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Economic Impact Analysis of Proposed Commercial and Industrial Solid Waste Incineration Regulation

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SECTION 1

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is developing regulations under Sections 111 and 129 of the Clean Air Act for commercial and industrial incineration units that burn nonhazardous solid waste materials. Section 129 requires EPA to develop and adopt "standards of performance" and "emission guidelines" for solid waste incineration units pursuant to Section 111 of the Act. Section 111(b) requires EPA to establish standards of performance for new sources, and Section 111(d) requires EPA to establish procedures for submitting state plans to implement emission guidelines for existing sources. Under Section 129, the standards and guidelines adopted for solid waste incineration units pursuant to Section 111 must reflect maximum achievable control technology (MACT). MACT is the maximum degree of reduction in emissions of specified air pollutants, taking into consideration the cost of achieving the reductions and any nonair quality health and environmental impacts and energy requirements.

Section 129 specifies the following ten pollutants for which emission limits are required: particulate matter, dioxins/furans, HCl, mercury, cadmium, lead, NO_x, SO_2, CO, and opacity. Additionally, Section 129 requires an operator training and certification program and siting criteria for new units. Because there is no major or area source distinction under Section 129, units of all sizes are covered. EPA has developed a definition of nonhazardous solid waste to clarify when a unit is subject to the Section 111 and 129 regulations.

1.1 Scope and Purpose

EPA identified 122 commercial and industrial incinerators located at 112 facilities. Based on these 122 sources and MACT guidelines, the Agency has identified control measures for the facilities to reduce HAP emissions. Control measures implemented to comply with the proposed regulation will impose regulatory costs on affected facilities in the commercial, industrial, and government sectors. The purpose of this report is to evaluate the impact (both negative and positive) of these costs on facilities, the parent companies who own the facilities, and the U.S. economy. Additionally, impacts on small entities are evaluated in compliance with the Regulatory Flexibility Act (RFA) and the Small Business Regulatory Enforcement Fairness Act (SBREFA).

The standards and guidelines will apply to new and existing commercial and industrial solid waste incineration units (CISWI) that burn nonhazardous solid waste. The combustion of hazardous waste under the Resource Conservation and Recovery Act (RCRA) is not covered. Additionally, to avoid any potential for overlapping regulations, incineration units are not covered under the standards and guidelines if they are addressed by regulations in 40 CFR Part 60 for municipal waste combustors (Subparts Cb, Ea, and Eb) or hospital/medical/infectious waste incinerators (Subparts Ce and Ec). Additionally, the standards and guidelines do not apply to incineration units that burn greater than 90 percent by weight pathological waste, which includes human and animal tissue and any associated containers or bedding materials.

The population of affected incinerators used in this analysis was developed from the EPA Inventory Database V.4—Incinerators/Flairs (referred to as the Inventory Database). The incinerators contained in the inventory database are based on information from the Aerometric Information Retrieval System (AIRS) and Ozone Transport Assessment Group (OTAG) databases, state and local permit records, and the combustion source Information Collection Request (ICR) conducted by the agency in 1997. The list of incinerator units contained in the Inventory Database was reviewed and updated by industry and environmental stakeholders as part of the Industrial Combustion Coordinated Rulemaking (ICCR), chartered under the Federal Advisory Committee Act (FACA). Information to support the small business impacts analysis was obtained from the American Business Information database and the Small Business Administration.

1.2 Organization of the Report

The remainder of this report is divided into five sections that support and provide details on the methodology and results of this analysis.

- **Section 2** provides background on waste production and disposal methods. Included is a discussion of incinerator technology and typical emissions and control costs associated with commercial and industrial incinerators.

- **Section 3** profiles the units and facilities affected by the regulation. Included in the profile is a description of the type and quantity of waste being incinerated and alternative waste management methods.

- **Section 4** profiles the industries with the largest number of affected facilities. Included are profiles of the lumber and wood products, paper and allied products, noncellulosic manmade fibers, pharmaceutical, organic chemicals, and fabricated metals industries.

- **Section 5** presents the economic analysis of the proposed regulation. The regulatory control options and associated costs of compliance are described and costs are linked to individual units in the incinerator population. Total cost of compliance is estimated for each regulatory control option, and market impacts are discussed. Alternative waste management options are also discussed in Section 5.

- **Section 6** assesses the firm-level impacts of the proposed regulation, including an initial regulatory flexibility analysis to evaluate the small business effects of the regulation.

SECTION 2

WASTE MANAGEMENT PRACTICES AND WASTE INCINERATORS

This section provides background information on waste management practices and waste incinerators. Included is a discussion of waste incinerator technologies and typical emissions generated by commercial and industrial waste incinerators.

2.1 Background on Waste Management Practices

The U.S. generates more than 360 million tons of solid waste per year. As shown in Table 2-1, California, New York, and Florida are the top three waste generating states in the U.S., as measured in terms of tons per year. Table 2-2 shows recent trends in total waste generated and in recycling and waste disposal methods. In 1998, 61 percent of solid waste was managed using landfills, 9 percent was incinerated, and the remaining 30 percent was recycled (Glenn, 1998).

As shown in Table 2-1, the share of total waste (by tons) incinerated in the U.S. has remained fairly constant since 1991. Currently, the Mid-Atlantic region and the South have the highest incinerator capacity in the country, 27,650 ton/day (tpd) and 27,070 tpd, respectively. These regions are followed by New England with 19,390 tpd and the Great Lakes with 12,505 tpd. Incineration capacity west of the Mississippi is lower than 10,000 tpd. The majority of incinerated wastes in all parts of the country are handled by municipal and commercial waste management organizations and are controlled regulated under separate regulations for municipal waste combustors.

Approximately 80 percent of incinerated waste (by weight) is defined as nonhazardous waste, also known as Subtitle D waste. Subtitle D waste includes any solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, or institutional operations that is not regulated as hazardous under Subtitle C of RCRA. The large majority of Subtitle D waste is handed by municipal or private waste management organizations. A survey of industrial Subtitle D establishments found that approximately three-fourths of the waste management practices of Subtitle D establishments include off-site

Table 2-1. Solid Waste Generation Recycling and Disposal Methods by State

State	Solid Waste (tons/yr)	Recycled[a] (%)	Incinerated (%)	Landfilled (%)
Alabama[b]	5,549,000	23	5	72
Alaska	560,000	7	15	78
Arizona[b]	5,700,000	18	0	82
Arkansas[b]	4,287,000	36	1	63
California[b,c]	45,000,000	30	0	70
Colorado[d]	3,084,000	18e	0	82
Connecticut[d]	2,950,000	23	60	17
Delaware[b]	1,189,000	31	20	49
Dist. of Columbia	246,000	8	92	0
Florida[d,f]	23,617,000	40	17	43
Georgia[b]	14,645,000	33	1	66
Hawaii[b,c]	2,125,000	25	27	48
Idaho[b]	886,000	n/a	n/a	n/a
Illinois[b,f]	13,386,000	28	0	72
Indiana[d,f]	7,171,000	23	10	67
Iowa[b]	3,462,000	32	1	67
Kansas[g]	4,250,000	11	0	89
Kentucky[c]	4,418,000	28	0	72
Louisiana[c]	3,894,000	14	0	86
Maine[f,g]	1,339,000	41	40	19
Maryland[b,d]	5,329,000	29	23	48
Massachusetts[d]	7,160,000	33	45	22
Michigan[b,c]	13,500,000	25	10	65
Minnesota[d]	4,780,000	42	30	28
Mississippi[b,d]	2,360,000	13	4	83
Missouri[b,d]	7,896,000	33	0	67
Montana[b,d]	1,039,000	5	2	93
Nebraska[b,g]	2,000,000	27	0	73
Nevada[b]	3,955,000	15	0	85
New Hampshire[b,f]	1,200,000	25	14	61
New Jersey[d]	8,200,000	45	18	37
New Mexico[b,d]	1,400,000	12	0	88
New York[b,g]	28,800,000	39	12	49
North Carolina[b,c]	9,843,000	26	1	73
North Dakota[f]	510,000	21	0	79
Ohio[d]	12,339,000	19	1	80
Oklahoma[d]	2,500,000	12	10	78
Oregon[d,f]	3,836,000	28	7	65
Pennsylvania[d]	9,440,000	26	21	53
Rhode Island	477,000	23	0	77
South Carolina[b,c]	8,361,000	34	3	63
South Dakota[b]	510,000	42	0	58
Tennessee[b,d]	9,496,000	40	4	56
Texas[b,d]	21,738,000	n/a	n/a	n/a
Utah[b,d]	3,760,000	19	8	73
Vermont[b,d]	600,000	30	15	55
Virginia	9,000,000	35	18	47
Washington[d]	6,527,000	48	4	48
West Virginia[c]	2,000,000	20	0	80
Wisconsin[g]	3,622,000	36	3	61
Wyoming	530,000	5	0	95
Total	340,466,000	30	9	61

[a]Includes yard trimmings composting; [b]includes industrial and/or construction and demolition debris waste disposed of at MSW facilities; [c]based on FY1996-97 data; [d]based on 1996 data; [e]no official estimate—based on Recycle Colorado and BioCycle data; [f]based on 1995 data; [g]based on 1990 data

Table 2-2. National Waste Generation, Recycling, Incineration, and Landfilling Rates (1988-1998)

Waste Survey Year	Total Tons Generated	Recycled[a] (%)	Incinerated (%)	Landfilled (%)
1989	250,000,000	n/a	n/a	n/a
1990	269,000,000	8	8	84
1991	293,613,000	11.5	11.5	77
1992	280,675,000	14	10	76
1993	291,742,000	17	11	72
1994	306,866,000	19	10	71
1995	322,879,000	23	10	67
1996	326,709,000	27	10	63
1997	327,460,000	28	10	62
1998	340,466,000	30	9	61

[a]Includes yard trimmings composting.
n/a = not available
Source: Glenn, Jim. 1998. "The State of Garbage: A BioCycle Nationwide Survey, Part I." *BioCycle* 39(4):32-43.

waste management. Table 2-3 indicates the percentage of U.S. facilities engaging in different waste management practices. Land- based waste management practices account for the large majority of on-site waste management activities.

As shown in Table 2-3, less than one percent of the industrial facilities surveyed in 1981 used incineration as a waste management practice. In addition, based on information from the 1997 combustion source ICR, a significant number of incineration units have been shut down between 1985 and 1995, with most of this waste being switched to land-based management practices, such as on-site and off-site landfills.

2.2 Incinerator Technology

Industrial and commercial incinerators vary greatly in size, capacity, technology, and materials combusted (EPA, 1998). However, the majority have capacities between 150 and 2,000 pounds per hour and are of single or multiple chamber design. Typically, these incinerators are manually charged and intermittently fed. A few industrial incinerators are on par with municipal waste combustors in both size and capacity (EPA, 1993). The most

Table 2-3. Facilities Engaged in Waste Management Practices

Waste Management Practice	Number of Facilities Engaging in Management Practice	Percentage of Facilities Engaging in Management Practice	Metric tons of Subtitle D Waste (millions)
On-site Landfills	2,321	3.2%	78.4
On-site Surface Impoundments	6,680	9.2%	6,700.0
On-site Land Application Units	2,136	3.9%	90.1
On-site Waste Piles	4,204	5.8%	69.9
On-site Recycling/ Reclaim/Reuses	4,608	6.4%	n/a
On-site Incineration	463	0.6%	n/a
On-site Tank Treatment	1,683	2.3%	n/a
Off-site Practices[a]	54,409	75.1%	n/a
Others[b]	8,023	11.1%	n/a

[a]Sold or sent off-site for management.
[b]Includes unspecified practices, on-site underground injection, and underground boilers.
n/a = Not available
Source: Schroeder, Kirsten, Robert Clickner, and Esther Miller. 1987. *Screening Survey of Industrial Subtitle D Establishments: Draft Final Report.* Submitted to EPA, Office of Solid Waste under contract number 68-01-7359.

common types of commercial and industrial nonhazardous waste incinerators are described below.

2.2.1 Excess Air

In excess air incinerators, waste is batch fed into a primary chamber and moved through the unit by hydraulic transfer rams, oscillating grates, or a revolving hearth. As materials combust, bottom ash may be discharged to a wet quench pit, and recirculated combustion air and flue gas may help maintain desired temperatures. In some incinerators, a secondary chamber provides additional flue gas residence time for improved fuel/carbon burnout. Some facilities recover energy by sending waste heat to a boiler.

2.2.2 Starved Air

Waste is batch fed into a starved air incinerator's primary chamber and moved through by either hydraulic transfer rams or reciprocating grates. Bottom ash may be discharged into a wet quench pit. Gases flow into a secondary chamber where they may be recharged and circulated back into the primary chamber. As with excess air incinerators, starved air incinerators may also send waste heat to a boiler for energy recovery. The two types differ in that starved air units operate using less air in the primary chamber (EPA, 1993).

2.2.3 Air Curtain

Also known as trench combustors, air curtain incinerators forcefully project a curtain of air across a pit in which open burning occurs (EPA, 1993). The air curtain is meant to increase combustion efficiency while reducing smoke and emissions of particulate matter. The waste may also be underfired with air to decrease the amount of time needed for complete combustion. These units are commonly used to combust wood wastes, yard wastes, and clean lumber.

2.2.4 Fluidized Bed

In a fluidized bed incinerator, waste is either continuously or batch fed into a combuster vessel equipped with a gas distribution plate. An undergird air windbox at the bottom fluidizes the combustion bed. Undergird air is maintained at a high flow rate to optimize combustion. Overfire air may be used to decrease the amount of time needed for combustion.

2.2.5 Rotary Kiln

A rotary kiln incinerator is a steel shell slightly tilted on its horizontal axis into which waste materials are typically batch fed. As the shell rotates, hot air is introduced into the chamber and the waste material is "tumbled" by its own gravity. Rotation and length and slope of the kiln determine the time needed for materials to combust (Santoleri, 1992). Rotary kiln incinerators evolved from kilns used in the lime, cement, and aggregate industries. They are generally considered to be the most flexible incineration systems (Santoleri, 1992).

Other less common incineration technologies include open burn, liquid injection, rotary hearth, and fixed hearth.

2.3 Incinerator Emissions

Emissions from incinerators vary by incinerator type and materials combusted. Consistent with Section 129, the ICCR Coordinating Committee (EPA, 1998) recommended six general emissions categories for municipal, industrial, and commercial incinerators:

2.3.1 Particulate Matter

The amount of particulate matter (PM) generated depends on the waste characteristics, physical nature of the incinerator design, and the incinerator's operation. During operation, solid flyash from incombustible matter in the unit may be released with the flue gas.

2.3.2 Metals

Metals enter the incinerator through the waste stream. During combustion, metals may be emitted in gaseous form or condense onto PM.

2.3.3 Acid Gases

The chief acid gases of concern are hydrogen chloride (HCl) and sulfur dioxide (SO_2). The presence of HCl and SO_2 in the flue gas is related to the amount of chlorine and sulfur in the combusting materials and combustion air. HCl derives from the chlorine in wastes such as paper products and plastics. SO_2 develops when items such as asphalt shingles, gypsum products, some paper products, rubber, and other materials containing sulfur are combusted.

2.3.4 Carbon Monoxide

Carbon monoxide (CO) develops from carbon not fully oxidized into carbon dioxide (CO_2). CO can be a good indicator of combustion efficiency. For example, high levels of CO might indicate that sufficiently high temperatures inside the unit were not maintained long enough to completely convert CO to CO_2. Oxygen and air distribution vary by incinerator type, causing levels of CO to vary as well.

2.3.5 Nitrogen Oxides

Nitrogen oxides (NO_x) are formed during most combustion processes. For incinerators, NO_x is generated from oxidation of nitrogen in the wastes and from fixation of atmospheric nitrogen.

2.3.6 Organic Compounds

A host of toxic organic compounds exists in the waste or is generated during combustion. They may condense, be absorbed onto PM, or be emitted as gases.

SECTION 3

PROFILES OF AFFECTED UNITS AND FACILITIES

EPA identified 122 commercial, industrial, and government incinerators located at 112 facilities that combust nonhazardous solid wastes. The population of affected incinerators included in the economic impact analysis was developed from the EPA Inventory Database V.4—Incinerators/Flairs (referred to as the Inventory Database). The list of incinerators contained in this database was developed from information in the AIRS and OTAG databases, state and local permit records, and the combustion source ICR conducted by the agency. The incinerator units contained in the EPA Inventory Database were reviewed by industry and environmental stakeholders as part of the ICCR FACA process. In addition, stakeholders contributed to the Inventory Database by identifying and including omitted units.

3.1 Affected Units

Incinerators listed in the Inventory Database range in capacity from 6 to 40,000 pounds per hour. Figure 3-1 presents the distribution of units by capacity. Over half of the units have capacities between 150 and 2,000 pounds per hour. Only two units have capacities greater than 10,000 pounds per hour.

Figure 3-2 presents a summary of key characteristics for the incinerator units in the Inventory Database. The majority of the units in the database have more than one chamber and approximately two thirds of incinerator units in the database are described as being either intermittently or single-batch fed. One third of the units are continuously fed; two of these units incorporate automatic feeding technology. As shown in Figure 3-2c, over half of the units burn solid materials.

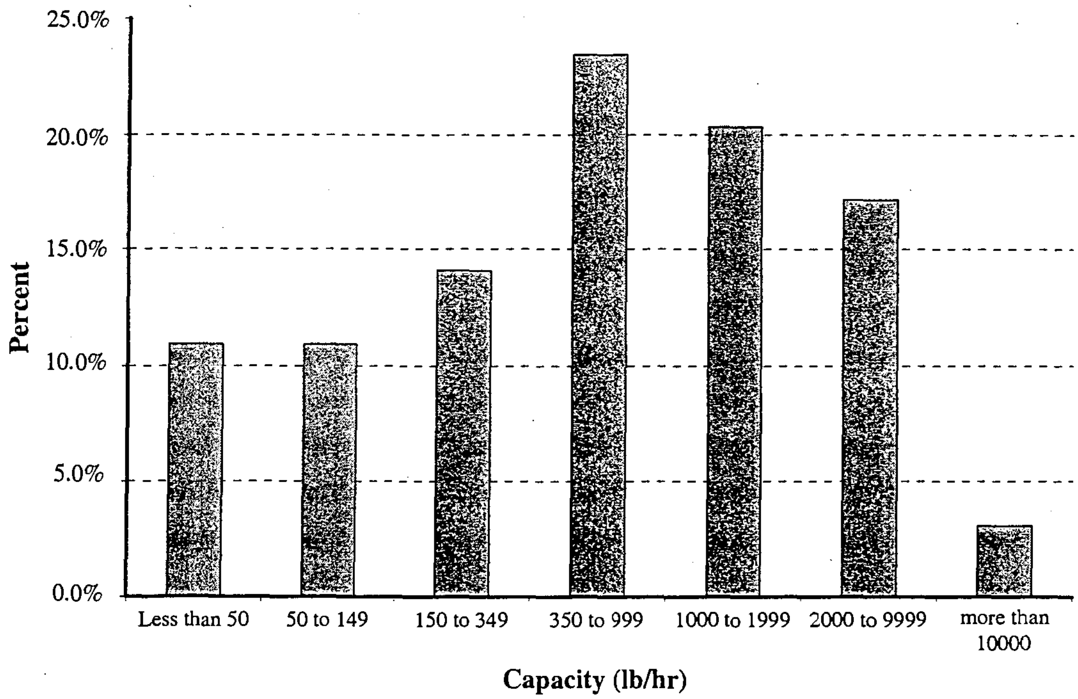

Figure 3-1. Distribution of Incinerator Unit Capacity in the Inventory Database

Of the many types of incinerators in the Inventory Database, most are classified as excess air technology incinerators. Other incinerator technologies represented in the database include fixed hearth, starved air, rotary kiln, and fluidized bed technologies. Table 3-1 shows the number of each type of incinerator in the database.

