion facilities and their site-specific land uses and environmental settings are characterized.[4] The randomly selected facilities in the study include the following: 43 on-site incinerators, 13 commercial incinerators, 15 cement kilns, and five lightweight aggregate kilns.[5]

The pollutants analyzed in the risk assessment are dioxins and furans, selected metals, particulate matter (PM), chlorine, and hydrogen chloride.[6,7] The metals modeled in the analysis include the following: antimony, arsenic, barium, beryllium, cadmium, chromium[8], copper, cobalt, lead, manganese, mercury[9], nickel, selenium, silver, and thallium.[10] The fate and transport of the emissions of these pollutants are modeled to arrive at concentrations in air, soil, surface water, and sediments. To assess human health risks, these concentrations can be converted to estimated doses to the exposed populations using exposure factors such as inhalation and ingestion rates. These doses are used to calculate cancer and non-cancer risks if the appropriate health benchmarks are available. To assess potential ecological risks, soil, surface water, and sediment concentrations are

[4] For a more detailed discussion of the land use characterization, see: Zachary Pekar and Tony Marimpietri. January 27, 1998. Memorandum, "Description of Methodologies and Data Sources Used in Characterizing Land Use (including Human/Livestock Populations), Air Modeling Impacts, and Waterbody/Watershed Characteristics for HWC Study Areas," prepared for David Layland, U.S. Environmental Protection Agency.

[5] According to the risk assessment, the random sample of 65 facilities ensures that the probability of modeling at least one high-risk facility is 90 percent. The other 11 combustion facilities were selected for the risk assessment at Proposal. Because these 11 facilities were not selected at random, they are handled differently from the 65 randomly selected facilities in extrapolating risks to reflect the universe of facilities.

[6] PM, chlorine, and hydrogen chloride are not evaluated in the screening for ecological risks.

[7] The national risk assessment did not include an assessment of the risk posed by nondioxin products of incomplete combustion (PICs) due to the lack of sufficient emission measurements. However, as part of this final rule, EPA is recommending that permitting authorities evaluate the need for conducting Site Specific Risk Assessments (SSRAs) on a case-by-case basis, and therefore if there is any reason to believe that operation in accordance with the MACT standards alone is not protective of human health and the environment (due to nondioxin PICs), the permitting authorities could require additional control based on results from a SSRA. It is important to note that EPA does not anticipate that a large number of SSRAs will need to be conducted.

[8] Both chromium (III) and chromium (VI) were evaluated in the risk assessment.

[9] Includes divalent mercury (via ingestion), elemental mercury (via inhalation), and methyl mercury (via ingestion).

[10] We recognize that these chemicals are not all HAPs; however, the risk assessment analyzed all chemical constituents covered by the rule for which sufficient data were available.

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compared with eco-toxicological criteria representing protective screening values for ecological risks.[11] Because these criteria are based on *de minimis* ecological effects and thus represent conservative values, an exceedence of the eco-toxicological criteria does not necessarily indicate ecological damages; it simply suggests that potential damages cannot be ruled out.

To characterize the cancer and non-cancer risks to the populations listed above, the risk assessment breaks down the area surrounding each modeled combustion facility into 16 polar grid sectors, as illustrated in Exhibit 6-1. For each polar grid sector, risk estimates can be developed for different age groups and receptor populations (e.g., 0-5 year old children of subsistence fishers). This approach is used because geographic and demographic differences across polar grid sectors lead to sectoral variation in individual risks. Thus, individual risk results are aggregated across sectors and weighted by population in each sector to generate the distribution of risk to individuals in the affected area.[12] An additional Monte Carlo analysis was conducted to incorporate variability in other exposure factors such as inhalation and ingestion rates for three scenarios that were originally thought to comprise the majority of the risk to the study area population. These scenarios address cancer risk from dioxin exposure to beef and dairy farms and non-cancer risk from methyl mercury exposure to recreational anglers.

HUMAN HEALTH BENEFITS

This section describes in greater detail the approaches for characterizing human health benefits. The starting point for assessing benefits is identifying those pollutants for which emission reductions are expected to result in improvements to human health or the environment. We then summarize the relevant results from the risk assessment for the pollutants of concern, focusing on population risk results based on central tendency exposure parameters so that benefits can be appropriately compared with total costs. We express the risk assessment data as indicators of potential benefits, such as reduced cancer incidence or reduced potential for developing particular illnesses. Where possible, we assign monetary values to these benefits using a benefits transfer approach.

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[11] The methodology used to develop the eco-toxicological criteria is largely a product of the ecological risk assessment work conducted to support the proposed HWIR for process waste.

[12] Some of the exposure levels will not be sector specific (e.g., exposure to dioxin in dairy products is based on an average concentration at dairies throughout the entire study area).

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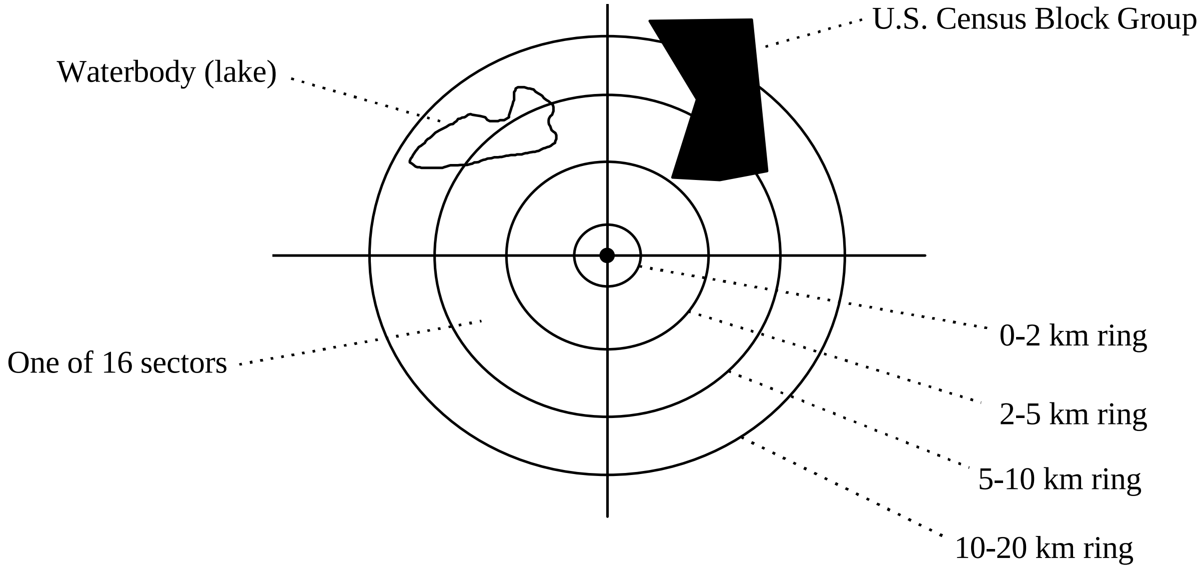
Exhibit 6-1

**DIAGRAM OF 16 SECTOR POLAR-BASED GRID
USED IN THE RISK ASSESSMENT**



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Human Health Benefits Methodology

The approach for assessing human health benefits is divided into two components -- benefits from cancer risk reductions and benefits from non-cancer risk reductions. We separate the discussion in this way because the interpretation of risk reductions for carcinogenic pollutants is very different than that for non-carcinogens. As explained above, for both cancer and non-cancer benefits, we focus on population risks because these results form the basis for assessing total benefits of the MACT standards. In general, these results concern the population overall with regards to different age groups, though risk reductions associated with certain pollutants, such as lead, specifically affect children within the population. In these cases, we focus on the benefits to a subset of children, ages 0-19.[13]

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[13] In light of recent federal initiatives and other attention regarding the unique vulnerability of children to environmental health threats, we provide a more detailed discussion of reduced risks to children's health in Appendix I.

In addition to population results, we also describe individual risk results for the hypothetical worst case scenarios for both cancer and non-cancer risks.[14] Because we do not have population data for the most sensitive sub-populations, we can only describe individual risk results for subsistence farmers and fishermen and cannot make statements concerning the total number of people that may experience health benefits associated with the MACT standards.

Approach for Assessing Benefits from Cancer Risk Reductions

The basic approach for assessing benefits from cancer risk reductions relies on two analytic components. First, we use cancer risk reductions for all non-subsistence receptors in the vicinity of combustion facilities. These risk reduction estimates are derived from the median individual risk values and population data for non-subsistence populations.[15] Carcinogens included in the risk assessment are dioxin/furans, arsenic, beryllium, cadmium, chromium (VI), and nickel. Second, we use cancer risk reductions associated with the ingestion of dioxin-contaminated foods grown or raised near combustion facilities but distributed nationwide. We then calculate total cancer risk reductions by summing the avoided cases in communities near combustion facilities with the number of cases avoided due to reduced dioxin in the national food supply.[16] That is,

Total cancer risk reductions = *Avoided cases in communities near combustion facilities + Avoided cases due to reduced dioxin in the national food supply.*

[14] As we explain in more detail later on, the hypothetical worst case individual scenarios are associated with subsistence receptors (i.e., subsistence fishermen and farmers) for whom no population data are available. As a result, we cannot quantify nor monetize benefits for these groups, though we qualitatively discuss the pollutants and receptor groups involved.

[15] Cancer incidence estimates use direct and indirect exposure pathways for all non-subsistence receptors, excluding recreational anglers. Population risks could not be calculated for recreational anglers because detailed population data were not available for this receptor population.

[16] Summing these estimates may pose the potential for double-counting, considering that dioxin-contaminated food ingestion is also evaluated on the local level. However, if we make the assumption that most of the agriculture products produced within 20 kilometers of the facility are consumed outside the local area (considering the extensive national food distribution networks that exist), then we minimize the potential for double-counting. Discussions with EPA and Research Triangle Institute, the contractor that prepared the Combustion Risk Assessment, confirmed that this in fact is a reasonable assumption.

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To assign monetary values to cancer risk reduction estimates, we apply the value of a statistical life (VSL) to the risk reduction expected to result from the MACT standards. The VSL is based on an individual's willingness to pay (WTP) to reduce a risk of premature death or their willingness to accept (WTA) increases in mortality risk.[17] Because there are many different estimates of VSL in the economic literature, we estimate the reduced mortality benefits using a range of VSL estimates from 26 policy-relevant value-of-life studies. As shown in Exhibit 6-2, the estimated VSL figures from these studies range from $0.7 million to $15.9 million, with an average value of $5.6 million (in 1996 dollars). To value the mortality risk reductions, we multiply the expected number of annual premature statistical deaths avoided by the high-end, low-end, and mean value of the VSL estimates.

Approach for Assessing Benefits from Non-Cancer Risk Reductions

A variety of approaches are used to evaluate the benefits of reducing particulate matter, lead, and mercury.[18] For particulate matter, we estimate both morbidity and mortality benefits; this is the only non-carcinogen in the risk assessment for which there is sufficient dose-response information to estimate numbers of cases of disease and deaths from exposures. For lead and mercury, we use upper bound estimates of the population at risk, because we only have information on the *potential* of an adverse effect and we cannot say anything about the *likelihood* of these effects.

We assign monetary values to non-cancer benefits using a direct cost approach which focuses on the expenditures averted by decreasing the occurrence of an illness or other health effect. While the WTP approach used for valuing the cancer risk reductions is conceptually superior to the direct cost approach, measurement difficulties, such as estimating the severity of various illnesses precludes us from using this approach here. Direct cost measures are expected to understate true benefits because they do not include cost of pain, suffering, and time lost. On the other hand, because we use upper bound estimates of the population at risk, we cannot conclude that the results are biased in one direction or the other. Below is a more detailed description of our approach for assessing benefits from specific non-cancer pollutants.

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[17] We use the VSL approach for the MACT benefits assessment instead of applying estimates of the Value of a Statistical Life Year (which values the number of life years lost as the result of premature mortality) because, while we have age stratified cancer incidence data for the local populations near combustors, we do not have such data for cancer incidence from nationwide consumption of dioxin-contaminated foods.

[18] Particulate matter and lead are the only non-carcinogens for which emission reductions provide human health benefits. We also include a section on mercury due to the public concerns regarding this HAP. The risk assessment, however, finds no human health benefits for non-subsistence populations from mercury emission reductions.

