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Economic Analysis of the Final Regulations Addressing Cooling Water Intake Structures for New Facilities

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Chapter 1: Introduction and Overview

INTRODUCTION

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EPA is promulgating regulations implementing section 316(b) of the Clean Water Act (CWA) for new facilities (33 U.S.C. 1326(b)). The final rule establishes national technology-based performance requirements applicable to the location, design, construction, and capacity of cooling water intake structures (CWIS) at new facilities. The final national requirements establish the best technology available (BTA) to minimize the adverse environmental impact (AEI) associated with the use of these structures. Means by which CWIS cause AEI include impingement (where fish and other aquatic life are trapped on equipment at the entrance to CWIS) and entrainment (where aquatic organisms, eggs, and larvae are taken into the cooling system, passed through the heat exchanger, and then discharged back into the source water body).

The final rule applies to new greenfield and stand-alone facilities that use CWIS to withdraw water from waters of the U.S. and that have or require a National Pollutant Discharge Elimination System (NPDES) permit.

Not covered under this final regulation are existing facilities operating CWIS, including existing facilities proposing substantial additions or modifications to their operations. These facilities will be addressed by a separate rule.

1.1 SCOPE OF THE FINAL RULE

The *Economic Analysis of the Final Regulations Addressing Cooling Water Intake Structures for New Facilities* (EA) assesses the economic impacts of the final section 316(b) New Facility Rule. Facilities covered under this regulation include any facility that meets the "new facility" criteria established for this regulation, is considered a point source under Sections 301 or 306 of the CWA, and proposes to operate a CWIS that will withdraw water for cooling purposes from a water of the United States.

For this final regulation, EPA divided new facilities into two groups:

- ***Electric generators:*** new facilities engaged in the generation of electricity using a steam electric prime mover; and
- ***Manufacturing facilities:*** new facilities engaged in a primary economic activity other than electricity generation.

EPA estimates that 83 new electric generators and 38 new manufacturing facilities will be subject to the final section 316(b) New Facility Rule over the next 20 years.

1.2 Definitions of Key Concepts

This EA presents EPA's analyses of costs, benefits, and potential economic impacts as a result of the final section 316(b) rule. In addition to important economic concepts, which will be presented in the following chapters, understanding this document requires familiarity with a few key concepts applicable to CWA section 316(b) and this regulation. This section defines these key concepts.

- ***Cooling Water Intake Structure (CWIS):*** The total physical structure and any associated constructed waterways used to withdraw cooling water from waters of the U.S. The CWIS extends from the point at which water is withdrawn from the water source up to, and including, the intake pumps.

- ***Entrainment:*** The incorporation of all life stages of fish and shellfish with intake water flow entering and passing through a CWIS and into a cooling water system.

- ***Impingement:*** The entrapment of all life stages of fish and shellfish on the outer part of an intake structure or against screening devices during periods of intake water withdrawal.

- ***Manufacturing Facility:*** An establishment engaged in the mechanical or chemical transformation of materials or substances into new products. Manufacturing facilities are classified under Standard Industrial Classification (SIC) Codes 20 to 39 (U.S. DOL, 2001).

- ***New Facility:*** Any building, structure, facility, or installation that meets the definition of a "new source" or "new discharger" in 40 CFR 122.2 and 122.29(b)(1), (2), and (4); commences construction after the effective date of this rule; and has a new or modified CWIS.

- ***Steam Electric Generator:*** A facility employing one or more generating units in which the prime mover is a steam turbine. The turbines convert thermal energy (steam or hot water) produced by generators or boilers to mechanical energy or shaft torque. This mechanical energy is used to power electric generators, which convert the mechanical energy to electricity, including combined-cycle electric generating units. Electric generators are classified under SIC Major Group 49 (*Electric, Gas, and Sanitary Services*).

1.3 Summary of the Final Rule

The final section 316(b) New Facility Rule establishes national requirements for BTA, based on a two-track approach, for minimizing AEI at CWIS at new facilities. Facilities are subject to the rule only if they meet the following criteria:

- they use a CWIS to withdraw from a water of the U.S.;

- they have or require a National Pollutant Discharge Elimination System (NPDES) permit issued under section 402 of the Clean Water Act (CWA);

- they have a design intake flow of equal to or greater than two million gallons per day (MGD); and

- they use at least twenty-five percent of the water withdrawn for cooling purposes.

Based on size, Track I establishes uniform requirements. Track II allows for a site-specific study to demonstrate that alternatives to the Track I requirements will reduce impingement mortality and entrainment for all life stages of fish and shellfish to a level of reduction comparable to the level the facility would achieve at the CWIS if Track I requirements were met.

The following subsections discuss the role of location in the final section 316(b) New Facility Rule and present the specific BTA standards required under the rule.

1.3.1 Location

For costing purposes, EPA distinguishes between two types of water body: freshwater bodies and marine water bodies. Freshwater bodies include freshwater rivers or streams, and lakes or reservoirs. Marine water bodies include tidal rivers or estuaries, and oceans. For the purposes of this rule, these water body types are defined as follows:

- ***Freshwater river or stream*** means a lotic (free-flowing) system that does not receive significant inflows of water from oceans or bays due to tidal action.

- ***Lake or reservoir*** means any inland body of open water with some minimum surface area free of rooted vegetation and with an average hydraulic retention time of more than seven days. Lakes or reservoirs might be natural water bodies or impounded streams, usually fresh, surrounded by land or by land and a man-made retainer (e.g., a dam). Lakes or reservoirs might be fed by rivers, streams, springs, and/or local precipitation. Flow-through reservoirs with an average hydraulic retention time of seven days or less should be considered a freshwater river or stream.

- ***Tidal river*** means the most seaward reach of a river or stream where the salinity is less than or equal to 0.5 parts per thousand (by mass) at a time of annual low flow and whose surface elevation responds to the effects of coastal lunar tides. ***Estuary*** means all or part of the mouth of a river or stream or other body of water having an unimpaired natural connection with open seas and within which the sea water is measurably diluted with fresh water derived from land drainage. The salinity of an estuary exceeds 0.5 parts per thousand (by mass), but is less than 30 parts per thousand (by mass).

- ***Ocean*** means marine open coastal waters with a salinity greater than or equal to 30 parts per thousand (by mass).

1.3.2 BTA Standards for the Final Rule

The final section 316(b) New Facility Rule establishes technology-based performance requirements, based on a two-track approach, that reflect BTA for minimizing AEI of a CWIS.

- Track I, the "fast track," establishes national intake capacity (based on size) and velocity requirements, as well as location- and capacity-based requirements to reduce intake flow below certain proportions of certain water bodies (referred to as "proportional-flow requirements"). It also requires the permit applicant to select and implement design and construction technologies to minimize impingement mortality and entrainment of all life stages of fish and shellfish.[1]

- Track II, the "demonstration track," allows permit applicants to conduct site-specific studies to demonstrate that alternatives to the Track I requirements will achieve a level of impingement mortality and entrainment reduction for all stages of fish and shellfish at the CWIS comparable to the level of reduction that would be achieved under Track I. Track II also requires the applicant to meet the same proportional flow requirements that apply in Track I.

The main requirements of the final rule relate to (1) design intake flow, (2) design intake velocity, (3) other design and construction technologies, and (4) additional requirements defined by the Director. The following subsections discuss these four requirements.

a. Design intake flow

Intake flow refers to the volume of water that is withdrawn through the intake structure. The intake flow of a CWIS is a primary factor affecting the entrainment of organisms. Organisms entrained include small fish and immature life stages (eggs and larvae) of many species that lack sufficient mobility to move away from the intake structure. Limiting the volume of the water withdrawn from a water body can limit the potential for these organisms to be entrained.

[1] These design and construction technologies may be modified by the permit director in subsequent permits if the original design and construction technologies do not meet the environmental goals of today's rule, or if such modifications are necessary because of the effects of multiple intakes on the same water body, seasonal variations in the aquatic environment, or the presence of regional important, threatened, or endangered species.

Design intake flow standards restrict the maximum flow a facility may withdraw from a water body. The final rule includes two restrictions on intake flows. First, it sets maximum flow rates relative to the flow of the source water body. These flow rates are expressed as a percentage of the water bodies' mean annual flow or volume. Second, the final rule requires that facilities with intake flows equal to or greater than 10 MGD reduce their flow to a level commensurate with that achievable with a closed-cycle recirculating cooling system (Track I).

b. Design intake velocity

Velocity refers to the speed with which water is drawn into a CWIS. Intake velocity is a key factor that affects the impingement of fish and other aquatic biota. The final rule requires that the design through-screen velocity must be less than or equal to 0.5 ft/sec (Track I). Through-screen or through-technology velocity is the velocity that is measured through the screen face or just as the organisms are entering the technology.

c. Other design and construction technologies

In addition to design flow and velocity requirements, the final section 316(b) New Facility Rule requires implementation of additional technologies that help reduce the impact on the aquatic environment. Such other design and construction technologies include operational measures that minimize I&E of fish, eggs, and larvae.

Examples of technologies that minimize I&E include technologies such as fine mesh screens, intake traveling screens, and Gunderbooms that exclude smaller organisms from entering the CWIS; passive intake systems such as wedge wire screens, perforated pipes, porous dikes, and artificial filter beds; and diversion and/or avoidance systems. Examples of technologies that maximize survival of organisms after they have been impinged include fish handling systems such as bypass systems, fish buckets, fish baskets, fish troughs, fish elevators, fish pumps, spray wash systems, and fish sills. A facility with an intake equal to or greater than 10 MGD must select design and construction technologies if certain conditions exist at the location of the CWIS. A facility with an intake flow equal to 2 MGD and less than 10 MGD must select technologies to minimize entrainment but only has to install technologies to reduce impingement if certain conditions exist.

1.4 Organization of the EA Report

The remaining chapters of this EA are organized as follows:

- ***Chapter 2:*** The Section 316(b) Industries and the Need for Regulation provides a brief discussion of the industries affected by this regulation, discusses the environmental impacts from operating CWIS, and explains the need for this regulatory effort.

- ***Chapter 3:*** Profile of the Electric Power Industry presents a profile of the market in which affected electric generators will operate.

- ***Chapter 4:*** Profile of Manufacturers presents profiles of the market in which affected manufacturing facilities will operate.

- ***Chapter 5:*** Baseline Projections of New Facilities describes EPA's methodology and data sources for estimating the number of new electric generators and manufacturing facilities subject to this regulation.

- ***Chapter 6:*** Facility Compliance Costs summarizes the technology costs detailed in the *Technical Development Document* (U.S. EPA, 2001) of this regulation and estimates the costs of compliance for each facility in scope of the final rule. The chapter also presents facility compliance costs aggregated to the national level and provides compliance cost estimates for six additional facility analyses.

- ***Chapter 7:*** Economic Impact Analysis presents the methodology used to estimate the economic impacts of the regulation and presents the impact analysis results.

- ***Chapter 8:*** Regulatory Flexibility Analysis presents EPA's estimates of small business impacts from the final section 316(b) New Facility Rule.

- ***Chapter 9:*** Other Economic Analyses outlines the requirements for analysis under the Unfunded Mandates Reform Act and presents the results of the analysis for this regulation. This chapter also addresses EPA's compliance with Executive Order 13132 on "Federalism," Executive Order 13211 on "Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use," and the Paperwork Reduction Act of 1995, and presents the total social cost of the rule.

- ***Chapter 10:*** Alternative Regulatory Options describes three alternative regulatory options considered by EPA and their costs.

- ***Chapter 11:*** CWIS Impingement and Entrainment (I&E) Impacts and Potential Benefits presents a discussion of environmental impacts resulting from the operation of CWIS and provides a qualitative assessment of potential benefits from the final rule.

REFERENCES

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Chapter 2: The Section 316(b) Industries and the Need for Regulation

INTRODUCTION

Section 316(b) of the Clean Water Act (CWA) directs EPA to assure that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impact (AEI). Based on this statutory language, section 316(b) is already in effect and should be implemented with each NPDES permit issued to a directly discharging facility. However, in the absence of regulations that establish standards for BTA, section 316(b) has been applied inconsistently, using a case-by-case approach for some industries and it has not been rigorously applied to many other industries.

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The final section 316(b) New Facility Rule addresses section 316(b) by regulating new facilities that operate cooling water intake structures (CWIS), are required to have a National Pollution Discharge Elimination System (NPDES) permit, and meet certain criteria with respect to their intake flow.[1] While all new CWIS that meet these criteria are subject to the regulation, this economic analysis focuses on facilities in two major sectors: (1) steam electric generators; and (2) four manufacturing industry sectors with substantial cooling water use.

This chapter provides a brief overview of the analyzed sectors, their use of cooling water, and the need for this regulation.

2.1 OVERVIEW OF FACILITIES SUBJECT TO SECTION 316(B) REGULATION

The final section 316(b) New Facility Rule applies to new greenfield and stand-alone facilities proposing to operate CWIS that directly withdraw water from a water of the United States. Existing facilities operating CWIS, including facilities proposing substantial additions or modifications to their operations, are not covered under this regulation. These existing facilities will be addressed by a separate rule.

The following two subsections describe the section 316(b) sectors analyzed for this regulatory effort and the new facilities expected to be built within these sectors over the next 20 years. More detail on the two sectors and their facilities, firms, and market characteristics is provided in *Chapter 3: Profile of the Electric Power Industry* and *Chapter 4: Profile of*

[1] Only facilities that have a design intake flow of equal to or greater than two million gallons per day and that use at least twenty-five percent of their intake flow for cooling purposes are regulated under the final section 316(b) New Facility Rule.

Manufacturers. An in-depth discussion of how EPA identified and estimated new facilities potentially subject to this regulation is provided in *Chapter 5: Baseline Projection of New Facilities*.

2.1.1 Section 316(b) Sectors

EPA identified two major sectors for analysis in support of this regulation: (1) steam electric generators; and (2) manufacturing industries with substantial cooling water use. Through past section 316(b) regulatory efforts and EPA's effluent guidelines program, the Agency identified steam electric generators as the largest industrial users of cooling water. The condensers that support the steam turbines in these facilities require substantial amounts of cooling water. EPA estimates that traditional steam electric utilities (SIC Codes 4911 and 493) and steam electric nonutility power producers (SIC Major Group 49) account for approximately 92.5 percent of total cooling water intake in the United States (see Table 2-1).

Beyond steam electric generators, other industrial facilities use cooling water in their production processes (e.g., to cool equipment, for heat quenching, etc.). EPA used information from the *1982 Census of Manufactures* to identify four major manufacturing sectors showing substantial cooling water use: (1) Paper and Allied Products (SIC Major Group 26); (2) Chemicals and Allied Products (SIC Major Group 28); (3) Petroleum and Coal Products (SIC Major Group 29); and (4) Primary Metals Industries (SIC Major Group 33). As illustrated in Table 2-1, steam electric utilities, steam electric nonutility power producers, and the four major manufacturing sectors together account for approximately 99 percent of the total cooling water intake in the United States.

Table 2-1: Cooling Water Intake by Sector

Sector[a] (SIC Code)	Cooling Water Intake Flow[b]		
	Billion Gal./Yr.	Percent of Total	Cumulative Percent
Steam Electric Utility Power Producers (49)	70,000	90.9%	90.9%
Steam Electric Nonutility Power Producers (49)	1,172	1.5%	92.4%
Chemicals and Allied Products (28)	2,797	3.6%	96.0%
Primary Metals Industries (33)	1,312	1.7%	97.8%
Petroleum and Coal Products (29)	590	0.8%	98.5%
Paper and Allied Products (26)	534	0.7%	99.2%
Additional 14 Categories[c]	607	0.8%	100.0%

[a] The table is based on reported primary SIC codes.
[b] Data on cooling water use are from the *1982 Census of Manufactures*, except for traditional steam electric utilities, which are from the Form EIA-767 database, and the steam electric nonutility power producers, which are from the Form EIA-867 database. 1982 was the last year in which the Census of Manufactures reported cooling water use.
[c] 14 additional major industrial categories (major SIC codes) with effluent guidelines.

Source: U.S. DOC, 1982; U.S. DOE, 1995; U.S. DOE, 1996.

The six sectors identified for analysis comprise a substantial portion of all U.S. industries. As shown in Table 2-2, the six sectors combined account for almost 50,000 facilities, 3 million employees, and more than $1.5 trillion in sales and $150 billion in payroll. The four manufacturing sectors alone account for approximately 25 percent of total U.S. manufacturing sales and 13 percent of manufacturing employment. While existing facilities are not subject to the final section 316(b) New Facility Rule, construction of new facilities subject to the rule is most likely to occur in the same sectors. The economic characteristics of these sectors are therefore relevant to assessing potential economic impacts on facilities subject to the final rule.

Table 2-2: Summary 1997 Economic Data for Major Industry Sectors Subject to Section 316(b) Regulation: Facilities, Employment, Estimated Revenue, and Payroll (in Millions of 2000 Dollars[a])

Sector (SIC)	Number of Facilities	Employment	Sales, Receipts, or Shipments ($ millions)	Payroll ($ millions)
Utilities and Nonutilities (49)	22,306	844,766	570,244	56,593
Paper and Allied Products (26)	6,509	623,799	174,692	25,952
Chemicals and Allied Products (28)	12,401	843,469	430,792	40,874
Petroleum and Coal Products (29)	2,136	106,863	228,518	7,176
Primary Metals (33)	6,559	692,943	185,344	25,836
All Section 316(b) Sectors	**49,911**	**3,111,840**	**1,589,590**	**156,431**
Total U.S. Manufacturing	377,673	17,633,977	4,151,367	624,226
Section 316(b) Manufacturing Sectors as a Percent of Total U.S. Manufacturing[b]	7.3%	12.9%	24.6%	16.0%

[a] Dollar values adjusted from 1997 to 2000 using Producer Price Indexes (BLS, 2000).
[b] Only the four section 316(b) manufacturing sectors (26, 28, 29, and 33) are included in the percentage. SIC 49 is not part of total U.S. manufacturing.

Source: U.S. DOC, 1997.

2.1.2 New Facilities

This section summarizes EPA's methodology for estimating the number of new steam electric generators and manufacturing facilities that may be subject to section 316(b) requirements and presents the results of the analysis.

a. New steam electric generators

EPA determined the number of new steam electric generators subject to the final section 316(b) New Facility Rule using the following approach:

- EPA determined total steam electric capacity additions for the 2001 to 2020 analysis period using forecasts from the Energy Information Administration's (EIA) Annual Energy Outlook 2001 (U.S. DOE, 2000).
- EPA estimated the share of total combined-cycle and coal capacity additions that will be built at new greenfield and stand-alone facilities (as opposed to existing facilities) using the February 2001 version of the NEWGen database (RDI, 2001).
- EPA estimated the total number of new facilities (in scope and out of scope of this rule) using average facility sizes from the NEWGen database and EIA's electric generator databases (U.S. DOE, 1998a and 1998b).
- EPA determined the number of new facilities subject to the final section 316(b) New Facility Rule using information on the in-scope rate from state permitting authorities (for combined-cycle facilities) and the section 316(b) Industry Survey (for coal facilities) (U.S. EPA, 2000).

This approach resulted in an estimate of 83 new steam electric generators over the next 20 years that meet the new facility criteria specified by this rule.

b. New manufacturing facilities

The Agency estimated the number of new manufacturing facilities subject to the final section 316(b) New Facility Rule using a two-step approach:

- EPA first estimated the total number of new facilities in each manufacturing sector known to be a significant user of cooling water.[2] This determination was made using industry-specific growth rates and assumptions about the share of growth that would be met by new facilities (as opposed to expansions at existing facilities).

- EPA then used results from the section 316(b) Industry Survey to determine how many of the new facilities in each industry sector would be subject to the final section 316(b) New Facility Rule.

Based on this approach, EPA estimated that a total of 38 new manufacturing facilities in scope of the final section 316(b) New Facility Rule will begin operation during the next 20 years. Of the 38 facilities, 22 are chemical facilities, ten are steel facilities, two are petroleum refineries, two are paper mills, and two are aluminum facilities.

Table 2-3 presents the estimated number of new in-scope facilities by major sector and SIC code.

Table 2-3: Projected Number of In-Scope Facilities

SIC Code	SIC Description	Projected Number of New Facilities Over 20 Years	
		Total	**In-Scope**
Electric Generators			
SIC 49	Electric Generators	276	83
Manufacturing Facilities			
SIC 26	Paper and Allied Products	2	2
SIC 28	Chemicals and Allied Products	282	22
SIC 29	Petroleum Refining and Related Industries	2	2
SIC 33	Primary Metals Industries		
SIC 331	Blast Furnaces and Basic Steel Products	78	10
SIC 333 SIC 335	Primary Aluminum, Aluminum Rolling, and Drawing and Other Nonferrous Metals	16	2
Total Manufacturing		*380*	*38*
Total		**656**	**121**

Source: U.S. EPA analysis, 2001.

EPA also consulted with industry associations and experts. Information obtained from these sources was generally consistent with the calculated estimates.

[2] EPA identified significant users of cooling water at the 4-digit Standard Industrial Classification (SIC) code level, based on information from the section 316(b) Industry Survey.

2.2 THE NEED FOR SECTION 316(B) REGULATION

Section 316(b) provides that any standard established to address impacts from CWIS "shall require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impact." To date, no national standard for BTA that will minimize adverse environmental impact (AEI) from CWIS has been established. As a result, many CWIS have been constructed on sensitive aquatic systems with capacities and designs that cause damage to the water bodies from which they withdraw water.

Several factors drive the need for this final section 316(b) rule. Each of these factors is discussed in the following subsections.

2.2.1 The Need to Reduce Adverse Environmental Impacts

Adverse environmental impacts occur when facilities impinge aquatic organisms on their CWIS' intake screens, entrain them within their cooling system, or otherwise negatively affect habitats that support aquatic species. Exposure of aquatic organisms to impingement and entrainment (I&E) depends on the location, design, construction, capacity, and operation of a facility's CWIS (U.S. EPA, 1976; SAIC, 1994; SAIC, 1996). The regulatory goals of section 316(b) include the following:

- ensure that the location, design, construction, and capacity of a facility's CWIS reflect best technology available for minimizing adverse environmental impact;

- protect individuals, populations, and communities of aquatic organisms from harm (reduced viability or increased mortality) due to the physical and chemical stresses of I&E; and

- protect aquatic organisms and habitat that are indirectly affected by CWIS because of trophic interactions with species that are impinged or entrained.

a. Impingement

Impingement occurs when fish are trapped against CWIS' intake screens by the velocity of the intake flow. Fish may die or be injured as a result of (1) starvation and exhaustion; (2) asphyxiation when velocity forces prevent proper gill movement; (3) abrasion by screen wash spray; and (4) asphyxiation due to removal from water for prolonged periods.

b. Entrainment

Small organisms, such as eggs and larvae, are entrained when they pass through a plant's condenser cooling system. Damage can result from (1) physical impacts from pump and condenser tubing; (2) pressure changes caused by diversion of cooling water; (3) thermal shock experienced in condenser and discharge tunnels; and (4) chemical toxemia induced by the addition of anti-fouling agents such as chlorine. Mortality of entrained organisms is usually high.

c. Minimizing AEI

Review of the available literature and section 316(b) demonstration studies obtained from NPDES permit files has identified numerous documented cases of impacts associated with I&E and the effects of I&E on individual organisms and on populations of aquatic organisms. For example, specific losses attributed to individual steam electric generating plants include annual losses of 3 to 4 billion larvae, equivalent to 23 million adult fish and shellfish,[3] 23 tons of fish and shellfish of recreational, commercial, or forage value lost each year,[4] and 1 million fish lost during a three-week study period.[5] The yearly loss of billions of individuals is not the only problem. Often, there are impacts to populations as well. For example, studies of Hudson River fish populations predicted year-class reductions of up to 20 percent for striped bass, 25 percent for

[3] Brunswick Nuclear Steam Electric Generating Plant (U.S. EPA, Region IV, 1979).

[4] Crystal River Power Plant (U.S. EPA, Region IV, 1986).

[5] D.C. Cook Nuclear Power Plant (Thurber, 1985)

bay anchovy, and 43 percent for Atlantic tom cod, even without assuming 100 percent mortality of entrained organisms.[6] A modeling effort looking at the impact of entrainment mortality on the population of a selected species in the Cape Fear estuarine system predicted a 15 to 35 percent reduction in the population.[7]

The following are other documented impacts occurring as a result of CWIS:

❖ ***Brayton Point***

PG&E Generating's Brayton Point plant (formerly owned by New England Power Company) is located in Mt. Hope Bay, in the northeastern reach of Narragansett Bay, Rhode Island. In order to increase electric generating capacity, Unit 4 was switched from closed-cycle to once-through cooling in 1985. The modification of Unit 4 resulted in an increase in cooling water intake flow of 45 percent. Studies of the CWIS's impacts on fish abundance trends found that Mt. Hope Bay experienced a decline in finfish species of recreational, commercial, and ecological importance.[8] The rate of population decline increased substantially with the full implementation of the once-through cooling mode for Unit 4. The modification of Unit 4 is estimated to have resulted in an 87 percent reduction in finfish abundance based on a time series-intervention model. These impacts were associated with both I&E and the thermal discharges. Entrainment data indicated that 4.9 billion tautog eggs, 0.86 billion windowpane eggs, and 0.89 billion winter flounder larvae were entrained in 1994 alone. Using adult equivalent analyses, the entrainment and impingement of fish eggs and larvae in 1994 translated to a loss of 30,885 pounds of adult tautog, 20,146 pounds of adult windowpane, and 96,507 pounds of adult winter flounder. In contrast, species abundance trends were relatively stable in coastal areas and portions of Narragansett Bay that are not influenced by the Brayton Point CWIS.

❖ ***San Onofre Nuclear Generating Station***

The San Onofre Nuclear Generating Station (SONGS) is on the coastline of the Southern California Bight, approximately 2.5 miles southeast of San Clemente, California. The marine portions of Units 2 and 3, which are once-through, open-cycle cooling systems, began commercial operation in August of 1993 and 1994, respectively. Since then, many studies have been completed to evaluate the impact of the SONGS facility on the marine environment.[9]

Estimates of lost midwater fish species due to direct entrainment by CWIS at SONGS are between 16.5 to 45 tons per year. This loss represents a 41 percent mortality rate for fish (primarily northern anchovy, queenfish, and white croaker) entrained by intake water at SONGS. In a normal year, approximately 350,000 juvenile white croaker are estimated to be killed through entrainment at SONGS. This number represents 33,000 adult individuals or 3.5 tons of adult fish. Changes in densities of fish populations within the vicinity of the plant, relative to control populations, were observed in species of queen fish and white croaker. The density of queenfish and white croaker within three kilometers of SONGS decreased by 34 to 63 percent in shallow water samples and 50 to 70 percent in deep water samples.

The main purpose of this regulation is to minimize losses such as those described above.

2.2.2 The Need to Address Market Imperfections

The conceptual basis of environmental legislation in general, and the Clean Water Act and the section 316(b) regulation in particular, is the need to correct imperfections in the markets that arise from uncompensated environmental externalities. Facilities withdraw cooling water from a water of the U.S. to support electricity generation, steam generation, manufacturing, and other business activities, thereby impinging and entraining organisms without accounting for the consequences of these actions on the ecosystem or other parties who do not directly participate in the business transactions. In effect, the actions of these section 316(b) facilities impose environmental harm or costs on the environment and on other parties (sometimes referred to as *third parties*). These costs, however, are not recognized by the responsible entities in the conventional market-based accounting framework. Because the responsible entities do not account for these costs to the ecosystem and society,

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[6] Bowline Point, Indian Point 2 & 3, and Roseton Steam Electric Generating Stations (ConEd, 2000).

[7] Brunswick Nuclear Steam Electric Generating Plant (U.S. EPA, Region IV, 1979).

[8] Brayton Point Station (Gibson, 1996).

[9] San Onofre Nuclear Generating Station (SAIC, 1993).

they are *external* to the market framework and the consequent production and pricing decisions of the responsible entities. In addition, because no party is compensated for the adverse consequences of I&E, the externality is *uncompensated*.

Business decisions will yield a less than optimal allocation of economic resources to production activities, and, as a result, a less than optimal mix and quantity of goods and services, when external costs are not accounted for in the production and pricing decisions of the section 316(b) industries. In particular, the quantity of AEI caused by the business activities of the responsible business entities will exceed optimal levels and society will not maximize total possible welfare. Adverse distributional effects may be an additional effect of the uncompensated environmental externalities. If the distribution of I&E and ensuing AEI is not random among the U.S. population but instead is concentrated among certain population subgroups based on socio-economic or other demographic characteristics, then the uncompensated environmental externalities may produce undesirable transfers of economic welfare among subgroups of the population.

The goal of environmental legislation and subsequent implementing actions, such as the section 316(b) regulation that is the subject of this analysis, is to correct environmental externalities by requiring the responsible parties to reduce their actions causing environmental damage. Congress, in enacting the authorizing legislation, and EPA, in promulgating the implementing regulations, act on behalf of society to minimize environmental impacts (i.e., achieve a lower level of I&E and associated environmental harm). These actions result in a supply of goods and services that more nearly approximates the mix and level of goods and services that would occur if the industries impinging and entraining organisms fully accounted for the costs of their AEI-generating activities.

Requiring facilities to minimize their environmental impacts by reducing levels of I&E (i.e., reducing environmental harm) is one approach to addressing the problem of environmental externalities. This approach internalizes the external costs by turning the societal cost of environmental harm into a direct business cost – the cost of achieving compliance with the regulation – for the impinging and entraining entities. A facility causing AEI will either incur the costs of minimizing its environmental impacts, or will determine that compliance is not in its best financial interest and will cease the AEI-generating activities.

It is theoretically possible to correct the market imperfection by means other than direct regulation. Negotiation and/or litigation, for example, could achieve an optimal allocation of economic resources and mix of production activities within the economy. However, the transaction costs of assembling the affected parties and involving them in the negotiation/litigation process as well as the public goods character of the improvement sought by negotiation or litigation will frequently render this approach to addressing the market imperfection impractical. Although the environmental impacts associated with CWIS have been documented since the first attempt at section 316(b) regulation in the late 1970s, implementation of section 316(b) to date has failed to address the market imperfections associated with CWIS effectively.

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Chapter 3: Profile of the Electric Power Industry

INTRODUCTION

This profile compiles and analyzes economic and financial data for the electric power generating industry. It provides information on the structure and overall performance of the industry and explains important trends that may influence the nature and magnitude of economic impacts from the section 316(b) New Facility Rule. While this profile does not specifically address new electric generating facilities subject to the rule, the information presented is nevertheless relevant to new facilities as it describes the market into which new facilities must enter and the existing facilities against which they will compete.

CHAPTER CONTENTS

The electric power industry is one of the most extensively studied industries. The Energy Information Administration (EIA), among others, publishes a multitude of reports, documents, and studies on an annual basis. This profile is not intended to duplicate those efforts. Rather, this profile compiles, summarizes, and presents those industry data that are important in the context of the section 316(b) New Facility Rule. For more information on general concepts, trends, and developments in the electric power industry, the last section of this profile, "References," presents a select list of other publications on the industry.

The remainder of this profile is organized as follows:

- Section 3.1 provides a brief overview of the industry, including descriptions of major industry sectors, types of generating facilities, and the entities that own generating facilities.

- Section 3.2 provides data on industry production and capacity.

- Section 3.3 focuses on existing section 316(b) facilities. The existing electric generation profile is important for a number of reasons. First, existing facilities represent the economic and financial market into which new electric generators will be entering. Second, characteristics of existing coal facilities, and proposed combined-cycle facilities were used to develop the characteristics of the model coal and combined-cycle facilities for the final section 316(b) New Facility Rule. The final rule regulates *new facilities* that require a National Pollutant Discharge Elimination System (NPDES) permit, use a CWIS that withdraws cooling water from a water of the United States, and meet the MGD and percentage of water thresholds established in the rule. This section provides information on the economic, and financial, and cooling water use characteristics of *existing facilities* with a CWIS and an NPDES permit.[1] The application of the new facility rule is described in section 125.81 of the rule.

[1] Note that this profile section *includes* existing facilities that do not meet the MGD and percentage of water thresholds established in the rule.

- Section 3.4 provides a brief discussion of factors affecting the future of the electric power industry, including the status of restructuring, and summarizes forecasts of market conditions through the year 2020.

3.1 Industry Overview

This section provides a brief overview of the industry, including descriptions of major industry sectors, types of generating facilities, and the entities that own generating facilities.

3.1.1 Industry Sectors

The electricity business is made up of three major functional service components or sectors: *generation*, *transmission*, and *distribution*. These terms are defined as follows (Beamon, 1998; Joskow, 1997):[2]

- The ***generation*** sector includes the power plants that produce, or "generate," electricity.[3] Electric energy is produced using a specific generating technology, e.g., internal combustion engines and turbines. Turbines can be driven by wind, moving water (hydroelectric), or steam from fossil fuel-fired boilers or nuclear reactions. Other methods of power generation include geothermal or photovoltaic (solar) technologies.

- The ***transmission*** sector can be thought of as the interstate highway system of the business – the large, high-voltage power lines that deliver electricity from power plants to local areas. Electricity transmission involves the "transportation" of electricity from power plants to distribution centers using a complex system. Transmission requires: interconnecting and integrating a number of generating facilities into a stable, synchronized, alternating current (AC) network; scheduling and dispatching all connected plants to balance the demand and supply of electricity in real time; and managing the system for equipment failures, network constraints, and interaction with other transmission networks.

- The ***distribution*** sector can be thought of as the local delivery system – the relatively low-voltage power lines that bring power to homes and businesses. Electricity distribution relies on a system of wires and transformers along streets and underground to provide electricity to residential, commercial, and industrial consumers. The distribution system involves both the provision of the hardware (e.g., lines, poles, transformers) and a set of retailing functions, such as metering, billing, and various demand management services.

Of the three industry sectors, only electricity generation uses cooling water and is subject to section 316(b) . The remainder of this profile will focus on the generation sector of the industry.

3.1.2 Prime Movers

Electric power plants use a variety of ***prime movers*** to generate electricity. The type of prime mover used at a given plant is determined based on the type of load the plant is designed to serve, the availability of fuels, and energy requirements. Most prime movers use fossil fuels (coal, petroleum, and natural gas) as an energy source and employ some type of turbine to produce electricity. The six most common prime movers are (U.S. DOE, 2000a):

- ***Steam Turbine:*** Steam turbine, or "steam electric" units require a fuel source to boil water and produce steam that drives the turbine. Either the burning of fossil fuels or a nuclear reaction can be used to produce the heat and steam necessary to generate electricity. These units are generally ***baseload*** units that are run continuously to serve the minimum load required by the system. Steam electric units generate the majority of electricity produced at power plants in the U.S.

- ***Gas Combustion Turbine:*** Gas turbine units burn a combination of natural gas and distillate oil in a high pressure chamber to produce hot gases that are passed directly through the turbine. Units with this prime mover are generally less than 100 megawatts in size, less efficient than steam turbines, and used for ***peakload*** operation

[2] Terms highlighted in bold and italic font are defined in the glossary at the end of this chapter.

[3] The terms "plant" and "facility" are used interchangeably throughout this profile.

serving the highest daily, weekly, or seasonal loads. Gas turbine units have quick startup times and can be installed at a variety of site locations, making them ideal for peak, emergency, and reserve-power requirements.

- ***Combined-Cycle Turbine:*** Combined-cycle units utilize both steam and gas turbine prime mover technologies to increase the efficiency of the gas turbine system. After combusting natural gas in gas turbine units, the hot gases from the turbines are transported to a waste-heat recovery steam boiler where water is heated to produce steam for a second steam turbine. The steam may be produced solely by recovery of gas turbine exhaust or with additional fuel input to the steam boiler. Combined-cycle generating units are generally used for ***intermediate loads***.

- ***Internal Combustion Engines:*** Internal combustion engines contain one or more cylinders in which fuel is combusted to drive a generator. These units are generally about 5 megawatts in size, can be installed on short notice, and can begin producing electricity almost instantaneously. Like gas turbines, internal combustion units are generally used only for peak loads.

- ***Water Turbine:*** Units with water turbines, or "hydroelectric units," use either falling water or the force of a natural river current to spin turbines and produce electricity. These units are used for all types of loads.

- ***Other Prime Movers:*** Other methods of power generation include geothermal, solar, wind, and biomass prime movers. The contribution of these prime movers is small relative to total power production in the U.S., but the role of these prime movers may expand in the future because recent legislation includes incentives for their use.

Table 3-1 provides data on the number of existing utility and nonutility power plants by prime mover. This table includes all plants that have at least one non-retired unit and that submitted Forms EIA-860A (Annual Electric Generator Report - Utilities) or EIA-860B (Annual Electric Generator Report - Nonutilities) in 1998. For the purpose of this analysis, plants were classified as "steam turbine" or "combined-cycle" if they have at least one generating unit of that type. Plants that do not have any steam electric units, were classified under the prime mover type that accounts for the largest share of the plant's total electricity generation.

Table 3-1: Number of Existing Utility and Nonutility Plants by Prime Mover, 1998

Prime Mover	Utility[a]	Nonutility[a]
	Number of Plants	Number of Plants
Steam Turbine	823	768
Combined-Cycle	48	200
Gas Turbine	315	256
Internal Combustion	616	338
Hydroelectric	1,201	356
Other	39	75
Total	**3,042**	**1,993**

[a] See definition of utility and nonutility in Section 3.1.3.

Source: U.S. DOE, 1998a; U.S. DOE, 1998b.

Only prime movers with a steam electric generating cycle use substantial amounts of cooling water. These generators include steam turbines and combined-cycle technologies. As a result, the analysis in support of the section 316(b) New Facility Rule focuses on generating plants with a steam electric prime mover. This profile will, therefore, differentiate between steam electric and other prime movers.

3.1.3 Ownership

The U.S. electric power industry consists of two broad categories of firms that own and operate electric generating plants: utilities and nonutilities. Generally, they can be defined as follows (U.S. DOE, 2000a):

- ***Utility:*** A regulated entity providing electric power, traditionally vertically integrated. Utilities may or may not generate electricity. "Transmission utility" refers to the regulated owner/operator of the transmission system only. "Distribution utility" refers to the regulated owner/operator of the distribution system serving retail customers.

- ***Nonutility:*** Entities that generate power for their own use and/or for sale to utilities and others. Nonutility power producers include cogenerators, small power producers, and independent power producers. Nonutilities do not have a designated franchised service area and do not transmit or distribute electricity.