3.2 Affected Facilities

The 122 incinerator units identified in the Inventory Database are located at 112 facilities. Table 3-2 presents the distribution of units and facilities by industry grouping. The chemical industry accounts for approximately 30 percent of affected units and 28 percent of affected facilities. Table 3-3 presents a breakdown of the affected facilities for SIC code 28 (chemical industry). Pharmaceuticals, inorganic chemicals, man-made fibers, and

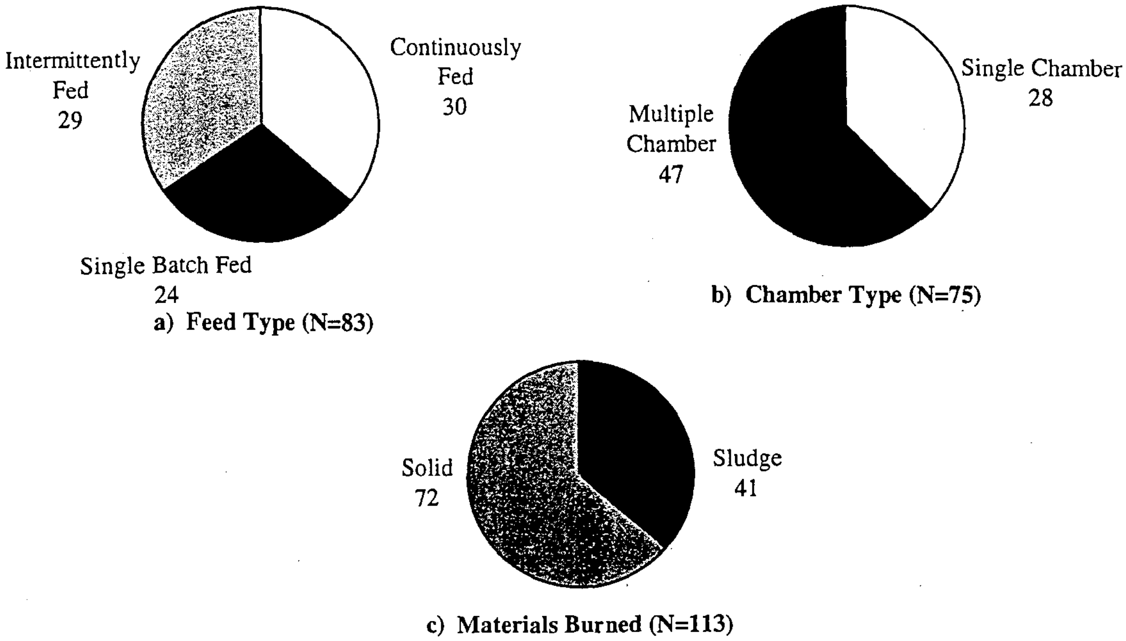

Figure 3-2. Characteristics of Incinerator Units in the Inventory Database

Note: Due to nonresponses, totals do not sum to 122.

plastics account for the majority of the units for SIC 28. The chemical industry also has the highest number of incinerators per facility, averaging 1.2 units per facility. Most other industries tend to have one incinerator per facility.

Other two-digit SIC code industries with more that three affected units include pulp and paper, wood products, and fabricated metal. These industries, along with the pharmaceutical, inorganic chemicals, and man-made fibers industries are profiled in Section 4.

3.3 Waste Incinerated and Alternative Management Practices

There is substantial variation in the quantity and type of waste being incinerated by units contained in the Inventory Database, reflecting the substantial diversity across the affected industries. Table 3-4 lists the type of principal waste being incinerated. Facilities burning waste petroleum products account for approximately 10 percent of facilities for

Table 3-1. Incineration Technologies in Inventory Database

Technology	Number in Database[a]
Excess Air	39
Fixed Hearth	16
Starved Air	12
Rotary Kiln	7
Fluidized Bed	4
Air Curtain (Forced Air; Trench Combuster)	3
Rotary Hearth	2
Liquid Injection	1
Open Burn	1

[a]Total number of units does not total to 122 because of nonresponses.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through-4b5. Research Triangle Park, North Carolina. September 16-17.

which information was available. Appendix A contains a more detailed description the wastes included in each category in Table 3-4.

As shown in Table 3-5, wood products and pharmaceuticals account for the majority of industrial waste being incinerated as measured by annual tons. Based on information in the Inventory Database, waste wood products account for over 2,300 tons per year and waste chemical products account for over 1,000 tons per year. Pharmaceutical products (medicines and packaging) that have been returned or have expired also account for a large share of waste chemical products being incinerated.

Table 3-2. Affected Facilities by Industry Grouping and Government Sector

SIC		# Facilities
07	Agricultural Services	3
13	Oil & Gas Extraction	2
20	Food & Kindred Products	1
22	Textile Mill Products	2
23	Apparel	1
24	Lumber & Wood Products	8
25	Furniture & Fixtures	1
26	Paper & Allied Products	6
27	Printing & Publishing	1
28	Chemicals & Allied Products	32
30	Rubber & Misc. Plastics	2
32	Stone, Clay, Glass, & Concrete Products	1
33	Primary Metals Industries	1
34	Fabricated Metal Products	9
35	Industrial & Commercial Machinery	3
36	Electronic Equipment	2
37	Transportation Equipment	4
40	Railroad Transportation	2
42	Motor Freight Transport & Warehousing	1
49	Electric, Gas, & Sanitary Services	3
50	Durable Goods Wholesale Trade	3
51	Nondurable Goods Wholesale Trade	1
55	Automotive Dealers & Gas Stations	1
76	Misc. Repair Services	1
87	Engineering	1
State	State Governments	2
City	City Governments	5
Military	Armed Services	8
University	Universities	5
Total		112

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

Table 3-3. Breakdown of Affected Facilities in the Chemical Industry

SIC	Description	# Units	# Facilities
2800	C&AP—Unclassified	3	2
2821	Plastics Materials, Synthetic Resins, & Nonvulcanizable Elastomers	5	4
2822	Synthetic Rubber, Vulcanizable Elastomers	1	1
2824	Man-Made Organic Fibers, Except Cellulosic	5	3
2833	Medicinal Chemicals & Botanical Products	4	3
2834	Pharmaceutical Preparations	8	8
2869	Industrial Organic Chemicals, N.E.C.	6	6
2875	Fertilizers, Mixing Only	1	1
2879	Pesticides & Agricultural Chemicals, N.E.C.	2	2
2895	Carbon Black	2	2
Total		37	32

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

Table 3-4. Type of Waste Being Incinerated

Type of Waste	Number of Facilities[a]
Organic Sludge	3
Fumes and Gases	6
Waste Petroleum Products	8
Pharmaceutical Products	8
Paint Products	8
Paper and Wood Products	11
Other Biomass Products	6
Other	29

[a]Due to nonresponses, the total number of facilities does not equal 112.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through-4b5. Research Triangle Park, North Carolina. September 16-17.

Table 3-5. Quantity of Waste Being Incinerated by Business Category[a]

Industry (SIC)	# Units	Average Unit Tons/year	Total Industry Tons/year	Maximum Unit Tons/year	Minimum Unit Tons/year
Oil & Gas Extraction (13)	2	41.9	83.8	75.0	8.8
Food (20)	1	26.0	26.0	26.0	26.0
Textile & Apparel (22 & 23)	1	1,617.8	1,612.8	1,612.8	1,612.8
Wood & Paper (24, 25, 26, & 27)	9	4,698.5	42,286.1	30,300.8	138.0
Chemicals (28)	24	1,590.7	38,175.8	3,647	3.0
Rubber (30)	1	1,275.3	1,275.3	1,275.3	1,275.3
Metals (33 & 34)	5	152.3	761.6	540.0	5.0
Equipment (35, 36, & 37)	6	42.0	251.8	112.5	3.6
Trans., Comm., Elec., Gas & San. Svcs. (40s)	3	2,835.5	8,506.6	8,400.0	1.6
Government Facilities	9	248.4	2,235.7	1,248.0	0.3
Universities	5	73.7	368.7	256.23	14.04

[a]Due to nonresponses, the total number of facilities does not equal 112.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

SECTION 4

PROFILES OF AFFECTED INDUSTRIES

This section contains profiles of the major industries affected by the proposed commercial and industrial waste incinerator regulation. Included are profiles of the following industries:

- Lumber and Wood Products (SIC 24),
- Paper and Allied Products (SIC 26),
- Noncellulosic Man-Made Fibers (SIC 2824),
- Pharmaceutical Preparations, Medicinal Chemicals, and Botanical Products (SIC 2833, 2834),
- Industrial Organic Chemicals (SIC 2869), and
- Fabricated Metals (SIC 34).

4.1 Lumber and Wood Products (SIC 24)

The lumber and wood products industry is comprised of a large number of establishments engaged in logging, operating sawmills and planing mills, and manufacturing structural wood panels, wooden containers, and other wood products. Table 4-1 lists the lumber and wood products markets that are likely to be affected by the commercial and industrial waste incinerator proposed regulation. Most products are produced for the domestic market, but exports increasingly account for a larger proportion of sales (DRI et al., 1998). The largest consumers of lumber and wood products are the remodeling and construction industries.

In 1996, the lumber and wood products industry's total value of shipments was $85,724.0 million. As seen in Table 4-2, shipment values increased steadily through the late 1980s before declining slightly through the early 1990s as new construction starts and furniture purchases declined (DRI et al., 1998). Shipment values recovered, however, as the economy expanded in the mid-1990s.

Table 4-1. Lumber and Wood Products Markets Likely to Be Affected by the Regulation

SIC	Description
2421	Sawmills and Planing Mills, General
2434	Wood Kitchen Cabinets
2449	Wood Containers, N.E.C.
2491	Wood Preserving
2493	Reconstituted Wood Products
2499	Wood Products, N.E.C.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

Table 4-2. Value of Shipments for the Lumber and Wood Products Industry (SIC 24), 1987-1996

Year	Value of Shipments (1992 $million)
1987	85,383.4
1988	85,381.2
1989	85,656.8
1990	86,203.0
1991	81,666.0
1992	81,564.8
1993	74,379.6
1994	79,602.0
1995	87,574.6
1996	85,724.0

Sources: U.S. Department of Commerce, Bureau of the Census. 1996b. *1992 Census of Manufactures, Subject Series: General Summary*. Washington, DC: General Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures [Multiple Years]*. Washington, DC: Government Printing Office.

4.1.1 *Supply Side of the Industry*

4.1.1.1 *Production Processes*

Sawn lumber. Sawn lumber is softwood or hardwood trimmed at a sawmill for future uses in construction, flooring, furniture, or other markets. Softwoods, such as douglas fir and spruce, are used for framing in residential or light-commercial construction. Hardwoods, such as maple and oak, are used in flooring, furniture, crating, and other applications.

Lumber is prepared at mills using a four-step process. First, logs are debarked and trimmed into cants, or partially finished lumber. The cants are then cut to specific lengths. Logs are generally kept wet during storage to prevent cracking and to keep them supple. However, after being cut, the boards undergo a drying process, either in open air or in a kiln, to reduce the moisture content. The drying process may take several months and varies according to the plant's climate and the process used. Finally, the lumber may be treated with a surface protectant to prevent sap stains and prepare it for export (EPA, 1995a).

Reconstituted wood products. Reconstituted wood products, such as particleboard, medium density fiberboard, hardboard, and oriented strandboard, are made from raw wood that is combined with resins and other additives and processed into boards. The size of the wood particles used varies from sawdust to strands of wood. Once combined, the ingredients are formed into a mat and then, at high temperatures, pressed into a board. A final finishing process prepares the boards for delivery.

Wood preserving. Wood is treated with preservative to protect it from mechanical, physical, and chemical influences (EPA, 1995a). Treatment agents are either water-based inorganics, such as copper arsenate (78 percent), or oil-borne organics, such as creosote (21 percent) (EPA, 1995a). Wood preservatives are usually applied using a pressure treatment process or a dipping tank. Producers achieve the best results when the lumber's moisture content is reduced to a point where the preservative can be easily soaked into the wood. Treated wood is then placed in a kiln or stacked in a low-humidity climate to dry.

4.1.1.2 *Types of Output*

The lumber and wood products industry produces essential inputs into the construction, remodeling, and furniture sectors. Lumber and reconstituted wood products are produced in an array of sizes and can be treated to enhance their value and shelf-life. These products are intermediate goods; they are purchased by other industries and incorporated into higher value-added products. In addition to sawmills, the lumber and wood products industry includes kitchen cabinets, wood containers, and other wooden products used for fabricating finished goods for immediate consumption.

4.1.1.3 Major By-Products and Co-Products

Shavings, sawdust, and wood chips are the principal co-products of sawn lumber. Paper mills and reconstituted wood products frequently purchase this material as an input. By-products are limited to emissions from the drying process and from use of preservatives.

Very little solid waste is generated by reconstituted wood products manufacturing. Because the production process incorporates all parts of the sawn log, little is left over as waste. However, air emissions from dryers are a source of emissions.

Wood preserving results in two types of by-products: air emissions and process debris. As preservatives dry, either in a kiln or outside, they emit various chemicals into the air. At plants with dipping processes, wood chips, stones, and other debris build up in the dipping tank. The debris is routinely collected and disposed of.

Based on the Inventory Database, eight units at lumber and wood products plants incinerate some portion of their industrial waste (Table 4-3). Generally, units are incinerating unreclaimed sawdust, chips, filters, dust, and natural gas. For the three units for which capacity information is available, approximately 2,340.5 tons of material are incinerated annually.

4.1.1.4 Costs of Production

The costs of production for the wood products industry fluctuate with the demand for the industry's products. Most notably, the costs of production steadily declined during the early 1990s as recession stifled furniture purchases and new housing starts (see Table 4-4). Overall, employment in the lumber and wood products industry increased approximately 6 percent from 1987 to 1996. During this same period payroll costs decreased 12 percent, indicating a decrease in average annual income per employee. New capital investment and costs of materials generally moved in tandem over the 10-year-period, increasing from 1987 to 1990 and 1994 to 1996 and decreasing 1991 to 1993.

Table 4-3. Wastes and By-Products Incinerated at Lumber and Wood Products Facilities

Facility Name	SIC	Materials Combusted	Percentage Annual Input[a]	Waste Description
Atlantic Wood Industries, Inc.	2491	Wood: Timber: Mostly Bark	100	
Burroughs-Ross Colville Company	2499	Wood: Timber: Little Bark	100	
Haas Cabinets	2434	Industrial Solid Waste, N.H.	95	Fiberglass overspray filters loaded with overspray from finish system
		Natural Gas	5	
Home-Crest Corporation	2434	Industrial Solid Waste, N.H.	70	Paint filters and varnish dust
		Natural Gas	30	
L.D. McFarland	2499	Wood: Timber: Mostly Bark	100	
La. Skid & Pallet Company of BR	2449	No. 4 Fuel Oil	1	
		Wood: Dried Milled Lumber	99	
Service Products, Inc.	2493	Natural Gas	10	
		Wood Adulterated Coproduct	90	Hardboard
Zosel Lumber Company	2421	Wood: Timber: Mostly Bark	100	

[a]Calculated on a volume basis.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

4.1.1.5 Capacity Utilization

Full production capacity is broadly defined as the maximum level of production an establishment can obtain under normal operating conditions. The capacity utilization ratio is the ratio of the actual production level to the full production level. Table 4-5 presents the historical trends in capacity utilization for the lumber and wood products industry. The varying capacity utilization ratios reflect adjusting production levels and new production

Table 4-4. Inputs for the Lumber and Wood Products Industry (SIC 24), 1987-1996

Year	Labor: Quantity (thousands)	Labor: Payroll (1992 $million)	Materials (1992 $million)	New Capital Investment (1992 $million)
		SIC 24, Lumber and Wood Products		
1987	698.4	15,555.5	50,509.2	2,234.3
1988	702.4	15,800.0	51,341.0	2,099.4
1989	684.2	15,381.3	51,742.2	2,329.9
1990	677.7	15,612.9	53,369.0	2,315.3
1991	623.6	14,675.8	50,416.3	2,006.5
1992	655.8	13,881.8	48,570.0	1,760.1
1993	685.4	11,798.9	45,300.3	1,538.1
1994	718.5	12,212.5	48,535.6	1,956.8
1995	740.2	13,915.4	53,732.9	2,553.1
1996	738.7	13,933.7	52,450.1	2,659.9

Sources: U.S. Department of Commerce, Bureau of the Census. 1996b. *1992 Census of Manufactures, Subject Series: General Summary*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures [Multiple Years]*. Washington, DC: Government Printing Office.

Table 4-5. Capacity Utilization Ratios for Lumber and Wood Products Industry, 1991 to 1996

1991	1992	1993	1994	1995	1996
78	80	81	80	77	78

Source: U.S. Department of Commerce, Bureau of the Census. 1998. *Survey of Plant Capacity: 1996*. Washington, DC: Government Printing Office.

facilities going on- or off-line. The capacity utilization ratio for the industry in 1996 was 78; the 6-year average was 79.

4.1.2 Demand Side of the Industry

4.1.2.1 Product Characteristics

Lumber and wood products are valued both for their physical attributes and their relative low-cost. Woods are available in varying degrees of durability, shades, and sizes and can be easily shaped. Lumber and wood products have long been the principal raw materials for the residential and light commercial construction industries, the remodeling industry, and the furniture industry. Wood is readily available because over one-third of the United States is forested. The ready supply of wood reduces its costs.

