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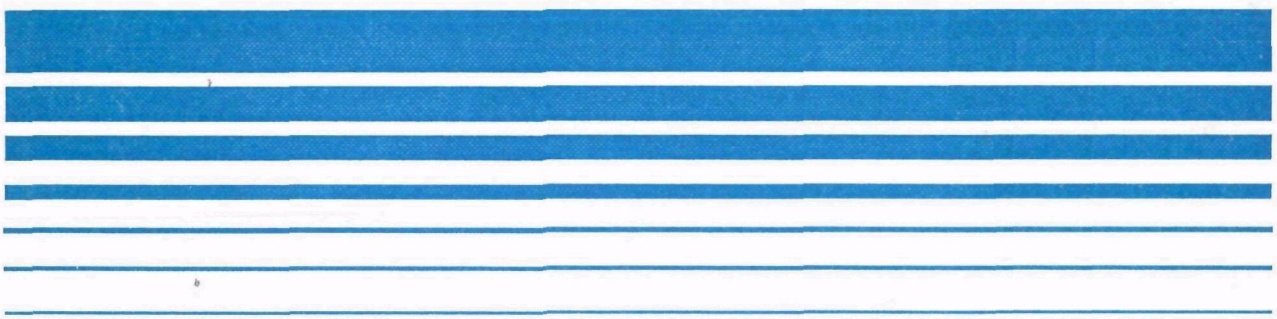
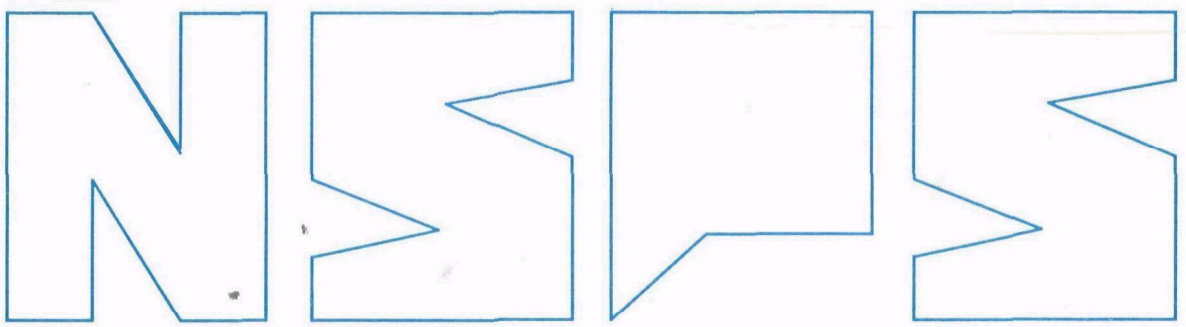
Air Pollutant Emission Standards and Guidelines for Municipal Waste Combustors: Revision and Update of Economic Impact Analysis and Regulatory Impact Analysis





EPA-450/3-91-003

Air Pollutant Emission Standards and Guidelines for Municipal Waste Combustors:

Revision and Update of Economic Impact Analysis and Regulatory Impact Analysis

Emission Standards Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina

November 1990

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NOTICE: This report addresses air pollutant emission standards and guidelines for municipal waste combustor (MWC) plants that have design capacities (aggregated over all combustors at each site) to combust 35 or more Mg of municipal solid waste per day. Subsequent to the analysis, the U.S. Congress passed the Clean Air Act Amendments of 1990. The Amendments distinguish between MWC units (individual combustors) with capacities greater than 225 Mg per day, and those smaller, without regard to aggregate plant capacity. Pursuant to the intent of the Amendments, EPA modified the emission standards and guidelines so that they pertain only to MWC units greater than 225 Mg per day in capacity. This action removes from the purview of the standards and guidelines about 15 percent of the total national combustion capacity analyzed in this report. Consequently, most impact estimates in this report (national costs, emission reductions, etc.) are higher than is likely to be the case. The Preambles to the promulgated standards and guidelines contain revised impact estimates. (See Docket A-89-08, entry IV-B-23 for an explanation of the revised impact estimates.)

The Amendments direct EPA to promulgate standards and guidelines for MWC units with capacities greater than 225 Mg per day now, supplementary standards and guidelines for these same units within one year, and standards and guidelines for MWC units with capacities equal to or less than 225 Mg per day within two years. Most of the impact estimates in this report now serve as preliminary estimates for the complete set of standards and guidelines.

In addition to changing the lower size cutoff, EPA deleted the proposed materials separation requirements. EPA no longer anticipates that such requirements will be a part of the complete set of standards and guidelines. In this report all discussion and impact estimates associated with the initially-proposed materials separation requirements are separable, and should be disregarded.

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CONVERSIONS AND DEFINITIONS

This report uses metric units, as well as acronyms and terms that may not be familiar to all readers. Following is a short guide to conversions and definitions for a selection of the units, acronyms, and terms.

CONVERSIONS

To Approximate	As	Multiply by	Examples from Text
Mg (megagram)	Ton (2,000 lb)	1.1025	35 Mg ≈ 39 tons 225 Mg ≈ 250 tons
g/dscm (grams/dry standard cubic meter)	gr/dscf (grains/dry standard cubic foot)	0.44	0.02 g/dscm ≈ 0.01 gr/dscf 0.18 g/dscm ≈ 0.08 gr/dscf
TJ (terajoule)	10^6Btu (million British Thermal Units)	948	8.54 TJ ≈ 8,100 10^6Btu 34.2 TJ ≈ 32,400 10^6Btu
TJ (terajoule)	MWh (megawatt hours)	278	4.32 TJ ≈ 1,200 MWh 13 TJ ≈ 3,600 MWh

OTHER MEASURES

dscm	Dry standard cubic meter
ng	Nanogram–one billionth of a gram
Nm^3	Normal cubic meter (A normal cubic meter is at 0°C, while a standard cubic meter is at 20°C; both at 1 atmosphere of pressure.)
mg	Milligram–one thousandth of a gram
ppmv	Parts per million by volume
10^3; 10^6	Thousands; Millions

POLLUTANTS

CDD/CDF	Polychlorinated dibenzo-*p*-dioxins and dibenzofurans
CO	Carbon monoxide
HCl	Hydrogen chloride
NO_x	Nitrogen oxides
Pb	Lead
PM	Particulate matter
SO_2	Sulfur dioxide

GENERAL ACRONYMS

APCD	Air pollution control device
FBC	Fluidized bed combustion
MSW	Municipal solid waste
MWC	Municipal waste combustor
RDF	Refuse-derived fuel

ECONOMIC TERMS

National enterprise cost	The sum of the regulatory costs incurred by each MWC, discounted and annualized at market interest rates
National social cost	The sum of the regulatory costs incurred by each MWC, discounted and annualized at interest rates reflecting society's opportunity costs for capital and consumption
1987$	Constant (real) dollars at their fourth quarter 1987 value
Tipping fee	The charge for incinerating or landfilling MSW, usually $/Mg, imposed by MWCs or landfill operators on MSW collectors. Tipping fees, where they are charged, do not reflect the cost of collecting and transporting MSW to the disposal site and often fail to reflect the full cost of incineration or landfilling
Unit cost	The cost per Mg of waste combusted

REGULATORY AND LEGISLATIVE TERMS

Baseline	Conditions that would exist were there to be no new Clean Air Act §111(b) and (d) regulation of MWCs
Guidelines	Clean Air Act §111(d) emission standards for existing sources
Model plant	A hypothetical MWC representative of a class of MWCs; used to analyze impacts of regulation
NSPS	Clean Air Act §111(b) new source performance standards
RCRA	Resource Conservation and Recovery Act
RFA	Regulatory Flexibility Act; also regulatory flexibility analysis, a study of the impact of regulations on small entities (businesses, governments, and organizations)
EIA	Economic Impact Analysis; Used to refer to the *Economic Impact of Air Pollutant Emission Standards for New Municipal Waste Combustors* (EPA, 1989b), *Economic Impact of Air Polutant Emission Guidelines for Existing Municipal Waste Combustors* (EPA, 1989a), or this report unless otherwise specified
RIA	Regulatory Impact Analysis; Used to refer to the *Regulatory Impact Analysis of Air Pollutant Emission Standards and Guidelines for Municipal Waste Combustors* (EPA, 1989f) unless otherwise specified
§111(b)	Clean Air Act section governing emission standards for new sources (NSPSs)
§111(d)	Clean Air Act section governing emission standards for existing sources
Subtitle D	RCRA subtitle governing sanitary landfills

ASSUMPTIONS AND CONVENTIONS

Myriad assumptions, analytical conventions, and underlying calculations form the basis for projecting the economic impacts of EPA regulations. This page summarizes the principal assumptions, conventions, and calculated values used in this report. Chapter 5 describes how projected impacts would be different if some of these assumptions, conventions, and values are changed.

- Effective date for the §111(b) NSPS and §111(d) Guidelines: December 20, 1990
- Affected MWCs:
  - NSPS: MWCs over 35 Mg per day capacity placed under construction on or after the effective date
  - Guidelines: MWCs over 35 Mg per day capacity placed under construction before the effective date
- Lifetimes of physical facilities:
  - Planned MWCs: 30 years after incurring initial compliance costs
  - Existing MWCs: Depending on age of MWC, 15 or 30 years after incurring initial compliance costs
  - APCDs: 15 years
- % utilization of daily capacity (There are some exceptions. These percents remain constant over time.):
  - Mass burn: 84.7%
  - RDF and FBC: 82.7%
  - Modular: 81.7%
- Monetary units: Constant (real) 1987 dollars, usually for the 4th quarter
- Capital costs for each MWC and APCD:
  - Incurred only at the outset of operation of the MWC or APCD
  - Amortized over the lifetime of the MWC or APCD when included in annualized costs
- Annual operating costs and revenues for each MWC or APCD:
  - Invariant over the lifetime of the MWC or APCD
  - Proportional to MWC capacity utilization (for analysis purposes when alternative capacity utilization rates are introduced)
- Materials separation costs: negligible
- Market discount rates for computing accounting costs:
  - 8% real WACC for private MWCs
  - 4% real municipal revenue bond rate of interest for public MWCs
- Social discount rates for computing social costs:
  - 10% for capital costs
  - 3% for operating costs

CHAPTER 1
INTRODUCTION AND SUMMARY

The U.S. Environmental Protection Agency (EPA) proposed New Source Performance Standards (NSPS) and Guidelines for air emissions from new and existing municipal waste combustors (MWCs) on December 20, 1989. Subsequent to proposal, EPA made several changes in the requirements of the regulation in response to new technical information and to public comments by MWC owners and operators, government officials, vendors of plants and equipment, and other interested parties. This report presents the revised and updated economic impacts of the NSPS and Guidelines prepared for promulgation.

Three reports published prior to the proposal date contain much of the background information pertinent to this update. In August of 1989, EPA published the *Economic Impact of Air Pollutant Emission Standards for New Municipal Waste Combustors* (EPA, 1989b) and the *Economic Impact of Air Pollutant Emission Guidelines for Existing Municipal Waste Combustors* (EPA, 1989a). These economic impact analysis (EIA) reports present the economic impacts of five regulatory alternatives considered for proposal. In addition, EPA published the *Regulatory Impact Analysis of Air Pollutant Emission Standards and Guidelines for Municipal Waste Combustors* (EPA, 1989f). The regulatory impact analysis (RIA) combined the findings of the EIA reports with other analyses of the proposed regulation. This report updates elements of the three reports cited above and incorporates the impacts reported in the *Air Pollutant Emissions Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a).

1.1 BACKGROUND INFORMATION

Chapter 2 contains background information regarding the affected waste flows, the characteristics of planned and existing model plants, the economic impact scenarios used to estimate impacts for this analysis, and the requirements of the regulation to be promulgated. Based on data reported in the *Characterization of Municipal Solid Waste in the United States: 1990 Update* (EPA, 1990b), this report presents revised waste flow projections for landfilling and materials recovery. Because the projected waste flow to combustion reported in the *Characterization of Municipal Solid Waste in the United States: 1990 Update* approximates the projected waste flow to combustors used in the 1989 EIA and RIA reports, the projected waste flow to combustors has not been revised for this update.

For plants subject to NSPS, the emission reduction requirements apply to MWCs placed under construction after December 20, 1989, and above the 35 Mg per day cutoff. For plants subject to Guidelines, the emission reduction requirements apply to MWCs operating or under construction before December 20, 1989, and above the 35 Mg per day cutoff. Facilities affected by the materials separation requirement are those plants over 100 Mg per day excluding existing plants located in states with 25 percent mandatory recycling requirements.

A model plant approach is used to estimate economic impacts. Characteristics of these "representative" plants, including a revised size classification for plants subject to Guidelines, are presented in Chapter 2. With the exception of the change in size classification, the model plants used for this analysis are identical to those used in the earlier EIA and RIA reports.

Impacts are estimated under two economic impact scenarios similar to those used to estimate impacts in the 1989 EIA and RIA reports. In the first scenario, called the "No Substitution" Scenario, the impacts of the regulation are estimated under the assumption that MWC owners *do not* substitute other forms of waste disposal for combustion in response to the regulation. This No Substitution Scenario is equivalent to Scenario I in the earlier EIA and RIA reports. Under the second scenario, called the "Substitution" Scenario, the impacts of the regulation are estimated under the assumption that MWC owners may substitute away from combustion in response to the regulation.[1] This Substitution Scenario is referred to as Scenario II for Guidelines and Scenario III for NSPS in the 1989 EIA and RIA reports.

Several changes in the requirements have occurred since proposal:

- a size cutoff for the emission reduction requirements,
- a size cutoff for the materials separation requirements,
- a new definition of the size classification for large and very large existing plants, and
- the addition of NO_x to the list of regulated pollutants.

These changes in the requirements of the regulation as well as others are outlined in Chapter 2.

1.2 IMPACTS OF THE REGULATION

Chapter 3 describes the methods and assumptions used to estimate the revised economic impacts, and Chapter 4 presents the results of the revised cost and emission impact analyses.

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[1] Some existing combustor facilities will be replaced even without the Guidelines. This change is also incorporated in the Substitution Scenario.

Impacts for planned and existing facilities are estimated at the model plant and the national level under both the No Substitution and Substitution Scenarios. Chapter 5 presents the results of a sensitivity analysis performed to estimate the impacts of using alternative estimates of materials separation costs and capacity utilization.

1.2.1 Cost Increases and Emission Reductions

Tables 1-1 and 1-2 present the national-level impacts of the regulation under two economic impact scenarios. The unit costs presented in this report, including national-level average compliance cost per Mg, are based on the waste combusted at facilities affected by the regulation. Total social costs are 1.7 to 2.5 times higher for existing facilities than for planned facilities. This difference in total cost is attributable to the higher estimated waste flow subject to Guidelines. Annualized social costs per Mg of waste combusted average 14 to 20 percent lower for existing facilities than for planned facilities reflecting the less stringent requirements for MWCs subject to Guidelines.

In addition to cost impacts, the national emission reductions and national energy impacts due to the regulation are estimated. These impacts do not include any change in emissions or energy usage due to the materials separation requirements. The estimates of emission reductions include the new pollutant, NO_x, covered by the regulation.

TABLE 1-1. NSPS NATIONAL COST IMPACTS (1987 $)[a]

Scenario	Annualized Social Costs[b] (10^6/yr)	Annualized Social Costs per Mg MSW[b,d] ($/Mg)	Annualized Enterprise Costs[c] (10^6/yr)	Annualized Enterprise Costs per Mg MSW[c,d] ($/Mg)
No Substitution				
PM and Acid Gas control	168	11.20	145	9.69
NO_x control	26.7	1.79	22.3	1.49
Materials Separation[e]	negligible	negligible	negligible	negligible
Total	194	13.00	167	11.20
Substitution				
Total	107	13.50	91	11.50

[a] Costs are calculated using average capacity utilization based on the annual operating hours reported in Table 2-1. Costs calculated for higher capacity utilization are presented in Chapter 5. Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff for the emission reduction requirement. Plants under 35 Mg per day account for less than 1 percent of the waste flow to planned plants in this analysis.

[b] Annualized social costs are the sum of capital costs, annualized at *10 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[c] Annualized public enterprise costs are the sum of capital costs, annualized at *4 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[d] Computed by dividing the total annualized cost by the estimated annual waste combusted at MWC facilities affected by the regulation.

[e] Materials separation costs are assumed to be negligible (EPA, 1990c). Quantitative estimates of materials separation costs are presented for the sensitivity analysis discussed in Chapter 5.

TABLE 1-2. GUIDELINES NATIONAL COST IMPACTS (1987 $)[a]

Scenario	Annualized Social Costs[b] (10^6/yr)	Annualized Social Costs per Mg MSW[b,d] ($/Mg)	Annualized Enterprise Costs[c] (10^6/yr)	Annualized Enterprise Costs per Mg MSW[c,d] ($/Mg)
No Substitution				
GCP, PM, and Acid Gas control	328	11.20	272	9.27
Materials Separation[e]	negligible	negligible	negligible	negligible
Total	328	11.20	272	9.27
Substitution				
Total	265	10.40	222	8.69

[a] Costs are calculated using average capacity utilization based on annual operating hours reported in Table 2-2. Costs calculated for higher capacity utilization are presented in Chapter 5. Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff for the emission reduction requirements. Plants under 35 Mg per day account for less than 1 percent of the waste flow to existing plants in this analysis and represent only a portion of the actual population of existing plants under 35 Mg per day.

[b] Annualized social costs are the sum of capital costs, annualized at *10 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[c] Annualized public enterprise costs are the sum of capital costs, annualized at *4 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[d] Computed by dividing the total annualized cost by the estimated annual waste combusted at MWC facilities affected by the regulation.

[e] Materials separation costs are assumed to be negligible (EPA, 1990c). Quantitative estimates of materials separation costs are presented for the sensitivity analysis discussed in Chapter 5.

1.2.2 Sensitivity Analysis: Materials Separation Costs and High Capacity Utilization

Two estimates of materials separation costs based on costs presented in the *Air Pollutant Emissions Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a) are incorporated in the sensitivity analysis in Chapter 5. The estimate of materials separation costs referred to as materials separation 1 reflects a net cost savings. Assumptions used to estimate materials separation 1 result in revenues and avoided costs that exceed annualized capital and operating costs associated with materials separation. The estimate of materials separation costs referred to as materials separation 2 in this analysis reflects assumptions that result in costs rather than cost savings.

National-level cost impacts are estimated for both the No Substitution and Substitution Scenarios with these alternative estimates of materials separation. Under the No Substitution Scenario for planned plants affected by the regulation, estimated social costs are $154 million with materials separation 1 and $329 million with materials separation 2. This represents an estimated cost savings of $40.2 million with materials separation 1 and an estimated cost of $135 million with materials separation 2. Under the No Substitution Scenario for existing plants affected by the regulation, estimated social costs are $274 million with materials separation 1 and $551 million with materials separation 2 costs. This reflects an estimated cost savings of $53.9 million with materials separation 1 and an estimated cost of $223 million with materials separation 2.

The Substitution Scenario social costs for planned plants are $114 and $125 million with materials separation 1 and materials separation 2, respectively. For plants subject to Guidelines, estimated social costs are $219 million with materials separation 1 and $470 million with materials separation 2 under the Substitution Scenario.

Chapter 5 also provides an analysis of the sensitivity of costs to changes in capacity utilization. The impacts reported in Chapter 4 of this analysis are estimated using average capacity utilization reported in the *1988-89 Resource Recovery Yearbook* (Gould, 1988). Section 5.2, however, presents national costs and emission reductions calculated using higher capacity utilization reported in the *Municipal Waste Combustors—Background Information for Proposed Standards: 111(b) Model Plant Description and Costs of Control* (EPA, 1989d) and the *Municipal Waste Combustors—Background Information for Proposed Guidelines for Existing Facilities* (EPA, 1989c).

Cost impacts calculated using high capacity utilization averaged 2 to 4 percent lower than those calculated using average capacity utilization for both planned and existing facilities. Emission reductions at planned plants calculated using higher capacity utilization are identical to those calculated using average capacity utilization. For Guidelines plants, however, emission reductions estimated using higher capacity utilization are higher for some pollutants and lower for others. This is due to the change in the mix of facilities used to estimate these high capacity utilization impacts for existing plants.

1.3 SMALL FACILITY IMPACTS

The regulation includes a cutoff for very small facilities below 35 Mg per day capacity. There is, however, concern that small facilities above the cutoff may be more affected by the regulation than larger facilities. Chapter 6 presents a profile of small facilities including a description of the facility characteristics such as plant capacity and type of ownership as well as a discussion of the distribution of economic impacts on small facilities.

Chapter 7 examines the potential for, and possible magnitude of, substitution of small combustors (< 35 Mg per day) that are exempt from the emission standards for planned modular facilities.

1.3.1 Profile of Small Facilities: Ownership and Severity of Impacts

The analysis of impacts in Chapter 6 focuses on small MWCs with capacities between 35 and 90 Mg per day. There are 32 existing and 3 planned MWCs with design capacities between 35 and 90 Mg per day identified for this analysis. Of these, 17 percent are privately owned and 83 percent are publicly owned.

The requirements of the Regulatory Flexibility Act (RFA) are used to help structure the analysis of impacts on small facilities. Impacts on governments, private firms, and households are examined in Section 6.3 of this analysis. Small governments are defined in the RFA as those with a population of 50,000 or less, and small businesses are defined by the Small Business Association general size standard definition as those averaging $6 million or less in annual revenue over the most recent three fiscal years. Based on these size definitions, 26 facilities owned by small entities and 9 owned by large entities are identified for this analysis.

Three indexes are used to measure impacts on government entities. Under one of the three indexes, 14 of the 25 entities examined will likely suffer severe impacts due to the

regulation. Data were insufficient to determine whether severe impacts are indicated under the other two indexes of government impacts.

Six privately owned plants are identified for this analysis. Of these, three are owned by small firms and three by large firms. The impact of regulation on these private firms was calculated based on EPA guidance (1982) that impacts may be significant when the "compliance costs are greater than 5 percent of production cost." Because EPA guidance does not define production costs in this context, three definitions are discussed in this section. Compliance costs are estimated to range from 20 to 25 percent of production costs for planned plants and from 15 to 65 percent of production costs for existing plants based on the broadest definition of production costs.