Utilities can be further divided into three major ownership categories: investor-owned utilities, publicly-owned utilities, and rural electric cooperatives. Each category is discussed below.

a. Investor-owned utilities

Investor-owned utilities (IOUs) are for-profit businesses that can take two basic organizational forms: the individual corporation and the holding company. An individual corporation is a single utility company with its own investors; a holding company is a business entity that owns one or more utility companies and may have other diversified holdings as well. Like all businesses, the objective of an IOU is to produce a return for its investors. IOUs are entities with designated franchise areas. They are required to charge reasonable and comparable prices to similar classifications of consumers and give consumers access to services under similar conditions. Most IOUs engage in all three activities: generation, transmission, and distribution. In 1998, IOUs operated 1,607 facilities, which accounted for approximately 75 percent of all U.S. electric generation capacity (U.S. DOE, 1998a).

b. Publicly-owned utilities

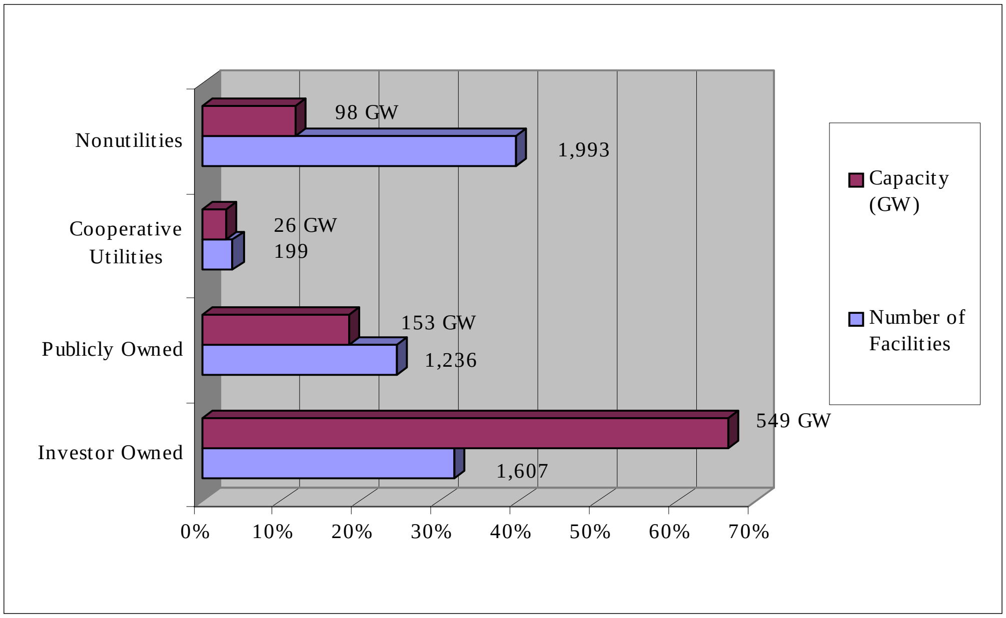
Publicly-owned electric utilities can be municipalities, public power districts, state authorities, irrigation projects, and other state agencies established to serve their local municipalities or nearby communities. Excess funds or "profits" from the operation of these utilities are put toward community programs and local government budgets, increasing facility efficiency and capacity, and reducing rates. This profile also includes federally-owned facilities in this category. Most municipal utilities are nongenerators engaging solely in the purchase of wholesale electricity for resale and distribution. The larger municipal utilities, as well as state and federal utilities, usually generate, transmit, and distribute electricity. In general, publicly-owned utilities have access to tax-free financing and do not pay certain taxes or dividends, giving them some cost advantages over IOUs. In 1998, publicly-owned utilities operated 1,236 facilities and accounted for approximately 21 percent of all U.S. electric generation capacity (U.S. DOE, 1998a).

c. Rural electric cooperatives

Cooperative electric utilities ("coops") are member-owned entities created to provide electricity to those members. Rural electric cooperatives operated 199 generating facilities in 1998. These utilities, established under the Rural Electrification Act of 1936, provide electricity to small rural and farming communities (usually fewer than 1,500 consumers). Fewer than ten percent of coops generate electricity; most are primarily engaged in distribution. Cooperatives operate in 46 states and are incorporated under state laws. The National Rural Utilities Cooperative Finance Corporation, the Federal Financing Bank, and the Bank of Cooperatives are important sources of financing for these utilities (U.S. DOE, 1998a).

Figure 3-1 presents the number of generating facilities and their capacity in 1998 by type of ownership. The horizontal axis also presents the percentage of the U.S. total that each type represents. This figure is based on data for all plants that have at least one non-retired unit and that submitted Forms EIA-860A or EIA-860B in 1998. The graphic shows that nonutilities account for the largest percentage of facilities (1,993, or about 40 percent), but only represent 12 percent of total U.S. generating capacity. Investor-owned utilities operate the second largest number of facilities, 1,607, and generate 66 percent of total U.S. capacity.

Figure 3-1: Distribution of Facilities and Capacity [a] by Ownership Type, 1998



[a] Capacity is a measure of a generating unit's ability to produce electricity. Capacity is defined as the designed full-load continuous output rating for an electric generating unit.

Source: *U.S. DOE, 1998a; U.S. DOE, 1998b; U.S. DOE, 1998c.*

Plants owned and operated by utilities and nonutilities may be affected differently by the section 316(b) New Facility Rule due to differing competitive roles in the market. Much of the following discussion therefore differentiates between these two groups.

3.2 DOMESTIC PRODUCTION

This section presents an overview of U.S. generating capacity and electricity generation. Subsection 3.2.1 provides data on capacity, and Subsection 3.2.2 provides data on generation. Subsection 3.2.3 presents an overview of the geographic distribution of generation plants and capacity.

3.2.1 Generating Capacity[4]

Utilities own and operate the majority of the generating capacity in the United States (87 percent). Nonutilities owned only 13 percent of the total capacity in 1998 and produced less than 12 percent of the electricity in the country (U.S. DOE, 1999b). Nonutility capacity and generation have increased substantially in the past few years, however, since passage of legislation aimed at increasing competition in the industry. Nonutility capacity has increased by 103 percent between 1991 and 1998, compared with the decrease in utility capacity of one percent over the same time period.[5]

Figure 3-2 shows the growth in utility and nonutility capacity from 1991 to 1998. The growth in nonutility capacity, combined with a slight decrease in utility capacity, has resulted in a modest growth in total generating capacity.

CAPACITY/CAPABILITY

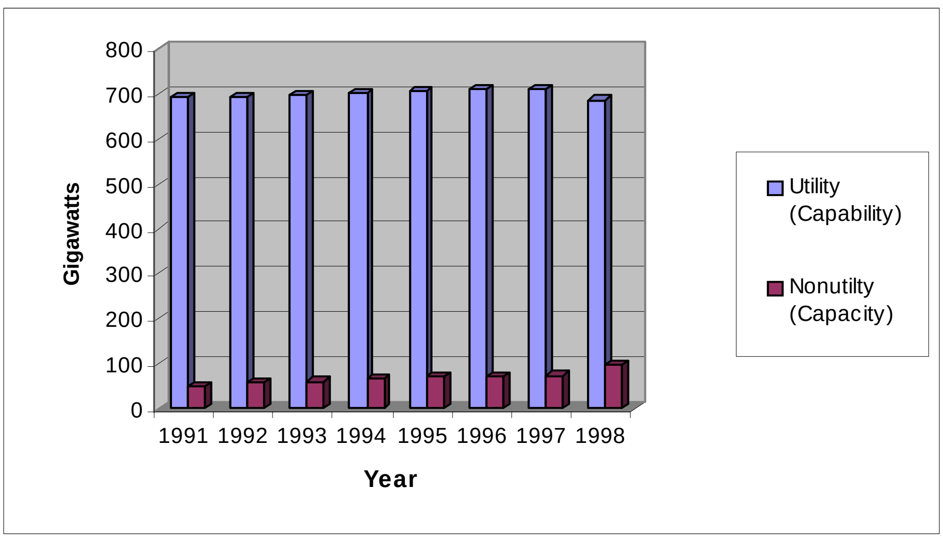
The rating of a generating unit is a measure of its ability to produce electricity. Generator ratings are expressed in megawatts (MW). Capacity and capability are the two common measures:

Nameplate capacity is the full-load continuous output rating of the generating unit under specified conditions, as designated by the manufacturer.

Net capability is the steady hourly output that the generating unit is expected to supply to the system load, as demonstrated by test procedures. The capability of the generating unit in the summer is generally less than in the winter due to high ambient-air and cooling-water temperatures, which cause generating units to be less efficient. The nameplate capacity of a generating unit is generally greater than its net capability.

U.S. DOE, 2000a

Figure 3-2: Generating Capability, 1991 to 1998



Source: U.S. DOE, 1999b; U.S. DOE,1996b.

[4] The numbers presented in this section are *capability* for utilities and *capacity* for nonutilities (see text box for the difference between these two measures). For convenience purposes, this section will refer to both measures as"capacity."

[5] More accurate data were available starting in 1991, therefore, 1991 was selected as the initial year for trends analysis.

3.2.2 Electricity Generation

Total net electricity generation in the U.S. for 1998 was 3,618 billion kWh. Utility-owned plants accounted for 89 percent of this amount. Total net generation has increased by 18 percent over the eight-year period from 1991 to 1998. During this period, nonutilities increased their electricity generation by 71 percent. In comparison, generation by utilities increased by only 14 percent (U.S. DOE, 1999b). This trend is expected to continue with deregulation in the coming years, as more facilities are purchased and built by nonutility power producers.

Table 3-2 shows the change in net generation between 1991 and 1998 by fuel source for utilities and nonutilities.

Measures of Generation

The production of electricity is referred to as generation and is measured in ***kilowatthours (kWh)***. Generation can be measured as:

Gross generation: The total amount of power produced by an electric power plant.

Net generation: Power available to the transmission system beyond that needed to operate plant equipment. For example, around 7% of electricity generated by steam electric units is used to operate equipment.

Electricity available to consumers: Power available for sale to customers. Approximately 8 to 9 percent of net generation is lost during the transmission and distribution process.

U.S. DOE, 2000a

Table 3-2: Net Generation by Energy Source and Ownership Type, 1991 to 1998 (GWh)

Energy Source	Utilities			Nonutilities[a]			Total		
	1991	1998	% Change	1991	1998	% Change	1991	1998	% Change
Coal	1,551	1,807	17%	39	68	73%	1,590	1,876	18%
Hydropower	280	304	9%	6	14	134%	286	319	11%
Nuclear	613	674	10%	0	0	0%	613	674	10%
Petroleum	111	110	-1%	8	17	124%	119	127	7%
Gas	264	309	17%	127	240	89%	391	550	40%
Renewables[b]	10	7	-29%	57	66	15%	67	73	8%
Total	**2,830**	**3,212**	**14%**	**238**	**406**	**71%**	**3,067**	**3,618**	**18%**

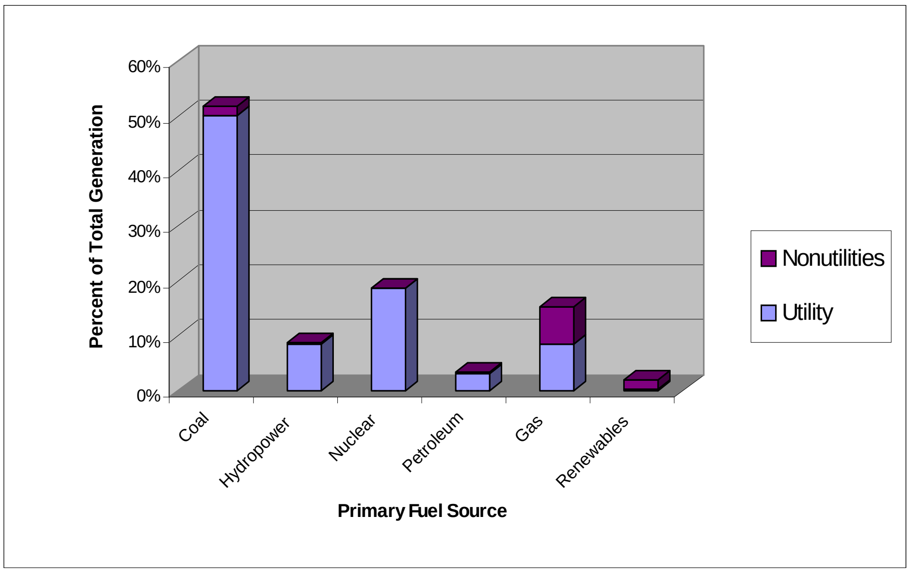
[a] Nonutility generation was converted from gross to net generation based on prime mover-specific conversion factors (U.S. DOE, 1996b). As a result of this conversion, the total net generation estimates differ slightly from EIA published totals by fuel type.
[b] Renewables include solar, wind, wood, biomass, and geothermal energy sources.

Source: U.S. DOE, 1999a; U.S. DOE, 1999b; U.S. DOE,1996a; U.S. DOE,1996b.

As shown in Table 3-2, coal and natural gas generation grew the fastest among the utility fuel source categories, each increasing by 17 percent between 1991 and 1998. Nuclear generation increased by 10 percent, while hydroelectric generation increased by 9 percent. Utility generation from renewable energy sources decreased significantly (29 percent) between 1991 and 1998. Nonutility generation has grown at a much higher rate between 1991 and 1998 with the passage of legislation aimed at increasing competition in the industry. Nonutility hydroelectric generation grew the fastest among the energy source categories, increasing 134 percent between 1991 and 1998. Generation from petroleum-fired facilities also increased substantially, with a 124 percent increase in generation between 1991 and 1998.

Figure 3-3 shows total net generation for the U.S. by primary fuel source for utilities and nonutilities. Electricity generation from coal-fired plants accounts for 52 percent of total 1998 generation. Electric utilities generate 96 percent (1,807 billion kWh) of the 1,876 billion kWh of electricity generated by coal-fired plants. This represents approximately 56 percent of total utility generation, and 50% of total generation. The remaining 2 percent (68 billion kWh) of coal-fired generation is provided by nonutilities, accounting for 17 percent of total nonutility generation. The second largest source of electricity generation is nuclear power plants, accounting for 19 percent of total generation and approximately 21 percent of total utility generation. Figure 3-3 shows that 100 percent of nuclear generation is owned and operated by utilities. Another significant source of electricity generation is gas-fired power plants, which account for 59 percent of nonutility generation and 15 percent of total generation.

Figure 3-3: Percent of Electricity Generation by Primary Fuel Source, 1998



Source: U.S. DOE,1999a; U.S. DOE,1999b.

The section 316(b) New Facility Rule will affect facilities differently based on the fuel sources and prime movers used to generate electricity. As mentioned in Section 3.1.2 above, only prime movers with a steam electric generating cycle use substantial amounts of cooling water.

3.2.3 Geographic Distribution

Electricity is a commodity that cannot be stored or easily transported over long distances. As a result, the geographic distribution of power plants is of primary importance to ensure a reliable supply of electricity to all customers. The U.S. bulk power system is composed of three major networks, or power grids:

- the *Eastern Interconnected System*, consisting of one third of the U.S., from the east coast to east of the Missouri River;
- the *Western Interconnected System*, west of the Missouri River, including the Southwest and areas west of the Rocky Mountains; and
- the *Texas Interconnected System*, the smallest of the three, consisting of the majority of Texas.

The Texas system is not connected with the other two systems, while the other two have limited interconnection to each other. The Eastern and Western systems are integrated or have links to the Canadian grid system. The Western and Texas systems have links with Mexico.

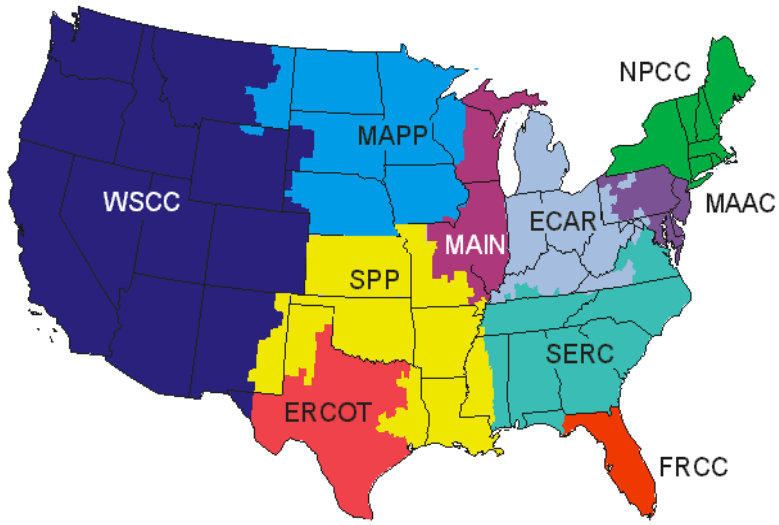
These major networks contain extra-high voltage connections that allow for power transactions from one part of the network to another. Wholesale transactions can take place within these networks to reduce power costs, increase supply options, and ensure system reliability. ***Reliability*** refers to the ability of power systems to meet the demands of consumers at any given time. Efforts to enhance reliability reduce the chances of power outages.

The North American Electric Reliability Council (NERC) is responsible for the overall reliability, planning, and coordination of the power grids. This voluntary organization was formed in 1968 by electric utilities, following a 1965 blackout in the Northeast. NERC is organized into nine regional councils that cover the 48 contiguous states, Hawaii, part of Alaska, and portions of Canada and Mexico. These regional councils are responsible for the overall coordination of bulk power policies that affect their regions' reliability and quality of service. Each NERC region deals with electricity reliability issues in its region, based on available capacity and transmission constraints. The councils also aid in the exchange of information among member utilities in each region and among regions. Service areas of the member utilities determine the boundaries of the NERC regions. Though limited by the larger bulk power grids described in the previous section, NERC regions do not necessarily follow any state boundaries. Figure 3-4 below provides a map of the NERC regions, which include:

- ECAR – East Central Area Reliability Coordination Agreement
- ERCOT – Electric Reliability Council of Texas
- FRCC – Florida Reliability Coordinating Council
- MAAC – Mid-Atlantic Area Council
- MAIN – Mid-America Interconnect Network
- MAPP – Mid-Continent Area Power Pool (U.S.)
- NPCC – Northeast Power Coordinating Council (U.S.)
- SERC – Southeastern Electric Reliability Council
- SPP – Southwest Power Pool
- WSCC – Western Systems Coordinating Council (U.S.)

Alaska and Hawaii are not shown in Figure 3-4. Part of Alaska is covered by the Alaska Systems Coordinating Council (ASCC), an affiliate NERC member. The state of Hawaii also has its own reliability authority (HI).

Figure 3-4: North American Electric Reliability Council (NERC) Regions



Source: EIA, 1996.

The section 316(b) New Facility Rule may affect plants located in different NERC regions differently. Economic characteristics of new facilities affected by the section 316(b) New Facility Rule are likely to vary across regions by fuel mix, and the costs of fuel, transportation, labor, and construction. Baseline differences in economic characteristics across regions may influence the impact of the section 316(b) New Facility Rule on profitability, electricity prices, and other impact measures. However, as discussed in *Chapter 9: Other Economic Analyses*, the section 316(b) New Facility Rule will have little or no impact on electricity prices in a particular region since relatively few new plants in any region incur costs under the rule.

Table 3-3 shows the distribution of all existing utilities, utility-owned plants, and capacity by NERC region. The table shows that while the Mid-Continent Area Power Pool (MAPP) has the largest number of utilities, 24 percent, these utilities only represent five percent of total capacity. Conversely, only five percent of the nation's utilities are located in the Southeastern Electric Reliability Council (SERC), yet these utilities are generally larger and account for 23 percent of the industry's total generating capacity.

Table 3-3: Distribution of Existing Generation Utilities, Utility Plants, and Capacity by NERC Region, 1998

NERC Region	Generation Utilities		Utility Plants		Capacity	
	Number	% of Total	Number	% of Total	Total MW	% of Total
ASCC	51	6%	166	5%	1,925	0%
ECAR	96	11%	283	9%	110,039	15%
ERCOT	27	3%	106	3%	55,890	8%
FRCC	18	2%	63	2%	38,667	5%
HI	3	0%	16	1%	1,580	0%
MAAC	21	2%	121	4%	56,824	8%
MAIN	62	7%	196	6%	52,916	7%
MAPP	211	24%	398	13%	35,737	5%
NPCC	67	8%	372	12%	46,303	6%
SERC	42	5%	320	11%	164,745	23%
SPP	143	17%	259	9%	45,807	6%
WSCC	125	14%	742	24%	118,349	16%
Total	**866**	**100%**	**3,042**	**100%**	**728,782**	**100%**

Source: U.S. DOE, 1998a.

Table 3-4 shows the distribution of existing nonutility plants and capacity by NERC region. The table shows that the Western Systems Coordinating Council (WSCC) has the largest number of nonutility plants, 592, and accounts for the largest share of total nonutility capacity, 28 percent.

Table 3-4: Distribution of Nonutility Plants and Capacity by NERC Region, 1998

NERC Region	Nonutility Plants		Capacity	
	Number	% of Total	Total MW	% of Total
ASCC	27	1%	398	0%
ECAR	142	7%	5,386	5%
ERCOT	74	4%	9,543	10%
FRCC	58	3%	3,239	3%
HI	14	1%	769	1%
MAAC	107	5%	6,126	6%
MAIN	115	6%	2,734	3%
MAPP	72	4%	1,611	2%
NPCC	395	20%	18,855	19%
SERC	277	14%	14,615	15%
SPP	45	2%	1,848	2%
WSCC	592	30%	27,809	28%
Unknown	75	4%	5,418	6%
Total	**1,993**	**100%**	**98,352**	**100%**

Source: U.S. DOE, 1998a; U.S. DOE, 1998b.

3.3 Existing Plants with CWIS and NPDES Permit

Section 316(b) of the Clean Water Act applies to a point source facility uses or proposes to use a cooling water intake structure water that directly withdraws cooling water from a water of the United States. Among power plants, only those facilities employing a steam electric generating technology require cooling water and are therefore of interest to this analysis. Steam electric generating technologies include units with steam electric turbines and combined-cycle units with a steam component.

The following sections describe existing utility and nonutility power plants that would be subject to the section 316(b) New Facility Rule *if they were new facilities*. These are existing facilities that hold a National Pollutant Discharge Elimination System (NPDES) permit and operate a CWIS.[6] The remainder of this chapter will refer to these facilities as "existing section 316(b) plants."

[6] The section 316(b) New Facility Rule applies in part to new facilities that have a design intake flow of at least 2 MGD and use 25 percent of their water for cooling water purposes. Some of the facilities discussed in this section may not meet both of these criteria.

Utilities and nonutilities are discussed in separate subsections because the data sources, definitions, and potential factors influencing the magnitude of impacts are different for the two sectors. Each subsection presents the following information:

- ***Ownership type:*** This section discusses existing section 316(b) facilities with respect to the entity that owns them. Utilities are classified into investor-owned utilities, rural electric cooperatives, municipalities, and other publicly-owned utilities (see Section 3.1.3). This differentiation is important because EPA has separately considered impacts on governments in its regulatory development (see *Chapter 9: Other Economic Analyses* for the analysis of government impacts of the section 316(b) New Facility Rule). The utility ownership categories do not apply to nonutilities. The ownership type discussion for nonutilities differentiates between two types of plants: (1) plants that were originally built by nonutility power producers ("original nonutility plants") and (2) plants that used to be owned by utilities but that were sold to nonutilities as a result of industry deregulation ("former utility plants"). Differentiation between these two types of nonutilities is important because of their different economic and operational characteristics.

- ***Ownership size:*** This section presents information on the Small Business Administration (SBA) entity size of the owners of existing section 316(b) facilities. EPA has considered economic impacts on small entities when developing this regulation (see *Chapter 8: Regulatory Flexibility Analysis/SBREFA* for the small entity analysis of new facilities subject to the section 316(b) New Facility Rule).

- ***Plant size:*** This section discusses the existing section 316(b) facilities by the size of their generation capacity. The size of a plant is important because it partly determines its need for cooling water.

- ***Geographic distribution:*** This section discusses plants by NERC region. The geographic distribution of facilities is important because a high concentration of facilities with costs under a regulation could lead to impacts on a regional level. Everything else being equal, the higher the share of plants with costs, the higher the likelihood that there may be economic and/or system reliability impacts as a result of the regulation.

- ***Water body and cooling system type:*** This section presents information on the type of water body from which existing section 316(b) facilities draw their cooling water and the type of cooling system they operate. Cooling systems can be either once-through or recirculating systems.[7] Plants with once-through cooling water systems withdraw between 70 and 98 percent more water than those with recirculating systems.

WATER USE BY STEAM ELECTRIC POWER PLANTS

Steam electric generating plants are the single largest industrial users of water in the United States. In 1995:

- steam electric plants withdrew an estimated 190 billion gallons per day, accounting for 39 percent of freshwater use and 47 percent of combined fresh and saline water withdrawals for offstream uses (uses that temporarily or permanently remove water from its source);
- fossil-fuel steam plants accounted for 71 percent of the total water use by the power industry;
- nuclear steam plants and geothermal plants accounted for 29 percent and less than 1 percent, respectively;
- surface water was the source for more than 99 percent of total power industry withdrawals;
- approximately 69 percent of water intake by the power industry was from freshwater sources, 31 percent was from saline sources.

USGS, 1995

[7] Once-through cooling systems withdraw water from the water body, run the water through condensers, and discharge the water after a single use. Recirculating systems, on the other hand, reuse water withdrawn from the source. These systems take new water into the system only to replenish losses from evaporation or other processes during the cooling process. Recirculating systems use cooling towers or ponds to cool water before passing it through condensers again.

3.3.1 Existing Section 316(b) Utility Plants

EPA identified steam electric prime movers that require cooling water using information from the EIA data collection U.S. DOE, 1998a.[8] These prime movers include:

- Atmospheric Fluidized Bed Combustion (AB)
- Combined-Cycle Steam Turbine with Supplementary Firing (CA)
- Steam Turbine – Common Header (CH)
- Combined-Cycle – Single Shaft (CS)
- Combined-Cycle Steam Turbine – Waste Heat Boiler Only (CW)
- Steam Turbine – Geothermal (GE)
- Integrated Coal Gasification Combined-Cycle (IG)
- Steam Turbine – Boiling Water Nuclear Reactor (NB)
- Steam Turbine – Graphite Nuclear Reactor (NG)
- Steam Turbine – High Temperature Gas-Cooled Nuclear Reactor (NH)
- Steam Turbine – Pressurized Water Nuclear Reactor (NP)
- Steam Turbine – Solar (SS)
- Steam Turbine – Boiler (ST)

Using this list of steam electric prime movers and U.S. DOE, 1998a information on the reported operating status of units, EPA identified 871 facilities that have at least one generating unit with a steam electric prime mover. Additional information from the section 316(b) Industry Surveys was used to determine that 618 of the 871 facilities operate a CWIS and hold an NPDES permit. Table 3-5 provides information on the number of utilities, utility plants, and generating units, and the generating capacity in 1998. The table provides information for the industry as a whole, for the steam electric part of the industry, and for the part of the industry potentially affected by the section 316(b) New Facility Rule.

Table 3-5: Number of Existing Utilities, Utility Plants, Units, and Capacity, 1998

	Total[a]	Steam Electric[b]		Steam Electric with CWIS and NPDES Permit[c]	
		Number	% of Total	Number	% of Total
Utilities	866	312	36%	202	23%
Plants	3,042	871	29%	618	20%
Units	10,208	2,231	22%	1,669	16%
Nameplate Capacity (MW)	728,782	562,117	77%	498,331	68%

[a] Includes only generating capacity not permanently shut down or sold to nonutilities.
[b] Utilities and plants are listed as steam electric if they have at least one steam electric unit.
[c] The number of plants, units, and capacity was sample weighted to account for survey non-respondents.

Source: U.S. EPA, 2000; U.S. DOE, 1998a.

Table 3-5 shows that the 871 steam electric plants account for only 29 percent of all plants but for 77 percent of all capacity. The 618 plants that withdraw cooling water from a water of the United States and hold an NPDES permit represent 20 percent of all plants, are owned by 23 percent of all utilities, and account for approximately 68 percent of reported utility generation capacity. The remainder of this section will focus on the 618 utility plants that withdraw from a water of the United States and hold an NPDES permit.

[8] U.S. DOE, 1998a (Annual Electric Generator Report) collects data used to create an annual inventory of utilities. The data collected includes: type of prime mover; nameplate rating; energy source; year of initial commercial operation; operating status; cooling water source, and NERC region.

a. Ownership type

Table 3-6 shows the distribution of the 202 utilities that own the 618 existing section 316(b) plants, as well as the total generating capacity of these entities, by type of ownership. The table also shows the total number of plants, utilities, and capacity by type of ownership. Utilities can be divided into three major ownership categories: investor-owned utilities, publicly-owned utilities (including municipalities, political subdivision, and federal and state-owned utilities), and rural electric cooperatives. Table 3-6 shows that 30 percent of plants operated by investor-owned utilities have a CWIS and an NPDES permit. These 480 facilities account for 78 percent of all existing plants with a CWIS and an NPDES permit.[9] In contrast, the percentage of all plants that have a CWIS and an NPDES permit is much lower for the other ownership types: 17 percent for rural electric cooperatives, eight percent for municipalities, and 10 percent for other publicly owned utilities.

Table 3-6: Existing Utilities, Plants, and Capacity by Ownership Type, 1998[a]

Ownership Type	Utilities			Plants			Capacity (MW)		
	Total Number of Utilities	Utilities with Plants with CWIS and NPDES		Total Number of Plants	Plants with CWIS and NPDES[b]		Total Capacity	Capacity with CWIS and NPDES[b]	
		Number	% of Total		Number	% of Total		MW	% of Total
Investor-Owned	168	119	71%	1,607	480	30%	549,439	422,427	77%
Coop	68	21	31%	199	33	17%	25,860	14,435	56%
Municipal	566	51	9%	842	65	8%	43,574	16,995	39%
Other Public	64	11	17%	394	39	10%	109,909	44,473	40%
Total	**866**	**202**	**23%**	**3,042**	**618**	**20%**	**728,782**	**498,331**	**68%**

[a] Numbers may not add up to totals due to independent rounding.
[b] The number of plants and capacity was sample weighted to account for survey non-respondents.

Source: U.S. DOE, 1999c; U.S. DOE, 1998a; U.S. DOE, 1998c.

b. Ownership size

EPA used the Small Business Administration (SBA) small entity size standards for SIC code 4911 (electric output of four million megawatt hours or less per year) to make the small entity determination.[10] Table 3-7 provides information on the total number of utilities and utility plants owned by small entities by type of ownership. The table shows that 66 of the 202 utilities with existing section 316(b) plants, or 33 percent, may be small. The size distribution varies considerably by ownership type: only nine percent of all other public utilities and ten percent of all investor-owned utilities with existing section 316(b) plants may be small, compared to 88 percent of all municipalities. The same is true on the plant level: only three percent of the 480 existing section 316(b) plants operated by an investor-owned utility are owned by a small entity. The

[9] Four-hundred and eighty Investor Owned Plants divided by 618 total plants equals about 78 percent.

[10] SBA defines "small business" as a firm with an annual electricity output of four million MWh or less and "small governmental jurisdictions" as governments of cities, counties, towns, school districts, or special districts with a population of less than 50,000 people. Information on the population of all municipal utilities was not readily available for all municipalities. EPA therefore used the small business standard for all utilities.

corresponding percentages for municipalities, other publicly owned utilities, and electric cooperatives are 78 percent, three percent, and 24 percent, respectively.[11]

Table 3-7 also shows the percentage of all small utilities and all plants owned by small utilities that comprise the "section 316(b)" part of the industry. Sixty-six, or 10 percent, of all 679 small utilities operate existing section 316(b) plants. At the plant level, between one percent (other public) and eight percent (investor-owned) of small utility plants have CWIS and NPDES permits.

Table 3-7: Existing Small Utilities and Utility Plants by Ownership Type, 1998

Ownership Type	Total			With CWIS and NPDES Permit [a,b]			Small with CWIS and NPDES/ Total Small
	Total	Small	% Small	Total	Small	% Small	
Utilities							
Investor-Owned	168	50	30%	119	12	10%	24%
Coop	68	50	74%	21	8	38%	16%
Municipal	566	555	98%	51	45	88%	8%
Other Public	64	24	38%	11	1	9%	4%
Total	866	679	78%	202	66	33%	10%
Plants							
Investor-Owned	1,607	203	13%	480	16	3%	8%
Coop	199	145	73%	33	8	24%	6%
Municipal	842	773	92%	65	51	78%	7%
Other Public	394	69	18%	39	1	3%	1%
Total	**3,042**	**1,190**	**39%**	**618**	**76**	**11%**	**6%**

[a] Numbers may not add up to totals due to independent rounding.
[b] The number of plants was sample weighted to account for survey non-respondents.

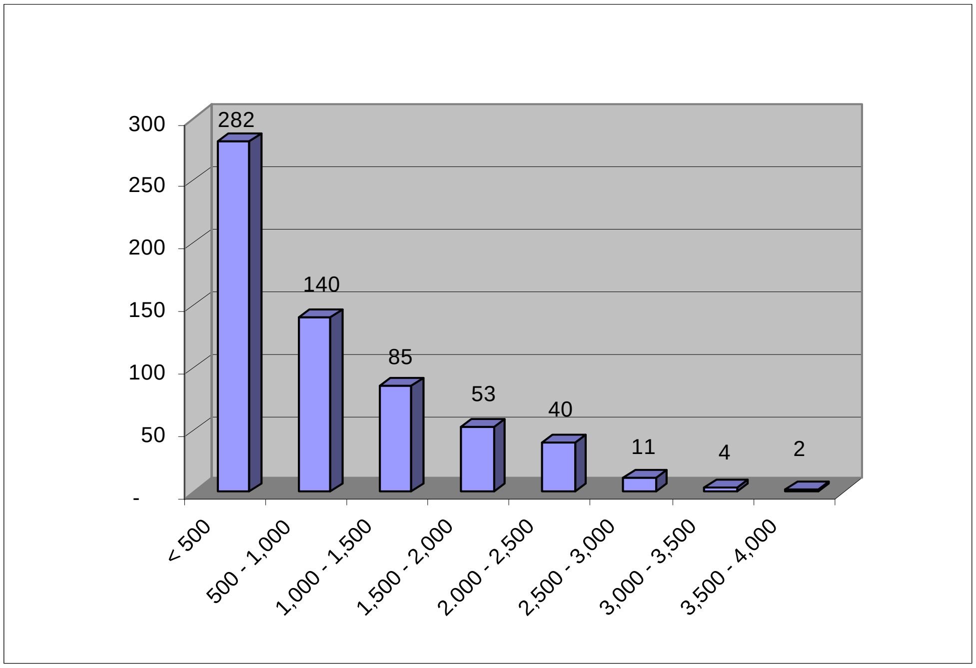
Source: U.S. SBA, 2000; U.S. DOE, 2000d; U.S. DOE, 1999c; U.S. DOE, 1998a; U.S. DOE, 1998c.

[11] Note that for investor-owned utilities, the small business determination is generally made at the holding company level. Holding company information was not available for all investor-owned utilities. The small business determination was therefore made at the utility level. This approach will overstate the number of investor-owned utilities and their plants that are classified as small.

c. Plant size

EPA also analyzed the steam electric facilities with a CWIS and an NPDES permit with respect to their generating capacity. Of the 618 plants, 282 (46 percent) have a total nameplate capacity of 500 megawatts or less, and 422 (68 percent) have a total capacity of 1,000 megawatts or less. Figure 3-5 presents the distribution of existing utility plants with a CWIS and an NPDES permit by plant size.

Figure 3-5: Number of Existing Utility Plants with CWIS and NPDES Permit by Plant Size (in MW), 1998 [a,b]



[a] Numbers may not add up to totals due to independent rounding.
[b] The number of plants was sample weighted to account for survey non-respondents.

Source: U.S. EPA, 2000; U.S. DOE, 1998a.

d. Geographic distribution

Table 3-8 shows the distribution of existing section 316(b) utility plants by NERC region. The figure shows that there are considerable differences between the regions in terms of both the number of existing utility plants with a CWIS and an NPDES permit, and the percentage of all plants that they represent. Excluding Alaska, which only has one utility plant with a CWIS and an NPDES permit, the percentage of existing section 316(b) facilities ranges from six percent in the Western Systems Coordinating Council (WSCC) to 56 percent in the Electric Reliability Council of Texas (ERCOT). The East Central Area Reliability Coordination Agreement (ECAR) has the highest absolute number of existing section 316(b) facilities with 116, or 41 percent of all facilities, followed by the Southeastern Electric Reliability Council (SERC) with 111 facilities, or 35 percent of all facilities.

Table 3-8: Existing Utility Plants by NERC Region, 1998

NERC Region	Total Number of Plants	Plants with CWIS and NPDES Permit[a,b]	
		Number	% of Total
ASCC	166	1	1%
ECAR	283	116	41%
ERCOT	106	59	56%
FRCC	63	29	46%
HI	16	3	19%
MAAC	121	48	40%
MAIN	196	58	30%
MAPP	398	56	14%
NPCC	372	52	14%
SERC	320	111	35%
SPP	259	43	17%
WSCC	742	41	6%
Total	**3,042**	**618**	**20%**

[a] Numbers may not add up to totals due to independent rounding.
[b] The number of plants was sample weighted to account for survey non-respondents.

Source: U.S. EPA, 2000; U.S. DOE, 1998a.

e. Water body and cooling system type

Table 3-9 shows that most of the existing utility plants with a CWIS and an NPDES permit draw water from a freshwater river (331, or 54 percent). The next most frequent water body types are lakes or reservoirs with 166 plants (27 percent) and estuaries or tidal rivers with 97 plants (16 percent). The table also shows that most of these plants, 404 or 65 percent, employ a once-through cooling system. Of the plants that withdraw from an estuary, the most sensitive type of water body, only six percent use a recirculating system while 87 percent have a once-through system. In contrast, a combined 29 percent (147 out of 504 plants) of plants located on freshwater rivers, lakes or reservoirs, and multiple freshwater bodies of water have a recirculating system.

Table 3-9: Number of Existing Utility Plants by Water Body Type and Cooling System Type[a]

Water Body Type	Cooling System Type										
	Recirculating		Once-Through		Combination		Other		Unknown		Total [b]
	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	
Estuary/ Tidal River	6	6%	84	87%	6	6%	1	1%	0	0%	97
Ocean	0	0%	8	100%	0	0%	0	0%	0	0%	8
Lake/ Reservoir	40	24%	115	69%	9	5%	2	1%	0	0%	166
Freshwater River	101	31%	188	57%	22	7%	18	5%	2	1%	331
Multiple Freshwater	6	86%	1	14%	0	0%	0	0%	0	0%	7
Other/ Unknown	0	0%	8	100%	0	0%	0	0%	0	0%	8
Total	**153**	**25%**	**404**	**65%**	**37**	**6%**	**21**	**3%**	**2**	**0%**	**618**

[a] The number of plants was sample weighted to account for survey non-respondents.
[b] Numbers may not add up to totals due to independent rounding.

Source: U.S. EPA, 2000; U.S. DOE, 1998a.

3.3.2 Existing Section 316(b) Nonutility Plants

EPA identified nonutility steam electric prime movers that require cooling water using information from the EIA data collection Forms EIA-860B[12] and EIA-867.[13] These prime movers include:

- Geothermal Binary (GB)
- Steam Turbine – Fluidized Bed Combustion (SF)
- Solar – Photovoltaic (SO)
- Steam Turbine (ST)

In addition, prime movers that are part of a combined-cycle unit were classified as steam electric.

U.S. DOE, 1998b includes two types of nonutilities: facilities whose primary business activity is the generation of electricity, and manufacturing facilities that operate industrial boilers in addition to their primary manufacturing processes. The discussion of existing section 316(b) nonutilities focuses on those nonutility facilities that generate electricity as their primary line of business.[14] Manufacturing facilities with industrial boilers are included in the industry profiles in *Chapter 4: Profile of Manufacturers*.