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Exhibit 6-2

SUMMARY OF MORTALITY VALUATION ESTIMATES

Study	Type of Estimate	Valuation (millions 1996$)
Kneisner and Leeth (1991) (US)	Labor Market	0.7
Smith and Gilbert (1984)	Labor Market	0.8
Dillingham (1985)	Labor Market	1.1
Butler (1983)	Labor Market	1.3
Miller and Guria (1991)	Contingent Value	1.4
Moore and Viscusi (1988a)	Labor Market	2.9
Viscusi, Magat, and Huber (1991b)	Contingent Value	3.2
Marin and Psacharopoulos (1982)	Labor Market	3.3
Gegax et al. (1985)	Contingent Value	3.9
Kneisner and Leeth (1991) (Australia)	Labor Market	3.9
Gerking, de Haan, and Schulze (1988)	Contingent Value	4.0
Cousineau, Lacroix, and Girard (1988)	Labor Market	4.2
Jones-Lee (1989)	Contingent Value	4.5
Dillingham (1985)	Labor Market	4.6
Viscusi (1978, 1979)	Labor Market	4.8
R.S. Smith (1976)	Labor Market	5.4
V.K. Smith (1976)	Labor Market	5.5
Olson (1981)	Labor Market	6.1
Viscusi (1981)	Labor Market	7.7
R.S. Smith (1974)	Labor Market	8.5
Moore and Viscusi (1988a)	Labor Market	8.6
Kneisner and Leeth (1991) (Japan)	Labor Market	8.9
Herzog and Schlottman (1987)	Labor Market	10.7
Leigh and Folson (1984)	Labor Market	11.4
Leigh (1987)	Labor Market	12.2
Garen (1988)	Labor Market	15.9
Mean Value		**5.6**

Source: Viscusi, W. Kip. *Fatal Tradeoffs: Public and Private Responsibilities for Risk.* New York: Oxford University Press, 1992

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Benefits from Reduced Exposure to Particulate Matter

In addition to avoided illnesses and deaths, benefits of reduced PM emissions include valuation of work loss days and mild restricted activity days (MRAD). To assess benefits from reduced particulate matter exposure, we first estimate the number of excess mortality cases, cases of illnesses, restricted activity days, and work loss days in the baseline. We then estimate the number of cases under three MACT standards: Floor Standard, Recommended MACT Standard, and BTF-ACI MACT Standard. To determine potential benefits for each option, we then subtract the number of post-MACT cases from the number of baseline cases. We estimated benefits based on the dollar value associated with the following health conditions:

- respiratory diseases,
- chronic bronchitis,
- ischemic heart disease,
- congestive heart failure,
- asthma,
- work loss days, and
- mild restricted activity days (MRAD).[19]

For avoided deaths, we assign monetary values in the same way as for avoided cancer cases, using a range of estimates for the statistical value of a life (see discussion above). To value the morbidity risk reductions associated with exposure to particulate matter, we multiply the expected number of annual reductions for each ailment by the cost of the condition, as shown in Exhibit 6-3. The estimated cost of each illness includes the hospital charge, the costs of associated physician care, and the opportunity cost of time spent in the hospital.[20] Since these estimates do not include post-hospital costs or pain and suffering of the afflicted individuals, the cost of illness estimates may understate the benefits.

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[19] Work loss days and mild restricted activity days do not necessarily affect a worker's income and do not generally require hospitalization. It does, however, result in lost economic productivity and consequently, a loss to society.

[20] Opportunity cost of time spent in the hospital is in addition to work loss days and MRAD. Cost estimates come from the following source: U.S. EPA. October 1997. *The Benefits and Costs of the Clean Air Act, 1970 to 1990*, pages I-11 and I-12. For the following three illnesses, respiratory illness, ischemic heart disease, and congestive heart failure estimate, physician charges come from Abt Associates, Incorporated (1992), *The Medical Costs of Five Illnesses Related to Exposure to Pollutants*, prepared for U.S. EPA, Office of Pollution Prevention and Toxics, Washington, DC. Hospital charge estimates for these three illnesses are from A. Elixhauser, R.M. Andrews, and S. Fox, Agency for Health Care Policy and Research (AHCPR), Center for General Health Services Intramural Research, U.S. Department of Health and Human Services (1993), *Clinical Classifications for Health Policy Research: Discharge Statistics by Principal Diagnosis and Procedure.*

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Exhibit 6-3

COSTS OF ILLNESS ASSOCIATED WITH PM

Illness	Estimated Cost Per Incidence (1996 $)
Respiratory Illness	$7,200
Chronic bronchitis	$306,000
Ischemic heart disease	$12,000
Congestive heart failure	$9,800
Asthma	$38
Work Loss Days	$98 (cost per day)
Mild Restricted Activity Day	$45 (cost per day)

Source: U.S. Environmental Protection Agency, *The Benefits and Costs of the Clean Air Act, 1970 to 1990*, October 1997, I11-I12

Note: In the case of work loss days and mild restricted activity days estimates represent costs incurred per day.

Benefits from Reduced Exposure to Lead

The primary effect from chronic exposure to lead is central nervous system effects. Children are particularly sensitive to the effects of lead and excess exposure can affect a child's nervous system and cognitive development. We assess benefits from reduced lead exposure by estimating the number of children whose total blood lead levels are reduced below levels of concern (10μg/dL).[21] Because we could not find an economic valuation study that estimates the cost of illness associated with children's blood lead levels exceeding 10μg/dL, and due to the low potential benefits suggested by the risk assessment, we do not attempt to monetize these benefits.

[21] The lead modeling in the risk assessment uses a distribution of background lead levels with a central tendency estimates of 3.6μg/dL. Background concentration at the 99th percentile exceed 10μg/dL.

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Benefits from Reduced Exposure to Mercury

Recreational anglers exposed to mercury above levels of concern are potentially at risk for bearing children with developmental abnormalities.[22] To project the benefits of reduced exposure, we estimate the median cost of developmental abnormalities using a range of estimates for various birth defects provided in the Waitzman *et al*. study (see Exhibit 6-4).[23] In a recent survey of the non-cancer economic literature, this study was found to provide reasonable benefit measures.[24] Using the birth rate of the general population, we assume that 1.67 percent of recreational anglers potentially at risk will have children in a given year.[25] Similar to the other benefits for which we assign monetary values, this estimate also may understate benefits because it does not include avoided pain and suffering.

It is important to note that this approach uses upper bound estimates of the population at risk to compute benefits for mercury. The cost of developmental abnormalities is applied to all recreational anglers *potentially* at risk (i.e., those exposed to mercury above levels of concern (HQ>1)). This approach does not allow us to say anything about the likelihood of an adverse effect for the anglers at risk; we can only say that we cannot rule out adverse impacts for these individuals. Subsistence fishermen, those individuals who obtain a significant portion of their dietary fish intake from their own fishing activities, potentially face even greater risk for bearing children with developmental abnormalities as a result of higher mercury exposure levels in their daily fish consumption. Because we do not have population data for subsistence fishermen, we describe potential health benefits to this sensitive sub-population by describing changes in individual hazard quotients.

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[22] Given the current state of scientific knowledge, there is controversy regarding modeling mercury concentrations in fish. The November 1998 risk assessment uses the IEM-2M model to evaluate the fate and transport of mercury in waterbodies. This is the same model that was used in the 1998 Mercury Report to Congress.

[23] N.J. Waitzman, R.M Scheffler, and P.S. Romano. 1996. *The Costs of Birth Defects.* University Press of America, Inc., Lanham, Maryland. This study provides estimates of the costs of birth defects involving major structural anomalies, and includes both direct and indirect costs. The direct costs include medical, developmental, and special education outlays. Indirect costs consist of the foregone earnings and fringe benefits from premature mortality, excess morbidity, lower wages, and lower labor force participation rates. In addition, indirect costs include foregone nonmarket production, based on the cost of hiring people for household work.

[24] Industrial Economics, Social Science Discussion Group. September 30, 1997. *Handbook for Non-Cancer Valuation: Draft,* prepared for U.S. EPA.

[25] U.S. Department of Commerce, Bureau of the Census. 1995. *Statistical Abstract of the United States 1995.* 115th ed., 73.

Exhibit 6-4 COSTS OF ILLNESS ASSOCIATED WITH VARIOUS BIRTH DEFECTS	
Health Condition	**Cost per Case (thousands)**
Spina bifida	$324
Truncus arteriosus	$557
Transposition of great arteries/ Double Outlet Right Ventricle	$294
Single ventricle	$379
Tetralogy of Fallot	$288
Cleft lip or palate	$112
Tracheoesophageal fistula	$160
Atresia of the small intestine	$82
Colorectal atresia	$135
Renal agenesis	$276
Urinary tract obstruction	$93
Upper-limb reduction	$110
Lower-limb reduction	$219
Diaphragmatic hernia	$276
Gastroschisis	$119
Omphalocele	$194
Down syndrome	$497
Median	$219

Source: Waitzman et al. (1996).
Note: Figures are in 1996 dollars.

Human Health Benefits Results

Human health benefits are expected from both cancer and non-cancer risk reductions. A summary of the benefits is provided in Exhibits 6-5 through 6-7. Below, we describe the results in more detail.

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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. The majority of the cancer risk reductions are linked to consumption of dioxin-contaminated agricultural products exported beyond the boundaries of the study area (20 km). Roughly one-third of the cancer risk reductions occur in local populations living near combustion facilities. Cancer risks for local populations are attributed primarily to reductions in arsenic and chromium emissions; these pollutants account for almost 80 percent of total local cancer incidences in the baseline. By applying the full range of VSL estimates to these cases, total annual cancer risk reductions at the MACT floor are valued between $86,000 to $2 million, with a best estimate of $0.69 million. The VSL estimates for the two beyond-the-floor scenarios are considerably higher. The central estimate for the Final Rule is roughly $2 million dollars, with a range between $0.26 million and $6 million. Benefits for the BTF-ACI standard range between $0.3 million and $6.4 million; the central estimate is $2.3 million.

Across all receptor populations, individual cancer risks are greatest for subsistence farmers who obtain the majority of their dietary intake of all agricultural commodities from home-production.[26] Dioxin and arsenic are the primary pollutants that drive the cancer risks for this sensitive receptor population. As mentioned previously, lack of population data prevents us from quantifying benefits for this hypothetical sub-population, but we can characterize the reduction in risk from baseline to implementation of the MACT standards. For instance, subsistence farmers exposed to the highest pollutant levels face getting cancer with a probability of five in 100,000.[27] With the exception of one particular scenario, the cancer risk for all subsistence farmers is reduced below levels of concern after implementation of the MACT standards.[28] In addition to the cancer risk reductions for the overall population, the MACT standards will result in lower cancer risks for the children of especially sensitive sub-populations.

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[26] The following pathways pertain to this subsistence receptor: ingestion of home-produced beef, pork, chicken, eggs, milk, root vegetables, exposed fruit, exposed vegetables, and fish caught on farm ponds.

[27] The hypothetical scenario with the greatest individual cancer risk is that for children (ages 0-5 and 6-11) of subsistence farmers resulting from dioxin associated with commercial incinerator emissions.

[28] Baseline cancer risk for subsistence farmer family members ages 0-5 and 6-11 associated with cement kiln emissions is 2E-05; it remains 2E-05 following the implementation of either the Floor or Recommended MACT standards. At the most stringent level, BTF-ACI MACT, the cancer risk is reduced to 1E-05. It is important to emphasize that because of the absence of subsistence farmer population estimates, these hypothetical scenarios represent only the upper bound. No conclusions can be made as to the incidence rates associated with individual risks.

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Exhibit 6-5

BENEFITS SUMMARY: BASELINE TO MACT FLOOR

Human Health Benefit	Reduction in Number of Cases per Year	Annual Undiscounted Value (1996 $ millions)
Cancer deaths avoided	0.12	$ 0.69 ($0.09 - $1.96)
PM10 deaths avoided	1.50	$ 8.40 ($1.05 - $23.85)
PM10-related disease avoided		$ 18.99
hospital admissions	6	$ 0.05
chronic bronchitis	25	$ 7.77
asthma	267,600	$ 10.17
work loss days/ MRAD	19,800	$ 1.00
Recreational anglers potentially at risk for having offspring with developmental abnormalities	0	$ 0.00
Children age 0-5 with blood lead > 10μg/dL	2	-
Total Annual Monetary Benefits		**$ 28.08 ($20.13 - $44.80)**

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 levels are not monetized.
3. We use cost of illness approach for valuing some 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).

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Exhibit 6-6

BENEFITS SUMMARY: BASELINE TO RECOMMENDED MACT (FINAL STANDARDS)

Human Health Benefit	**Reduction in Number of Cases per Year**	**Annual Undiscounted Value (1996 $ millions)**
Cancer deaths avoided	0.37	$ 2.05 ($0.26 - $5.81)
PM10 deaths avoided	1.5	$ 8.40 ($1.05 - $23.85)
PM10-related disease avoided		$ 18.99
hospital admissions	6	$ 0.05
chronic bronchitis	25	$ 7.77
asthma	267,600	$ 10.17
work loss days/ MRAD	19,800	$ 1.00
Recreational anglers potentially at risk for having offspring with developmental abnormalities	0	$0.00
Children age 0-5 with blood lead > 10μg/dL	2	-
Total Annual Monetary Benefits		**$29.44** **($23.30 - $48.65)**

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 levels are not monetized.
3. We use cost of illness approach for valuing some 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).

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Exhibit 6-7

BENEFITS SUMMARY: BASELINE TO BTF-ACI MACT

Human Health Benefit	Reduction in Number of Cases per Year	Annual Undiscounted Value (1996 $ millions)
Cancer deaths avoided	0.41	$ 2.27 ($0.28 - $6.44)
PM10 deaths avoided	1.5	$ 8.40 ($1.05 - $23.85)
PM10-related disease avoided		$ 18.99
hospital admissions	6	$ 0.05
chronic bronchitis	25	$ 7.77
asthma	267,600	$ 10.17
work loss days/ MRAD	19,800	$ 1.00
Recreational anglers potentially at risk for having offspring with developmental abnormalities	0	$0.00
Children age 0-5 with blood lead > 10μg/dL	2	-
Total Annual Monetary Benefits		**$ 29.66** **($20.32 - $49.28)**

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 levels are not monetized.
3. We use cost of illness approach for valuing some 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).