4.1.2.2 Uses and Consumers of Products

Lumber and wood products are used in a wide range of applications, including: residential and noresidential construction; repair/remodeling and home improvement projects; manufactured housing; millwork and wood products; pulp, paper, and paperboard mills; toys and sporting goods; kitchen cabinets; crates and other wooden containers; office and household furniture; and motor homes and recreational vehicles (DRI et al., 1998).

4.1.3 Organization of the Industry

4.1.3.1 Firm Characteristics

In 1992, 33,878 companies produced lumber and wood products and operated 35,807 facilities, as shown in Table 4-6. By way of comparison, in 1987, 32,014 companies controlled 33,987 facilities. About two-thirds of all establishments have nine or fewer employees. Between 1987 and 1992, the number of facilities with nine or fewer employees increased more than 10 percent to 23,590. These facilities' share of the value of shipments increased about 18.3 percent. Although the number of establishments employing 100 to 249 people decreased during that time, that category's shipment value jumped nearly 40 percent. The remaining facility categories lost both facilities and value of shipment.

Table 4-6. Size of Establishments and Value of Shipments for the Lumber and Wood Products Industry (SIC 24)

	1987		1992	
Average Number of Employees in Establishment	Number of Facilities	Value of Shipments (1992 $million)	Number of Facilities	Value of Shipments (1992 $million)
1 to 4 employees	14,562	2,769.7	15,921	3,288.9
5 to 9 employees	6,702	4,264.4	7,669	5,030.4
10 to 19 employees	5,353	6,982.3	5,331	6,902.8
20 to 49 employees	4,160	28,551.3	3,924	26,964.9
50 to 99 employees	1,702	(D)	1,615	(D)
100 to 249 employees	1,190	24,583.3	1,082	34,051.4
250 to 499 employees	260	12,093.4	219	(D)
500 to 999 employees	47	3,907.9	39	3,331.4
1,000 to 2,499 employees	4	2,231.3	4	598.6
2,500 or more employees	2	(D)	3	1,396.4
Total	33,987	85,383.4	35,807	81,564.8

(D) = undisclosed

Sources: U.S. Department of Commerce, Bureau of the Census. 1991. *1987 Census of Manufactures, Subject Series: General Summary*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1996b. *1992 Census of Manufactures, Subject Series: General Summary*. Washington, DC: Government Printing Office.

Market structure can affect the size and distribution of regulatory impacts. Concentration ratios are often used to evaluate the degree of competition in a market, with low concentration indicating the presence of a competitive market, and higher concentration suggesting less competitive markets. Firms in less-concentrated industries are more likely to be price takers, while firms in more-concentrated industries are more likely to influence market prices. Typical measures include four- and eight-firm concentration ratios (CR4 and CR8) and Herfindahl-Hirschman indices (HHI). The four-firm concentration ratios for lumber and wood products subsectors represented in the incinerator inventory database range between 13 and 50, meaning that, in each subsector, the top firms' combined sales ranged from 13 to 50 percent of that respective subsector's total sales. The eight-firm concentration ratios ranged from 47 to 66 (U.S. Dept. of Commerce, 1995b). The CR4 and CR8 indicate that a few firms control 50 percent or less of the market.

Although there is no objective criterion for determining market structure based on the values of concentration ratios, the 1992 Department of Justice's (DOJ's) Horizontal Merger Guidelines provide criteria for doing so based on HHIs. According to these criteria, industries with HHIs below 1,000 are considered unconcentrated (i.e., more competitive), those with HHIs between 1,000 and 1,800 are considered moderately concentrated (i.e., moderately competitive), and those with HHIs above 1,800 are considered highly concentrated (i.e., less competitive) (DOJ, 1992). Firms in less-concentrated industries are more likely to be price takers, while firms in more-concentrated industries are more likely to be able to influence market prices. The unconcentrated nature of the markets is also indicated by HHIs of 1,000 or less (DOJ, 1992). Table 4-7 presents various measures of market concentration for sectors within the lumber and wood products industry. All lumber and wood products industries are considered unconcentrated and competitive.

4.1.4 Markets and Trends

The U.S. market for lumber and wood products is maturing, and manufacturers are looking to enter other markets. Although 91 percent of the industry's products are consumed by the U.S. domestic market, the share of exports increases each year. Exports more than doubled in value from $3 billion in 1986 to $7.3 billion in 1996 (DRI et al., 1998). The U.S. market grew only 2 percent during that time frame. American manufacturers are focusing on growing construction markets in Canada, Mexico, and the Pacific Rim, with products such as durable hardwood veneer products and reconstituted wood boards (EPA, 1995a).

4.2 Paper and Allied Products (SIC 26)

The paper and allied products industry is one of the largest manufacturing industries in the United States. In 1996, the industry shipped nearly $150 billion in paper commodities. The industry produces a wide range of wood pulp, primary paper products, and paperboard products such as: printing and writing papers, industrial papers, tissues, container board, and boxboard. The industry also includes manufacturers that "convert"primary paper and paperboard into finished products like envelopes, packaging, and shipping containers (EPA,

Table 4-7. Measures of Market Concentration for Lumber and Wood Products Markets

SIC	Description	CR4	CR8	HHI	Number of Companies	Number of Facilities
2421	Saw Mills and Planing Mills	14	20	78	5,302	6004
2434	Wood Kitchen Cabinets	19	25	156	4,303	4323
2449	Wood Containers, N.E.C.	34	47	414	217	225
2491	Wood Preserving	17	28	152	408	486
2493	Reconstituted Wood Products	50	66	765	193	288
2499	Wood Products, N.E.C.	13	19	70	2,656	2754

Sources: U.S. Department of Commerce, Bureau of the Census. 1995b. *1992 Concentration Ratios in Manufacturing*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1996b. *1992 Census of Manufactures, Subject Series: General Summary*. Washington, DC: Government Printing Office.

1995b). Paper and allied products industry subsectors that are likely to be affected by the commercial and industrial waste incinerator proposed regulation are listed in Table 4-8.

Table 4-8. Paper and Allied Products Industry Markets Likely to Be Affected by Regulation

SIC	Industry Description
2611	Pulp Mills
2621	Paper Mills
2676	Sanitary Paper Products

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

Table 4-9 lists the paper and allied products industry's value of shipments from 1987 to 1996. The industry's performance is tied to raw material prices, labor conditions, and worldwide inventories and demand (EPA, 1995b). Performance over the 10-year period was typical of most manufacturing industries. The industry expanded in the late 1980s, then contracted as demand tapered off as the industry suffered recessionary effects. In the two years after 1994, the industry's value of shipments increased 9.3 percent to $149.5 billion.

Table 4-9. Value of Shipments for the Paper and Allied Products Industry (SIC 26), 1987-1996

Year	Value of Shipments (1992 $million)
1987	129,927.8
1988	136,829.4
1989	138,978.3
1990	136,175.7
1991	132,225.0
1992	133,200.7
1993	131,362.2
1994	136,879.9
1995	135,470.3
1996	149,517.1

Sources: U.S. Department of Commerce, Bureau of the Census. 1996b. *1992 Census of Manufactures, Subject Series: General Summary*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures, [Multiple Years]*. Washington, DC: Government Printing Office.

4.2.1 Supply Side of the Industry

4.2.1.1 Production Process

The manufacturing paper and allied products industry is capital- and resource-intensive, consuming large amounts of pulp wood and water in the manufacturing process. Approximately half of all paper and allied products establishments are integrated facilities, meaning that they produce both pulp and paper on-site. The remaining half produce only paper products; few facilities produce only pulp (EPA, 1995b).

The paper and paperboard manufacturing process can be divided into three general steps: pulp making, pulp processing, and paper/paperboard production. Paper and paperboard are manufactured using what is essentially the same process. The principal difference between the two products is that paperboard is thicker than paper's 0.3 mm.

Producers manufacture pulp mixtures by using chemicals, machines, or both to reduce raw material into small fibers. In the case of wood, the most common pulping material, chemical pulping actions release cellulose fibers by selectively destroying the chemical bonds that bind the fibers together (EPA, 1995b). Impurities are removed from the pulp which then may be bleached to improve brightness. Only about 20 percent of pulp and paper mills practice bleaching (EPA, 1995b). The pulp may also be further processed to aid in the paper-making process.

During the paper-making stage, the pulp is strengthened and then converted into paper. Pulp can be combined with dyes, resins, filler materials, or other additives to better fulfill specifications for the final product. Next, the water is removed from the pulp, leaving the pulp on a wire or wire mesh conveyor. The fibers bond together as they are carried through heated presses and rollers. The paper is stored on large rolls before being shipped for conversion into another product, such as envelopes and boxes, or cut into paper sheets for immediate consumption.

4.2.1.2 Types of Output

The paper and allied products industry's output ranges from writing papers to containers and packaging. Paper products include: printing and writing papers; paperboard boxes; corrugated and solid fiber boxes; fiber cans, drums, and similar products; sanitary food containers; building paper; packaging; bags; sanitary paper napkins; envelopes; stationary products; and other converted paper products.

4.2.1.3 Major By-Products and Co-Products

The paper and allied products industry is the largest user of industrial process water in the U.S. In 1988, a typical mill used between 16,000 and 17,000 gallons of water per ton of paper produced. The equivalent amount of waste water discharged each day is about 16 million cubic meters (EPA, 1995b). Most facilities operate waste water treatment facilities on site to remove biological oxygen demand (BOD), total suspended solids (TSS), and other pollutants before discharging the water into a nearby waterway.

Based on the Inventory Database, six units at pulp and paper facilities incinerate some portion of their industrial waste (Table 4-10). Generally, units are incinerating fuels, industrial wastewater sludge, process gases, and process liquids. For the three units for which capacity information is available, approximately 36,060 tons of material are incinerated annually.

4.2.1.4 Costs of Production

Historical statistics for the costs of production for the paper and allied products industry are listed in Table 4-11. From 1987 to 1996, industry payroll generally ranged from approximately $19 to 20 billion. Employment peaked at 633,200 persons in 1989 and declined slightly to 630,600 persons by 1996. Materials costs averaged $74.4 billion a year and new capital investment averaged $8.3 billion a year.

4.2.1.5 Capacity Utilization

Table 4-12 presents the trend in capacity utilization for the paper and allied products industry. The varying capacities reflect adjusting production levels and new production facilities going on- or off-line. The average capacity utilization ratio for the paper and allied products industry between 1991 and 1996 was approximately 80, with capacity declining slightly in recent years.

4.2.2 Demand Side of the Industry

4.2.2.1 Product Characteristics

Paper is valued for its diversity in product types, applications, and low cost due to ready access to raw materials. Manufacturers produce papers of varying durabilities, textures, and colors. Consumers purchasing large quantity of papers may have papers tailored to their specification. Papers may be simple writing papers or newsprint for personal consumption and for the printing and publishing industry or durable for conversion into shipping cartons, drums, or sanitary boxes. Inputs in the paper production process are readily available in the U.S. because one-third of the country is forested, and facilities generally have ready access to waterways.

Table 4-10. Waste and By-Products Incinerated at Paper and Allied Products Facilities

Facility Name	SIC	Materials Combusted	Percentage Annual Input[a]	Waste Description
Fraser Paper Company	2621	No. 2 Distillate Fuel Oil	1	
		Natural Gas	47	
		Industrial Wastewater Sludge	52	Collected from mill process: fiber, filler, and biomass
Kimberly Clark Corporation	2676	Industrial Solid Waste, N.H.	95	Off spec. diaper raw materials, trim waste, paper, corrugated cartons, and plastic
		Liquid Petroleum Gas	0	
		Natural Gas	5	
Pope & Talbot, Inc.	2621	Natural Gas	100	
		Industrial Wastewater Sludge	0	Paper mill sludge from waste treatment plant
Tenneco Packaging Company	2621	No. 2 Distillate Fuel Oil	100	
		Industrial Wastewater Sludge	0	Sludge from activated sludge wastewater treatment plant
Union Camp-Eastover	2621	No. 2 Distillate Fuel Oil	9	
		Decorative Laminate Scrap	41	
		Liquid Petroleum Gas	<1	
		Process Co-product Gas	49	Rectified methanol from pulpmill condensates; pulp mill noncondensible gases
Weyerhaeuser	2611	Natural Gas	68	
		Process Co-product Gas	24	NCGS from pulping process
		Process Co-product Liquid	8	Turpentine and methanol from fuel condesate stripper

[a]Calculated on a volume basis.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research

Table 4-11. Inputs for the Paper and Allied Products Industry (SIC 26), 1987 to 1996

	Labor			
Year	Quantity (thousands)	Payroll (1992 $million)	Materials (1992 $million)	New Capital Investment (1992 $million)
1987	611.1	20,098.6	70,040.6	6,857.5
1988	619.8	19,659.0	73,447.4	8,083.8
1989	633.2	19,493.1	75,132.5	10,092.9
1990	631.2	19,605.2	74,568.8	11,267.2
1991	624.7	19,856.3	72,602.5	9,353.9
1992	626.3	20,491.9	73,188.0	7,962.4
1993	626.3	20,602.6	73,062.6	7,265.2
1994	621.4	20,429.7	76,461.6	6,961.7
1995	629.2	18,784.3	79,968.6	7,056.8
1996	630.6	19,750.0	75,805.9	8,005.9

Sources: U.S. Department of Commerce, Bureau of the Census. 1996b. *1992 Census of Manufactures, Subject Series: General Summery*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures [Multiple Years]*. Washington, DC: Government Printing Office.

Table 4-12. Capacity Utilization Ratios for the Paper and Allied Products Industry, 1991-1996

1991	1992	1993	1994	1995	1996
78	80	81	80	77	78

Source: U.S. Department of Commerce, Bureau of the Census. 1998. *Survey of Plant Capacity: 1996*. Washington, DC: Government Printing Office.

4.2.2.2 Uses and Consumers of Products

The paper and allied products industry is an integral part of the U.S. economy; nearly every industry and service sector relies on paper products for its personal, education, and business needs. Among a myriad of uses, papers are used for correspondence, printing and publishing, packing and storage, and sanitary purposes. Common applications are all manners of reading material, correspondence, sanitary containers, shipping cartons and drums, and miscellaneous packing materials.

4.2.3 Organization of the Industry

4.2.3.1 Firm Characteristics

In 1992, 4,264 companies produced paper and allied products and operated 6,416 facilities. By way of comparison, 4,215 controlled 6,292 facilities in 1987. Although the number of small firms and facilities increased during those 5 years, the industry is dominated by high-volume, low-cost producers (DRI et al., 1998). Even though they account for only 45 percent of all facilities, those with 50 or more employees contribute more than 93 percent of the industry's total value of shipments (see Table 4-13). (According to the Small Business Administration, those companies employing fewer than 500 employees are "small.")

For paper and allied products markets likely to be affected by the proposed commercial and industrial solid waste incinerator regulation, the four firm concentration ratios ranged between 29 and 68 in 1992 (see Table 4-14). This means that, in each subsector, the top firms' combined sales ranged from 29 and 68 percent of their respective industrys total sales. For example, in the sanitary paper products industry, the CR4 ratios indicate that a few firms control 68 percent of the market. This sector's moderately concentrated nature is also indicated by its HHI of 1451 (DOJ, 1992). The remaining two sectors' HHIs indicate that their respective markets are unconcentrated (i.e., competitive).

4.2.4 Markets and Trends

The Department of Commerce projects that shipments of paper and allied products will increase through 2002 by an annual average of 2.5 percent (DRI et al., 1998). Because nearly all of the industry's products are consumer related, shipments will be most affected by the health of the U.S. and global economy. The U.S. is a key competitor in the international market for paper products and, after Canada, is the largest exporter of paper products. According to DRI et al., the largest paper and allied products exporters in the world are Canada (with 23 percent of the market), the United States (10 to 15 percent), Finland (8 percent), and Sweden (7 percent) (1998).

Table 4-13. Size of Establishments and Value of Shipments for the Paper and Allied Products Industry (SIC 26)

Number of Employees in Establishment	1987 Number of Facilities	1987 Value of Shipments ($million)	1992 Number of Facilities	1992 Value of Shipments ($million)
1 to 4 employees	729	640.6	786	216
4 to 9 employees	531	(D)	565	483
10 to 19 employees	888	1,563.4	816	1,456.5
20 to 49 employees	1,433	18,328.6	1,389	6,366.6
50 to 99 employees	1,018	(D)	1,088	12,811.5
100 to 249 employees	1,176	32,141.7	1,253	35,114.0
250 to 499 employees	308	24,221.1	298	22,281.2
500 to 999 employees	145	28,129.1	159	31,356.5
1,000 to 2,499 employees	63	24,903.1	62	23,115.4
2,500 or more employees	1	(D)		
Total	1,732	129,927.8	6,416	133,200.7

(D) = undisclosed

Sources: U.S. Department of Commerce, Bureau of the Census. 1990d. *1987 Census of Manufactures, Industry Series: Pulp, Paper, and Board Mills*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1995c. *1992 Census of Manufactures, Industry Series: Pulp, Paper, and Board Mills*. Washington, DC: Government Printing Office. 1995c.

4.3 Noncellulosic Man-Made Fibers Industry (SIC 2824)

The man-made fibers industry accounts for nearly 6.25 percent of the $300 billion a year chemical industry. Noncellulosic man-made fibers production comprises approximately 90 percent of the total amount of man-made fibers produced in the U.S. annually. Man-made fibers are used in products as varied as clothing and tires (Mote, 1994). These fibers are largely intermediate goods and are shipped to other manufacturers in the form of yarn, tow, staple, or monofilament. Thereafter, they are transformed into consumer and industrial products. In addition to being less expensive than natural fibers, synthetic fibers are also more durable, hold their shape better, and are more uniform (Mote, 1994).

Table 4-14. Measurements of Market Concentration for Paper and Allied Products Markets

SIC	Description	CR4	CR8	HHI	Number of Companies	Number of Facilities
2611	Pulp Mills	48	75	858	29	45
2621	Paper Mills	29	49	392	127	280
2676	Sanitary Paper Products	68	82	1,451	80	150

Sources: U.S. Department of Commerce, Bureau of the Census. 1995b. *1992 Concentration Ratios in Manufacturing*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1995e. *1992 Census of Manufactures, Industry Series: Pulp, Paper, and Board Mills*. Washington, DC: Government Printing Office.

Table 4-15 presents shipment values for the industry from 1987 to 1996. In 1996, the industry shipped $11,883.5 million in man-made fibers, a performance on par with that of the late 1980s. With the exception of 1991 and 1994-95, the industry's value of shipments has been fairly stable for the past decade.