Using the identified list of steam electric prime movers, and U.S. DOE, 1998b information on the reported operating status of generating units, EPA identified 449 facilities that have at least one generating unit with a steam electric prime mover. Additional information from the section 316(b) Industry Survey determined that 62 of the 449 facilities operate a CWIS and hold an NPDES permit. Table 3-10 provides information on the number of parent entities, nonutility plants, and generating units, and their generating capacity in 1998. The table provides information for the industry as a whole, for the steam electric part of the industry, and for the "section 316(b)" part of the industry.

Table 3-10: Number of Nonutilities, Nonutility Plants, Units, and Capacity, 1998

	Total	Total Steam Electric Nonutilities [a]	Nonutilities with CWIS and NPDES Permit[a,b]	
			Number	% of Steam Electric
Parent Entities	1,485	385	39	10%
Nonutility Plants	1,993	449	62	14%
Nonutility Units	5,178	699	106	15%
Nameplate Capacity (MW)	98,352	40,042	22,765	57%

[a] Includes only nonutility plants generating electricity as their primary line of business.
[b] The number of plants, units, and capacity was sample weighted to account for survey non-respondents.

Source: U.S. EPA, 2000; U.S. DOE, 1998b.

[12] U.S. DOE, 1998b (Annual Nonutility Electric Generator Report) is the equivalent of U.S. DOE, 1998a for utilities. It is the annual inventory of nonutility plants and collects data on the type of prime mover, nameplate rating, energy source, year of initial commercial operation, and operating status.

[13] Form EIA-867 (Annual Nonutility Power Producer Report) is the predecessor of U.S. DOE, 1998b. Form EIA-867 contained similar, but more detailed, information to U.S. DOE, 1998b but was confidential. The EIA provided EPA with a list of nonutilities with steam electric prime movers from the 1996 Form EIA-867, which formed the basis for the EPA's section 316(b) Industry Survey and this analysis.

[14] EPA identified manufacturing facilities operating *steam electric* industrial boilers using SIC code information from Form EIA-867. Those facilities were removed from the analysis. The discussion of steam electric nonutilities and nonutilities with CWIS and NPDES permit, therefore, only includes facilities with electricity generation as their main line of business. However, the same information was not available for facilities with non-steam prime movers. Industry totals, therefore, include industrial boilers.

a. Ownership type

Nonutility power producers that generate electricity as their main line of business fall into two different categories: "original nonutility plants" and "former utility plants."

❖ ***Original nonutility plants***

For the purposes of this analysis, original nonutility plants are those that were originally built by a nonutility. These plants primarily include facilities qualifying under the Public Utility Regulatory Policies Act of 1978 (PURPA), cogeneration facilities, independent power producers, and exempt wholesale generators under the Energy Policy Act of 1992 (EPACT).

EPA identified original nonutility plants with a CWIS and an NPDES permit through the section 316(b) Industry Survey. This profile further differentiates original nonutility plants by their primary Standard Industrial Classification (SIC) code, as reported in the section 316(b) Industry Survey. Reported SIC codes include:

- 4911 – Electric Services
- 4931 – Electric and Other Services Combined
- 4939 – Combination Utilities, Not Elsewhere Classified
- 4953 – Refuse Systems
- 4961 – Steam and Air-Conditioning Supply

❖ ***Former utility plants***

Former utility plants are those that used to be owned by a utility power producer but have been sold to a nonutility as a result of industry deregulation. These were identified from U.S. DOE, 1998b by their plant code.[15]

[15] Plants formerly owned by a regulated utility have an identification code number that is less than 10,000 whereas nonutilities have a code number greater than 10,000. When utility plants are sold to nonutilities, they retain their original plant code.

Table 3-11 shows that original nonutilities account for the vast majority of plants (1,944 out of 1,993, or 98 percent). Only 49 out of the 1,993 nonutility plants, or two percent, were formerly owned by utilities. However, these 49 facilities account for almost 24 percent of all nonutility generating capacity (23,232 MW divided by 98,352 MW). Sixty-two of the 1,993 nonutility plants operate a CWIS and hold an NPDES permit. Most of these section 316(b) facilities (38, or 61 percent) are original nonutility plants. Only 24 of the 62 section 316(b) nonutility plants are former utility plants, but they account for almost 90 percent of all section 316(b) nonutility capacity (20,476 MW divided by 22,765 MW).

The table also shows that only one percent of all original nonutility plants have a CWIS and an NPDES permit,[16] compared to 49 percent of all former utility plants.

Table 3-11: Existing Nonutility Firms, Plants, and Capacity by SIC Code, 1998[a]

SIC Code	Firms			Plants			Capacity (MW)		
	Total Number of Firms	Firms with Plants with CWIS and NPDES[b]		Total Number of Plants	Plants with CWIS and NPDES[b]		Total Capacity	Capacity with CWIS and NPDES[b]	
		Number	% of Total		Number	% of Total		MW	% of Total
Original Nonutilities									
4911	1,463[b]	10	2%	1,944	11	1%	75,120	1,203	3%
4931		4			7			521	
4939		2			2			83	
4953		5			7			259	
4961		1			1			8	
Other SIC		2			10			215	
Former Utility Plants									
n/a	22	15	68%	49	24	49%	23,232	20,476	88%
Total	**1,485**	**39**	**3%**	**1,993**	**62**	**3%**	**98,352**	**22,765**	**23%**

[a] Numbers may not add up to totals due to independent rounding.
[b] The number of plants and capacity was sample weighted to account for survey non-respondents.

Source: U.S. EPA, 2000; U.S. DOE, 1998b.

[16] This percentage understates the true share of section 316(b) nonutility plants because the total number of plants includes industrial boilers while the number of section 316(b) nonutilities does not.

b. Ownership size

EPA used the Small Business Administration (SBA) small entity size standards to determine the number of existing section 316(b) nonutility plants owned by small firms. Table 3-12 shows that of the 38 original nonutility plants with CWIS and NPDES permits 32 percent are owned by a small entity. Another three percent are owned by a firm of unknown size which may also qualify as a small entity.

Information on the business size for former utility plants was not readily available from the EIA databases. EPA research on the new owners of these plants showed that all 24 former utility plants are now owned by a large business.

Table 3-12: Number of Nonutility Plants with CWIS and NPDES Permit by Firm Size, 1998[a]

SIC Code	Large		Small		Unknown		Total[b]
	No.	% of SIC	No.	% of SIC	No.	% of SIC	
Original Nonutilities							
4911	9	82%	1	9%	1	9%	11
4931	6	86%	1	14%	0	0%	7
4939	1	50%	1	50%	0	0%	2
4953	7	100%	0	0%	0	0%	7
4961	1	100%	0	0%	0	0%	1
Other SIC	1	10%	9	90%	0	0%	10
Total Original Nonutilities	25	66%	12	32%	1	3%	38
Former Utility Plants							
Former Utility Plants	24	100%	0	0%	0	0%	24
Total	**49**	**79%**	**12**	**19%**	**1**	**2%**	**62**

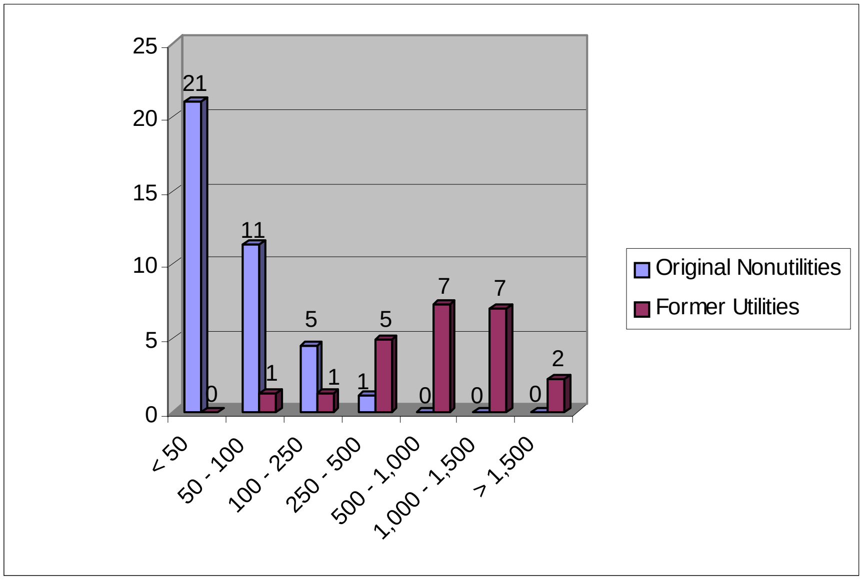
[a] The number of plants was sample weighted to account for survey non-respondents.
[b] Numbers may not add up to totals due to independent rounding.

Source: U.S. EPA, 2000; D&B Database, 2000; U.S. SBA, 2000; U.S. DOE, 1998b.

c. Plant size

EPA also analyzed the steam electric nonutilities with a CWIS and an NPDES permit with respect to their generating capacity. Figure 3-7 shows that the original nonutility plants are much smaller than the former utility plants. Of the 38 original utility plants, 21 (55 percent) have a total nameplate capacity of 50 MW or less and 32 (84 percent) have a capacity of 100 MW or less. No original nonutility plant has a capacity of more than 500 MW. In contrast, only two (nine percent) former utility plants are smaller than 250 MW while 16 (70 percent) are larger than 500 MW and nine (39 percent) are larger than 1,000 MW.

Figure 3-6: Number of Existing Nonutility Plants with CWIS and NPDES Permit by Generating Capacity (in MW), 1998[a,b]



[a] Numbers may not add up to totals due to independent rounding.
[b] The number of plants was sample weighted to account for survey non-respondents.

Source: U.S. DOE, 1998b; U.S. EPA, 2000.

d. Geographic distribution

Table 3-13 shows the distribution of existing section 316(b) nonutility plants by NERC region. The table shows that the Northeast Power Coordinating Council (NPCC) has the highest absolute number of existing section 316(b) nonutility plants with 18, or 29 percent of all 62 plants with a CWIS and an NPDES permit, followed by the Western System Coordinating Council (WSCC) with 12 plants.

The Southwest Power Pool (SPP) has the largest percentage of plants with a CWIS and an NPDES permit compared to all nonutility plants within the region (19 percent).[17]

Table 3-13: Nonutility Plants by NERC Region, 1998

NERC Region	Total Number of Plants	Plants with CWIS & NPDES Permit[a,b]	
		Number	% of Total
ASCC	27	0	0%
ECAR	142	1	1%
ERCOT	74	0	0%
FRCC	58	1	2%
HI	14	0	0%
MAAC	107	7	6%
MAIN	115	0	0%
MAPP	72	0	0%
NPCC	395	18	5%
SERC	277	4	2%
SPP	45	9	19%
WSCC	592	12	2%
Not Available	75	9	13%
Total	**1,993**	**62**	**3%**

[a] Numbers may not add up to totals due to independent rounding.
[b] The number of plants was sample weighted to account for survey non-respondents.

Source: U.S. EPA, 2000; U.S. DOE, 1998a; U.S. DOE, 1998b.

[17] As explained earlier, the total number of plants includes industrial boilers while the number of plants with a CWIS and an NPDES permit does not. Therefore, the percentages are likely higher than presented.

e. Water body and cooling system type

Table 3-14 shows the distribution of existing section 316(b) nonutility plants by type of water body and cooling system. The table shows that most of the original nonutility plants with a CWIS and an NPDES permit draw water from a freshwater river (27, or 71 percent) while most of the former utility plants withdraw from an estuary or tidal river (7, or 29 percent).

The table also shows that most of the nonutilities employ a once-through system: 16, or 42 percent, for original nonutilities and 20, or 83 percent, for former nonutility plants. Thirteen nonutilities withdraw from an estuary or tidal river (six original nonutilities and seven former utility plants). All 13 estuarine nonutility plants operate a once-through system.

Table 3-14: Number of Nonutility Plants by Water Body Type and Cooling System Type[a]

Water Body Type	Cooling System Type						
	Recirculating		Once-Through		Combination		Total [b]
	No.	% of Total	No.	% of Total	No.	% of Total	
Original Nonutilities							
Estuary/ Tidal River	0	0%	6	100%	0	0%	6
Ocean	0	0%	0	0%	0	0%	0
Lake/ Reservoir	6	100%	0	0%	0	0%	6
Freshwater River	8	30%	10	37%	9	33%	27
Other/ Unknown	0	0%	0	0%	0	0%	0
Total	**13**	**34%**	**16**	**42%**	**9**	**24%**	**38**
Former Utility Plants							
Estuary/ Tidal River	0	0%	7	100%	0	0%	7
Ocean	0	0%	1	100%	0	0%	1
Lake/ Reservoir	0	0%	4	100%	0	0%	4
Freshwater River	4	67%	2	33%	0	0%	6
Other/ Unknown	0	0%	6	100%	0	0%	6
Total	**4**	**17%**	**20**	**83%**	**0**	**0%**	**24**

[a] The number of plants was sample weighted to account for survey non-respondents.
[b] Numbers may not add up to totals due to independent rounding.

Source: U.S. EPA, 2000; U.S. DOE, 1998b.

3.4 INDUSTRY OUTLOOK

This section discusses industry trends that are currently affecting the structure of the electric power industry and may therefore affect the magnitude of impacts from the section 316(b) New Facility Rule. The most important change in the electric power industry is deregulation – the transition from a highly regulated monopolistic to a less regulated, more competitive industry. Subsection 3.4.1 discusses the current status of deregulation. Subsection 3.4.2 presents a summary of forecasts from the Annual Energy Outlook 2001.

3.4.1 Current Status of Industry Deregulation

The electric power industry is evolving from a highly regulated, monopolistic industry with traditionally-structured electric utilities to a less regulated, more competitive industry.[18] The industry has traditionally been regulated based on the premise that the supply of electricity is a natural monopoly, where a single supplier could provide electric services at a lower total cost than could be provided by several competing suppliers. Today, the relationship between electricity consumers and suppliers is undergoing substantial change. Some states have implemented plans that will change the procurement and pricing of electricity significantly, and many more plan to do so during the first few years of the 21st century (Beamon, 1998).

a. Key changes in the industry's structure

Industry deregulation already has changed and continues to fundamentally change the structure of the electric power industry. Some of the key changes include:

- ***Provision of services:*** Under the traditional regulatory system, the generation, transmission, and distribution of electric power were handled by vertically-integrated utilities. Since the mid-1990s, federal and state policies have led to increased competition in the generation sector of the industry. Increased competition has resulted in a separation of power generation, transmission, and retail distribution services. Utilities that provide transmission and distribution services will continue to be regulated and will be required to divest of their generation assets. Entities that generate electricity will no longer be subject to geographic or rate regulation.

- ***Relationship between electricity providers and consumers:*** Under traditional regulation, utilities were granted a geographic franchise area and provided electric service to all customers in that area at a rate approved by the regulatory commission. A consumer's electric supply choice was limited to the utility franchised to serve their area. Similarly, electricity suppliers were not free to pursue customers outside their designated service territories. Although most consumers will continue to receive power through their local distribution company (LDC), retail competition will allow them to select the company that generates the electricity they purchase.

DEREGULATION UPDATE: 2000

The year 2000 was a transition year for the electric industry as the nation moved state by state toward restructuring. Consolidation through mergers and acquisitions was prominent as was the divestiture of generating assets, as some electric utilities exited the generation business in order to concentrate on the distribution of electricity. Others used the opportunity to purchase divested assets to build critical mass that many think will be necessary to survive in what is expected to be a very competitive industry.

In California, the transition from a highly regulated industry into a competitive market proved problematic. In April 1998, California became the first state to restructure its electric industry. Yet, in 2000, rolling blackouts, sky-high electricity prices, and utilities nearing bankruptcy were all linked to the restructuring of California's electric industry. The attention that was focused on the pitfalls of restructuring in California affected restructuring sentiment in other states. During the year, only two additional states enacted restructuring legislation – Michigan and West Virginia – bringing the year-end total to 23 states and the District of Columbia.

U.S. DOE, 2000

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[18] Several key pieces of federal legislation have made the changes in the industry's structure possible. The ***Public Utility Regulatory Policies Act (PURPA)*** of 1978 opened up competition in the generation market by creating a class of nonutility electricity-generating companies referred to as "qualifying facilities." The ***Energy Policy Act (EPACT)*** of 1992 removed constraints on ownership of electric generation facilities, and encouraged increased competition in the wholesale electric power business (Beamon, 1998).

- ***Electricity prices:*** Under the traditional system, state and federal authorities regulated all aspects of utilities' business operations, including their prices. Electricity prices were determined administratively for each utility, based on the average cost of producing and delivering power to customers and a reasonable rate of return. As a result of deregulation, competitive market forces will set generation prices. Buyers and sellers of power will negotiate through power pools or one-on-one to set the price of electricity. As in all competitive markets, prices will reflect the interaction of supply and demand for electricity. During most time periods, the price of electricity will be set by the generating unit with the highest operating costs needed to meet spot market generation demand (i.e., the "marginal cost" of production) (Beamon, 1998).

b. New industry participants

The Energy Policy Act of 1992 (EPACT) provides for open access to transmission systems, to allow nonutility generators to enter the wholesale market more easily. In response to these requirements, utilities are proposing to form Independent System Operators (ISOs) to operate the transmission grid, regional transmission groups, and open access same-time information systems (OASIS) to inform competitors of available capacity on their transmission systems. The advent of open transmission access has fostered the development of ***power marketers*** and ***power brokers*** as new participants in the electric power industry. Power marketers buy and sell wholesale electricity and fall under the jurisdiction of the Federal Energy Regulatory Commission (FERC), since they take ownership of electricity and are engaged in interstate trade. Power marketers generally do not own generation or transmission facilities or sell power to retail customers. A growing number of power marketers have filed with the FERC and have had rates approved. Power brokers, on the other hand, arrange the sale and purchase of electric energy, transmission, and other services between buyers and sellers, but do not take title to any of the power sold.

c. State activities

Many states are taking steps to promote competition in their electricity markets. The status of these efforts varies across states. Some states are just beginning to study what a competitive electricity market might mean; others are beginning pilot programs; still others have designed restructured electricity markets and passed enabling legislation. As of September 2001, the following states have already enacted restructuring legislation (U.S. DOE, 2000b):

- Arizona
- Arkansas
- California
- Connecticut
- Delaware
- District of Columbia
- Illinois
- Maine
- Maryland
- Massachusetts
- Michigan
- Montana
- Nevada
- New Hampshire
- New Jersey
- New Mexico
- Ohio
- Oklahoma
- Oregon
- Pennsylvania
- Rhode Island
- Texas
- Virginia
- West Virginia

Even in states where consumer choice is available, important aspects of implementation may still be undecided. Key aspects of implementing restructuring include treatment of ***stranded costs***, pricing of transmission and distribution services, and the design market structures required to ensure that the benefits of competition flow to all consumers (Beamon, 1998).

3.4.2 Energy Market Model Forecasts

This section discusses forecasts of electric energy supply, demand, and prices based on data and modeling by the EIA and presented in the *Annual Energy Outlook 2001* (U.S. DOE, 2000c). The EIA models future market conditions through the year 2020, based on a range of assumptions regarding overall economic growth, global fuel prices, and legislation and regulations affecting energy markets. The projections are based on the results from EIA's National Energy Modeling System (NEMS) using assumptions reflecting economic conditions as of July 2000. Since that time, domestic economic growth has slowed considerably, suggesting that projections based on current economic conditions might be significantly different. The following discussion presents EIA's reference case results.

a. Electricity demand

The AEO2001 projects electricity demand to grow by approximately 1.8 percent annually between 2001 and 2020. This growth is driven by an estimated 1.9 percent annual increase in the demand for electricity from both the residential and commercial sector. Residential demand is expected to increase by 1.9 percent annually resulting from an increase in the number of households, particularly in the south where most new homes use central air conditioning, while increased demand from the commercial sector is associated with a steady growth in commercial floorspace. EIA expects electricity demand from the industrial sector to increase by 1.4 percent annually over the same forecast period, largely in response to an increase in industrial output.

b. Capacity Retirements

The AOE2001 projects total nuclear generation capacity to decline by an estimated 27 percent (or 26 gigawatts) between 1999 and 2020 due to nuclear power plant retirement. To produce this estimate, EIA compared the costs associated with extending the life of aging nuclear generation facilities to the cost of building new capacity to meet the need for additional electricity generation. EIA also expects total fossil fuel-fired generation capacity to decline due to retirements. EIA expects that total fossil-steam capacity will decrease by an estimated 8 percent (or 43 gigawatts) over the same time period.

c. Capacity Additions

Additional generation capacity will be needed to meet the estimated growth in electricity demand and offset the retirement of existing capacity. EIA expects utilities to employ other options, such as life extensions and repowering, to power imports from Canada and Mexico, and purchases from cogenerators before building new capacity. The Agency forecasts that utilities will choose technologies for new generation capacity that seek to minimize cost while meeting environmental and emission constraints. Of the new capacity forecasted to come on-line between 2001 and 2020, 55 percent is projected to be combined-cycle technology and 37 percent is projected to be combustion turbine technology. This additional capacity is expected to be fueled by natural gas or both oil and natural gas, and to supply primarily peak and intermediate capacity. Another six percent of additional capacity is expected to be provided by new coal-fired plants, while the remaining two percent is forecasted to come from renewable technologies.

d. Electricity Generation

The AEO2001 projects increased electricity generation from both natural gas and coal-fired plants to meet growing demand and to offset lost capacity due to plant retirements. The forecast projects that coal-fired plants will account for more than half of the industry's total generation in 2001. Although coal-fired generation is predicted to increase steadily between 2001 and 2020, its share of total generation is expected to decrease from 52 percent to an estimated 44 percent. This decrease in the share of coal generation is in favor of less capital-intensive and more efficient natural gas generation technologies. The share of total generation associated with gas-fired technologies is projected to increase from approximately 16 percent in 2001 to an estimated 36 percent in 2020, replacing nuclear power as the second largest source of electricity generation. Generation from oil-fired plants is expected to decline over the forecast period as oil-fired steam generators are replaced by gas turbine technologies.

e. Electricity Prices

EIA expects the average price of electricity, as well as the price paid by customers in each sector (residential, commercial, and industrial), to decrease between 2001 and 2020 as a result of competition among electricity suppliers. Specific market restructuring plans differ from state to state. Some states have begun deregulating their electricity markets; EIA expects most states to phase in increased customer access to electricity suppliers. Increases in the cost of fuels like natural gas and oil are not expected to increase electricity prices; these increases are expected to be offset by reductions in the price of other fuels and shifts to more efficient generating technologies.

Glossary

Baseload: A baseload generating unit is normally used to satisfy all or part of the minimum or base load of the system and, as a consequence, produces electricity at an essentially constant rate and runs continuously. Baseload units are generally the newest, largest, and most efficient of the three types of units. (http://www.eia.doe.gov/cneaf/electricity/page/prim2/chapter2.html)

Combined-Cycle Turbine: An electric generating technology in which electricity is produced from otherwise lost waste heat exiting from one or more gas (combustion) turbines. The exiting heat is routed to a conventional boiler or to heat recovery steam generator for utilization by a steam turbine in the production of electricity. This process increases the efficiency of the electric generating unit.

Distribution: The portion of an electric system that is dedicated to delivering electric energy to an end user.

Electricity Available to Consumers: Power available for sale to customers. Approximately 8 to 9 percent of net generation is lost during the transmission and distribution process.

Energy Policy Act (EPACT): In 1992 the EPACT removed constraints on ownership of electric generation facilities and encouraged increased competition on the wholesale electric power business.

Gas Combustion Turbine: A gas turbine typically consisting of an axial-flow air compressor and one or more combustion chambers, where liquid or gaseous fuel is burned and the hot gases are passed to the turbine. The hot gases expand to drive the generator and are then used to run the compressor.

Generation: The process of producing electric energy by transforming other forms of energy. Generation is also the amount of electric energy produced, expressed in ***watthours (Wh)***.

Gross Generation: The total amount of electric energy produced by the generating units at a generating station or stations, measured at the generator terminals.

Intermediate load: Intermediate-load generating units meet system requirements that are greater than baseload but less than peakload. Intermediate-load units are used during the transition between baseload and peak load requirements. (http://www.eia.doe.gov/cneaf/electricity/page/prim2/chapter2.html)

Internal Combustion Engine: An internal combustion engine has one or more cylinders in which the process of combustion takes place, converting energy released from the rapid burning of a fuel-air mixture into mechanical energy. Diesel or gas-fired engines are the principal fuel types used in these generators.

Kilowatthours (kWh): One thousand ***watthours (Wh)***.

Nameplate Capacity: The amount of electric power delivered or required for which a generator, turbine, transformer, transmission circuit, station, or system is rated by the manufacturer.

Net Capacity: The amount of electric power delivered or required for which a generator, turbine, transformer, transmission circuit, station, or system is rated by the manufacturer, exclusive of station use, and unspecified conditions for a given time interval.

Net Generation: Gross generation minus plant use from all plants owned by the same utility.

Nonutility: A corporation, person, agency, authority, or other legal entity or instrumentality that owns electric generating capacity and is not an electric utility. Nonutility power producers include qualifying cogenerators, qualifying small power producers, and other nonutility generators (including independent power producers) without a designated franchised service area that do not file forms listed in the Code of Federal Regulations, Title 18, Part 141. (http://www.eia.doe.gov/emeu/iea/glossary.html)

Other Prime Movers: Methods of power generation other than ***steam turbine***, ***combined-cycle***, ***gas combustion turbine***, ***internal combustion engine***, and ***water turbine***. Other prime movers include: geothermal, solar, wind, and biomass.

Peakload: A peakload generating unit, normally the least efficient of the three unit types, is used to meet requirements during the periods of greatest, or peak, load on the system. (http://www.eia.doe.gov/cneaf/electricity/page/prim2/chapter2.html)

Power Marketers: Business entities engaged in buying, selling, and marketing electricity. Power marketers do not usually own generating or transmission facilities. Power marketers, as opposed to brokers, take ownership of the electricity and are involved in interstate trade. These entities file with the Federal Energy Regulatory Commission for status as a power marketer. (http://www.eia.doe.gov/cneaf/electricity/epav1/glossary.html)

Power Brokers: An entity that arranges the sale and purchase of electric energy, transmission, and other services between buyers and sellers, but does not take title to any of the power sold. (http://www.eia.doe.gov/cneaf/electricity/epav1/glossary.html)

Prime Movers: The engine, turbine, water wheel or similar machine that drives an electric generator. Also, for reporting purposes, a device that directly converts energy to electricity, e.g., photovoltaic, solar, and fuel cell(s).

Public Utility Regulatory Policies Act (PURPA): In 1978 PURPA opened up competition in the electricity generation market by creating a class of nonutility electricity-generating companies referred to as “qualifying facilities.”

Reliability: Electric system reliability has two components: adequacy and security. Adequacy is the ability of the electric system to supply customers at all times, taking into account scheduled and unscheduled outages of system facilities. Security is the ability of the electric system to withstand sudden disturbances, such as electric short circuits or unanticipated loss of system facilities. (http://www.eia.doe.gov/cneaf/electricity/epav1/glossary.html)

Steam Turbine: A generating unit in which the prime mover is a steam turbine. The turbines convert thermal energy (steam or hot water) produced by generators or boilers to mechanical energy or shaft torque. This mechanical energy is used to power electric generators, including combined-cycle electric generating units, that convert the mechanical energy to electricity.

Stranded Costs: The difference between revenues under competition and costs of providing service, including the inherited fixed costs from the previous regulated market. (http://www.eia.doe.gov/cneaf/electricity/epav1/glossary.html)

Transmission: The movement or transfer of electric energy over an interconnected group of lines and associated equipment between points of supply and points at which it is transformed for delivery to consumers, or is delivered to other electric systems. Transmission is considered to end when the energy is transformed for distribution to the consumer.

Utility: A corporation, person, agency, authority, or other legal entity or instrumentality that owns and/or operates facilities within the United States, its territories, or Puerto Rico for the generation, transmission, distribution, or sale of electric energy primarily for use by the public and files forms listed in the Code of Federal Regulations, Title 18, Part 141. Facilities that qualify as cogenerators or small power producers under the Public Utility Regulatory Policies Act (PURPA) are not considered electric utilities. (http://www.eia.doe.gov/emeu/iea/glossary.html)

Water Turbine: A unit in which the turbine generator is driven by falling water.

Watt: The electrical unit of power. The rate of energy transfer equivalent to 1 ampere flowing under the pressure of 1 volt at unity power factor.(Does not appear in text)

Watthour (Wh): An electrical energy unit of measure equal to 1 watt of power supplied to, or take from, an electric circuit steadily for 1 hour. (Does not appear in text)

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Chapter 4: Profile of Manufacturers

INTRODUCTION

Based on the *1982 Census of Manufactures* and information from effluent guideline development materials, EPA identified four industrial categories other than SIC Major Group 49 that are most likely to be affected by the section 316(b) regulation. These industries, referred to collectively here as "manufacturers," were selected because of their known use of cooling water. They are Paper and Allied Products (SIC 26), Chemicals and Allied Products (SIC 28), Petroleum and Coal Products (SIC 29), and Primary Metal Industries (SIC 33).

CHAPTER CONTENTS

While facilities in other industrial groups also use cooling water and may therefore be subject to section 316(b) regulations, their total cooling water intake flow is believed to be small relative to that of the four selected industries. Therefore, this Profile of Manufacturers focuses on the manufacturing groups listed above.

The remainder of this chapter is divided into five sections:[1]

- 4A: Paper and Allied Products (SIC 26)
- 4B: Chemicals and Allied Products (SIC 28)
- 4C: Petroleum and Coal Products (SIC 29)
- 4D: Steel (SIC 331)
- 4E: Aluminum (SIC 333/335)

Each industry section is further divided into the following four subsections: (1) domestic production, (2) structure and competitiveness, (3) financial condition and performance, and (4) section 316(b) facilities. Each sector profile only presents data for SIC codes that were identified in the section 316(b) Detailed Industry Questionnaire as important users of cooling water directly withdrawn from a water of the United States.[2]

The Census of Manufactures provided much of the data used in this chapter to analyze trends in each industry. The 1997 Census used North American Industry Classification System (NAICS) codes for the first time, replacing the Standard Industrial Classification (SIC) codes used earlier. This change introduced a discontinuity in the data for some industries for which there is not a one-to-one map between the old SIC codes and the new NAICS codes. For purposes of these profiles, EPA therefore made only limited use of the 1997 Census data, and instead relied where possible on data from other sources to assess economic trends before and after 1997 on a consistent basis.

Demand for the output of all of the industries profiled in this chapter is strongly influenced by overall economic conditions. At the time these profiles were prepared, there was substantial uncertainty about the state of the U.S. and world economies. The U.S. economic expansion that began in 1992 was the longest on record, but a slowing of growth began to become evident in the second half of 2000. It remains uncertain whether the economy will continue to grow, although at a reduced rate, or slip into recession. While some of the data presented in this profile may not reflect the recent economic slowdown, the discussion highlights the effects of current economic conditions on each industry. The forecasts used in Chapter 5 to predict

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[1] Steel and aluminum are the two dominant products in the U.S. industrial metals industry. These two markets, however, are structured differently and are therefore discussed in two separate profile sections.

[2] The electronic version of this report is comprised of six separate files, one for each of the five industries and one for the glossary of terms.

the number of new facilities may not fully reflect the recent slowdown and may overstate growth in the near term. Given the long-term focus of this analysis, EPA believes that it is appropriate to focus on average growth rates over the long-term, despite the uncertainty about near term economic conditions. Post-war contractions in the U.S. economy have averaged 11 months before returning to positive growth.[3] The most recent Congressional Budget forecasts, issued in August 2001, project growth in real GDP of 1.7 percent for 2001 and 2.6 percent for 2002, with a long-term forecast of 3.2 percent per year growth for the period 2003 through 2011.[4]

[3] The National Bureau of Economic Research dates business cycles and provides historical records of expansions and contractions at http://www.nber.org/cycles.

[4] Congressional Budget Office. 2001. *The Budget and Economic Outlook: An Update.* August 28.

4A Paper and Allied Products (SIC 26)

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified five 4-digit SIC codes in the Paper and Allied Products industry (SIC 26) with at least one existing facility that operates a CWIS, holds a NPDES permit, and withdraws equal to or greater than two million gallons per day (MGD) from a water of the United States, and uses at least 25 percent of its intake flow for cooling purposes. (Facilities with these characteristics are hereafter referred to as "section 316(b) facilities"). For each of the five SIC codes, Table 4A-1 below provides a description of the industry sector, a list of primary products manufactured, the total number of detailed questionnaire respondents (weighted to represent national results), and the number and percent of section 316(b) facilities.

Table 4A-1: Section 316(b) Facilities in the Paper and Allied Products Industry (SIC 26)

SIC	SIC Description	Important Products Manufactured	Number of Weighted Detailed Questionnaire Survey Respondents		
			Total	Section 316(b) Facilities	
				No.[a]	%
2611	Pulp Mills	Pulp from wood or from other materials, such as rags, linters, wastepaper, and straw; integrated logging and pulp mill operations if primarily shipping pulp.	60	26	43.6%
2621	Paper Mills	Paper from wood pulp and other fiber pulp, converted paper products; integrated operations of producing pulp and manufacturing paper if primarily shipping paper or paper products.	290	74	25.4%
2631	Paperboard Mills	Paperboard, including paperboard coated on the paperboard machine, from wood pulp and other fiber pulp; and converted paperboard products; integrated operations of producing pulp and manufacturing paperboard if primarily shipping paperboard or paperboard products.	190	43	22.4%
Total			***539***	***142***	***26.4%***
Other Paper and Allied Products Sectors					
2676	Sanitary Paper Products	Sanitary paper products from purchased paper, such as facial tissues and handkerchiefs, table napkins, toilet paper, towels, disposable diapers, and sanitary napkins and tampons.	4	2	50.0%
2679	Converted Paper and Paperboard Products, Not Elsewhere Classified	Laminated building paper, cigarette paper, confetti, pressed and molded pulp cups and dishes, paper doilies, egg cartons, egg case filler flats, papier-mache, filter paper, foil board, gift wrap paper, wallpaper, etc.	19	3	14.2%
Total Other			***23***	***4***	***50.0%***
Total Paper and Allied Products (SIC 26)					
Total SIC Code 26			**562**	**147**	**26.1%**

[a] Individual numbers may not add up due to independent rounding.

Source: U.S. EPA, 2000; Executive Office of the President, 1987.

The responses to the Detailed Industry Questionnaire indicate that three main sectors account for the largest numbers of section 316(b) facilities in the Paper and Allied Products industry: (1) Pulp Mills (SIC 2611), (2) Paper Mills (SIC 2621), and (3) Paperboard Mills (SIC 2631). Fifty percent of the 147 section 316(b) facilities in the Paper and Allied Products industry are paper mills. Paperboard mills and pulp mills account for 29 and 18 percent of facilities, respectively. The remainder of the Paper and Allied Products profile therefore focuses on these three industries.

4A.1 Domestic Production

The Paper and Allied Products industry is one of the top ten U.S. manufacturing industries, and among the top five sectors in sales of nondurable goods. Growth in the paper industry is closely tied to overall gross domestic product (GDP) growth because nearly all of the industry's end-uses are consumer oriented. Although the domestic market consumes over 90 percent of total U.S. paper and allied product output, exports have taken on an increasingly important role, and growth in a number of key foreign paper and paperboard markets are a key factor in the health and expansion of the U.S. industry (McGraw-Hill, 2000). The industry is considered mature, with growth slower than that of the GDP, and U.S. producers have been actively seeking growth opportunities in overseas markets. While exports still represent a small share of domestic shipments, they exert an important marginal influence on capacity utilization. Prices and industry profits, which are very sensitive to capacity utilization, have therefore also become very sensitive to trends in global markets. The industry has seen relatively stable production and sales over the last decade, but has experienced seen more volatile capacity utilization, profitability, and prices (Ince, 1999).

The U.S. Paper and Allied Products industry has a world-wide reputation as a high quality, high volume, and low-cost producer. The industry benefits from many key operating advantages, including a large domestic market; the world's highest per capita consumption; a modern manufacturing infrastructure; adequate raw material, water, and energy resources; a highly skilled labor force; and an efficient transportation and distribution network (Stanley, 2000). U.S. producers face growing competition from new facilities constructed overseas, however (McGraw-Hill, 2000).

The industry is one of the primary users of energy, second only to the chemicals and metals industries. However, 56 percent of total energy used in 1998-99 was self-generated (McGraw-Hill, 2000).

a. Output

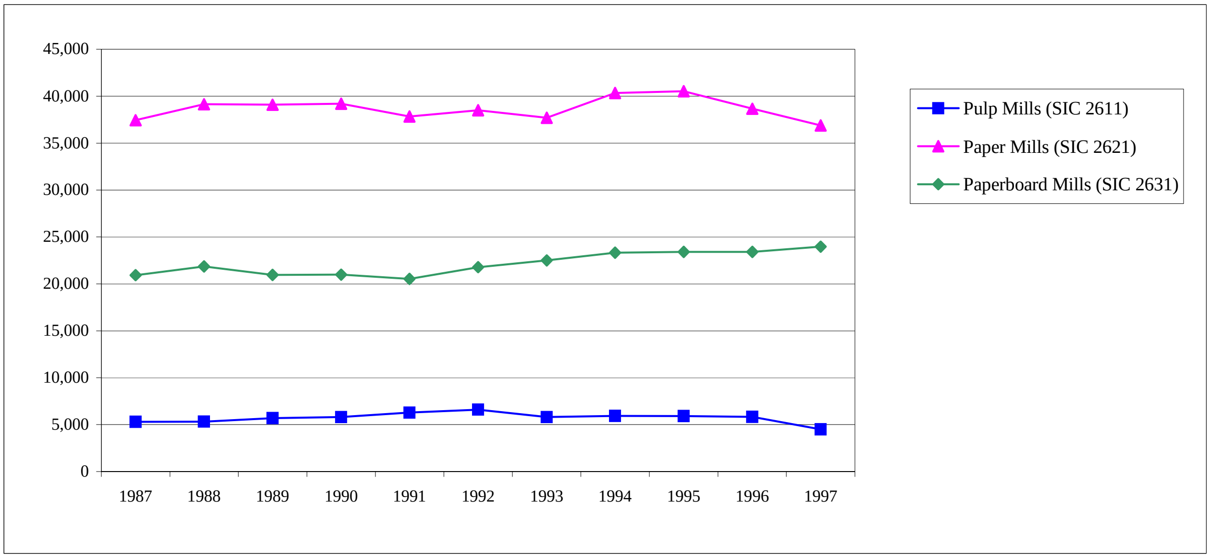
The U.S. Paper and Allied Products industry has experienced continued globalization and cyclical pattens in production and earnings over the last two decades. Capital investments in the 1980s resulted in significant overcapacity. U.S. producers experienced record sales in 1995. In 1996, lower domestic and foreign demand, declining prices, and inventory drawdowns led to a decline in the industry's total shipments by 2.2 percent in real terms. More recently, three consecutive years of increasing demand, and slowly increasing prices led to better industry performance. During these years, domestic producers controlled operating rates, to allow drawdown of high inventories and higher capacity utilization . U.S. producers have also placed a greater emphasis on foreign markets, both through export sales and investments in overseas facilities (McGraw-Hill, 2000). The paper products industry had improved sales and stronger earnings in 1999 and early 2000, but began to experience declines in sales in the second half of 2000, reflecting reduced paper and packaging demand due to the slowdown in the U.S. economy and a growth in imports (S&P, 2001). Most products were characterized by weak demand, reduced production and price reductions in 2001, due to continuing reductions in domestic demand (Paperloop, 2001).