Increased costs of waste disposal due to the regulation will likely be passed to the customers served by small MWCs. To estimate the additional burden on households associated with the regulation, two indexes are used. Under the first index impacts for 30 communities were calculated. Severe impacts are indicated for households in three communities using this index. Under Index 2, impacts for 28 communities were calculated. No severe impacts are indicated for households in this analysis using this measure.

As these measures of severity indicate, some of the small communities and small owners identified for this analysis will likely suffer severe impacts due to the regulation. EPA, however, has already taken measures to help mitigate impacts at small plants. Specific mitigation measures include

- a cutoff of 35 Mg per day for emission reduction requirements built into the regulatory structure,
- a cutoff of 100 Mg per day for materials separation requirements built into the regulatory structure,
- less stringent emission reduction requirements for small plants subject to the regulation, and
- latitude for states to make case-by-case judgments on schedule and stringency under the Guidelines.

1.3.2 Substitution Across the Small Size Cutoffs

Chapter 7 analyzes the possible impact of the Standards on substitution across the emissions size cutoff of 35 Mg per day. The finding of that analysis is that the cutoff provides a significant financial incentive for communities to revise plans for those combustors with

capacities less than approximately 100 Mg per day. This incentive ranges from $46 per Mg of waste combusted for facilities just larger than 35 Mg per day capacity down to $9 per Mg of waste combusted for facilities nearing 100 Mg per day capacity.

The quantitative analysis of substitution across the emissions cutoff results in such substitution for 11 planned facilities combusting approximately 335,000 Mg of waste annually. The communities making these substitutions are estimated to reduce the cost by just over $2 million dollars per year.

CHAPTER 2
BACKGROUND INFORMATION

2.1 BASELINE PROJECTIONS

Baseline projections of waste flows to MWCs, landfills, and materials recovery were developed in the Economic Impact Analyses and Regulatory Impact Analysis (EIA and RIA) reports (EPA, 1989a; EPA, 1989b; EPA, 1989f). To estimate those waste flows, data from Office of Solid Waste (OSW), Franklin Associates, Radian, Kidder-Peabody, GBB, and Frost & Sullivan were used. For this updated analysis, the estimates of total amount of waste generated, waste flows to materials recovery, and waste flows to landfilling are revised based on data contained in the *Characterization of Municipal Solid Waste in the U.S.: 1990 Update* (EPA, 1990b). The estimates of waste flows to combustion reported in the 1989 EIA and RIA reports are unchanged for this revised analysis. Figure 2-1 shows the revised baseline waste flows.

In the 1989 EIA and RIA reports, it was projected that waste flows to landfilling would remain unchanged at 188.1 million Mg per year from 1986 through 1996. The revised projection shows waste flows to landfills dropping from 120 million Mg in 1986 to 95 million Mg in 1996. There are two reasons for the differences in these projections. First, the earlier projection was based on the estimated waste flow to landfills in 1986 as reported in the *OSW Subtitle D Landfill Regulatory Impact Analysis* (Temple, Barker, and Sloan, Inc. et al., 1989), which includes some wastes that are not MSW by definition, such as small generator hazardous waste, construction wastes, and waste from industrial and commercial sources. The revised projection includes only waste defined as MSW. In addition, the projected growth rate used to calculate the earlier estimate of waste flows to landfills did not reflect shrinking landfill capacity in the U.S. The *OSW Subtitle D Landfill Regulatory Impact Analysis* (Temple, Barker, and Sloan, Inc. et al., 1989) projects that landfill capacity will be reduced to 45 percent of the 1986 level by 1996. The revised baseline waste flow projection for this report reflects this trend away from landfilling.

The earlier projection for recovery of MSW reflected recovery rates that changed very slowly or not at all. When such factors as state deposit laws and recycling laws, increasing costs of conventional waste disposal, the trend toward banning certain yard wastes in landfills, and increased public access to recovery options are accounted for, however, the projected materials recovery rate increases 159 percent over the period 1986 to 1996 (EPA, 1990b).

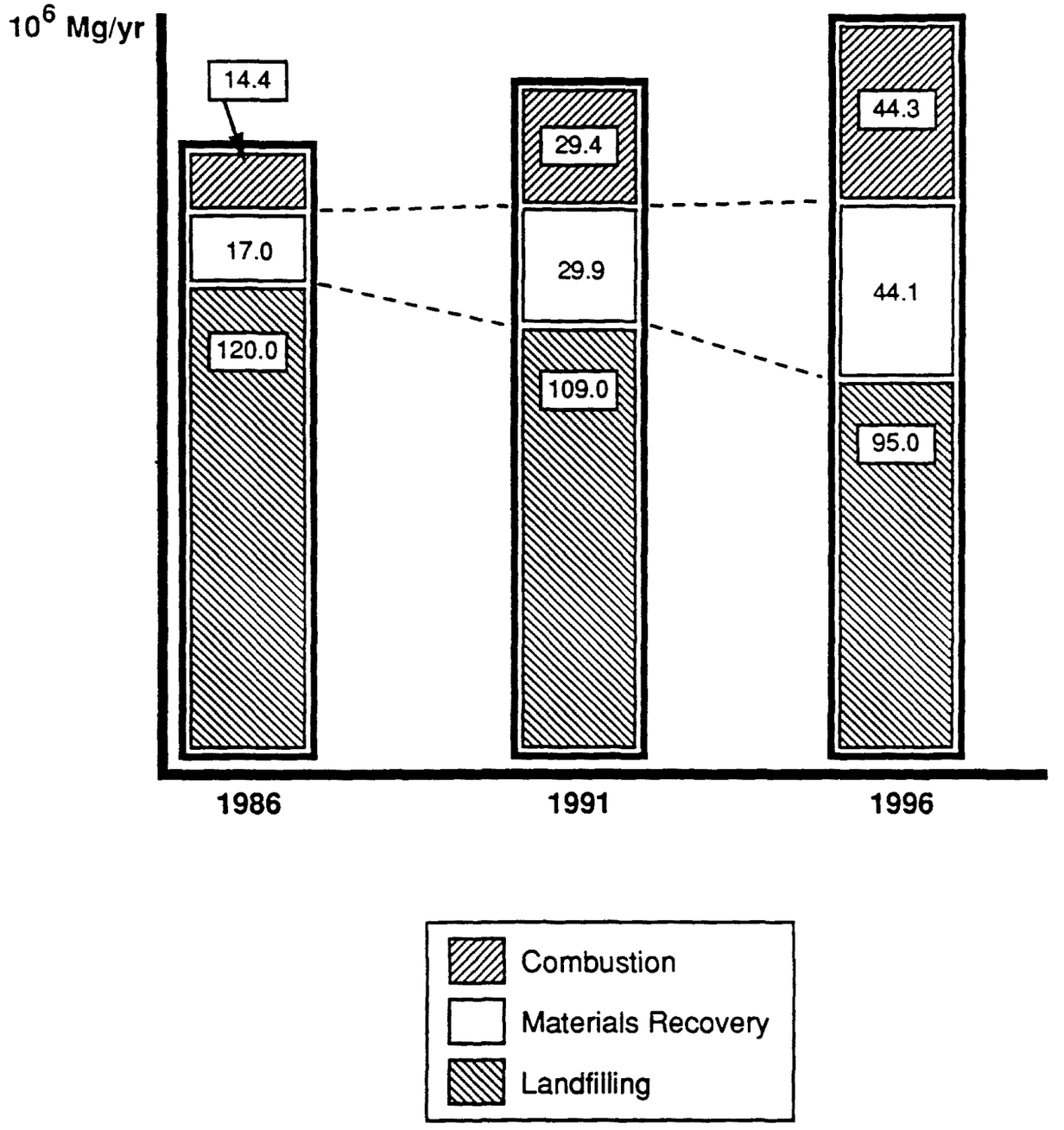


Figure 2-1. Solid Waste Flow Projections, 1986 through 1996

2.2 MODEL PLANT APPROACH

Representative MWCs called model plants are used to estimate the impacts of the regulation on MWCs nationwide. Tables 2-1 and 2-2 provide a list of the model plants and the corresponding capacity, size classification, energy recovery capability, and annual operating hours. This characterization of the model plants is identical to that used for the 1989 EIA and RIA reports with the exception of the size classification for the Guidelines model plants. All existing MWCs were classified as small or large for the 1989 EIA, and as small, large, or very large (over 2000 Mg per day capacity) for the 1989 RIA. For this updated analysis, existing MWCs over 1000 Mg per day capacity are classified as "very large." Emission requirements discussed in Section 2.4 are assigned to model plants according to the size classification.

2.3 SCENARIO APPROACH

It is difficult to predict how public and private decision makers constrained by institutional considerations will respond to the regulation. Faced with increased costs of waste disposal due to the regulation, decision makers may respond by making expensive modifications to existing MWCs, adding control equipment in their plans for new MWCs, or restructuring their entire waste management program. Because of the uncertainty surrounding the response to the regulation, two economic impact scenarios are examined.

Under the first scenario, called the "No Substitution" Scenario, it is assumed that decision makers make the necessary modifications to existing and planned MWCs to meet the requirements of the regulation with no substitution away from baseline MWCs. In other words, it is assumed that the amount of waste combusted at MWCs and the number of MWCs will remain constant. In the 1989 EIA and RIA this scenario is called Scenario I.

Impacts are estimated based on the assumption that MWC owners will respond to the regulation by employing APCD modification and establishing materials separation programs. In this scenario planned facilities are not downsized and capacity utilization at planned or existing facilities is unchanged. It is assumed that the increased waste flows to materials separation will result in a decrease in the amount of waste landfilled, not a decrease in the amount of waste combusted.

Under the second scenario, called the "Substitution" Scenario, decision makers may choose to substitute away from baseline MWCs to a more cost-effective waste disposal technology. Referred to as Scenario II in the 1989 EIA and RIA, the Guidelines Substitution Scenario reports the impact of replacing Guidelines MWC plants with new MWC plants based

TABLE 2-1. CHARACTERISTICS OF NSPS MODEL PLANTS

Model Plant Number	Abbreviated Term	Definition of Term	Model Plant Capacity (Mg/day)	Model Plant Size Category[a]	Energy Recovery	Annual Operating Hours
1	MB/WW (small)	Mass Burn/Waterwall (small)	180	S	steam	5,000
2	MB/WW (mid-size)	Mass Burn/Waterwall (mid-size)	730	L	electric	7,420
3	MB/WW (large)	Mass Burn/Waterwall (large)	2,040	L	electric	7,420
4	MB/REF	Mass Burn/Refractory Wall	450	L	electric	7,420
5	MB/RC	Mass Burn/Rotary Combustor	950	L	electric	7,420
6	RDF	Refuse Derived Fuel	1,810	L	electric	7,245
7	RDF/CF	Refuse Derived Fuel/Co-fired	1,810	L	electric	3,622
8	MOD/EA	Modular/Excess Air	220	S	electric	7,157
9	MOD/SA (small)	Modular/Starved Air (small)	45	S	none	5,000
10	MOD/SA (mid-size)	Modular/Starved Air (mid-size)	90	S	electric	7,157
11	FBC/CB	Fluidized Bed Combustion (Circulating Bed)	820	L	electric	7,271
12	FBC/BB	Fluidized Bed Combustion (Bubbling Bed)	820	L	electric	7,271

[a] Model Plants with design capacity less than or equal to 225 Mg per day are classified as small and plants with capacity greater than 225 Mg per day are classified as large. Specified control technologies (except materials separation) are assigned to model plants according to this size classification.

TABLE 2-2. CHARACTERISTICS OF GUIDELINES MODEL PLANTS

Model Plant Number	Abbreviated Term	Definition of Term	Model Plant Capacity (Mg/day)	Model Plant Size Category[a]	Energy Recovery	Annual Operating Hours
1	MB/REF/TG	Mass Burn/Refractory Wall/Travelling Grate	680	L	none	6,500
2	MB/REF/RG	Mass Burn/Refractory Wall/Rocking Grate	220	S	none	6,200
3	MB/REF/RK	Mass Burn/Refractory Wall/Rotary Kiln	820	L	none	7,420
4	MB/WW(large)	Mass Burn/Waterwall (large)	2,040	VL	electric	7,420
5	MB/WW(mid-size)	Mass Burn/Waterwall (mid-size)	980	L	electric	7,420
6	MB/WW(small)	Mass Burn/Waterwall (small)	180	S	electric	7,420
7	RDF (large)	Refuse Derived Fuel (large)	1,810	VL	electric	7,245
8	RDF (small)	Refuse Derived Fuel (small)	540	L	electric	7,245
9	MOD/SA/TR	Modular/Starved Air/TransferRams	140	S	steam	4,772
10	MOD/SA/G	Modular/Starved Air/Grates	45	S	none	6,500
11	MOD/EA	Modular/Excess Air	180	S	steam	7,157
12	MB/RWW	Mass Burn/Rotary Waterwall	450	L	electric	7,420
13	TRANS MOD/EA	Transitional Modular/Excess Air	380	L	electric	7,157
14	TRANS MB/WW	Transitional Mass Burn/Waterwall	180	S	electric	7,420
15	TRANS RDF (large)	Transitional Refuse Derived Fuel (large)	1,810	VL	electric	7,245
16	TRANS RDF (small)	Transitional Refuse Derived Fuel (small)	540	L	electric	7,245
17	TRANS MB/RWW	Transitional Mass Burn/Rotary Waterwall	450	L	electric	7,420

[a] Model Plants with design capacity less than or equal to 225 Mg per day are classified as small, plants with capacity greater than 225 and less than or equal to 1,000 Mg per day are classified as large, and plants with greater than 1,000 Mg per day capacity are classified as very large. Specified control technologies (except materials separation) are assigned to model plants according to this size classification.

on a cost-minimizing choice criterion. In the NSPS Substitution Scenario, the impact of substituting landfills or alternative MWCs for baseline MWCs, using a discrete choice model based on historical patterns of choice, is estimated. This scenario was referred to as Scenario III in the earlier analyses.

2.4 REQUIREMENTS OF THE REGULATION

In the 1989 EIA and RIA reports, five regulatory alternatives for the planned MWC plants and five regulatory alternatives for existing plants were presented. The proposed regulation appeared in the December 20, 1989, *Federal Register*. In response to comments by MWC owners and operators, equipment vendors, environmental organizations, government officials, and other interested individuals, several changes were made in the regulation including the addition of maximum emission limits for NO_x, a cutoff for very small plants, and changes in the size classification for existing plants. Table 2-3 outlines the maximum emission levels allowed for the various types of pollutants controlled under the regulation. The proposed materials separation requirements have also been revised to include a 100 Mg per day size cutoff.

2.4.1 Emission Reduction Requirements

The most significant change in the regulation since proposal involves a cutoff exempting very small facilities. The regulation as proposed in the *Federal Register* covered all existing and planned plants that burn MSW without regard to capacity, including medical waste incinerators (MWIs) that combust MSW. Because MWIs will be controlled under separate regulation now under consideration, however, EPA set a 35 Mg per day cutoff that exempts virtually all MWIs (over 7,000 units) (White, 1990b). This cutoff also exempts MWCs under 35 Mg per day from the emission requirements.

Despite the introduction of a size cutoff, the baseline waste combusted or number of plants subject to regulation has not been changed. Even though the profile of existing facilities does include a few MWCs below 35 Mg per day, these plants constitute less than one percent of baseline capacity. Furthermore, it is now believed that small MWCs with capacities between 35 and 100 Mg per day were underrepresented in the baseline data bases. Continued use of the original baseline compensates to some degree for this shortcoming. Very small MWCs between 25 and 35 Mg per day must submit a report to qualify for the exemption. Very small MWCs below 25 Mg per day capacity qualify without submitting a report.

TABLE 2-3. EMISSION REDUCTION REQUIREMENTS FOR MWC PLANTS SUBJECT TO NSPS AND GUIDELINES

	NSPS Small Plants (35 to 225 Mg/day)	NSPS Large Plants (> 225 Mg/day)	Guidelines Small Plants (35 to 225 Mg/day)	Guidelines Large Plants (225 to 1000 Mg/day)	Guidelines Very Large Plants (>1000 Mg/day)
Control Technology Basis	GCP DSI FF	GCP SD FF	GCP ESP	GCP DSI ESP	GCP SD ESP
Emission Limits					
CDD/CDF	75 ng/dscm	30 ng/dscm	500 ng/dscm	125 ng/dscm (250 ng/dscm for RDF)	60 ng/dscm
CO	50 to 150 ppmv (Varies by technology)	50 to 150 ppmv (Varies by technology)	50 to 250 ppmv (Varies by technology)	50 to 250 ppmv (Varies by technology)	50 to 250 ppmv (Varies by technology)
PM	34 mg/dscm	34 mg/dscm	69 mg/dscm	69 mg/dscm	34 mg/dscm
SO_2	50% reduction or 30 ppmv	80% reduction or 30 ppmv	No Guidelines	50% reduction or 30 ppmv	70% reduction or 30 ppmv
HCl	80% reduction or 25 ppmv	95% reduction or 25 ppmv	No Guidelines	50% reduction or 25 ppmv	95% reduction or 25 ppmv
NO_x	No Standards	180 ppmv	No Guidelines	No Guidelines	No Guidelines

Key: good combustion practices (GCP), dry sorbent injection (DSI), fabric filter (FF), spray dryer (SD), electrostatic precipitator (ESP), polychlorinated dibenzo-*p*-dioxins and dibenzofurans (CDD/CDF), carbon monoxide (CO), particulate matter (PM), sulfur dioxide (SO_2), hydrogen chloride (HCl), nitrogen oxides (NO_x), nanograms (ng), dry standard cubic meter (dscm), parts per million by volume (ppmv), and milligrams (mg).

New Size Classification

Plants are subject to different levels of emission control depending on their size classification and the emission measure. Small plants between 35 and 225 Mg per day capacity are subject to less stringent emission reduction requirements than large or very large plants for selected emissions (see Table 2-3). Similarly, for selected emissions, large Guidelines MWCs with capacities between 225 and 1000 Mg per day are subject to less stringent emissions requirements than very large Guidelines MWCs with capacities greater than 1000 Mg per day. Estimates of economic impact are based on the control technologies that would achieve emission requirements for each plant size.

New Pollutant Included in Emission Requirements

This revised analysis includes a requirement covering NO_x emissions for NSPS plants. As shown in Table 2-3, NO_x requirements are included for large NSPS plants only.

2.4.2 Materials Separation Requirements

Materials separation requirements covering both Guidelines and NSPS plants are included in the MWC regulations and have been incorporated into this revised EIA and RIA. The materials separation requirements are summarized in Table 2-4 and apply only to MWCs with capacities greater than 100 Mg per day. In addition, the materials separation requirements have special provisions that relax these requirements somewhat for plants whose local markets for secondary materials do not develop as anticipated.

The materials separation component of the revised EIA and RIA is based on the cost analysis of materials separation programs contained in *Air Pollutant Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). Cost estimates derived from this report are applied to model plants with capacities greater than 100 Mg per day to obtain the cost components for the materials separation requirements used in Chapter 5 (Byrd, 1990).

TABLE 2-4. MATERIALS SEPARATION REQUIREMENTS FOR MWC PLANTS SUBJECT TO NSPS AND GUIDELINES

Plant Size (Mg per Day)	Materials Separation Requirements
0 to 100	None
Over 100	• Annual percent weight reduction (separation) requirement prior to combustion: – 15 percent reduction in MSW by 1993 or first year of MWC operation, – 20 percent reduction in MSW by 1994 or second year of MWC operation, and – 25 percent reduction in MSW by 1995 or third and subsequent years. • Credit is given for the separation of the following items: paper, metal, glass, plastic, household batteries, vehicle batteries, tires, used oil, household hazardous waste, and yard waste. • Credit for yard waste separation is limited to a maximum of 10 percent. • A program to remove lead-acid batteries from the MSW stream prior to combustion is required.

CHAPTER 3
METHODOLOGY USED TO CALCULATE IMPACTS OF THE REGULATION

3.1 METHODS USED TO CALCULATE THE NO SUBSTITUTION SCENARIO IMPACTS

Under the No Substitution Scenario, the cost of meeting the emission reduction requirements and the materials separation requirements for planned and existing facilities is calculated. Under this scenario, current and projected owners and operators of MWCs respond to the regulation by adopting the control equipment identified in Table 2-3 and current and projected owners and communities served by MWCs respond by implementing a materials separation program.

Under this scenario three basic assumptions are made regarding the affected waste flow, including the MSW combusted and the MSW diverted to a materials separation program:

1. Waste flows combusted do not change as communities implement separation programs in response to the regulation. In other words, there is no change in capacity utilization at existing plants and no downsizing of planned facilities.

2. Communities implement a materials separation program that ultimately results in 25 percent of the waste flow being diverted to a materials separation program.

3. The service area must be increased to account for the additional 25 percent of total waste processed due to materials separation.

Tables 3-1 and 3-2 contain the estimated number of plants (scaling factors), estimated MWC capacity, and estimated affected waste flow combusted for NSPS and Guidelines model plant categories, respectively.

The model plant costs and national-level costs associated with meeting the emission reduction requirements are calculated using the same methods and assumptions outlined in the 1989 EIA and RIA reports (EPA, 1989a; EPA, 1989b; EPA, 1989c). These costs are based on engineering cost estimates for model plants (EPA, 1989c; EPA, 1989d; White, 1990a; Soderberg, 1990) and include the cost of retrofitting existing plants or installing control equipment at new plants. Materials separation costs are assumed to be negligible for this analysis (EPA, 1990c). Compliance costs do not include any baseline cost of building or operating the plants. Using these input costs, the enterprise costs—the costs to the firm or entity that owns the MWC—and the social costs of the regulation are estimated.