4.3.1 Supply Side of the Industry

4.3.1.1 Production Processes

Man-made fibers are derived from both natural and petroleum-based ingredients that are melted together to form liquids containing free-moving molecules. The liquid passes through small holes in vats called spinnerets. As the liquid exits the vats, it hardens to form long filaments.

Manufacturers produce man-made fibers using four variations of the process described above: dry, wet, melt, and core spinning (Mote, 1994). In dry spinning, the raw materials are dissolved in solvents. After passing through the spinnerets, the fibers-to-be are exposed to hot air. The solvents evaporate, leaving behind a solid filament. Wet spinning is quite similar to dry spinning. The main difference between the two is that, after the stream exits the vat through the spinneret, it falls into a coagulating chemical bath. As the stream enters the bath, it hardens, leaving a solid filament as the product.

Table 4-15. Value of Shipments for the Noncellulosic Man-Made Fibers Industry (SIC 2824), 1987-1996

Year	Value of Shipments (1992 $million)
1987	11,622.8
1988	11,894.4
1989	11,893.8
1990	11,232.7
1991	10,817.8
1992	11,113.0
1993	11,643.8
1994	12,146.2
1995	12,004.3
1996	11,883.5

Sources: U.S. Department of Commerce, Bureau of the Census. 1995a. *1992 Census of Manufactures, Industry Series: Plastics Materials, Synthetic Rubber, and Man-made Fibers.* Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures [Multiple Years].* Washington, DC: Government Printing Office.

Melt and core spinning are simple processes. In melt spinning, the raw materials are blended together and extruded. They dry upon contact with air to form the filaments. Core spinning involves spinning together a continuous filament yarn with a short-length hard fiber to form a composite. This is the newest method of production.

4.3.1.2 Types of Output

The man-made fiber industry produces fibers derived from molecules containing combinations of carbon, hydrogen, nitrogen, and oxygen. The output includes polyester, nylon, olefins, and acrylics.

These fibers are sold to manufacturers in four forms: yarn, monofilament, staple, and tow. Monofilaments are single, long strands used in toothbrushes and nylon stockings. Staple comprises fibers that are cut short. Staple is usually blended with other materials to form yarns. Tow is much like staple, but it is kept in long, rope-like form before being cut at a later time.

4.3.1.3 Major By-Products and Co-Products

SIC 2824 has no co-products. Few by-products are associated with man-made fibers. Emissions from man-made fiber production are largely recovered by using activated carbon. However some carbon disulfide and hydrogen sulfide escape during production (Mote, 1994).

Based on the Inventory Database, five units at man-made fibers plants incinerate some portion of their industrial waste. Generally units are incinerating natural gas, plastics, and fuel oils. As shown in Table 4-16, approximately 6 percent of Monsanto's incinerator input is plastics. The DuPont May Plant incinerator burns waste oil by-products. Based on data in the CIWI database, DuPont incinerates an estimated 220.1 tons of material per year. Monsanto incinerates approximately 39.6 tons.

Table 4-16. Wastes and By-Products Incinerated at Noncellulosic Man-Made Fibers Facilities

Facility Name	Materials	Percentage Annual Input[a]	Solid Waste Description
DuPont—Seaford	#2 Distillate Fuel Oil	100	
	Other Solid	0	Nylon 6,6 Polymer
Monsanto Company	Natural Gas	94	
	Plastics	6	
	Natural Gas	94	
	Plastics	6	
	Natural Gas	94	
	Plastics	6	
DuPont—May Plant	#2 Distillate Fuel Oil	30	
	Liquid Waste	70	Vegetable, Coconut, Rice, and Silicone Oils

[a]Calculated on a volume basis.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

4.3.1.4 Costs of Production

New capital investments, increased productivity, and technology improvements have allowed the industry to cut its labor costs (Mote, 1994). The number of people employed by the man-made fiber industry has declined over the past 15 years. Between 1987 and 1996 employment in the industry decreased nearly 18 percent (Table 4-17). By comparison, the costs of materials fell by 4.3 percent during the same period, most likely because of the decline in the level of production. New capital investments averaged $706.6 million per year from 1987 to 1996. Investments contributed to the creation of new production strategies to help minimize increasing costs and make the production process more efficient (Mote, 1994).

Table 4-17. Inputs for the Noncellulosic Man-Made Fibers Industry (SIC 2824), 1987-1996

	Labor			
Year	**Quantity (thousands)**	**Payroll (1992 $million)**	**Materials (1992 $million)**	**New Capital Investment (1992 $million)**
1987	45.4	1,547.4	5,933.3	533.4
1988	45.8	1,522.6	6,000.8	688.4
1989	48.0	1,513.1	5,929.8	696.3
1990	48.1	1,513.1	5,078.2	800.8
1991	46.9	1,531.1	4,797.9	790.7
1992	44.4	1,545.2	5,337.1	721.3
1993	42.3	1,487.1	5,593.9	929.0
1994	40.7	1,409.5	5,747.5	560.8
1995	38.6	1,347.4	5,965.6	638.3
1996	38.5	1,363.0	5,679.5	(D)

(D) = undisclosed.

Sources: U.S. Department of Commerce, Bureau of the Census. 1995a. *1992 Census of Manufactures, Industry Series: Plastics Materials, Synthetic Rubber, and Man-made Fibers*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures, [Multiple Years]*. Washington, DC: Government Printing Office.

4.3.1.5 Capacity Utilization

Table 4-18 presents the historical trends in the capacity utilization for the man-made fibers industry. The full production capacity utilization ratio for the noncellulosic man-made fibers industry was 92 in 1996.

Table 4-18. Capacity Utilization Ratios for the Noncellulosic Man-Made Fibers Industry, 1989-1996

	1989	1990	1991	1992	1993	1994	1995	1996
SIC 2824	88	89	89	86	88	91	89	92

Note: The capacity utilization ratio is the ratio of the actual production level to the full production capacity level.

Source: U.S. Department of Commerce, Bureau of the Census. 1996a & 1998. *Survey of Plant Capacity: 1994 & 1996*. Washington, DC: Government Printing Office.

4.3.2 Demand Side of the Industry

4.3.2.1 Product Characteristics

Man-made fibers are valued for their versatility and variety. They are less expensive than most natural fibers and are more durable and uniform (DRI et al., 1998). Used predominantly by the apparel and textile industry, synthetic fibers are flexible and resist aging and do not react to exposure to the elements. The fibers can be manipulated during the manufacturing process to become softer, rougher, stronger, or more resilient. They can be dyed and are easily woven to form other materials. Polyester and nylon are two key fibers produced by this industry. Polyester does not retain moisture, provides excellent electrical insulation, and is highly resistant to solvents. Nylon has a high strength-to-weight ratio, is not easily permanently deformed, and is resistant to abrasion.

4.3.2.2 Uses and Consumers of Products

The largest consumer of synthetic fibers is the floor-coverings industry. This sector consumes roughly 32 percent of all fibers produced to make floor coverings for residential, institutional, and industrial purposes. The apparel and various household textile industries consume about 25 percent and 10 percent, respectively (Mote, 1994). The remainder is used in such varied industries as tires (for reinforcement), rope, surgical and sanitary supplies, fiberfill, electrical insulation, and plastics reinforcements.

Polyester fibers are used predominantly by the home furnishings and apparel industries, as well as general textile facilities. Nylon is mostly used in carpeting, but also in apparel, noncarpet home furnishings, ropes, and miscellaneous industrial products. Acrylics and olefins are used in apparel and highly durable carpeting, respectively. In response to increasing pressure from both the government and environmental groups, the industry is seeking methods for recycling fibers such as polyester into new fabrics and carpet materials.

4.3.3 Organization of the Industry

4.3.3.1 Firm Characteristics

In 1992, 42 companies produced noncellulosic organic fibers and operated 71 facilities. By way of comparison, 47 companies controlled 72 facilities in 1987. The top five firms' sales were nearly four times that of the next five largest firms during the time period presented in Table 4-19. Facilities with 250 to nearly 2,500 employees increased their share of the total value of shipments from 89.7 percent in 1987 to 95.4 percent in 1995.

The four-firm concentration ratio for this industry in 1992 was 74, meaning that the top four firms accounted for 74 percent of the industry's total sales. The eight-firm concentration ratio for the same years was 90 (BOC, 1995b). These ratios indicate that a few firms control a large share of the market. The highly concentrated nature of the man-made noncellulosic fibers industry is also indicated by its HHI of 2,158 (DOJ, 1992). According to the Department of Justice's Horizontal Merger Guidelines, industries with HHIs above 1,800 are considered highly concentrated (i.e., less competitive). Table 4-20 presents several measures of market concentration in the man-made fiber (noncellulosic) industry.

4.3.4 Markets and Trends

The U.S. Department of Commerce expects the man-made fiber market to grow by 19 percent between 1995 and 2000. Consumption of polyester, the most popular fiber, is expected to increase 16 percent over the same period (DRI et al., 1998). Although American companies control 90 percent of the U.S. market for man-made fibers, their global market share has dropped in the last half of the 20th century. According to DRI et al., U.S. corporations controlled approximately 18 percent of the global market for man-made fibers in 1992; in 1950 that figure was 50 percent (1998). In the 1990s, 50 percent of the worldwide

Table 4-19. Size of Establishments and Value of Shipments for the Noncellulosic Man-Made Fibers Industry (SIC 2824)

	1987		1992	
Number of Employees in Establishment	Number of Facilities	Value of Shipments (1992 $million)	Number of Facilities	Value of Shipments (1992 $million)
1 to 4 employees	3	2.2	1	47.8
5 to 9 employees	5	9.5	0	0
10 to 19 employees	1	(D)	2	(D)
20 to 49 employees	4	25.0	7	(D)
50 to 99 employees	7	69.0	8	105.5
100 to 249 employees	17	470.9	14	355.7
250 to 499 employees	8	750.5	13	1,224.2
500 to 999 employees	9	1532.8	6	909.9
1,000 to 2,499 employees	17	8888.7	19	8,470.7
2,500 or more employees	1	(D)	1	(D)
Total	72	11622.8	71	11,113.8

(D) = undisclosed

Sources: U.S. Department of Commerce, Bureau of the Census. 1990a. *1987 Census of Manufactures, Industry Series: Plastics Materials, Synthetic Rubber, and Man-made Fibers*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1995a. *1992 Census of Manufactures, Industry Series: Plastics Materials, Synthetic Rubber, and Man-made Fibers*. Washington, DC: Government Printing Office.

capacity for polyester production is in Asia, compared to 13 percent in the U.S. (DRI et al., 1998). The U.S. is the world's largest exporter of synthetic fibers, followed by Taiwan and Japan. Other significant exporters are Austria, Canada, and the Southeast Asian nations.

Table 4-20. Measures of Market Concentration for the Noncellulosic Man-Made Fibers Industry (SIC 2824)

SIC	Description	CR4	CR8	HHI	Number of Companies	Number of Facilities
SIC 2824	Man-Made Organic Fibers, Noncellulosic	74	90	2,158	42	71

Sources: U.S. Department of Commerce, Bureau of the Census. 1995b. *1992 Concentration Ratios in Manufacturing*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1995a. *1992 Census of Manufactures, Industry Series: Plastics Materials, Synthetic Rubber, and Man-made Fibers*. Washington, DC: Government Printing Office.

4.4 Pharmaceutical Preparations and Medicinal Chemicals and Botanical Products (SIC 2833, 2834)

The pharmaceutical preparations industry (SIC 2834) and the medicinal chemicals and botanical products industry (SIC 2833) are both primarily engaged in the research, development, manufacture, and/or processing of medicinal chemicals and pharmaceutical products. Apart from manufacturing drugs for human and veterinary consumption, the industries grind, grade, and mill botanical products that are inputs for other industries. Typically, most facilities cross over into both industries (EPA, 1997a). Products include drugs, vitamins, herbal remedies, and production inputs, such as alkaloids and other active medicinal principals.

Table 4-21 presents both industries' value of shipments from 1987 to 1996. Medicinals and botanicals' performance during the late 1980s and early 1990s was mixed. However, shipments increased steadily from 1994 to 1996, increasing 37.7 percent as natural products such as herbs and vitamins became more popular (EPA, 1997a). Pharmaceutical preparations' shipments increased steadily over the 10-year period. From 1987 to 1996, the industry's shipments increased 24.3 percent to $55.1 billion in 1996.

4.4.1 Supply Side of the Industry

4.4.1.1 Production Processes

The medicinals and botanical products industry and the pharmaceutical preparations industry share similar production processes. Many products of the former are inputs in the

Table 4-21. Value of Shipments, for the Botanicals, Medicinals, and Pharmaceutical Preparations Industries, 1987-1996

Year	SIC 2833 Medicinals & Botanicals ($million)	SIC 2834 Pharmaceutical Preparations ($million)
1987	4,629.1	44,345.7
1988	5,375.4	46,399.1
1989	5,708.9	48,083.6
1990	5,535.8	49,718.0
1991	6,637.7	49,866.3
1992	6,438.5	50,417.9
1993	5,669.2	50,973.5
1994	5,774.7	53,144.7
1995	6,404.1	53,225.9
1996	7,952.8	55,103.6

Sources: U.S. Department of Commerce, Bureau of the Census. 1995c. *1992 Census of Manufactures, Industry Series: Drug Industry*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures [Multiple Years]*. Washington, DC: Government Printing Office.

latter's production process. There are three manufacturing stages: research and development, preparation of bulk ingredients, and formulation of the final product.

The research and development stage is a long process both to ensure the validity and benefit of the end product and to satisfy the requirements of stringent federal regulatory committees (The pharmaceutical industry operates under strict oversight of the Food and Drug Administration [FDA].). Therefore, every stage in the development of new drugs is thoroughly documented and studied. After a new compound is discovered, it is subjected to numerous laboratory and animal tests. Results are presented to the FDA via applications that present and fully disclose all findings to date. As research and development proceeds, studies are gradually expanded to involve human trials of the new compound. Should the compound be approved by the FDA, the new product is readied for mass production.

To ensure a uniform product, all ingredients are prepared in bulk using batch processes. Companies produce enough of each ingredient to satisfy projected sales demand

(EPA, 1997a). Prior to production, all equipment is thoroughly cleaned, prepared, and validated to prevent any contaminants from entering the production cycle. Most ingredients are prepared by chemical synthesis, a method whereby primary ingredients undergo a complex series of processes, including many intermediate stages and chemical reactions in a step-by-step fashion (EPA, 1997a).

After the bulk materials are prepared, they are converted into a final usable form. Common forms include tablets, pills, liquids, creams, and ointments. Equipment used in this final stage is prepared in the same manner as that involved in the bulk preparation process. Clean and validated machinery is used to process and package the pharmaceuticals for shipment and consumption.

4.4.1.2 Types of Output

Both industries produce pharmaceutical and botanical products for end consumption and intermediate products for the industries' own applications. Products include vitamins, herbal remedies, and alkaloids. Prescription and over-the-counter drugs are produced in liquid, tablet, cream, and other forms.

4.4.1.3 Major By-Products and Co-Products

Both industries produce many by-products because of the large number of primary inputs and the extensive chemical processes involved. Wastes and emissions vary by the process employed, raw materials consumed, and equipment used. In general, emissions originate during drying and heating stages and during process water discharge. Emissions controls are in place pursuant to environmental regulations. Other wastes include used filters, spent raw materials, rejected product, and reaction residues (EPA, 1997a).

Based on the Inventory Database, four units in the medicinal chemicals and botanicals industry incinerate some portion of their industrial wastes. The pharmaceuticals industry operates seven units. Generally, these units are incinerating fuels, industrial waste water sludge, animal remains, industrial solid wastes, medical wastes, returned and rejected product, and garbage (see Table 4-22). For the ten units for which capacity information is available, approximately 11,662 tons of material is incinerated annually.

4.4.1.4 Costs of Production

Table 4-23 presents SIC 2833 industry's costs of production and employment statistics from 1987 to 1996. Employment was stable during the late 1980s before steadily growing in the 1990s. In 1987, medicinals and botanicals employed 11,600 people. By 1996, the industry employed 16,800, an increase of nearly 45 percent. Materials costs matched the increase in shipments over this same period. Industry growth also fed new capital investments which averaged $191.2 million a year in the late 1980s and $515.6 million a year in the early to mid 1990s.

SIC 2834's costs of production and employment for 1987 to 1996 are presented in Table 4-24. The number of persons employed by the industry ranged between 120,000 and 144,000; employment peaked in 1990 before declining by 21,000 jobs by the end of 1992. During this 10-year period, the cost of materials rose 42.1 percent. The increase is associated with increased product shipments and the development of new, more expensive relatively more expensive medications (DRI et al., 1998). New capital investment averaged $2.3 billion a year.

Table 4-22. Wastes and Materials Incinerated at Botanicals, Medicinals, and Pharmaceutical Preparations Facilities

Facility Name	SIC	Materials Combusted	Percentage Annual Input[a]	Additional Waste Description
Glaxo Wellcome	2833	Natural Gas	NA	NA
		Unknown Codes		
Hoffman LaRoche	2833	Pathological: Animal Remains	<1	
		No. 2 Distillate Fuel Oil	<1	
		Industrial Solid Waste, N.H.	11	Returned pharmaceutical products and packaging
		Medical Waste	4	
		Natural Gas	85	
		Other Solid	<1	Confidential papers
Pfizer, Inc.	2833	No. 2 Distillate Fuel Oil	50	
		Liquid Petroleum Gas	1	
		Industrial Wastewater Sludge	49	Biological secondary sludge from industrial wastewater treatment
Bristol Myers	2834	Industrial Solid Waste, N.H.	NA	Returned and rejected products and packaging
		Liquid Petroleum Gas		
		Other Solid		Gauzes, oily rags, paper, cardboard, sweepings, and plastics
		Plastics		
King Pharmaceuticals	2834	Industrial Solid Waste, N.H.	NA	Waste ethical drugs, sweeping, waste narcotic controlled drugs
		Natural Gas		
Merck, Sharpe, & Dohme	2834	Pathological: Animal Remains	0.5	
		Municipal Commercial Waste: Type 0 - Trash	4.5	
		Municipal Commercial Waste: Type 1 - Trash	7.2	
		Medical Waste	6.6	
		Natural Gas	74.3	
		Other Solid	6.9	Returned pharmaceutical products
Marion Merrell Dav Inc.	2834	Type 0 - Trash	10	
		Animal Remains	10	
		Medical Waste	5	
		Natural Gas	75	
Merck & Company	2834	No. 2 Distillate Fuel Oil	80	Activated sludge from wastewater treatment system
		Industrial Wastewater Sludge	20	
Ortho-McNeil	2834	Liquid Waste	NA	Ethyl acetate isopropanol
		Natural Gas		
Roche Products, Inc.	2834	Process Engineered Fuels	NA	
		Industrial Solid Waste, N.H.		Returned and rejected pharmaceutical products
		Liquid Petroleum Gas		
Squibb Manufacturing	2834	No. 2 Distillate Fuel Oil	23	
		Industrial Solid Waste, N.H.	10	
		Liquid Petroleum GAs	<1	
		Other Solid	12	Waste activated charcoals and earth used as filter media; trash, sweepings, cafeteria wastes, garbage
		Industrial Wastewater Sludge	>54	Sludge from wastewater treatment plant

[a] Calculated on a volume basis.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina.