Figure 4A-1 shows the trend in ***value of shipments*** and ***value added*** for the three profiled sectors.[1] Value of shipments and value added are two of the most common measures of manufacturing output. They provide insight into the overall economic health and outlook for an industry. Value of shipments is the sum of the receipts a manufacturer earns from the sale of its outputs. It is an indicator of the overall size of a market or the size of a firm in relation to its market or competitors. Value added is used to measure the value of production activity in a particular industry. It is the difference between the value of shipments and the value of purchased inputs used to make the products sold.

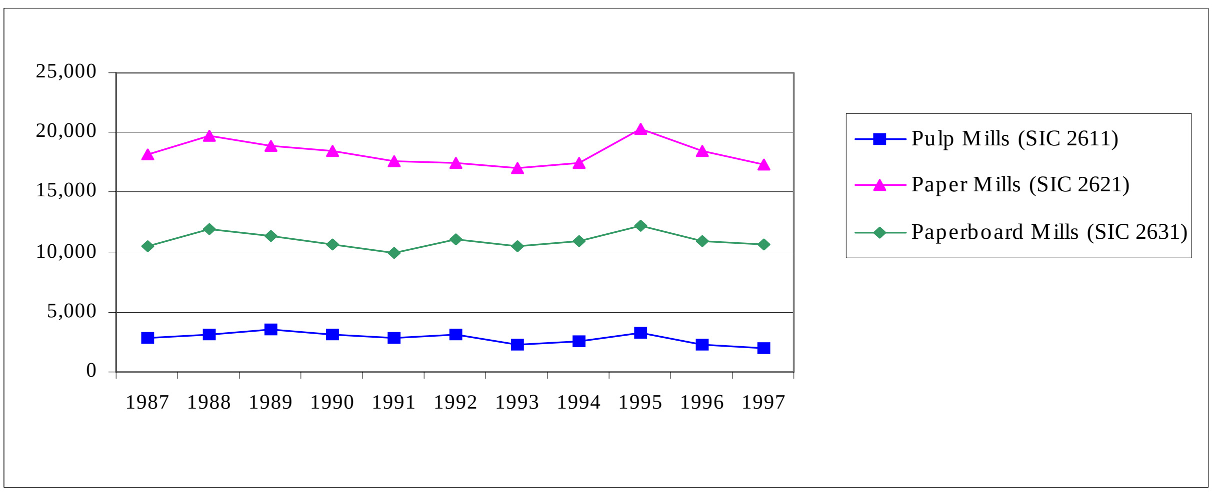
[1] Terms highlighted in bold and italic font are further explained in the glossary.

Figure 4A-1: Value of Shipments and Value Added for Profiled Paper and Allied Products Sectors (in millions, constant $2000)

Value of Shipments



Value Added



Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

Trends in industry output differ somewhat by stage of industry production. As Table 4A-2 shows, pulp production (SIC 2611) has experienced the slowest growth among the three profiled sectors over the period 1989 to 2000, but paper mill and paperboard mill production growth has also been well below the growth in U.S. GDP. All three sectors show periods of alternating growth and contraction in year-to-year production. Table 4A-2 shows sharp decreases in production in the first half of 2001, compared to the comparable period in 2000, in all three sectors.

Table 4A-2: Pulp and Paper Industry Industrial Production Indexes

Year	Pulp Mills		Paper Mills		Paperboard Mills	
	Index 1992=100	Percent Change	Index 1992=100	Percent Change	Index 1992=100	Percent Change
1989	94.9	n/a	95.3	n/a	92.1	n/a
1990	96.9	2.1%	97.8	2.6%	94.2	2.3%
1991	97.6	0.7%	97.6	-0.2%	96.6	2.5%
1992	100.0	2.5%	100.0	2.5%	100.0	3.5%
1993	98.6	-1.4%	104.0	4.0%	103.3	3.3%
1994	101.1	2.5%	106.8	2.7%	109.3	5.8%
1995	103.0	1.9%	108.3	1.4%	111.5	2.0%
1996	100.3	-2.6%	105.1	-3.0%	114.1	2.3%
1997	102.7	2.4%	110.8	5.4%	120.2	5.3%
1998	100.5	-2.1%	111.5	0.6%	119.0	-1.0%
1999	98.6	-1.9%	112.4	0.8%	122.0	2.5%
2000	98.7	0.1%	112.5	0.1%	116.9	-4.2%
Total Percent Change 1989-2000	*4%*		*18%*		*27%*	
Average Annual Growth Rate	*0.4%*		*1.5%*		*2.2%*	
Jan.-August 2000[a]	100.6	n/a	113.8	n/a	119.2	n/a
Jan.-August 2001[a]	91.6	-8.9%	105.3	-7.5%	112.6	-5.5%

[a] Data is an average over the seven month period.

Source: Federal Reserve Board, 2001.

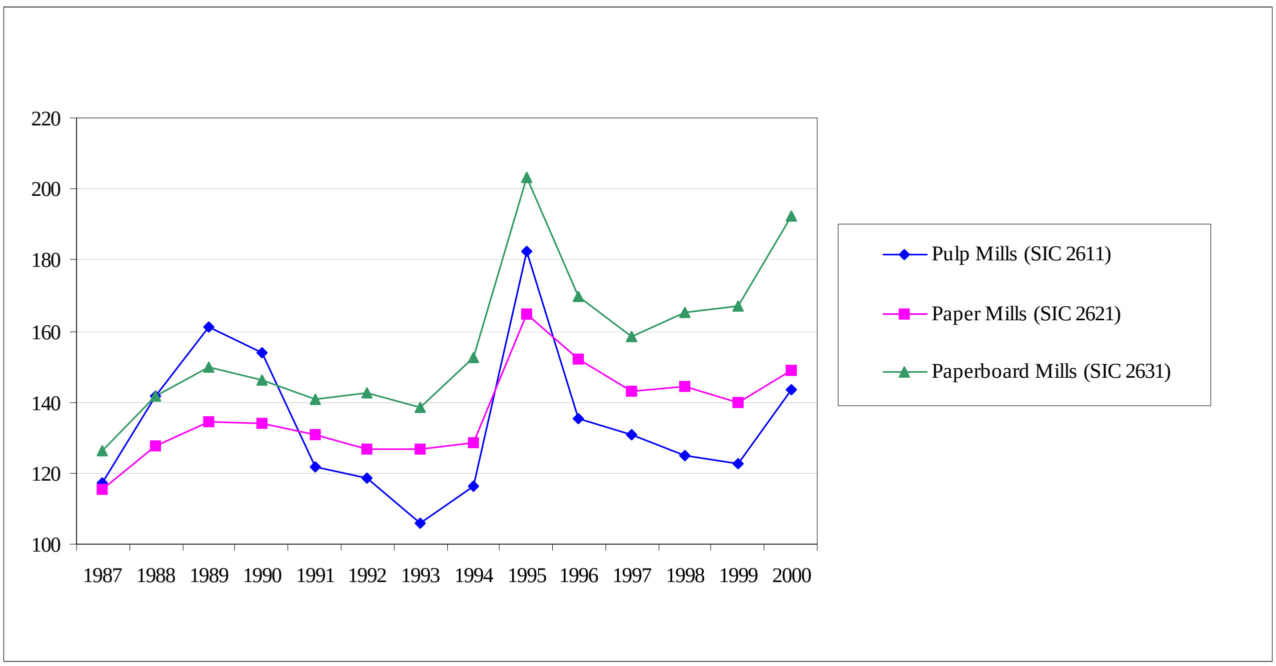
b. Prices

Price levels in the U.S. paper industry closely reflect domestic and foreign demand and industry capacity and operating rates, which determine supply (S&P, 2001). Prices tend to be volatile due to mismatches between short-term supply and demand. The industry is very capital intensive, and it makes significant time to bring new capacity on-line. Prices therefore tend to escalate when demand and capacity utilization rise, and drop sharply when demand softens or when new capacity comes on line. Producers have in the past been reluctant to reduce production when demand declines, because fixed capital costs are a substantial portion of total manufacturing costs, which can result in persistent oversupply. During the recent economic slowdown, however, there is evidence that producers are more willing to incur downtime to prevent sharp reductions in prices (Ince, 1999; S&P, 2001).

The paper industry suffered from low prices throughout the early 1990s. The depressed prices were the result of the paper boom of the late 1980s wmid, 1999 and 2001). Production cutbacks in the face of substantial declines in demand in late 2000 and 2001 have prevented major price declines for paper products (S&P, 2001).

Figure 4A-2 shows the ***producer price index*** (PPI) at the 4-digit SIC code for the profiled pulp, paper, and paperboard sectors. The PPI is a family of indexes that measure price changes from the perspective of the seller. This profile uses the PPI to express monetary values in constant dollars.

Figure 4A-2: Producer Price Indexes for Profiled Paper and Allied Products Sectors



Source: BLS, 2000.

c. Number of facilities and firms

The Statistics of U.S. Businesses reports that the number of facilities and firms in the Pulp Mills sector decreased by 11% percent between 1989 and 1997. One of the reasons for this trend has been the dramatic increase in the number of mills that produce deinked recycled market pulp. These are secondary fiber processing plants that use recovered paper and paperboard as their sole source of raw material. Producers of deinked market pulp have experienced strong demand over the past several years in both U.S. and foreign markets. As a result, the U.S. deinked recycled market pulp capacity more than doubled between 1994 and 1998 (McGraw-Hill, 2000). Since 1994, the secondary fiber share of total papermaking fiber production has increased steadily, reaching a record 37 percent in 1999 (McGraw-Hill, 2000).

There has also been a decline in the number of paper and paperboard mills. Overcapacity in the 1990s has limited the construction of new facilities. In 1998 and 1999, 577,000 and 2.5 million tons of paper and paperboard capacity were removed from the capacity base. Over the same period, more than one million tons of pulp capacity were removed (Pponline, 1999).

Tables 4A-3 and 4A-4 present the number of facilities and firms for the three profiled Paper and Allied Products sectors between 1989 and 1997.

Table 4A-3: Number of Facilities for Profiled Paper and Allied Products Sectors

Year	Pulp Mills (SIC 2611)		Paper Mills (SIC 2621)		Paperboard Mills (SIC 2631)	
	Number of Facilities	Percent Change	Number of Facilities	Percent Change	Number of Facilities	Percent Change
1989	46	n/a	322	n/a	221	n/a
1990	46	0%	327	2%	226	2%
1991	53	15%	349	7%	228	1%
1992	44	-17%	324	-7%	222	-3%
1993	46	5%	306	-6%	217	-2%
1994	52	13%	316	3%	218	0%
1995	53	2%	317	0%	219	0%
1996	62	17%	344	9%	228	4%
1997	41	-34%	259	-25%	214	-6%
Total Percent Change 1989-1997	*-11%*		*-20%*		*-3%*	
Average Annual Growth Rate	*-1%*		*-3%*		*0%*	

Source: U.S. SBA, 2000.

Table 4A-4: Number of Firms for Profiled Paper and Allied Products Sectors						
Year	**Pulp Mills (SIC 2611)**		**Paper Mills (SIC 2621)**		**Paperboard Mills (SIC 2631)**	
	Number of Firms	**Percent Change**	**Number of Firms**	**Percent Change**	**Number of Firms**	**Percent Change**
1990	31	n/a	158	n/a	102	n/a
1991	37	19%	186	18%	102	0%
1992	29	-22%	161	-13%	95	-7%
1993	32	10%	153	-5%	99	4%
1994	37	16%	163	7%	96	-3%
1995	32	-14%	163	0%	93	-3%
1996	43	34%	186	14%	101	9%
1997	27	-37%	131	-30%	85	-16%
Total Percent Change 1990-1997	*-13%*		*-17%*		*-17%*	
Average Annual Growth Rate	*-2%*		*-3%*		*-3%*	

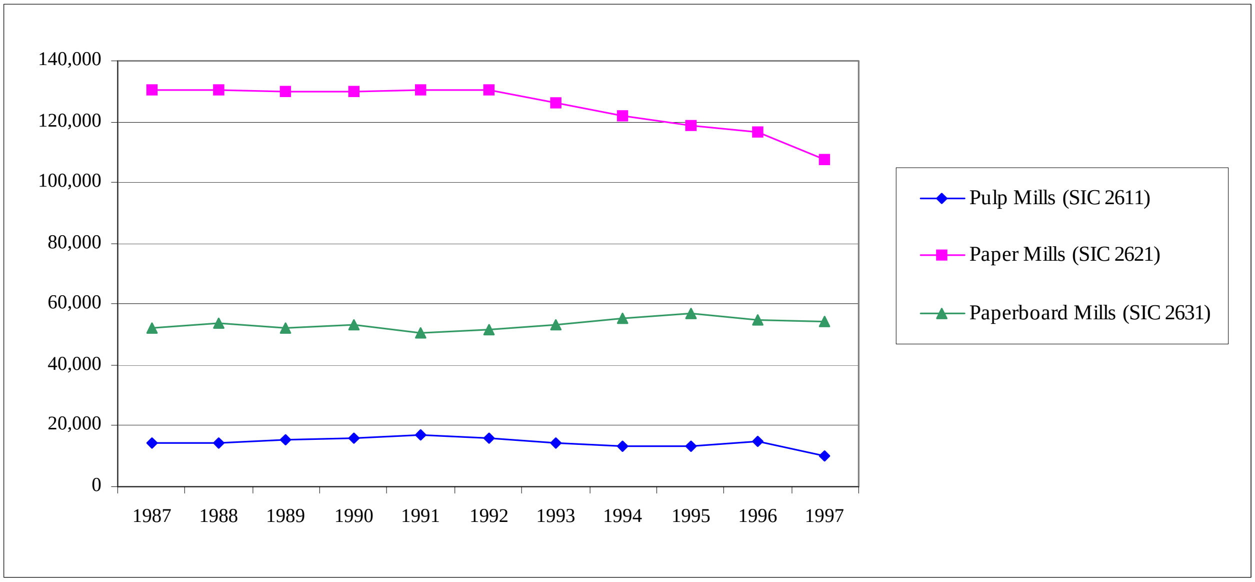
Source: U.S. SBA, 2000.

d. Employment and productivity

The U.S. Paper and Allied Products industry is among the most modern in the world. It has a highly skilled labor force and is characterized by large capital expenditures which are largely aimed at production improvements.

Employment in the three profiled paper industry sectors has remained relatively constant or declined between 1987 and 1992. Figure 4A-3 below presents employment levels for the three profiled Paper and Allied Products sectors between 1987 and 1997.

Figure 4A-3: Employment for Profiled Paper and Allied Products Sectors



Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

Table 4A-5 presents the change in value added per labor hour, a measure of ***labor productivity***, for each of the profiled industry sectors between 1987 and 1997. The table shows that labor productivity in the Pulp Mills sector has been relatively volatile, posting several double-digit gains and losses between 1987 and 1997. These changes have been primarily driven by fluctuations in value added. Overall, the sector's productivity increased by 3 percent during this period. The Paper Mills and Paperboard Mills sectors have experienced overall labor productivity changes of 12 percent and -3 percent, respectively.

Table 4A-5: Productivity Trends for Profiled Paper and Allied Products Sectors (in millions, constant $2000)

Year	Pulp Mills (SIC 2611)				Paper Mills (SIC 2621)				Paperboard Mills (SIC 2631)			
	Value Added	Prod. Hrs. (mill.)	Value Added/Hour		Value Added	Prod. Hrs. (mill.)	Value Added/Hour		Value Added	Prod. Hrs. (mill.)	Value Added/Hour	
			No.	% Change			No.	% Change			No.	% Change
1987	2,796	24	117	n/a	18,150	213	85	n/a	10,541	89	119	n/a
1988	3,154	24	132	13%	19,686	215	92	8%	11,928	91	131	10%
1989	3,502	25	138	5%	18,892	214	88	-4%	11,293	89	127	-3%
1990	3,185	28	115	-17%	18,421	211	87	-1%	10,705	91	118	-7%
1991	2,880	28	104	-10%	17,606	212	83	-5%	9,924	87	115	-3%
1992	3,092	26	118	13%	17,440	215	81	-2%	11,057	88	125	9%
1993	2,319	23	100	-15%	17,045	212	80	-1%	10,470	90	116	-7%
1994	2,577	22	118	18%	17,434	206	85	6%	10,945	94	117	1%
1995	3,320	25	134	14%	20,311	200	102	20%	12,174	98	125	7%
1996	2,329	24	97	-28%	18,415	197	93	-9%	10,939	95	115	-8%
1997	2,006	17	121	25%	17,290	183	95	2%	10,659	92	116	1%
Total Percent Change 1987-1997	*-28%*	*-29%*	*3%*		*-5%*	*-14%*	*12%*		*1%*	*3%*	*-3%*	
Average Annual Growth Rate	*-3%*	*-3%*	*0.3%*		*-0.5%*	*-2%*	*1%*		*0.1%*	*0.3%*	*-0.3%*	

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

e. Capital expenditures

The Paper and Allied Products industry is a highly capital intensive industry. Capital-intensive industries are characterized by large manufacturing facilities which reflect the economies of scale required to manufacture products efficiently. ***New capital expenditures*** are needed to modernize, expand, and replace existing capacity. Consistent high levels of capital expenditures have made the Paper and Allied Products industry one of the most modern industries in the world (Stanley, 2000). The total level of capital expenditures for the pulp, paper, and paperboard industries was $5.3 billion in 1997 (in constant $2000). The Paper Mills and Paperboard Mills sectors accounted for approximately 91 percent of that spending (see Table 4A-6). Most of the spending is for production improvements (through existing machine upgrades, retrofits, or new installed equipment), environmental concerns, and increased recycling (McGraw Hill, 2000).

A fair amount of the industry's new capital expenditures has been spent on environmental equipment. The Department of Commerce estimates that environmental spending has accounted for about 14 percent of all capital outlays made by the U.S. paper industry since the 1980s, and the Cluster Rule promulgated in 1998 is expected to require increased environmental expenditures (S&P, 2001).

Table 4A-6: Capital Expenditures for Profiled Paper and Allied Products Sectors (in millions, constant $2000)

Year	Pulp Mills (SIC 2611)		Paper Mills (SIC 2621)		Paperboard Mills (SIC 2631)	
	Capital Expenditures ($2000 millions)	Percent Change	Capital Expenditures ($2000 millions)	Percent Change	Capital Expenditures ($2000 millions)	Percent Change
1987	283	n/a	3,562	n/a	1,178	n/a
1988	313	10.6%	3,851	8.1%	2,062	75.0%
1989	619	97.8%	5785	50.2%	2122	2.9%
1990	982	58.6%	4747	-17.9%	3923	84.9%
1991	1167	18.8%	4129	-13.0%	2943	-25.0%
1992	935	-19.9%	3420	-17.2%	2753	-6.5%
1993	577	-38.3%	3363	-1.7%	2286	-17.0%
1994	388	-32.8%	3716	10.5%	2202	-3.7%
1995	444	14.4%	2,423	-34.8%	2,058	-6.5%
1996	739	66.4%	3070	26.7%	2,674	29.9%
1997	467	-36.8%	2878	-6.3%	1954	-26.9%
Total Percent Change 1987- 1997	*65%*		*-19%*		*66%*	
Average Annual Growth Rate	*5%*		*-2%*		*5%*	

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

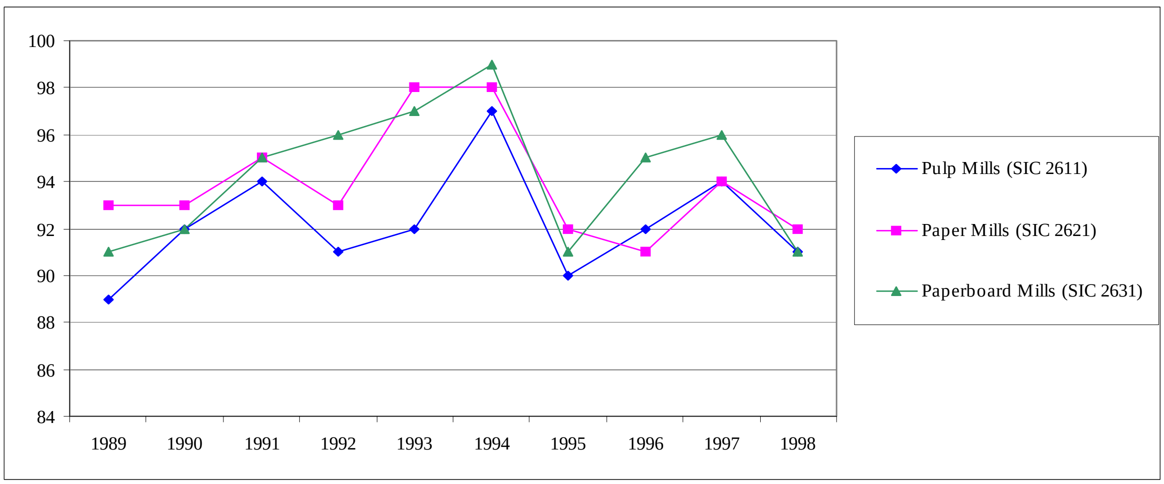
f. Capacity utilization

Capacity utilization measures actual output as a percentage of total potential output given the available capacity. Capacity utilization is an index used to identify potential excess or insufficient capacity in an industry and can help project whether new investment is likely. According to the U.S. Industry and Trade Outlook, a utilization rate in the range of 92 to 96 percent is necessary for the Pulp Mills sector to remain productive and profitable (McGraw-Hill, 2000).

The capacity utilization trends shown in Figure 4A-4 show sharp fluctuations in all three profiled sectors. Capacity utilization rates increased between 1989 and 1994, and then plummeted in 1995. This sharp drop was the result of the inventory drawdown cycle which had begun in 1995 in response to low demand and oversupply (McGraw-Hill, 2000). As inventories were sold off and global economic activity started to pick up, capacity utilization rates began to increase again in 1996, peaked in 1997, and again declined in 1998 due to reduced demand from the Asian market (S&P, 2001).

Figure 4A-4 presents the capacity utilization indexes from 1989 to 1998 for the three profiled sectors.

Figure 4A-4: Capacity Utilization Rates (Fourth Quarter) for Profiled Paper and Allied Products Sectors



Source: U.S. DOC, 1989-1998.

4A.2 Structure and Competitiveness

Paper and Allied Products companies range in size from giant corporations having billions of dollars of sales, to small producers with revenue bases a fraction of the size. Because all Paper and Allied Products companies use the same base materials in their production, most manufacture more than one product. To escape the extreme price volatility of commodity markets, many smaller manufacturers have differentiated their products by offering value-added grades. The smaller markets for value-added products make this avenue less available to the larger firms (S&P, 2001).

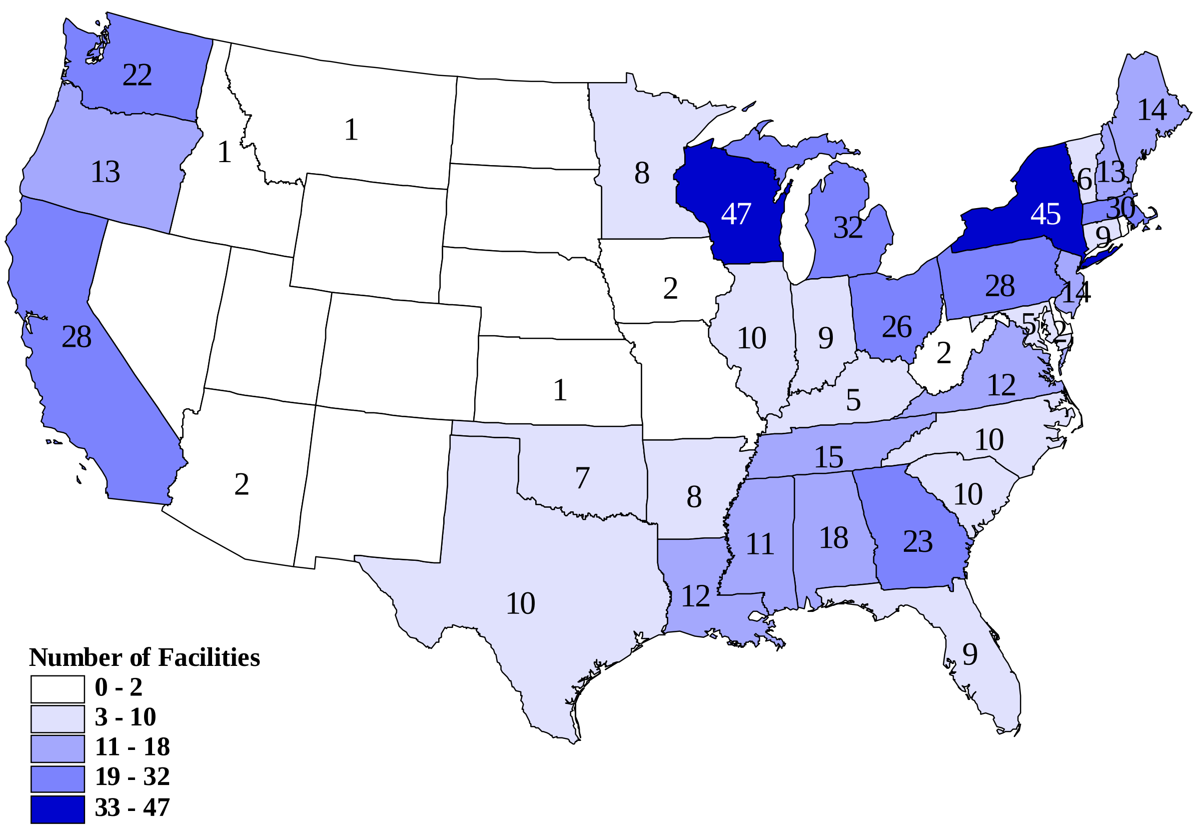
The paper industry has been consolidating through mergers and has been closing down older mills over the last few years, as a way to improve profit growth in a mature industry. About six percent of North American containerboard capacity was shut down (most on a permanent basis) in late 1998 and early 1999. Companies have been reluctant to invest in any major new capacity that might result in excess capacity (S&P, 2001). New capacity additions in 1999 in the Paper and Allied Products industry were at their lowest level in the past ten years and this limitation on new capacity is expected to continue (Pponline.com, 2000). Major recent mergers include International Paper's acquisition of Champion International in 2000 and Union Camp in 1999, Georgia-Pacific's takeover of Fort James Corp. (itself a 1997 combination of James River and Fort Howard), and Wyerhaeuser's bid in late 2000 for Willamette Industries Inc. (S&P, 2001).

a. Geographic distribution

The geographic distribution of pulp, paper, and paperboard mills varies with the different types of mills. Traditional pulp mills tend to be located in regions where pulp trees are harvested from natural stands or tree farms. The Southeast (GA, AL, NC, TN, FL, MS, KY), Northwest (WA, CA, AK), Northeast (ME) and Northern Central (WI, MI) regions account for the major concentrations of pulp mills. Deinked market pulp plants, on the other hand, are typically located close to large metropolitan areas, which can consistently provide large amounts of recovered paper and paperboard (McGraw-Hill, 2000).

Paper mills are more widely distributed, located in proximity to pulping operations and/or near converting sector markets. Since the primary market for paperboard products is manufacturing, the distribution of paperboard mills is similar to that of the manufacturing industry in general.

Figure 4A-5: Number of Facilities in Profiled Paper and Allied Products Sectors by State



Source: U.S. DOC, 1987, 1992, and 1997.

b. Facility size

Most of the facilities in the three profiled industry sectors fall in the middle employment size categories, with either 100 to 249, or 250 to 499 employees. However, the larger facilities (those with 500 or more employees) account for the majority of the industries' value of shipments.

The number of independent pulp mills is smaller than the number of paper and paperboard mills, and pulp mills have considerably lower value of shipments. The larger facilities dominate value of shipments in all three sectors, however.

- Seventy-one percent of all *Pulp Mills* employ 100 employees or more. These facilities account for approximately 97 percent of the sector's value of shipments.

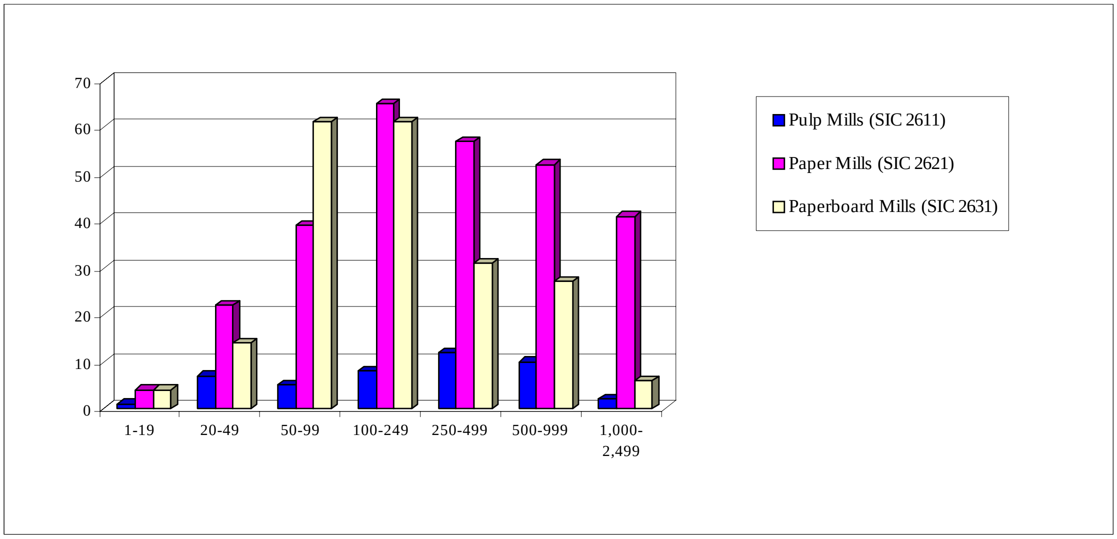
- Thirty-three percent of all *Paper Mills* have more than 500 employees. They account for 71 percent of the sector's value of shipments.

- Sixteen percent of all *Paperboard Mills* employ 500 people or more. These facilities account for 56 percent of the sector's value of shipments.

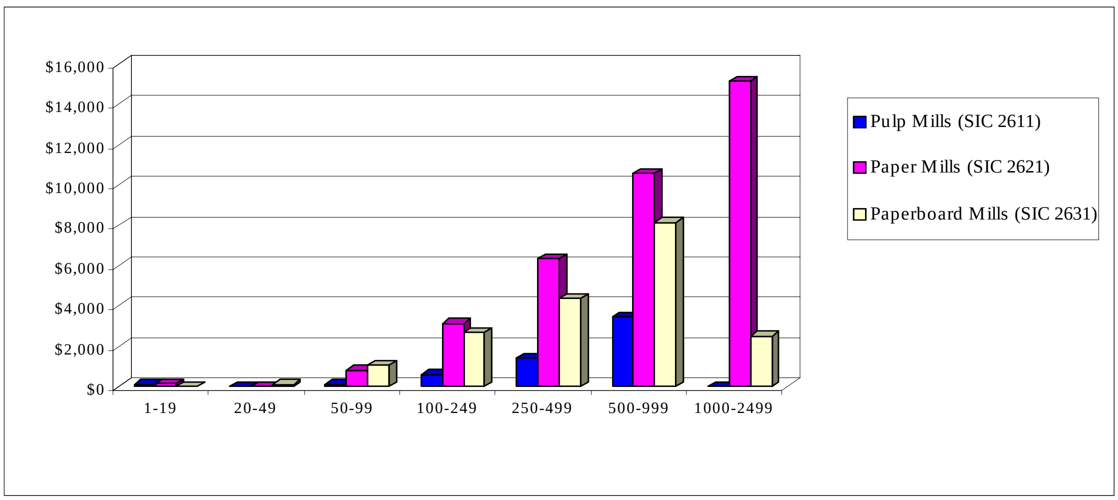
The distribution of the number of facilities and the industries' value of shipment are presented in Figure 4A-6 below.

Figure 4A-6: Number of Facilities and Value of Shipments by Employment Size Category for Profiled Paper and Allied Products Sectors

Number of Facilities (1992)



1992 Value of Shipments (in millions)



Source: U.S. DOC, 1987, 1992, and 1997.

c. Firm size

The Small Business Administration (SBA) defines small firms in the Paper and Allied Products industries according to the firm's number of employees. Firms in SIC codes 2611, 2621, and 2631 are defined as small if they have fewer than 750 employees.

The size categories reported in the Statistics of U.S. Businesses (SUSB) do not coincide with the SBA small firm standard of 750 employees. It is therefore not possible to apply the SBA size thresholds precisely. The SUSB data presented in Table 4A-6 below show the following size distribution in 1997:

- 12 of 27 firms in the *Pulp Mills* sector had less than 500 employees. Therefore, at least 44 percent of firms were classified as small. These small firms owned 15 facilities, or 37 percent of all facilities in the sector.

- 72 of 131 (55 percent) firms in the *Paper Mills* sector had less than 500 employees. These small firms owned 77, or 30 percent of all paper mills.

- 41 of 85 firms in the *Paperboard Mills* sector had less than 500 employees. Therefore, at least 48 percent of paperboard mills were classified as small. These firms owned 42, or 20 percent of all paperboard mills

An unknown number of the firms with more than 500 employees have less than 750 employees, and would therefore be classified as small firms. Table 4A-7 below shows the distribution of firms, facilities, and receipts for each profiled sector by employment size of the parent firm.

Table 4A-7: Number of Firms, Facilities, and Estimated Receipts by Firm Size Category for Profiled Paper and Allied Products Sectors, 1997

Employment Size Category	Pulp Mills (SIC 2611)			Paper Mills (SIC 2621)			Paperboard Mills SIC 2631		
	No. of Firms	No. of Facilities	Estimated Receipts (in millions, constant $2000)	No. of Firms	No. of Facilities	Estimated Receipts (in millions, constant $2000)	No. of Firms	No. of Facilities	Estimated Receipts (in millions, constant $2000)
0-19	2	2	21	5	5	49	8	8	68
20-99	5	5	53	23	23	224	12	12	103
100-499	5	8	148	44	49	3,048	21	22	731
500+	15	26	3,834	59	182	33,926	44	172	18,900
Total	*27*	*41*	*4,055*	*131*	*259*	*37,246*	*85*	*214*	*19,802*

Source: U.S. SBA, 2000.

d. Concentration and specialization ratios

Concentration is the degree to which industry output is concentrated in a few large firms. Concentration is closely related to entry barriers, with more concentrated industries generally having higher barriers.

The four-firm ***concentration ratio*** (CR4) and the ***Herfindahl-Hirschman Index*** (HHI) are common measures of industry concentration. The CR4 indicates the market share of the four largest firms. For example, a CR4 of 72 percent means that the four largest firms in the industry account for 72 percent of the industry's total value of shipments. The higher the concentration ratio, the less competition there is in the industry, other things being equal.[2] An industry with a CR4 of more than 50 percent is generally considered concentrated. The HHI indicates concentration based on the largest 50 firms in the industry. It is equal to the sum of the squares of the market shares for the largest 50 firms in the industry. For example, if an industry consists of only three firms with market shares of 60, 30, and 10 percent, respectively, the HHI of this industry would be equal to 4,600 ($60^2 + 30^2 + 10^2$). The higher the index, the fewer the number of firms supplying the industry and the more concentrated the industry. An industry is considered concentrated if the HHI exceeds 1,000.

The concentration ratios for the three profiled industry sectors remained relatively stable between 1987 and 1992. None of the profiled industries are considered concentrated based on the CR4 or the HHI. The Pulp Mills sector has the highest concentration of the three sectors, with a CR4 of 48 percent and a HHI of 858 in 1992. Recent mergers and acquisitions have led to an increase in concentration in the paper and paperboard sector. The top five U.S. firms are reported to now control 38 percent of production capacity, with higher concentrations in individual product lines due to targeted consolidation and specialization (Ince, 1999).[3] The paper and paperboard mills (SICs 2621 and 2631) also account for most of the production of their primary products, as shown by their high coverage ratios. Pulp mills (SIC 2611) account for a lower percentage of all pulp shipments, with pulp also commonly produced by integrated paper mills. Data from the 1997 Census of Manufacturers reports that the coverage ratio for pulp mills declined to 59 percent in 1997, suggesting a trend away from mills specializing in pulp production (U.S. DOC, 1987, 1992, and 1992).

The ***specialization ratio*** is the percentage of the industry's production accounted for by primary product shipments. The ***coverage ratio*** is the percentage of the industry's product shipments coming from facilities from the same primary industry. The coverage ratio provides an indication of how much of the production/product of interest is captured by the facilities classified in an SIC code.

The specialization ratios presented in Table 4A-8 indicate a relatively high degree of specialization for each profiled Paper and Allied Products industry sector.

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[2] Note that the measured concentration ratio and the HHF are very sensitive to how the industry is defined. An industry with a high concentration in domestic production may nonetheless be subject to significant competitive pressures if it competes with foreign producers or if it competes with products produced by other industries (e.g., plastics vs. aluminum in beverage containers). Concentration ratios are therefore only one indicator of the extent of competition in an industry.

[3] Reported capacity concentrations for the top five firms are 60% in newsprint, 58% in uncoated groundwood, 65% in coated groundwood, 43% in containerboard, and 40% in paper grade market pulp (Ince, 1999, quoting the industry newsletter Pulp & Paper Week).

Table 4A-8: Selected Ratios for Profiled Paper and Allied Products Sectors

SIC Code	Year	Total Number of Firms	Concentration Ratios					Specialization Ratio	Coverage Ratio
			4 Firm (CR4)	8 Firm (CR8)	20 Firm (CR20)	50 Firm (CR50)	Herfindahl-Hirschman Index		
2611	1987	26	44%	69%	99%	100%	743	87%	69%
	1992	29	48%	75%	98%	100%	858	81%	72%
2621	1987	122	33%	50%	78%	94%	432	91%	96%
	1992	127	29%	49%	77%	94%	392	90%	95%
2631	1987	91	32%	51%	77%	97%	431	91%	90%
	1992	89	31%	52%	80%	97%	438	92%	89%

Source: U.S. DOC, 1987, 1992, and 1997.

e. Foreign trade

The Paper and Allied Products industry has been in a period of globalization for more than a decade. Many U.S. Paper and Allied Products companies are active exporters, but they also engage in foreign production, converting, and packaging operations, and have joint ventures and direct foreign capital investments in partnerships and ownerships (Stanley, 2000).

Exports play an important role in the Paper and Allied Products industry. Sixty-five percent of the industry's shipment growth between 1989 and 1998 was derived from export sales. Some of the domestic industry's key trade partners – long a target for any excess U.S. paper production – have undertaken significant investments in their own world-class production facilities (S&P, 2001). The strength of the U.S. dollar versus Asian currencies has also reduced the competitiveness of U.S. pulp exports to that region (McGraw-Hill, 2000). Despite improved demand in portions of Europe and Latin America, the Asian financial crisis, which began in 1997, still affects the global pulp industry (Stanley, 2000).