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Benefits from Non-Cancer Risk Reductions

The non-cancer human health benefits from the MACT standards come from reductions in particulate matter. Some additional non-cancer benefits come from reduced blood lead levels in children living near combustion facilities.[29] Total annual non-cancer benefits for the Final Standard are valued between $23 million to $49 million, with a best estimate of $29 million.

Particulate Matter. Benefits from reduced exposure to PM come primarily from emission reductions at on-site incinerators. There are approximately two avoided premature deaths each year due to reduced particulate matter emissions; these fatal risk reductions are valued at $8.4 million annually. However, the majority of the health benefits are due to non-fatal effects (avoided illnesses and fewer days of restricted activity or work loss); these non-fatal human health benefits are valued at $19 million per year. Reductions in chronic bronchitis account for almost half of the morbidity benefits. In addition, over 250,000 asthma attacks and over 19,800 days of work loss or MRAD will be avoided annually due to the MACT standards. While separate results are not available for children, it is safe to assume that many of the respiratory health benefits will be experienced by children, who are thought to be especially vulnerable to the effects of PM exposure.[30]

Mercury. Across all age groups and populations, hazard quotients in the baseline are below levels of concern. After the MACT standards are implemented, the risk assessment estimates relatively small decreases in absolute exposures to mercury. For cement kilns, high-end hazard quotients in adults are projected to be reduced from a range of 0.09 to 0.4 to a range from 0.06 to 0.2 under the final MACT standards. In children, high-end hazard quotients are projected to be reduced from a range of 0.2 to 0.8 to a range of 0.2 to 0.6 under the final MACT standards. For lightweight aggregate kilns, high-end hazard quotients in both adults and children are below 0.1 for baseline emissions and under MACT. For incinerators, high-end hazard quotients are below 0.01 in adults and below 0.1 in children for baseline emissions and under MACT. Taken together, these results appear to suggest that risks from mercury emissions (on an incremental basis) are likely to be small.[31]

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[29] Other pollutants were found to pose negligible individual risks and consequently not included in the results.

[30] U.S. EPA. September 1996. *Environmental Health Threats to Children.* EPA 175-F-96-001, 4.

[31] The preamble of the Rule provides a detailed discussion of factors contributing to this uncertainty.

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Lead. The MACT standards are expected to reduce lead exposure below levels of concern for two children annually. Also, the MACT standards will result in reduced lead levels for children of sub-populations with higher levels of exposure. For instance, cumulative lead exposures will be reduced from approximately 12 to 10.5 μg/dL for the 1 percent of subsistence farmers living near incinerators with the highest exposure levels. Children of subsistence fishermen, commercial beef farmers, and commercial dairy farmers who face the greatest levels of cumulative lead exposure will also experience reductions of about 0.5μg/dL in blood lead levels.

Human Health Benefits Summary

Annual human health benefits associated with emission reductions from the final MACT standards include approximately two avoided premature deaths, and reductions of six hospital admissions, over 250,000 asthma attacks, and about 20,000 days of work loss or MRAD. Additional health and ecological benefits are possible if additional emission reductions are achieved as a result of a SSRA or less toxic CKD resulting from feed control.[32] Exhibit 6-8 summarizes the quantifiable human health benefits across combustion sources and MACT standards. As shown in the exhibit, with the exception of cancer risk reductions, human health benefits do not vary across the MACT regulatory scenarios. Cancer risk reductions vary only slightly across MACT scenarios. Overall, the majority of human health benefits are due to reductions in incinerator emissions. This result is primarily due to the fact that incinerators comprise roughly 70 percent of the total number of hazardous waste combustion systems.

[32] EPA does not, however, anticipate a large number of SSRAs will need to be performed. Also, even if a SSRA is conducted, the results from the SSRA may demonstrate that no additional control is necessary.

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Exhibit 6-8

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

LWAK/Human Health Benefits	Floor	Recommended	BTF-ACI
Cancer deaths avoided	0	0.06	0.06
PM10 deaths avoided	0	0	0
PM10-related disease avoided			
hospital admissions	0.01	0.01	0.01
chronic bronchitis	0.07	0.07	0.07
asthma	509	509	509
work loss days/ MRAD	36.5	36.5	36.5
Recreational anglers potentially at risk for having offspring with developmental abnormalities	0	0	0
Children age 0-5 with blood lead > 10μg/dL	0	0	0
Cement Kilns/Human Health Benefits	**Floor**	**Recommended**	**BTF-ACI**
Cancer deaths avoided	0.01	0.01	0.03
PM10 deaths avoided	0	0	0
PM10-related disease avoided			
hospital admissions	0.04	0.04	0.04
chronic bronchitis	0.15	0.15	0.15
asthma	10,668	10,668	10,668
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 > 10μg/dL	0	0	0
All Incinerators/Human Health Benefits	**Floor**	**Recommended**	**BTF-ACI**
Cancer deaths avoided	0.11	0.29	0.31
PM10 deaths avoided	1.49	1.49	1.49
PM10-related disease avoided			
hospital admissions	5.85	5.85	5.85
chronic bronchitis	25	25	25
asthma	256,371	256,371	256,371
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 > 10μg/dL	2	2	2

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ECOLOGICAL BENEFITS

Ecological benefits are based on a screening analysis for ecological risks that compares soil, surface water, and sediment concentrations with eco-toxicological criteria based on *de minimis* thresholds for ecological effects. Because these criteria represent conservative values, exceeding the eco-toxicological criteria only indicates the **potential** for adverse ecological effects and does not necessarily indicate ecological damages. For this reason, we describe benefits of avoiding adverse ecological impacts qualitatively.

The basic approach for determining whether ecosystems and/or biota are potentially at risk consists of five steps:

- First, the risk assessment identified susceptible ecological receptors. Because combustion facilities are located across the country, ecological receptors for the screening analysis were chosen to represent relatively common species and communities of wildlife.[33]
- Second, the risk assessment developed eco-toxicological criteria for receptors that represent acceptable pollutant concentrations (i.e., at these levels, there is a low potential for adverse ecological effects).[34]
- Third, the risk assessment estimated baseline and post-MACT pollutant concentrations in sediments, soils, and surface water in the study areas.
- Fourth, for each land area or water body modeled, the risk assessment compared the modeled media concentrations to ecologically protective levels to estimate eco-toxicological hazard quotients.
- Lastly, to estimate the potential for adverse ecological effects in the study areas, the risk assessment totaled the area of polar grid sectors (for terrestrial ecosystems) and water bodies (from aquatic ecosystems) with hazard quotients exceeding one.

To assess potential ecological benefits from the risk assessment results, we compare the surface area of land or water bodies potentially at risk in the baseline with the area post-MACT. The reduction in surface area potentially at risk indicates a potential for avoiding adverse ecological impacts. We do not assign monetary values to these potential benefits, because no methods are available for translating the eco-toxicological criteria into a benefit measure, such as increased fish populations.

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[33] Threatened and endangered species and/or habitats were not included in the analysis.

[34] A description of the eco-toxicological criteria developed can be found in Research Triangle Institute. February 20, 1998. Memorandum, "Description of the SERA Methodology," prepared for the U.S. EPA.

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Ecological Benefits Results

Ecological benefits are assessed based on reductions in dioxin/furans and selected metals. Lead is the only pollutant of concern for aquatic ecosystems. Mercury appears to be of greatest concern for terrestrial ecosystems. Dioxin and lead emission reductions also provide some potential benefits for terrestrial ecosystems. Under the Final Standards, the eco-toxicological hazard quotient is reduced to below the level of concern for 38 square kilometers of water surface area. For terrestrial ecosystems, the land area that may experience reductions in ecological risk criteria below levels of concern ranges from 115 square kilometers to 147 square kilometers under the Final Standards.[35] Under the BTF-ACI Standards, up to 161 square kilometers of terrestrial ecosystems may experience improvements. Ecological benefit results are summarized in Exhibit 6-9.

It is important to note that these reductions of ecological risk criteria below levels of concern only indicate the potential for an ecological improvement. It is not clear that a stringent MACT standard would necessarily provide ecological benefits to areas around combustion facilities. Also, because the screening-level nature of the ecological risk assessment does not allow us to predict the type or magnitude of benefits, we cannot assign monetary values to these potential ecological benefits.

WASTE MINIMIZATION BENEFITS

While many facilities may implement end-of-pipe controls such as fabric filters and high-energy scrubbers to achieve MACT control, emission reductions may also be accomplished by reducing the volume and/or toxicity of wastes currently combusted. In addition, generators may also consider waste management alternatives such as solvent recycling. For purposes of this analysis, these types of responses will be referred to as "waste minimization." This section analyzes the potential waste minimization benefits of the MACT rule.

As the MACT standards are implemented, the costs of waste burning will increase, thus shifting market incentives toward greater waste minimization. As discussed in Chapter 5, higher waste burning costs will result in higher combustion prices, assuming that demand is not completely elastic. To predict the quantity of waste that could be economically diverted from combustion to waste minimization, we conducted a comprehensive waste minimization analysis which considers in-process recycling, out-of-process recycling and source reduction.[36] The objective of the analysis

[35] The low-end estimate assumes the same waterbodies or land areas are affected by different pollutants. That is, under the Recommended MACT, the six square kilometers of land nearby incinerators that experience ecological improvements associated with lead emission reductions are captured in the 87 square kilometers of land nearby incinerators associated with mercury reductions.

[36] The waste minimization report is included as Appendix F: Allen White and David Miller, Tellus Institute. July 24, 1997. "Economic Analysis of Waste Minimization Alternatives to Hazardous Waste Combustion."

was to predict the quantity of hazardous wastes that may be diverted to these waste minimization alternatives under different combustion price increase scenarios.

Exhibit 6-9 **ECOLOGICAL BENEFITS SUMMARY**			
LWAKs: Reduction in Area (km^2) of Land or Water Bodies Impacted			
Media Affected & Pollutant of Concern	**Floor MACT**	**Recommended MACT**	**BTF-ACI MACT**
Soil- Dioxin	0	3	3
Soil- Lead	0	0	0
Soil- Mercury	3	3	3
Surface Water- Lead	0	0	0
Cement Kilns: Reduction in Area (km^2) of Land or Water Bodies Impacted			
Media Affected & Pollutant of Concern	**Floor MACT**	**Recommended MACT**	**BTF-ACI MACT**
Soil- Dioxin	4	4	4
Soil- Lead	0	0	0
Soil- Mercury	25	25	39
Surface Water- Lead	1	1	1
All Incinerators: Reduction in Area (km^2) of Land or Water Bodies Impacted			
Media Affected & Pollutant of Concern	**Floor MACT**	**Recommended MACT**	**BTF-ACI MACT**
Soil- Dioxin	0	19	19
Soil- Lead	6	6	6
Soil- Mercury	87	87	87
Surface Water- Lead	37	37	37

Overall, the analysis shows that a variety of waste minimization alternatives are available for managing those hazardous waste streams that are currently combusted. The quantity that we expect to be diverted from combustion to waste minimization alternatives, however, depends on the expected price increase for combustion services. At price increases of $10 to $20 per ton, which we anticipate to result from the rule, approximately 240,000 tons of hazardous waste may be diverted

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from combustion to waste minimization alternatives. This corresponds to approximately 8 percent of waste quantities currently combusted.[37]

Methodology for Characterizing Waste Minimization Benefits

The overall approach for the waste minimization analysis was deductive, using data on waste and technologies to build a model of the waste minimization decision-making process on the part of the generating facility. The model required three basic inputs:

- a characterization of the wastes currently being combusted, particularly with regard to their original sources;
- characterization of available waste minimization technologies, including both cost profile and waste stream applicability; and
- a decision framework.

For waste characterization, EPA used the RCRA Biennial Reporting System (BRS), the only national database that comprehensively tracks combusted hazardous wastes.[38] For technology characterization, EPA solicited information from waste minimization technology vendors and consultants. For a decision framework, EPA employed Total Cost Assessment (TCA), a method that Tellus Institute, a non-profit research organization, developed for evaluating investments — particularly pollution prevention investments.

Using BRS data, we developed a profile of where and how combusted hazardous wastes are generated, and we identified the dominant waste categories. We then identified the technologies most applicable to these waste categories, and gathered capital and operating cost information. TCA enabled us to estimate the profitability of each technology at different scales. We applied these estimates to the BRS data to develop a relationship between the price of combustion and the demand for waste minimization.

Lacking a workable, well-defined characterization of source reduction opportunities, we were unable to analyze opportunities such as process redesign, product redesign, and input substitution in the same manner as waste minimization technologies. Source reduction is closely tied to the specifics of the particular production process, so it is not possible to make defensible generalizations

[37] It is important to note that there is some overlap in the quantities of waste that are diverted due to system consolidation and quantity of waste minimization due to price increases.