Table 4-23. Inputs for Botanical Products and Medicinal Chemicals Industry (SIC 2833), 1987-1996

	Labor			
Year	**Quantity (thousand)**	**Payroll ($million)**	**Materials ($million)**	**New Capital Investment ($million)**
1987	11.6	520.2	2,229.3	158.2
1988	11.3	494.4	2,658.8	194.9
1989	11.4	504.9	3,118.4	263.4
1990	10.9	476.4	2,902.4	218.9
1991	12.5	568.6	3,368.2	512.9
1992	13.0	587.1	3,245.9	550.5
1993	13.0	584.3	2,638.4	470.0
1994	13.9	572.6	2,755.2	480.3
1995	14.1	625.0	3,006.0	356.2
1996	16.8	752.1	3,793.9	752.1

Sources: U.S. Department of Commerce, Bureau of the Census. 1995c. *1992 Census of Manufactures, Industry Series: Drug Industry*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures, [Multiple Years]*. Washington, DC: Government Printing Office.

Table 4-24. Inputs for the Pharmaceutical Preparations Industry (SIC 2834), 1987-1996

Year	Labor		Materials ($million)	New Capital Investment ($million)
	Quantity (thousands)	Payroll ($million)		
1987	131.6	5,759.2	11,693.7	2,032.7
1988	133.4	5,447.2	12,634.8	2,234.0
1989	141.8	6,177.5	12,874.2	2,321.4
1990	143.8	6,223.9	13,237.6	2,035.3
1991	129.1	5,275.8	13,546.6	1,864.7
1992	122.8	4,949.4	13,542.5	2,450.0
1993	128.2	5,184.2	13,508.7	2,385.2
1994	134.2	5,368.4	13,526.1	2,531.9
1995	143.0	5,712.4	15,333.6	2,856.1
1996	136.9	5,547.3	16,611.1	2,317.0

Sources: U.S. Department of Commerce, Bureau of the Census. 1995c. *1992 Census of Manufactures, Industry Series: Drug Industry*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures, [Multiple Years]*. Washington, DC: Government Printing Office.

4.4.1.5 Capacity Utilization

Table 4-25 presents the trend in these ratios from 1991 to 1996 for both industries. The varying capacity ratios reflect adjusting production volumes and new production facilities and capacity going both on and off-line. In 1996, the capacity utilization ratio for SIC 2833 and 2834 were 84 and 67, respectively.

4.4.2 Demand Side of the Industry

New product introductions and improvements on older medications by the drug industry have greatly improved the health and well-being of the U.S. population (DRI et al., 1998). Products help alleviate or reduce physical, mental, and emotional ailments or reduce the severity of symptoms associated with disease, age, and degenerative conditions. Dietary supplements, such as vitamins and herbal remedies, ensure that consumers receive nutrients

Table 4-25. Capacity Utilization Ratios for the Botanical Products and Medicinal Chemicals (SIC 2833) and Pharmaceutical Preparations (SIC 2834) Industries, 1991-1996

	1991	1992	1993	1994	1995	1996
SIC 2833	84	86	89	80	90	84
SIC 2834	76	74	70	67	63	67

Note: Capacity utilization ratio is the ratio of the actual production level to the full production level.

Source: U.S. Department of Commerce, Bureau of the Census. 1998. *Survey of Plant Capacity: 1996*. Washington, DC: Government Printing Office.

of which they may not ordinarily consume enough. Products are available in a range of dosage types, such as tablets and liquids.

Although prescription medications are increasingly distributed through third parties, such as hospitals and health maintenance organizations, the general population remains the end-user of pharmaceutical products. As the average age of the U.S. population adjusts to reflect large numbers of older people, the variety and number of drugs consumed increases. An older population will generally consume more medications to maintain and improve quality of life (DRI et al., 1998).

4.4.3 Organization of the Industry

4.4.3.1 Firm Characteristics

In 1992, 208 companies produced medicinal chemicals and botanical products and operated 225 facilities (see Table 4-26). The number of companies and facilities in 1992 was the same as that of 1987, although shipment values increased almost 40 percent. The average facility employed more people in 1992 than in 1987. In fact, the number of facilities employing 50 or more people grew from 37 to 45. These facilities accounted for the lion's share of the industry's shipments. According to the Small Business Administration, companies are considered small if they employ fewer than 750 employees. It is unclear what percentage of the facilities listed in Table 4-26 are small companies.

In 1992, 585 companies manufactured pharmaceutical preparations and operated 691 facilities. By way of comparison, 640 companies operated 732 facilities in 1987. Although the number of facilities declined by 41, no particular category lost or gained an exceptional number of facilities. The biggest movement was in the five to nine employees category, which lost 35 facilities. In both years, facilities with more than 50 employees accounted for at least 95 percent of the industry's shipments.

Table 4-26. Size of Establishments and Value of Shipments for the Botanical Products and Medicinal Chemicals (SIC 2833) and Pharmaceutical Preparations (SIC 2834) Industries

	1987		1992	
Number of Employees in Establishment	Number of Facilities	Value of Shipments (Smillion)	Number of Facilities	Value of Shipments ($million)
SIC 2833				
1 to 4 employees	61	20.7	62	23.8
5 to 9 employees	34	38.6	42	58.3
10 to 19 employees	46	237.0	47	357.1
20 to 49 employees	47	287.3	29	182.0
50 to 99 employees	15	273.6	25	653.9
100 to 249 employees	12	520.6	10	5,163.4
250 to 499 employees	5	753.0	4	(D)
500 to 999 employees	4	2478.2	3	(D)
1,000 to 2,499 employees	1	(D)	3	(D)
Total	225	4629.1	225	6,438.5
SIC 2834				
1 to 4 employees	158	58.7	152	115.6
5 to 9 employees	108	178.8	73	105.4
10 to 19 employees	102	320.3	101	284.6
20 to 49 employees	117	932.5	110	815.7
50 to 99 employees	66	1231.0	65	1,966.8
100 to 249 employees	76	3596.0	77	2,912.4
250 to 499 employees	50	9239.7	56	11,394.6
500 to 999 employees	23	4946.9	30	10,077.7
1,000 to 2,499 employees	24	15,100.9	21	14,525.7
2,500 employees or more	8	8740.9	6	8,219.4
Total	732	44,345.7	691	50,417.9

(D) = undisclosed

Sources: U.S. Department of Commerce, Bureau of the Census. 1990b. *1987 Census of Manufactures, Industry Series: Drug Industry*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1995c. *1992 Census of Manufactures, Industry Series: Drug Industry*. Washington, DC: Government Printing Office.

Table 4-27 presents the measures of market concentration for both industries. For the medicinals and botanicals industry, the four-firm concentration ratio was 76. The eight-firm concentration ratio was 84 (U.S. Dept. of Commerce, 1995b). The highly concentrated nature of the market is further indicated by an HHI of 2,999 (DOJ, 1992). According to the Department of Justice's Horizontal Merger Guidelines, industries with HHIs above 1,800 are less competitive.

Table 4-27. Measures of Market Concentration for the Botanical Products and Medicinal Chemicals (SIC 2833) and Pharmaceutical Preparations (SIC 2834) Industries

SIC	Industry	CR4	CR8	HHI	Number of Companies	Number of Facilities
2833	Medicinal Chemicals & Botanical Products	76	84	2,999	208	225
2834	Pharmaceutical Preparations	26	42	341	585	691

Sources: U.S. Department of Commerce, Bureau of the Census. 1995b. *1992 Concentration Ratios in Manufacturing*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1995c. *1992 Census of Manufactures, Industry Series: Drug Industry*. Washington, DC: Government Printing Office.

The pharmaceuticals preparations industry is less concentrated that the medicinal chemicals and botanical products industry. For SIC 2834, the CR4 and CR8 were 26 and 42, respectively, in 1992. The industry's HHI was 341, indicating a competitive market.

4.4.4 Markets and Trends

According to the Department of Commerce, global growth in the consumption of pharmaceuticals is projected to accelerate over the coming decade as populations in developed countries age and those in developing nations gain wider access to health care. Currently, the U.S. remains the largest market for drugs, medicinals, and botanicals and produces more new products than any other country (DRI et al., 1998). But, nearly two-fifths of American producers' sales are generated abroad. Top markets for American exports are China, NAFTA, Australia, and Japan. Most imports originate in Canada, Russia, Mexico, Trinidad and Tobago, and Norway.

4.5 Industrial Organic Chemicals Industry (SIC 2869)

The industrial organic chemicals (not elsewhere classified) industry (SIC 2869) produces organic chemicals for end-use applications and for inputs into numerous other chemical manufacturing industries. In nominal terms, it was the single largest segment of the $367 billion dollar chemical and allied products industry (SIC 28) in 1996, accounting for approximately 17 percent of the industry's shipments.

All organic chemicals are, by definition, carbon-based and are divided into two general categories: commodity and specialty. Commodity chemical manufacturers compete on price and produce large volumes of staple chemicals using continuous manufacturing processes. Specialty chemicals cater to custom markets, using batch processes to produce a diverse range of chemicals. Specialty chemicals generally require more technical expertise and research and development than the more standardized commodity chemicals industry (EPA, 1995c). Consequently, specialty chemical manufacturers have a greater value added to their products. End products for all industrial organic chemical producers are as varied as synthetic perfumes, flavoring chemicals, glycerin, and plasticizers.

Table 4-28 presents the shipments of industrial organic chemicals from 1987 to 1996. In real terms, the industry's shipments rose in the late 1980s to a high of $54.9 billion before declining in the early 1990s as the U.S. economy went into recession. By the mid 1990s, the industry recovered, as product values reached record highs (DRI et al., 1998). Between 1993 and 1996, the industry's shipments grew 7.3 percent to $57.7 billion.

4.5.1 Supply Side of the Industry

4.5.1.1 Production Processes

Processes used to manufacture industrial organic chemicals are as varied as the end-products themselves. There are thousands of possible ingredients and hundreds of processes. Therefore, what follows is a general description of the ingredients and stages involved in a typical manufacturing process.

Essentially a set of ingredients (feedstocks) is combined in a series of reactions to produce end-products and intermediates (EPA, 1995c). The typical chemical synthesis processes incorporate multiple feedstocks in a series of chemical reactions. Commodity

Table 4-28. Value of Shipments for the Industrial Organic Chemicals, N.E.C. Industry (SIC 2869), 1987-1996

Year	Value of Shipments (1992 $million)
1987	48,581.7
1988	53,434.7
1989	54,962.9
1990	53,238.8
1991	51,795.6
1992	54,254.2
1993	53,805.2
1994	57,357.1
1995	59,484.3
1996	57,743.3

Sources: U.S. Department of Commerce, Bureau of the Census. 1995d. *1992 Census of Manufactures, Industry Series: Industrial Organic Chemicals*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures, Multiple Years*. Washington, DC: Government Printing Office.

chemicals are produced in a continuous reactor and specialty chemicals are produced in batches. Specialty chemicals may undergo a series of reaction steps, as opposed to commodity chemicals' one continuous reaction because a finite amount of ingredients are prepared and used in the production process. Reactions usually take place at high temperatures, with one or two additional components being intermittently added. As the production advances, by-products are removed using separation, distillation, or refrigeration techniques. The final product may undergo a drying or pelletizing stage to form a more manageable substance.

4.5.1.2 Types of Output

Miscellaneous industrial organic chemicals comprise nine general categories of products:

- aliphitic and other acyclic organic chemicals (ethylene); acetic, chloroaceptic, adipic, formic, oxalic, and tartaric acids and their metallic salts; chloral, formaldehyde, and methylamine;

- solvents (ethyl alcohol etc.); methanol; amyl, butyl, and ethyl acetates; ethers; acetone, carbon disulfide and chlorinated solvents;
- polyhydric alcohols (synthetic glycerin, etc.);
- synthetic perfume and flavoring materials (citral, methyl, oinone, etc.);
- rubber processing chemicals, both accelerators and antioxidants (cyclic and acyclic);
- cyclic and acyclic plasticizers (phosphoric acid, etc.);
- synthetic tanning agents;
- chemical warfare gases; and
- esters, amines, etc., of polyhydric alcohols and fatty and other acids.

4.5.1.3 Major By-Products and Co-Products

Co-products, by-products, and emissions vary according to the ingredients, processes, maintenance practices, and equipment used (EPA, 1997). Frequently, residuals from the reaction process that are separated from the end product are resold or possibly reused in the manufacturing process. A by-product from one process may be another's input. The industry is strictly regulated because it emits chemicals through many types of media, including discharges to air, land, and water, and because of the volume and composition of these emissions.

Based on the Inventory Database, six units at industrial organic chemical facilities incinerate some portion of their industrial waste. Generally, units are incinerating fuels, industrial sold wastes, liquid wastes, sludge, process gasses, waste oils, and wastewaters (see Table 4-29). For the three units for which capacity information is available, approximately 7,438.4 tons of material are incinerated annually.

4.5.1.4 Costs of Production

Of all the factors of production, employment in industrial organic chemicals fluctuated most often between 1987 and 1996 (see Table 4-30). During that time, employment fell

Table 4-29. Wastes and Materials Incinerated at Industrial Organic Chemicals Facilities

Facility Name	Waste	Percentage Annual Input[a]	Additional Waste Description
ArcoChemical Company	Liquid Waste	70	Liquid hydrocarbons waste containing salts and catalyst
	Natural Gas	30	
Ashland Chemical Corporation	Aqueous Waste	10	
	Natural Gas	66	
	Other Gas	24	Distillate and fumes from reactors.
BASF Corporation	Industrial Solid Waste, N.H.	95	N-Methylpyrolidine Reside and 1,4 Butonediol Heavy Ends
	Natural Gas	5	
BASF Corporation	Liquid Waste	NA	Liquid waste from air oxidation process
	Natural Gas		
	Other Gas		Off-gas from air oxidation process, storage tanks, vents, and distillation vents
Chevron Chemical Corporation	Industrial Solid Waste, N.H.	30	Solids from manufacturing process and product storage
	Natural Gas	40	Vent gas
	Process Co-Product Gas	0	
	Waste Oil	30	
Exxon Chemical	Natural Gas	36	
	Petrochemical Process Gas	35	
	Process Coproduct Solid	2	Co-product of partial accidations process
	Industrial Wastewater Sludge	27	Wastewater treatment plant sludge (dry and wet)

[a]Calculated on a volume basis.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research

Table 4-30. Inputs for the Industrial Organic Chemicals Industry (SIC 2869), 1987 to 1996

Year	Labor		Materials	New Capital
	Quantity (thousands)	Payroll (1992 $million)	(1992 $million)	Investment (1992 $million)
1987	100.3	4,295.8	28,147.7	2,307.4
1988	97.1	4,045.1	29,492.8	2,996.5
1989	97.9	3,977.4	29,676.4	3,513.0
1990	100.3	4,144.6	29,579.2	4,085.5
1991	101.0	4,297.3	29,335.2	4,428.7
1992	100.1	4,504.2	31,860.6	4,216.6
1993	97.8	4,540.2	30,920.1	3,386.1
1994	89.8	4,476.5	33,267.4	2,942.8
1995	92.1	4,510.4	33,163.9	3,791.0
1996	100.3	5,144.8	36,068.9	4,794.7

Sources: U.S. Department of Commerce, Bureau of the Census. 1995d. *1992 Census of Manufactures.* Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures.* Washington, DC: Government Printing Office.

8.18 percent to 92,100, after a high of 101,000 in 1991. Most jobs lost were at the production level (DRI et al., 1998). Facilities became far more computerized, incorporating advanced technologies into the production process. Even with the drop in employment, payroll was $200 million more in 1995 than in 1987. The cost of materials fluctuated between $29 and $36 billion for these years, and new capital investment averaged $3,646 million a year.

4.5.1.5 Capacity Utilization

Table 4-31 presents the trend in capacity utilization ratios from 1991 to 1996 for the industrial organic chemicals industry. The varying capacity utilization ratios reflect changes in production volumes and new production facilities and capacities going on- and off-line. The capacity utilization ratio for the industry averaged 85.3 over the 6-year period presented.

Table 4-33. Measurements of Market Concentration for the Industrial Organic Chemicals Industry

CR4	CR8	HHI	Number of Companies	Number of Facilities
29	43	336	489	705

Sources: U.S. Department of Commerce, Bureau of the Census. 1995b. *1992 Concentration Ratios in Manufacturing*. Washington, DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1995a. *1992 Census of Manufactures, Industry Series: Industrial Organic Chemicals Industry*. Washington, DC: Government Printing Office.

metal products are produced from both ferrous and nonferrous metals that may be finished using a variety of techniques including: electroplating, coloring, anodizing, and coating. The industry's output are either end-products or intermediates used in other manufacturing industries or the construction industry.

The fabricated metals industry's value of shipments decreased during the 1990s recession, but later recovered and grew to record levels (DRI et al., 1998). From 1989 to 1991, the industry's value of shipments decreased nearly 7 percent (see Table 4-34) to $161 billion. As the U.S. economy emerged from recession, however, the total value of shipments grew approximately 23 percent to $197.4 billion in 1996.

4.6.1 Supply Side of the Industry

4.6.1.1 Production Processes

The industry's various production processes involve one or more of the following stages: metal fabrication, metal preparation, and metal finishing.

During the metal fabrication stage, molten metals are cast into sheets that can be some way shaped into a more manageable form. Oils, solvents, acids, and other agents are employed throughout the process to help clean, form, and cut the materials. After a shape is formed, it is cut, formed, bent, rolled, or otherwise configurated, according to specifications.