This profile uses two measures of foreign competitiveness: ***export dependence*** and ***import penetration***. Export dependence is the share of value of shipments that is exported. Import penetration is the share of domestic consumption met by imports. Imports and exports play a much larger role in the Pulp Mills sector than for the other two sectors. Import penetration and export dependence levels for the Pulp Mills sector were an estimated 62 and 63 percent, respectively, in 2000. The Paper and Paperboard sectors, import penetration and export dependence were 17 and 11 percent in 2000, respectively. Table 4A-9 presents trade statistics for each of the profiled Paper and Allied Products industry sectors. Figure 4A-7 shows the rise in imports in all sectors in the last two years.

Table 4A-9: Trade Statistics for Profiled Paper and Allied Products Sectors

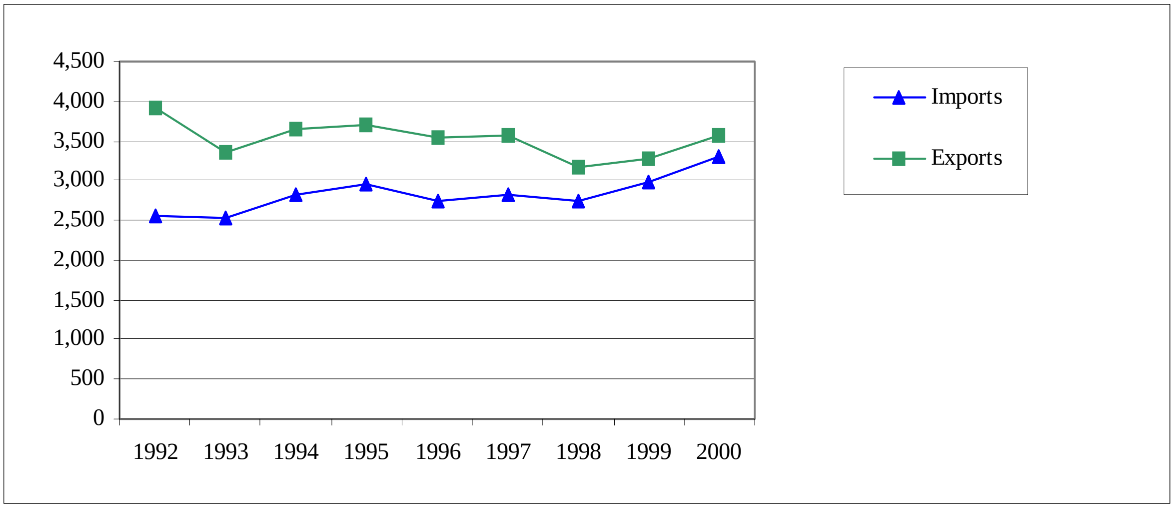
Year	Value of Imports (in millions, constant $2000)	Value of Exports (in millions, constant $2000)	Value of Shipments (in millions, constant $2000)	Implied Domestic Consumption[a]	Import Penetration[b]	Export Dependence[c]
Pulp Mills (SIC 2611)						
1992	2,546	3,916	6,615	5,245	49%	59%
1993	2,532	3,364	5,804	4,972	51%	58%
1994	2,813	3,636	5,942	5,119	55%	61%
1995	2,944	3,693	5,907	5,158	57%	63%
1996	2,753	3,554	5,829	5,028	55%	61%
1997[d]	2,815	3,561	6,330	5,584	50%	56%
1998[d]	2,742	3,180	6,009	5,571	49%	53%
1999[e]	2,974	3,288	6,123	5,809	51%	54%
2000[f]	3,302	3,556	5,622	5,368	62%	63%
Total Percent Change 1992-2000	*30%*	*-9%*	*-15%*	*2.3%*		
Average Annual Growth Rate	*3.3%*	*-1.2%*	*-2.0%*	*0.3%*		
Paper and Paperboard Mills (SIC 2621, 2631)						
1992	8,500	5,402	61,994	65,092	13%	9%
1993	9,258	5,394	62,151	66,015	14%	9%
1994	8,901	5,838	64,752	67,815	13%	9%
1995	9,453	5,966	62,548	66,035	14%	10%
1996	9,658	6,715	63,386	66,329	15%	11%
1997[d]	10,194	7,407	66,803	69,590	15%	11%
1998[d]	10,831	6,877	65,886	69,840	16%	10%
1999[e]	11,228	6,726	66,085	70,587	16%	10%
2000[f]	11,198	6,698	61,956	66,456	17%	11%
Total Percent Change 1992-2000	*32%*	*24%*	*-0.1%*	*2.1%*		
Average Annual Growth Rate	*3.5%*	*2.7%*	*0.0%*	*0.3%*		

[a] Calculated by EPA as shipments + imports - exports.
[b] Calculated by EPA as imports divided by implied domestic consumption.
[c] Calculated by EPA as exports divided by shipments.
[d] Value of Shipments are estimated.
[e] Estimates.
[f] Forecasts.

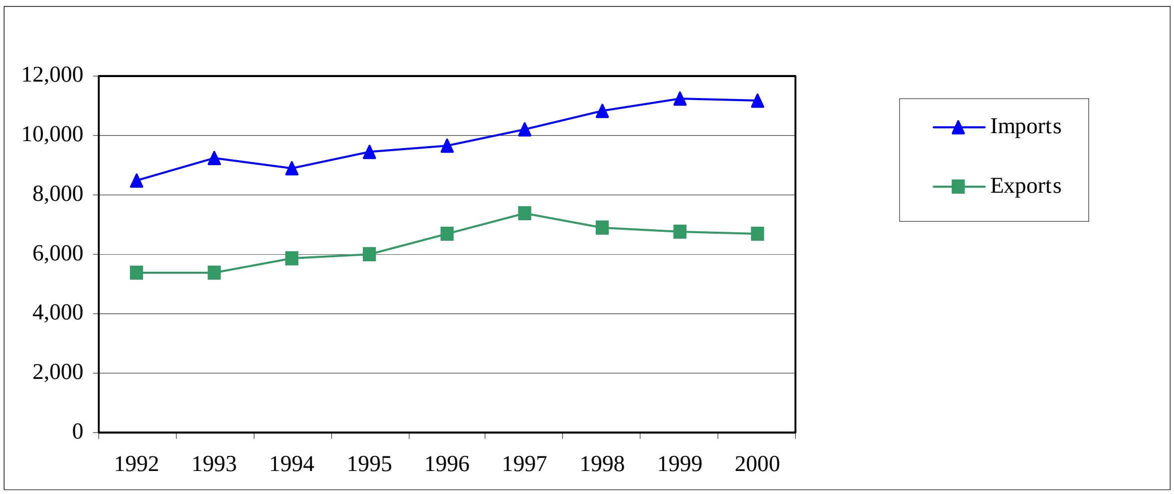
Source: U.S. DOC, 2001.

Figure 4A-7: Value of Imports and Exports for Profiled Paper and Allied Products Sectors (in millions, constant $2000)

Pulp Mills (SIC 2611)



Paper and Paperboard Mills (SIC 2621 and 2631)



Source: U.S. DOC, 2001.

4A.3 Financial Condition and Performance

Financial performance in the Paper and Allied Products industry is closely linked to macroeconomic cycles, both in the domestic market and those of key foreign trade partners, and the resulting levels of demand. Many pulp producers, for example, have not been very profitable during most of the 1990s as chronic oversupply, cyclical demand, rapidly fluctuating operating rates, sharp inventory swings, and uneven world demand has plagued the global pulp market for more than a decade (Stanley, 2000).

Table 4A-10 presents trends in operating margins for the Pulp Mills, Paper Mills, and Paperboard Mills sectors between 1987 and 1997. The table shows substantial year-to-year fluctuations in margins in all three sectors, but especially in the Pulp Mills sector. These fluctuation are a reflection of changes in product prices which have resulted from oversupply in the industry. More recently, earnings have suffered from a combination of price declines and higher energy costs, which Standard & Poor's estimates can account for as much as 20 percent of paper manufacturing costs in certain grades (S&P 2001). S&P also reports that consolidations in recent years have helped profit margins, by allowing companies to spread administrative and research and development costs over a larger asset base and by eliminating redundant operations (S&P 2001).

Table 4A-10: Operating Margins for Profiled Paper and Allied Products Sectors (in millions, constant $2000)				
Year	Value of Shipments	Cost of Materials	Payroll (all employees)	Operating Margin
Pulp Mills (SIC 2611)				
1987	5,287	2,475	656	41%
1988	5,323	2,185	566	48%
1989	5,704	2,265	536	51%
1990	5,817	2,690	623	43%
1991	6,275	3,402	821	33%
1992	6,614	3,579	834	33%
1993	5,804	3,372	850	27%
1994	5,942	3,301	751	32%
1995	5,906	2,736	547	44%
1996	5,829	3,470	742	28%
1997	4,506	2,440	581	33%
Paper Mills (SIC 2621)				
1987	37,443	19,241	5,965	33%
1988	39,154	19,588	5,571	36%
1989	39,094	20,417	5,443	34%
1990	39,197	20,930	5,617	32%
1991	37,849	20,413	5,929	30%
1992	38,510	21,109	6,367	29%
1993	37,707	20,810	6,302	28%
1994	40,329	22,615	6,311	28%
1995	40,518	20,936	4,958	36%
1996	38,656	20,122	5,470	34%
1997	36,880	19,502	5,592	32%
Paperboard Mills (SIC 2631)				
1987	20,932	10,428	2,834	37%
1988	21,868	9,974	2,669	42%
1989	20,946	9,708	2,514	42%
1990	20,979	10,285	2,700	38%
1991	20,530	10,640	2,772	35%
1992	21,777	10,812	2,882	37%
1993	22,488	12,043	3,122	33%
1994	23,329	12,272	3,050	34%
1995	23,418	11,393	2,427	41%
1996	22,969	12,015	2,945	35%
1997	23,974	13,339	3,265	31%

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

4A.4 Facilities Operating Cooling Water Intake Structures

In 1982, the Paper and Allied Products industry withdrew 534 billion gallons of cooling water, accounting for approximately 0.7 percent of total industrial cooling water intake in the United States. The industry ranked 5th in industrial cooling water use, behind the electric power generation industry, and the chemical, primary metals, and petroleum industries (1982 Census of Manufactures).

This section presents information from EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* on existing facilities with the following characteristics:

- they withdraw from a water of the United States;
- they hold an NPDES permit;
- they have a design intake flow of equal to or greater than two MGD;
- they use at least 25 percent of that flow for cooling purposes.

These facilities are not "new facilities" as defined by the proposed section 316(b) New Facility Rule and are therefore not subject to this regulation. However, they meet the criteria of the proposed rule except that they are already in operation. These existing facilities therefore provide a good indication of what new facilities in these sectors may look like. The remainder of this section refers to existing facilities with the above characteristics as "section 316(b) facilities."

a. Cooling water uses and systems

Information collected in the Detailed Industry Questionnaire found that an estimated 26 out of 66 pulp mills (39 percent), 74 out of 286 paper mills (26 percent), and 43 out of 187 paperboard mills (23 percent) meet the characteristics of a section 316(b) facility. Most section 316(b) facilities in the profiled Paper and Allied Products sectors use cooling water for contact and non-contact production line or process cooling, electricity generation, and air conditioning:

- Eighty-seven percent of section 316(b) *pulp mills* use cooling water for production line (or process) contact or noncontact cooling. The two other major uses of cooling water by pulp mills are air conditioning and electricity generation, by approximately 94 and 54 percent of facilities, respectively.

- Eighty-five percent of section 316(b) *paper mills* use cooling water for production line (or process) contact or noncontact cooling. Sixty-six percent also use cooling water for electricity generation and 57 percent for air conditioning.

- Eighty-eight percent of section 316(b) *paperboard mills* use cooling water for production line (or process) contact or noncontact cooling. The two other major uses of cooling water by pulp mills are electricity generation by approximately 70 percent and air conditioning by approximately 59 percent of facilities.

Table 4A-11 shows the distribution of existing section 316(b) facilities in the profiled Paper and Allied Products sectors by type of water body and cooling system. The table shows that most of the existing section 316(b) facilities have either a once-through system (61, or 43 percent) or employ a combination of a once-through and closed system (35, or 24 percent). Sixteen facilities (11 percent) have a recirculating system, while the remaining thirty facilities (21 percent) employ some other type of cooling system. The majority of existing facilities draw water exclusively from either a freshwater water stream or river (109, or 76 percent), or a lake or reservoir (19, or 13 percent). Ninety-six percent (138) of all 316(b) facilities in the profiled Paper and Allied Products sectors withdraw water from a combination of freshwater streams or rivers and lakes or reservoirs. The remaining six facilities (4 percent) withdraw from an estuary or tidal river. All of the CWISs drawing from an estuary or tidal river use a once-through cooling system.

Table 4A-11: Number of Section 316(b) Facilities by Water Body Type and Cooling System for Profiled Paper and Allied Products Sectors

Water Body Type	Recirculating		Combination		Once-Through		Other		Grand Total
	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	
Pulp Mills (SIC 2611)									
Freshwater Stream or River	6	32%	6	32%	6	32%	1	5%	19
Freshwater Stream or River & Lake or Reservoir	0	0%	1	100%	0	0%	0	0%	1
Lake or Reservoir	0	0%	0	0%	0	0%	6	100%	6
Total [a]	***6***	***23%***	***7***	***27%***	***6***	***23%***	***7***	***27%***	***26***
Paper Mills (SIC 2621)									
Estuary or Tidal River	0	0%	0	0%	2	100%	0	0%	2
Freshwater Stream or River	3	5%	12	20%	29	48%	16	27%	60
Freshwater Stream or River & Lake or Reservoir	0	0%	0	0%	2	100%	0	0%	2
Lake or Reservoir	0	0%	1	11%	3	33%	4	44%	9
Lake or Reservoir & Estuary or Tidal River	0	0%	0	0%	1	100%	0	0%	1
Total [a]	***3***	***4%***	***13***	***18%***	***36***	***49%***	***20***	***27%***	***74***
Paperboard Mills (SIC 2631)									
Estuary or Tidal River	0	0%	0	0%	3	100%	0	0%	3
Freshwater Stream or River	4	13%	12	40%	14	47%	0	0%	30
Freshwater Stream or River & Lake or Reservoir	0	0%	3	50%	0	0%	3	50%	6
Lake or Reservoir	3	60%	0	0%	2	40%	0	0%	5
Total [a]	***7***	***16%***	***15***	***35%***	***19***	***44%***	***3***	***7%***	***43***
Total Paper and Allied Products Industry (SIC 26)									
Estuary or Tidal River	0	0%	0	0%	5	100%	0	0%	5
Freshwater Stream or River	13	12%	30	28%	49	45%	17	16%	109
Freshwater Stream or River & Lake or Reservoir	0	0%	4	44%	2	22%	3	33%	9
Lake or Reservoir	3	16%	1	5%	5	26%	10	53%	19
Lake or Reservoir & Estuary or Tidal River	0	0%	0	0%	1	100%	0	0%	1
Total [a]	**16**	**11%**	**35**	**24%**	**61**	**43%**	**30**	**21%**	**143**

[a] Individual numbers may not add up to total due to independent rounding.

Source: *U.S. EPA, 2000.*

b. Facility size

Paper and Allied Product facilities have a design intake flow of more than two MGD, withdraw from a water of the U.S., hold an NPDES permit, and use at least 25 percent of intake water for cooling purposes are generally larger than facilities that do not meet these criteria:

- Twenty-three percent of all facilities in the overall *Paper Mills* sector had fewer than 100 employees in 1992; none of the section 316(b) facilities in that sector fall into that employment category.

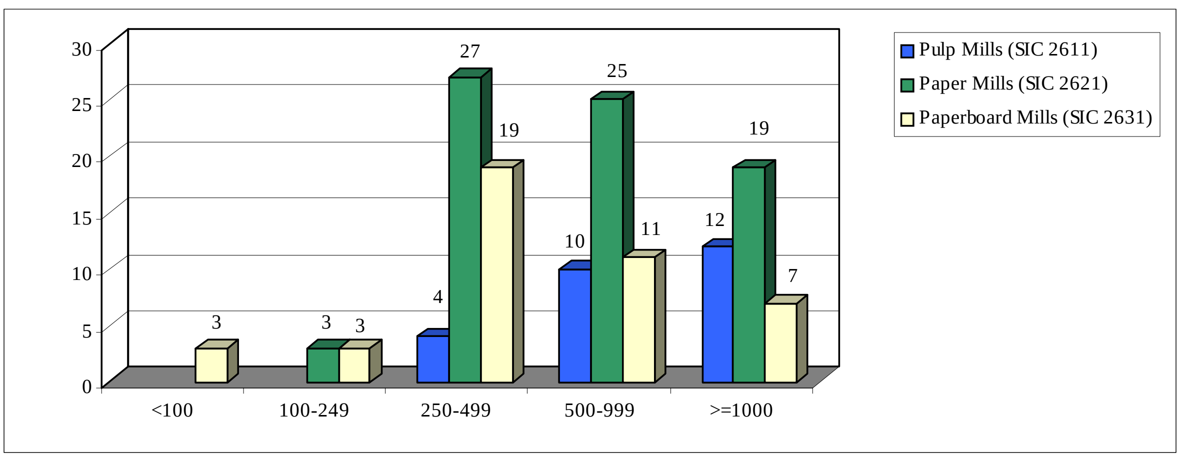
- Twenty-nine percent of all facilities in the *Pulp Mills* sector had fewer than 100 employees in 1992, compared with 7 percent of the section 316(b) facilities.

- Thirty-nine percent of all facilities in the *Paperboard Mills* sector had fewer than 100 employees, compared to none of the section 316(b) facilities.

The majority of section 316(b) pulp mills, 22 or 85 percent, employ 500 employees or greater. The section 316(b) paper and paperboard mills are more evenly distributed across employment categories. Twenty-seven paper mill facilities (36 percent) employ 250-499 employees, and 44 facilities (59 percent) employ 500 employees or more. Nineteen, or 44 percent, of paperboard facilities employ 250-499 employees, and 18 facilities (42 percent) employ more than 500 employees.

Figure 4A-8 shows the number of section 316(b) facilities in the profiled pulp and paper sectors by employment size category.

Figure 4A-8: Number of Section 316(b) Facilities by Employment Size for Profiled Paper and Allied Products Sectors



Source: U.S. EPA, 2000.

c. Firm size

EPA used the Small Business Administration (SBA) small entity size standards to determine the number of existing sectin 316(b) facilities in the three profiled Paper and Allied Products sectors that are owned by small firms. Firms in this industry are considered small if they employ fewer than 750 people.

Table 4A-12 shows that section 316(b) facilities in this industry are predominantly owned by large firms. All of the paper and paperboard mills are owned by large firms, and ninety-two percent (68 facilities) of pulp mills are owned by large firms. Small firms own four pulp mills. An additional two pulp mill facilities are owned by firms of unknown size, which may also qualify as small firms.

Table 4A-12: Number of Section 316(b) Facilities in Profiled Paper and Allied Products Sectors by Firm Size

SIC Code	SIC Description	Large		Small		Unknown		Total
		Number	% of SIC	Number	% of SIC	Number	% of SIC	
2611	Pulp Mills	26	100%	0	0%	0	0%	26
2621	Paper Mills	68	92%	4	5%	2	3%	74
2631	Paperboard Mills	43	100%	0	0%	0	0%	43
Total		137	96%	4	3%	2	1%	143

Source: U.S. EPA, 2000; D&B, 2001.

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4B CHEMICALS AND ALLIED PRODUCTS (SIC 28)

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified fifteen 4-digit SIC codes in the Chemical and Allied Products Industry (SIC 28) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws equal to or greater than two million gallons per day (MGD) from a water of the United States, and uses at least 25 percent of its intake flow for cooling purposes (facilities with these characteristics are hereafter referred to as "section 316(b) facilities"). For each of the fifteen SIC codes, Table 4B-1 below provides a description of the industry sector, a list of primary products manufactured, the total number of detailed questionnaire respondents (weighted ro represent national results), and the number and percent of section 316(b) facilities.

Table 4B-1: Section 316(b) Facilities in the Chemicals and Allied Products Industry (SIC 28)

SIC	SIC Description	Important Products Manufactured	Number of Weighted Detailed Questionnaire Survey Respondents: Total	Section 316(b) Facilities: No.[a]	Section 316(b) Facilities: %
Inorganic Chemicals (SIC 281)[b]					
2812	Alkalies and Chlorine	Alkalies, caustic soda, chlorine, and soda ash	28	20	68.7%
2813	Industrial Gases	Industrial gases (including organic) for sale in compressed, liquid, and solid forms	110	4	3.9%
2816	Inorganic Pigments	Black pigments, except carbon black, white pigments, and color pigments	26	4	16.7%
2819	Industrial Inorganic Chemicals, Not Elsewhere Classified	Miscellaneous other industrial inorganic chemicals	271	33	12.2%
Total Inorganic Chemicals			***435***	***61***	***14.1%***
Plastics Material and Resins (SIC 282)					
2821	Plastics Material and Synthetic Resins, and Nonvulcanizable Elastomers	Cellulose plastics materials; phenolic and other tar acid resins; urea and melamine resins; vinyl resins; styrene resins; alkyd resins; acrylic resins; polyethylene resins; polypropylene resins; rosin modified resins; coumarone-indene and petroleum polymer resins; miscellaneous resins	***305***	***15***	***4.8%***
Organic Chemicals (SIC 286)[c]					
2865	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	Aromatic chemicals, such as benzene, toluene, mixed xylenes naphthalene, synthetic organic dyes, and synthetic organic pigments	59	4	7.3%
2869	Industrial Organic Chemicals, Not Elsewhere Classified	Aliphatic and other acyclic organic chemicals; solvents; polyhydric alcohols; synthetic perfume and flavoring materials; rubber processing chemicals; plasticizers; synthetic tanning agents; chemical warfare gases; and esters, amines, etc.	364	48	13.1%
Total Organic Chemicals			***423***	***52***	***12.3%***

Table 4B-1: Section 316(b) Facilities in the Chemicals and Allied Products Industry (SIC 28)

SIC	SIC Description	Important Products Manufactured	Number of Weighted Detailed Questionnaire Survey Respondents: Total	Section 316(b) Facilities: No.[a]	Section 316(b) Facilities: %
Other Chemical Sectors					
2823	Cellulosic Manmade Fibers	Cellulose acetate and regenerated cellulose such as rayon by the viscose or cuprammonium process	7	1	14.9%
2824	Manmade Organic Fibers, Except Cellulosic	Regenerated proteins, and polymers or copolymers of such components as vinyl chloride, vinylidene chloride, linear esters, vinyl alcohols, acrylonitrile, ethylenes, amides, and related polymeric materials	36	9	24.1%
2833	Medicinal Chemicals and Botanical Products	Agar-agar and similar products of natural origin, endocrine products, manufacturing or isolating basic vitamins, and isolating active medicinal principals such as alkaloids from botanical drugs and herbs	33	3	9.9%
2834	Pharmaceutical Preparations	Intended for final consumption, such as ampoules, tablets, capsules, vials, ointments, medicinal powders, solutions, and suspensions	91	4	4.7%
2841	Soaps and Other Detergents, Except Speciality Cleaners	Soap, synthetic organic detergents, inorganic alkaline detergents	36	4	12.0%
2873	Nitrogenous Fertilizers	Ammonia fertilizer compounds and anhydrous ammonia, nitric acid, ammonium nitrate, ammonium sulfate and nitrogen solutions, urea, and natural organic fertilizers (except compost) and mixtures	60	9	14.4%
2874	Phosphatic Fertilizers	Phosphoric acid; normal, enriched, and concentrated superphosphates; ammonium phosphates; nitro-phosphates; and calcium meta-phosphates	41	1	2.9%
2899	Chemicals and Chemical Preparations, Not Elsewhere Classified	Fatty acids; essential oils; gelatin (except vegetable); sizes; bluing; laundry sours; writing and stamp pad ink; industrial compounds; metal, oil, and water treating compounds; waterproofing compounds; and chemical supplies for foundries	162	4	2.7%
Total Other			***466***	***36***	***7.6%***
Total Chemicals and Allied Products (SIC 28)					
Total SIC Code 28			**1,629**	**163**	**10.0%**

[a] Individual numbers may not add up due to independent rounding.
[b] SIC code 281 is officially titled "Industrial Inorganic Chemicals." However, to avoid confusion with SIC code 2819, "Industrial Inorganic Chemicals, Not Elsewhere Classified," this profile will refer to SIC code 281 as the "Inorganic Chemicals sector."
[c] SIC code 286 is officially titled "Industrial Organic Chemicals." However, to avoid confusion with SIC code 2869, "Industrial Organic Chemicals, Not Elsewhere Classified," this profile will refer to SIC code 286 as the "Organic Chemicals sector."

Source: U.S. EPA, 2000; Executive Office of the President, 1987.

The responses to the Detailed Questionnaire indicate that three main chemical sectors account for 78 percent of the chemicals industry section 316(b) facilities: (1) Inorganic Chemicals (including SIC codes 2812, 2813, 2816, and 2819); (2) Plastics Material and Resins (SIC code 2821); and (3) Organic Chemicals (including SIC codes 2865 and 2869). Of the 163 section 316(b) facilities in the Chemical industry, 61 facilities, or 37 percent, belong to the Inorganic Chemicals sector, 52, or 32 percent, belong to the Organic Chemicals sector, and 15, or 9 percent, belong to the Plastics and Resins sector. This profile therefore provides detailed information for these three industry groups.

4B.1 Domestic Production

The U.S. Chemical and Allied products industry includes a large number of companies that, in total, produce more than 70,000 different chemical products. These products range from commodity materials used in other industries to finished consumer products such as soaps and detergents. The industry accounts for nearly 12 percent of U.S. manufacturing value added, and produces approximately two percent of total national gross domestic product (McGraw-Hill, 2000).

Raw materials containing hydrocarbons such as oil, natural gas, and coal are primary feedstocks for the production of organic chemicals. Inorganic chemicals are chemicals that do not contain carbon but are produced from other gases and minerals (McGraw-Hill, 2000).

The Chemicals and Allied products industry is highly energy intensive, consuming about 7 percent of total annual U.S. energy output (McGraw-Hill, 2000). It is one of the largest industrial users of electric energy and also consumes large amounts of oil and natural gas. In total, the industry accounts for approximately seven percent of total U.S. energy consumption, including 11 percent of all natural gas use. Just over 50 percent of the industry's energy consumption is used as feedstock in the production of chemical products. The remaining energy consumption is for fuel and power for production processes. Oil accounts for approximately 42 percent of total energy consumption by the industry. For some products, e.g., petrochemicals, energy costs account for up to 85 percent of total production costs. Overall, total energy costs represent seven percent of the value of chemical industry shipments (S&P, 2001).

a. Output

Figure 4B-1 shows the trend in ***value of shipments*** and ***value added*** for the three profiled sectors between 1988 and 1997.[1] Value of shipments and value added are two of the most common measures of manufacturing output. They provide insight into the overall economic health and outlook for an industry. Value of shipments is the sum of the receipts a manufacturer earns from the sale of its outputs. It is an indicator of the overall size of a market or the size of a firm in relation to its market or competitors. Value added is used to measure the value of production activity in a particular industry. It is the difference between the value of shipments and the value of inputs used to make the products sold.

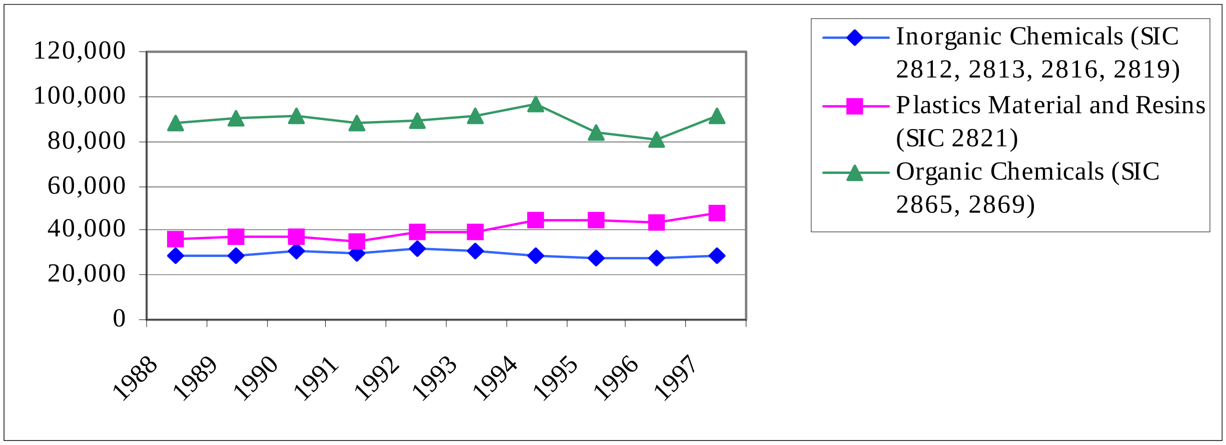
The Organic Chemicals sector (SIC 286) experienced a significant decrease in both value of shipments and value added between 1994 and 1996, before rebounding in 1997. The decrease was a function of increased competition in the global market for petrochemicals which comprise the majority of organic chemical products. The increased competition stems from the considerable capacity expansions for these products seen in developing nations in recent years (McGraw-Hill, 2000).

The Plastics Material and Resin (SIC 2821) and Inorganic Chemicals (SIC 281) sectors have remained relatively stable over the period between 1988 and 1997. The stability in these industry sectors reflects various trends in the markets for their products which are heavily influenced by the overall health and stability of the U.S. economy. In the early 1990s, domestic producers benefitted from the relatively weak dollar which made U.S. products more competitive in the global market. In more recent years, the strength of the U.S. economy has bolstered domestic end-use markets, offsetting the reductions in exports that have resulted from increased global competition and a strengthened dollar (McGraw-Hill, 2000).

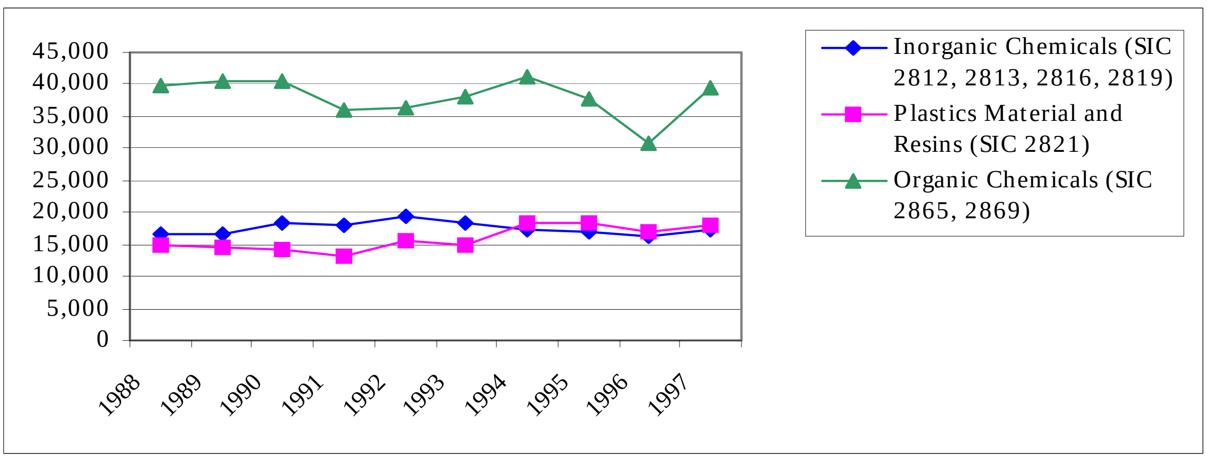
[1] Terms highlighted in bold and italic font are further explained in the glossary.

Figure 4B-1: Value of Shipments and Value Added for Profiled Chemical Sectors (in millions, constant $2000)

Value of Shipments



Value Added



Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

Table 4B-2 provides the Federal Reserve System's index of industrial production for the three profiled sectors, which shows trends in production since 1997. This index reflects total output in physical terms, whereas value of shipments and value added reflects the value of production. Table 4B-2 shows varying trends in the three sectors since 1997, but sharp declines in production in all three sectors in the first half of 2001. These declines have been caused by the dramatic slowdown in the U.S. economy, which has affected demand in major chemical-using sectors such as steel, apparel, textiles, forest products, and the technology sectors (Chemical Marketing Reporter, 2001).

Table 4B-2: Chemicals Industry Industrial Production Indexes

Year	Basic Inorganic Chemicals[a]		Plastics Materials		Industrial Organic Chemicals	
	Index 1992=100	Percent Change	Index 1992=100	Percent Change	Index 1992=100	Percent Change
1989	92.6	n/a	94.6	n/a	103.5	n/a
1990	101.2	9.3%	95.3	0.7%	104.9	1.4%
1991	97.7	-3.5%	90.4	-5.1%	99.9	-4.8%
1992	100.0	2.4%	100.0	10.6%	100.0	0.1%
1993	95.3	-4.7%	98.0	-2.0%	98.7	-1.3%
1994	88.8	-6.8%	111.9	14.2%	104.9	6.3%
1995	91.0	2.5%	113.0	1.0%	105.6	0.7%
1996	92.6	1.8%	109.2	-3.4%	106.3	0.7%
1997	98.1	5.9%	120.2	10.1%	114.3	7.5%
1998	95.2	-3.0%	131.0	9.0%	108.8	-4.8%
1999	98.9	3.9%	139.5	6.5%	114.6	5.3%
2000	102.7	3.8%	137.7	-1.3%	114.9	0.3%
Total Percent Change 1989-1997	*11%*		*46%*		*11%*	
Average Annual Growth Rate	*0.9%*		*3.5%*		*1.0%*	
Jan.-June 2000[b]	101.9	n/a	142.6	n/a	117.5	n/a
Jan.-June 2001[b]	95.5	-35.6%	132.9	-7%	98.1	-17%

[a] Includes alkalies and chlorine, inorganic pigments and inorganic chemicals.
[b] Average over the six month period.

Source: Federal Reserve Board, 2001.

b. Prices

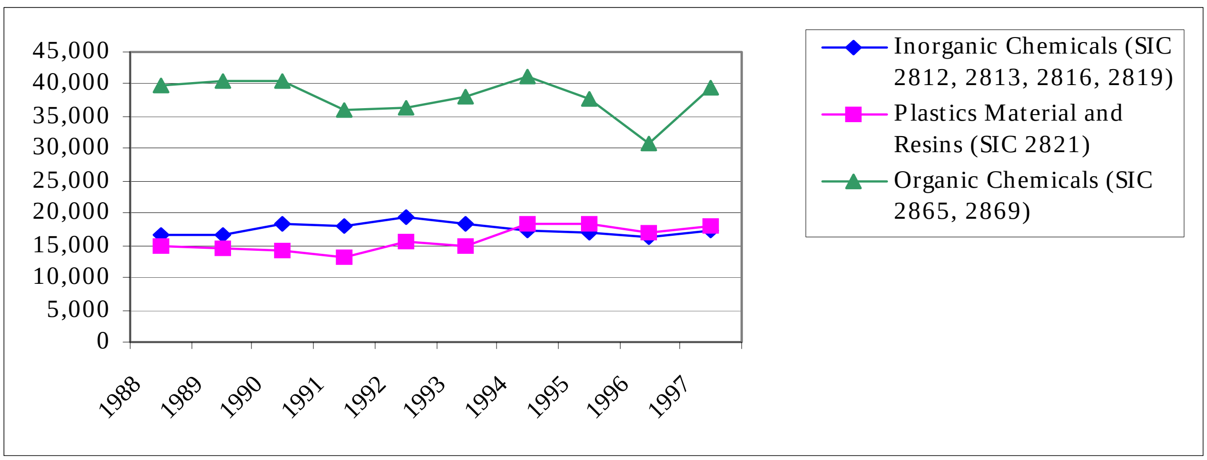
Selling prices for the products of the Organic and Inorganic Chemical sectors have increased from 1987 to 1989 and remained stable through 1994. Between 1994 and 1995, prices increased sharply, followed by a period of stable prices through 1997. Prices for plastics material and resins followed a trend similar to the other two chemical industry sectors but with larger fluctuations (see Figure 4B-2).

The fluctuations in chemical and plastics prices are in part a function of energy prices. Basic petrochemicals, which comprise the majority of organic chemical products, require energy input which can account for up to 85 percent of total production costs. The prices of natural gas and oil therefore influence the production costs and the selling price for these products. High basic petrochemical prices affect prices for chemical intermediates and final end products, including organic chemicals and plastics.

Another factor influencing prices for commodity chemical products is the cyclical nature of market supply and demand conditions. The Plastics, and Organic and Inorganic Chemical sectors are characterized by large capacity additions which can lead to fluctuations in prices in response to imbalances in supply and demand.

Figure 4B-2 shows the ***producer price index*** (PPI) at the 4-digit SIC code for the profiled chemical sectors. The PPI is a family of indexes that measure price changes from the perspective of the seller. This profile uses the PPI to express monetary values in constant dollars.

Figure 4B-2: Producer Price Indexes for Profiled Chemical Sectors



Source: BLS, 2000.

A recent sharp rise in prices for organic chemicals and plastics materials and resins is due in part to increases in the price of natural gas. Natural gas liquids are the feedstock for 70 percent of U.S. ethylene production, and the high natural gas prices are putting U.S. organic chemicals and, to a lesser extent, plastic resin producers at a disadvantage relative to foreign producers who rely on naphta and gas oil as a feedstock. Natural gas prices have declined recently, however, which will ease this pressure on U.S. producers (Chemical Market Reporter, 2001). Recent price increases for plastics and resins also reflect a shift by U.S. producers away from commodity resins to emphasize speciality and higher-value-added products (McGraw-Hill, 2000).

c. Number of facilities and firms

According to the Statistics of U.S. Businesses, the number of facilities in the Organic and Inorganic Chemical sectors remained relatively stable between 1989 and 1997. Table 4B-3 shows a downward trend in the number of facilities producing inorganic chemical products following a peak in 1991. This decrease is likely the result of the recent trend towards consolidation in the inorganic chemical sector. Consolidation is a means of paring costs with companies making acquisitions and consolidating operations in an attempt to reduce costs and achieve economies of scale (S&P, 2001).

While the number of producers in the Organic and Inorganic Chemical sectors has remained stable, the Plastics Material and Resins sector has experienced a significant increase in the number of facilities reported between 1993 and 1996, reflecting growth in the demand for plastics in a number of end-uses (McGraw-Hill, 2000).

Table 4B-3: Number of Facilities for Profiled Chemical Sectors[a]

Year	Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)		Plastics Material and Resins (SIC 2821)		Organic Chemicals (SIC 2865, 2869)	
	Number of Facilities	Percent Change	Number of Facilities	Percent Change	Number of Facilities	Percent Change
1989	1,387	n/a	504	n/a	844	n/a
1990	1,421	2%	517	3%	837	-1%
1991	1,508	6%	529	2%	851	2%
1992	1,466	-3%	460	-13%	888	4%
1993	1,476	1%	502	9%	908	2%
1994	1,460	-1%	499	-1%	902	-1%
1995	1,425	-2%	558	12%	907	1%
1996	1,396	-4%	630	26%	868	-4%
1997	1,414	1%	593	-6%	945	9%
Total Percent Change 1989-1997	*2%*		*18%*		*12%*	
Average Annual Growth Rate	*0.2%*		*2.1%*		*1.4%*	

[a] The Statistics of U.S. Business is derived from Census County Business Patterns data, and reports somewhat different numbers of firms and facilities than other Census data sources.