[38] The U.S. EPA 1993, Biennial Reporting System (BRS) was used for the waste minimization analysis because the 1995 data were not available at the time.

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across facilities or industries. Instead, we elected to develop an alternative approach that uses Toxics Release Inventory (TRI) data to infer source reduction achievements at a sample of progressive New Jersey facilities, and then extrapolate to an estimate of future source reduction potential across the nation. This methodology is presented graphically in Exhibit 6-10.

Waste Minimization Analysis Results

This analysis of waste minimization potential suggests that generators currently burning hazardous wastes may have a number of options for reducing or eliminating these wastes. At an average combustion price increase of $20 per ton expected for the Recommended MACT standard (at the 70 percent design level), EPA predicts that approximately 239,000 tons[39] of hazardous waste will be diverted from combustion to waste minimization alternatives.[40] Below we highlight other interesting results from the waste minimization analysis.

- Chemicals and allied products (SIC 28) generated the majority (64 percent) of combusted hazardous waste in 1993.[41] SIC 28 facilities work with large quantities of organic chemicals as inputs, solvents, products, byproducts, and cleaning agents, so it is not surprising that they top the list. We also focus on oil wastes and waste paint because these wastes are generated by a large number of facilities and waste minimization technologies are available for managing these waste types.

- Four technologies — filtration, reverse osmosis, ion exchange for metals, and oil-water separation — appear to be more cost-effective than combustion even at combustion prices as low as $50 per ton. Other financial, technical, and regulatory forces are likely constraining generators from shifting to these technologies.

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[39] Due to the timing of the waste minimization analysis, this estimate may not account for wastes that quality for the comparable fuel exclusion. In a separate analysis, we estimated that about 100,000 tons of currently combusted wastes (excluding wastes burned in on-site boilers) qualify for the comparable fuel exclusion. *(Economic Analysis Report for the Combustion MACT Fast-Track Rulemaking*, prepared by Industrial Economics, Incorporated; prepared for U.S. EPA's Office of Solid Waste, March 1998.)

[40] This result assumes a starting combustion price of $150 per ton.

[41] 1993 BRS data only reported SIC, NAICS information was not available. See Appendix G for conversions from SIC to NAICS.

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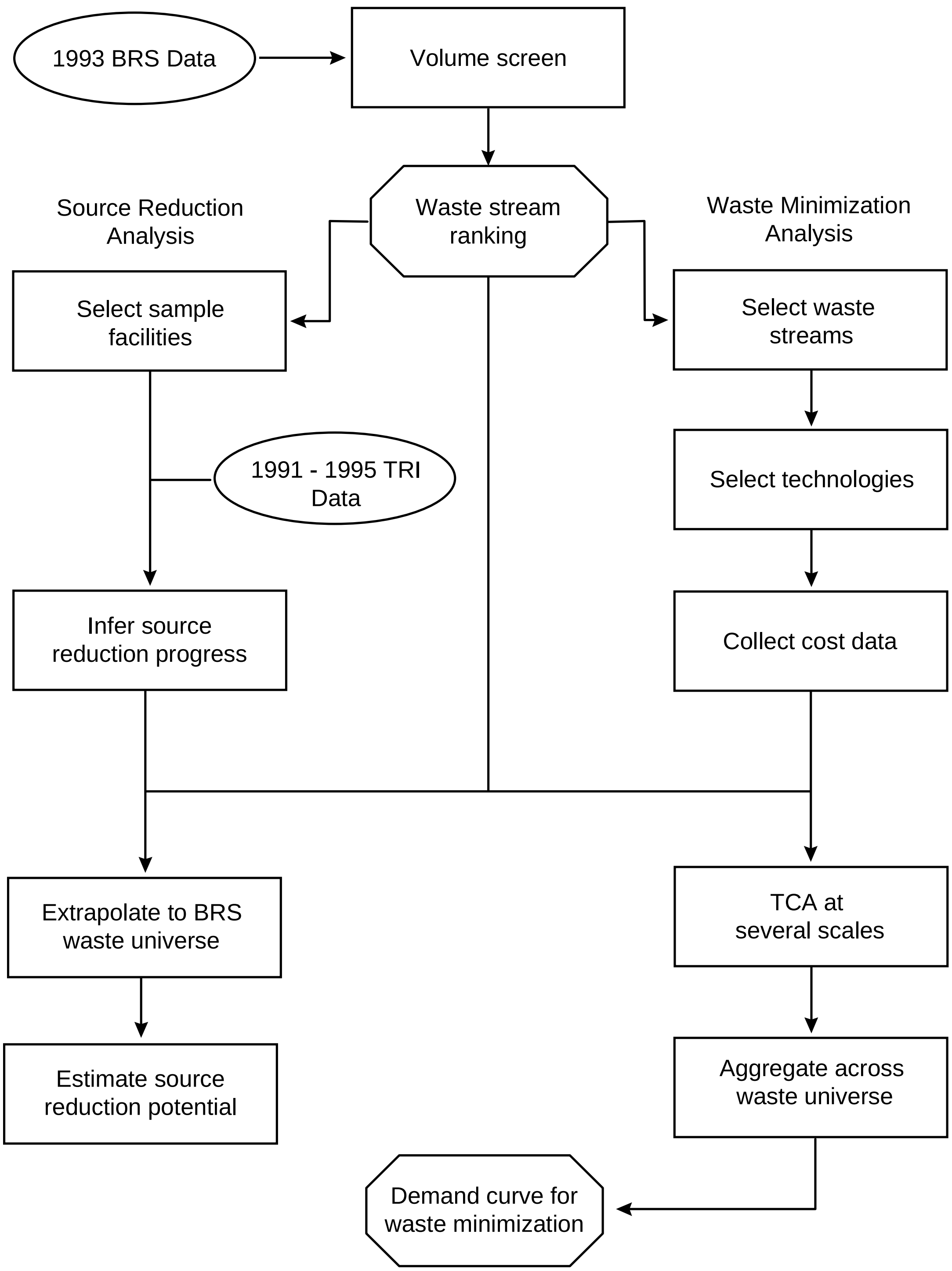
Exhibit 6-10
WASTE MINIMIZATION METHODOLOGY FLOW CHART



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- Distillation and ion exchange for acids display some sensitivity to combustion prices. Ion exchange for acids becomes competitive when combustion prices reach $120 per ton; vacuum distillation becomes competitive when combustion prices reach $150 per ton for larger generators and $160 per ton for smaller generators; simple distillation becomes competitive when combustion prices reach $200 per ton.

- The financial analysis suggests that three technologies — diffusion dialysis, electrodialysis, and pyrohydrolysis — are not cost-competitive with combustion even if combustion prices for liquids rise to $400 per ton.

- Over 500,000 tons of currently combusted waste will likely be eliminated by source reduction over the next ten to fifteen years, regardless of combustion prices. The rate of source reduction is not expected to be sensitive to changes in combustion prices because other benefits, such as improved yields from reduced waste, decreased downtime from reduced buildup of contaminants, improved product quality, or improved environmental image are usually more important than avoided disposal costs in justifying source reduction projects.

Caveats and Limitations

The waste minimization analysis is subject to several caveats and limitations. Most importantly, the underlying BRS data are broad and lack detail. Information on constituents, contaminants, and concentrations are vague or absent from the data. Some of the waste streams we deemed eligible for particular waste minimization technologies may present special circumstances that require additional investment, whether for superior equipment or for additional processing steps, that would increase the costs of waste minimization.

Another limitation regards our costing assumptions. The cost information for waste minimization technologies consists of vendor quotes for basic installations. Though systematically and aggressively pursued, these price quotes are subject to wide margins of uncertainty. Additional equipment may be needed in particular cases, beyond the installation cost assumptions that we developed. Some waste streams may also require additional processing. Neither waste stream data nor vendor information provided enough information to evaluate these possibilities.

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CONCLUSIONS

Overall, the final HWC MACT standards are expected to result annually in approximately $29 million in human health benefits. In addition, up to 147 square kilometers of land and 38 square kilometers of surface water near combustion facilities may experience ecological improvements. In particular, the MACT standards are expected to result in the following:

- **Reductions in premature deaths.** Risk reductions associated with the MACT standards are expected to result in approximately two fewer premature deaths per year. Particulate matter accounts for most of the avoided premature deaths; reductions in carcinogenic pollutants account for a small portion of the avoided premature deaths.

- **Reductions in diseases associated with particulate matter exposure.** Avoided cases of chronic bronchitis (25 cases) and asthma (267,600 cases) account for the majority of health benefits. Nearly 20,000 days of work loss or restricted activity will also be avoided annually due to the final MACT standards. In addition, PM reductions are expected to result in six fewer hospital admissions per year.

- **Reductions in Risks to Sensitive Sub-Populations.** The risk assessment reveals that both cancer and non-cancer risks will be reduced for certain sensitive sub-populations -- namely children, subsistence fishermen, and subsistence farmers -- who face potentially higher exposure levels due to behavior patterns, physiological traits, and other factors. Though in all cases the benefits are difficult to quantify in terms of avoided deaths or illnesses, reductions in risk to sensitive sub-populations are of importance in terms of evaluating distributional impacts from HWC facility emissions.

- **Potential reductions in number of children with developmental abnormalities.** The risk assessment reports that baseline mercury levels are below that of concern. Thus, there are no significant human health benefits associated with mercury emission reductions. With regard to lead emission reductions, we expect that there will be two fewer children per year with abnormal cognitive development due to reductions in lead exposure.

- **Potential ecological improvements.** About 38 square kilometers of water may experience a decrease in potential risks to ecosystems. For terrestrial areas, the amount of land that may experience reductions in risk range between 115 square kilometers to 147 square kilometers.

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- **Waste minimization benefits.** A variety of waste minimization alternatives are available for managing those hazardous waste streams that are currently combusted. At combustion price increases of $10 to $20 per ton, approximately 240,000 tons of hazardous waste will be diverted from combustion to waste minimization alternatives. This corresponds to approximately 8 percent of waste quantities currently combusted.

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EQUITY CONSIDERATIONS AND OTHER IMPACTS CHAPTER 7

As required by applicable statute and executive order, EPA must complete an analysis of the MACT standards with regard to equity considerations and other regulatory concerns. This chapter assesses the potential impacts of the rulemaking associated with the following areas:

- Regulatory flexibility;
- Environmental justice;
- Children's health protection;
- Joint impacts of other EPA rules on cement kilns;
- Unfunded mandates;
- Tribal governments; and
- Regulatory takings.

In the first section, we present the results of our regulatory flexibility analysis, which focuses on the potential effects of the rulemaking on small entities. Next, we discuss the MACT standards in terms of potential environmental justice considerations for minority and low-income populations residing near combustion facilities and in terms of special concerns about the health of all children exposed to combustion facility emissions. We then describe how other proposed EPA rules, together with the HWC MACT standards, will likely affect the cement industry. Following this section, we introduce the regulatory basis for addressing federal unfunded mandates to the private and public sectors, including Indian tribal governments and their communities, and then present the results of our analysis in terms of the MACT standards. Lastly, we provide a similar discussion concerning the potential for regulatory takings of private property associated with the MACT standards.

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ASSESSMENT OF SMALL ENTITY IMPACTS

The Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 requires federal agencies to consider impacts on "small entities" throughout the regulatory process.[1] According to SBREFA, an initial analysis should be conducted to determine whether small entities will be adversely affected by the regulation. This section describes the assessment that EPA has conducted to determine whether the Combustion MACT Standards will adversely impact small entities. Appendix G contains the full report, *Assessment of Small Entity Impacts Associated with the Combustion MACT Rule*.

The primary small entity group that EPA assessed in the analysis was privately-owned hazardous waste combustion facilities (i.e., small businesses). We did not evaluate other small HWC entities because the only government facilities are federal (and therefore they are not small) and we did not identify any HWC facilities owned by nonprofits.[2] To come into compliance with MACT, combustion systems on average will likely spend between $250,000 and $1.5 million per year on pollution control measures, monitoring, and other regulatory requirements. The first step in screening these facilities for potential impacts is to identify those combustion facilities that are small businesses. For this analysis, EPA identified small businesses based on data and guidelines developed by the Small Business Administration (SBA). Size thresholds were determined in terms of annual revenues or the number of employees, and vary by business area as identified in the Standard Industrial Classification (SIC).[3] Once the small businesses were identified, we calculated site-specific compliance costs of the standards as a percentage of total facility sales; we used this figure as the basis for our assessment of small entity impacts.

As a supplementary analysis, EPA also examined indirect effects on small business hazardous waste generators and fuel blenders. These industry sectors may be indirectly affected by the rule as some of the costs are expected to be passed on by combustors in the form of higher disposal prices. In our analysis, we considered two possible scenarios: a 25 percent and a 75 percent price pass through from combustors to generators and fuel blenders.[4] To determine potential indirect impacts, we identified small business fuel blenders and generators. Because there are relatively few fuel blenders, these facilities were analyzed using company-specific financial and employment information. Generators, however, were analyzed using a screening approach that identified industries (by SIC code) dominated by small businesses.

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[1] Small entities include small businesses, small governments, and small nonprofit organizations.