TABLE 3-1. BASELINE SCALING FACTORS, PLANT CAPACITY, AND WASTE FLOW ESTIMATES FOR MWC PLANTS SUBJECT TO NSPS[a]

Model Plant Number	Model Plant Description	Individual Model Plant Capacity (Mg/day)	Scaling Factors[b]	National Capacity[c] (10^6 Mg/yr)	National Waste Flow[d] (10^6 Mg/yr)
1	MB/WW (small)	180	16.81	1.11	0.64
2	MB/WW (mid-size)	730	7.28	1.93	1.63
3	MB/WW (large)	2,040	8.49	6.33	5.36
4	MB/REF	450	3.24	0.54	0.45
5	MB/RC	950	3.24	1.12	0.95
6	RDF	1,810	5.39	3.57	2.95
7	RDF/CF	1,810	3.31	2.19	0.91
8	MOD/EA	220	3.35	0.27	0.22
9	MOD/SA (small)	45	1.80	0.03	0.02
10	MOD/SA (mid-size)	90	7.13	0.24	0.19
11	FBC/BB	820	2.06	0.61	0.51
12	FBC/CB	820	4.54	1.35	1.12
	TOTAL		66.64	19.29	14.95

[a] Details may not add to totals due to rounding.

[b] These scaling factors are based on the annual operating hours reported in Table 2-1, total projected waste flows subject to NSPS, and the distribution of MWCs reported in the *Municipal Waste Combustors—Background Information for Proposed Standards: 111(b) Model Plant Description and Costs of Control* (EPA, 1989d). These scaling factors are used to estimate the number of MWC plants subject to NSPS under the No Substitution Scenario.

[c] National capacity estimates are calculated based on model plant capacity, an assumed 365-day operating year, and model plant scaling factors reported in this table.

[d] Waste flow estimates are calculated based on the annual operating hours reported in Table 2-1 and the scaling factors presented in this table.

TABLE 3-2. BASELINE SCALING FACTORS, PLANT CAPACITY, AND WASTE FLOW ESTIMATES FOR MWC PLANTS SUBJECT TO EMISSION GUIDELINES[a]

Model Plant Number	Model Plant Description	Individual Model Plant Capacity (Mg/day)	Scaling Factors[b]	National Capacity[c] (10^6 Mg/yr)	National Waste Flow[d] (10^6 Mg/yr)
1	MB/REF/TG	680	5.53	1.37	1.02
2	MB/REF/RG	220	22.75	1.81	1.28
3	MB/REF/RK	820	4.78	1.42	1.21
4	MB/WW (large)	2,040	11.05	8.23	6.97
5	MB/WW (mid-size)	980	17.51	6.26	5.30
6	MB/WW (small)	180	9.30	0.62	0.52
7	RDF (large)	1,810	5.00	3.31	2.74
8	RDF (small)	540	14.10	2.80	2.32
9	MOD/SA/TR	140	19.56	0.97	0.53
10	MOD/SA/G	45	46.60	0.77	0.57
11	MOD/EA	180	8.38	0.55	0.45
12	MB/RWW	450	2.43	0.40	0.34
13	TRANS MOD/EA	380	2.11	0.29	0.24
14	TRANS MB/WW	180	2.91	0.19	0.16
15	TRANS RDF (large)	1,810	4.22	2.79	2.31
16	TRANS RDF (small)	540	2.64	0.53	0.43
17	TRANS MB/RWW	450	4.27	0.71	0.60
	Assigned		183.14	33.04	27.00
	Unassigned	—	15.93	2.84	2.35
	TOTAL		199.07	35.87	29.35

[a] Details may not add to totals due to rounding.

[b] These scaling factors are based on the annual operating hours reported in Table 2-2, total projected waste flows subject to Guidelines, and the distribution of MWCs reported in the *Municipal Waste Combustors—Background Information for Proposed Guidelines for Existing Facilities* (EPA, 1989c). These scaling factors are used to estimate the number of MWC plants subject to Guidelines under the No Substitution Scenario.

[c] National capacity estimates are calculated based on model plant capacity, an assumed 365-day operating year, and model plant scaling factors reported in this table.

[d] Waste flow estimates are calculated based on the annual operating hours reported in Table 2-2 and the scaling factors presented in this table.

Chapter 3 of the 1989 EIA reports presents a cash flow model for calculating the net present value of model plant costs and the parameters used to calculate these costs. These parameters include the discount rate, tax rate, rate of inflation, length of investment period, and depreciation method. For this update, these same parameters and assumptions are used to calculate annualized enterprise costs of meeting the emission reduction requirement. To compute annualized costs per Mg, the total control costs for the model plant are divided by the estimated amount of waste combusted per year at the model plant.

To calculate national-level costs, the costs for each model plant are multiplied by the corresponding "No Substitution" scaling factor (see Tables 3-1 and 3-2). The scaling factors are derived by dividing the estimated total waste combusted by plants in each model plant category by the waste combusted by each model plant. Scaling factors roughly estimate the number of plants represented by each model plant category. After multiplying the model plant cost by its corresponding scale factor, these scaled costs are then summed across all the model plant categories to compute national-level costs.

Table 3-2 shows that the national cost impacts for Guidelines plants include costs for plants in an unassigned technology category. These are plants that do not match well with a model plant category, size, and technology. An additional factor is used to adjust for this problem. This factor is calculated as the ratio of total plant capacity affected by the regulation, including the capacity represented by the unassigned technology, to the total affected capacity assigned to a model plant category. Using the resulting factor, 1.087, the final estimate of national costs is adjusted for existing plants. This factor reflects the implicit assumption that the average compliance cost per Mg of waste combusted is the same for the unassigned plants as that estimated for the assigned plants.

Estimates of national-level social costs are also presented. A different discounting procedure from that used in computing enterprise costs was used to compute social costs (EPA, 1989a). Although this measure does attempt to account for the difference between social and private rates of time preference, it is not quite an ideal estimate of social costs. In particular, these elements of social cost due to the regulation as a whole are missing from the No Substitution Scenario:

- credit for the substitution of other, now less costly, forms of waste disposal for combustion;

- credit for those MWCs that can already meet the emission requirements or that can do so using technical or management methods that are less expensive than those identified by EPA;

- credits for the health and welfare benefits of emission reductions due to the regulations;

- additions to cost for mandatory materials separation programs that require firms and households to devote additional time and resources to processing and storing wastes before collection;

- adjustment costs associated with shifting resources to meet the requirements of the regulations;

- additional administrative costs borne by government entities and private organizations associated with enforcing the regulations; and

- net credits or costs for increasing the size of the combustor service area.

3.2 METHODS USED TO CALCULATE THE SUBSTITUTION SCENARIO IMPACTS

The 1989 EIA and RIA reports (EPA, 1989a; EPA, 1989b; EPA, 1989f) contained a substitution scenario for existing and planned plants called Scenario II and Scenario III respectively. The methods used to calculate impacts under these substitution scenarios are described in detail in the 1989 EIA reports. With a few modifications the same descriptions apply to the substitution scenarios presented in this update of the EIA and RIA reports. The methods used to calculate impacts for planned MWCs have been modified to include the impact of downsizing plant capacity in response to the materials separation requirement. The methods used to calculate impacts for existing plants have been modified to exclude control costs attributable to so-called "baseline" substitution.

3.2.1 NSPS Substitution Scenario

For the NSPS Substitution Scenario, impacts are calculated under the assumption that projected owners of MWC plants may respond to the regulation by substituting one combustion technology for another or by substituting away from combustion to landfilling, resulting in fewe combustors being built. The steps outlined in order below are used to estimate impacts under th NSPS Substitution Scenario:

1. Compute baseline waste flow shares subject to disposal choice for each disposal technology including landfilling, mass burn combustion, modular combustion, RDF/FBC combustion, and materials separation.

2. Compute revised waste flow shares subject to disposal choice for combustion and materials separation assuming that MSW decision makers respond to the materials separation requirement by downsizing planned MWC plant capacity.

3. Compute the incremental change in waste flow shares subject to disposal choice in response to increased costs of combustion with the regulation.

4. Project the post-regulatory waste flow shares to each disposal technology keeping total waste flow constant.

5. Calculate Substitution Scenario model plant scaling factors, national capacity, and national waste flows based on the post-regulatory waste flow shares to combustion technologies and downsized model plant capacity.

6. Multiply the model plant impacts at downsized plants by the Substitution Scenario scaling factors to estimate national-level impacts.

Steps 3 through 6 are identical to those outlined in the 1989 EIA report (EPA, 1989b) describing the methods used to calculate Scenario III impacts. Steps 1 and 2 address the

modifications in methodology to account for downsizing planned MWCs in response to the materials separation requirement.

Table 3-3 reports the estimated baseline waste flows and waste flow shares subject to disposal choice before and after downsizing. In Step 1, the "before downsizing" waste flow shares subject to disposal choice are estimated. The combustion component of this total is based on the projected waste flow to planned MWCs reported in Table 3-1. Specifically, the total waste flow subject to disposal choice at mass burn facilities is estimated by summing the national-level waste flows to planned mass burn model plants. This method is repeated for modular and RDF/FBC facilities in turn. The landfilling and materials separation components of estimated waste flow subject to disposal choice are based on the difference between the respective 1991 waste flows and the respective 1996 projected waste flows reported in the *Characterization of Municipal Solid Waste in the United States: 1990 Update* (EPA, 1990b).

In Step 2, the "after downsizing" waste flows subject to disposal choice are estimated. Table 3-4 shows the revised capacity and waste flow projections for planned MWCs in each model plant category based on the estimated percent reduction in plant capacity reported in *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). No change in plant capacity is projected for model plants 9 and 10 because these plants are below the cutoff for the materials separation requirement. Based on these percentage reductions in plant capacity, it is estimated that 2.47 million Mg of waste is diverted from planned MWCs to materials separation in response to the regulation. In Table 3-3, 2.47 million Mg of MSW is subtracted from the "before downsizing" combustion total and added to the "before downsizing" materials separation total to compute the "after downsizing" waste flows. The waste flow to landfilling is unchanged.

In Step 3, the incremental change in waste flow shares is estimated as described in the 1989 EIA report using the Mathtech discrete choice model (Bentley and Spitz, 1989). First, the waste flow shares after the inclusion of Subtitle D Costs for landfills are estimated using the discrete choice model (see Table 3-5). These shares are the basis from which incremental changes in waste flow shares are calculated. Next, estimated costs of control at downsized mass burn, modular, and RDF/FBC MWCs are added to the model. This yields new estimates of waste flow shares to each of the combustion technologies as well as landfilling. Using these waste flow share estimates and the estimates reported in Table 3-5 (after inclusion of Subtitle D), incremental changes in the waste flows are estimated.

TABLE 3-3. ESTIMATED BASELINE WASTE FLOWS SUBJECT TO DISPOSAL CHOICE BY TECHNOLOGY

Technology	Before Downsizing		After Downsizing	
	10^6 Mg/yr	Share (%)	10^6 Mg/yr	Share (%)
Mass Burn	9.03	20.99	7.53	17.49
Modular	0.43	0.99	0.35	0.82
RDF/FBC	5.49	12.75	4.60	10.69
Landfill	13.84	32.16	13.84	32.16
Material Separation	14.25	33.11	16.72	38.84
TOTAL	43.05	100.00	43.05	100.00

TABLE 3-4. ESTIMATED DOWNSIZING OF NSPS MODEL PLANTS DUE TO THE MATERIALS SEPARATION REQUIREMENT

Model Plant Number	Model Plant Description	Model Plant Capacity Before Downsizing (Mg/day)	Estimated Percent Reduction in Plant Size (%)	Model Plant Capacity After Downsizing (Mg/day)
1	MB/WW (small)	180	18.01	150
2	MB/WW (mid-size)	730	16.26	610
3	MB/WW (large)	2,040	16.62	1,700
4	MB/REF	450	16.68	380
5	MB/RC	950	16.68	790
6	RDF	1,810	16.23	1,520
7	RDF/CF	1,810	16.31	1,520
8	MOD/EA	220	17.25	180
9	MOD/SA (small)	45	0[b]	45
10	MOD/SA (mid-size)	90	0[b]	90
11	FBC/BB	820	15.88	690
12	FBC/CB	820	15.88	690

[a] For an explanation of percent reduction in plant size see Table 3-4 in *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a).

[b] Model plants 9 and 10 are not downsized because plants below 100 mg per day capacity are not subject to materials separation requirements.

TABLE 3-5. WASTE FLOW SHARES ESTIMATED BY THE DISCRETE CHOICE MODEL[a]

Technology	Before Inclusion of Subtitle D Costs	After Inclusion of Subtitle D Costs[b]
Mass Burn	13.79%	16.34%
Modular	5.94%	6.91%
Refuse-Derived Fuel	8.02%	9.60%
Landfill	72.25%	67.15%
TOTAL	100.00%	100.00%

[a] See *A Model of the MSW Choice Decision* (Bentley and Spitz, 1989) for an explanation of the model used to estimate waste flow shares.

[b] Based on costs reported in the OSW Landfill RIA (Temple, Barker, and Sloan, Inc. et al., 1989).

In Step 4, the incremental waste flow changes are applied to the "after downsizing" shares reported in Table 3-3 to estimate the post-regulatory waste flows reported in Table 3-6. As indicated in the table, an additional adjustment is made to keep total waste flows subject to disposal choice constant.

Table 3-7 presents the Substitution Scenario model plant scaling factors and corresponding national capacity and national waste flows estimated in Step 5. To compute these scale factors, the total waste flow to a particular combustion technology reported in Table 3-6 is allocated to the NSPS model plants using that same technology. This allocation is made in proportion to the No Substitution waste flows to model plants using that combustion technology. For example, estimated post-regulatory waste flows to mass burn MWCs are 5.29 million Mg per year. There are 5 mass burn model plants. In the No Substitution Scenario, model plant 1 receives 7 percent of the waste flow processed at mass burn MWCs. Likewise, in the Substitution Scenario, model plant 1 receives 7 percent of the waste flow processed at mass burn facilities.

In Step 6, the scaling factors are used to calculate national level costs and emission reductions under the Substitution Scenario. The scaling factors are multiplied by model plant costs and emission reductions estimated for downsized facilities. These scaled impacts are then summed across all model plant categories to compute national totals.

3.2.2 Guidelines Substitution Scenario

The Guidelines Substitution Scenario estimates the impacts of the regulation under the assumption that MWC owners may respond to the regulation by substituting new MWC plants for existing ones based on a cost-minimizing criterion. In addition, it is assumed that existing plants are not downsized or operated at reduced capacity utilization in response to the materials separation requirement. Rather, it is assumed that the service area must be increased to account for the additional waste that must be collected to meet the materials separation requirement.

The methods used to describe Scenario II in the 1989 EIA report (EPA, 1989a) are identical to those used to calculate the Substitution Scenario impacts reported in this update with one exception. In the earlier report, control costs associated with meeting the NSPS at replacement plants were attributed to the Guidelines regardless of whether the substitution was due to normal baseline plant closure or the costs of the regulation. In this analysis, it is assumed

TABLE 3-6. ESTIMATED WASTE FLOWS SUBJECT TO DISPOSAL CHOICE BY TECHNOLOGY AND REGULATORY ALTERNATIVE (10^6 Mg/yr)

Technology	Baseline After Downsizing	Post-Regulatory
Before Adjustment for Constant Total Waste Flow		
Mass Burn	7.53	4.98
Modular	0.35	0.29
RDF/FBC	4.60	2.22
Landfill	13.84	16.28
Materials Separation	16.72	16.72
TOTAL	43.05	40.48
After Adjustment for Constant Total Waste Flow		
Mass Burn	7.53	5.29
Modular	0.35	0.30
RDF/FBC	4.60	2.36
Landfill	13.84	17.31
Materials Separation	16.72	17.78
TOTAL	43.05	43.05

TABLE 3-7. NATIONAL WASTE FLOWS AND SCALING FACTORS BY MODEL PLANT CATEGORY UNDER THE NSPS SUBSTITUTION SCENARIO[a]

Model Plant Number	Model Plant Description	Individual Model Plant Capacity (Mg/day)	Scaling Factors[b]	National Capacity[c] (10^6 Mg/yr)	National Waste Flow[d] (10^6 Mg/yr)
1	MB/WW (small)	150	11.81	0.64	0.37
2	MB/WW (mid-size)	610	5.12	1.13	0.96
3	MB/WW (large)	1,700	5.97	3.71	3.14
4	MB/REF	380	2.27	0.31	0.27
5	MB/RC	790	2.27	0.66	0.56
6	RDF	1,520	2.76	1.53	1.27
7	RDF/CF	1,520	1.70	0.94	0.39
8	MOD/EA	180	2.89	0.19	0.16
9	MOD/SA (small)	35	1.55	0.02	0.01
10	MOD/SA (mid-size)	75	6.14	0.17	0.14
11	FBC/BB	690	1.06	0.27	0.22
12	FBC/CB	690	2.33	0.58	0.48
	TOTAL		45.88	10.16	7.96

[a] Model plant capacity reflects downsizing. See Table 3-3 for estimated percent reduction in plant size due to downsizing.

[b] These scaling factors are used to estimate the number of MWC plants subject to NSPS under the substitution scenario.

[c] National capacity estimates are calculated based on model plant capacity, an assumed 365-day operating year, and model plant scaling factors reported in this table.

[d] Waste flow estimates are calculated based on the annual operating hours reported in Table 2-1 and the scaling factors presented in this table.

that control costs at new plants that substitute for existing MWCs in the baseline are included in the costs of NSPS. Only those costs associated with substitution beyond the baseline are attributed to the Guidelines.

Using a cost-minimizing criterion it is estimated that substitution in the baseline will occur for the three model plants listed in Table 3-8. No substitution beyond the baseline will occur. These model plants represent older less cost-effective MWCs. It is assumed that the existing plants represented by model plants 1, 2, and 3 would have been phased out and replaced by new plants without the regulation. Therefore, Guidelines Substitution Scenario impacts include costs and emission reductions for plants represented by model plants 4 through 17 only.

TABLE 3-8. GUIDELINES SUBSTITUTION SCENARIO: BASELINE SUBSTITUTION

Model Plant Number	Plant Capacity (Mg/day)	Cost per Mg/MSW ($/Mg)
Before Substitution in the Baseline: Model Plant Costs[a]		
1	680	46.40
2	220	63.30
3	820	36.20
After Substitution in the Baseline: New Plant Costs[b]		
1	680	22.90
2	220	51.60
3	820	25.80

[a] Baseline costs are computed from operating costs only.

[b] Baseline costs are computed from capital costs annualized over 30 years, with a real discount rate of 4 percent, plus operating costs.

CHAPTER 4
IMPACTS OF THE REGULATION

This chapter presents the model plant and national-level impacts of the regulation for NSPS and Guidelines facilities. For the national-level impacts, the "No Substitution" impacts as well as the "Substitution" impacts are presented. In addition, emission reductions and energy impacts due to the regulation are presented.

4.1 MODEL PLANT IMPACTS

Tables 4-1 and 4-2 show the annualized enterprise costs of the regulation for publicly owned model plants. For planned plants subject to NSPS, estimated compliance costs per Mg combusted range from $8.83 to $47.40. Estimated compliance costs for existing plants range from $0 to $20.40 per Mg combusted.

Tables 4-3 and 4-4 present the annualized enterprise costs per Mg by MWC size classification for publicly owned planned and existing plants, respectively. The emission reduction requirements and the technology basis for each size classification are presented in Chapter 2, Table 2-3. For both planned and existing plants, small plants are subject to less stringent control than large plants. Under the Guidelines, large facilities are subject to less stringent control than very large facilities. However, the NSPS plants over 1,000 Mg per day capacity have the same requirements as those between 225 and 1,000 Mg per day capacity. There is no regulatory distinction between "large" and "very large" planned plants.

In absolute terms, the estimated costs of compliance are lower for smaller plants with less stringent requirements and higher for larger plants with more stringent requirements. The costs per Mg do not reflect this because the larger plants are able to spread these costs over a greater annual waste flow combusted.

Tables 4-5 and 4-6 present the baseline and post-regulatory enterprise costs for publicly owned NSPS and Guidelines model plants, respectively. These tables also report the percentage increase over the baseline associated with the post-regulatory costs. Post-regulatory costs range from 22.4 to 314 percent over the baseline for NSPS plants. Impacts range from 0 to 270 percent for Guidelines model plants.

4.2 NATIONAL-LEVEL IMPACTS

Tables 4-7 and 4-8 show the national-level costs for MWC plants subject to NSPS and Guidelines, respectively, under both the No Substitution and Substitution Scenarios. Under the No Substitution Scenario, total waste flow to existing plants is approximately 2 times the projected waste flow to planned plants. However, total annualized social cost for existing plants is only 1.7 times the total cost for planned MWCs because the requirements for planned facilities are more stringent and, therefore, more costly to implement than the requirements for existing plants. As a result, annualized social costs per Mg of waste combusted are about 14 percent lower for existing facilities ($11.20) than for planned facilities ($13.00) under the No Substitution Scenario.

Under the Substitution Scenario, the difference in total waste flow to planned versus existing facilities is even greater. Under this Scenario existing plants combust over 3 times as much waste as planned plants, while total annualized social costs for existing plants are less than 2.5 times the cost for planned plants. Annualized social costs per Mg combusted at existing plants are about 20 percent lower than costs per Mg at planned plants.

Under the No Substitution Scenario, annualized enterprise costs for planned MWCs average $11.20 per Mg combusted for plants subject to NSPS and $9.27 for plants subject to Guidelines. Based on a full pass-through of these estimated enterprise control costs by the MWC, this represents price impacts of 26 percent at NSPS plants and 22 percent at Guidelines plants (see Tables 4-9 and 4-10). Impacts under the Substitution Scenario are 27 percent for NSPS plants and 20 percent for Guidelines plants. An average tipping fee of $47.20 per Mg (Pettit, 1988) at MWC facilities was used as the basis for calculating price impacts.

Tables 4-11 and 4-12 present the baseline emissions and emission reductions for planned MWC plants subject to the NSPS and existing plants subject to the Guidelines, respectively. Tables 4-13 and 4-14 present the energy impacts incremental to the baseline for NSPS and Guidelines plants. These impacts do not reflect any emission reductions or energy impacts due to materials separation.