Source: U.S. SBA, 2000.

The trend in the number of firms between 1989 and 1997 has been similar to the number of facilities. The number of firms remained relatively stable for the Inorganic and Organic Chemical sectors. The Plastics Material and Resins sector experienced a significant increase in the number of firms reported between 1993 and 1997 from 284 to 358 firms.

Table 4B-4 shows the number of firms in the three profiled chemical sectors between 1990 and 1997.

Table 4B-4: Number of Firms for Profiled Chemical Sectors[a]

Year	Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)		Plastics Material and Resins (SIC 2821)		Organic Chemicals (SIC 2865, 2869)	
	Number of Firms	Percent Change	Number of Firms	Percent Change	Number of Firms	Percent Change
1990	640	n/a	301	n/a	579	n/a
1991	678	6%	319	6%	584	1%
1992	699	3%	255	-20%	611	5%
1993	683	-2%	284	11%	648	6%
1994	677	-1%	295	4%	644	-1%
1995	657	-3%	343	16%	644	0%
1996	625	-5%	403	17%	596	-7%
1997	611	-2%	358	-11%	674	13%
Total Percent Change 1990-1997	*-5%*		*19%*		*16%*	
Average Annual Growth Rate	*-0.7%*		*2.5%*		*2.2%*	

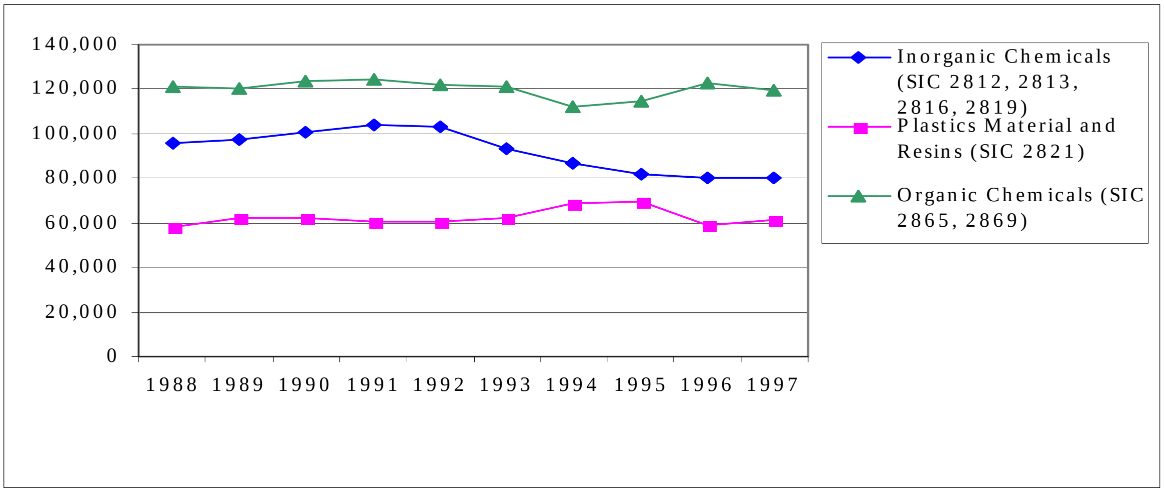
[a] The Statistics of U.S. Business is derived from Census County Business Patterns data, and reports somewhat different numbers of firms and facilities than other Census data sources.

Source: U.S. SBA, 2000.

d. Employment and productivity

Employment is a measure of the level and trend of activity in an industry. Figure 4B-3 below provides information on employment from the Annual Survey of Manufactures. With the exception of minor short-lived fluctuations, employment in the Organic Chemical and Plastics and Resins sectors remained stable between 1992 and 1996. The Inorganic Chemicals sector, however, experienced a significant decrease in employment from 103,400 to 80,200 employees over the same time period. This decrease reflects the industry's restructuring and downsizing efforts intended to reduce costs in response to competitive challenges.

Figure 4B-3: Employment for Profiled Chemical Sectors



Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

Table 4B-5 presents the change in value added per labor hour, a measure of ***labor productivity***, for each of the profiled industry sectors between 1988 and 1997. The trends in each sector, particularly Plastic Materials and Resins and Organic Chemicals, show considerable volatility throughout the early and mid 1990s. The gains in productivity in the Inorganic Chemicals sector reflect facilities' attempts to reduce costs by restructuring production and materials handling processes in response to maturing domestic markets and increased global competition (S&P, 2001).

Table 4B-5: Productivity Trends for Profiled Chemical Sectors (in millions, constant $2000)												
Year	Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)				Plastics Material and Resins (SIC 2821)				Organic Chemicals (SIC 2865, 2869)			
	Value Added	Prod. Hours (mill.)	Value Added/Hour		Value Added	Prod. Hours (mill.)	Value Added/Hour		Value Added	Prod. Hours (mill.)	Value Added/Hour	
			No.	% Change			No.	% Change			No.	% Change
1988	16,514	114	145	n/a	15,057	80	189	n/a	39,697	152	262	n/a
1989	16,785	109	154	6%	14,491	84	173	-8%	40,649	155	263	1%
1990	18,424	115	161	4%	14,363	83	174	1%	40,509	156	260	-1%
1991	17,900	121	148	-8%	13,120	81	162	-7%	36,170	156	232	-11%
1992	19,219	120	160	8%	15,576	79	198	22%	36,332	155	234	1%
1993	18,339	108	170	6%	14,845	81	183	-8%	37,945	156	243	4%
1994	17,183	101	170	0%	18,260	89	204	11%	41,052	146	282	16%
1995	17,026	100	170	0%	18,193	92	199	-3%	37,741	148	256	-9%
1996	16,246	97	168	-1%	16,815	81	209	5%	30,666	158	194	-24%
1997	17,367	91	191	14%	17,931	82	219	5%	39,391	152	260	34%
Total Percent Change 1988-1997	*5%*	*-20%*	*32%*		*19%*	*3%*	*16%*		*-1%*	*0%*	*-1%*	
Average Annual Percent Change	*1%*	*-2%*	*3%*		*2%*	*0.3%*	*2%*		*-0.1%*	*0%*	*-0.1%*	

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

e. Capital expenditures

The chemicals industry is relatively capital-intensive, with aggregate capital spending of $33.6 billion in 1999 (S&P, 2001). Capital-intensive industries are characterized by large, technologically complex manufacturing facilities which reflect the economies of scale required to manufacture products efficiently. ***New capital expenditures*** are needed to extensively modernize, expand, and replace existing capacity to meet growing demand. All three profiled chemical industry sectors have experienced substantial increases in capital expenditures over the past eleven years. Table 4B-6 shows that capital expenditures in the Inorganic Chemicals, the Plastics, and the Organic Chemicals sectors have increased by 98, 79, and 30 percent, respectively, over the past eleven years. Much of this growth in capital expenditures is driven by investment in capacity expansions to meet the increase in global demand for chemical products. Domestically, the continued substitution of synthetic materials for other basic materials and rising living standards has resulted in consistent growth in the demand for chemical commodities (S&P, 2001).

Table 4B-6: Capital Expenditures for Profiled Chemical Sectors (in millions, constant $2000)

Year	Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)		Plastics (SIC 2821)		Organic Chemicals (SIC 2865, 2869)	
	Capital Expenditures	Percent Change	Capital Expenditures	Percent Change	Capital Expenditures	Percent Change
1987	1,059	n/a	1,742	n/a	n/a	n/a
1988	1,076	2%	1,832	5%	4,760	n/a
1989	1,558	45%	2,193	20%	5,667	19%
1990	1,517	-3%	2,870	31%	7,179	27%
1991	1,581	4%	2,683	-7%	7,303	2%
1992	1,794	13%	2,128	-21%	6,714	-8%
1993	1,393	-22%	2,392	12%	5,748	-14%
1994	1,493	7%	3,026	27%	4,915	-14%
1995	1,787	20%	2,401	-21%	5,445	11%
1996	1,958	10%	3,057	27%	6,730	23%
1997	2,095	7%	3,118	2%	6,170	-8%
Total Percent Change 1987-1997	*98%*		*79%*		*30%*	
Average Annual Growth Rate	*7%*		*6%*		*3%*	

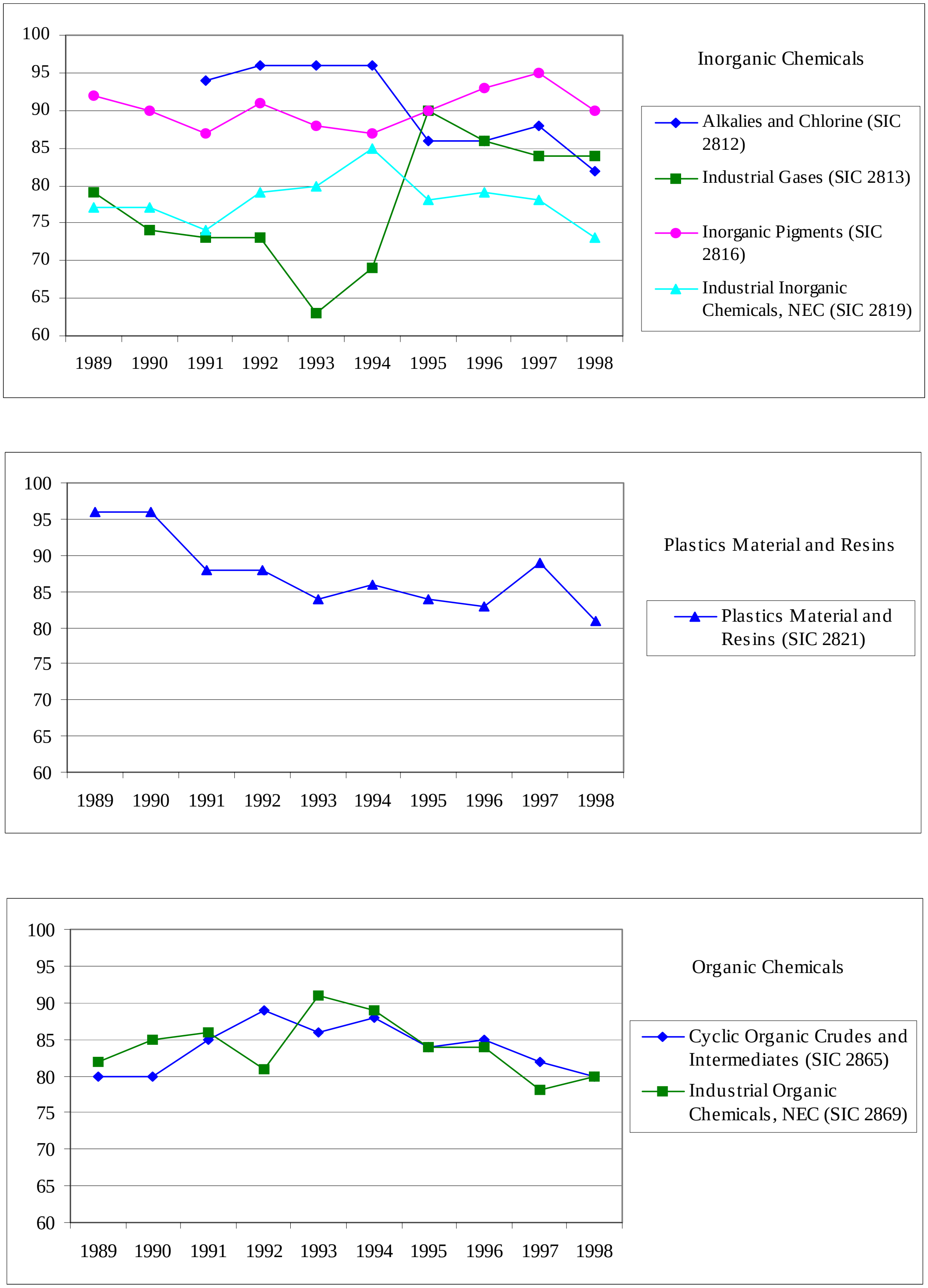
Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

f. Capacity utilization

Capacity utilization measures actual output as a percentage of total potential output given the available capacity, and is used as a key barometer of an industry's health. Capacity utilization is an index used to identify potential excess or insufficient capacity in an industry which can help project whether new investment is likely. To take advantage of economies of scale, chemical commodities are typically produced in large facilities. Capacity additions in this industry are often made on a relatively large scale and can substantially affect the industry's capacity utilization rates. Figure 4B-4 presents the capacity utilization index from 1989 to 1998 for specific 4-digit SIC codes within each of the profiled sectors in the chemicals industry. Capacity utilization in the Organic Chemicals sector has remained stable throughout the 1990s with only moderate fluctuations between 1989 and 1998. Plastics and Resins capacity utilization has shown a downward trend, as the production of many commodity resins has shifted overseas. U.S. producers have responded by emphasizing the manufacture of speciality and higher-value-added products and by rationalizing capacity to improve profitability (McGraw-Hill, 2000).

Overall, the Inorganic Chemicals sector has demonstrated the most volatility in capacity utilization between 1989 and 1998. The chlor-alkali industry (SIC code 2812) has experienced an almost consistent decline in the capacity utilization index since its high of 96 percent from 1992 through 1994. This decrease reflects the enactment of treaties and legislation designed to reduce the emission of chlorinated compounds into the environment. These regulations decreased the demand for chlorine which, together with caustic soda, accounts for more than 75 percent of production by this sector. The significant increase in capacity utilization in the industrial gases sector (SIC code 2813) in the mid 1990s reflects the expansion of key end-use markets such as the chemicals, primary metals, and electronics industries. In contrast, capacity utilization in the pigments and other inorganic chemicals sectors (SIC codes 2816 and 2819) remained relatively stable between 1989 and 1998. The stability in these sectors reflects the fact that these are essentially mature markets where the demand for products tend to track growth in gross domestic product (GDP) (McGraw-Hill 2000).

Figure 4B-4: Capacity Utilization Rates (Fourth Quarter) for Profiled Chemical Sectors



Source: U.S. DOC, 1989-1998.

4B.2 Structure and Competitiveness

The chemicals industry continues to restructure and reduce costs in response to competitive challenges, including global oversupply for commodities. In the early 1990s, the chemical industry's cost-cutting came largely from restructuring and downsizing. The industry has taken steps to improve productivity, and consolidated to cut costs. In general, companies seeking growth within maturing industry sectors are making acquisitions to achieve production or marketing efficiencies. The Plastics Material and Resins sector (SIC code 282), for example, has recently experienced sizable consolidations (S&P, 2001).

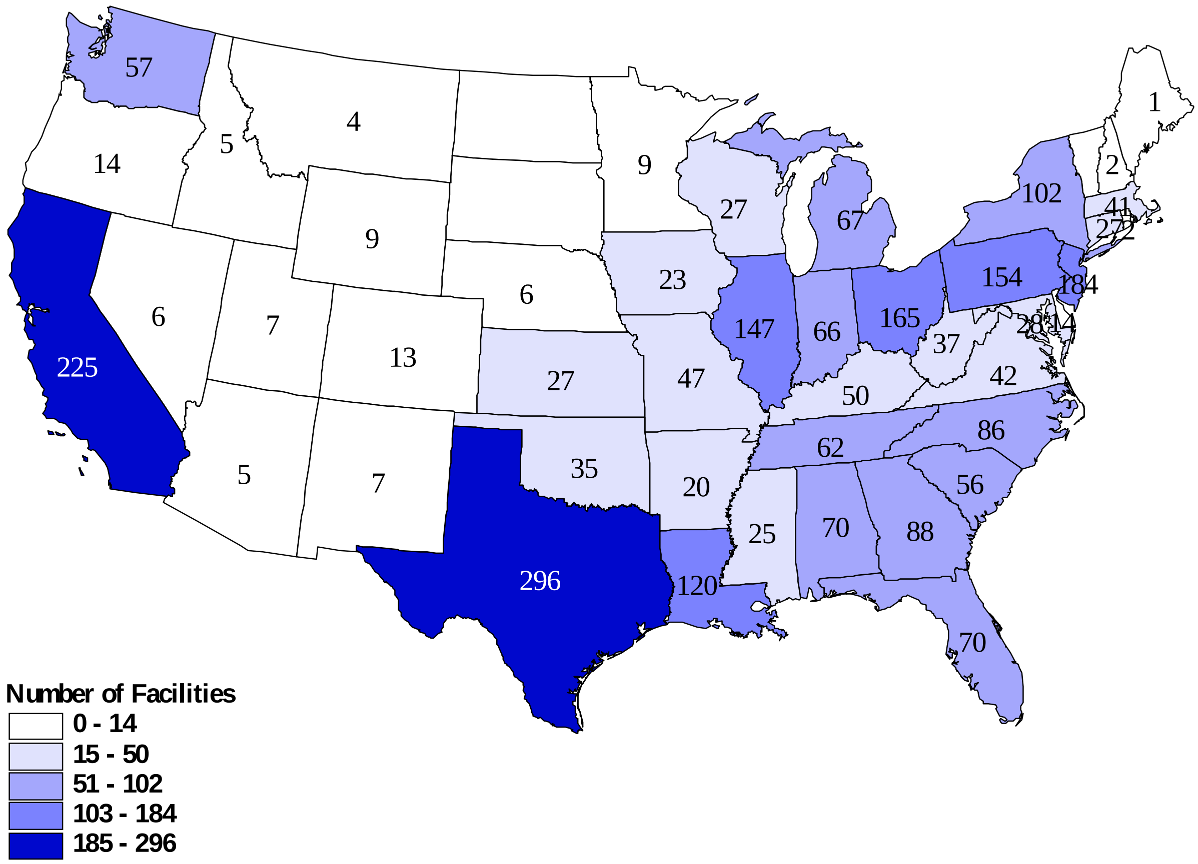
a. Geographic distribution

Chemical manufacturing facilities are located in every state but almost two-thirds of U.S. chemical production is concentrated in ten states. Given the low value of many commodity chemicals and the handling problems posed by products such as industrial gases, nearly two-thirds of the tonnage shipped was transported less than 250 miles in 1998 (S&P, 2001).

Facilities producing cyclic crudes and intermediates (SIC 2865) and unclassified industrial organic chemicals, not elsewhere classified (SIC 2869), are concentrated in Texas, New Jersey, Ohio, California, New York, and Illinois. Facility sites are typically chosen for their access to raw materials such as petroleum and coal products and to transportation routes. In addition, since much of the market for organic chemicals is the chemical industry, facilities tend to cluster near such end-users (U.S. EPA, 1995a).

Inorganic Chemical facilities (SIC 281) are typically located near consumers and, to a lesser extent, raw materials. The largest use of inorganic chemicals is in industrial processes for the manufacture of chemicals and nonchemical products. Facilities are therefore concentrated in the heavy industrial regions along the Gulf Coast, both East and West coasts, and the Great Lakes region. Since a large portion of the inorganic chemicals produced are used by the Organic Chemicals manufacturing industry, the geographical distribution of inorganic facilities is very similar to that of organic chemicals facilities (U.S. EPA, 1995b). Facilities in the Plastics Material and Resins sector (SIC 2821) are concentrated in the heavy industrial regions, similar to both the organic and inorganic chemicals facilities.

Figure 4B-5: Number of Chemical Facilities by State for Profiled Chemical Sectors



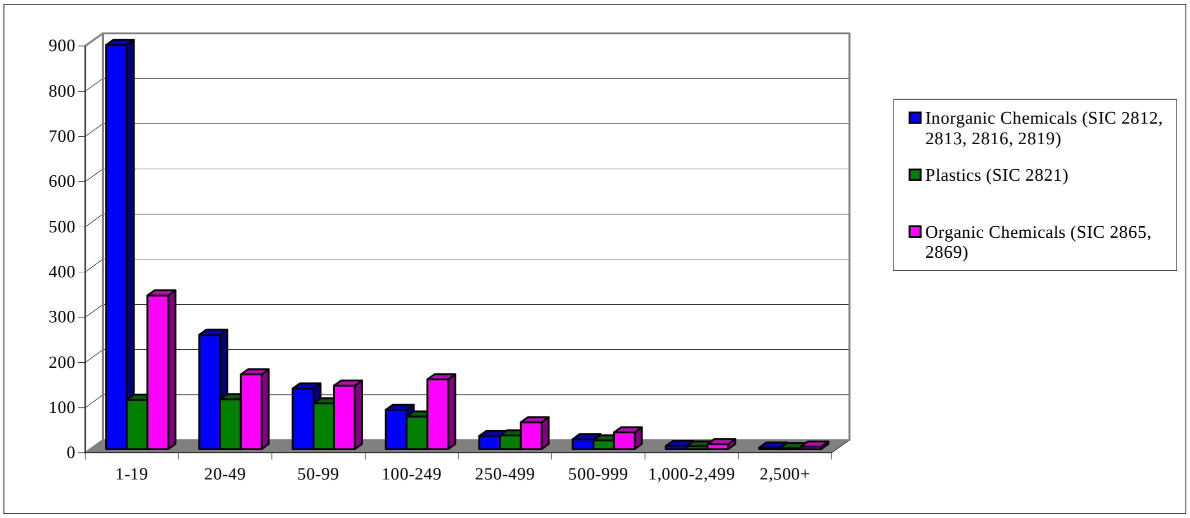
Source: U.S. DOC, 1987, 1992, and 1997.

b. Facility size

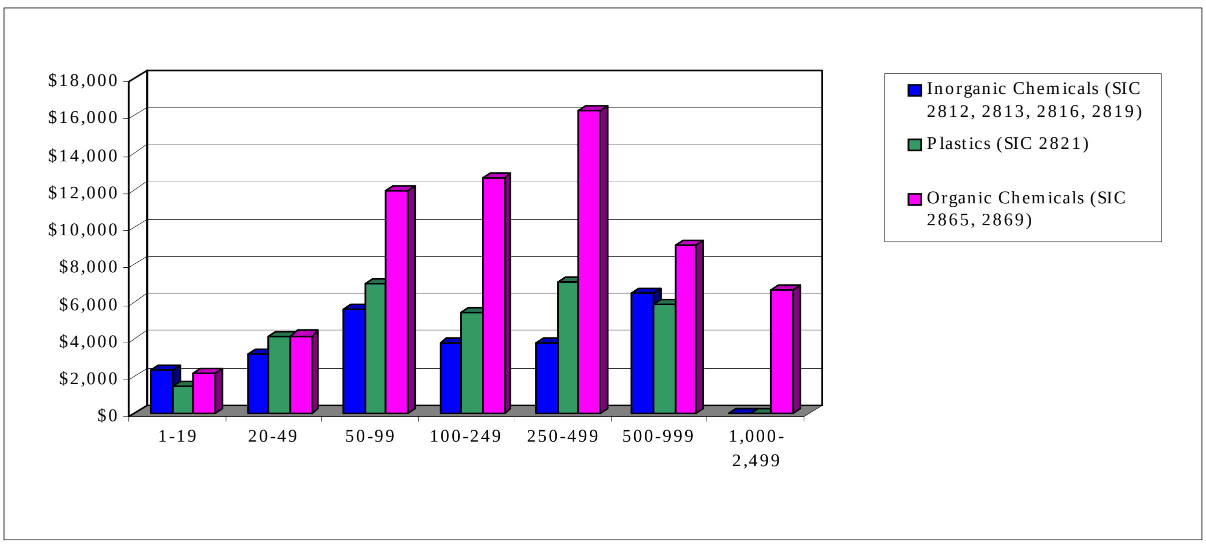
The three profiled chemicals industry sectors are characterized by a large number of small facilities, with more than 67 percent of facilities employing fewer than 50 employees and only eight percent employing 250 or more employees. However, the larger facilities in the three sectors account for the majority of the industries' output. This fact is most pronounced in the Inorganic Chemicals sector where facilities with fewer than 20 employees account for 63 percent of all facilities but for only 8 percent of the industry's value of shipments. In the Organic Chemicals sector, approximately 29 percent of all facilities employ 100 employees or more. These facilities account for about 87 percent of the value of shipments for the industry. Similarly, facilities in the Plastics Industry with more than 100 employees account for only 29 percent of all facilities but for 80 percent of the industry's value of shipments (see Figure 4B-6 below).

Figure 4B-6: Number of Facilities and Value Added by Employment Size Category in 1992 for Profiled Chemical Sectors

Number of Facilities (1992)



1992 Value of Shipments (in millions)



Source: U.S. DOC, 1987, 1992, and 1997.

c. Firm size

The Small Business Administration (SBA) defines small firms in the chemical industries according to the firm's number of employees. Firms in the Inorganic Chemicals sector (SIC codes 2812, 2813, 2816, 2819) and in Industrial Organic Chemicals, NEC (SIC code 2869) are defined as small if they have 1,000 or fewer employees; firms in Plastics Material and Resins (SIC 2821) and Cyclic Organic Crudes and Intermediates (SIC code 2865) are defined as small if they have 750 or fewer employees.

The size categories reported in the Statistics of U.S. Businesses (SUSB) do not coincide with the SBA small firm standards of 750 and 1,000 employees. It is therefore not possible to apply the SBA size thresholds precisely. The SUSB data presented in Table 4B-6 show that in 1997, 475 of 611 firms in the Inorganic Chemicals sector had less than 500 employees. Therefore, at least 78 percent of firms in this sector were classified as small. These small firms owned 524 facilities, or 37 percent of all facilities in the sector. In the Plastics and Resins Industry sector, 272 of 358 firms, or 76 percent, had less than 500 employees in 1997. These small firms owned 294 of 593 facilities (50 percent) in the sector. In the Organic Chemicals Industry sector, 74 percent of facilities (496 of 674) had fewer than 500 employees, owning 57 percent of all facilities in that sector.

Table 4B-7 below shows the distribution of firms, facilities, and receipts in the Inorganic Chemicals, Plastics Material and Resins, and Organic Chemicals sectors by the employment size of the parent firm.

Table 4B-7: Number of Firms, Facilities and Estimated Receipts by Firm Size Category for Profiled Chemical Sectors (1997)

Employment Size Category	Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)			Plastics Material and Resins (SIC 2821)			Organic Chemicals (SIC 2865, 2869)		
	No. of Firms	Number of Facilities	Estimated Receipts (in millions, constant $2000)	No. of Firms	Number of Facilities	Estimated Receipts (in millions, constant $2000)	No. of Firms	Number of Facilities	Estimated Receipts (in millions, constant $2000)
0-19	294	299	396	120	120	477	255	255	670
20-99	122	137	1,291	108	111	1,399	148	160	2,752
100-499	59	88	2,700	44	63	3,141	93	121	5,053
500+	136	890	3,606	86	299	5,548	178	409	9,908
Total	*611*	*1,414*	*7,993*	*358*	*593*	*10,565*	*674*	*945*	*18,383*

Source: U.S. SBA, 2000.

d. Concentration and specialization ratios

Concentration is the degree to which industry output is concentrated in a few large firms. Concentration is closely related to entry barriers with more concentrated industries generally having higher barriers.

The four-firm ***concentration ratio*** (CR4) and the ***Herfindahl-Hirschman Index*** (HHI) are common measures of industry concentration. The CR4 indicates the market share of the four largest firms. For example, a CR4 of 72 percent means that the four largest firms in the industry account for 72 percent of the industry's total value of shipments. The higher the concentration ratio, the less competition there is in the industry, other things being equal.[2] An industry with a CR4 of more than 50 percent is generally considered concentrated. The HHI indicates concentration based on the largest 50 firms in the industry. It is equal to the sum of the squares of the market shares for the largest 50 firms in the industry. For example, if an industry consists of only three firms with market shares of 60, 30, and 10 percent, respectively, the HHI of this industry would be equal to 4,600 ($60^2 + 30^2 + 10^2$). The higher the index, the fewer the number of firms supplying the industry and the more concentrated the industry. An industry is considered concentrated if the HHI exceeds 1,000.

Of the profiled Chemicals and Allied Products, only Alkalies and Chlorine (SIC 2812), Industrial Gases (SIC 2813), and Inorganic Pigments (SIC 2816) would be considered highly concentrated based on their CR4 and HHI values. In contrast, Industrial Inorganic Chemicals, NEC (SIC 2819), Plastics Material and Resins (SIC 2821), Cyclic Crudes and Intermediates (SIC 2865), and Industrial Organic Chemicals, NEC (SIC 2869) would be considered competitive. The diversity of products in some of the profiled sectors, however, make generalizations about concentration less reliable than in industries with a more limited product slate. There could be significant variations in the numbers of producers of individual products within the SICs with numerous products (e.g. SIC 2869, Industrial Organic Chemicals, not elsewhere classified).

The ***specialization ratio*** is the percentage of the industry's production accounted for by primary product shipments. The ***coverage ratio*** is the percentage of the relevant product shipments that are produced as primary products by facilities in the comparable SIC. The specialization ratios presented in Table 4B-8 indicate a relatively high degree of specialization for each profiled chemical industry sector. The coverage ratios indicate that the facilities classified in the profiled SICs produce more than 80 percent of the relevant products as primary products, except for SIC 2812 (Alkalies and Chlorine) and 2865 (Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments), where a larger portion of the relevant products produced are produced by facilities classified in other SICs.

[2] Note that the measured concentration ratio and the HHF are very sensitive to how the industry is defined. An industry with a high concentration in domestic production may nonetheless be subject to significant competitive pressures if it competes with foreign producers or if it competes with products produced by other industries (e.g., plastics vs. aluminum in beverage containers). Concentration ratios are therefore only one indicator of the extent of competition in an industry.

Table 4B-8: Selected Ratios for Four-Digit SIC Codes for Profiled Chemical Sectors

SIC Code	Year	Concentration Ratios: 4 Firm (CR4)	8 Firm (CR8)	20 Firm (CR20)	50 Firm (CR50)	Herfindahl-Hirschman Index	Specialization Ratio	Coverage Ratio
Inorganic Chemicals								
2812	87	72%	93%	99%	100%	2,328	86%	65%
	92	75%	90%	99%	100%	1,994	76%	75%
2813	87	77%	88%	95%	98%	1,538	98%	94%
	92	78%	91%	96%	99%	1,629	96%	94%
2816	87	64%	76%	94%	99%	1,550	94%	89%
	92	69%	79%	93%	99%	1,910	95%	89%
2819	87	38%	49%	68%	84%	468	91%	80%
	92	39%	50%	68%	85%	677	91%	82%
Plastics Material and Resins								
2821	87	20%	33%	61%	89%	248	88%	81%
	92	24%	39%	63%	90%	284	86%	80%
Organic Chemicals								
2865	87	34%	50%	77%	96%	542	80%	61%
	92	31%	45%	72%	94%	428	86%	61%
2869	87	31%	48%	68%	86%	376	75%	84%
	92	29%	43%	67%	86%	336	76%	85%

Source: U.S. DOC, 1987, 1992, and 1997.

e. Foreign trade

The chemicals industry is the largest exporter in the United States. The industry generates more than 10 percent of the nation's total exports, and overseas sales constitute a growing share of U.S. chemical company revenues. The major U.S. producers still derive 50 percent or more of their revenue from domestic sales, however (S&P, 2001).

This profile uses two measures of foreign competitiveness: ***export dependence*** and ***import penetration***. Export dependence is the share of value of shipments that is exported. Import penetration is the share of domestic consumption met by imports. Table 4B-9 presents trade statistics for each of the profiled chemical sectors. Both export dependence and import penetration have experienced modest positive trends in each of these sectors between 1989 and 1996. Globalization of the market has become a key factor influencing foreign competitiveness in the Inorganic Chemicals sector (SIC 281). In recent years import penetration has been increasing at a slightly higher rate than export dependence in this sector due to a strengthened U.S. dollar, weakness in the European and Japanese markets, and increased production in lower-cost developing nations (McGraw-Hill, 2000). Increased globalization has also been a dominant trend affecting trade statistics in the Plastics Material and Resins sector (SIC 2821). Imports and exports of plastics and resins have increased significantly over the past eight years reflecting the continued growth in the global market. Import penetration has grown more quickly than export dependence in this sector due to declining export opportunities and increased competition from imports driven by increased foreign capacity. The U.S. remained a net exporter of plastics and resins, despite these trends. The market for organic chemicals, particularly petrochemicals, has become increasingly competitive. Significant capacity expansions for petrochemicals worldwide have increased competition from imports and begun to limit export opportunities. Nevertheless, exports in Organic Chemicals (SIC 2865, 2869) remained slightly higher than imports between 1989 and 1996.

Table 4B-9: Trade Statistics for Profiled Chemical Sectors

Year	Value of imports (in millions, constant $2000)	Value of exports (in millions, constant $2000)	Value of shipments (in millions, constant $2000)	Implied Domestic Consumption[a]	Import Penetration[b]	Export Dependence[c]
(a)	(b)	(c)	(d)	(e)	(f)	(g)
Inorganic Chemicals, Except Pigments (SIC 2812, 2813, 2819)						
1989	5,107	5,798	26,306	25,615	20%	22%
1990	5,185	5,590	28,442	28,036	18%	20%
1991	5,145	5,993	28,164	27,316	19%	21%
1992	5,150	6,341	30,560	29,368	18%	21%
1993	4,973	5,938	30,214	29,249	17%	20%
1994	5,410	5,994	31,591	31,007	17%	19%
1995	5,650	6,226	30,623	30,047	19%	20%
1996	5,972	6,089	28,612	28,494	21%	21%
Total Percent Change 1989-1996	*16.9%*	*5.0%*	*8.8%*	*11.2%*		
Average Annual Growth Rate	*2.0%*	*0.6%*	*1.1%*	*1.3%*		
Plastics Materials and Resins (SIC 2821)						
1989	1,732	6,157	37,095	32,670	5%	17%
1990	2,133	7,376	36,895	31,651	7%	20%
1991	2,115	8,796	35,226	28,544	7%	25%
1992	2,570	8,735	39,023	32,859	8%	22%
1993	3,127	8,918	39,176	33,385	9%	23%
1994	3,914	10,055	44,511	38,370	10%	23%
1995	4,220	10,682	44,980	38,518	11%	24%
1996	4,586	11,627	44,037	36,996	12%	26%
Total Percent Change 1989-1996	164.8%	88.8%	18.7%	13.2%		
Average Annual Growth Rate	15.0%	10.0%	2.0%	2.0%		

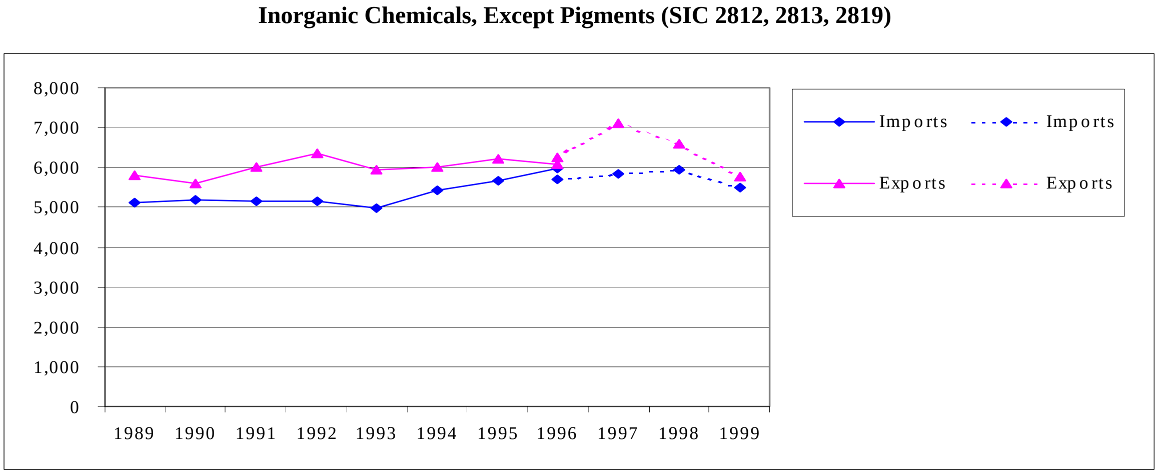
Table 4B-9: Trade Statistics for Profiled Chemical Sectors						
Year	**Value of imports (in millions, constant $2000)**	**Value of exports (in millions, constant $2000)**	**Value of shipments (in millions, constant $2000)**	**Implied Domestic Consumption[a]**	**Import Penetration[b]**	**Export Dependence[c]**
(a)	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**
Organic Chemicals, Except Gum & Wood (SIC 2865, 2869)						
1989	7,464	12,710	90,496	85,249	9%	14%
1990	8,108	12,654	91,856	87,309	9%	14%
1991	8,416	12,943	87,940	83,413	10%	15%
1992	9,307	12,954	89,251	85,605	11%	15%
1993	9,464	13,492	90,847	86,819	11%	15%
1994	11,004	15,747	97,130	92,387	12%	16%
1995	11,367	16,801	84,391	78,956	14%	20%
1996	12,344	15,190	80,719	77,872	16%	19%
Total Percent Change 1989-1996	*65.4%*	*19.5%*	*-10.8%*	*-8.7%*		
Average Annual Growth Rate	7.5%	2.6%	-1.6%	-1.3%		

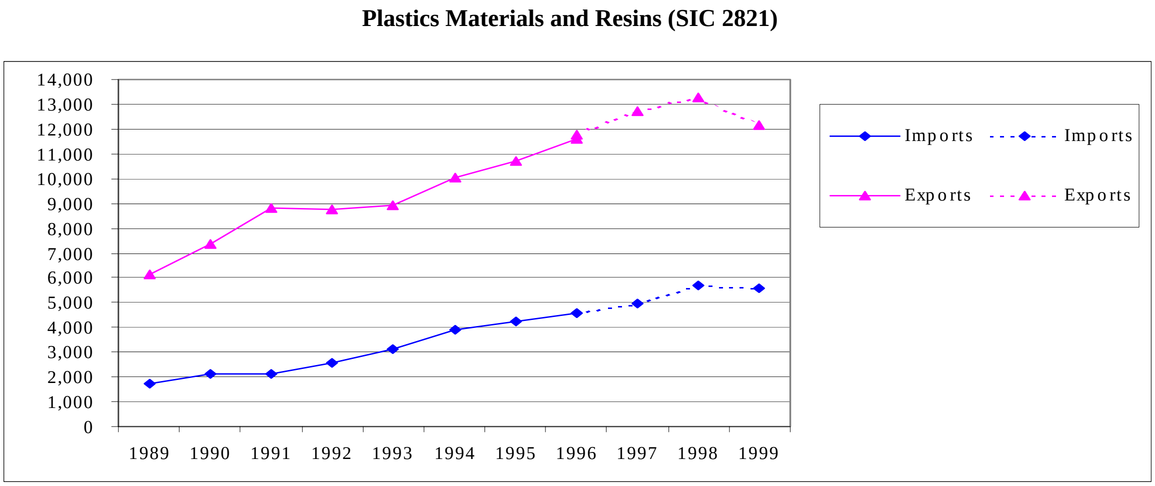
[a] Calculated by EPA as shipments + imports - exports.
[b] Calculated by EPA as imports divided by implied domestic consumption.
[c] Calculated by EPA as exports divided by shipments.