[2] We also did not identify any HWC facilities owned by tribal governments.

[3] See Appendix G for conversions from SIC to NAICS.

[4] For the 25 percent scenario, the weighted average price increase is $5 per ton of hazardous waste. For the 75 percent scenario, the increase is $16 per ton.

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Few small combustors will likely be adversely affected by the Combustion MACT rule. Due to the capital intensive nature of the industry, only six out of 172 identified combustion facilities were categorized as small entities. Of these six, two would have costs greater than 1 percent of sales (Exhibit 7-1). Both of these facilities are owned by a common parent that qualifies as a small business. Therefore, the Combustion MACT rule affects a very limited number of small business combustors, and has significant effects on only two of these facilities. According to EPA's interim guidance on SBREFA, a rule that adversely affects less than 100 small entities is presumed not to have a significant impact on a substantial number of small entities.[5]

In our supplementary analysis we found that indirect impacts on hazardous waste generators will not likely be significant. Of the 2,113 small generators identified in our analysis, less than 1 percent (18 generators) would have costs exceeding 1 percent of sales given our 25 percent pass through assumption (see Chapter 5 for a description of the price pass-through). If we assume a 75 percent pass through, approximately 3 percent of generators (58 facilities) would have costs greater than 1 percent of sales (Exhibit 7-1). Between 10 and 19 of these facilities would experience costs exceeding 3 percent of sales. Thus, although there are a relatively large number of small business generators, the number of these facilities facing significant impacts is very low.

If we assume compliance costs are passed through to fuel blenders alone (and not subsequently to generators), the potential indirect impacts on small business fuel blenders are more significant than those for generators and combustors. We do not believe this scenario (in which fuel blenders bear the full burden of the combustion price increase) is likely, given that generator demand for such services is relatively inelastic. However, even under this scenario, there are not a substantial number of blenders affected. Of the 67 fuel blenders in the analysis, twenty-one were identified as small businesses. As Exhibit 7-1 indicates, between six and 14 of these facilities would experience costs exceeding 1 percent of sales, and between four and seven would have costs exceeding 3 percent of sales.

[5] U.S. Environmental Protection Agency, *Revised Interim Guidance for EPA Rulewriters: Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act*, March 29, 1999.

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Exhibit 7-1

SMALL ENTITY ANALYSIS RESULTS

	Direct Impacts	Indirect Impacts	
	Combustors	**Generators**	**Blenders**
Number of establishments identified	172	11,054	67
Number of small entities (% of total)	6 (3.5%)	2,113 (19.1%)	21 (31.3%)
Number of small entities with costs exceeding 1% of sales (% of total small entities)	2 (33%)	18-58 (0.85%-2.7%)	6-14 (29%-67%)
Number of small entities with costs exceeding 3% of sales (% of total small entities)	0 (0.0%)	10-19 (0.47%-0.90%)	4-7 (19%-33%)

Note: The number of generators and blenders that are indirectly impacted are independent estimates and should not be added together.

In general, the Combustion MACT Standards will not have significant impacts on a substantial number of small entities. In particular, the direct impacts on small business combustion facilities and the indirect impacts on small business generators are minor. Only the impacts on fuel blenders may be notable; however, the absolute number of these facilities affected is very small.

ENVIRONMENTAL JUSTICE ANALYSIS

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (February 11, 1994), requires federal agencies to identify disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations.[6] Among other actions, the agencies are directed to improve research and data collection regarding health and environmental effects in minority and low-income communities.

[6] For the purposes of this analysis, minority populations include Black, Asian, American Indian, Hispanic, and other non-White individuals.

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To comply with this executive order, EPA assessed whether the Combustion MACT Standards will have disproportionate effects on minority populations or low-income populations. We accomplished this task by analyzing the demographic data presented in the reports, "Race, Ethnicity, and Poverty Status of the Populations Living Near Cement Plants in the United States" (EPA, August 1994), and "Race, Ethnicity, and Poverty Status of the Populations Living Near Commercial Hazardous Waste Incinerators in the United States" (EPA, October 1994). These reports examine the number of low-income and minority individuals living near cement kilns and commercial hazardous waste incinerators, and also provide county, state, and national population percentages for various sub-populations.

Our analysis of the demographic data in these reports provides several important findings about the environmental justice impacts of the MACT Standards:

- The Combustion MACT Standards should not have any adverse environmental or health effects on minority populations and low-income populations. Any impacts the rule has on these populations are likely to be positive because it will potentially reduce emissions from combustion facilities near minority and low-income population groups.

- In general, combustion facilities are not more likely to be located in areas with disproportionately high minority and low-income populations. However, current data indicate that hazardous waste-burning cement kilns are located in areas that have relatively high low-income populations. These populations may incur some environmental and health benefits as a result of the MACT Standards.

- A small number of commercial hazardous waste incinerators located in highly urbanized areas are found to have disproportionately high concentrations of minorities and low-income populations within one and five mile radii. The reduced emissions at these facilities due to the MACT Standards could represent environmental and health improvements for minorities and low-income populations in these areas.

These findings, as well as our data analysis approach, are further discussed in the remainder of this section.

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Approach

Our analysis of environmental justice relies on demographic data as an indicator of potential environmental and health impacts from the Combustion MACT Standards. While a risk assessment would be the preferred way to determine these impacts, the necessary resources were not available to complete such an analysis. Instead, we assess the environmental justice impact of the Combustion MACT Standards by examining demographic data using two separate approaches.

For our first approach, the "facility approach," we assess whether there are a significant number of combustion facilities located in areas where the nearby populations are disproportionately minority or low-income. Specifically, we compare populations within one and five miles of each sample combustion facility to populations at the county, state, and national levels. With this information, we can determine the percentage of facilities that are located in areas with disproportionately high minority or low-income populations relative to local, statewide, or national totals.

For our second approach, the "population exposure approach," we consider the total population exposed to emissions from combustion facilities. Unlike the facility focus of our first approach, this method examines *total* minority and low-income numbers of potentially exposed people near combustion facilities. Specifically, we combine the general, minority, and low-income population numbers from within one and five miles of each combustion facility to derive total figures for all of the facilities, and then compare these totals to county, state, and national levels. This approach enables us to more easily identify trends that the facility analysis does not make as apparent. The population exposure approach, for example, is a better indicator of whether combustion facilities with particularly large surrounding populations have a disproportionate impact on total exposed populations.

For both the facility and population exposure approaches we use data from the two aforementioned EPA reports on demographic composition near combustion facilities. These reports provide minority and low-income population data for 14 commercial hazardous waste incinerators and 18 hazardous waste burning cement kilns that are currently permitted to burn hazardous waste.[7] For each of these combustion facilities, population data are provided at half, one, two, three, four and

[7] The report, U.S. EPA, August 1994, "Race, Ethnicity, and Poverty Status of the Populations Living Near Cement Plants in the United States," includes data on non-hazardous waste burning cement kilns; however, we did not include these facilities in our analysis because they are not regulated under the Combustion MACT Standards.

five mile radii from the site location.[8] Population data are also included for the counties and states for each combustion facility. Along with these data, for both of our approaches we use a national minority percentage of 24 percent and a low-income percentage of 13 percent. Both of these figures are based on U.S. Census data.

<u>Results</u>

We present our results according to the two different approaches that we use to assess environmental justice impacts of the Combustion MACT Standards. For each approach, we describe our results for minority populations followed by low-income population results. At the end of this section, we present our summary conclusions. Appendix H provides additional data on minority and low-income populations near hazardous waste-burning cement kilns and incinerators.

Facility Approach

Applying the facility approach, we find evidence that combustion facilities are somewhat more likely to be located in areas with disproportionately high minority populations compared to the counties in which they are located, but not with respect to state and national minority populations. Exhibit 7-2 compares minority populations at one and five mile radii from combustion facilities to county, state, and national minority levels. As Exhibit 7-2 indicates, combustion facilities appear more likely to be located in areas with minority levels that are less than state and national levels. For example, only 34 percent of all combustion facilities have minority percentages within five miles that exceed the national average, while 66 percent are below the national average. Within one mile, the value for facilities exceeding the national minority average falls to 31 percent.[9] Compared to the county minority levels, however, combustion facilities are somewhat more likely to be located in

[8] Due to resource constraints, of the six radii we only review data at the one and five mile radii from each combustion facility. However, these two radii provide a sufficient range for our analysis.

[9] Total population within one mile of combustion facilities is below 1,000 at 79 percent of the incinerators and 39 percent of the cement kilns in this analysis.

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Exhibit 7-2

MINORITY POPULATIONS NEAR COMBUSTION FACILITIES, SITE-BY-SITE BASIS

	Percent combustors where minority % within 1 mile > county minority %	Percent combustors where minority % within 1 mile > state minority %	Percent combustors where minority % within 1 mile > national minority %	Percent combustors where minority % within 5 miles > county minority %	Percent combustors where minority % within 5 miles > state minority %	Percent combustors where minority % within 5 miles > national minority %
Hazardous Waste Incinerators	50%	36%	36%	50%	43%	43%
Hazardous Waste Burning Cement Kilns	72%	44%	28%	56%	28%	28%
Total	**63%**	**41%**	**31%**	**53%**	**34%**	**34%**

Notes:
- **County and state minority percentages vary according to the location of the combustion facility.**
- **The national minority percentage is 24 percent.**

areas with disproportionately high minority populations. For instance, 63 percent of all combustion facilities have minority percentages within one mile that exceed minority percentages for the county where the facility is located; for hazardous waste burning kilns, the figure is 72 percent. Tables 1 and 2 in Appendix H show comparisons of one mile and five mile minority population percentages at combustion facilities with county, state, and national levels.

With the facility approach, we find that combustion facilities, particularly cement kilns, are somewhat more likely to be located in areas with disproportionately high low-income populations than areas with fewer low-income people. Exhibit 7-3 compares low-income populations at one and five mile radii from combustion facilities to county, state, and national levels. As the exhibit shows, more than half of the combustion facilities have low-income population percentages that are greater than percentages at the county, state, and national levels. For instance, within one mile of all combustion facilities, 63 percent of the sites have low-income population percentages that are greater than percentages for this group at the national level. Within one mile of hazardous waste burning cement kilns, 72 percent of the sites have low-income population percentages that are greater than the national poverty percentage. For commercial hazardous waste incinerators, the low-income percentages near these facilities are just as likely to be less than, versus greater than, the percentages for this group at county, state, and national levels. Tables 3 and 4 in Appendix H compare one mile and five mile low-income population percentages at combustion facilities with county, state, and national levels.

Population Exposure Approach

Based on the total population of exposed individuals, our review of potential environmental justice impacts on minorities results in somewhat different findings from the facility approach. According to total population numbers, minorities are disproportionately located near commercial hazardous waste incinerators. However, minority populations are not disproportionately located near cement kilns. Exhibit 7-4 shows how many people live near combustion facilities and what portion of the population is comprised of minorities. As the exhibit indicates, 48 percent of the total population within five miles of commercial hazardous waste incinerators is classified as minority. This figure is more than twice the national minority percentage (24 percent). The minority population percentage (45 percent) within one mile of incinerators is also significantly greater than the national level.[10]

The high percentage of minorities living near commercial hazardous waste incinerators is driven primarily by several facilities that are located in highly urbanized areas. These facilities have large general populations as well as significant minority populations nearby, particularly within five miles. Since the population exposure analysis considers total population figures, these urban

[10] The total population within five miles of incinerators is nearly 50 times greater than the population within one mile of these facilities.

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Exhibit 7-3

LOW-INCOME POPULATIONS NEAR COMBUSTION FACILITIES, SITE-BY-SITE BASIS

	Percent combustors where poverty % within 1 mile > county poverty %	Percent combustors where poverty % within 1 mile > state poverty %	Percent combustors where poverty % within 1 mile >national poverty %	Percent combustors where poverty % within 5 miles > county poverty %	Percent combustors where poverty % within 5 miles > state poverty %	Percent combustors where poverty % within 5 miles > national poverty %
Hazardous Waste Incinerators	50%	50%	50%	50%	57%	57%
Hazardous Waste Burning Cement Kilns	67%	72%	72%	56%	78%	67%
Total	**59%**	**63%**	**63%**	**53%**	**69%**	**63%**

Notes:
- County and state poverty percentages vary according to the location of the combustion facility.
- The national poverty percentage is 13 percent.

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Exhibit 7-4

POTENTIALLY EXPOSED GENERAL AND MINORITY POPULATIONS

	Total Population within 1 mile	Minority Population within 1 mile	Minority Percentage within 1 mile	Total Population within 5 miles	Minority Population within 5 miles	Minority Percentage within 5 miles
Hazardous Waste Incinerators	18,119	8,182	45%	846,511	403,021	48%
Hazardous Waste Burning Cement Kilns	39,858	6,111	15%	324,521	28,610	9%
Total	**57,977**	**14,293**	**25%**	**1,171,032**	**431,631**	**37%**

incinerators are primarily responsible for the high total minority percentages near commercial hazardous waste incinerators. Incinerators in less densely populated areas, on the other hand, do not have as significant effect on total and minority population figures. While a few cement kilns have high surrounding minority population percentages, these facilities are not located in highly urbanized areas and therefore do not significantly increase total minority percentages. Tables 5 and 6 in Appendix H present detailed facility-by-facility data that illustrate this trend.