TABLE 4-1. ANNUALIZED ENTERPRISE COSTS OF CONTROL FOR PUBLICLY OWNED NSPS MODEL PLANTS (1987$)[a]

Model Plant Number	Model Plant Description	Model Plant Capacity (Mg/day)	Annualized Enterprise Compliance Costs (10^3/yr)[b]	Annualized Enterprise Compliance Costs ($/Mg)[c]
1	MB/WW (small)	180	639	16.90
2	MB/WW (mid-size)	730	2,720	12.10
3	MB/WW (large)	2,040	5,840	9.26
4	MB/REF	450	2,550	18.20
5	MB/RC	950	3,190	10.80
6	RDF	1,810	6,350	11.60
7	RDF/CF	1,810	3,850	14.10
8	MOD/EA	220	573	8.83
9	MOD/SA (small)	45	448	47.40
10	MOD/SA (mid-size)	90	460	17.00
11	FBC/BB	820	2,350	9.50
12	FBC/CB	820	2,350	9.50

[a] Control costs are costs over the baseline model plant costs. These costs are incurred to meet the requirements of the NSPS.

[b] Total annualized costs based on a 30-year plant life, 15-year APCD life, and a real discount rate of 4 percent.

[c] Computed by dividing total annualized cost by the estimated amount of MSW combusted per year at the model plant.

TABLE 4-2. ANNUALIZED ENTERPRISE COSTS OF CONTROL FOR PUBLICLY OWNED GUIDELINES MODEL PLANTS (1987$)[a]

Model Plant Number	Model Plant Description	Model Plant Capacity (Mg/day)	Annualized Enterprise Compliance Costs (10^3/yr)[b]	Annualized Enterprise Compliance Costs ($/Mg)[c]
1	MB/REF/TG	680	2,250	12.20
2	MB/REF/RG	220	987	17.60
3	MB/REF/RK	820	2,370	9.39
4	MB/WW(large)	2,040	5,180	8.22
5	MB/WW(mid-size)	980	2,270	7.51
6	MB/WW(small)	180	275	4.90
7	RDF (large)	1,810	5,520	10.10
8	RDF (small)	540	2,190	13.30
9	MOD/SA/TR	140	155	5.73
10	MOD/SA/G	45	250	20.40
11	MOD/EA	180	0	0.00
12	MB/RWW	450	1,280	9.11
13	TRANS MOD/EA	380	805	7.09
14	TRANS MB/WW	180	0	0.00
15	TRANS RDF (large)	1,810	4,000	7.30
16	TRANS RDF (small)	540	1,570	9.56
17	TRANS MB/RWW	450	1,290	9.17

[a] Control costs are costs over the baseline model plant costs. These costs are incurred to meet the requirements of the Guidelines.

[b] Total annualized costs based on a 15-year APCD life and a real discount rate of 4 percent.

[c] Computed by dividing total annualized cost by the estimated amount of MSW combusted per year at the model plant.

TABLE 4-3. ANNUALIZED ENTERPRISE COSTS OF CONTROL PER Mg MSW COMBUSTED FOR PUBLICLY OWNED NSPS MODEL PLANTS BY SIZE CLASSIFICATION (1987 $)[a]

	MWC Plant Capacity		
	Small— ≤ 225 Mg/day ($/Mg)	Large— 225-1000 Mg/day ($/Mg)	Very Large— > 1000 Mg/day ($/Mg)
Total	8.83 - 47.40	9.50 - 18.20	9.26 - 14.10

[a] Costs are calculated using average capacity utilization based on the annual operating hours reported in Table 2-1. Costs calculated on higher capacity utilization are presented in Chapter 5. Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff for the emission reduction requirement. Plants under 35 Mg per day account for less than 1 percent of the waste flow to planned plants in this analysis. Materials separation costs are assumed to be negligible (EPA, 1990c). Quantitative estimates of materials separation costs are presented for the sensitivity analysis discussed in Chapter 5.

TABLE 4-4. ANNUALIZED ENTERPRISE COSTS OF CONTROL PER Mg MSW COMBUSTED FOR PUBLICLY OWNED GUIDELINES MODEL PLANTS BY SIZE CLASSIFICATION (1987 $)[a]

	MWC Plant Capacity		
	Small— 35-225 Mg/day ($/Mg)	Large— 225-1,000 Mg/day ($/Mg)	Very Large— > 1,000 Mg/day ($/Mg)
Total	0.00 - 20.40	7.09 - 13.30	7.30 - 10.10

[a] Costs are calculated using average capacity utilization based on the annual operating hours reported in Table 2-2. Costs calculated on higher capacity utilization are presented in Chapter 5. Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff for the emission reduction requirement. Plants under 35 Mg per day account for less than 1 percent of the waste flow to planned plants in this analysis. Materials separation costs are assumed to be negligible (EPA, 1990c). Quantitative estimates of materials separation costs are presented for the sensitivity analysis discussed in Chapter 5.

TABLE 4-5. ANNUALIZED ENTERPRISE COSTS AND PERCENTAGE INCREASE IN COSTS FOR PUBLICLY OWNED NSPS MODEL PLANTS (1987$)[a]

Model Plant Number	Model Plant Description	Baseline Cost per Mg MSW[b] ($/Mg)	Post-Regulatory Cost per Mg MSW[c] ($/Mg)	Percentage Change over Baseline
1	MB/WW (small)	75.40	92.30	22.4
2	MB/WW (mid-size)	20.70	32.80	58.7
3	MB/WW (large)	9.40	18.70	98.6
4	MB/REF	44.00	62.20	41.4
5	MB/RC	21.30	32.10	50.9
6	RDF	3.69	15.30	314
7	RDF/CF	17.70	31.80	79.3
8	MOD/EA	30.50	39.30	29.0
9	MOD/SA (small)	54.20	102.00	87.4
10	MOD/SA (mid-size)	30.10	47.20	56.5
11	FBC/BB	13.20	22.70	72.3
12	FBC/CB	13.20	22.70	72.3

[a] Materials separation costs are assumed to be negligible (EPA, 1990c). Quantitative estimates of materials separation costs are presented for the sensitivity analysis discussed in Chapter 5.

[b] Baseline costs are computed from capital costs annualized over 30 years, with a real discount rate of 4 percent, plus operating costs.

[c] Post-regulatory costs are baseline costs plus the cost of control.

TABLE 4-6. ANNUALIZED ENTERPRISE COSTS AND PERCENTAGE INCREASE IN COSTS FOR PUBLICLY OWNED GUIDELINES MODEL PLANTS (1987$)[a]

Model Plant Number	Model Plant Description	Baseline Cost per Mg MSW[b] ($/Mg)	Post-Regulatory Cost per Mg MSW[c] ($/Mg)	Percentage Change over Baseline
1	MB/REF/TG	46.40	58.60	26.3
2	MB/REF/RG	63.30	80.90	27.7
3	MB/REF/RK	36.40	45.80	25.8
4	MB/WW(large)	-3.13	5.09	262
5	MB/WW(mid-size)	5.08	12.60	148
6	MB/WW(small)	24.40	29.30	20.1
7	RDF (large)	-19.70	-9.66	51.1
8	RDF (small)	-4.94	8.39	270
9	MOD/SA/TR	5.17	10.90	111
10	MOD/SA/G	23.80	44.10	85.6
11	MOD/EA	3.39	3.39	0
12	MB/RWW	10.50	19.60	87.1
13	TRANS MOD/EA	14.20	21.30	49.8
14	TRANS MB/WW	24.40	24.40	0
15	TRANS RDF (large)	14.20	21.50	51.4
16	TRANS RDF (small)	27.40	36.90	34.9
17	TRANS MB/RWW	10.50	19.60	87.8

[a] Materials separation costs are assumed to be negligible (EPA, 1990c). Quantitative estimates of materials separation costs are presented for the sensitivity analysis discussed in Chapter 5.

[b] Baseline costs are computed from operating costs only.

[c] Post-regulatory costs are baseline costs plus the cost of control.

TABLE 4-7. NSPS NATIONAL COST IMPACTS (1987 $)[a]

Scenario	Annualized Social Costs[b] (10^6/yr)	Annualized Social Costs per Mg MSW[b,d] ($/Mg)	Annualized Enterprise Costs[c] (10^6/yr)	Annualized Enterprise Costs per Mg MSW[c,d] ($/Mg)
No Substitution				
PM and Acid Gas control	168	11.20	145	9.69
NO_x control	26.7	1.79	22.3	1.49
Materials Separation[e]	negligible	negligible	negligible	negligible
Total	194	13.00	167	11.20
Substitution				
Total	107	13.50	91	11.50

[a] Costs are calculated using average capacity utilization based on the annual operating hours reported in Table 2-1. Costs calculated for higher capacity utilization are presented in Chapter 5. Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff for the emission reduction requirement. Plants under 35 Mg per day account for less than 1 percent of the waste flow to planned plants in this analysis.

[b] Annualized social costs are the sum of capital costs, annualized at *10 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[c] Annualized public enterprise costs are the sum of capital costs, annualized at *4 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[d] Computed by dividing the total annualized cost by the estimated annual waste combusted at MWC facilities affected by the regulation.

[e] Materials separation costs are assumed to be negligible (EPA, 1990c). Quantitative estimates of materials separation costs are presented for the sensitivity analysis discussed in Chapter 5.

TABLE 4-8. GUIDELINES NATIONAL COST IMPACTS (1987 $)[a]

Scenario	Annualized Social Costs[b] (10^6/yr)	Annualized Social Costs per Mg MSW[b,d] ($/Mg)	Annualized Enterprise Costs[c] (10^6/yr)	Annualized Enterprise Costs per Mg MSW[c,d] ($/Mg)
No Substitution				
GCP, PM, and Acid Gas control	328	11.20	272	9.27
Materials Separation[e]	negligible	negligible	negligible	negligible
Total	328	11.20	272	9.27
Substitution				
Total	265	10.40	222	8.69

[a] Costs are calculated using average capacity utilization based on annual operating hours reported in Table 2-2. Costs calculated for higher capacity utilization are presented in Chapter 5. Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff for the emission reduction requirements. Plants under 35 Mg per day account for less than 1 percent of the waste flow to existing plants in this analysis and represent only a portion of the actual population of existing plants under 35 Mg per day.

[b] Annualized social costs are the sum of capital costs, annualized at *10 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[c] Annualized public enterprise costs are the sum of capital costs, annualized at *4 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[d] Computed by dividing the total annualized cost by the estimated annual waste combusted at MWC facilities affected by the regulation.

[e] Materials separation costs are assumed to be negligible (EPA, 1990c). Quantitative estimates of materials separation costs are presented for the sensitivity analysis discussed in Chapter 5.

TABLE 4-9. PERCENTAGE PRICE INCREASES BASED ON FULL PASS-THROUGH OF ESTIMATED NSPS ENTERPRISE COSTS OF CONTROL PER Mg OF MUNICIPAL SOLID WASTE[a]

Scenario	Percentage Increase
No Substitution	26
Substitution	27

[a] Based on average resource recovery facility tipping fee for 1988 of $43.96 per Mg (Pettit, 1989), converted to last quarter 1987$ to an average $42.70 per Mg.

TABLE 4-10. PERCENTAGE PRICE INCREASES BASED ON FULL PASS-THROUGH OF ESTIMATED GUIDELINES ENTERPRISE COSTS OF CONTROL PER Mg OF MUNICIPAL SOLID WASTE[a]

Scenario	Percentage Increase
No Substitution	22
Substitution	20

[a] Based on average resource recovery facility tipping fee for 1988 of $43.96 per Mg (Pettit, 1989), converted to last quarter 1987$ to an average $42.70 per Mg.

TABLE 4-11. NSPS NATIONAL BASELINE EMISSIONS AND EMISSIONS REDUCTIONS (Mg per Yr)[a]

Scenario	CDD/CDF	CO	PM	SO_2	HCl	Pb	NO_x	Solid Waste Residuals[b]
No Substitution								
Baseline Emissions	0.031	5,470	7,540	42,000	49,300	127	27,700	3,700,000
Emissions Reductions from Baseline	0.030	0	5,270	36,400	47,200	123	9,340	-332,000
Percent Reductions from Baseline	97.8	0	69.8	86.7	95.8	97.5	33.7	-8.96
Substitution								
Baseline Emissions	0.015	2,810	4,076	21,700	26,200	71	14,700	2,680,000
Emissions Reductions from Baseline	0.014	0	2,870	18,700	25,100	69.4	4,920	-167,000
Percent Reductions from Baseline	97.5	0	70.5	86.0	95.6	97.6	33.4	-8.04

[a] Based on average capacity utilization reported in the *1988-89 Resource Recovery Yearbook* (Gould, 1988). The values reported here do not include any emission reduction due to materials separation. MWCs subject to NSPS are assumed to have GCP in the baseline.

[b] Includes bottom ash and fly ash with some residual quench water. Negative values reflect increases in ash emissions relative to the baseline.

KEY: polychlorinated dibenzo-*p*-dioxins and dibenzofurans (CDD/CDF), carbon monoxide (CO), particulate matter (PM), sulfur dioxide (SO_2), hydrogen chloride (HCl), lead (Pb), and nitrogen oxides (NO_x).

TABLE 4-12. GUIDELINES NATIONAL BASELINE EMISSIONS AND EMISSIONS REDUCTIONS (Mg per Yr)[a]

Scenario	CDD/CDF	CO	PM	SO_2	HCl	Pb	Solid Waste Residuals[b]
No Substitution							
Baseline Emissions	0.213	25,600	11,300	86,200	108,000	247	7,360,000
Emissions Reductions from Baseline	0.198	10,700	6,210	48,200	78,200	154	-214,000
Percent Reductions from Baseline	92.9	41.6	54.9	55.9	72.5	62.3	-2.91
Substitution							
Baseline Emissions	0.126	15,500	5,340	76,700	94,300	124	5,970,000
Emissions Reductions from Baseline	0.115	3,560	1,240	45,500	72,800	55.1	-446,000
Percent Reductions from Baseline	91.6	22.9	23.2	59.3	77.2	44.4	-7.47

[a] Based on average capacity utilization reported in the *1988-89 Resource Recovery Yearbook* (Gould, 1988). The values reported here do not include any emission reduction due to materials separation.

[b] Includes bottom ash and fly ash with some residual quench water. Negative values reflect increases in ash emissions relative to the baseline.

KEY: polychlorinated dibenzo-*p*-dioxins and dibenzofurans (CDD/CDF), carbon monoxide (CO), particulate matter (PM), sulfur dioxide (SO_2), hydrogen chloride (HCl), and lead (Pb).

TABLE 4-13. NSPS NATIONAL ENERGY IMPACTS[a]

Scenario	Electrical Use (Tj/yr)	Gas Use (Tj/yr)
No Substitution	951	0
Substitution	516	0

[a] Energy impacts for air pollution control equipment only.

TABLE 4-14. GUIDELINES NATIONAL ENERGY IMPACTS[a]

Scenario	Electrical Use (Tj/yr)	Gas Use (Tj/yr)
No Substitution	760	809
Substitution	698	31.7

[a] Energy impacts for air pollution control equipment only.

CHAPTER 5
SENSITIVITY ANALYSIS

In the 1989 EIA reports, a sensitivity analysis was performed to show how alternative views of discounting affect the estimated impacts of the regulation. Additionally, impacts calculated using a higher capacity utilization were reported in the earlier analysis. The purpose of the sensitivity analysis in this update is to show the effect of changing the assumptions related to materials separation costs and capacity utilization.

Impacts reported elsewhere in this report are calculated under the assumption that costs associated with the materials separation requirement are negligible (EPA, 1990c). Section 5.1 provides a sensitivity analysis of these results by presenting two alternative estimates of materials separation costs. Section 5.1.1 outlines the methods used to calculate materials separation costs. and Sections 5.1.2 and 5.1.3 present the model plant and national-level results of the sensitivity analysis for materials separation costs, respectively. Both the No Substitution Scenario impacts and the Substitution Scenario impacts are presented in Section 5.1.3.

Average capacity utilization estimates reported in the *1988-89 Resource Recovery Yearbook* (Gould, 1988) are used to calculate impacts reported throughout this report. Section 5.2 provides a sensitivity analysis using higher capacity utilization estimates to calculate national-level costs and emission reductions.

5.1 MATERIALS SEPARATION SENSITIVITY ANALYSIS

5.1.1 Methods Used to Calculate Costs of the Materials Separation Requirements

It is assumed that the costs of meeting the materials separation requirement vary with the municipality served by the MWC. The materials separation costs estimated for this sensitivity analysis are based on those reported in the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). There are, however, several differences in the methods used in the Materials Separation study and those used to estimate the costs of materials separation for this analysis. For example, the Materials Separation study uses a model community/model program approach rather than a model plant approach. The estimates of total waste flow and number of MWC plants affected by the regulation also differ between the two studies. Outlined below are the adjustments and methods used for this analysis.

Costs presented in the Materials Separation study vary by the type of materials separation program implemented and type of community served. The study presents 21 possible cost combinations resulting from seven model communities based on population and population density and three model programs based on the degree of curbside separation, the imposition of mandatory participation ordinances, the application of unit pricing incentives, and the type of post-collection processing.

Because of the uncertainty surrounding the type of separation program communities may choose to implement, the effect the regulation will have on secondary materials markets, and the variation in costs associated with landfilling and waste collection from community to community, two estimates of materials separation costs using differing assumptions were developed for the Materials Separation study. This effectively doubles the number of possible cost combinations. These parallel cost estimates are identified in this analysis as materials separation 1 and materials separation 2.

To estimate the materials separation 1 and materials separation 2 costs for the model plants used in this analysis, the model program costs associated with each planned and existing MWC facility in the Materials Separation study were identified (Byrd, 1990). Then the model plant number corresponding to each plant was identified. The inventory of 67 planned plants in the Materials Separation study is identical to the inventory used for this update. But the inventory of existing plants (and the estimated waste flow to these plants) is different from the inventory used for this update. This analysis includes approximately 200 existing plants, and the Materials Separation study identified 213 existing plants. A model plant number for 156 of the 213 plants was identified based on lists contained in the *Municipal Waste Combustors—Background Information for Proposed Guidelines for Existing Facilities* (EPA, 1989c). Of the remaining 57 plants, 24 are in the unassigned technology category (Radian, 1988) and 33 are not identified for the model plant analysis used to estimate impacts in the 1989 EIA and RIA reports and this update. Therefore, only cost data for the 156 plants were used for this analysis.

The components of the materials separation 1 and material separation 2 costs include annualized capital costs, annual operating costs, avoided landfill costs, avoided transportation costs, and materials recovery revenue. With the 67 planned plants and 156 existing plants, a weighted average cost per Mg of waste combusted was calculated for each model plant category using the formula below:

$$WAC_j = \frac{\left(\sum_i [(K_{ij} + C_{ij}) - (L_{ij} + Tr_{ij} + R_{ij})]\right)}{\left(\sum_i (Q_{ij})\right)}$$

where

ij = The i^{th} MWC plant in the j^{th} model plant category;

WAC_j = weighted average materials separation cost per Mg of waste combusted for the j^{th} model plant category;

K = annualized capital costs (Assumes a 4 percent discount rate for enterprise costs and a 10 percent discount rate for social costs. Length of investment period varies with the type of plant and equipment. These costs are the same for materials separation 1 and 2.);

C = annual operating costs (Assumes these costs are the same each year over the life of the MWC. Materials separation 1 costs are lower than materials separation 2 costs. See the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a) for an explanation of these costs.);

L = avoided landfill costs (based on $45.64 per Mg of waste diverted for materials separation 1 and $23.30 per Mg of waste diverted for materials separation 2);

Tr = avoided transportation costs (Avoided costs are higher in absolute value for materials separation 1 and lower for materials separation 2. See the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a) for an explanation of these costs.);

R = credits from the sale of recovered materials (Revenues are higher in absolute value for materials separation 1 and lower for materials separation 2. See the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a) for an explanation of these costs.); and

Q = the total amount of waste combusted per year at affected facilities.

Materials separation 1 and materials separation 2 costs per Mg are calculated in this way for each model plant category above the 100 Mg per day cutoff for materials separation. For those model plants below the cutoff, it is assumed that materials separation costs are zero. These weighted average costs per Mg are used to calculate the national-level materials separation costs for planned plants subject to NSPS and existing plants subject to Guidelines.

NSPS

For planned plants subject to NSPS, the weighted average cost per Mg is multiplied by the estimated annual waste combusted at the corresponding model plant to compute the annualized cost of materials separation for each model plant. Then the annualized model plant

cost is multiplied by its corresponding scaling factor and summed over all the model plant categories to compute NSPS national-level materials separation costs.

The scaling factors for the NSPS No Substitution Scenario are identical to those used for calculating impacts assuming negligible materials separation costs (see Tables 3-1 and 3-2). Consistent with the assumptions used to calculate impacts under the No Substitution Scenario, no change in the waste flow or number of MWCs is projected with the alternative estimates of materials separation costs.

For the NSPS Substitution Scenario, however, revised scaling factors are calculated for model plants using the steps outlined in Chapter 3. Control costs including materials separation 1 and materials separation 2 are inserted in the discrete choice model (Bentley and Spitz, 1989) to estimate incremental changes in the waste flow shares. Using these costs in the model results in a different projected waste flow share and, thus, a different incremental change in the waste flow than that computed using negligible (or zero) costs for materials separation. Table 5-1 reports the estimated waste flows to combustion, materials recovery, and landfilling with materials separation 1 and materials separation 2. The waste flow share to combustion is then used to calculate revised scaling factors using the method described in Chapter 3. Table 5-2 reports the scaling factors, national capacity, and national waste flows estimated using materials separation 1 and materials separation 2.

Guidelines

Model plant costs for existing plants subject to Guidelines are also computed by multiplying the weighted average cost per Mg by the estimated annual waste combusted at the corresponding model plant. The scaling factors reported in Table 3-2 are the basis for calculating national impacts under both the No Substitution and the Substitution Scenarios for Guidelines plants. Before multiplying the model plant annualized costs by the scaling factors, however, these scaling factors are adjusted to account for baseline recycling. It is estimated that combustors in states with baseline recycling—excluding plants under 100 Mg per day capacity—account for 37 percent of the waste flow to existing MWC plants (Byrd, 1990). Therefore, those existing plants in states with baseline recycling are excluded by multiplying the scaling factors in Table 3-2 by 63 percent (100 percent less 37 percent). It is assumed that the distribution of plant capacity and technology in states with recycling requirements is equivalent to the distribution of MWC capacity and technology nationwide.