The surface of the metal may require preparation prior to any final finishing stages (EPA, 1995d). Most finishing processes require a clean, smooth surface to achieve best

Table 4-34. Value of Shipments for the Fabricated Metals Industry (SIC 34), 1987 to 1996

Year	(1992 $ millions)
1987	16,8706.1
1988	17,6160.1
1989	17,2599.7
1990	16,7345.2
1991	16,0993.1
1992	16,6532.0
1993	17,2763.6
1994	18,4972.8
1995	19,1192.6
1996	19,7363.2

Sources: U.S. Department of Commerce, Bureau of the Census. 1996b. *1992 Census of Manufactures, Subject Series: General Summary*. Washington, DC: General Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1990-1998. *Annual Survey of Manufactures [Multiple Years]*. Washington, DC: Government Printing Office.

results. Organic solvents, acids, or alkaloids may be applied to degrease the metal or remove any of the substances applied during the metals fabrication process.

Surface finishing operations include: electroplating, anodizing, and chemical conversion coating; a brief description of each follows (EPA, 1995d).

- Anodizing is an electrolytic process that converts the metal surface to an insoluble oxide coating. The process guards against corrosion, creates decorative surfaces, and provides a base for painting and other coating processes. Sulfuric acid is the most common agent used in an anodizing process.

- Chemical conversion coating processes are produced on various metals by chemical or electrochemical treatment. Chromating, phosphating, metal coloring, and passivating are all examples of a chemical conversion coating process. The surface metal is converted to an oxide or similar metallic compound to produce a decorative finish.

- Electroplating applies a metal coating on the surface of another metal by electrodeposition. Manufacturers employ this process to provide corrosion resistence, hardness, wear resistence, electrical or thermal conductivity, or decoration.

4.6.1.2 Types of Output

Fabricated metals products include:

SIC 341—Metal Cans and Shipping Containers

SIC 342—Cutlery, Handtools, & General Hardware

SIC 343—Heating Equipment and Plumbing Fixtures

SIC 344—Fabricated Structural Metal Products

SIC 345—Bolts, Nuts, Screws, Washers, and Rivets

SIC 346—Metal Forgings and Stampings

SIC 347—Coating, Engraving, and Allied Services

SIC 348—Ordnance and Accessories

SIC 349—Miscellaneous Fabricated Metal Products

4.6.1.3 Major By-Products and Co-Products

The industry produces a large number of by-products. Air emissions include metal-ion-bearing mists, acid mists, and evaporated solvents. Water and solid waste emissions are generally wastewaters, industrial sludges, metal chips, ignitable wastes, filters, and other pollutants (EPA, 1995d). There are generally few or no co-products.

Based on the Inventory Database, ten units at fabricated metals facilities incinerate some portion of their industrial waste. Units are typically burning fuels, rubbish, industrial wastewater sludge, other sludges, solid waste, paints, and filters (see Table 4-35). For the five units for which capacity information was available, approximately 761.1 tons of material is incinerated annually.

Table 4-35. Wastes and Materials Incinerated at Fabricated Metals Facilities

Facility Name	SIC	Waste Description	Percentage Annual Input[a]	Waste Description
Armtec Defense Products Company	3489	Industrial Sludge	11	
		Industrial Solid Waste, N.H.	11	Paper containing nitrocellulose; molded paper containing nitrocellulose
		Natural Gas	70	
		Industrial Wastewater Sludge	8	
Gonzalez Steel Drum Company	3412	Natural Gas	NA	
		Other Solids		Paint
Owens-Brockway	3499	Other Liquid	10	Laquer and paint
		Natural Gas	90	
Bretford Manufactuing	3469	Natural Gas	85	
		Municipal/Commercial Solid Waste: Type 0 - Trash	15	
Knaak Manufacturing	3449	Industrial Solid Waste, N.H.	NA	Paint filters
		Municipal/Commercial Solid Waste: Type 1 - Rubbish		
Hitachi Magnetic Materials	3499	Natural Gas	100	
Imperial Fabricating Company	3499	Natural Gas	100	
Rollex Corporation	3444	Natural Gas	100	
Streasau Laboratory	3483	No. 2 Distillate Fuel Oil	65	
		Process Co-product Solid	35	Paper; waste explosives

[a]Calculated on a volume basis.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

Table 4-36. Inputs for Fabricated Metals Industry (SIC 36), 1987 to 1996

Year	Labor: Quantity (thousands)	Labor: Payroll (1992 $million)	Materials (1992 $million)	New Capital Investment (1992 $million)
1987	1459.9	40079.2	83172.8	5514.7
1988	1494.6	41301.2	88755.7	4633.7
1989	1486.6	39842.4	87965.8	4876.8
1990	1460.3	39090.9	85251.1	4891.2
1991	1387.2	38143.4	82073.5	4210.0
1992	1362.3	38961.8	82264.5	4437.5
1993	1370.8	39526.2	85336.2	5696.1
1994	1407.1	40870.9	91776.0	5634.0
1995	1463.6	41653.4	96598.8	6632.1
1996	1483.0	42542.3	98467.2	6339.0

Source: U.S. Department of Commerce, Bureau of the Census. 1996b. *1992 Census of Manufactures, Subject Series: General Summary.* Washington, DC: Government Printing Office.

4.6.1.4 Costs of Production

The costs of production for the industry fluctuate with the demand for the industry's products. Most notably, the costs of production and number of persons employed by the industry declined in the early 1990s because orders from other manufacturing sectors and the construction industry slowed. Although employment in the industry fluctuated during the ten year period presented in Table 4-36, overall employment between 1987 and 1996 remained essentially unchanged. Raw materials and payroll costs moved in tandem with the industry's value of shipments. New capital investment average $5,286.5 million a year during the 10-year period.

4.6.1.5 Capacity Utilization

Table 4-37 presents the historical trends in capacity utilization for the fabricated metals industry. The varying capacity utilization ratios reflect fluctuations in demand and new production facilities and capacity coming on and old production facilities being closed. The average ratio for 1991 to 1996 was 56.7.

Table 4-37. Capacity Utilization Ratios for Fabricated Metals Industry, 1991-1996

1991	1992	1993	1994	1995	1996
57	58	59	61	53	52

Note: The capacity utilization ratio of the actual production level to the full production level

Source: U.S. Department of Commerce, Bureau of the Census. 1998. *Survey of Plant Capacity: 1996.* Washington, DC: Government Printing Office.

4.6.2 Demand Side of the Industry

Intermediate and end-use fabricated metal products are consumed by many industries and individual consumers. Metals are more durable and stronger than other materials and can be easily shaped into usable forms. Cutlery, handtools, bolts, drums, stampings, framing, and heating equipment are all products produced by the fabricated metals industry. Consumers include individuals, automobile manufacturers, appliance manufacturers, the construction industry, and a multitude of other manufacturers.

4.6.3 Organization of the Industry

4.6.3.1 Firm Characteristics

In 1992, 32,959 companies manufactured fabricated metals products and operated 36,429 facilities. By way of comparison, 32,470 companies operated 36,098 facilities in 1987. In 1992, the average firm owned 1.1 establishments. In both years, over 80 percent of all facilities employed fewer than 50 people but only accounted for 39 percent of the industry's value of shipments. According to the small business administration, nearly all fabricated metals companies are considered small if their total employment does not exceed 500 employees. However, it is unclear what percentage of the facilities listed in Table 4-38 are owned by small companies.

The four firm concentration ratios for fabricated metal products markets represented in the incinerator inventory database range between 8 and 83, meaning that, in each subsector, the top four firms' combined sales was between 8 and 83 percent of that respective subsector's combined sales (see Table 4-39). The eight firm concentration ratios ranged from 13 to 89 (U.S. Dept. of Commerce, 1995b). The ratios indicate that a few firms control over 80 percent of the market or less. The varying concentration of the market is also indicated by

Table 4-38. Size of Establishments and Value of Shipments for the Fabricated Metals Industry (SIC 36)

Number of Employees in Establishment	1987 Number of Facilities	1987 Value of Shipments (1992 $million)	1992 Number of Facilities	1992 Value of Shipments (1992 $million)
1 to 4 employees	8,882	1,594.5	9,941	1,886.7
5 to 9 employees	6,328	12,260.9	6,273	12,377.7
10 to 19 employees	6,998	(D)	6,698	(D)
20 to 49 employees	7,498	22,774.7	7,223	50,650.7
50 to 99 employees	3,353	26,028.7	3,307	(D)
100 to 249 employees	2,145	41,800.4	2,192	45,844.0
250 to 499 employees	629	26,596.6	570	25,536.9
500 to 999 employees	175	14,175.5	165	13,723.2
1,000 to 2,499 employees	62	12,545.6	47	10,756.6
2,500 or more employees	22	10,846.9	13	5,756.1
Total	36,092	168,706.1	36,429	166,532.0

(D) = undisclosed

Sources: U.S. Department of Commerce, Bureau of the Census. 1996b. *1992 Census of Manufactures, Subject Series: General Summary.* Washington, DC: General Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1991. *1987 Census of Manufactures, Subject Series: General Summary.* Washington, DC: General Printing Office.

the differences in the HHIs. The ordinance industry's HHI was 1,929 in 1992. According the Department of Justice's Horizontal Merger Guidelines, industries with HHIs of 1,800 or more are considered highly concentrated (i.e., less competitive). Most industries classified under SIC 34 have HHIs less than 1,000, indicating that those markets are generally competitive.

4.6.4 Markets and Trends

Most industries in SIC 34 are largely dependent upon the demands of other industries (EPA, 1995d). Structural products are largely dependent on the commercial and industrial construction industry; as more buildings are built, the quantity of structural metals (such as beams) increases. The general component (washers, nuts, bolts), and metal finishing sectors

Table 4-39. Measures of Market Concentration for Fabricated Metals Markets

SIC	Description	CR4	CR8	HHI	Number of Companies	Number of Facilities
3412	Metal Shipping Barrels, Drums, Kegs, and Pails	36	52	490	116	155
3444	Sheet Metal Work	9	13	34	4,465	4,702
3449	Misc. Structural Metal Work	26	34	258	563	658
3469	Metal Stampings, N.E.C.	8	13	31	2,632	2,748
3483	Ammunition, Except for Small Arms	57	70	1,529	55	70
3489	Ordnance and Accessories, N.E.C.	83	89	1,929	71	72
3499	Fabricated Metal Products, N.E.C.	10	14	40	3,383	3,444

Source: U.S. Department of Commerce, Bureau of the Census. 1996b. *1992 Census of Manufactures, Subject Series: General Summary.* Washington, DC: Government Printing Office.

face similar demand. Captive (or on-site) metal finishing facilities are more numerous than independent finishers. However, independent finishers are usually less specialized and accommodate many customers. Sales in the fabricated metals industry are primarily driven by orders for consumer durables, such as automobiles, washing machines, and electronics (EPA,1995e).

SECTION 5

ECONOMIC IMPACTS

Control measures implemented to comply with the proposed regulation will impose regulatory costs on affected facilities in the commercial, industrial, and government sectors. This section estimates the cost associated with the control measures and investigates alternative waste disposal methods available to facilities.

5.1 Control Cost Estimates

Model incinerator units were developed to evaluate impacts on existing sources. These model are representative of the population contained in the Inventory Database. Model unit control costs are linked to individual units in the Inventory Database to estimate the total control costs associated with the proposed regulation.

5.1.1 Model Units

Three separate model units were developed, representing typical incinerator units in the Inventory Database. A brief description of the model units is presented in Table 5-1. A detailed discussion of the model units and the assumptions used in their development is presented in the docket for the commercial and industrial solid waste incinerator rulemaking (ICCR, 1998).

The model units were mapped to the 122 individual incinerator units in the Inventory Database. Approximately 52 percent of the units in the Inventory Database are classified as Model B, 36 percent are Model C, and the remaining 12 percent are Model A. Table 5-2 shows the distribution of model units by industry. Most of the units in the chemical industry, the industry segment with the largest number of units, are classified as Model B and Model C.

Model unit capital and operating costs (independent of control costs) are presented in Table 5-3. Model A, the large continuous feed unit, has the highest capital and operating costs. The total annualized cost (annualized capital cost and operating and maintenance

Table 5-1. Description of Model Incinerator Units

Model Parameters	Model A	Model B	Model C
Waste Type	Sludge/liquid	Solids	Solids
Technology	Excess Air	Excess Air	Excess Air
Chamber Design	Single Chamber	Single Chamber	Multiple Chamber
Waste Charging	Continuous	Batch	Intermittent
Capacity	1,500 lbs/hr	100 lbs/hr 500 lbs/batch	1,500 lbs/hr
Operating Time	4,719 hrs/yr	2,838 hrs/yr	2,838 hrs/yr

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

costs) for Model A is $252,759 per year. In comparison, Model B, the smaller batch feed unit, has annualized costs of $30,988 per year.

5.1.2 New Sources

Frequently a proposed rule will include new source performance standards, and these associated control costs will be included in the economic analysis. It is customary to project the baseline to some point in the future (e.g., 5 years) based on forecasted growth trends and to account for the new sources arising over that time period in the control cost estimates of the proposed regulation.

However, no net growth in the number of commercial or industrial incinerator units is projected in the foreseeable future. Thus, no economic inpacts are expected due to the regulation of new sources. This assumption of zero growth in the number of incinerator units is based on information collected during the ICCR process.[1]

[1] It is possible that some existing units will be shut down and replaced by new units. Any new units would be required to meet the same emissions limits as existing units included in the proposed CISWI regulation.

Table 5-2. Distribution of Model Incinerator Units

SIC	Industry Description	Model 1	Model 2	Model 3	Total Number of Units
07	Agricultural Services		3		3
13	Oil & Gas Extraction		1	1	2
20	Food & Kindred Products			1	1
22	Textile Mill Products		1	1	2
23	Apparel			1	1
24	Lumber & Wood Products	1	5	2	8
25	Furniture & Fixtures		3		3
26	Paper & Allied Products	1	2	3	6
27	Printing & Publishing		1		1
28	Chemicals & Allied Products	5	17	15	37
30	Rubber & Misc. Plastics	1		1	2
32	Stone, Clay, Glass, & Concrete Products	1			1
33	Primary Metals Industries		1		1
34	Fabricated Metal Products		6	4	10
35	Industrial & Commercial Machinery	2	1	1	4
36	Electronic Equipment		1	2	3
37	Transportation Equipment		1	3	4
40	Railroad Transportation			2	2
42	Motor Freight Transport & Warehousing		1		1
49	Electric, Gas, & Sanitary Services		2	1	3
50	Durable Goods Wholesale Trade		2	1	3
51	Nondurable Goods Wholesale Trade		1		1
55	Automotive Dealers & Gas Stations	1			1
76	Misc. Repair Services		1		1
87	Engineering, Accounting, Research, Management and Related Services		1		1
State	State Governments	1	1		2
City	City Governments	1	2	2	5
Federal	Federal Government	1	5	2	8
University	Universities		5		5
Total		15	64	43	122

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

Table 5-3. Summary of Model Incinerator Costs (third-quarter 1998 dollars)

	Model A	Model B	Model C
	Sludge/Liquid	Solids	Solids
Total Capital Investment ($)	$708,850	$78,184	$259,264
Total O&M ($/yr)	$109,529	$14,772	$47,074
Annualized Capital ($/yr)	$143,231	$16,216	$52,523
Total Annual Costs ($/yr)	$252,759	$30,988	$99,597

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

5.2 Unit-Level Control Costs

Control costs are estimated for two regulatory alternatives. These two alternatives are refereed to as the Floor Alternative and the Above the Floor Alternative. The Floor Alternative is based on the emission levels associated with an incinerator unit with a wet scrubber. The Above the Floor Alternative is based on emission levels associated with an incinerator unit with both a wet scrubber and a Carbon Injection/Fabric Filter System. A technical description of these two regulatory alternatives and the procedures used to identify the Floor and Above the Floor Alternatives is presented in the docket for the CISWI rulemaking (ICCR, 1998).

For each of the two regulatory alternatives, a series of control costs were estimated for each model unit. The series of control cost estimates correspond to the varying level of existing controls currently in place on the incinerators identified in the Inventory Database. For example, under the Floor Alternative, it is assumed that units with no existing controls would install a wet scrubber, and a unit with dry sorbent injection (DSI) would install a Packed Bed (PB) scrubber. Thus, units with existing controls generally have lower assigned control costs.

Table 5-4a presents the Floor Alternative unit control costs for Models 1, 2, and 3 for the levels of existing controls on units in the database. Similarly, Table 5-4b presents unit-level control costs for the Above the Floor Alternative. A detailed technical description

Table 5-4a. Total Annualized Unit-Level Control Costs for Floor Alternative

Existing Controls	Additional Controls Required[a]	Model 1 Control Costs	Model 2 Control Costs	Model 3 Control Costs
Units With Wet Scrubbers	No Additional Control Requirements	$20,700	$20,315	$20,315
Units With Fabric Filters or Dry Sorbent Injection and Fabric Filters	Packed Bed	$159,782	$57,318	$117,222
Units That are Uncontrolled	Wet Scrubbers	$186,307	$69,319	$141,366

[a] All units must comply with testing and monitoring, and operator training and certification requirements regardless of existing controls

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

Table 5-4b. Total Annualized Unit-Level Control Costs for Above the Floor Alternative

Existing Controls	Additional Controls Required[a]	Model 1 Control Costs	Model 2 Control Costs	Model 3 Control Costs
Units With Wet Scrubbers	Carbon Injection/Fabric Filters	$211,203	$115,169	$184,609
Units With Fabric Filters	Packed Bed and Carbon Injection	$205,293	$62,686	$142,060
Units With Dry Sorbent Injection and Fabric Filters	Carbon Injection	$66,211	$25,683	$45,153
Units That are Uncontrolled	Carbon Injection/Fabric Filters and Packed Bed	$350,285	$152,172	$281,516

[a] All units must comply with testing and monitoring, and operator training and certification requirements regardless of existing controls.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

of the existing and add-on control options is presented in the docket for the CISWI rulemaking (ICCR, 1998).

The control costs listed in Tables 5-4a and 5-4b are the total annualized costs (TACs) associated with the regulatory scenarios. The TAC comprises annualized capital costs and total operating and maintenance costs. Capital costs are discounted using a 7 percent social discount rate to obtain annualized capital costs. Total operating and maintenance costs include operation and maintenance of the control equipment, testing and monitoring, and operator training and certification.

5.3 Total Annual Control Costs

Total control costs are estimated by linking the unit-level control costs in Table 5-4a and Table 5-4b to the individual incinerator units identified in the Inventory Database. Total annual control costs for the Floor Alternative are estimated to be $11,590,228, and total annual control costs for the Above the Floor Alternative are estimated to be $24,519,126.

Table 5-5 presents total annual control costs broken out by industry. For the Floor Alternative, the chemical industry accounts for 27.5 percent of the control costs. Fabricated metals and lumber and wood products account for 8.5 percent and 7.0 percent of total control costs, respectively.