These findings indicate that the MACT Standards may have significant environmental justice impacts around commercial hazardous waste incinerators in highly urbanized areas. The standards are likely to reduce emissions from combustion facilities; therefore, populations near these facilities may accrue significant health and environmental benefits. Overall, a large number of individuals that will accrue these benefits live in urbanized areas and a significant percentage of these individuals are minority. Thus, the MACT Standards may have disproportionately positive health and environmental effects on minority populations near urban incinerators.

Based on the population exposure analysis, low-income populations are also over-represented near commercial hazardous waste incinerators, though not as significantly as minority populations. As Exhibit 7-5 shows, the total low-income population percentages within five miles (24 percent) and one mile (23 percent) of commercial hazardous waste incinerators are nearly twice the national poverty percentage (13 percent). Low-income population percentages near hazardous waste-burning cement kilns are nearly equivalent to the national level. Therefore, we conclude that the MACT Standards may result in environmental and health benefits to low-income populations near commercial hazardous waste incinerators.

Summary

The two approaches we use to address environmental justice impacts result in somewhat different findings. With our facility approach, it appears that commercial hazardous waste incinerators are not necessarily more likely to be located in areas with disproportionately high minority or low income populations. However, hazardous waste burning cement kilns are somewhat more likely to be located in areas where minority populations within one mile exceed county averages. Kilns are also more likely to be located in areas with low income populations.

Based on our population exposure approach, minority and low-income populations in aggregate are disproportionately located near combustion facilities, particularly within one and five miles of commercial hazardous waste incinerators. Furthermore, near commercial hazardous waste incinerators that are located in highly urbanized areas, minority population percentages are significantly greater than the national level. Thus, using the population exposure approach to estimate environmental justice impacts, the Combustion MACT Standards may result in significant health and environmental benefits to minority and low-income populations.

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Exhibit 7-5

POTENTIALLY EXPOSED GENERAL AND LOW-INCOME POPULATIONS

	Total Poverty-Assessed Population w/in 1 mile	Low-Income Population w/in 1 mile	Low-Income Percentage within 1 mile	Total Poverty-Assessed Population w/in 5 miles	Low-Income Population w/in 1 mile	Low-Income Percentage within 5 miles
Incinerators	17,596	4,013	23%	813,859	197,456	24%
Cement Kilns	36,815	6,323	17%	302,892	36,343	12%
Total	**54,411**	**10,336**	**19%**	**1,116,751**	**233,799**	**21%**

Note: "Poverty-Assessed Population" is the population for which poverty status has been evaluated. (This population estimate occasionally differs slightly from total population estimates).

While these two distinct approaches are both potentially useful, the population exposure method is probably a more representative measure of environmental justice impacts of the MACT Standards. Whereas the facility approach weighs each combustion facility equally regardless of the magnitude of nearby populations, the population exposure approach considers total general, minority, and low-income populations surrounding each site. This latter technique provides a more complete picture of the populations residing near combustion facilities, and is therefore more indicative of the overall potential impacts of the MACT Standards on environmental justice populations.

CHILDREN'S HEALTH PROTECTION ANALYSIS

Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks" (April 21, 1997), directs federal agencies and departments to evaluate the health effects of proposed health-related or risk-related regulations on children.[11] For economically significant rules that concern an environmental health or safety risk that may disproportionately affect children, Executive Order 13045 also requires an explanation as to why the planned regulation is preferable to other potentially effective and feasible alternatives considered.[12] The HWC MACT standards are exempt from the requirements of Executive Order 13045 because the rule is a technology-based regulation (MACT) rather than a risk-based one.[13] Nevertheless, the risk assessment performed for the MACT standards does address threats to children's health by evaluating reduced risks associated with hazardous waste combustion for children as well as for adults and the population overall.[14]

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[11] In addition, two separate directives issued by EPA, "Policy on Evaluating Health Risks to Children" (October 1995) and "National Agenda to Protect Children's Health from Environmental Threats" (October 1996), also call for consideration of children's health within risk assessments and other components of regulatory analyses.

[12] As defined in Executive Order 13045, an economically significant rule is any rulemaking that has an annual effect on the economy of $100 million or more, or would adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local or tribal governments or communities.

[13] U.S. Environmental Protection Agency, "EPA's Rule Writer's Guide to Executive Order 13045: Guidance for Considering Risks to Children During the Establishment of Public Health-Related and Risk-Related Standards," Interim Final Guidance, April 21, 1998, page 3.

[14] Appendix I provides a more detailed discussion on reduced risks to children's health.

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Approach

The risk assessment for the MACT standards evaluated both cancer and non-cancer risks for all exposed sub-populations across four different age groups: 0-5 years, 6-11 years, 12-19 years, and adults over 20 years.[15] Where possible, the MACT risk assessment provided both population and individual risk results for children. The modeling effort is a multi-pathway analysis that estimates both inhalation and ingestion pathways in order to examine potential effects of combined exposures to children. In terms of cancer risks, the assessment considered the combined effects of several carcinogens, corresponding with one of the goals of EPA's "National Agenda to Protect Children's Health from Environmental Threats."[16] Moreover, areas for potential reductions in risk and related health effects identified by the HWC MACT risk assessment are all targeted as priority issues by EPA's children's health protection agenda.

Summary of Results

The key findings from the HWC MACT risk assessment with regards to children's health are listed below according to cancer and non-cancer risks:[17]

- **Cancer Risks.** In general, children do not face significant cancer risks from hazardous waste combustion emissions. Only in the case of children of subsistence farmers do baseline cancer risks (driven primarily by dioxin) exceed $1x10^{-5}$ for the most highly exposed children. Following implementation of the Recommended MACT standards, however, these cancer risks are expected to be reduced to below levels of concern ($<1x10^{-5}$) for the portion of this sensitive subpopulation living near incinerators. For the portion of this sensitive children group living near kilns, however, risks may not be reduced below levels of concern.

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[15] See Chapter 6, "Benefits Assessment," for a complete description of the risk assessment methodology.

[16] U.S. Environmental Protection Agency, *Environmental Health Threats to Children*, EPA 175-F-96-001, September 1996, pages 2 and 6.

[17] Risk assessment results are based on floor and beyond the floor (BTF) MACT options from January 1998 and are reported in the EPA Technical Support Document, "Risk Assessment Support to the Development of Technical Standards for the Emissions from Combustion Units Burning Hazardous Wastes, Human Health and Ecological Risk Results: Baseline and MACT," Prepared by Research Triangle Institute, Prepared for U.S. Environmental Protection Agency, Office of Solid Waste, January 1998.

- **Non-Cancer Risks.** The non-cancer risk reductions resulting from implementation of the MACT standards will most likely benefit children directly. Non-cancer health benefits to children are associated with reduced exposures to particulate matter (PM) and lead. A recent EPA report indicates that these pollutants significantly affect children.[18]

  -- PM reductions will prevent 268,000 asthma attacks in the general population. If these cases are equally distributed across age groups, over 77,000 asthma attacks affecting children will be avoided each year.

  -- Reduced lead exposures for children are expected post-MACT which may prevent cognitive and nervous system developmental abnormalities. In particular, the blood lead levels of two children are expected to be reduced to below levels of concern ($<10\mu g/dL$); also, the MACT standards will reduce overall blood lead levels for children of subsistence farmers living near incinerators from approximately 12 $\mu g/dL$ in the baseline to about $10.5\mu g/dL$ post-MACT.

As the risk results indicate, the HWC MACT standards will not result in adverse but rather positive effects for the protection of children's health. In fact, as described above, children are expected to be the direct recipients for a number of the potential health benefits associated with the MACT standards.

JOINT IMPACTS OF THREE EPA RULES ON THE CEMENT INDUSTRY

EPA is also promulgating two other rules that affect the cement industry. The Cement Kiln Dust (CKD) Rule applies to all cement kilns, those that burn hazardous waste as well as those that only burn conventional fuels. The other EPA rule, the Portland Cement MACT, establishes emission standards for non hazardous waste-burning cement kilns. This section addresses the joint impacts of these rules, in conjunction with the Hazardous Waste Combustion MACT standards, on the cement industry as a whole.[19]

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[18] U.S. Environmental Protection Agency, *Environmental Health Threats to Children*, EPA 175-F-96-001, September 1996, page 4.

[19] Detailed results from this analysis are included in Appendix J, "Multi-Rule Analysis."

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The joint impacts analysis uses a revised version of the economic impact model developed for the Portland Cement (PC) MACT rulemaking to estimate social costs, market impacts and industry impacts for cement kilns.[20] Together, the social costs of the three rules total $186 million annually.[21] For Portland Cement, lost consumer surplus accounts for 60 percent ($113 million) of the social costs, while lost domestic producer surplus accounts for the remaining social costs ($74 million).[22]

As a result of the three rules combined, cement kiln earnings are estimated to decrease by about 6 percent across the entire cement industry.[23] These lost earnings are a result of cost increases of about 2 percent and revenue decreases of almost 3 percent. The increased costs of waste burning and cement production are expected to result in 15 kilns that may cease cement production and five kilns that will stop burning hazardous waste. The market exit of only one of the 15 kilns that stops manufacturing cement is due to the joint impacts of all three rules; the remaining 14 market exits result from the CKD and the PC MACT alone.

With regard to market impacts, the joint effect of all three rules is expected to cause the price of Portland cement to increase by 2 percent and Portland cement production to decrease by 4 percent. Foreign imports of cement are expected to increase by over 10 percent. Consistent with the price increase expected solely from the HWC MACT (see Chapter 5), hazardous waste combustion prices are expected to increase by about 9 percent for liquids and 3 percent for solids. Hazardous-waste burning kilns are expected to burn about 10 percent less hazardous waste as a result of the three EPA rules.

UNFUNDED MANDATES ANALYSIS

Signed into law on March 22, 1995, the Unfunded Mandates Reform Act (UMRA) calls on federal agencies that issue any regulation containing an unfunded mandate to fulfill certain requirements, such as providing a statement supporting the need to issue the regulations and

[20] The model also estimates impacts on commercial incinerators and LWAKs. However, we focus on cement kilns in this summary.

[21] This estimate only includes changes in consumer and producer surplus associated with the manufacture of domestic Portland Cement; we do not include changes in producer surplus associated with foreign producers.

[22] We do not include changes in consumer surplus for the hazardous waste-burning component of the business because the analysis did not break these losses by combustion sector (e.g., cement kilns).

[23] Earnings before interest and taxes.

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describing prior consultation with representatives of affected state, local, and tribal governments.[24] Requirements in the UMRA apply only to those federal regulations containing a significant unfunded mandate. The UMRA defines a significant unfunded mandate as a federal rule that either:

1. Results in estimated costs to state, local, and tribal governments in aggregate of $100 million or more in any one year; or

2. Results in estimated annual costs to the private sector of $100 million or more in any one year.

Federal rules are exempt from the UMRA requirements if:

1. The rule implements requirements specifically set forth in law; or

2. Compliance with the rule is voluntary for state and local governmental entities.

Based on these criteria set forth by the UMRA, the MACT standards do not contain a significant unfunded mandate. As reported in the economic impact results section, the MACT standards are not likely to result in annualized expenditures of $100 million or more either for the private sector or for state and local governments in the aggregate under the recommended MACT option, especially after allowing for market adjustments.[25] In any case, because EPA is issuing the MACT standards under the authority of the Clean Air Act (CAA), the rule should be exempt from all relevant requirements of the UMRA. In addition, compliance with the rule is voluntary for non-federal governmental entities since state and local agencies choose whether or not to apply to EPA for the permitting authority necessary to implement the MACT standards.

TRIBAL GOVERNMENTS ANALYSIS

Similar in purpose to the UMRA, Executive Order 13084, "Consultation and Coordination With Indian Tribal Governments" (May 14, 1998), addresses related unfunded mandates concerns with regard to the sovereignty of tribal governments. In terms of specific rulemaking efforts, the applicable sections of Executive Order 13084 impose requirements on federal agencies that promulgate regulations, not required by statute, that significantly or uniquely affect Indian tribal

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[24] Other requirements include a statement concerning estimated costs and benefits, consideration of regulatory alternatives, consultation with affected government entities, and a small government plan for those rules “significantly or uniquely” affecting small government agencies. Even though the MACT standards are exempt from these requirements, as we explain below, many of them are already satisfied by other components of this *Assessment*.

[25] See Exhibit 5-6, “Total Annual Pre-Tax Compliance Costs (millions) After Combustion System Consolidations” and Exhibit 4-9, “Summary of HWC MACT Incremental Costs to Government.”

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governments and their communities. The requirements include description of the extent of prior consultation with affected tribal governments, a summary of the nature of their concerns, and a statement supporting the need to issue the regulation.