TABLE 5-1. ESTIMATED WASTE FLOWS SUBJECT TO DISPOSAL CHOICE BY TECHNOLOGY (10^6 Mg/Yr): WITH MATERIALS SEPARATION 1 AND MATERIALS SEPARATION 2 COSTS

Technology	Baseline Including Subtitle D	Post-Regulatory with Materials Separation 1	Post-Regulatory with Materials Separation 2
Before Adjustment for Constant Total Waste Flow			
Mass Burn	7.53	5.74	3.40
Modular	0.35	0.44	0.22
RDF/FBC	4.60	3.42	1.71
Landfill	13.84	14.78	17.46
Materials Separation	16.72	16.72	16.72
TOTAL	43.05	41.11	39.51
After Adjustment for Constant Total Waste Flow			
Mass Burn	7.53	6.01	3.70
Modular	0.35	0.46	0.24
RDF/FBC	4.60	3.58	1.87
Landfill	13.84	15.48	19.02
Materials Separation	16.72	17.51	18.22
TOTAL	43.05	43.05	43.05

TABLE 5-2. NATIONAL WASTE FLOWS AND SCALING FACTORS BY MODEL PLANT CATEGORY UNDER THE NSPS SUBSTITUTION SCENARIO: WITH MATERIALS SEPARATION 1 AND MATERIALS SEPARATION 2 COSTS[a]

Model Plant Number	Model Plant Description	Individual Model Plant Capacity (Mg/day)	Scaling Factor[b]	National Capacity[c] (10^6 Mg/yr)	National Waste Flow[d] (10^6 Mg/yr)
With Materials Separation 1					
1	MB/WW (small)	150	16.81	13.42	0.52
2	MB/WW (mid-size)	610	7.28	5.81	1.37
3	MB/WW (large)	1,700	8.49	6.78	4.47
4	MB/REF	380	3.24	2.58	0.38
5	MB/RC	790	3.24	2.58	0.79
6	RDF	1,520	5.39	4.19	2.47
7	RDF/CF	1,520	3.31	2.58	0.76
8	MOD/EA	180	3.35	4.42	0.18
9	MOD/SA (small)	35	1.80	2.37	0.01
10	MOD/SA (mid-size)	75	7.13	9.39	0.16
11	FBC/BB	690	2.06	1.61	0.43
12	FBC/CB	690	4.54	3.54	0.94
	TOTAL		66.64	59.27	12.48
With Materials Separation 2					
1	MB/WW (small)	150	16.81	8.26	0.52
2	MB/WW (mid-size)	610	7.28	3.58	1.37
3	MB/WW (large)	1,700	8.49	4.17	4.47
4	MB/REF	380	3.24	1.59	0.38
5	MB/RC	790	3.24	1.59	0.79
6	RDF	1,520	5.39	2.18	2.47
7	RDF/CF	1,520	3.31	1.34	0.76
8	MOD/EA	180	3.35	2.32	0.18
9	MOD/SA (small)	35	1.80	1.24	0.01
10	MOD/SA (mid-size)	75	7.13	4.92	0.16
11	FBC/BB	690	2.06	0.84	0.43
12	FBC/CB	690	4.54	1.84	0.94
	TOTAL		66.64	33.87	12.48

[a] These scaling factors are used to estimate the number of MWC plants subject to NSPS under the substitution scenario.

[b] These scaling factors are based on the annual operating hours reported in Table 2-1, total projected waste flows subject to NSPS, and the distribution of MWCs reported in the *Municipal Waste Combustors—Background Information for Proposed Standards: 111(b) Model Plant Description and Costs of Control* (EPA, 1989d). These scaling factors are used to estimate the number of MWC plants subject to NSPS under the No Substitution Scenario.

[c] National capacity estimates are calculated based on model plant capacity, an assumed 365-day operating year, and model plant scaling factors reported in this table.

[d] Waste flow estimates are calculated based on the annual operating hours reported in Table 2-1 and the scaling factors presented in this table.

The emission reduction values do not reflect any impact due to materials separation requirements. Removing the target materials listed in Table 2-4 will likely have an impact on emission factors. Nevertheless, no change in these factors resulting from a change in the composition of waste combusted has been estimated. It should also be noted that the energy impacts, similarly, do not reflect any impacts due to a change in the composition of waste combusted.

5.1.2 Model Plant Impacts of the Materials Separation Requirements

Assumptions regarding materials recovery revenue, avoided landfill costs, and avoided transportation costs lead to an estimated cost savings for most model plant categories with materials separation 1. For materials separation 2, expenses outweigh avoided costs and revenues. Therefore, estimated impacts calculated using materials separation 1 and materials separation 2 bracket the impacts calculated using negligible costs for materials separation.

Tables 5-3 and 5-4 show the enterprise costs of the regulation for publicly owned model plants with materials separation 1 and materials separation 2 costs. For planned plants subject to NSPS, estimated compliance costs per Mg combusted range from $4.69 to $47.40 with materials separation 1 costs and from $16.90 to $47.40 with materials separation 2 costs. Estimated impacts for existing model plants with materials separation 1 costs range from negative $1.09 (reflecting cost savings due to materials recovery revenue) to $20.40 per Mg of waste combusted; and impacts using materials separation 2 costs range from $13.70 to $28.90 per Mg combusted. Tables 5-5 and 5-6 present the annualized enterprise costs per Mg by MWC size classification for publicly owned planned and existing plants, respectively. Costs per Mg for the small plants vary widely because this classification includes some plants with materials separation costs (those above the 100 Mg per day materials separation cutoff) and some with no materials separation costs (those below the cutoff).

Tables 5-7 and 5-8 present the NSPS baseline and post-regulatory enterprise costs for publicly owned model plants with materials separation 1 costs and materials separation 2 costs, respectively. These tables also report the percentage increase over the baseline associated with the post-regulatory costs. Post-regulatory costs, including materials separation 1 costs, range from 25.9 to 217 percent over the baseline. Impacts range from 44.1 to 542 percent with materials separation 2 costs.

Tables 5-9 and 5-10 present the cost impacts with materials separation 1 and 2 for publicly owned Guidelines model plants. Impacts range from 6.88 to 189 percent with materials separation 1 costs and from 44.3 to 569 percent with materials separation 2 costs.

TABLE 5-3. ANNUALIZED ENTERPRISE COSTS OF CONTROL FOR PUBLICLY OWNED NSPS MODEL PLANTS (1987$): WITH MATERIALS SEPARATION 1 AND MATERIALS SEPARATION 2 COSTS[a]

Model Plant Number	Model Plant Description	Model Plant Capacity (Mg/day)	Annualized Enterprise Compliance Costs (10^3/yr)[b, d]		Annualized Enterprise Compliance Costs ($/Mg)[b, c, d]	
			Including Materials Separation 1 Costs	Including Materials Separation 2 Costs	Including Materials Separation 1 Costs	Including Materials Separation 2 Costs
1	MB/WW (small)	180	737	1,260	19.50	33.30
2	MB/WW (mid-size)	730	1,760	4,460	7.83	19.90
3	MB/WW (large)	2,040	2,960	10,800	4.69	17.10
4	MB/REF	450	1,910	3,660	13.60	26.10
5	MB/RC	950	1,840	5,510	6.23	18.70
6	RDF	1,810	4,380	11,000	8.00	20.00
7	RDF/CF	1,810	3,260	4,910	11.90	18.00
8	MOD/EA	220	564	1,400	8.69	21.61
9	MOD/SA (small)	45	447	447	47.40	47.40
10	MOD/SA (mid-size)	90	460	460	17.00	17.00
11	FBC/BB	820	1,700	4,790	6.86	19.35
12	FBC/CB	820	1,380	4,180	5.57	16.90

[a] Control costs are costs over the baseline model plant costs. These costs are incurred to meet the requirements of the NSPS.

[b] Total annualized costs based on a 30-year plant life, 15-year APCD life, and a real discount rate of 4 percent.

[c] Computed by dividing total annualized cost by the estimated amount of MSW combusted per year at the model plant.

[d] For an explanation of the assumptions used to calculate materials separation 1 and 2, see the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). Materials separation costs do not include any allowance for costs to households that are required to separate wastes. These costs are net of landfill costs and transportation costs avoided because of separation, and include credit for the sale of materials recovered. The No Substitution costs do not include downsizing credits and were calculated based on the inventory of plants and projected waste combusted by MWCs reported in Table 3-1.

TABLE 5-4. ANNUALIZED ENTERPRISE COSTS OF CONTROL FOR PUBLICLY OWNED GUIDELINES MODEL PLANTS (1987$): WITH MATERIALS SEPARATION 1 AND MATERIALS SEPARATION 2 COSTS[a]

Model Plant Number	Model Plant Description	Model Plant Capacity (Mg/day)	Annualized Enterprise Compliance Costs (10^3/yr)[b, d]		Annualized Enterprise Compliance Costs ($/Mg)[b, c, d]	
			Including Materials Separation 1 Costs	Including Materials Separation 2 Costs	Including Materials Separation 1 Costs	Including Materials Separation 2 Costs
1	MB/REF/TG	680	1,610	3,790	8.74	20.50
2	MB/REF/RG	220	737	1,650	13.10	29.30
3	MB/REF/RK	820	632	7,300	2.51	28.90
4	MB/WW(large)	2,040	2,280	11,300	3.61	17.80
5	MB/WW(mid-size)	980	921	5,490	3.04	18.10
6	MB/WW(small)	180	506	1,430	9.03	25.50
7	RDF (large)	1,810	2,720	10,500	4.97	19.30
8	RDF (small)	540	1,540	3,960	9.37	24.10
9	MOD/SA/TR	140	245	675	9.07	25.00
10	MOD/SA/G	45	250	250	20.40	20.40
11	MOD/EA	180	-59.2	742	-1.09	13.70
12	MB/RWW	450	982	3,460	7.00	24.70
13	TRANS MOD/EA	380	602	2,310	5.30	20.30
14	TRANS MB/WW	180	232	1,160	4.13	20.60
15	TRANS RDF (large)	1,810	955	9,250	1.74	16.90
16	TRANS RDF (small)	540	394	3,270	2.40	19.90
17	TRANS MB/RWW	450	467	2,660	3.33	19.00

[a] Control costs are costs over the baseline model plant costs. These costs are incurred to meet the requirements of the Guidelines.

[b] Total annualized costs based on a 15-year APCD life and a real discount rate of 4 percent.

[c] Computed by dividing total annualized cost by the estimated amount of MSW processed per year at the model plant.

[d] For an explanation of the assumptions used to calculate materials separation 1 and 2, see the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). Materials separation costs do not include any allowance for costs to households that are required to separate wastes. These costs are net of landfill costs and transportation costs avoided because of separation, and include credit for the sale of materials recovered. The No Substitution costs were calculated based on the inventory of plants and projected waste flows reported in Table 3-2.

TABLE 5-5. ANNUALIZED ENTERPRISE COSTS OF CONTROL PER Mg FOR PUBLICLY OWNED NSPS MODEL PLANTS BY SIZE CLASSIFICATION (1987 $): WITH MATERIALS SEPARATION 1 AND MATERIALS SEPARATION 2 COSTS[a]

	MWC Plant Capacity		
	Small— ≤ 225 Mg/day ($/Mg)	Large— 225-1000 Mg/day ($/Mg)	Very Large— > 1000 Mg/day ($/Mg)
With Materials Separation[b] 1	8.69 - 47.40	5.57 - 13.60	4.69 - 11.90
With Materials Separation[b] 2	17.00 - 47.40	16.90 - 26.10	17.10 - 20.00

[a] Costs are calculated using average capacity utilization values reported in the *1988-89 Resource Recovery Yearbook* (Gould, 1988). Cost per Mg based on a real discount rate of 4 percent. Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff. Plants under 35 Mg per day account for less than 1 percent of the waste flow to planned plants in this analysis.

[b] For an explanation of the assumptions used to calculate materials separation 1 and 2, see the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). Materials separation costs do not include any allowance for costs to households that are required to separate wastes. These costs are net of landfill costs and transportation costs avoided because of separation, and include credit for the sale of materials recovered. The No Substitution costs do not include downsizing credits and were calculated based on the inventory of plants and projected waste combusted by MWCs reported in Table 3-1.

TABLE 5-6. ANNUALIZED ENTERPRISE COSTS OF CONTROL PER Mg FOR PUBLICLY OWNED GUIDELINES MODEL PLANTS BY SIZE CLASSIFICATION (1987 $): WITH MATERIALS SEPARATION 1 AND MATERIALS SEPARATION 2 COSTS[a]

	MWC Plant Capacity		
	Small— 35-225 Mg/day ($/Mg)	Large— 225-1,000 Mg/day ($/Mg)	Very Large— > 1,000 Mg/day ($/Mg)
With Materials Separation[b] 1	(1.09) - 20.40	2.40 - 9.37	1.74 - 4.97
With Materials Separation[b] 2	13.70 - 29.30	18.10 - 28.90	16.90 19.30

[a] Costs are calculated using average capacity utilization values reported in the *1988-89 Resource Recovery Yearbook* (Gould, 1988). Cost per Mg based on a real discount rate of 4 percent. Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff. Plants under 35 Mg per day account for less than 1 percent of the waste flow to existing plants in this analysis and represent only a portion of the actual population of existing plants under 35 Mg per day.

[b] For an explanation of the assumptions used to calculate materials separation 1 and 2, see the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). Materials separation costs do not include any allowance for costs to households that are required to separate wastes. These costs are net of landfill costs and transportation costs avoided because of separation, and include credit for the sale of materials recovered. The No Substitution costs were calculated based on the inventory of plants and projected waste flows reported in Table 3-2.

TABLE 5-7. ANNUALIZED ENTERPRISE COSTS AND PERCENTAGE INCREASE IN COSTS FOR PUBLICLY OWNED NSPS MODEL PLANTS (1987$): WITH MATERIALS SEPARATION 1 COSTS[a]

Model Plant #	Model Plant Description	Baseline Cost per Mg MSW[b] ($/Mg)	Post-Regulatory Cost per Mg MSW[c] ($/Mg)	Percentage Change over Baseline
1	MB/WW (small)	75.40	94.90	25.9
2	MB/WW (mid-size)	20.70	28.50	37.9
3	MB/WW (large)	9.40	14.10	49.9
4	MB/REF	44.00	57.60	30.9
5	MB/RC	21.30	27.50	29.4
6	RDF	3.69	11.70	217
7	RDF/CF	17.70	29.60	67.2
8	MOD/EA	30.50	39.10	28.6
9	MOD/SA (small)	50.20	102.00	87.4
10	MOD/SA (mid-size)	30.10	47.20	56.5
11	FBC/BB	13.20	20.00	52.2
12	FBC/CB	13.20	18.70	42.4

[a] For an explanation of the assumptions used to calculate materials separation 1, see the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). Materials separation costs do not include any allowance for costs to households that are required to separate wastes. These costs are net of landfill costs and transportation costs avoided because of separation, and include credit for the sale of materials recovered. The No Substitution costs do not include downsizing credits and were calculated based on the inventory of plants and projected waste combusted by MWCs reported in Table 3-1.

[b] Baseline costs are computed from capital costs annualized over 30 years, with a real discount rate of 4 percent, plus operating costs.

[c] Post-regulatory costs are baseline costs plus the cost of control.

TABLE 5-8. ANNUALIZED ENTERPRISE COSTS AND PERCENTAGE INCREASE IN COSTS FOR PUBLICLY OWNED NSPS MODEL PLANTS (1987$): WITH MATERIALS SEPARATION 2 COSTS[a]

Model Plant Number	Model Plant Description	Baseline Cost per Mg MSW[b] ($/Mg)	Post-Regulatory Cost per Mg MSW[c] ($/Mg)	Percentage Change over Baseline
1	MB/WW (small)	75.40	109.00	44.1
2	MB/WW (mid-size)	20.70	40.60	96.1
3	MB/WW (large)	9.40	26.50	182
4	MB/REF	44.00	70.00	59.3
5	MB/RC	21.30	40.00	88.1
6	RDF	3.69	23.70	542
7	RDF/CF	17.70	35.70	101
8	MOD/EA	30.50	52.10	71.0
9	MOD/SA (small)	50.20	102.00	87.4
10	MOD/SA (mid-size)	30.10	47.20	56.5
11	FBC/BB	13.20	32.50	147
12	FBC/CB	13.20	30.10	129

[a] For an explanation of the assumptions used to calculate materials separation 2, see the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). Materials separation costs do not include any allowance for costs to households that are required to separate wastes. These costs are net of landfill costs and transportation costs avoided because of separation, and include credit for the sale of materials recovered. The No Substitution costs do not include downsizing credits and were calculated based on the inventory of plants and projected waste combusted by MWCs reported in Table 3-1.

[b] Baseline costs are computed from capital costs annualized over 30 years, with a real discount rate of 4 percent, plus operating costs.

[c] Post-regulatory costs are baseline costs plus the cost of control.

TABLE 5-9. ANNUALIZED ENTERPRISE COSTS AND PERCENTAGE INCREASE IN COSTS FOR PUBLICLY OWNED GUIDELINES MODEL PLANTS (1987$): WITH MATERIALS SEPARATION 1 COSTS[a]

Model Plant #	Model Plant Description	Baseline Cost per Mg MSW[b] ($/Mg)	Post-Regulatory Cost per Mg MSW[c] ($/Mg)	Percentage Change over Baseline
1	MB/REF/TG	46.40	55.10	18.8
2	MB/REF/RG	63.30	76.40	20.7
3	MB/REF/RK	36.40	38.90	6.88
4	MB/WW(large)	-3.13	0.48	115
5	MB/WW(mid-size)	5.08	8.12	59.9
6	MB/WW(small)	24.40	33.40	37.0
7	RDF (large)	-19.70	-14.80	25.2
8	RDF (small)	-4.94	4.42	189
9	MOD/SA/TR	5.17	14.20	175
10	MOD/SA/G	23.80	44.10	85.6
11	MOD/EA	3.39	2.29	32.3
12	MB/RWW	10.50	17.50	67.0
13	TRANS MOD/EA	14.20	19.50	37.3
14	TRANS MB/WW	24.40	28.50	16.9
15	TRANS RDF (large)	14.20	16.00	12.3
16	TRANS RDF (small)	27.40	29.80	8.76
17	TRANS MB/RWW	10.50	13.80	31.9

[a] For an explanation of the assumptions used to calculate materials separation 1, see the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). Materials separation costs do not include any allowance for costs to households that are required to separate wastes. These costs are net of landfill costs and transportation costs avoided because of separation, and include credit for the sale of materials recovered. The No Substitution costs were calculated based on the inventory of plants and projected waste flows reported in Table 3-2.

[b] Baseline costs are computed from operating costs only.

[c] Post-regulatory costs are baseline costs plus the cost of control.

TABLE 5-10. ANNUALIZED ENTERPRISE COSTS AND PERCENTAGE INCREASE IN COSTS FOR PUBLICLY OWNED GUIDELINES MODEL PLANTS (1987$): WITH MATERIALS SEPARATION 2 COSTS[a]

Model Plant Number	Model Plant Description	Baseline Cost per Mg MSW[b] ($/Mg)	Post-Regulatory Cost per Mg MSW[c] ($/Mg)	Percentage Change over Baseline
1	MB/REF/TG	46.40	66.90	44.3
2	MB/REF/RG	63.30	92.60	46.2
3	MB/REF/RK	36.40	65.30	79.4
4	MB/WW(large)	-3.13	14.70	569
5	MB/WW(mid-size)	5.08	23.20	357
6	MB/WW(small)	24.40	49.90	105
7	RDF (large)	-19.70	-0.48	97.6
8	RDF (small)	-4.94	19.10	487
9	MOD/SA/TR	5.17	30.10	483
10	MOD/SA/G	23.80	44.10	85.6
11	MOD/EA	3.39	17.10	405
12	MB/RWW	10.50	35.10	236
13	TRANS MOD/EA	14.20	34.50	143
14	TRANS MB/WW	24.40	45.00	84.6
15	TRANS RDF (large)	14.20	31.10	119
16	TRANS RDF (small)	27.40	47.30	72.7
17	TRANS MB/RWW	10.50	29.40	181

[a] For an explanation of the assumptions used to calculate materials separation 2, see the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). Materials separation costs do not include any allowance for costs to households that are required to separate wastes. These costs are net of landfill costs and transportation costs avoided because of separation, and include credit for the sale of materials recovered. The No Substitution costs were calculated based on the inventory of plants and projected waste flows reported in Table 3-2.

[b] Baseline costs are computed from operating costs only.

[c] Costs of the regulation are baseline costs plus the cost of control.

5.1.3 National-Level Impacts of the Materials Separation Requirements

Tables 5-11 and 5-12 show the national-level costs for MWC plants subject to NSPS and Guidelines, respectively, under both the No Substitution and the Substitution Scenarios. Under the No Substitution Scenario, annualized social costs per Mg of waste combusted are about 21 percent lower for existing facilities ($8.19) than for planned facilities ($10.30) using materials separation 1 costs. Under the Substitution Scenario, average social costs per Mg combusted are about 33 percent higher for planned facilities than for existing facilities using materials separation 1 costs. Annualized social costs calculated using materials separation 2 estimates average $22 to $23 per Mg of waste combusted for both planned and existing plants under both economic impact scenarios.

Materials separation 1 annualized enterprise costs for planned MWCs average $7.48 per Mg combusted for plants subject to NSPS and $5.00 for plants subject to Guidelines under the No Substitution Scenario. Based on a full pass-through of these estimated enterprise control costs by the MWC, this represents price impacts of 18 percent at NSPS plants and 12 percent at Guidelines plants (see Tables 5-13 and 5-14). An average tipping fee of $47.20 per Mg (Pettit, 1988) at MWC facilities was used as the basis for calculating price impacts. Materials separation 2 annualized enterprise costs at both planned and existing facilities average from $19 to $20 per Mg of waste combusted under the No Substitution Scenario. This represents price impacts of slightly less than 50 percent. Price impacts under the Substitution Scenario with materials separation 1 are 19 percent and 11 percent for planned and existing plants, respectively. Price impacts estimated using materials separation 2 under the Substitution Scenario are approximately 40 to 50 percent for both planned and existing facilities

5.2 HIGH CAPACITY UTILIZATION SENSITIVITY ANALYSIS

For impacts reported elsewhere in this report, we adopted average capacity utilization values reported in the *1988-89 Resource Recovery Yearbook* (Gould, 1988) to calculate the waste flows combusted at most of the model plants. (Capacity utilization values at some model plants were adjusted to reflect co-fired capacity, increased downtime at older or smaller plants, or a stand-by unit.) However, capacity utilization values reported in the *Municipal Waste Combustors—Background Information for Proposed Standards: 111(b) Model Plant Description and Costs of Control* (EPA, 1989d) and *Municipal Waste Combustors—Background Information for Proposed Guidelines for Existing Facilities* (EPA, 1989c) average as much as 8 percentage points higher than those used in this report.