For the Above the Floor Alternative, the percentage distribution of control costs is basically the same as for the Floor Alternative. The chemical industry accounts for 28.9 percent of control costs. Fabricated metals and lumber and wood products account for 8.3 percent and 6.8 percent of total control costs, respectively.

5.4 Alternative Disposal Methods Analysis

The total annual control costs shown in Table 5-5 represent an upper bound of the costs of the regulation because these total costs are based on the assumption that firm behavior does not change and that all facilities simply install the control technologies required to meet the emissions standards. Affected facilities, however, have several options available to them to meet the emission limits of the regulation, ranging from alternative waste management practices to closing down the facility generating the waste. It is possible that for some firms these alternatives will be "less costly" compared to installing the control technology and this will lower the total economic impact of the regulation.

Table 5-5. Total Annual Control Costs

SIC	Industry Description	Floor Alternative Control Costs	Percentage Floor Alternative Control Costs by Industry	Above the Floor Alternative Control Costs	Percentage Above the Floor Alternative Control Costs by Industry
07	Agricultural Services	207,957	1.8%	456,516	1.9%
13	Oil & Gas Extraction	210,685	1.8%	433,688	1.8%
20	Food & Kindred Products	141,366	1.2%	281,516	1.2%
22	Textile Mill Products	210,685	1.8%	433,688	1.8%
23	Apparel	141,366	1.2%	281,516	1.2%
24	Lumber & Wood Prod.	815,634	7.0%	1,674,177	6.8%
25	Furniture & Fixtures	207,957	1.8%	456,516	1.9%
26	Paper & Allied Products	219,182	1.9%	863,333	3.5%
27	Printing & Publishing	69,319	0.6%	152,172	0.6%
28	Chemicals & Allied Products	3,182,869	27.5%	7,078,791	28.9%
30	Rubber & Misc. Plastics	323,673	2.8%	631,801	2.6%
32	Stone, Clay, Glass, & Concrete Products	186,307	1.6%	350,285	1.4%
33	Primary Metals Industries	69,319	0.6%	152,172	0.6%
34	Fabricated Metal Products	981,378	8.5%	2,039,096	8.3%
35	Ind. & Commrcl. Mach.	583,299	5.0%	1,134,258	4.6%
36	Electronic Equipment	352,051	3.0%	715,204	2.9%
37	Transportation Equipment	469,273	4.0%	857,264	3.5%
40	Railroad Transportation	282,732	2.4%	563,032	2.3%
42	Motor Freight Transport & Warehousing	20,315	0.2%	25,683	0.1%
49	Electric, Gas, & Sanitary Services	250,004	2.4%	585,860	2.4%
50	Durable Goods Wholesale Trade	280,004	2.4%	585,860	2.4%
51	Nondurable Goods Wholesale Trade	69,319	0.6%	152,172	0.6%
55	Automotive Dealers & Gas Stations	186,307	1.6%	350,285	1.4%
76	Misc. Repair Services	69,319	0.6%	152,172	0.6%
87	Eng., Acct., Res. Mgmt. & Rel. Svcs.	69,319	0.6%	152,172	0.6%
State	State Governments	210,685	1.8%	433,688	1.8%
City	City Governments	607,677	5.2%	1,217,661	5.0%
Federal	Federal Government	791,632	6.8%	1,547,688	6.3%
University	Universities	346,595	3.0%	760,860	3.1%
Total		$11,590,228	100.0%	$24,519,126	100.0%

Based on information provided by the ICCR process, alternative disposal methods are the most likely "noncontrol-technology" option facilities have to comply with the proposed regulations. Under this scenario, a facility would close its incinerator unit (with other business operations unchanged) and dispose of its waste through the use of landfills, for example. Although alternative disposal methods may involve some additional costs, such as waste transportation and tipping fees, facilities would realize some cost saving from eliminating operating, maintenance and fuel costs associated with operating the incinerator units. If the net change is that costs associated with alternative disposal methods are less than the costs of the control technologies (presented in Table 5-4a or Table 5-4b), then it may be in the best interest of the facility to shut down the incineration unit.

As part of the combustion source ICR, facilities were asked to identify what their alternative disposal methods would be if they were not able to incinerate their wastes. Facility responses are listed in Table 5-6. The most common alternative disposal methods cited were special disposal contracts and off-site landfills. In addition, several facilities indicated that their "waste" could be sold as either a product or a fuel. Eight facilities indicated that they had no other disposal alternative besides incineration.

To investigate the economic feasibility of alternative disposal methods, we analyzed the benefits and costs associated with facilities closing their incineration unit and using off-site landfills to dispose of the waste previously being incinerated. The alternative net costs (i.e., negative net benefits) from switching from on-site incineration to off-site disposal (landfill) can be expressed as

Alternative Net Costs = (costs of off-site disposal) – (O&M costs of on-site incineration) = ([Transportation + tipping fees] * tons/yr) - (total O&M costs)

where

Transportation costs	= cost per ton of transporting the waste to off-site landfill plus any incremental costs associated with storage
Tipping fees	= cost per ton charged by landfill
Tons/yr	= tons of waste incinerated per year
Total O&M costs	= total cost of operating and maintaining incinerator unit per year.

For our analysis we assume that the average transportation cost is \$8.43/ton. This is based on a typical hauling distance of 30 miles (Boss and Maxfield, 1997), and an average hauling fee of \$0.28/ton, per mile (Kosmicki, 1997). In reality, transportation costs may vary

Table 5-6. Alternative Disposal Methods

Alternative Disposal Method	Number of Facilities[a]
Dispose of on Site	11
Local Trash	12
Special Disposal Contract	43
Off-site Landfill	29
Sell as Product	5
Sell as Fuel	10
Vent to Atmosphere	5
Waste Water Treatment Plant	4
No Other Alternative	8
Don't Know	5
Other Disposal Method	18

[a] Sum of responses is greater than the number of facilities (112) because some facilities listed multiple alternative disposal methods.

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

greatly by facility, depending of the distance to the closest landfill. Correspondingly, respondents in the combustion source ICR who responded that they had no alternative disposal methods may have implicitly been stating that they were too far from any landfills to make this option economically feasible.

Tipping fees in the U.S. generally range $30 to $60 dollars/ton, depending on regional factors such as state regulations and the opportunity cost of land (Glenn, 1998). The maximum tipping fee in the U.S. is approximately $100/ton. For our analysis we use the average national tipping fee of $49.75/ton (Glenn, 1998), yielding a total alternative disposal cost (transportation plus tipping fee) of $58.18/ton.

The number of tons per year incinerated for each facility was estimated based on information collected from the ICR. Annual tons per year incinerated was calculated as

$$\text{Tons/yr} = (\text{Annual operating hours}) * (\text{unit Capacity lb/hr}) * (\text{average unit operating rate})$$

Based on this information, it is estimated that it may be economically feasible for over 50 percent of incinerators for which we have capacity information to use landfills as an alternative disposal method, replacing incineration.[2] Economically feasible implies that the annualized cost of installing the control technology (wet scrubber, for example) and operating the incinerator is greater than the net alternative disposal cost for a given unit. Table 5-7 shows the average TAC control costs and the range of estimated alternative costs by industry type.[3]

However, the above cost analysis does not account for the possible intangible benefits associated with on-site incineration. These intangible benefits may include convenience of continuous/on-demand waste disposal

- storage costs associated with accumulation of waste between disposal pick-ups
- administrative costs associated with contracting for transportation
- uncertainties regarding transportation and tipping fees and availability of future access to landfills.

Thus, the share of actual facilities selecting alternative disposal methods may be less than the percent estimate presented in the above analysis. However, based in the combustion source ICR, it is likely that some facilities will change to alternative options. As a result, the use of alterative waste disposal methods may reduce the economic impact of the regulation.

5.5 Market Impacts

The purpose of the market analysis is to describe and quantify how control cost requirements impact the markets where the affected facilities buy inputs and sell outputs. To achieve this purpose, a market model analysis is typically conducted to transform the control

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[2]This is based on 28 units, the majority of which are from the chemical and allied products industry. Thus, the 50 percent estimate may not be representative of the population as a whole. The intent of the analysis is to illustrate that economically feasible alternatives may exist.

[3]The alternative disposal methods analysis was not conducted for the Above the Floor Alternative because the results are intended to demonstrate the feasibility of alternative methods and are not used to estimate economic impacts. The higher control costs of the Above the Floor Alternative would likely increase the percentage of incinerators for which landfills would be economically feasible.

Table 5-7. Economic Feasibility of Alternative Waste Management (landfills)

SIC	SIC Code	Avg. Total Annual Cost (Floor Alternative)	Avg. Net Alt. Cost (Trans. + Tipping Fees—Total O&M costs)	Maximum Alternative Cost	Minimum Alternative Cost	No. Units with Avail. Data[a]	No. Units Where Off-site Disposal is Econ. Feasible[b]
07	Agricultural	-	-	-	-	-	-
13	Oil & Gas Extraction	136,266	2,436	4,364	509	2	2
20	Food & Kindred Products	188,440	1,510	1,510	1,510	1	1
22	Textile Mill Products	-	-	-	-	-	-
23	Apparel	188,440	93,833	93,833	93,833	1	1
24	Lumber & Wood Products	144,154	47,136	122,527	8,029	3	3
25	Furniture & Fixtures	-	-	-	-	-	-
26	Paper & Allied Products	83,246	699,332	1,762,898	78,741	3	1
27	Printing & Publishing	84,019	130,322	130,322	130,322	1	0
28	Chemicals & Allied Products	122,960	167,085	637,769	22,055	8	3
30	Rubber & Misc. Plastics	260,037	74,197	74,197	74,197	1	1
32	Stone, Clay, Glass, & Concrete Products	-	-	-	-	-	-
33	Primary Metals Industries	-	-	-	-	-	-
34	Fabricated Metal Products	143,719	31,417	31,417	31,417	1	1
35	Indstrl & Commrcl Machinery	188,440	304	304	304	1	1
36	Electronic Equipment	153,657	6,126	6,126	6,126	1	1
37	Transportation Equipment	188,440	1,257	1,257	1,257	1	1
40	Railroad Transportation	-	-	-	-	-	-
42	Motor Freight Transport & Warehousing	-	-	-	-	-	-
49	Electric, Gas, & Sanitary Services	84,091	488,712	488,712	488,712	1	0
50	Durable Goods Wholesale Trade	-	-	-	-	-	-
51	Nondurable Goods Wholesale Trade	-	-	-	-	-	-
55	Automotive Dealers & Gas Stations	-	-	-	-	-	-
76	Misc. Repair Services	-	-	-	-	-	-
87	Eng., Acct., Res. Mgmt. & Rel. Svcs.	-	-	-	-	-	-
State	State Governments	-	-	-	-	-	-
City	City Governments	-	-	-	-	-	-
Federal	Federal Government	133,646	10,607	31,417	65	3	3
University	Universities	-	-	-	-	-	-
Total						28	19

cost estimates associated with affected facilities to changes in production decisions, thus altering the affected markets that lead to changes in price, quantity, and social welfare.

Figure 5-1 presents a conceptual overview of the market analysis. As shown in Figure 5-1a, the total market supply is the horizontal sum of affected and unaffected facilities' supply. The supply curve for affected and unaffected facilities is assumed to be upward sloping reflecting varying technology and efficiency factors that differentiate existing supply conditions. Demand is represented by a downward sloping function, indicating that as price decreases, the quantity demanded increases. The slope of the demand function reflects how responsive demand is to changes in price (e.g., the price elasticity of demand). The baseline market equilibrium (without regulation) is defined by the market price (P) and quantity (Q) that equate the supply and demand (i.e., the point where the supply and demand curves intersect).

Figure 5-1b shows the regulation market equilibrium. Compliance costs have shifted up the affected facilities' supply curve and this contributes to an upward shift in the total market supply curve. The unaffected facilities' supply curve does not change. In addition, the demand curve does not shift as a result of the regulation because the control costs do not affect consumers' tastes or preferences. As shown in Figure 5-1b, the upward shift in the total market supply function leads to an increase in price and a decrease in quantity.

Changes in the market price and quantity are used to adjust engineering estimates of control costs to estimate economic impacts. In addition, changes in market price and quantity are used to assess the share of the regulatory costs that are borne by consumers and producers. For example, do producers bear the production cost increase associated with the regulation or are these costs passed on to consumers in the form of higher prices?

The size of the shift in the total market supply curve depends on two factors:

1. The relative size of the shift in the supply curve for affected facilities, and

2. The proportion of facilities that are affected relative to the total market size.

Thus, in general, high control costs relative to production costs and a large share of the market being affected leads to a large upward shift in the total market supply function.

For the proposed CISWI regulation, our analysis indicates that control costs will be small relative to total production costs. In addition, the number of affected facilities in each individual market will also be small. Based on the Inventory Database, relatively few

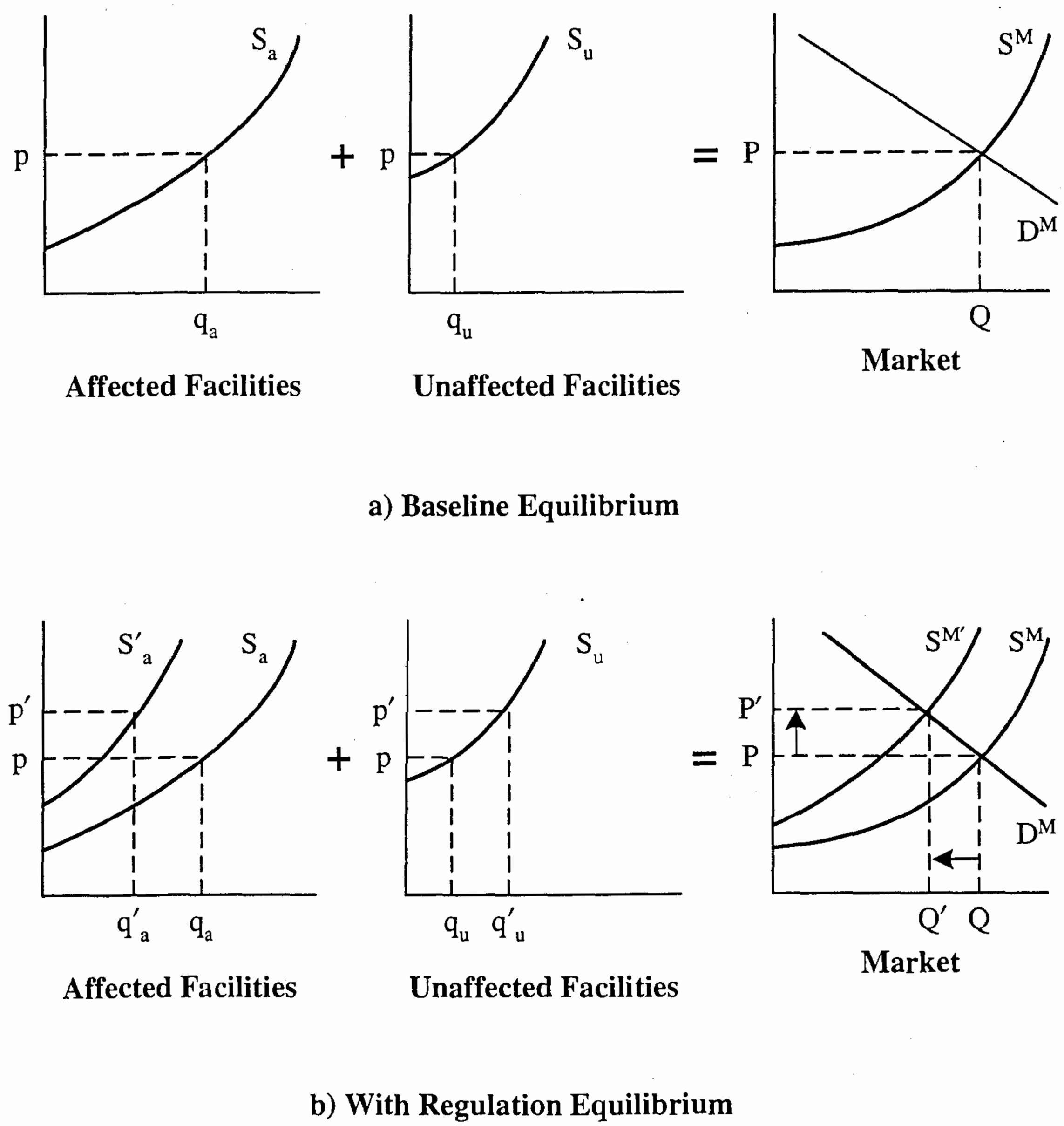

Figure 5-1. Market Equilibrium Without and With Regulation

facilities within each market will be affected by the regulation. In addition, as shown in Section 4, the major markets affected are competitive, implying that the individual affected facilities will not be able to influence market conditions.

As a result, our analysis indicates that there will be a very small shift in the total market supply functions for the industries affected by the regulation. And, because this will lead to little or no change in market price, control costs will be primarily borne by the affected producers in the industries with incineration units. In effect, competition from unaffected facilities will prevent affected facilities from passing the increased cost of the regulation onto consumers in the form of higher prices. This conclusion also implies that the regulation's impact on imports and exports will be negligible.

The economic analysis also indicates that the proposed regulation's impact on total employment in the industries affected will be negligible. As discussed in Section 6, the ratio of control costs to company sales is low. Thus, it is anticipated that no plants will close as a result of the regulation and that any decreases in production at affected facilities will be offset by increases in production by unaffected facilities.

5.6 Summary of Economic Impact Analysis

Control costs associated with the Floor Alternative for the proposed CISWI regulation are estimated to be approximately $11.6 million. This estimate is based on the 122 incinerator units identified in the Inventory Database and accounts for their existing control technologies. Control costs of the Above the Floor Alternatives are estimated to be approximately $24.5 million.

The rule affects a very small number of facilities in many different industries and government entities. Of the 112 affected facilities, 92 are spread among 25 different industries; 15 are spread among state, federal and city governments; and 5 are at universities.

Because of the competitive nature of the markets and the relatively small number of affected facilities in each market, producers will be unable to pass along the cost of the regulation to consumers in the short run. Hence, these costs will be borne by the affected domestic producers. This conclusion also implies that the regulation's impact on imports and exports will be negligible. The economic analysis also indicates that the proposed regulation's impact on total employment in the industries affected will be negligible. The ratio of control costs to company sales is low; only 9 of the 79 companies owning affected facilities in the 25 different industries had cost-to-sales ratios of 3 percent or more (see Section 6). It is anticipated that no plants will close as a result of the regulation. However, the use of alternative waste management decisions, such as the use of landfills or selling materials as fuels and intermediate products, should lower the total social cost of the regulation below the annual cost estimates of $11.6 million for the Floor Alternative, which assume add-on control technology is used for all affected units.