For many of the same reasons described in the UMRA discussion, the requirements of Executive Order 13084 do not apply to the HWC MACT standards. As mentioned above, promulgation of the MACT standards is occurring under the statutory authority of the CAA. In addition, while Executive Order 13084 does not provide a specific gauge for determining whether a regulation "significantly or uniquely affects" an Indian tribal government, the MACT standards are not expected to impose substantial direct compliance costs on tribal governments and their communities because we do not expect that a significant number of hazardous waste combustion facilities are located in tribal communities.[26] Finally, tribal governments will not be required to assume any permitting responsibilities associated with the MACT standards because, as previously stated, permitting authority is voluntary for non-federal government entities. In fact, while the CAA does allow tribal governments to implement its permitting requirements, none have yet assumed the authority.[27]

REGULATORY TAKINGS ANALYSIS

Executive Order 12630, "Government Actions and Interference with Constitutionally Protected Property Rights" (March 15, 1988), directs federal agencies to consider the private property takings implications of proposed regulation. Under the Fifth Amendment of the U.S. Constitution, the government may not take private property for public use without compensating the owner. Though the exact interpretation of this takings clause as applied to regulatory action is still

[26] We did not, however, conduct a quantitative geographic location analysis to verify this assumption.

[27] Pechulis, Kevin. U.S. Environmental Protection Agency RCRA Hotline, personal communication, March 19, 1998 and U.S. Environmental Protection Agency, "Air Pollution Operating Permit Program Update: Key Features and Benefits," EPA/451/K-98/002, February 1998.

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subject to an ongoing debate, a framework for interpretation has been established by legal precedent through a series of prominent court cases.[28]

Within the current context of mainstream legal precedent, a regulatory taking of private property is generally deemed to result if the court determines that the government action satisfies any of the following criteria:

- Results in a physical invasion of property;
- Denies the owner all reasonable or economically viable use of property;[29]
- Interferes with reasonable investment-backed expectations for property; or
- Fails to establish a justifiable connection between the requirements imposed (e.g., permit conditions) and the underlying purposes of the regulation.

Even if a regulatory requirement meets any or all of the designated conditions for a regulatory taking, courts may still find it exempt from the takings clause if the regulatory action is meant to prevent a "nuisance" or to provide other benefits to the public. A nuisance is defined as an activity

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[28] See, for instance, *Pennsylvania Coal Co. v. Mahon*, 260 U.S. 393 (1922), *Penn Central Transportation Co. v. City of New York* 438 U.S. 104 (1978), *Lucas v. South Carolina Coastal Council* 112 S. Ct. 2886 (1992), *Dolan v. City of Tigard* 114 S. Ct. 2309 (1994), and *Nollan v. California Coastal Commission* 483 U.S. 825 (1987). It is also worth noting the number of pieces of legislation introduced in recent U.S. Congressional sessions that aim to strengthen the defined framework for analysis of regulatory takings. The main goals of the bills include the following: expansion of the definition of a regulatory taking; introduction of additional administrative requirements for federal agencies issuing regulations likely to result in regulatory takings; and expedition of access to federal courts for parties seeking claims associated with regulatory takings. If passed, however, none of the legislation contains provisions likely to affect the principles of mainstream legal interpretation of regulatory takings that is utilized in the following analysis of the HWC MACT standards.

[29] No universally accepted formula exists for determining at what point direct economic impacts from regulatory action constitute a taking. Rather, courts must make this determination on a case-by-case basis. In the landmark *Lucas* decision, the U.S. Supreme Court proclaimed that a 100 percent deprivation in value most often, but not always, constitutes a taking. Recent case law includes many examples in which regulations deprived owners of as much as 50 percent or more of the value associated with the economic use of property, yet the court still ruled that the regulations did not deny the owner all reasonable economic value. For instance, see *Concrete Pipe and Products v. Construction Laborers Pension Trust for Southern California*, 113 S.Ct. 2264 (1993).

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or condition that either interferes with the public welfare or with the ability of another private citizen to enjoy his or her own property.[30]

Based on our review of relevant case law, the MACT standards are not likely to result in any regulatory taking. The rule will not require that private property be invaded or taken for public use. The rule also will not interfere with reasonable investment-backed expectations because it does not ban hazardous waste combustion but merely authorizes operating parameters. The investment-backed expectations of anyone opening a hazardous waste combustion facility since then would include a recognition of the existence of impending regulatory requirements. Persons already engaged in combustion would have had more than eight years to adjust their expectations and to prepare for accommodation of the forthcoming regulation. As a result, no facility owner should be able to assert interference with reasonable investment-backed expectations sufficient to support a taking.[31]

Because the rule does not prohibit the burning of hazardous waste, it does not deny the facility owners all viable economic use of their property. Nor does the rule prevent owners from putting their property to other profitable uses should they decide to cease combustion in the face of the regulation. In the case of on-site incinerators, cement kilns, and LWAKs, the primary economic use of property comes from other activities not directly associated with hazardous waste combustion. Even if these facilities stop burning waste, they will still be able to manufacture their primary products, such as cement, lightweight aggregate, or chemicals. In terms of commercial incinerators, those facilities that stop burning waste can still use their property for other industrial purposes.[32]

This evaluation of the MACT standards corresponds with the mainstream legal thought that only in rare instances will regulations be found to result in takings. Using legal precedent as the basis for this analysis, it is difficult to speculate fully on the potential for extreme takings interpretations as applied to the impacts of the MACT standards. The only areas where such an extreme interpretation of takings potentially *could* arise in the context of the MACT standards are the issues of deprivation of economically viable use of property and interference with reasonable investment-backed property expectations. However, it is still fairly easy to refute an extreme application of the takings clause to the MACT standards that is based on these criteria.

The economic impact results reported earlier do suggest that a number of facilities will exit the hazardous waste combustion market in the face of compliance costs associated with the MACT

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[30] Numerous court decisions have upheld regulations, while at the same time acknowledging the takings claims associated with them, on the basis of nuisance prevention and resource protection goals, ranging from landmark preservation to the control of industrial pollution in residential areas.

[31] See *Ruckelshaus v. Monsanto Co.,* 467 U.S. 986, 1005 (1984).

[32] For instance, many of the commercial incineration facilities provide other waste management services, like waste recycling, that will not be affected by the MACT standards.

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standards. It is important to note, however, that these closures are influenced more directly by market forces, such as overcapacity and marginal profit levels, than by the regulatory objectives of the MACT rule. Even under an extreme takings interpretation, it is doubtful that the MACT standards would be found to interfere directly with all viable use or economic value of property. Also, as we described above, the established statutory authority for the standards and the fact that the rule does not prohibit combustion altogether should exempt it from any claims of interference with reasonable investment-backed expectations. Regardless, the MACT standards would most likely qualify for an exemption to any regulatory takings claims because of the doctrines of public and private nuisance law.

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COMPARISONS OF COSTS, BENEFITS, AND OTHER IMPACTS — CHAPTER 8

A final component of the *Economic Assessment* for the MACT standards at combustion facilities is a comparison of the costs and benefits of the rule. This chapter uses two metrics for this comparison. We first consider cost-effectiveness measures which provide estimates of expenditures per unit reduction of emissions for each air pollutant and estimates of the cost per unit of benefit achieved by the rule. We then compare the total social costs of the rule with the total monetized benefits of the rule. Cost-benefit analysis is a central feature of virtually all economic assessments and evaluates the economic efficiency of environmental policies by measuring incremental costs and benefits, and hence their net impacts on society. In terms of economic efficiency, if the gainers could compensate the losers and still remain better off, the policy is deemed to be efficiency enhancing and therefore "good" from a policy perspective. Cost-benefit and cost-effectiveness analyses, however, should not be the only tools used in the establishment of any final regulatory action. The HWC MACT standards are expected to provide other benefits that are not expressed in monetary terms. 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 judgement which takes into account efficiency as well as equity concerns.

COST-EFFECTIVENESS ANALYSIS

Overview

EPA developed two types of cost-effectiveness measures that examine:

- cost per unit reduction of emissions for each air pollutant; and
- cost per benefit (i.e., benefits in the form of health and ecological improvements).

The first cost-effectiveness measure is useful for comparisons across various air pollution regulations. Moreover, EPA has typically used this cost-effectiveness measure (defined as "dollar-per-ton-of-pollutant-removed") to assess the decision to go beyond-the-floor (BTF) for MACT standards.[1] The second measure, cost per unit benefit, provides some insight into the rule's relative costs of achieving a given environmental improvement (e.g., cost per avoided premature death).

Cost-Effectiveness: Dollar per Unit of Reduced Emission

There are several dimensions a cost-effectiveness analysis can adopt to examine MACT standards. One approach is to estimate the aggregate cost-effectiveness of each MACT standard by summing total costs and dividing by the total emissions reductions across all pollutants. Aggregate cost-effectiveness figures, however, are misleading because the estimates do not account for the types of regulated pollutants, their relative toxicities, and their relative volumes of emissions. A more appropriate analysis requires disaggregating emission reductions and control costs by individual pollutants. Developing cost-effectiveness estimates for individual air pollutants helps EPA compare alternative emission standards for individual pollutants. The two analytic components of the individual cost-effectiveness measures are:

- estimates of emission control expenditures per air pollutant for each regulatory option; and

- estimates of emission reductions under each regulatory option.

Expenditures per air pollutant are based on the engineering costs for various pollution control measures as described in Chapter 4. Within each combustion sector (cement kilns, incinerators, and LWAKs), we sum each facility's costs of controlling emissions and amount of emission reductions for each pollutant. An additional adjustment is needed for control equipment that simultaneously reduces emissions for more than one air pollutant. For example, carbon injection or carbon beds can control both mercury and dioxins/furans. In addition, a fabric filter that may be required as part of a carbon injection system will also increase the capture performance of particulate matter, semi-volatile metals, and low-volatility metals. In the case of carbon injection (CI), EPA apportioned costs based on the required emission reduction for each pollutant. For example, if carbon injection (CI) equipment is assigned to a combustion system that requires a dioxin reduction of 40 percent and a mercury reduction of 80 percent, the individual cost calculations for this system are:

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[1] Martineau, Robert J. and David P. Novello, eds. 1998. *The Clean Air Act Handbook*, American Bar Association Publishing, Chicago.

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Cost for Mercury control = [80/(80+40) x *CI cost*]

Cost for Dioxin control = [40/(80+40) x *CI cost*]

These calculations split the costs of the carbon injection system between dioxin and mercury.

The other component of the individual cost-effectiveness measure is the emission reduction achieved when combustion facilities comply with the standards for the given regulatory option. In the emission reduction calculations, we assume emission reductions at the 70 percent design level. As a result combustion units will not experience emission reductions or incur costs if their emissions are below the 70 percent design level. However, combustion units that are already emitting below the standard, but above the 70 percent design level for a particular air pollutant will reduce emissions and incur costs. In addition, combustion units with emissions exceeding the standard will also reduce emissions to the 70 percent design level of the standard and incur the associated costs.

The emission reductions for the MACT Floor are calculated as the difference between the baseline emissions and the 70 percent design levels for the Floor standard. The emission reductions for the Recommended MACT and the BTF-ACI MACT standards are calculated as the difference between 70 percent of the Floor Standard and 70 percent of the beyond-the-floor regulatory option. Exhibit 8-1 indicates where incremental emission reductions are expected for each pollutant under the various regulatory options. Where there is no value in the table, no emission reductions are expected. For example, all LWAKs are currently meeting 70 percent of the Floor emission levels for the following pollutants: dioxins/furans, SVMs, carbon monoxide, and total hydrocarbons.

Exhibit 8-1

EXPECTED INCREMENTAL ANNUAL EMISSION REDUCTIONS

		Pollutant							
Source	**Options**	**TEQ, g**	**Hg, Mg**	**SVM, Mg**	**LVM, Mg**	**PM, Mg**	**CO, Mg**	**THC, Mg**	**TCl, Mg**
LWAK	Baseline to FLR	-	0.03	-	0.04	2.69	-	-	182.32
	FLR to REC	1.96	-	0.17	-	-	-	-	1433.20
	FLR to BTF-ACI	2.15	0.02	0.17	-	-	-	-	1433.20
INC	Baseline to FLR	3.40	3.46	55.87	6.86	1345.71	45.24	28.21	2672.02
	FLR to REC	17.93	-	-	-	-	-	-	-
	FLR to BTF-ACI	19.45	0.80	-	-	-	-	-	-
CK	Baseline to FLR	5.36	0.18	19.48	0.19	873.13	-	11.30	383.02
	FLR to REC	-	-	5.45	-	-	-	-	-
	FLR to BTF-ACI	3.71	0.69	5.45	-	-	-	-	-

Note: Emissions reductions are based on meeting the 70% design level.