TABLE 5-11. NSPS NATIONAL COST IMPACTS (1987 $): WITH MATERIALS SEPARATION 1 AND MATERIALS SEPARATION 2 COSTS[a]

Scenario	Annualized Social Costs[b] (10^6/yr)	Annualized Social Costs per Mg MSW[b,d] ($/Mg)	Annualized Enterprise Costs[c] (10^6/yr)	Annualized Enterprise Costs per Mg MSW[c,d] ($/Mg)
No Substitution				
PM and Acid Gas control	168	11.20	145	9.69
NO_x control	26.7	1.79	22.3	1.49
Materials Separation 1[e]	-40.2	-2.72	-54.7	-3.71
Materials Separation 2[e]	135	9.17	121	8.19
Total with Materials Separation 1	154	10.30	113	7.48
Total with Materials Separation 2	329	22.20	288	19.40
Substitution				
Total with Materials Separation 1	114	11.30	82.1	8.16
Total with Materials Separation 2	125	21.50	106	18.30

[a] Costs are calculated using average capacity utilization values reported in the *1988-89 Resource Recovery Yearbook* (Gould, 1988). Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff. Plants under 35 Mg per day account for less than 1 percent of the waste flow to planned plants in this analysis.

[b] Annualized social costs are the sum of capital costs, annualized at *10 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[c] Annualized public enterprise costs are the sum of capital costs, annualized at *4 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[d] Computed by dividing the total annualized cost by the estimated annual waste combusted at MWC facilities affected by the regulation.

[e] For an explanation of the assumptions used to calculate materials separation 1 and 2, see the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). Materials separation costs do not include any allowance for costs to households that are required to separate wastes. These costs are net of landfill costs and transportation costs avoided because of separation, and include credit for the sale of materials recovered. The No Substitution costs do not include downsizing credits and were calculated based on the inventory of plants and projected waste combusted by MWCs reported in Table 3-1. Total costs and average costs per Mg reflect the assumption that all planned plants over 100 Mg are affected by the materials separation requirement.

TABLE 5-12. GUIDELINES NATIONAL COST IMPACTS (1987 $): WITH MATERIALS SEPARATION 1 AND MATERIALS SEPARATION 2 COSTS[a]

Scenario	Annualized Social Costs[b] (10^6/yr)	Annualized Social Costs per Mg MSW[b,d] ($/Mg)	Annualized Enterprise Costs[c] (10^6/yr)	Annualized Enterprise Costs per Mg MSW[c,d] ($/Mg)
No Substitution				
GCP, PM, and Acid Gas control	328	11.20	272	9.27
Materials Separation 1[e]	-53.9	-2.98	-77.4	-4.27
Materials Separation 2[e]	223	12.30	200	11.00
Total with Materials Separation 1	274	8.19	195	5.00
Total with Materials Separation 2	551	23.50	472	20.30
Substitution				
Total with Materials Separation 1	219	7.53	157	4.62
Total with Materials Separation 2	470	23.10	406	20.10

[a] Costs are calculated using average capacity utilization reported in the *1988-89 Resource Recovery Yearbook* (Gould, 1988). Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff. Plants under 35 Mg per day account for less than 1 percent of the waste flow to existing plants in this analysis and represent only a portion of the actual population of existing plants under 35 Mg per day.

[b] Annualized social costs are the sum of capital costs, annualized at *10 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[c] Annualized public enterprise costs are the sum of capital costs, annualized at *4 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[d] Computed by dividing the total annualized cost by the estimated annual waste combusted at MWC facilities affected by the regulation.

[e] For an explanation of the assumptions used to calculate materials separation 1 and 2, see the *Air Pollution Emission Standards and Guidelines for Municipal Waste Combustors: Economic Analysis of Materials Separation Requirement* (EPA, 1990a). Materials separation costs do not include any allowance for costs to households that are required to separate wastes. These costs are net of landfill costs and transportation costs avoided because of separation, and include credit for the sale of materials recovered. The No Substitution costs were calculated based on the inventory of plants and projected waste flows reported in Table 3-2. Total costs and average costs per Mg for materials separation are adjusted to exclude MWCs located in states with mandatory recycling requirements and MWCs below 100 Mg per day capacity.

TABLE 5-13. PERCENTAGE PRICE INCREASES BASED ON FULL PASS-THROUGH OF ESTIMATED NSPS ENTERPRISE COSTS OF CONTROL PER Mg OF MUNICIPAL SOLID WASTE: WITH MATERIALS SEPARATION 1 AND MATERIALS SEPARATION 2 COSTS[a]

Scenario	Percent Increase
No Substitution	
With Materials Separation 1	18
With Materials Separation 2	45
Substitution	
With Materials Separation 1	19
With Materials Separation 2	43

[a] Based on average resource recovery facility tipping fee for 1988 of $43.96 per Mg (Pettit, 1989), converted to last quarter 1987$ to an average $42.70 per Mg.

TABLE 5-14. PERCENTAGE PRICE INCREASES BASED ON FULL PASS-THROUGH OF ESTIMATED GUIDELINES ENTERPRISE COSTS OF CONTROL PER Mg OF MUNICIPAL SOLID WASTE: WITH MATERIALS SEPARATION 1 AND MATERIALS SEPARATION 2 COSTS[a]

Scenario	Percent Increase
No Substitution	
With Materials Separation 1	12
With Materials Separation 2	48
Substitution	
With Materials Separation 1	11
With Materials Separation 2	47

[a] Based on average resource recovery facility tipping fee for 1988 of $43.96 per Mg (Pettit, 1989), converted to last quarter 1987$ to an average $42.70 per Mg.

Tables 5-15 and 5-16 present the scaling factors and estimated waste flow combusted calculated using the estimates of higher capacity utilization. Note that total waste flows subject to NSPS and Guidelines are unchanged from the values calculated in Chapter 3, Tables 3-1 and 3-2. Keeping total affected waste flows constant results in a decrease in the estimated scaling factor (number of model plants) as the amount of waste combusted at each plant increases. The distribution of waste flows to existing model plants changes slightly because the scaling factors are adjusted for model plant categories that contain transitional model plants only (EPA, 1989c). The distribution of waste flows to NSPS facilities is not affected by the adjustments for higher capacity utilization.

Tables 5-17 and 5-18 report the national social costs and national enterprise costs of the regulation for plants subject to NSPS and Guidelines using the higher capacity utilization estimates. These costs are 2 to 4 percent lower than the corresponding costs reported in Tables 4-7 and 4-8. Using a higher capacity utilization results in no change in baseline emissions or emission reductions for NSPS plants reported in Table 5-19. However, these values do change slightly for existing facilities (Table 5-20) due to a change in the mix of facilities subject to Guidelines.

TABLE 5-15. HIGH CAPACITY UTILIZATION SCALING FACTORS, PLANT CAPACITY, AND WASTE FLOW ESTIMATES FOR MWC PLANTS SUBJECT TO NSPS[a]

Model Plant Number	Model Plant Description	Model Plant Capacity (Mg/day)	Scaling Factors[b]	Capacity[c] (10^6 Mg/yr)	Waste Flow[d] (10^6 Mg/yr)
1	MB/WW (small)	180	16.81	1.11	0.64
2	MB/WW (mid-size)	730	6.75	1.79	1.63
3	MB/WW (large)	2,040	7.88	5.87	5.36
4	MB/REF	450	3.00	0.50	0.45
5	MB/RC	950	3.00	1.04	0.95
6	RDF	1,810	4.88	3.23	2.95
7	RDF/CF	1,810	3.00	1.99	0.91
8	MOD/EA	220	3.00	0.24	0.22
9	MOD/SA (small)	45	1.80	0.03	0.02
10	MOD/SA (mid-size)	90	6.38	0.21	0.19
11	FBC/BB	820	1.88	0.56	0.51
12	FBC/CB	820	4.13	1.23	1.12
	TOTAL		62.50	17.79	14.95

[a] Details may not add to totals due to rounding.

[b] These scaling factors are based on the model plant annual operating hours and distribution of MWCs reported in the *Municipal Waste Combustors—Background Information for Proposed Standards: 111(b) Model Plant Description and Costs of Control* (EPA, 1989d) and the total projected waste flows subject to NSPS reported in Table 3-1. These scaling factors are used to estimate the number of MWC plants subject to NSPS assuming high capacity utilization.

[c] Capacity estimates are calculated based on model plant capacity, an assumed 365-day operating year, and model plant scaling factors reported in this table.

[d] *Waste Combustors—Background Information for Proposed Standards: 111(b) Model Plant Description and Costs of Control* (EPA, 1989d) and the model plant scaling factors presented in this table.

TABLE 5-16. HIGH CAPACITY UTILIZATION SCALING FACTORS, PLANT CAPACITY, AND WASTE FLOW ESTIMATES FOR MWC PLANTS SUBJECT TO EMISSION GUIDELINES[a]

Model Plant Number	Model Plant Description	Model Plant Capacity (Mg/day)	Scaling Factors[b]	Capacity[c] (10^6 Mg/yr)	Waste Flow[d] (10^6 Mg/yr)
1	MB/REF/TG	680	5.53	1.37	1.02
2	MB/REF/RG	220	22.75	1.81	1.28
3	MB/REF/RK	820	4.78	1.42	1.30
4	MB/WW (large)	2,040	10.13	7.54	6.89
5	MB/WW (mid-size)	980	15.39	5.50	5.03
6	MB/WW (small)	180	9.30	0.62	0.56
7	RDF (large)	1,810	5.00	3.31	3.03
8	RDF (small)	540	14.10	2.80	2.56
9	MOD/SA/TR	140	18.75	0.93	0.57
10	MOD/SA/G	45	46.50	0.77	0.57
11	MOD/EA	180	8.38	0.55	0.51
12	MB/RWW	450	2.43	0.40	0.37
13	TRANS MOD/EA	380	1.64	0.23	0.21
14	TRANS MB/WW	180	2.34	0.15	0.14
15	TRANS RDF (large)	1,810	3.31	2.19	2.00
16	TRANS RDF (small)	540	2.08	0.41	0.38
17	TRANS MB/RWW	450	3.44	0.57	0.52
	Total Assigned		183.14	30.60	26.92
	Unassigned	—	15.93	2.76	2.43
	TOTAL		199.07	33.36	29.35

[a] Details may not add to totals due to rounding.

[b] These scaling factors are based on the model plant annual operating hours and distribution of MWCs reported in the *Municipal Waste Combustors—Background Information for Proposed Guidelines for Existing Facilities* (EPA, 1989c) and the total projected waste flows subject to Guidelines reported in Table 3-2. These scaling factors are used to estimate the number of MWC plants subject to Guidelines assuming high capacity utilization.

[c] Capacity estimates are calculated based on model plant capacity, an assumed 365-day operating year, and model plant scaling factors reported in this table.

[d] Waste flow estimates are calculated based on the annual operating hours reported in *Municipal Waste Combustors—Background Information for Proposed Guidelines for Existing Facilities* (EPA, 1989c) and the model plant scaling factors presented in this table.

TABLE 5-17. NSPS NATIONAL COST IMPACTS UNDER THE NO SUBSTITUTION SCENARIO (1987 $): HIGH CAPACITY UTILIZATION[a]

	Annualized Social Costs[b] (10^6/yr)	Annualized Social Costs per Mg MSW[b,d] ($/Mg)	Annualized Enterprise Costs[c] (10^6/yr)	Annualized Enterprise Costs per Mg MSW[c,d] ($/Mg)
PM and Acid Gas control	162	10.80	141	9.43
NO_x control	25.6	1.71	21.6	1.44
Materials Separation[e]	negligible	negligible	negligible	negligible
Total	187	12.50	163	10.90

[a] Costs are calculated using high capacity utilization values reported in the *MWCs—Background Information for Proposed Standards: 111(b) Model Plant Description and Costs of Control* (EPA, 1989d). Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff for the emission reduction requirements. Plants under 35 Mg per day account for less than 1 percent of the waste flow to planned plants in this analysis.

[b] Annualized social costs are the sum of capital costs, annualized at *10 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[c] Annualized public enterprise costs are the sum of capital costs, annualized at *4 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[d] Computed by dividing the total annualized cost by the estimated annual waste combusted at MWC facilities affected by the regulation.

[e] Materials separation costs are assumed to be negligible (EPA, 1990c). Quantitative estimates of materials separation costs are presented for the sensitivity analysis discussed in Chapter 5.

TABLE 5-18. GUIDELINES NATIONAL COST IMPACTS UNDER THE NO SUBSTITUTION SCENARIO (1987 $): HIGH CAPACITY UTILIZATION[a]

	Annualized Social Costs[b] (10^6/yr)	Annualized Social Costs per Mg MSW[b,d] ($/Mg)	Annualized Enterprise Costs[c] (10^6/yr)	Annualized Enterprise Costs per Mg MSW[c,d] ($/Mg)
GCP, PM, and Acid Gas control	319	10.90	266	9.07
Materials Separation[e]	negligible	negligible	negligible	negligible
Total	319	10.90	266	9.07

[a] Costs are calculated using high capacity utilization reported in the *Municipal Waste Combustors—Background Information for Proposed Guidelines for Existing Facilities* (EPA, 1989c). Estimates have not been adjusted to exclude plants under the 35 Mg per day cutoff for emission reduction requirements. Plants under 35 Mg per day account for less than 1 percent of the waste flow to existing plants in this analysis.

[b] Annualized social costs are the sum of capital costs, annualized at *10 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[c] Annualized public enterprise costs are the sum of capital costs, annualized at *4 percent*, and annual operating costs for MWC facilities or operators of materials separation programs.

[d] Computed by dividing the total annualized cost by the estimated annual waste combusted at MWC facilities affected by the regulation.

[e] Materials separation costs are assumed to be negligible (EPA, 1990c). Quantitative estimates of materials separation costs are presented for the sensitivity analysis discussed in Chapter 5.

TABLE 5-19. NSPS NATIONAL BASELINE EMISSIONS AND EMISSIONS REDUCTIONS (Mg per Yr): HIGH CAPACITY UTILIZATION[a]

Scenario	CDD/CDF	CO	PM	SO_2	HCl	Pb	NO_x	Solid Waste Residuals[b]
No Substitution								
Baseline Emissions	0.031	5,470	7,540	42,000	49,300	127	27,700	3,700,000
Emissions Reductions from Baseline	0.030	0	5,270	36,400	47,200	124	9,340	-332,000
Percent Reductions from Baseline	97.8	0	69.8	86.7	95.8	97.5	33.7	-8.96

[a] Energy impacts for air pollution control equipment only.

[b] Includes bottom ash and fly ash with some residual quench water. Negative values reflect increases in ash emissions relative to the baseline.

KEY: polychlorinated dibenzo-*p*-dioxins and dibenzofurans (CDD/CDF), carbon monoxide (CO), particulate matter (PM), sulfur dioxide (SO_2), hydrogen chloride (HCl), lead (Pb), and nitrogen oxides (NO_x).

TABLE 5-20. GUIDELINES NATIONAL BASELINE EMISSIONS AND EMISSIONS REDUCTIONS (Mg per Yr): HIGH CAPACITY UTILIZATION[a]

Scenario	CDD/CDF	CO	PM	SO_2	HCl	Pb	Solid Waste Residuals[b]
No Substitution							
Baseline Emissions	0.222	26,400	11,400	86,600	108,000	248	7,320,000
Emissions Reductions from Baseline	0.206	11,200	6,250	48,300	77,400	153	-212,000
Percent Reductions from Baseline	93.0	42.6	54.9	55.8	71.7	61.9	-2.89

[a] Energy impacts for air pollution control equipment only.

[b] Includes bottom ash and fly ash with some residual quench water. Negative values reflect increases in ash emissions relative to the baseline.

KEY: polychlorinated dibenzo-*p*-dioxins and dibenzofurans (CDD/CDF), carbon monoxide (CO), particulate matter (PM), sulfur dioxide (SO_2), hydrogen chloride (HCl), and lead (Pb).

CHAPTER 6
ANALYSIS OF ECONOMIC IMPACTS ON SMALL MWCs

Small MWCs in the context of this chapter include only those planned and existing MWCs with capacities below 90 Mg per day. The requirements of the Regulatory Flexibility Act (RFA) were used to help structure the analysis of impacts on small MWCs. Section 6.1 presents an overview of the requirements of the RFA with regard to small businesses and small governments. Section 6.2 describes the population of small MWCs identified. In Section 6.3 the impacts of the regulation on the small MWCs affected by the regulation are analyzed.

6.1 REQUIREMENTS OF THE REGULATORY FLEXIBILITY ACT

The RFA requires that federal agencies consider whether regulations they develop will have "a significant economic impact on a substantial number of small entities" (U.S. Small Business Administration, 1982). Small entities may include nonprofit organizations, small governmental jurisdictions, and small businesses. The RFA identifies small government jurisdictions as those with populations less than 50,000. Small businesses are identified by the Small Business Association general size standard definitions. For SIC code 4953, Refuse Systems, small business concerns are those receiving less than $6 million dollars per year, averaged over the most recent 3 fiscal years.

EPA (1982) provides guidelines for determining when a "substantial number" of these small entities have been "significantly impacted." EPA suggests that a "substantial number" is "more than 20 percent of these (small entities) affected for each industry the proposed rule would cover." However, each office may develop its own criterion for defining a substantial number. Impacts may be considered significant if any one of these conditions exist:

1. compliance costs are greater than five percent of production costs,
2. compliance costs, as a percent of sales, are at least 10 percent higher for small entities than for other entities,
3. capital costs of compliance are a significant portion of capital available, or
4. the requirements are likely to result in closures of small entities.

6.2 PROFILE OF SMALL MWCs

A data base of small MWCs was constructed to determine whether the regulation will have a significant economic impact on a substantial number of small entities. Current sources including the following were consulted:

- *1988-89 Resource Recovery Yearbook* (Gould, 1988)
- *City Currents*
- *Waste Age magazine* (November 1987 and November 1989 issues)
- *Kidder Peabody waste-to-energy industry analyses*
- *Municipal Waste Combustors—Background Information for Proposed Guidelines for Existing Facilities* (EPA, 1989c)
- *Municipal Waste Combustors—Background Information for Proposed Standards: 111(b) Model Plant Description and Costs of Control* (EPA, 1989d)

The municipalities identified in the literature search were contacted to guarantee the accuracy of the data. After excluding plants that were no longer in operation and planned plants that had been cancelled, 45 MWCs with capacities of 18 to 90 Mg per day were identified.

Several sources containing financial data on small firms were also consulted to determine the size of private firms identified as owners or operators of MWCs. These sources include the following:

- *Thomas Register of American Manufacturers Company Profiles*
- *Thomas Register of American Manufacturers Products and Services*
- *Moody's Industrial Manual*
- *Moody's Public Utility Manual*
- *Kelly's Business Directory*
- *Ward's Business Directory of U.S. Private and Public Companies*
- *Dunn and Bradstreet's Million Dollar Directory*
- *Dunn and Bradstreet's Business Information Reports*

For facilities where financial and operating information was unavailable or insufficient from these sources, the MWC owners and/or operators, equipment vendors, and public officials were contacted for supplementary data.

Data were collected for small MWCs with capacities of 18 to 90 Mg per day. Initially, the 18 Mg per day lower limit was chosen in anticipation of a size cutoff designed to exclude Medical Waste Incinerators (MWIs) from the regulation. [MWIs will be controlled under separate regulation now under consideration, and roughly 90 percent of total MWI design capacity and 99 percent of all MWI units are under 18 Mg per day (White, 1990b).] The cutoff was subsequently set at 35 Mg per day, which exempted virtually all MWIs (over 7,000 units). The 90 Mg per day upper limit was based on the assumption that a community with a population of 50,000 would generate approximately 80 to 90 Mg of refuse per day. This calculation is based on the 1988 estimated waste generation rate of 1.8 kg per person per day (EPA, 1990b). Although a small community may own a MWC with a per-day capacity greater than 90 Mg, the

facility probably serves more than 50,000 people. On the basis of population served, such a community would not qualify as a small governmental jurisdiction (U.S. Small Business Administration, 1982).

The 45 facilities identified for our analysis include 42 existing and 3 planned MWCs. The small number of planned MWCs between 18 and 90 Mg per day capacity is due in part to a trend toward larger facilities. The *1988-89 Resource Recovery Yearbook* (Gould, 1988) states that the average design capacity for planned resource recovery plants is 790 Mg per day. This represents a 19 percent increase in average facility size for planned units since 1986. There are two possible explanations for this trend toward larger facilities. First, facilities are shifting away from modular technology toward larger scale mass burn and RDF facilities (Gould, 1988). Second, emission regulations further accentuate economies of scale that are already present in the industry. As a result, an increasing number of communities are seeking to take advantage of these economies of scale through regionalization.

Figure 6-1 shows the distribution of MWCs with capacities of 18 to 90 Mg per day. The data indicate that MWCs are not concentrated toward either end of the spectrum, but that modular units are commonly constructed in capacity increments of 23 Mg per day (25 TPD). This accounts for the increased number of facilities within each range that encompasses multiples of 23 Mg per day (e.g., 23 Mg per day falls in the 18-26 Mg per day category, 46 Mg per day falls in the 45-53 Mg per day category). There are 35 facilities above and 10 below the 35 Mg per day cutoff for emission reduction requirements. None of the facilities are subject to the materials separation requirements.