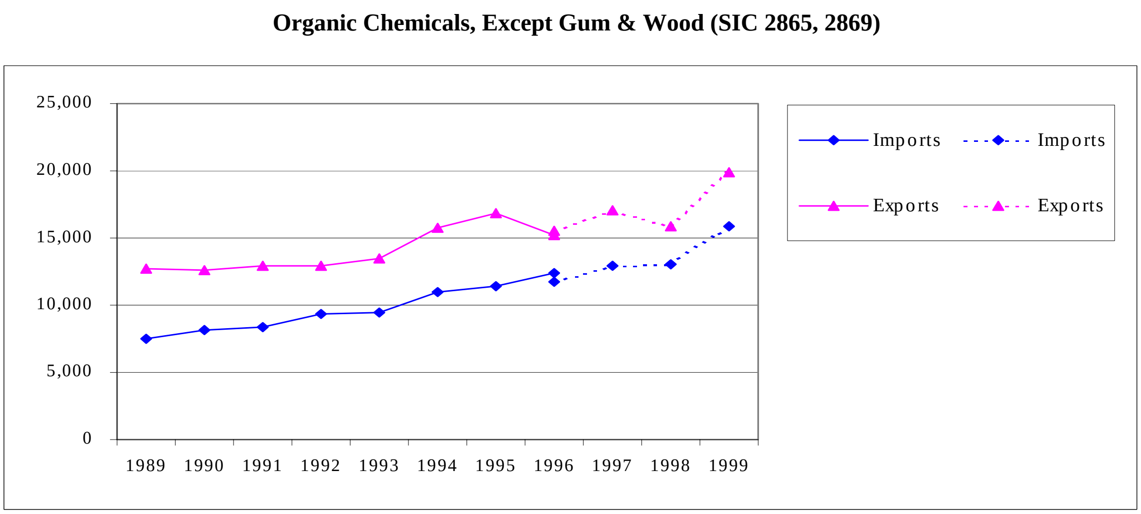
Source: U.S. DOC, 1997.

More recent export and import data shown in Figure 4B-7 show declines in the real value of both exports and imports of inorganic chemicals and plastics and resins in 1999. Exports and imports of organic chemicals rose in 1999. The chemicals industry experienced a decline in its trade balance in 2000, due to increased imports form Western Europe, encouraged by the strong U.S. dollar relative to the Euro, and growth in the petrochemical industry in the Middle East. Recent declines in the dollar relative to the Euro are expected to improve export performance, but declines in the global economy are resulting in mixed trade performance in 2001 (Chemical Market Reporter, 2001).

Figure 4B-7: Value of Imports and Exports for Profiled Chemical Sectors (in millions, constant $2000)







Source: U.S. DOC, 2000; U.S. DOC, 1997.

4B.3 Financial Condition and Performance

The chemical industry is generally characterized by large plant sizes and technologically complex production processes reflecting the economies of scale required to manufacture chemicals efficiently. Because of the high fixed costs associated with chemical manufacturing operations, larger production volumes are required to spread these costs over a greater number of units in order to maintain profitability. ***Operating margins*** for chemical producers are generally volatile due to rapid changes in selling prices, raw material costs, energy costs, and production levels. Other factors that affect margins for chemical producers include costs associated with businesses recently acquired or divested, major new capacity additions, or environmental costs (S&P, 2001).

Facing increased global competition, the U.S. chemical industry has restructured and reduced costs to maintain profitability and operating margins. Cost-cutting efforts in the early 1990s came largely from restructuring and downsizing, particularly in the Inorganic Chemicals sector. The industry has recently shifted toward consolidation as a means of paring costs by achieving production or marketing efficiencies while maintaining growth in maturing markets (S&P, 2001). These transactions are typically small scale involving individual product lines or facilities and are most common in the Organic Chemical and Plastics and Resins Industry sectors.

Table 4B-10 presents operating margins for each of the profiled chemical sectors between 1987 and 1997.

Table 4B-10: Operating Margins for Profiled Chemical Sectors (in millions, constant $2000)

Year	Value of Shipments	Cost of Materials	Payroll (all employees)	Operating Margin
Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)				
1987	26,306	11,335	4,083	41.4%
1988	28,442	12,102	4,175	42.8%
1989	28,164	11,485	4,042	44.9%
1990	30,560	12,754	4,375	43.9%
1991	30,214	12,397	4,617	43.7%
1992	31,591	12,428	4,850	45.3%
1993	30,623	12,306	4,506	45.1%
1994	28,612	11,380	4,222	45.5%
1995	27,913	1,108	3,817	46.9%
1996	27,223	11,097	3,675	45.7%
1997	28,593	11,144	3,784	47.8%
Plastics Material and Resins (SIC 2821)				
1987	36,668	21,530	2,802	33.6%
1988	36,637	22,059	2,476	33.0%
1989	37,095	22,635	2,658	31.8%
1990	36,895	22,838	2,928	30.2%
1991	35,226	22,153	2,955	28.7%
1992	39,023	23,485	3,330	31.3%
1993	39,176	24,217	3,476	29.3%
1994	44,511	26,363	3,741	32.4%
1995	44,902	27,109	3,422	32.0%
1996	44,037	27,269	3,146	30.9%
1997	47,587	29,794	3,346	30.4%
Organic Chemicals (SIC 2865, 2869)				
1988	88,009	49,088	6,777	36.5%
1989	90,496	50,166	6,649	37.2%
1990	91,856	52,098	7,219	35.4%
1991	87,940	51,527	7,382	33.0%
1992	89,251	53,169	7,564	32.0%
1993	90,847	52,858	7,847	33.2%
1994	97,130	56,191	7,722	34.2%
1995	84,607	47,402	6,497	36.3%
1996	80,719	50,203	7,199	28.9%
1997	90,811	51,430	1,975	35.7%

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

4B.4 Facilities Operating Cooling Water Intake Structures

In 1982, the Chemical and Allied Products industry withdrew 2,797 billion gallons of cooling water, accounting for approximately 3.6 percent of total industrial cooling water intake in the United States. The industry ranked 2nd in industrial cooling water use behind the electric power generation industry (1982 Census of Manufactures).

This section presents information from EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* on existing facilities with the following characteristics:

- they withdraw from a water of the United States;
- they hold an NPDES permit;
- they have a design intake flow of equal to or greater than two MGD;
- they use at least 25 percent of that flow for cooling purposes.

These facilities are not "new facilities" as defined by the proposed section 316(b) New Facility Rule and are therefore not subject to this regulation. However, they meet the criteria of the proposed rule except that they are already in operation. These existing facilities therefore provide a good indication of what new facilities in these sectors may look like. The remainder of this section refers to existing facilities with the above characteristics as "section 316(b) facilities."

a. Cooling water uses and systems

Information collected in the Detailed Questionnaire found that an estimated 61 out of 435 inorganic chemical facilities (14 percent), 15 out of 305 plastics facilities (5 percent), and 52 out of 427 organic chemical facilities (12 percent) meet the characteristics of a section 316(b) facility. Most section 316(b) facilities in the profiled Chemical and Allied Products sectors use cooling water for contact and non-contact production line or process cooling, electricity generation, and air conditioning:

- Ninety-eight percent (60 facilities) of section 316(b) *inorganic chemical* facilities use cooling water for production line (or process) contact or noncontact cooling. The two other major uses of cooling water are electricity generation and air conditioning, at 28 and 23 percent of facilities, respectively.

- All section 316(b) *plastics* facilities use cooling water for production line (or process) contact or noncontact cooling. Sixty-seven and 40 percent of facilities use cooling water for air conditioning and other uses, respectively. None of the section 316(b) plastics facilities use cooling water for electricity generation.

- All fifty-two section 316(b) *organic chemicals* facilities use cooling water for production line (or process) contact or noncontact cooling. Twenty-three percent (12 facilities) use cooling water for air conditioning, and 6 percent (3 facilities) use cooling water for electricity generation.

Table 4B-11 shows the distribution of existing section 316(b) facilities in the profiled chemical sectors by type of water body and cooling system. The table shows that most of the existing section 316(b) facilities have either a once-through system (65, or 51 percent) or employ a combination of a once through and a recirculating system (28, or 22 percent). The majority of existing facilities draw water from a freshwater stream or river (99, or 77 percent). All 316(b) in the three profiled chemical sectors that withdraw water from an ocean have a once though cooling system, while all facilities withdrawing from a lake or reservoir employ a combination of a once-through and a recirculating system.

Table 4B-11: Number of Section 316(b) Facilities by Water Body and Cooling System Type for Profiled Chemical Sectors

Water Body Type	Cooling System										
	Recirculating		Once-Through		Combination		None		Other		Total
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	
Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)											
Estuary or Tidal River	0	0%	4	31%	9	69%	0	0%	0	0%	13
Estuary or Tidal River & Lake or Reservoir	0	0%	1	100%	0	0%	0	0%	0	0%	1
Freshwater Stream or River	9	26%	21	62%	0	0%	0	0%	4	12%	34
Lake or Reservoir	0	0%	0	0%	4	100%	0	0%	0	0%	4
Ocean	0	0%	9	100%	0	0%	0	0%	0	0%	9
Total[a]	***9***	***15%***	***35***	***57%***	***13***	***21%***	***0***	***0%***	***4***	***7%***	***61***
Plastics Material and Resins (SIC 2821)											
Freshwater Stream or River	0	0%	0	0%	9	69%	4	31%	0	0%	13
Lake or Reservoir	0	0%	0	0%	2	100%	0	0%	0	0%	2
Total[a]	***0***	***0%***	***0***	***0%***	***11***	***73%***	***4***	***27%***	***0***	***0%***	***15***
Organic Chemicals (SIC 2865, 2869)											
Freshwater Stream or River	9	17%	30	58%	4	8%	0	0%	9	17%	52
Total[a]	***9***	***17%***	***30***	***58%***	***4***	***8%***	***0***	***0%***	***9***	***17%***	***52***
Total for Profiled Chemical Facilities (SIC 28)											
Estuary or Tidal River	0	0%	4	31%	9	69%	0	0%	0	0%	13
Estuary or Tidal River & Lake or Reservoir	0	0%	1	100%	0	0%	0	0%	0	0%	1
Freshwater Stream or River	18	18%	51	52%	13	13%	4	4%	13	13%	99
Lake or Reservoir	0	0%	0	0%	6	100%	0	0%	0	0%	6
Ocean	0	0%	9	100%	0	0%	0	0%	0	0%	9
Total[a]	**18**	**14%**	**65**	**51%**	**28**	**22%**	**4**	**3%**	**13**	**10%**	**128**

[a] Individual numbers may not add up to total due to independent rounding.

Source: U.S. EPA, 2000.

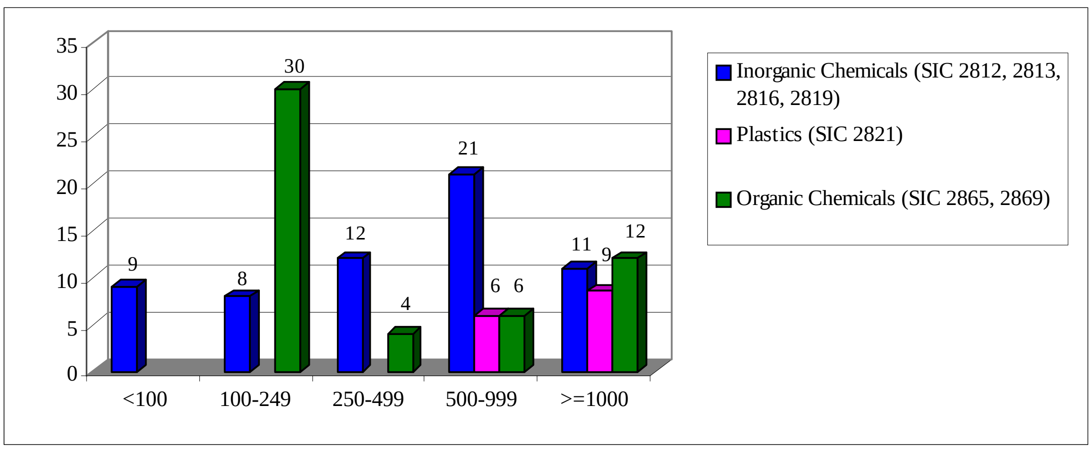
b. Facility size

Chemical facilities that withdraw more than two MGD from a water of the U.S., hold an NPDES permit, and use at least 25 percent of intake water for cooling purposes are generally larger than facilities that do not meet these criteria:

- Fifty-two percent of the section 316(b) facilities in the Inorganic Chemicals sector have greater than 500 employees, while 28 percent of these facilities employ less than 100 employees.
- All of section 316(b) plastics facilities employ at least 500 employees, and 60 percent employ over 1,000 employees.
- All section 316(b) organic chemical facilities employ more than 100 employees, and the largest number (30, or 58 percent) of facilities are in the employment size category of 100 to 259 employees. Thirty-five percent of the section 316(b) organic chemical facilities employ more than 500 employees.

Figure 4B-8 shows the number of section 316(b) facilities in the profiled chemical sectors by employment size category.

Figure 4B-8: Number of Section 316(b) Facilities by Employment Size Category for Profiled Chemical Sectors



Source: U.S. EPA, 2000.

c. Firm size

EPA used the Small Business Administration (SBA) small entity size standards to determine the number of existing section 316(b) facilities in the three profiled chemical sectors that are owned by small firms. Firms in the Inorganic Chemicals sector (SIC codes 2812, 2813, 2816, 2819) and in Industrial Organic Chemicals, NEC (SIC code 2869) are defined as small if they have 1,000 or fewer employees; firms in Plastics Material and Resins (SIC 2821) and Cyclic Organic Crudes and Intermediates (SIC code 2865) are defined as small if they have 750 or fewer employees.

Table 4B-12 shows that, of the 61 section 316(b) facilities in the Inorganic Chemicals sector, four, or 7 percent, are owned by a small firm. All four of these firms are in SIC 2816. None of the 15 section 316(b) facilities in the Plastics sector are owned by a small firm. Ninety-two percent of the section 316(b) facilities in the Organic Chemicals sector are classified as large. SIC 2869 accounts for all of the facilities owned by small firms in the Organic Chemicals sector. Overall, the profiled chemicals sector has 120 facilities (94 percent) owned by large firms, and 8 facilities (8 percent) owned by small firms.

Table 4B-12: Number of Section 316(b) Facilities by Firm Size for Profiled Chemical Sectors

SIC Code	Large		Small		Total
	No.	% of SIC	No.	% of SIC	
Inorganic Chemicals (SIC 2812, 2813, 2816, 2819)					
2812	20	100%	0	0%	20
2813	4	100%	0	0%	4
2816	0	0%	4	100%	4
2819	33	100%	0	0%	33
Total	***57***	***93%***	***4***	***7%***	***61***
Plastics Material and Resins (SIC 2821)					
2821	15	100%	0	0%	15
Organic Chemicals (SIC 2865, 2869)					
2865	4	100%	0	0%	4
2869	44	91%	4	9%	48
Total	***48***	***92%***	***4***	***8%***	***52***
Total for Profiled Chemical Facilities (SIC 28)					
Total	**120**	**94%**	**8**	**6%**	**128**

Source: U.S. EPA, 2000; D&B, 2001.

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4C PETROLEUM AND COAL PRODUCTS (SIC 29)

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified one 4-digit SIC code in the Petroleum and Coal Products Industry (SIC 29) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws equal to or greater than two million gallons per day (MGD) from a water of the United States, and uses at least 25 percent of its intake flow for cooling purposes. (Facilities with these characteristics are hereafter referred to as "section 316(b) facilities"). Table 4C-1 below provides a description of the industry sector, a list of primary products manufactured, the total number of detailed questionnaire respondents (weighted to represent national results), and the number and percent of section 316(b) facilities.

Table 4C-1: Section 316(b) Facilities in the Petroleum and Coal Products Industry (SIC 29)

SIC	SIC Description	Important Products Manufactured	Number of Weighted Detailed Questionnaire Survey Respondents		
			Total	Section 316(b) Facilities	
				No.	%
2911	Petroleum Refining	Gasoline, kerosene, distillate fuel oils, residual fuel oils, and lubricants, through fractionation or straight distillation of crude oil, redistillation of unfinished petroleum derivatives, cracking, or other processes; aliphatic and aromatic chemicals as byproducts	163	31	19.2%

Source: U.S. EPA, 2000; Executive Office of the President, 1987.

4C.1 Domestic Production

The petroleum refining industry accounts for about 4 percent of the value of shipments of the U.S. entire manufacturing sector and for 0.4 percent of the manufacturing sector's employment (U.S. DOE, 1999a). According to the Economic Census, petroleum refineries had a real value of shipments of approximately $212 billion dollars ($2000) and employed 64,789 people in 1997. Petroleum products contribute approximately 40 percent of the total energy used in the United States, including virtually all of the energy consumed in transportation (U.S. DOE, 1999a).

U.S. DOE Energy Information Administration (EIA) data report that there were 155 operable petroleum refineries in the U.S. as of January 2001, of which 150 were operating and five were idle (U.S. DOE, 2000a).[1] Some data reported in this profile are taken from EIA publications. Readers should note that the Census data reported for SIC 2911 cover a somewhat broader range of facilities than do the U.S. DOE/EIA data, and the two data sources are therefore not entirely comparable.[2]

The petroleum industry includes exploration and production of crude oil, refining, transportation, and marketing. Petroleum refining is a capital-intensive production process that converts crude oil into a variety of refined products. Refineries range in complexity, depending on the types of products produced. Nearly half of all U.S. refinery output is motor gasoline.

The number of U.S. refineries has declined by almost half since the early 1980s. The remaining refineries have improved

[1] In addition, there are three idle refineries in Puerto Rico and one operating refinery in the Virgin Islands.

[2] For comparison, preliminary 1997 Census data included 244 establishments for NAICS 3241/SIC 2911, whereas U.S. DOE/EIA reported 164 operable refineries as of January 1997.

their efficiency and flexibility to process heavier crude oils by adding "downstream" capacity.[3] While the number of refineries has declined, the average refinery capacity and utilization has increased, resulting in an increase in domestic refinery production overall.

a. Output

Table 4C-2 shows trends in production of petroleum refinery products from 1990 through 2000. In general, production of refined products has grown over this period, reflecting growth in transportation demand and other end-uses. There was a reduction in output due to the domestic economic recession in 1991.

Table 4C-2: Petroleum Refinery Product Production (million barrels per day)

Year	Motor Gasoline	Distillate Fuel Oil	Jet Fuel	Residual Fuel Oil	Other Products[a]	Total Output	Percent change
1990	6.96	2.92	1.49	0.95	2.95	15.27	n/a
1991	6.98	2.96	1.44	0.93	2.95	15.26	-0.1%
1992	7.06	2.97	1.40	0.89	3.08	15.40	0.9%
1993	7.30	3.13	1.42	0.84	3.10	15.79	2.5%
1994	7.18	3.20	1.45	0.83	3.13	15.79	0.0%
1995	7.48	3.16	1.42	0.79	3.14	15.99	1.3%
1996	7.56	3.32	1.52	0.73	3.19	16.32	2.1%
1997	7.74	3.39	1.55	0.71	3.37	16.76	2.7%
1998	7.89	3.42	1.53	0.76	3.43	17.03	1.6%
1999	7.93	3.40	1.57	0.70	3.39	16.99	-0.2%
2000	7.95	3.58	1.61	0.71	3.40	17.25	1.5%
Total Percent Change 1990-2000	*14.2%*	*22.6%*	*8.1%*	*-25.3%*	*15.3%*	*13.0%*	
Average Annual Growth Rate	*1.3%*	*2.1%*	*0.8%*	*-2.9%*	*1.4%*	*1.2%*	
Jan-July 2000[b]	8.17	3.50	1.59	0.67			
Jan-July 2001[b]	8.27	3.65	1.56	0.73			
Percent change	*1.2%*	*4.3%*	*-1.9%*	*9.0%*			

[a] Includes asphalt and road oil, liquified petroleum gases, petroleum coke, still gas, kerosene, petrochemical feedstocks, lubricants, wax, aviation gasoline, special napthas, and miscellaneous products.
[b] Monthly data for motor gasoline production include blending of fuel ethanol and an adjustment to correct for the imbalance of motor gasoline blending components.

Source: U.S. DOE, 2000b; U.S. DOE, 2001.

[3] The first step in refining is atmospheric distillation, which uses heat to separate various hydrocarbon components in crude oil. Beyond this basic step are more complex operations (generally referred to as "downstream" from the initial distillation) that increase the refinery's capacity to process a wide range of crude oils and increase the yield of lighter (low-boiling point) products such as gasoline. These downstream operations include vacuum distillation, cracking units, reforming units, and other processes (U.S. DOE, 1999a).

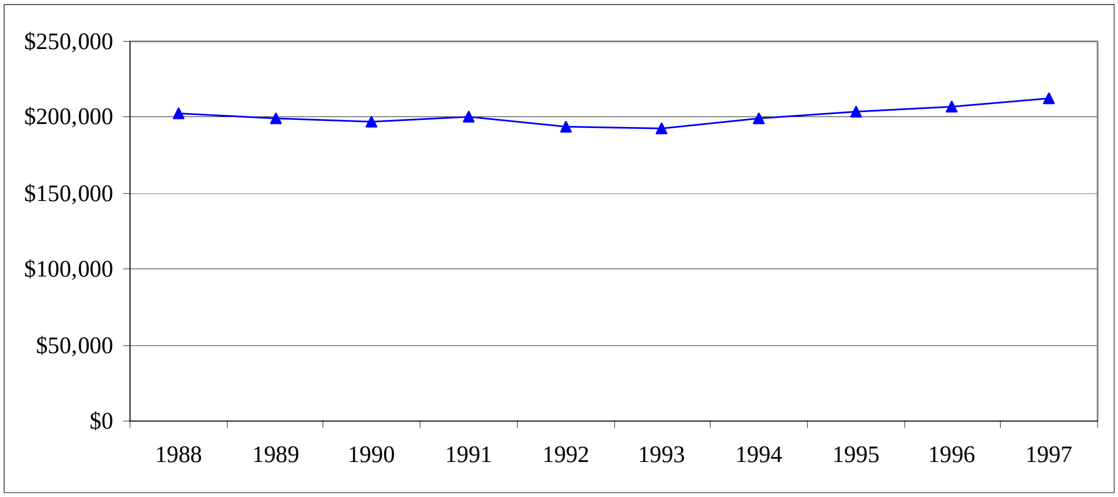
Value of shipments and ***value added*** are the two most common measures of manufacturing output.[4] These historical trends provide insight into the overall economic health and outlook for an industry. Value of shipments is the sum of the receipts a manufacturer earns from the sale of its outputs. It is an indicator of the overall size of a market or the size of a firm in relation to its market or competitors. Value added is used to measure the value of production activity in a particular industry. It is the difference between the value of shipments and the value of inputs used to make the products sold.

Nominal value of shipments and value added for petroleum refineries increased by 4 and 13 percent, respectively, from 1988 to 1997. Adjusted for changes in petroleum product prices (by the producer price index for SIC 2911), real value of shipments was fairly constant over this period, despite a decline in the number of operating refineries (see Figure 4C-1). Real value added for SIC 2911 declined from 1988 until 1990 and remained relatively stable through 1993. Between 1993 and 1997, there were significant gains with a decline in 1996.

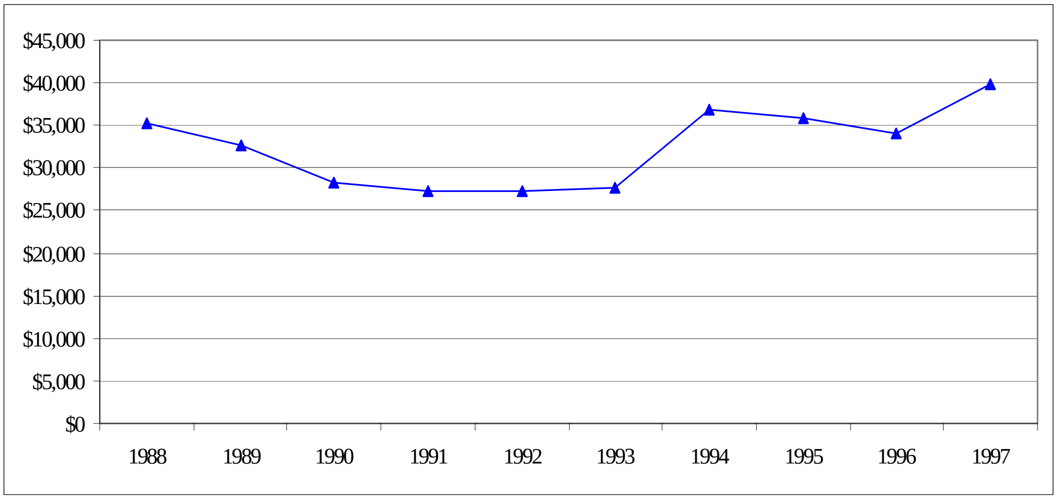
[4] Terms highlighted in bold and italic font are further explained in the glossary.

Figure 4C-1: Value of Shipments and Value Added for Petroleum Refineries (in millions, constant $2000)

Value of Shipments



Value Added



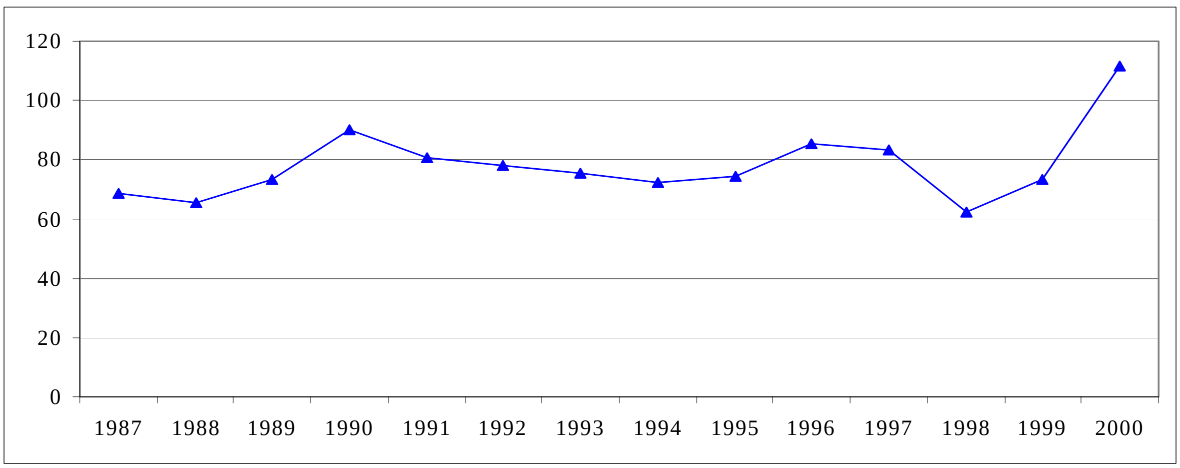
Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

b. Prices

Figure 4C-2 shows the ***producer price index*** (PPI) for the Petroleum Refinery sector. The PPI is a family of indexes that measure price changes from the perspective of the seller. This profile uses the PPI to inflate nominal monetary values to constant dollars.

The PPI for refined petroleum products showed substantial fluctuations in petroleum product prices between 1987 and 1998, with a strong upward trend between 1998 and 2000, as shown in Figure 4C-2. Higher prices through 2000 reflect low refinery product inventories and higher crude oil input prices (Value Line, 2001). Subsequent reductions in crude oil prices and slackening demand due to a slowing economy are likely to result in some reduction in prices, however.

Figure 4C-2: Producer Price Index for Petroleum Refineries

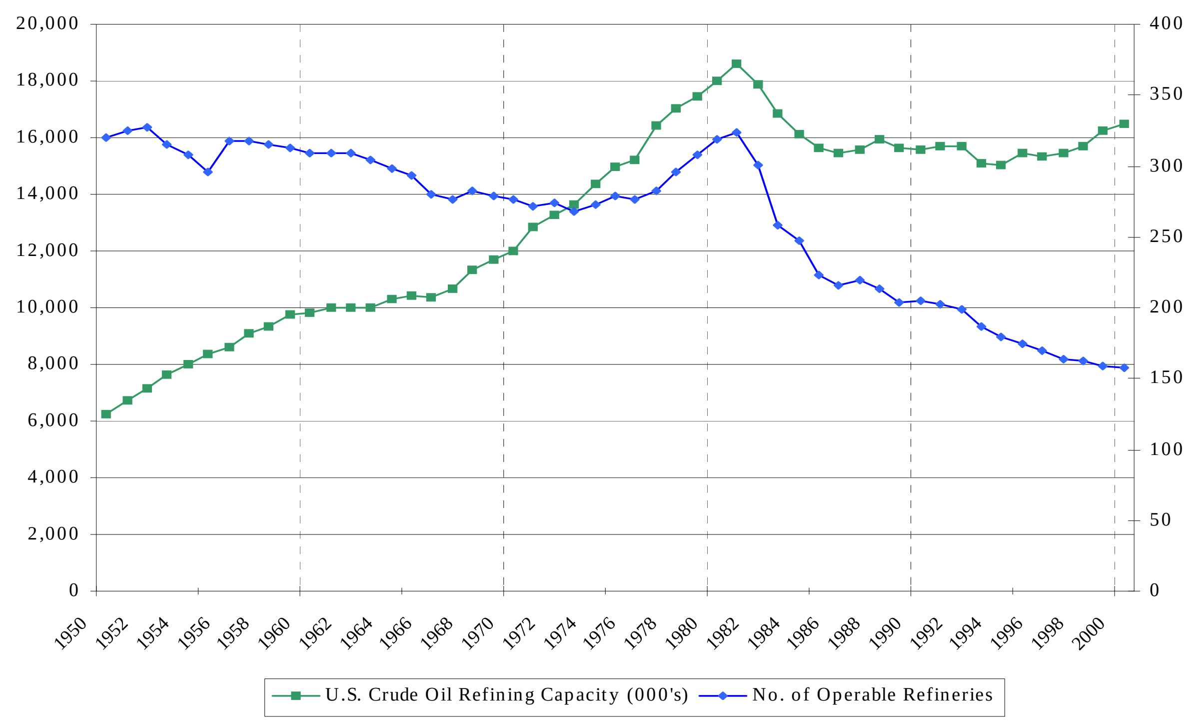


Source: BLS, 2000.

c. Number of facilities and firms

Figure 4C-3 shows historical trends in the numbers of refineries and refinery capacity. This figure shows that the number of operable refineries fell substantially between 1980 and 1999. This decrease resulted in part from the elimination of the Crude Oil Entitlements Program in the early 1980s. The Entitlements Program encouraged smaller refineries to add capacity throughout the 1970s. After the program was eliminated, surplus capacity and falling profit margins led to the closure of the least efficient capacity (U.S. DOE, 1999a). The decrease in the number of refineries has continued, as the industry has consolidated to improve margins. After peaking in the early 1980's, refining capacity decreased throughout the rest of the decade. Refining capacity has remained relatively stable since the decrease in the 1980's, with a slight upward trend in the past five years. This trend is expected to continue, with no new "greenfield" refineries likely to be built in the U.S., but continuing capacity expansion at existing facilities (S&P 2001).

Figure 4C-3: Trends in Numbers of Refineries and Refining Capacity 1949-2000



Source: U.S. DOE, 2000a.

Data from the Statistics of U.S. Businesses for SIC 2911 (Table 4C-3) shows that the number of firms reporting petroleum refining as their primary business has also declined since 1990.

Table 4C-3: Number of Firms and Facilities for Petroleum Refineries (SIC 2911)

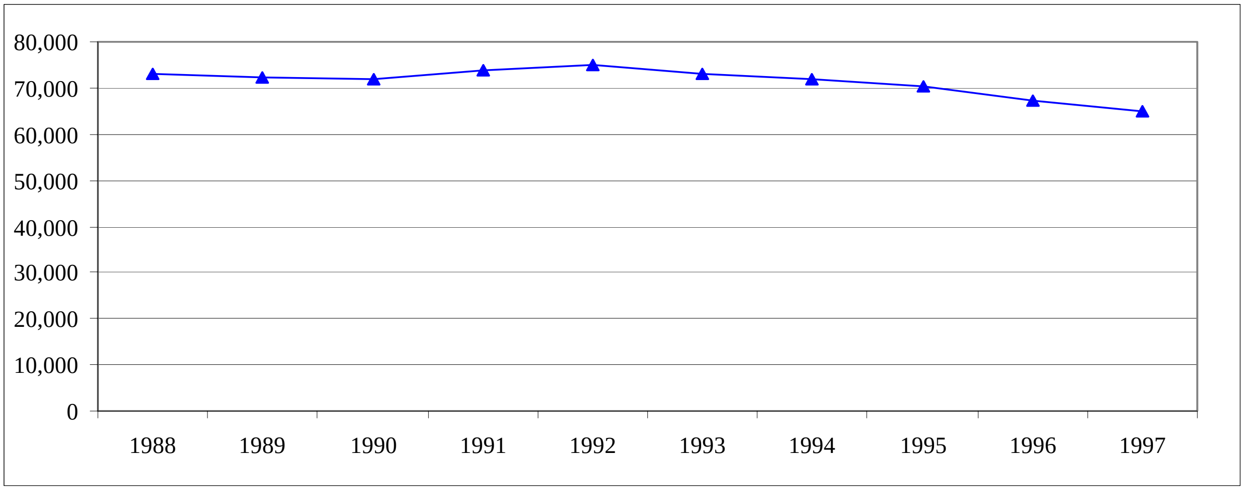
Year	Firms		Facilities	
	Number	Percent Change	Number	Percent Change
1990	215	n/a	340	n/a
1991	215	0%	346	2%
1992	185	-14%	303	-12%
1993	148	-20%	251	-17%
1994	161	9%	265	6%
1995	150	-7%	251	-5%
1996	173	15%	275	10%
1997	128	-26%	248	-10%
Total Percent Change 1990 - 1997	-40.5%		-27.1%	
Average Annual Growth Rate	-7.1%		-4.4%	

Source: U.S. SBA, 2000.

d. Employment and productivity

Employment levels in the petroleum refining industry declined by 13 percent between 1988 and 1997, from 73,200 to 64,789 employees, as shown in Figure 4C-4. After increasing in the early 1990s, employment at petroleum refineries has declined since 1992, reflecting overall industry consolidation.

Figure 4C-4: Employment for Petroleum Refineries (SIC 2911)



Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

Table 4C-4 shows substantial year-to-year changes in productivity, measured by real value added per production hour. These fluctuations reflect volatility in real value added, which in turn reflect variations in the relationship between input prices (primarily crude oil) and refinery product prices. Changes in production hours from year to year have been less volatile, but how a net reduction over the period 1988 to 1997, resulting in a small growth in real value added per production hour over that period.

Table 4C-4: Productivity Trends for Petroleum Refineries (SIC 2911)

Year	Production Hours (millions)	Value Added (in millions, constant $2000)	Real Value Added/Hour (in millions, constant $2000)	Growth Rates		
				Production Hours	Value Added	Real Value Added/Hour
1988	103	$35,302	343	n/a	n/a	n/a
1989	105	$32,722	313	1.6%	-7.3%	-8.7%
1990	106	$28,268	267	1.1%	-13.6%	-14.7%
1991	107	$27,308	256	0.7%	-3.4%	-4.1%
1992	109	$27,224	249	2.6%	-0.3%	-2.7%
1993	107	$27,767	261	-2.6%	2.0%	4.8%
1994	110	$36,796	335	3.3%	32.5%	28.4%
1995	107	$39,320	337	-2.4%	6.9%	0.6%
1996	103	$34,024	332	-4.5%	-13.5%	-1.5%
1997	100	$39,869	398	-2.3%	17.2%	19.9%
Total Percent Change 1988-1997	*-2.7%*	*12.9%*	*16.0%*			
Annual Average Growth Rate	*-0.3%*	*1.4%*	*1.7%*			

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, 1997.

e. Capital expenditures

Petroleum industry capital expenditures increased substantially between 1988 and 1993, and decreased between 1993 and 1997, as shown in Table 4C-5. In 1997 the industry spent $5.7 billion in constant 2000 dollars, as compared with $3.9 billion ($2000) in 1988. In the early 1990's, capital expenditures peaked at over $8 billion per year in real terms. Much recent investment in petroleum refineries has been to expand and de-bottleneck units downstream from distillation, partially in response to environmental requirements. Changes in refinery configurations have included adding catalytic cracking units, installing additional sulfur removal hydrotreaters, and using manufacturing additives such as oxygenates. These process changes have resulted from two factors:

- processing of heavier crudes with higher levels of sulfur and metals; and
- regulations requiring gasoline reformulation to reduce volatiles in gasoline and production of diesel fuels with reduced sulfur content (U.S. EPA, 1996b).

Environmentally-related investments have also accounted for a substantial portion of capital expenditures. Substantial capital investments by refineries will be required in the future, to comply with product quality regulations, including EPA's Tier 2 Gasoline Sulfur Rule requiring reductions in the sulfur content of gasoline; reductions or elimination of the use of MTBE in gasoline; and proposed sulfur reductions in highway diesel fuel (NPC, 2000).

Table 4C-5: Capital Expenditures for Petroleum Refineries (SIC 2911)

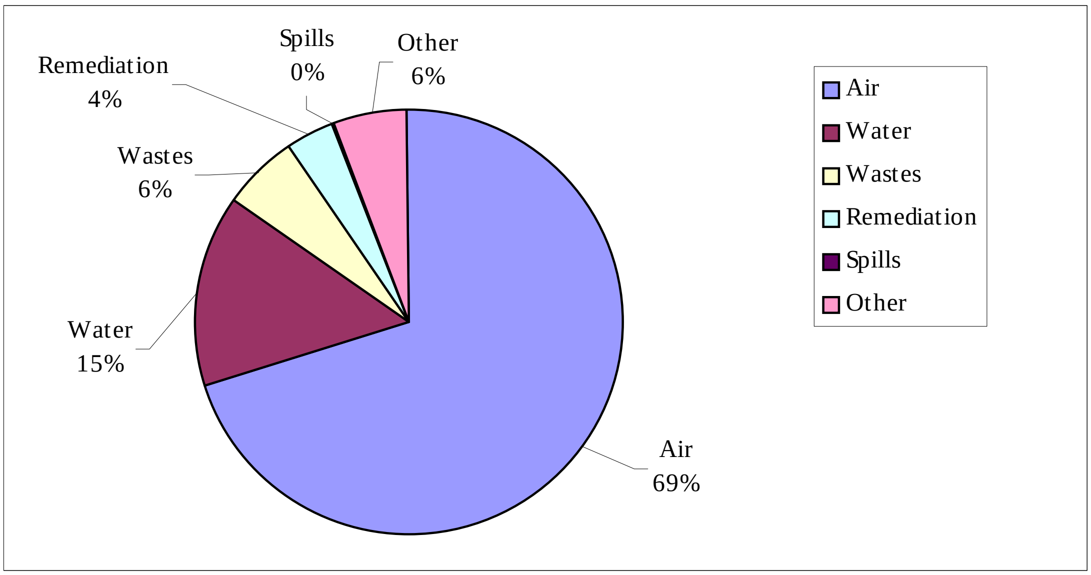
Year	Capital Expenditures (in millions, constant $2000)
1988	3,970
1989	4,529
1990	4,730
1991	7,726
1992	8,751
1993	8,883
1994	8,539
1995	8,788
1996	6,799
1997	5,704

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

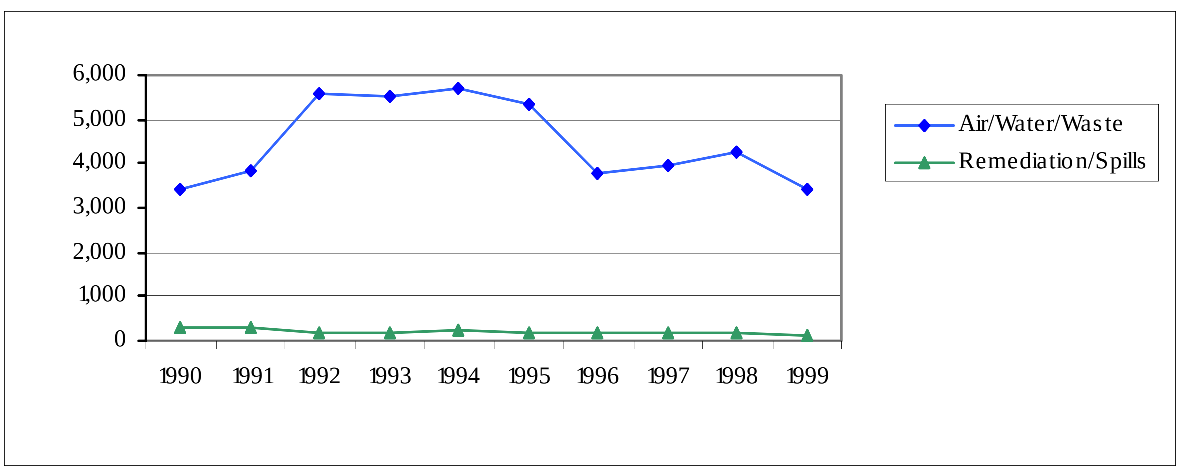
Figure 4C-5 shows pollution control expenditures (capital plus operating costs) reported by American Petroleum Institute (API) members. Expenditures to control current environmental releases (air, water and waste) account for the largest portion of total pollution control expenditures. Of the total 1999 environmental expenditures to address air, water, and waste pollution from on-going operations, 31 percent (1.8 million) was capital expenditures and 68 percent (4 million) was operating maintenance.