The general findings from the economic impact analysis are similar for the Floor and Above the Floor Alternatives. Whereas the control costs for individual affected units double under the Above the Floor Alternative, compared to the Floor Alternative, the economic analysis indicates that the Above the Floor Alternative's impact on employment and foreign trade would be negligible.

SECTION 6

REGULATORY FLEXIBILITY ANALYSIS

The regulatory costs imposed on domestic producers to reduce air emissions from commercial and industrial waste incineration will have a direct impact on owners of the affected facilities. Firms or individuals that own the facilities with incinerators are legal business entities that have the capacity to conduct business transactions and make business decisions that affect the facility. The legal and financial responsibility for compliance with a regulatory action ultimately rests with these owners, who must bear the financial consequences of their decisions. Thus, an analysis of the firm-level impacts of the proposed regulation involves identifying and characterizing affected entities, assessing their response options by modeling or characterizing the decision-making process, projecting how different parties will respond to a regulation, and analyzing the consequences of those decisions.

Environmental regulations, such as the proposed commercial and industrial waste incineration standard, affect both large and small businesses, but small businesses may have special problems in complying with such regulations. The Regulatory Flexibility Act (RFA) of 1980 requires that special consideration be given to small entities affected by federal regulation. Specifically, the RFA requires determining whether a regulation will significantly affect a substantial number of small entities or cause a disproportionate burden on small entities in comparison to large companies. In 1996, the Small Business Regulatory Enforcement Fairness Act (SBREFA) was passed, which further amended the RFA by expanding judicial review of agencies' compliance with the RFA and by expanding small business review of EPA rulemaking.

This analysis assesses the potential impacts of the standard on small businesses. To do that, the costs of the regulation are, to the extent possible, mapped to firm-level data and proportional cost effects are estimated for each identified firm. Then, the focus is placed on small firms and the question of whether there are a substantial number whose regulatory cost-to-sales impact is large. The control costs for the Floor Alternative are used to estimate cost-to-sales ratios.[1]

6.1 Analysis of Facility-Level and Parent-Level Data

Based on the Inventory Database, it is estimated that the proposed regulation will affect 112 existing facilities. As shown in Table 6-1, these 112 facilities are owned by 90 parent companies. The average number of facilities per company is 1.24; however, as illustrated in Table 6-1, a few large parent companies in the chemical industry and a military installation own several facilities with incinerators.

Employment and sales are typically used as measures of business size. Employment, sales, and tax revenue data (when applicable) were collected for the 90 parent companies.[2] Figure 6-1 shows the distribution of employees by parent company. Employment for parent companies ranges from 3 to 276,000 employees. Twenty-three of the firms have fewer than 500 employees, and 9 companies have more than 50,000 employees.

Sales provide another measure of business size. Figure 6-2 presents the sales distribution for affected parent companies. The median sales figure for affected companies is $916 million, and the average sales figure is $7.4 billion (excluding the federal government). As shown in Figure 6-2, the distribution of firm sales is skewed toward the higher end of the sales range. Approximately two-thirds of all parents have sales greater than $100 million. These figures include all sales associated with the parent company, not just facilities that are affected by the regulation (i.e., facilities with incinerators).

Based on Small Business Administration guidelines, 26 of the companies were identified as small businesses.[3] Small businesses by business type are presented in Table 6-2. The lumber and wood products industry contains the largest number (7) of the small

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[1]Using control costs for the Above the Floor Alternative would approximately double cost-to-sales results presented in this section. However, the overall findings from the analysis would remain unchanged.

[2]Total annualized cost is compared to tax revenue to assess the relative impact on local governments.

[3]Small business guidelines typically define small businesses based on employment and the threshold varies from industry to industry. For example, in the paints and allied products industry, a business with fewer than 500 employees is considered a small business; whereas in the industrial gases industry, a business with fewer than 1,000 employees is considered small. However, for a few industries, usually services, sales are used as the criterion. For example in the veterinary hospital industry, companies with less than $5 million in annual sales are defined as small businesses.

Table 6-1. Facility-Level and Parent-Level Data

SIC	Industry Description	Number of Facilities	Number of Parent Companies	Avg. Number of Facilities Per Parent Entity
07	Agricultural Services	3	3	1
13	Oil & Gas Extraction	2	1	1
20	Food & Kindred Products	1	1	1
22	Textile Mill Products	2	2	1
23	Apparel	1	1	1
24	Lumber & Wood Products	8	8	1
25	Furniture & Fixtures	1	1	1
26	Paper & Allied Products	6	6	1
27	Printing & Publishing	1	1	1
28	Chemicals & Allied Products	32	22	1.5
30	Rubber & Misc. Plastics	2	2	1
32	Stone, Clay, Glass, & Concrete Products	1	1	1
33	Primary Metals Industries	1	1	1
34	Fabricated Metal Products	9	9	1
35	Indstrl & Commrcl Machinery	3	3	1
36	Electronic Equipment	2	2	1
37	Transportation Equipment	4	4	1
40	Railroad Transportation	2	2	1
42	Motor Freight Transport & Warehousing	1	1	1
49	Electric, Gas, & Sanitary Services	3	3	1
50	Durable Goods Wholesale Trade	3	3	1
51	Nondurable Goods Wholesale Trade	1	0	0
55	Automotive Dealers & Gas Stations	1	1	1
76	Misc. Repair Services	1	0	0
87	Engineering, Acct, Res Mgmt & Rel. Svc.	1	1	1
State	State Governments	2	1	2
City	City Governments	5	5	1
Federal	Federal Government	8	1	8
University	Universities	5	4	1.3
Total		112	90	1.33

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

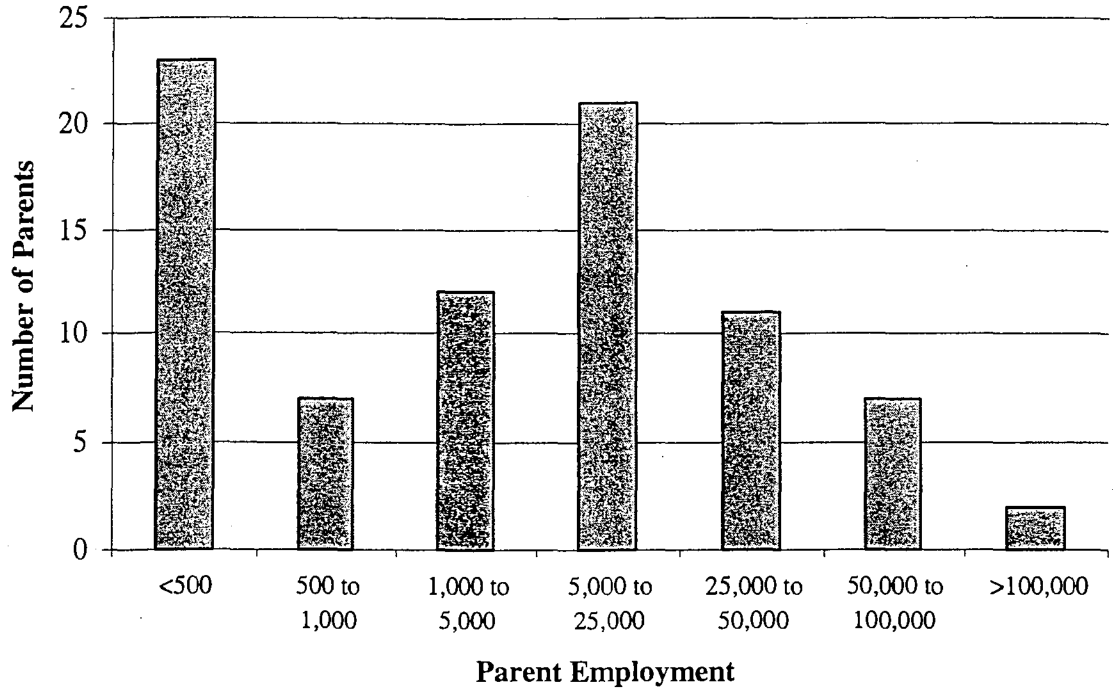

Figure 6-1. Parent Size by Employment Range

Includes 83 parent companies for which data are available.

businesses, followed by fabricated metals, veterinary hospitals, and wholesale trade sectors. Also, four cities are classified as small governments because they have fewer than 50,000 residents. The remaining six small businesses are distributed across six different two-digit SIC code groupings.

6.2 Small Business Impacts

Table 6-3 presents a summary of the ratio of floor control costs to sales for affected large and small entities. The average floor cost-to-sales ratio is 0.03 percent for large companies (excluding the federal government) and 4.72 percent for small companies. Only nine small businesses had floor cost-to-sales ratios greater than 3 percent, assuming add-on control is employed to meet the standard (rather than alternative disposal methods).

For the nine entities that had floor cost to sales ratios greater than 3 percent, the median volume of material incinerated was about 50 tons per year. Because of the relatively

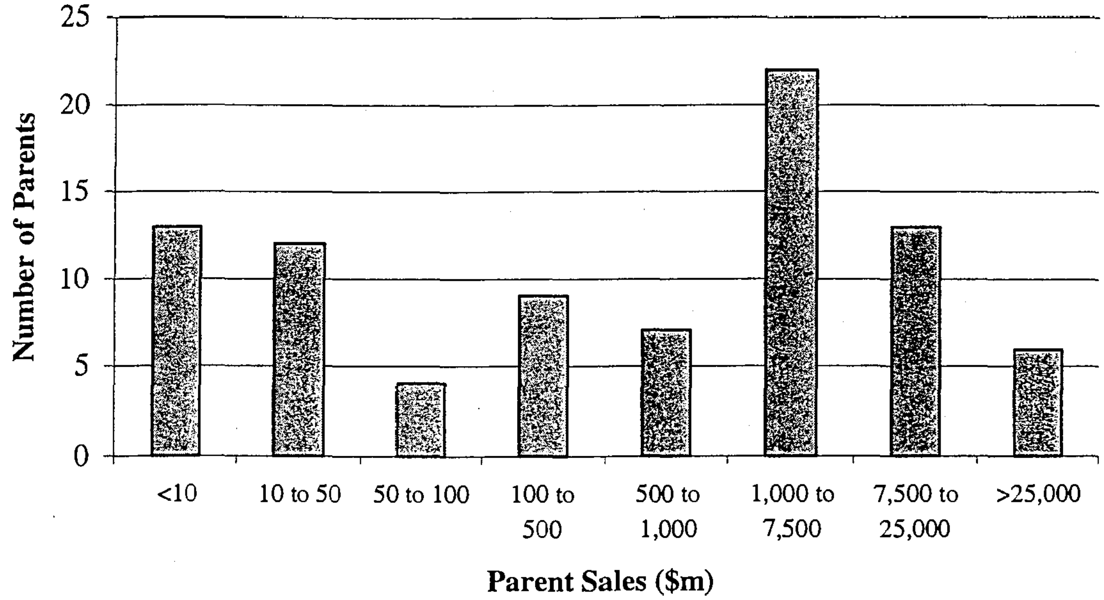

Figure 6-2. Number of Parents by Sales Range

Includes 86 parent companies for which data are available.

small number of tons per year being incinerated, the alternative net cost for landfilling (see Section 5.4) is likely to be less than the control costs for many of these facilities. Thus, it may be economically feasible for some of these small entities to switch to an alternative disposal methods, such as off-site landfills, and lower their net compliance costs.

Based on the low number of affected small firms and the relatively low control cost, this analysis suggests that the proposed regulation should not generate significant small business impact on a substantial number of small firms in the commercial, industrial, and government sectors.

Table 6-2. Small Parent Companies

SIC	Industry Description	Number of Facilities	Number of Parent Companies	Number of Small Parent Companies
07	Agricultural Services	3	3	3
13	Oil & Gas Extraction	2	1	1
20	Food & Kindred Products	1	1	0
22	Textile Mill Products	2	2	0
23	Apparel	1	1	0
24	Lumber & Wood Products	8	8	7
25	Furniture & Fixtures	1	1	0
26	Paper & Allied Products	6	6	0
27	Printing & Publishing	1	1	0
28	Chemicals & Allied Products	32	22	1
30	Rubber & Misc. Plastics	2	2	0
32	Stone, Clay, Glass, & Concrete Products	1	1	0
33	Primary Metals Industries	1	1	0
34	Fabricated Metal Products	9	9	3
35	Indstrl & Commrcl Machinery	3	3	0
36	Electronic Equipment	2	2	1
37	Transportation Equipment	4	4	0
40	Railroad Transportation	2	2	1
42	Motor Freight Transport & Warehousing	1	1	0
49	Electric, Gas, & Sanitary Services	3	3	1
50	Durable Goods Wholesale Trade	3	3	3
51	Nondurable Goods Wholesale Trade	1	0	0
55	Automotive Dealers & Gas Stations	1	1	1
76	Misc. Repair Services	1	0	0
87	Engineering, Acct, Res Mgmt & Rel. Svc.	1	1	0
State	State Governments	2	1	0
City	City Governments	5	5	4
Federal	Federal Government	8	1	0
University	Universities	5	4	0
Total		112	90	26

Source: Industrial Combustion Coordinated Rulemaking (ICCR). 1998. Data/Information Submitted to the Coordinating Committee at the Final Meeting of the Industrial Combustion Coordinated Rulemaking Federal Advisory Committee. EPA Docket Numbers A-94-63, II-K-4b2 through -4b5. Research Triangle Park, North Carolina. September 16-17.

Table 6-3. Floor Cost-to-Sales Ratio

	Large	Small
Number of Parent Entities	65	26
Average Floor Control Costs	$135,524.77	$114,131.73
Average Sales	$10,341.77 million[a]	$14.85 million
Average Cost-to-Sales Ratio	0.029%	4.72%[b]
Number of Companies with Cost-to-Sales Ratios Above 3%	0	9
Number of Companies with Cost-to-Sales Ratios Above 1%	0	15

[a] Excludes federal government tax revenues.
[b] The median cost-to-sales ratio for small companies is 1.85 percent.

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APPENDIX A

EXAMPLES OF WASTE BEING INCINERATED AT AFFECTED FACILITIES
(Source: ICCR, 1998)

Organic sludge

- wastewater treatment plant sludge (dry & wet)
- wet sludge consisting of 85% water and 15% dry solids
- sludge from activated sludge wastewater treatment plant

Fumes and gasses

- off-gas from air oxidation process, storage tank vents, distillation vents
- fumes from reactors
- natural gas
- organic fumes from condensation reaction of unsaturated polyester resin
- mineral spirits fumes are burned off without condensation
- pulp mill noncondensable gases

Petroleum products

- refined petroleum contaminated debris
- waste lubrication oils
- fuel oil, 65%, paper, 32%, waste explosives, 3%
- oil filters, oil field trash, process filters
- oil filters & process filters oil & gas
- petroleum sorbents, oil filters, fuel filters
- oil soaked pads—oil absorbent bags from floor drains
- waste oil from automotive vehicles and construction equipment

Pharmaceutical products

- off spec pharmaceutical products & packaging components
- nonhazardous industrial solid waste, including off-spec pharmaceutical and other commercial products, nonhazardous industrial wipers, etc.
- waste ethical drugs, sweeping, etc., waste narcotic controlled drugs
- returned pharmaceutical products with packaging (nonhazardous)
- returned pharmaceutical goods
- activated sludge from a pharmaceutical manufacturing plant wastewater treatment system
- tablets, capsules, noncorrugated carton
- illegal drugs and combustible contraband

Paint products

- paint from painted outside of david
- paint filters and varnish dust
- paint filters
- paint from production tooling
- laquer/paint from painting booths
- fiber paint booth filters & paper waste
- paint both filters containing cured 2-part urethane paint, floor sweepings
- used air filters from paint booths, dirty rags, drip paper from paint booths

Paper and wood

- broken wooden pallets
- molded paper articles containing nitrocellulose
- land-clearing debris from construction activity
- collected from papermill process; made up of fiber, filler, and biomass
- utility poles, salt-treated timbers

- 75% paper 25% plastic
- paper mill sludge from waste treatment plant-deink tissue mill
- ncgs from pulping operations
- hardboard—analysis attached
- classified paper waste & magnetic media
- off-specification diaper raw materials and trim waste, paper, corrugated cartons, plastic

Other biomass products

- vegetable oil, coconut oil, rice oil, silicone oil
- biomass waste from site wastewater treatment facility, ~90% water
- biological secondary sludge from aerobic treatment of industrial wastewater with 5 percent inert solids
- water with varying amounts of organics
- the combustion device destroys volatile organic compounds from pioneer's manufacturing processes (paper coating operations, and resin production) and distillate treatment system
- waste activated charcoal and waste diatomaceous earth used as filter media, non hazardous

Other

- fiberglass overspray filters loaded with overspray from finish system
- phosphate cleaner waste
- residue from herbicide intermediate production
- ethyl acetate isopropanol
- waste coolant, mop water, washer rinse water and wash water
- stoddard calibration fluid
- contaminated trash from ammunition production lines
- nylon 6,6 polymer
- pallets

- 98% water, 2% anti-static liquid mixed with water
- waste carbon black
- carbon black
- solids from manufacturing and product storage
- food materials, paint, varnishes and non-hazardous wastes no hazardous wastes are accepted
- polypropylene carpet backing
- n-methyl pyrrolidine residue
- multiple effect evaporator concentrate; concentrated blowdown from cooling tower
- empty drums

TECHNICAL REPORT DATA

(Please read Instructions on reverse before completing)

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

The U.S. Environmental Protection Agency (EPA) is developing regulations under Sections 111 and 129 of the Clean Air Act for commercial and industrial incineration units that burn nonhazardous solid waste materials. EPA identified 122 commercial and industrial incinerators located at 112 facilities that may be affected by this regulation. Control measures implemented to comply with the proposed regulation will impose regulatory costs on affected facilities in the commercial, industrial, and government sectors. This study evaluaties the impact (both negative and positive) of these costs on facilities, on the parent companies that own the facilities, and on the U.S. economy.

Of the 112 affected facilities, 92 are spread among 25 different industries; 15 are spread among state, federal, and city governments; and 5 are at universities. Control costs associated with the Floor Alternative for the proposed CISWI regulation are estimated to be approximately $11.6 million. However, the use of alternative waste management decisions, such as using landfills or selling materials as fuels and intermediate products, should lower the total social cost of the regulation below the annual cost estimate of $11.6 million for the Floor Alternative, assuming add-on control technology is used for all affected units. The analysis also suggests that the proposed regulation should not generate significant small business impacts on a substantial number of small firms in the commercial, industrial, and government sectors.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
	air pollution control, environmental regulation, economic impact analysis, incinerators, small business impacts	

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