Figure 6-2 shows the distribution of small MWCs by type of ownership. Only 6 of the total 45 facilities identified are owned by private firms, with 3 of these 6 having small private owners (as defined in Section 6.1). The remaining facilities are publicly owned—3 by the U.S. military, 3 by states, and 33 by municipalities or counties. Figure 6-3 shows the distribution of these publicly owned MWCs by ownership population. The critical value for the analysis of ownership population is 50,000 because the RFA defines small government entities as those with population below 50,000. Thirty small MWCs that are owned by local government entities have populations below 50,000.

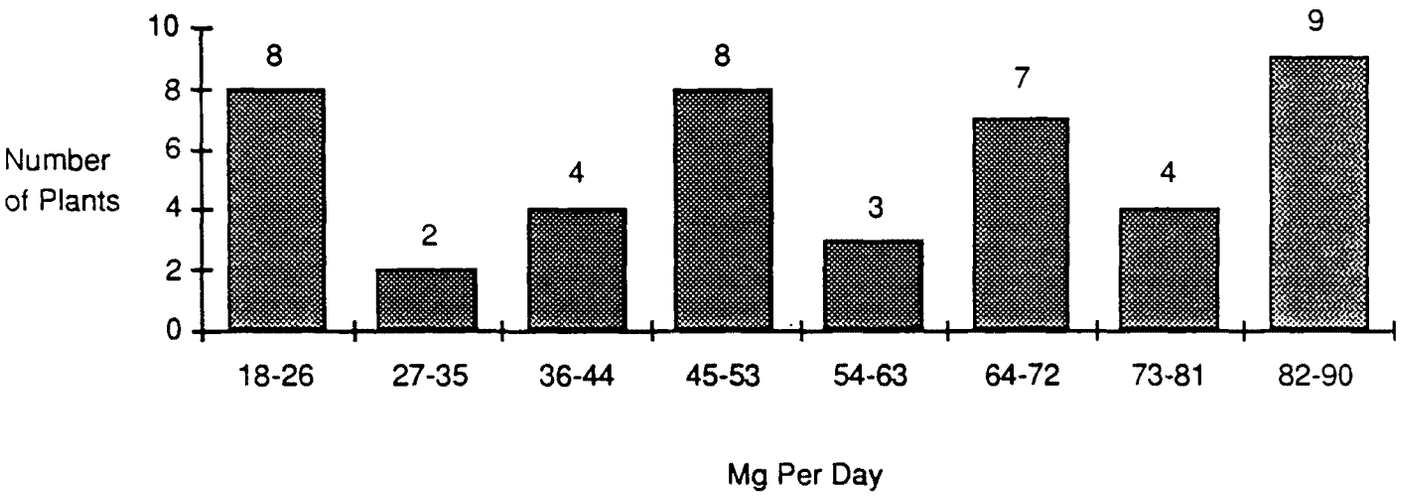


Figure 6-1. Distribution of MWCs with Capacities of 18 to 90 Mg per Day, by Capacity

N = 45

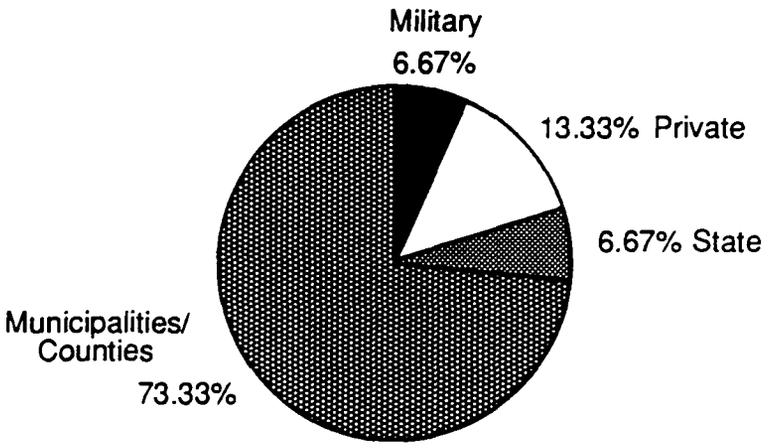


Figure 6-2. Distribution of MWCs with Capacities of 18 to 90 Mg per Day, by Type of Ownership
N = 45

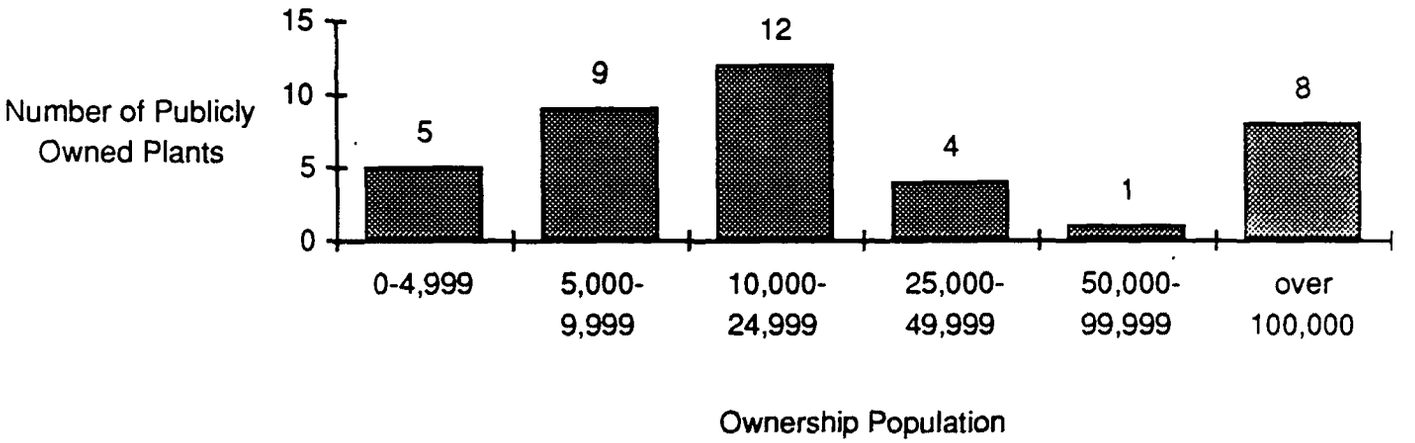


Figure 6-3. Distribution of Publicly Owned MWCs with Capacities of 18 to 90 Mg per Day, by Ownership Population N = 39

6.3 ECONOMIC IMPACT ON SMALL ENTITIES

This analysis is limited to small MWCs above the 35 Mg per day cutoff; 32 existing and 3 planned MWCs with design capacities between 35 and 90 Mg per day were identified. Of these, 17 percent are privately owned and 83 percent are publicly owned. Twenty-six facilities are owned by small entities and 9 are owned by large entities. Table 6-1 presents these small MWCs sorted by size of facility, size of owner, and type of ownership.

The 3 planned facilities include a 45 Mg per day publicly owned facility, a 68 Mg per day privately owned facility, and a 64 Mg per day privately owned facility. Under the criteria cited in Section 6.1, the publicly owned MWC is owned by a small entity and the privately owned MWCs are owned by large entities. Given the low number of planned small facilities that exceed the 35 Mg cutoff and the evidence of a trend toward larger facilities, the NSPS is not expected to affect a substantial number of small planned MWCs. Therefore, this section focuses on existing MWCs with capacities of 35 to 90 Mg per day when analyzing the economic impacts of the regulation on small facilities. Indeed, as discussed in the next chapter, the regulation encourages small facilities with capacities less than 35 Mg per day.

6.3.1 Analysis of Impacts on Governments

Plant-specific annual compliance costs for the small, publicly owned MWCs were calculated as the first step in the analysis of impacts on governments. All of the plants in the analysis of small MWCs are modular technology. Therefore, the costs for these facilities were estimated based on the costs for Guidelines model plant 10, a modular plant with a capacity of 45 Mg per day. The costs for model plant 10 (based on the enterprise cost parameters for publicly owned facilities) were scaled in proportion to the capacity of each plant in the data base. It is assumed that the plants are just meeting federal standards for emissions in the baseline. This assumption may tend to overestimate control costs for those plants with baseline controls in place that remove more pollution than currently required by federal standards.

The assessment of the impact of the regulation on specific government entities used the following three indexes designed to measure the entity's ability to meet the additional financial obligations incurred due to the regulation:

1. the sum of the average sewerage and sanitation cost per household and the average control cost per household as a percentage of median household income,
2. the sum of total debt service and additional debt service associated with the capital cost of control as a percentage of total general revenues, and
3. control costs as a percentage of total general expenditures.

TABLE 6-1. DISTRIBUTION OF MWCS BY FACILITY CAPACITY AND SIZE AND TYPE OF OWNERSHIP

Plant Size (Mg per day) and Type of Ownership	Size of Owner[a]		Cumulative Total
	Small	Large	
18 - 26			
Public	5	3	
Private	0	0	
			8
27 - 35			
Public	2	0	
Private	0	0	
			10
36 - 44			
Public	3	1	
Private	0	0	
			14
45 - 53			
Public	6	1	
Private	1	0	
			22
54 - 63			
Public	2	1	
Private	0	0	
			25
64 - 72			
Public	3	1	
Private	1	2	
			32
73 - 81			
Public	2	1	
Private	1	0	
			36
82 - 90			
Public	7	1	
Private	0	1	
			45

[a] For Standard Industrial Classification (SIC) 4953, Refuse Systems, small business concerns are those receiving less than $6 million per year averaged over the most recent 3 fiscal years. Small governmental jurisdictions are identified in the Regulatory Flexibility Act as those with populations less than 50,000.

The first two indexes are adaptations of indexes used in *Municipalities, Small Business, and Agriculture* (EPA, 1988) and are designed to measure each government's ability to issue revenue bonds or obtain loans to finance the additional control costs. One percent is set as a criterion for severity under Index 1; and 15 percent is set as a criterion for severity under Index 2. It is noted, however, that severity under Indexes 1 and 2 is subject to a second criterion. Namely, severity under both indexes must be indicated before a facility can be said to have a severe impact due to the regulation.

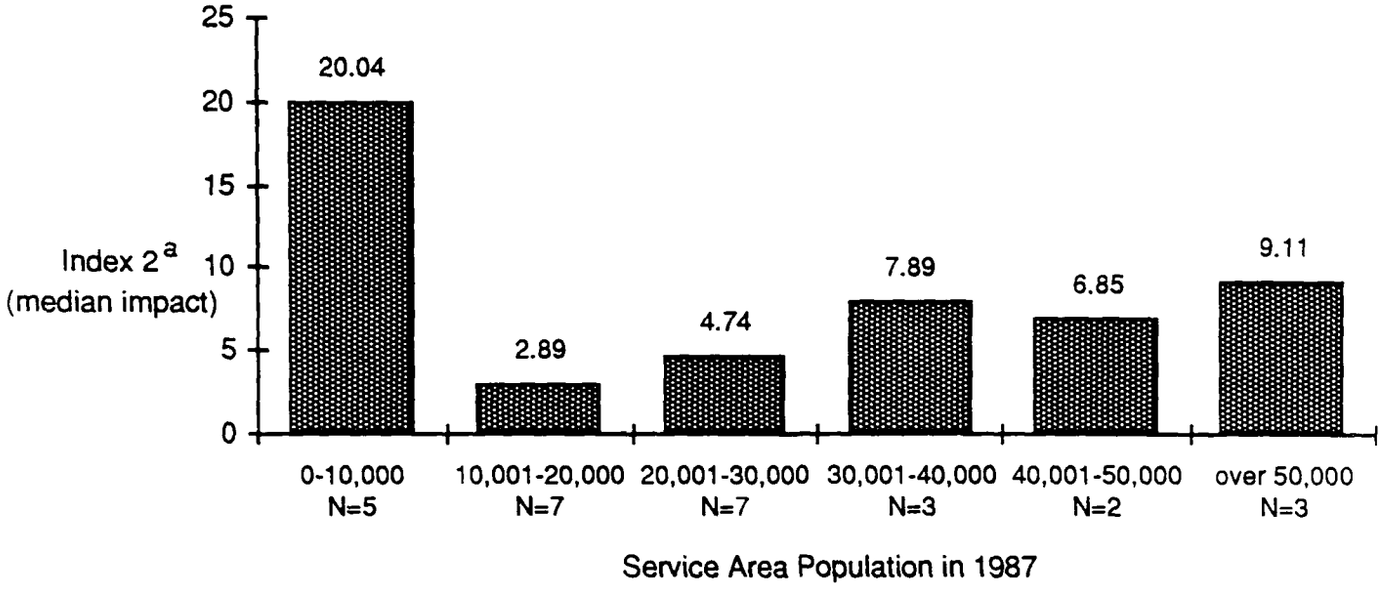
The third index is used in the *OSW Subtitle D Landfill RIA* (Temple, Barker & Sloan, Inc. et al., 1989) to measure the additional governmental cost burden associated with the regulation relative to existing government expenditures. One percent is set as the criterion for severity under this index.

Demographic and financial data were collected for each government entity identified in the analysis using the *1988 County and City Data Book, Tennessee Statistical Abstract 1989*, and *Virginia Statistical Abstract 1987*. Local government officials supplied data that were unavailable from these sources. All cost data were converted to last quarter 1987 dollars and population data were projected to 1987 levels.

Impacts as measured by Index 1 could be calculated for only 3 of the MWCs in the analysis due to data limitations. The measure of impacts using this index range from 1.08 percent to 7.39 percent. Impacts for all 3 facilities exceed the 1 percent criterion. However, none of these 3 facilities exceed the 15 percent criterion for Index 2. Consequently, jointly applying the second criterion indicates no severe impacts.

Figure 6-4 presents the distribution of impacts as measured by Index 2. Actual data on debt service is not available for each of the communities, but, debt outstanding is available for 27 of the communities. To estimate the debt service for each community, a capital recovery factor was first calculated based on an average municipal bond yield of 8.49 percent (calculated using data from December 1983 through April 1990 for BAA rated municipal bonds in *Moody's Bond Guide*) and a standard 20-year amortization period. This capital recovery factor was then applied to the debt outstanding for each community to approximate the debt payments.

Impacts under Index 2 for individual communities range from 0.06 percent to 51.0 percent. Of the 27 communities, 7 have impacts exceeding the 15 percent criterion. However, because of the limited data on sewerage and sanitation expenditures, it is impossible to jointly apply the second criterion to identify whether these 7 facilities have severe impacts from the regulation.



[a] Index 2 is the sum of total current debt service and additional debt service associated with compliance to the regulation as a percent of total general revenues. The Municipal Sector Study (U.S. EPA, 1988d) sets 15 percent as the criterion for severe impacts under this index.

Figure 6-4. Distribution of Government Impacts Under Guidelines for MWC Plants with Capacities of 35 to 90 Mg per Day, by Service Area Population: Index 2

N = 27

Figure 6-5 shows the distribution of government impacts measured by Index 3. Data were available to calculate impacts for 25 communities. Impacts range from 0.005 percent to 12.5 percent for these communities. Using the 1 percent criterion, it is estimated that 14 of the 25 facilities will suffer severe impacts.

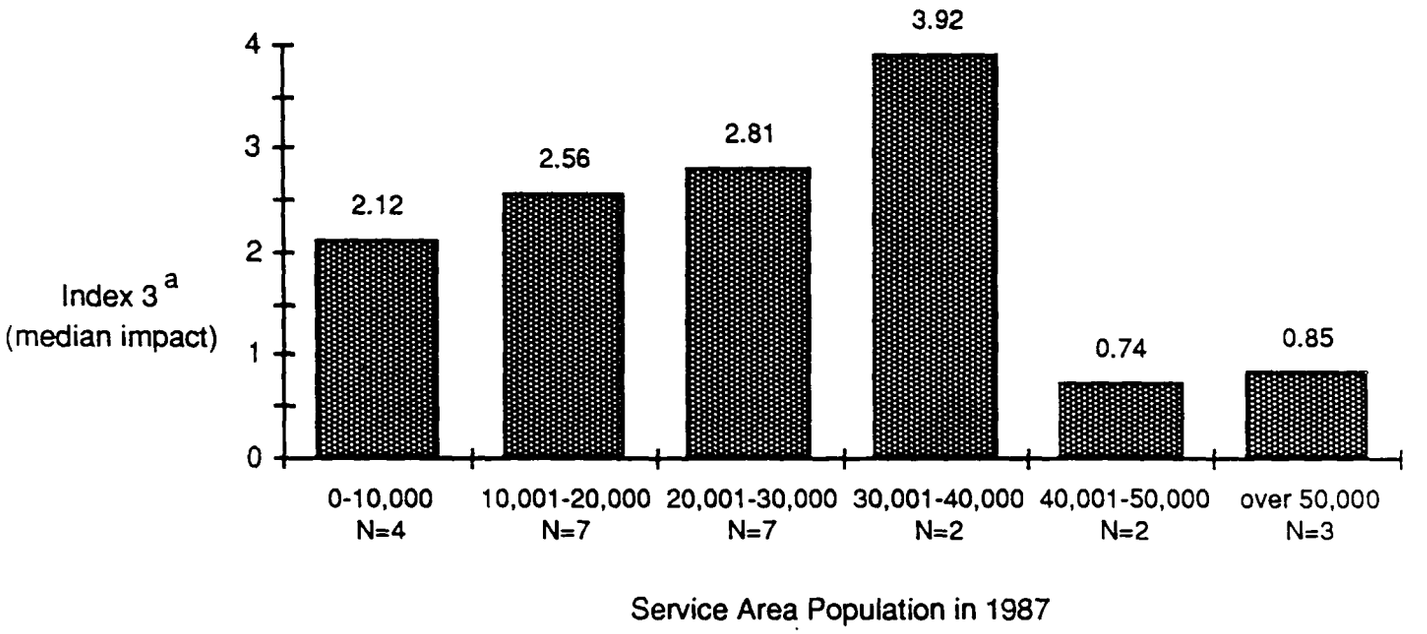
6.3.2 Analysis of Impacts on Private Firms

Impacts of the regulation on private firms may be direct or indirect in nature. The owners and operators of small MWCs who must install control equipment, train employees, or change operating practices will have direct impacts. On the other hand, firms that supply services and/or equipment to these small MWCs (but do not own a plant) will have indirect impacts and may actually benefit from the regulation as the demand for air pollution control equipment and technology increases.

In this section, the focus is limited to private firms that own small MWCs. Six privately owned MWCs with capacities between 35 and 90 Mg per day are identified. Of these, 3 are owned by small firms and 3 by large firms, based on the size classification for small businesses (see Section 6.1). Four of these MWCs are existing and 2 are planned; the planned MWCs are both owned by large firms.

Firm-specific data from which to compute impacts were unavailable from sources containing financial data on small firms listed in Section 6.2. Small firms are not subject to the same requirements regarding disclosure of costs and revenues as larger firms. Indeed, many small firms regard these data as confidential business information. However, by contacting the firms directly, limited data on annual revenues for 4 of the 6 firms were obtained. Two of the firms only indicated that their annual sales exceeded $6 million criterion. To estimate compliance costs at the existing plants, the compliance cost for Guidelines model plant 10 (based on the enterprise cost parameters for privately owned facilities) was scaled in proportion to the capacity of each plant. To estimate the compliance costs at the planned plants, the cost for NSPS model plant 9 was scaled in proportion to the capacity of each plant.

Section 6.1 lists four measures for determining whether economic impacts are significant for small entities. The first, third, and fourth measures apply absolute criteria, while the second measure applies a criterion designed to show the adversity of the impact on small entities relative to other, larger entities. Data were sufficient to calculate impacts under the first measure only.



[a]Index 3 measures control costs as a percent of total general expenditures. The OSW Landfill RIA sets 1 percent as the criterion for severe impacts under this index

Figure 6-5. Distribution of Government Impacts Under Guidelines for MWC Plants with Capacities of 35 to 90 Mg per Day, by Service Area Population: Index 3

N = 25

The first measure of economic impacts using EPA guidance outlined in Section 6.1 states that when "compliance costs are greater than 5 percent of production costs" impacts may be considered significant. EPA guidance does not define production costs in this context. However, the following definitions are consistent with the intent of this measure of economic impacts:

1. Production costs include only the costs directly associated with operating the MWC plant.

2. Production costs include the costs directly associated with operating the MWC plant plus the annualized capital costs of building the MWC plant.

3. Production costs include the costs directly associated with operating the MWC plant, the annualized capital costs of building the MWC plant, and costs associated with any other business activities not directly related to combustion.

These definitions yield estimates of production costs in an increasing order of magnitude. As the definition broadens, the likelihood of severe impacts declines.

To calculate impacts based on the first definition of production costs, we used baseline operating and compliance costs for the model plants identified above. Compliance costs are about 125 percent of production costs for planned plants and about 105 percent for existing plants.

Calculating impacts based on the second definition is more complicated because data on initial capital costs for existing facilities are not available. Consequently, annualized capital costs were approximated using data from the cash flow analysis of NSPS model plant 9 for both planned and existing plants. Compliance costs are about 90 and 66 percent of production costs for planned and existing plants, respectively, based on the second definition of production costs.

Using the first two definitions of production costs to estimate compliance costs as a percent of production costs will underestimate production costs and, thereby, overestimate impacts for MWCs owned by firms that engage in business activities not directly related to combustion. Because data on actual costs associated with these "non-combustion" activities are not available, annual sales data were used to approximate production costs under definition 3 above. Using this method to approximate costs reflects the implicit assumption that the firms in this analysis face perfectly competitive market structures. This assumption may tend to overestimate production costs (and, thereby, underestimate impacts) for firms that do not operate in perfectly competitive markets. Compliance costs are estimated to range from 20 to 25 percent of production costs for planned plants and 15 to 65 percent of production costs for existing plants based on the third definition of production costs.