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We develop individual cost-effectiveness (CE) measures for each MACT standard as follows:

- **Cost-Effectiveness Measures for MACT Floor —** Costs and emission reductions are incremental to the *baseline.*

- **Cost-Effectiveness Measures for Recommended MACT —** Costs and emission reductions are incremental to the *MACT Floor.*

- **Cost-Effectiveness Measures for BTF-ACI MACT —** Costs and emission reductions are incremental to the *MACT Floor.*

Cost-Effectiveness Results

We summarize the cost-effectiveness results in Exhibit 8-2 by pollutant, sector, and MACT standard. Cost-effectiveness results are measured in $1,000 per reduced megagram of emissions for all pollutants except dioxins. Cost-effectiveness for dioxins applies the metric of $1,000 per reduced gram of toxicity equivalent. In some cases, we do not present cost-effectiveness figures because there are no associated (incremental) emission reductions. For example, all LWAKs currently meet the Floor standards for reducing SVM emissions; thus, we do not report SVM cost-effectiveness results for LWAKs at the Floor. Similarly, we do not present cost-effectiveness measures for pollutants where EPA did not consider beyond-the-floor standards as part of its final rulemaking (e.g., particulate matter and LVMs). Below, we summarize key findings from the results:

- Across MACT standards and combustion sectors, cost-effectiveness measures exhibit wide variability. As shown in Exhibit 8-2, the cost-effectiveness of the HWC MACT standards ranges from $1,800 per megagram of reduced total chlorine emissions to $34 million per megagram of reduced mercury emissions. Dioxin control ranges from $25,000 to $903,000 per gram reduced.

- For cases in which we have cost-effectiveness figures for both the Floor and Recommended standards, the Recommended Standards appear more cost-effective than the Floor for reducing incinerator emissions of dioxins/furans.[2] For LWAK emissions of total chlorine, the cost-effectiveness of the Recommended Standard is similar to that of the Floor. While the SVM Recommended Standard for cement kilns appears less cost-effective than the

[2] "More cost-effective" means that incremental emission reductions are achieved at lower cost.

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Floor level, the cost-effectiveness of SVM control for cement kilns is similar to that of LWAKs at the Recommended Standard.

- For cases in which we have cost-effectiveness results for both BTF options (Recommended and BTF-ACI), the Recommended standard is either more cost-effective or not substantially different across the two MACT options, given the uncertainties in the analysis (e.g., SVMs).

<u>Cost-Effectiveness: Dollar per Health and Ecological Benefits</u>

This section evaluates cost-effectiveness per unit benefit (e.g., cost per health case avoided). EPA developed this second cost-effectiveness analysis to analyze and understand the relative costs of achieving specific benefits as standards become increasingly more stringent. The two components of this benefit cost-effectiveness measure are:

- estimates of specific health and ecological benefits associated with the Recommended Standard; and

- estimates of control expenditures associated with the reduction of emissions for pollutants directly linked to the benefit.

Approach for Calculating Cost-Effectiveness per Unit Benefit

In order to attribute costs to specific benefits, we had to: (i) identify the pollutants associated with specific benefits; (ii) determine the costs of controlling specific pollutants; and (iii) develop a cost allocation approach. For determining control costs, the analysis does not apply social cost estimates. Instead, we apply the same direct compliance (engineering) cost estimates used in constructing the "dollar per unit of reduced pollutant" metric for determination of control costs associated with a specific pollutant.[3] We focus on the Recommended MACT Standard in the cost-effectiveness of benefits, because human health and ecological benefits do not vary significantly across MACT standards.

[3] Following this, all caveats regarding the cost methodology discussed in the dollar per unit of reduced pollutant are also relevant to this benefits cost-effectiveness analysis.

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Exhibit 8-2

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	-	-	\$1.9
	FLR to REC	\$ 25	-	\$532	-	-	-	-	\$2.0
	FLR to BTF-ACI	\$535	\$34,327	\$316	-	-	-	-	\$2.0
INC	Baseline to FLR	\$903	\$ 3,537	\$ 34	\$ 256	\$12.9	\$19.6	\$12.3	\$1.8
	FLR to REC	\$368	-	-	-	-	-	-	-
	FLR to BTF-ACI	\$762	\$ 24,594	-	-	-	-	-	-
CK	Baseline to FLR	\$898	\$6,274	\$ 67	\$4,234	\$ 7.1	-	\$ 3.3	\$3.8
	FLR to REC	-	-	\$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

We use a straightforward cost allocation approach in which the total costs by pollutant are assigned to each health or ecological effect associated with reduction of that pollutant. For example, cost-effectiveness for avoided severe health effects (e.g., premature mortality from exposure to particulates and cancer caused by dioxins and furans) is calculated as follows:

$$\textit{Cost-Effectiveness} = \frac{\textit{Cost of controlling pollutants associated with mortality risks}}{\textit{Number of avoided premature mortality and cancer cases}}$$

$$= \frac{\textit{Cost of PM control + Cost of D/F control + Cost of metals control}^{4}}{\textit{Number of avoided premature mortality and cancer cases}}$$

$$= \$47 \times 10^{6} \div 1.8 \text{ cases} = \$26.5 \text{ million per life saved.}$$

We calculate cost-effectiveness benefit figures for morbidity and ecological benefits similarly. That is, we use the total costs of control for each pollutant associated with the health or ecological effect. This approach tends to overstate costs for particular benefits. Other cost allocation schemes, however, can underestimate costs if a particular benefit is the only benefit of interest.

Results of Cost-Effectiveness per Unit Benefit Analysis

The primary health and ecological benefits of the HWC MACT standards are avoided premature mortality (cancer and non-cancer), reduced morbidity, and reduced pollution to aquatic and terrestrial ecosystems. We group the benefit cost-effectiveness measures into these categories (as shown in Exhibit 8-3). As explained in the approach section above, in isolation, these cost-effectiveness per unit benefit measures are somewhat deceptive because they apply the full costs of control (by pollutant) to a single type of benefit (e.g., lives saved). The cost per unit benefit measures are therefore overestimates and should only be used as relative measures for comparison across MACT options. Below, we summarize the results.

[4] The cost of metals control reflects controlling SVM and LVM emissions.

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- **Dollar per avoided case of premature mortality (cancer and non-cancer)[5]:** The HWC MACT standards result in an estimated cost per life saved of $26.5 million. This is significantly higher than most estimates of the value of a "statistical life" found in the economic valuation literature.[6] The costs associated with mortality benefits reflect control of carcinogenic emissions (dioxin, SVMs, and LVMs) and particulate matter (PM). Benefits are based on the total number of avoided cases of cancer and premature mortality due to moving from the baseline to the Recommended MACT Standard.

Exhibit 8-3

COST-EFFECTIVENESS PER UNIT HEALTH AND ECOLOGICAL IMPROVEMENT
(using unadjusted, maximum cost of control)

Benefit Type	Pollutant(s)	Cost of Control (Engineering Costs) (1996 dollars)	Benefit	Cost-Effectiveness (dollar per unit benefit)
Health Benefits				
Avoided Premature Mortality Cases	SVM, LVM, dioxin, PM	$47.7 million	1.8 cases	$26.5 million per life saved
Avoided Morbidity (PM)	PM	$23.6 million	287,400 cases	$85 per case
Avoided Morbidity (lead)	SVM	$6 million	2 cases	$3 million per case
Ecological Benefits				
Reduction in area of Land and Water Impacted	dioxin, mercury, lead	$14 million	349 km^2	$40,257 per sq. km.

Notes:
1. These cost-effectiveness per unit benefit measures are upper bound estimates that apply the full costs of control (by pollutant) to a single type of benefit (e.g., lives saved). The cost per unit benefit measures should not be reported in isolation from other benefit estimates; they should only be used as relative measures to compare across MACT standards.
2. All figures are incremental from the baseline to the Recommended MACT Final standards.
3. Mortality cases comprise fatal cancers and fatalities from exposure to particulate matter.
4. PM morbidity cases comprise hospital admissions from respiratory diseases, cases of chronic bronchitis and asthma, work loss days, and mild restricted activity days.
5. Morbidity cases associated with exposure to lead are cases in which children have blood lead levels above 10μg/dL.

[5] Although cancer may not be fatal in all cases, for the purposes of this assessment, we apply the value of statistical life estimates to avoided cancer cases.

[6] For more information on the value of a statistical life, see Chapter 6.

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- **Dollar per avoided case of morbidity:** Cost-effectiveness for PM control is calculated at $85 per benefit case. For PM, benefits represent the total number of avoided adverse health effects, work loss days, and restricted activity days estimated for the Recommended MACT Standard. Cost-effectiveness for lead control is $3 million per benefit case. For lead, benefits represent the number of children with blood lead levels reduced to below levels of concern (i.e., below 10μg/dL).

- **Dollars per ecological benefit:** Cost-effectiveness for ecological benefits is $40,260 per square kilometer of land and surface water that experience reductions in ecological hazard quotients to levels below concern (i.e., HQ<1).

Caveats and Limitations

Our method for calculating cost-effectiveness makes several simplifying assumptions. The two most important address the metrics employed for measuring cost-effectiveness and the actual methodology used to estimate the cost and emission reduction figures. The analysis used two separate metrics. For the majority of pollutants, the metric applied was a dollars per megagram of emissions reduced.[7] With the exception of dioxins/furans, the cost-effectiveness metrics do not incorporate any measure of relative toxicity or scaling to adjust to relative emissions levels. Consequently, comparisons of cost effectiveness across pollutants are somewhat misleading. For example, cost-effectiveness values for dioxins/furans average over half a million dollars per gram reduced. In contrast, cost-effectiveness values for total chlorine (TCl) average $2,300 per megagram reduced. The stark differences in cost-effectiveness performance would suggest that it is not cost-effective to regulate dioxins/furans. However, required emission reductions for dioxins/furans range between 1.96 and 19.45 grams, while TCl reductions range roughly between 182 and 2,672 megagrams. The differences in relative scale of reductions account for the differences in cost-effectiveness. Moreover, the relative toxicity of dioxins/furans to total chlorine is not reflected.

[7] The one exception being dioxins/furans (TEQ), which was measured in dollars per gram of emissions reduced.

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The second caveat to the cost-effectiveness analysis concerns the methodology for estimating cost and emission reductions for individual pollutants. The method assumes that all facilities continue operating and install pollution control equipment or implement feed reductions to comply with the MACT standards. As discussed in earlier chapters of this *Assessment,* a number of other responses to the MACT standards are possible. For example, some facilities may cease waste burning in the face of increased compliance costs. However, it is difficult to trace the overall effect that these reactions would have on either expenditures per pollutant or on total emissions of each pollutant. Beyond this broad caveat, other factors influence the cost-effectiveness estimates:

- The feed control costing approach may lead us to overstate expenditures per pollutant. Feed control costs are upper-bound costs based on pollution control equipment and/or design, operation, and maintenance of existing pollution control equipment. Combustion facilities may in fact be able to implement waste feed control at lower cost.

- Costs are currently apportioned according to the percentage reduction required to meet the standard for each pollutant controlled by the device. While the approach chosen is reasonable, it does not take engineering/technological issues such as the relative ease with which a device can control one pollutant versus another into account.

- Finally, the assumption that units control emissions to the 70 percent design level may lead us to overstate emissions because some combustion facilities report design levels as low as 30 percent.

COST-BENEFIT COMPARISON

A comparison of the costs and benefits of the rule provides an assessment of its overall efficiency and impact on society. In this section, we compare the total social costs of the rule with the total monetized and non-monetized benefits of the rule. The total monetized benefits of the final standards and each option analyzed are summarized in Exhibit 8-4. As discussed in Chapter 6, monetized benefits represent only a subset of potential avoided health effects, both cancer and non-cancer cases. In comparison, the total social costs of the rule are provided in Exhibit 8-5. These cost ranges represent market- and non-market adjusted scenarios to bound the costs of the rule. Social costs also include government administrative costs.

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Exhibit 8-4

TOTAL MONETIZED HEALTH BENEFITS
(millions of 1996 dollars)

Combustion Sector	MACT STANDARD		
	Floor	**Recommended**	**BTF-ACI**
Cement Kilns	$0.51 ($0.46 - $0.61)	$0.51 ($0.46 - $0.61)	$0.62 ($0.46 - $0.93)
LWAKs	$0.04	$0.38 ($0.85 $1.01)	$0.38 ($0.85 $1.01)
Incinerators (on-site and commercial)	$27.44 ($19.60 - $43.92)	$28.45 ($19.73 - $46.79)	$28.56 ($19.74 - $47.10)
Total Monetized Benefits	**$28 ($20 - $44)**	**$29 ($21 - $48)**	**$30 ($21 - $49)**

Note: Figures may not add due to rounding.

Across all MACT regulatory scenarios, costs exceed monetized benefits more than two-fold. For the BTF-ACI MACT Standard, costs are more than four 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.

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Exhibit 8-5

TOTAL SOCIAL COSTS
(millions of 1996 dollars)

	MACT STANDARD		
Combustion Sector	**Floor**	**Recommended**	**BTF-ACI**
Cement Kilns	$21 ($21 - $30)	$25 ($25 - $32)	$34 ($34 - $43)
LWAKs	$4 ($4 - $6)	$5 ($5 - $7)	$7
Incinerators (on-site and commercial)	$33 ($33 - $39)	$34 ($34 - $39)	$83 ($83 - $90)
Output Adjustment Costs	$8	$8	$8
Government Costs	$300,000	$300,000	$300,000
Total Social Costs	**$65** **($65 - $82)**	**$73** **($72 - $86)**	**$132** **($131 - $142)**

Notes:
1. Figures may not add due to rounding.
2. Best estimates are based on 70% engineering design levels.
3. These figures do not include PM CEM costs.

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