6.3.3 Analysis of Household Impacts

Increased costs of waste disposal due to the regulation will likely be passed on to customers served by MWCs. Households generate most of the solid waste disposed of annually and, as such, are one group of customers that will incur increased costs of waste disposal. To estimate the additional burden on households associated with the regulation, demographic data and annual compliance costs are used to calculate the following two indexes:

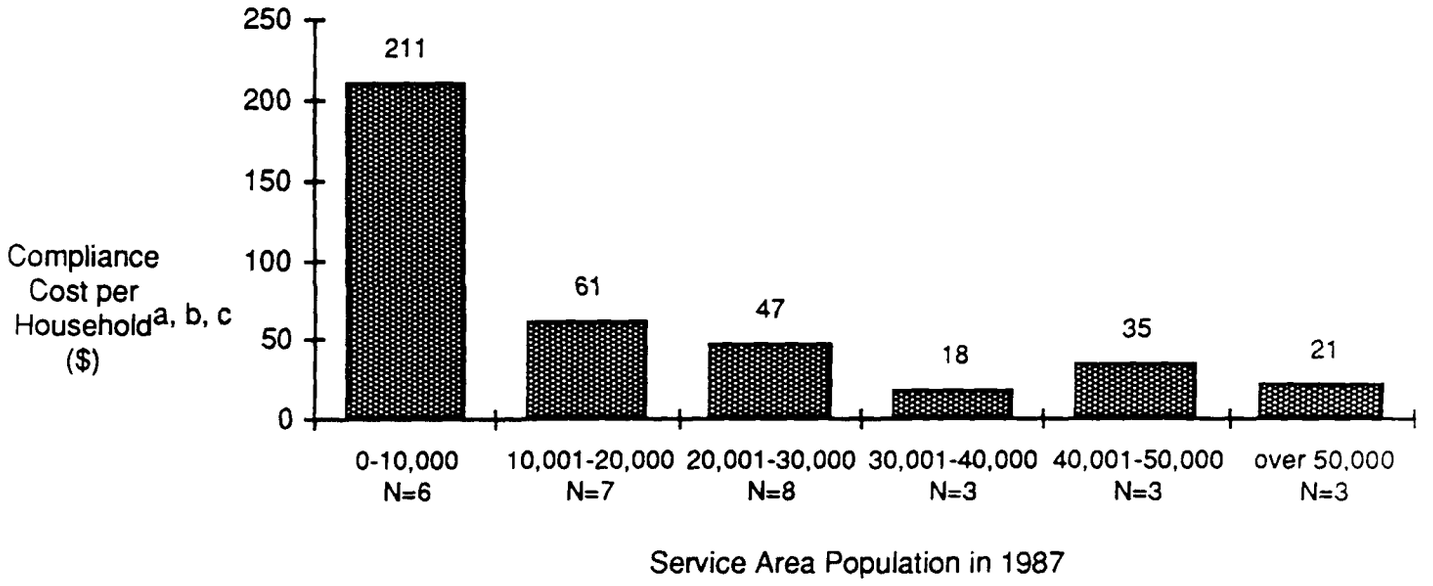
1. compliance cost per household, and
2. compliance cost per household as a percentage of median household income.

These two indexes are from the OSW *Subtitle D Landfill RIA* (Temple, Barker, and Sloan, Inc. et al., 1989). The first index provides an absolute measure of additional household burden while the latter provides a measure of the additional burden relative to a "representative" household income specific to each community.

The methodology used to calculate plant-specific compliance costs and the sources used to collect demographic data are the same as those described in Section 6.3.1 above. Where data on the number of households were unavailable, the population was divided by the 1987 average number persons per household reported in the *1990 Statistical Abstracts of the U.S.*

Figure 6-6 presents the distribution of household impacts under the first index. Impacts for 30 communities were calculated using this measure. Compliance costs per household range from $5 to $329 per household per year for these communities. The OSW *Subtitle D Landfill RIA* (Temple, Barker, and Sloan, Inc. et al., 1989) sets $220 as the criterion for severity. Under this criterion, households in three communities will suffer severe economic impacts due to the regulation.

Data on median household income were available for only four communities in the analysis. Per capita income, number of persons per household, and the average ratio of mean to median household income for the U.S. were used to estimate median household income for an additional 24 communities. Average cost per household as a percent of median household income ranged from 0.09 percent to 0.80 percent for these 28 communities. Household impacts are defined as severe in the OSW *Subtitle D Landfill RIA* (Temple, Barker, and Sloan, Inc. et al., 1989) if cost per household exceeds 1 percent of median household income. Under this criterion, none of the households served by MWCs in the analysis will suffer severe economic impacts.



[a] Costs refer to control costs only; no baseline costs are included.

[b] Household impacts were defined as "severe" if average cost exceeds $220 per household per year.

[c] Where data were unavailable on the number of households this was calculated based on the average number of persons per household as reported in the *1990 Statistical Abstracts*.

Figure 6-6. Distribution of Household Impacts Under Guidelines for MWC Plants with Capacities of 35 to 90 Mg per Day, by Service Area Population: Index 1

N = 30

6.3.4 Conclusion

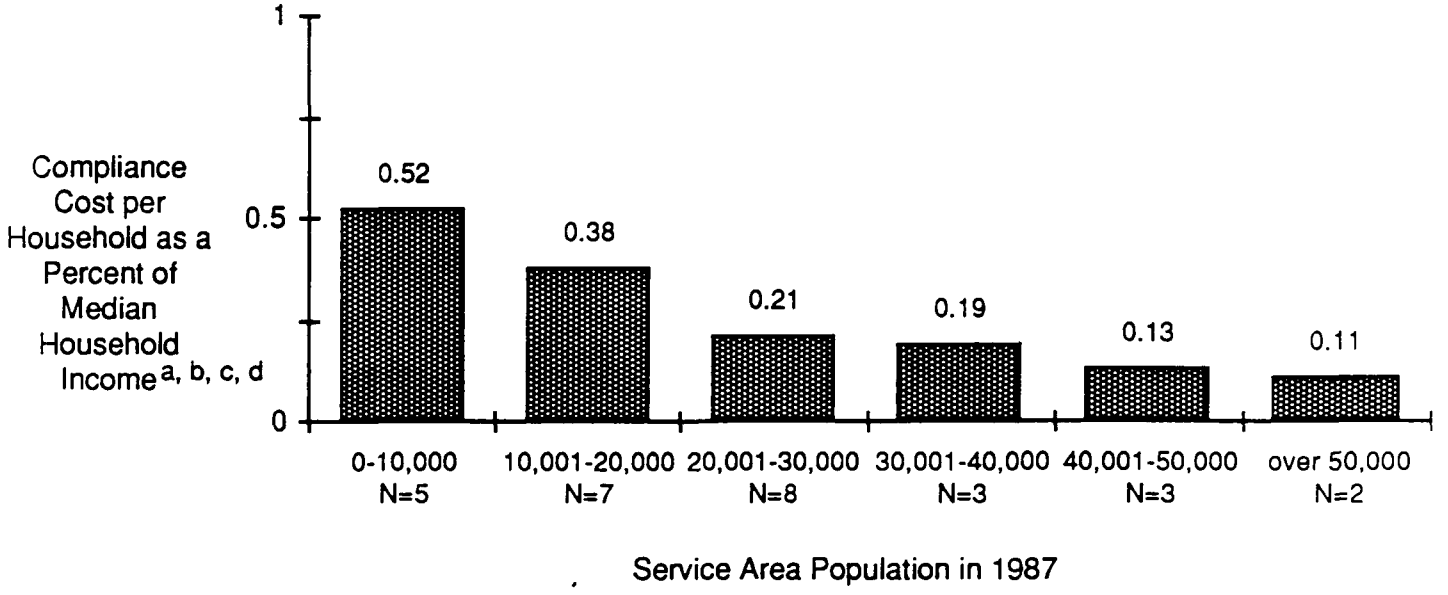
Thirty-two small existing MWCs subject to the Guidelines and 3 small planned MWCs subject to NSPS were identified. Of these, only 22 existing and 1 planned MWC are owned by small entities. In absolute terms, this represents a small number of small firms and municipalities affected by the regulation. In addition, this number represents a very small percentage of all small combustors (including MWIs). Therefore, the regulation is not expected to affect a substantial number of small plants.

The measures of impacts on households, governments, and private firms indicate that some of these small communities and small owners will suffer severe impacts due to the regulation. Therefore, EPA has taken measures to provide greater regulatory flexibility for small plants. Specific mitigation measures that address the needs of small plants include

- a cutoff of 35 Mg per day for emission reduction requirements built into the regulatory structure,
- a cutoff of 100 Mg per day for materials separation requirements built into the regulatory structure,
- less stringent emission reduction requirements for small plants subject to the regulation, and
- latitude for states to make case-by-case judgments on schedule and stringency under the Guidelines.

Raising the cutoff further would not only reduce the proportion of small entities affected, it would also exempt more large entities from the standards and result in higher MWC emissions.

The regulation will likely have a significant impact on all MWC plants, regardless of size. To ensure that small facilities do not suffer disproportionately more severe impacts than large facilities, EPA designed the regulatory flexibility measures mentioned above to help mitigate impacts at small plants.



[a] Costs refer to control costs only; no baseline costs are included.

[b] Household impacts were defined as "severe" if average costs per household per year exceeds 1 percent of median household income.

[c] Where data were unavailable on the number of households this was calculated based on the average number of persons per household as reported in the *1990 Statistical Abstracts*.

[d] Where data were unavailable on median household income, this was estimated based on per capita income, number of persons per household, and the average ratio of mean to median household income in the U.S.

Figure 6-7. Distribution of Household Impacts Under Guidelines for MWC Plants with Capacities of 35 to 90 Mg per Day, by Service Area Population: Index 2

N = 28

CHAPTER 7
SUBSTITUTION ACROSS THE EMISSIONS CUTOFF

Introducing a cutoff for emission control requirements protects small facilities from excessive control costs.[1] The cutoff also provides an opportunity for communities and firms planning to build MWCs to reduce plant costs by building combustors with capacities less than 35 Mg per day.[2] This prospect, referred to here as substitution across the emissions cutoff, arises because the NSPS would increase the control costs of plants with capacities > 35 Mg per day but not those of plants with capacities of 35 Mg per day or less.

In general, constructing and operating large combustors appears to offer some economies of scale. All other things equal, larger plants have lower costs per unit of waste combusted and communities have a financial incentive to build plants as large as justified by the amount of waste produced by their service area. This accounts, in part, for the trend toward the construction of bigger, regional combustor facilities.

If, however, control costs required by the NSPS are large enough, smaller plants that are not required to meet the same emissions limits could become financially attractive. Communities and firms may find it attractive to revise their plans and build one or more smaller combustors that fall below the emission standards cutoff. This might especially be the case if the smaller plants can also be built at favorable locations within the service area and confer reductions in transportation costs.

Assuming that the potential for substitution across the cutoff applies primarily to smaller plants with capacities between 35 and 225 Mg per day, the cutoff could affect up to 20 planned plants representing total capacity of about 540,000 Mg per year and total waste flows combusted of about 370,000 Mg per year by 1995.[3] If, because of the shorter lead time required for smaller facilities, the baseline forecast underestimates the number of small plants that would be affected by the NSPS, even more plants and MSW would be affected. Such substitution would reduce the

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[1] Since the costs of the materials separation requirements have been estimated as negligible, the effects of the materials separation cutoff are not considered in this discussion.

[2] Based on its analysis of relative costs (see Chapter 4) the Agency does not anticipate that the regulations will result the closing of existing MWCs and their replacement by new MWCs. Thus, substitution across the cutoff is not an issue for the Guidelines.

[3] Analysis of substitution across the cutoff is limited to modular technology because most plants in the size range affected by the cutoff are modular technology. The estimate of affected capacity is based on capacity represented by NSPS model plants 8, 9, and 10 (see Table 3-1). The estimate of affected waste flow is based on a capacity utilization rate of 68 percent applied to the estimated capacity. This capacity utilization rate is lower than average capacity utilization rates used to calculate impacts in earlier chapters and reflects data on capacity utilization gathered for the analysis of small facility impacts in Chapter 6.

cost and increase emissions relative to the economic impact estimates for NSPS provided in Chapters 4 and 5.

The analysis of this chapter:

- gauges the magnitude of incentive to "build small" created by the regulation;
- provides rough estimates of the change in plans that would result; and
- discusses circumstances that would encourage and discourage such a revision in plans.

7.1 ANALYTICAL FRAMEWORK

To assess the potential for substitution across the small size cutoff for emission standards, a comparative cost analysis is used. The costs that are compared are those for small modular plants that are not required to meet the emission requirements of the NSPS (< 35 Mg per day) and those larger modular plants affected by the NSPS. The cost of the larger plants, with controls, are compared to the minimum cost combination of smaller plants costs providing equivalent service. If the smaller plants are less costly, then the substitution is likely to occur.

These comparisons are made for a profile of waste flows and plant sizes drawn from the "No Substitution" waste flow and model plant forecast of Chapters 2 and 3. Additional detail for this profile was drawn from information collected on the sizes and number of existing modular plants for the small facilities analysis, the listing of planned facilities (EPA, 1989d), and data on existing and planned modular plants contained in *City Currents* (U.S. Conference of Mayors, 1989). This profile is shown in Table 7-1.

Plants were allocated to the profile in Table 7-1 in two steps. For plants between 0 and 90 Mg per day capacity, a database on existing small facilities was used. The total capacity of all facilities in the database was added, and this total capacity was compared to the capacity for model plant categories 9 and 10 found in Table 3-1. The distribution of facilities in the database was then scaled by this ratio of capacities to provide the distribution in the profile. A similar method, using a different database, was used in allocating the plants in the profile of facilities sized 90-225 Mg per day. The total capacity of plants in a database of medium facilities was compared to the total capacity of model plant category 8 found in Table 3-1. The distribution in this database was then scaled. Thus, Table 7-1 contains a profile of plants whose capacities add to the total capacity of model plant categories 8, 9 and 10.

TABLE 7-1. PROFILE OF MODEL PLANTS

Capacity (Mg/day)	Number	Capacity	Total Capacity
0-90			
	2	72.6	145
	2	68	136
	1	63.5	63.5
	1	54.4	54.4
	1	52.5	52.5
	3	45.3	136
	1	43	43
	1	36	36
	2	22.7	45.4
	2	19	38
Total	15		
90-225			
	3	180	540
	1	108	108
	1	92	92
Total	5		740

7.1.1 Cost Estimation

The baseline costs of modular facilities were obtained from capital cost data collected as part of the small facilities analysis and operating cost data contained in the new facilities cost report (EPA, 1989e). Capital costs were estimated to be proportional to plant capacity. Operating costs were estimated as a function of plant capacity and capacity utilization. Adding estimated expressions for average annualized capital costs and average annual operating costs resulted in the baseline average cost expression shown in Equation (7.1), where Q is capacity in Mg per day and U is capacity utilization rate,

$$\text{Average Baseline Cost per Mg of Waste Combusted} = \frac{31.97 - 0.23Q}{U} + 55.06 \qquad (7.1)$$

For example, using Equation (7.1) the average baseline cost, including baseline control equipment, for a 25 Mg per day plant with a utilization rate of 0.65, is estimated to be $95 per ton of waste combusted.

The control costs for those plants subject to the NSPS are based on a fixed capital cost component and an operating component, which is a function of waste flow and capacity utilization (EPA, 1989d). Equation (7.2) shows the estimated expression for control cost as a function of both the plant capacity and its utilization rate. In this expression, Q is capacity of the plant in Mg per day, and U is capacity utilization rate:

$$\text{Control Cost} = 2.563 + \frac{1,249}{QU} \qquad (7.2)$$

Adding the average baseline cost and the control cost gives an estimate of the average annual cost per Mg of waste combusted for a plant with a capacity > 35 Mg per day. These combined expressions estimate, for example, that a 50 Mg per day plant with a capacity utilization rate of 0.68 has a cost of $124 per Mg of waste combusted.

Equation (7.2) highlights the fact that control costs needed to ensure compliance with the emission standards are significant in both absolute value and relative to baseline costs, especially for those facilities just above the cutoff. These magnitudes in themselves suggest a strong incentive for substitution across the emissions cutoff.

Actual costs for any particular facility can vary substantially from these estimates depending on such factors as the price of land, composition of the trash, local labor and material costs, type and intensity of energy recovery, and baseline emission controls. The cost functions

employed in this analysis are based on relationships fitted to available data and reflect for the most part modular facilities equipped with steam recovery in the 25 to 200 Mg per day capacity range. These data were often quite limited, and the data that were available often exhibit considerable variation across the various components of baseline and control costs. Consequently, these cost equations and the analysis based on them represent best estimates of "average" conditions. Choices actually made for or against substitution across the baseline as a result of the NSPS can vary considerably in either direction from those characterized below due to variation in costs, especially for plant sizes outside the range of our data or for different energy recovery options.

7.1.2 Cost Comparisons

The cost functions described above are used to compare costs based on the "planned" facility profile. Using the baseline and control cost equations, the average cost per Mg of waste combusted for each planned facility is computed using that facility's estimated capacity and capacity utilization.

The cost of meeting the same combustion requirements using some mix of small plants was estimated using a non-linear, numerical optimization program called GINO and marketed by LINDO Systems (Liebman et al., 1986). This procedure identified the least-cost combination of sizes and capacity utilization rates a small facility would need to achieve the same capacity and waste combustion as the larger plant.

7.2 IMPACT OF THE CUTOFF ON FACILITY INVESTMENTS

When comparing the cost data for the large planned and least-cost combination of small (< 35 Mg per day) facilities, substitution (on average) is projected to occur for those large facilities whose average cost per Mg of waste combusted is less than for the small facilities. The results show that a combination of smaller facilities would provide the same combustion services at lower cost for all planned facilities projected in the profile to have less than 100 Mg capacity. The results for all such planned facilities are summarized in Table 7-2.

All plants under 100 Mg per day capacity would be able to reduce their average cost per Mg combusted when used in a combination of smaller facilities. These savings range from $46 per Mg at a 48 Mg per day capacity to $9 per Mg at 80 Mg per day capacity. The total annual cost savings would be $2.14 million. Of the plants in the profile of plants in Table 7-1, 11 of the

TABLE 7-2. DIFFERENCE BETWEEN AVERAGE COST PER MG OF WASTE COMBUSTED WITH ONE PLANT AND OPTIMAL NUMBER OF PLANTS AT A GIVEN CAPACITY AND UTILIZATION RATE

Facility Capacity (Mg)	Capacity Utilization	Average Cost (dollars per Mg)			Difference in Average Cost	Annual Rate Savings (10^3 $)
		1 Facility	2 Facilities	3 Facilities		
36	.5	173	103	—	60	394
43	.5	159	105	—	54	424
45.3	.68	122	92	—	28	945
52.5	.68	120	92	—	30	391
54.4	.68	119	91	—	27	364
63.5	.68	112	90	—	22	347
68	.68	108	90	—	18	608
72.6	.68	105		90	15	541
92	.68	93		91	2	46

20 would be built with a combination of smaller facilities. The capacity of these 11 is 570 Mg per day out of a total of 1,330 Mg per day for all 20 plants. The waste flow of these 11 plants is approximately 90,000 Mg per year.

7.3 ADDITIONAL CONSIDERATIONS

The comparative cost analysis described above provides quantitative estimates of the size of the financial incentive to substitute across the emissions cutoff and the waste flows and capacities of planned modular facilities affected by this substitution. This section discusses analytical elements that were not quantified that would work to either further discourage or encourage such substitution beyond the levels identified above.

First, the magnitude of financial incentives for substitution across the cutoff could well be reduced if constructing several smaller facilities also entailed substantial expenses that are primarily a function of the number of facilities rather than the size of the facility per se. The cost of land, siting, permitting, designing and other such "up-front" expenses may have such properties and may not be properly reflected in the cost functions employed in this analysis.

As part of the small facility analysis, however, data were collected on such up-front costs. For the most part these up-front expenses are negligible or quite small. Most of the facilities are publicly owned and the land on which they were built is often either owned by the community or donated to the community. Siting and permitting costs are seldom broken out separately (suggesting, perhaps, that they were not major cost items) and when they are broken out they are small or negligible. For example, the Galax, Virginia plant, a $2.3 million dollar facility, reported siting costs of $26,000 and included regulatory and permitting cost in a design fee of $42,000. These costs were included among the data used to estimate the baseline capital cost equations discussed above.

The quantitative analysis may also overestimate cost advantage of multiple small plants if these plants are required by state or local regulations or opinion to control beyond the "baseline" level. The importance of this consideration is difficult to gauge in as much as it depends on both current and future approaches to emission regulation adopted by state and local authorities.

On the other hand, two other components of cost may, in fact, add additional financial incentive for substitution across the baseline. As noted above, substituting several facilities for one larger facility may significantly reduce the cost of transporting MSW for combustion. In addition, some combination of landfilling in combination with one or more smaller combustors may provide an even less costly alternative to the planned facility. To the extent that such possibilities are common and significant, substitution across the cutoff would be both more frequent and more attractive than characterized in the quantitative analysis.

Second, the number and size of planned combustor facilities affected by the NSPS may have been over or underestimated in the quantitative analysis. As already noted, the two- or three-year planning horizon for modular facilities makes identifying what would have happened over the five-year planning horizon covered by the economic impact analysis more difficult. Trends toward regional combustor facilities, encouraged by economies of scale in mass burn and other combustion technologies fabricated on site, lend support to the notion that small combustors will provide only a small fraction of future waste combustion. On the other hand, the recent difficulty communities have experienced in obtaining approval for large combustor facilities may ultimately encourage greater reliance on smaller, local combustors where the community served is also the community that produces the MSW. These opposing considerations have not been formally factored into the quantitative analysis developed above.

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A companion report is "Economic Analysis of Materials Separation Requirement," EPA-450/3-91-002 (November 1990).

16. ABSTRACT

EPA is preparing for promulgation under Clean Air Act §111(b) emission standards for new MWCs and, under §111(d), emission guidelines for existing MWCs. The standards and guidelines will apply to MWCs with a capacity to combust 35 or more Mg of municipal solid waste per day. This report updates "Economic Impact of Air Pollutant Emission Standards for New Municipal Waste Combustors," EPA-450/3-89-006 (August 1989), "Economic Impact of Air Pollutant Emission Guidelines for Existing Municipal Waste Combustors," EPA-450/3-89-005 (August 1989), and "Regulatory Impact Analysis of Air Pollutant Emission Standards and Guidelines for Municipal Waste Combustors," EPA, October 1989. This update describes baseline projections of MWCs, economic analysis methodology, national costs and emission reductions attributable to the standards and guidelines, the sensitivity of costs to assumptions about capacity utilization and about materials separation requirements, and how the standards and guidelines may change communities' choices of waste disposal technology.

17. KEY WORDS AND DOCUMENT ANALYSIS

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