Figure 4C-5: Environmental Expenditures by Type and Medium for Petroleum Refineries (SIC 2911)

Environmental Expenditures by Individual Type, 1999



Refining Expenditures by Aggregated Types (in millions)



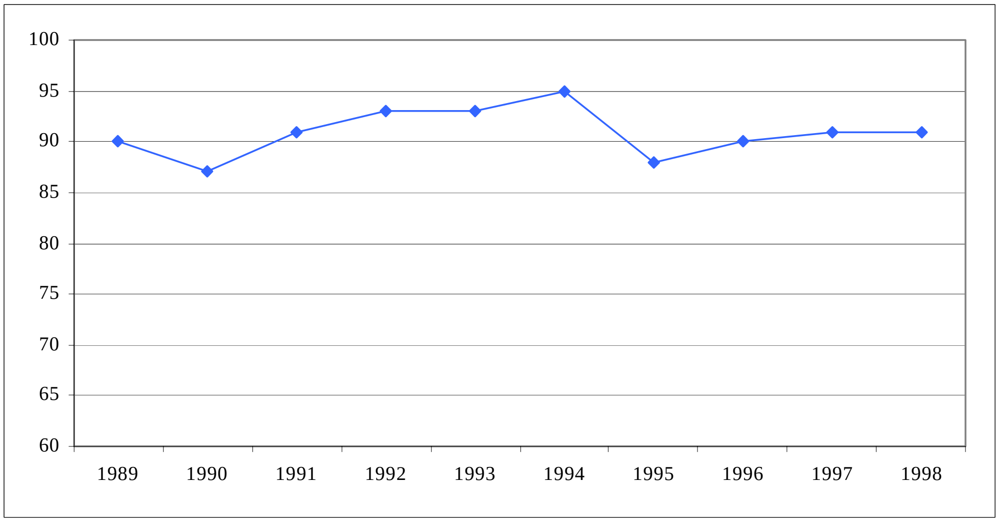
Source: American Petroleum Institute, 2001.

f. Capacity utilization

The most commonly-used measure of refinery capacity is expressed in terms of crude oil distillation capacity. EIA defines refinery capacity utilization as input divided by calendar day capacity. Calendar day capacity is the maximum amount of crude oil input that can be processed during a 24-hour period with certain limitations. Some downstream refinery capacities are measured in terms of "stream days," which is the amount a unit can process running full capacity under optimal crude and product mix conditions for 24 hours (U.S. DOE, 1999a). Downstream capacities are reported only for specific units or products, and are not summed across products, since not all products could be produced at the reported levels simultaneously.

As reported by the Census Bureau, Figure 4C-6 below shows the increase in overall capacity utilization in the petroleum industry from 1990 to 1994. After declining between 1994 and 1995, the capacity utilization gradually increased until 1998. Overall refinery utilization has remained high over this entire time period. Utilization of specific portions of refinery capacities may vary, however, as the industry adjusts to changes in the desired product mix and characteristics.

Figure 4C-6: Capacity Utilization Rates (Fourth Quarter) for Petroleum Refineries (SIC 2911)



Source: U.S. DOC, 1989-1998.

Standard & Poor's reports that utilization rates remained over 90 percent in 2000, as refineries appeared to operate on a "just-in-time" system to reduce costs, resulting in low refinery product inventories. High demand combined with low inventories has kept operating rates high (S&P 2001).

4C.2 Structure and Competitiveness

The petroleum refining industry in the United States is made up of integrated international oil companies, integrated domestic oil companies, and independent domestic refining/marketing companies. In general, the petroleum industry is highly integrated, with many firms involved in more than one sector. Large companies, referred to as the "majors," are fully integrated across crude oil exploration and production, refining, and marketing. Smaller, nonintegrated companies, referred to as the "independents," generally specialize in one sector of the industry.

Like the oil business in general, refining has been dominated in the 1990s by integrated internationals, specifically a few large companies such as Exxon Corporation, Mobil Corporation,[5] and Chevron Corporation. These three ranked in the top ten of Fortune's 500 sales ranking during this time period. Substantial diversification by major petroleum companies into other energy and non-energy sectors was financed by high oil prices in the 1970s and 1980s. With lower profitability in the 1990s, the major producers began to exit nonconventional energy operations (e.g., oil shale) as well as coal and non-energy operations in the 1990s. Some have recently ceased chemical production.

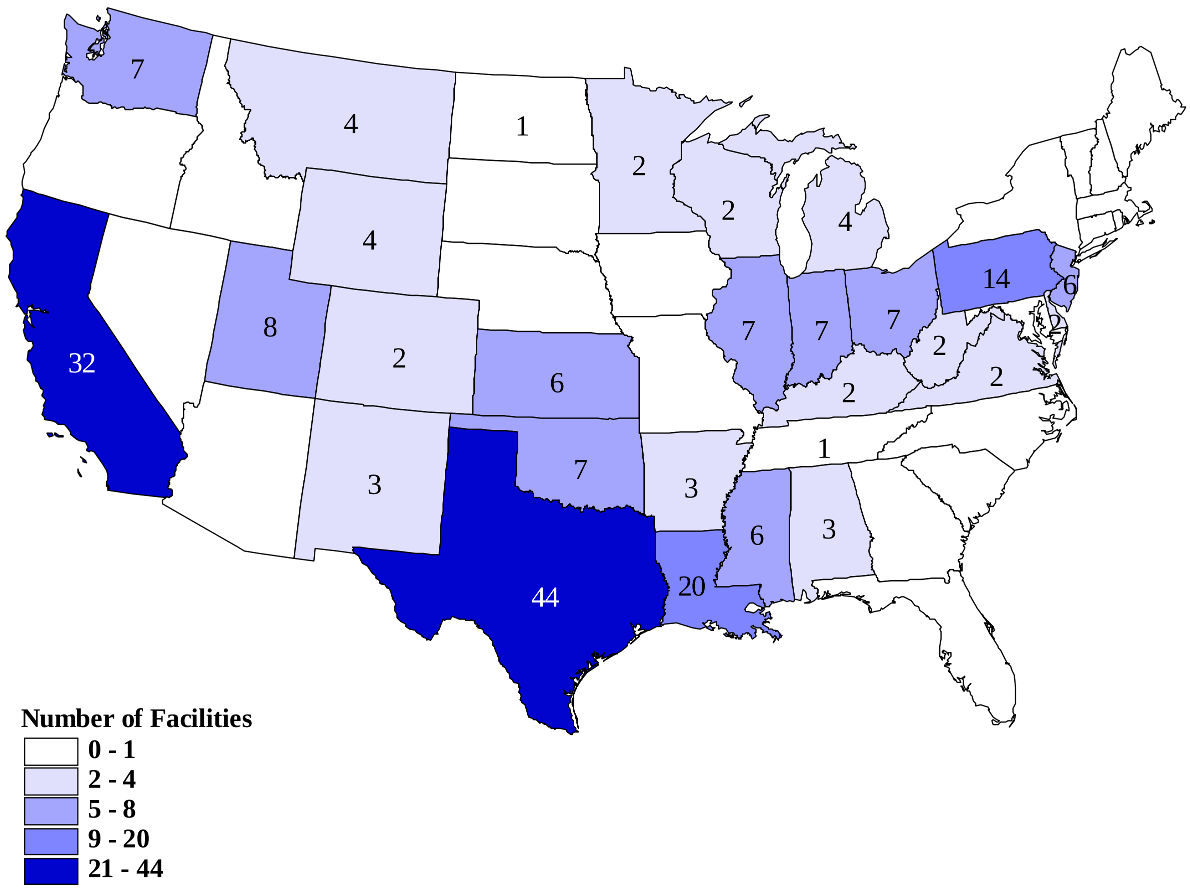
During the 1990s, several mergers, acquisitions, and joint ventures occurred in the petroleum refining industry in an effort to cut cost and increase profitability. This consolidation has taken place among the largest firms (as illustrated by the acquisition of Amoco Corporation by the British Petroleum and the mega-merger of Exxon and Mobil Corporation) as well as among independent refiners and marketers (e.g., the independent refiner/marketer Ultramar Diamond Shamrock (UDS) acquired Total Petroleum North America in 1997) (U.S. DOE, 1999b). BP Amoco recently announced a deal to sell its 250,000 barrel per day Alliance refinery in Louisiana to the leading U.S. independent refining and marketing company Tosco Corp.

[5] Exxon and Mobil Corporations have recently merged into one company.

a. Geographic distribution

Petroleum refining facilities are concentrated in areas near crude oil sources and near consumers. The cost of transporting crude oil feed stocks and finished products is an important influence on the location of refineries. Most petroleum refineries are located along the Gulf Coast and near the heavily industrialized areas of both the east and west coasts (U.S. DOE, 1997). Figure 4C-7 below shows the distribution of U.S. petroleum refineries. In 1992, there were 44 refineries in Texas, 32 in California, and 20 in Louisiana, accounting for 43 percent of all facilities in SIC 2911 in the United States.

Figure 4C-7: Geographic Distribution of Petroleum Refineries (SIC 2911)

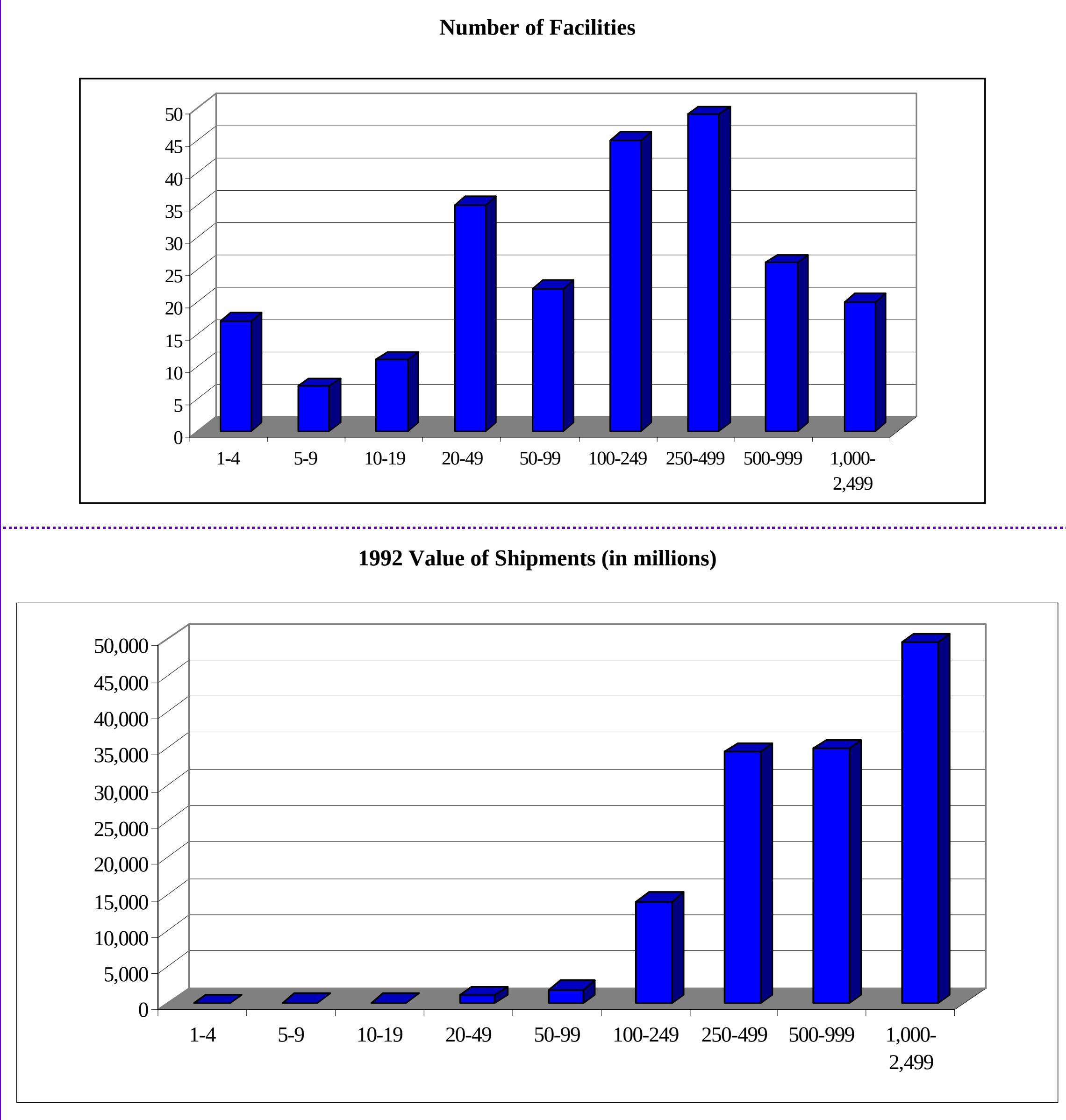


Source: U.S. DOC, 1987, 1992, and 1997.

b. Establishment size

A substantial portion of the facilities in SIC 2911 are large facilities, with 41 percent having 250 or more employees. Figure 4C-8 shows that approximately 87 percent of the value of shipments for the industry is produced by the 41 percent of establishments with more than 250 employees. Establishments with more than 1,000 employees are responsible for approximately 36 percent of all industry shipments.

Figure 4C-8: Value of Shipments and Number of Facilities for Petroleum Refineries by Employment Size Category (SIC 2911)



Source: U.S. DOC, 1987, 1992, and 1997.

c. Firm size

The Small Business Administration defines a small firm for SIC 2911 as a firm with 1,500 or fewer employees. The size categories reported in the Statistics of U.S. Businesses (SUSB) do not correspond with the SBA size classifications. It is therefore not possible to apply the SBA size threshold precisely. Table 4C-6 below shows the distribution of firms, establishments, and receipts in SIC 2911 by the employment size of the parent firm. The SUSB data show that 165 of the 248 SIC 2911 establishments reported for 1997 (67 percent) are owned by larger firms (those with 500 employees or more), some of which may be defined as small under the SBA definition, and 83 (33 percent) are owned by small firms (those with fewer than 500 employees).

Table 4C-6: Number of Firms, Establishments, and Estimated Receipts for Petroleum Refineries (SIC 2911) by Firm Employment Size Category (1997)

Employment Size Category	Number of Firms	Number of Establishments	Estimated Receipts (in millions, constant $2000)
0-19	27	27	451
20-99	22	23	1,432
100-499	25	33	6,508
500+	54	165	207,078
Total	*128*	*248*	*215,469*

Source: U.S. SBA, 2000.

d. Concentration and specialization ratios

Concentration is the degree to which industry output is concentrated in a few large firms. Concentration is closely related to entry barriers, with more concentrated industries generally having higher barriers.

The four-firm ***concentration ratio*** (CR4) and the ***Herfindahl-Hirschman Index*** (HHI) are common measures of industry concentration. The CR4 indicates the market share of the four largest firms. For example, a CR4 of 72 percent means that the four largest firms in the industry account for 72 percent of the industry's total value of shipments. The higher the concentration ratio, the less competition there is in the industry, other things being equal.[6] An industry with a CR4 of more than 50 percent is generally considered concentrated. The HHI indicates concentration based on the largest 50 firms in the industry. It is equal to the sum of the squares of the market shares for the largest 50 firms in the industry. For example, if an industry consists of only three firms with market shares of 60, 30, and 10 percent, respectively, the HHI of this industry would be equal to 4,600 ($60^2 + 30^2 + 10^2$). The higher the index, the fewer the number of firms supplying the industry and the more concentrated the industry. An industry is considered concentrated if the HHI exceeds 1,000.

The petroleum industry is considered competitive, based on CR4 and the HHI. As shown in Table 4C-6, the CR4 and the HHI for SIC 2911 are both below the benchmarks of 50 percent and 1,000, respectively.

The ***specialization ratio*** is the percentage of the industry's production accounted for by primary product shipments. The ***coverage ratio*** is the percentage of the industry's product shipments coming from facilities from the same primary industry. The coverage ratio provides an indication of how much of the production/product of interest is captured by the facilities classified in an SIC code. The specialization and coverage ratios presented in Table 4C-7 show a very high degree of specialization by petroleum refineries: In 1997, 97 percent of the value of shipments from SIC 2911 establishments were classified as SIC 2911 petroleum products. In addition, SIC 2911 establishments accounted for 99 percent of the value of all petroleum products shipped domestically.

Table 4C-7: Selected Ratios for Petroleum Refineries (SIC 2911/NAICS 324110)

SIC	Year	Total Number of Firms	Concentration Ratios					Specialization Ratio	Coverage Ratio
			4 Firm (CR4)	8 Firm (CR8)	20 Firm (CR20)	50 Firm (CR50)	Herfindahl-Hirschman Index		
2911	1987	200	32%	52%	78%	95%	435	99%	99%
	1992	132	30%	49%	78%	97%	414	99%	99%
	1997	122	28%	49%	83%	98%	422	97%	99%

Source: U.S. DOE, 1987, 1992, and 1997.

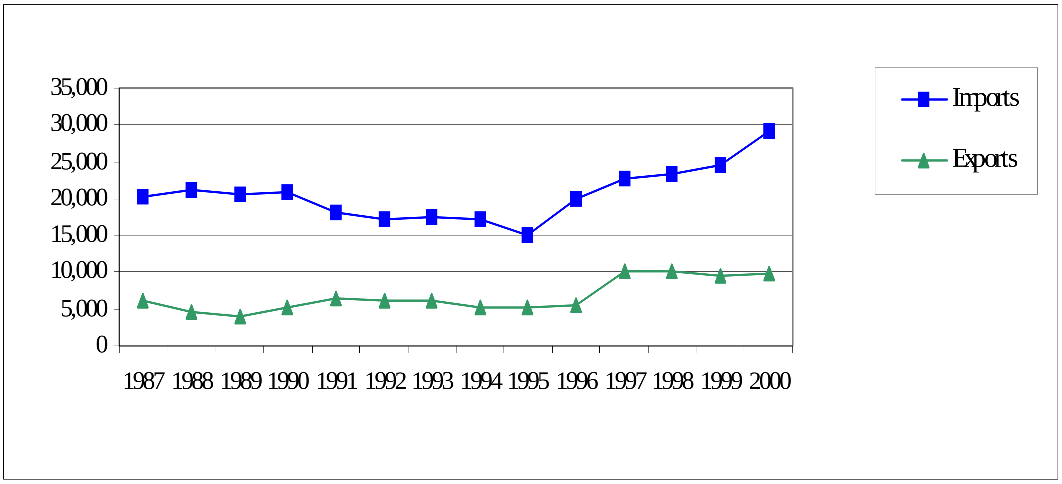
[6] Note that the measured concentration ratio and the HHF are very sensitive to how the industry is defined. An industry with a high concentration in domestic production may nonetheless be subject to significant competitive pressures if it competes with foreign producers or if it competes with products produced by other industries (e.g., plastics vs. aluminum in beverage containers). Concentration ratios are therefore only one indicator of the extent of competition in an industry.

e. Foreign trade

The United States consumes more petroleum than it produces, requiring net imports of both crude oil and products to meet domestic demand. In 1997, the U.S. imported 8.23 million barrels per day (MBD) of crude oil, or 56 percent of the total crude oil supply of 14.77 MBD, and imported 1.94 MBD of refined products. These refined product imports represented ten percent of the 18.62 MBD of refined products supplied to U.S. consumers. The U.S. exported 0.9 MBD of refined products in 1997.

Imports of refined petroleum products have fluctuated since 1985. Imports rose to 2.3 MB in the early 1980s, due to rapid growth in oil consumption, especially consumption of light products, which exceeded the growth in U.S. refining capacity. Imports then declined as a result of the 1990/91 recession and a surge in upgrading of refinery capacity resulting primarily from the Clean Air Act Amendments and other environmental requirements (U.S. DOE, 1997). Since the lowest point in 1995, imports have been steadily increasing through 2000 (see Figure 4C-9).

Figure 4C-9: Value of Imports and Exports for Petroleum Refining (in millions, constant $2000)



Source: U.S. DOE, 2000b.

Until the early 1980s, petroleum product exports consisted primarily of petroleum coke, because trade in most other products was restricted by allowances. Export license requirements for various petroleum products imposed in 1973 were eliminated in late 1981, however, and exports of other products began to grow. Petroleum exports continue to include heavy products such as residual fuel oil and petroleum coke, which are produced as co-products with motor gasoline and other light products. Production of these heavier products often exceeds U.S. demand, and foreign demand absorbs the excess. Petroleum coke is the leading petroleum export product, accounting for 30 percent of petroleum exports in 1997, followed by distillate fuel oil (15 percent of exports) and motor gasoline (almost 14 percent) (U.S. DOE, 1997). Exports generally reflect foreign demand, but other factors influence exports as well. For example, exports of motor gasoline increased due to high prices in Europe at the time of the 1990 Persian Gulf crisis. U.S. refiners and marketers have gained experience in marketing to diverse world markets, and U.S. products are now sold widely abroad (U.S. DOE, 1997). As reported by the International Trade Administration and shown in Figure 4C-9, the real value of petroleum exports fluctuated during the years 1989 to 1996, and have been steady for the four year period of 1997 through 2000.

Export dependence and ***import penetration*** are the two measures of foreign competition that are used in this profile. Export dependence is the share of value of shipments that is exported. Import penetration is the share of domestic consumption met by imports. Trade statistics for petroleum refineries from 1989 to 1997 are presented in Table 4C-8. This table shows the stability of both import penetration and export dependence for the petroleum refining industry.

Table 4C-8: Foreign Trade Statistics for Petroleum Refining

Year	Value of imports (in millions, constant $2000)	Value of exports (in millions, constant $2000)	Value of Shipments (in millions, constant $2000)	Implied Domestic Consumption[a]	Import Penetration[b]	Export Dependence[c]
1989	20,470	6,547	198,927	212,850	10%	3%
1990	20,933	5,239	197,450	213,144	10%	3%
1991	18,168	6,415	200,565	212,318	9%	3%
1992	17,075	6,086	194,180	205,169	8%	3%
1993	17,423	6,159	192,868	204,132	9%	3%
1994	17,219	5,194	198,911	210,936	8%	3%
1995	14,905	5,333	203,761	213,333	7%	3%
1996	19,978	5,560	206,804	221,222	9%	3%
1997	22,736	10,139	212,100	224,697	10%	5%
Total Percent Change 1989-1997	11%	55%	7%	6%		
Average Annual Growth Rate	1.3%	6%	0.8%	0.7%		

[a] Calculated by EPA as shipments + imports - exports.
[b] Calculated by EPA as imports divided by implied domestic consumption.
[c] Calculated by EPA as exports divided by shipments.

Source: U.S. DOC, 2001; U.S. DOE, 2000b.

4C.3 Financial Condition and Performance

Refiners' profitability depends on the spread between product prices on the one hand, and the price of crude oil and other inputs (the gross refining margin), investment costs, and operating costs on the other hand. Operating costs in turn reflect facility configurations (complexity), scale and efficiency, the mix of high-end versus low-end products produced, and location. Refinery yields vary with refinery configuration, operating practices, and crude oil characteristics. Revenues earned from a barrel of crude depend on the prices of different products, the mix of products produced, and the refinery yield for each product. Relatively small swings in the price of gasoline (which represents the largest product output) and the price of crude oil can cause large changes in cash margins and refinery profits.

Returns on investments to produce higher quality products from a given mix of crude oil (or to produce a given product mix from heavier crude oil) depend on the differentials between high and low quality crude. Price discounts for low quality crude have not always been enough to earn competitive returns on investments in extra coking and sulfur removal capacity.

Through the first half of the 1990s, the U.S. refining and marketing industry was characterized by unusually low product margins, low profitability, and substantial restructuring. These low profit margins were the result of three different factors: (1) increases in operating costs as a result of governmental regulations; (2) expensive upgrading of processing units to accommodate lower-quality crude oils;[7] and (3) upgrading of operations to adapt to changes in demand for refinery products.[8] A combination of higher cost as a result of these three trends and lower product prices as a result of competitive pressures led to pressure on profits (American Petroleum Institute, 1999).

In the late 1990s, the U.S. majors aggressively pursued cost-cutting throughout their operations (Rodekohr, 1999). There were improvements in both gross and net margins.[9] Reductions in costs resulted from:

- divesting marginal refineries and gasoline outlets;
- divesting less profitable activities (e.g., gasoline credit cards);
- reducing corporate overhead costs, including eliminating redundancies through restructuring;
- outsourcing some administrative activities; and
- use of new technologies requiring less labor.

These cost-cutting measures, along with increases in the prices of petroleum refining products, have resulted in significantly improved margins in the petroleum refining sector. Refinery profits remained high in 2000 and the first half of 2001, due to low product inventories and high operating rates.

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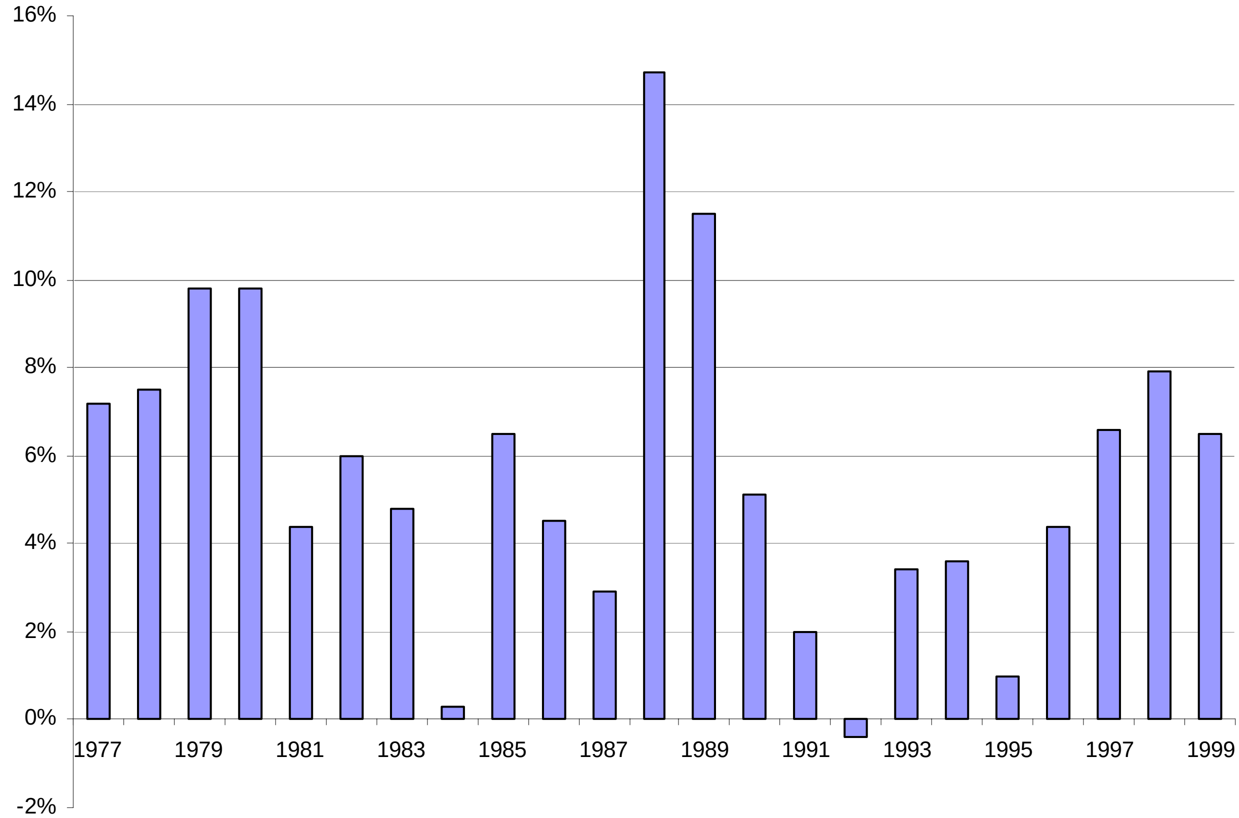
[7] Crude oils processed by U.S. refineries have become heavier and more contaminated with materials such as sulfur. This trend reflects reduced U.S. dependence on the more expensive high gravity ("light") and low sulfur ("sweet") crude oils produced in the Middle East, and greater reliance on crude oil from Latin America (especially Mexico and Venezuela), which is relatively heavy and contains higher sulfur ("sour") (U.S. DOE, 1999a).

[8] Demand for lighter products such as gasoline and diesel fuel has increased, and demand for heavier products has decreased.

[9] Gross margin is revenues per refined product barrel less raw materials cost (i.e., average product price minus average crude oil cost). Net margin is gross margin minus operating costs (all out-of-pocket refining and retailing expenses such as energy costs and marketing costs.)

The substantial fluctuation in return on investment from 1977 through 1999, including the relatively low returns in the early 1990s and improvements in the late 1990s, are shown in Figure 4C-10.[10]

Figure 4C-10: U.S. Petroleum and Natural Gas Refining and Marketing, Return on Investment 1977 - 1999



Source: U.S. DOE, Financial Reporting System.

[10] The Financial Reporting System (FRS) is described in U.S. DOE, 1997. Quarterly financial results are collected for a group of specialized refiner/marketers and major integrated petroleum companies. Data are reported separately for their U.S. refining/marketing lines of business. Companies drop in and out of the survey as a result of acquisitions and mergers. Data include only the U.S. operations for foreign affiliates (BP American, Fina, Shell Oil) but worldwide operations for U.S.-based companies. The surveyed companies account for approximately 80 percent of total U.S. companies' worldwide investment in petroleum and natural gas, and approximately 25 percent of worldwide refining capacity (excluding State Energy Companies) (Rodekohr, 1999).

Table 4C-9 below shows trends in estimated operating margins for the petroleum refining industry, based on Census data for SIC 2911. Margins increased over one percent overall between 1988 and 1997, from 15.6 percent to 16.5 percent, after declining in the early 1990s.

Table 4C-9: Operating Margins for Petroleum Refineries (SIC 2911)

Year	Value of Shipments (in millions, constant $2000)	Cost of Materials (in millions, constant $2000)	Payroll (all employees) (in millions, constant $2000)	Operating Margin
1988	$202,773	$166,070	$4,998	15.6%
1989	$198,927	$167,584	$4,525	13.5%
1990	$197,450	$171,595	$3,958	11.1%
1991	$200,565	$170,941	$4,757	12.4%
1992	$194,180	$166,627	$5,183	11.5%
1993	$192,868	$163,659	$5,543	12.3%
1994	$198,911	$163,074	$5,890	15.1%
1995	$203,986	$168,572	$5,678	14.6%
1996	$206,804	$173,851	$4,890	13.6%
1997	$212,100	$171,916	$5,161	16.5%

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, 1997.

4C.4 Facilities Operating Cooling Water Intake Structures

In 1982, the Petroleum and Coal Products industry (SIC 29) withdrew 590 billion gallons of cooling water, accounting for approximately 0.8 percent of total industrial cooling water intake in the United States. The industry ranked 4th in industrial cooling water use, behind the electric power generation industry and the chemical and primary metals industries (1982 Census of Manufactures).

This section presents information from EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* on existing facilities with the following characteristics:

- they withdraw from the waters of the United States;
- they hold an NPDES permit;
- they have a design intake flow of equal to or greater than two MGD;
- they use at least 25 percent of that flow for cooling purposes.

These facilities are not "new facilities" as defined by the section 316(b) New Facility Rule and are therefore not subject to this regulation. However, they meet the criteria of the rule except that they are already in operation. These existing facilities therefore provide a good indication of what new facilities in these sectors may look like. The remainder of this section refers to existing facilities with the above characteristics as "section 316(b) facilities."

a. Cooling water uses and systems

Information collected in the Detailed Questionnaire found that an estimated 31 of 163 petroleum refining facilities, or 19 percent, meet the characteristics of a section 316(b) facility. Eighty-seven percent of these facilities use cooling water for production line (or process) contact or noncontact cooling. Approximately 35 and 16 percent of the section 316(b) facilities also reported use of cooling water in electricity generation and air conditioning, respectively.

Table 4C-10 shows the distribution of existing section 316(b) petroleum refineries by type of water body and cooling system. Twenty-two facilities, or 71 percent, obtain their cooling water from either a freshwater stream or a river. Four facilities (13 percent) of refineries obtain their cooling water from either an estuary or a tidal river. Two facilities, or 6.5 percent, obtain their cooling water from a Great Lake. The other two sources of cooling water reported for petroleum refineries were oceans and a joint withdrawal from lakes/reservoirs and estuaries/tidal rivers, accounting for three percent each.

The most common cooling water system used by petroleum refineries is a recirculating cooling system, representing approximately 48 percent of all systems used by refineries. Thirty-two percent of all refineries use a combination cooling system. The remaining 20 percent use a once-through cooling system or another type of cooling system.

Table 4C-10: Number of Section 316(b) Petroleum Refining Facilities by Water Body Type and Cooling System Type

Water Body Type	Cooling System								Total
	Recirculating		Once-Through		Combination		Other		
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	
Estuary or Tidal River	0	0%	1	25%	3	75%	0	0%	4
Freshwater Stream or River	14	64%	2	9%	5	23%	1	5%	22
Great Lake	0	0%	0	0%	2	100%	0	0%	2
Lake or Reservoir	1	100%	0	0%	0	0%	0	0%	1
Lake or Reservoir & Estuary or Tidal River	0	0%	1	100%	0	0%	0	0%	1
Ocean	0	0%	1	100%	0	0%	0	0%	1
***Total*[a]**	***15***	***48%***	***5***	***16%***	***10***	***32%***	***1***	***3%***	***31***

[a] Individual numbers may not add up to total due to independent rounding.

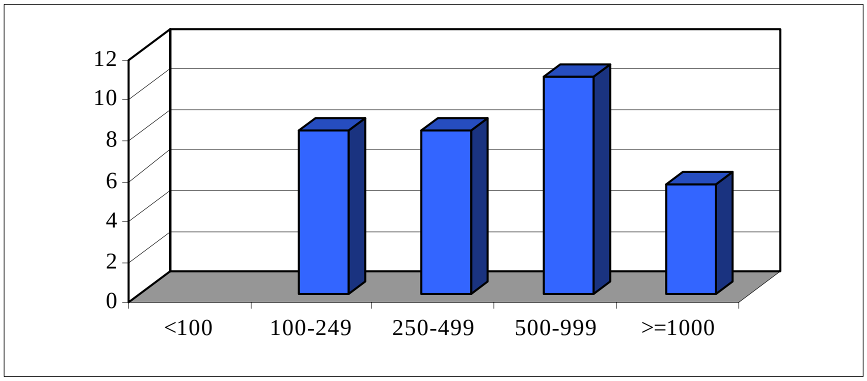
Source: U.S. EPA, 2000.

According to the American Petroleum Institute and EPA, water use in the petroleum refining industry has been declining because facilities are increasing their reuse of water. These restrictions are likely to reduce section 316(b)-related costs, and a complete phase out of once-through cooling water in refineries is expected (U.S. EPA, 1996a).

b. Facility size

Section 316(b) facilities in SIC 2911 are somewhat larger on average than the average employment size distribution of the industry as a whole, as reported in the Census. Figure 4C-11 shows the number of section 316(b) facilities by employment size category. Fifty-two percent of section 316(b) refineries employ over 500 people and all employ over 100 employees.

Figure 4C-11: Number of Section 316(b) Petroleum Refineries by Employment Size Category (SIC 2911)



Source: U.S. EPA, 2000.

c. Firm size

EPA used the Small Business Administration (SBA) small entity thresholds to determine the number of existing section 316(b) petroleum refineries owned by small firms. Firms in this industry are considered small if they employ fewer than 1,500 people. Table 4C-11 shows that 94 percent of all section 316(b) petroleum refineries are owned by large firms. Only two section 316(b) petroleum refining facilities are owned by small firms.

Table 4C-11: Number of Section 316(b) Petroleum Refineries by Firm Size

SIC	Large		Small		Total
	No.	% of SIC	No.	% of SIC	
2911	29	94%	2	6%	31

Source: U.S. EPA, 2000; D&B, 2001.

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4D STEEL (SIC 331)

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified five 4-digit SIC codes in the Steel Works, Blast Furnaces, and Rolling and Finishing Mills Industries (SIC 331) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws equal to or greater than two million gallons per day (MGD) from a water of the United States, and uses at least 25 percent of its intake flow for cooling purposes. (Facilities with these characteristics are hereafter referred to as "section 316(b) facilities"). For each of the five SIC codes, Table 4D-1 below provides a description of the industry sector, a list of primary products manufactured, the total number of detailed questionnaire respondents (weighted to represent national results), and the number and percent of section 316(b) facilities.

Table 4D-1: Section 316(b) Facilities in the Steel Industry (SIC 331)

SIC	SIC Description	Important Products Manufactured	Number of Weighted Detailed Questionnaire Survey Respondents		
			Total	Section 316(b) Facilities	
				No.	%
Steel Mills (SIC 3312)					
3312	Steel Works, Blast Furnaces (Including Coke Ovens), and Rolling Mills	Hot metal, pig iron, and silvery pig iron from iron ore and iron and steel scrap; converting pig iron, scrap iron, and scrap steel into steel; hot-rolling iron and steel into basic shapes, such as plates, sheets, strips, rods, bars, and tubing; merchant blast furnaces and byproduct or beehive coke ovens	***161***	***40***	***24.9%***
Steel Products (SICs 3315, 3316, 3317)					
3315	Steel Wiredrawing and Steel Nails and Spikes	Drawing wire from purchased iron or steel rods, bars, or wire; further manufacture of products made from wire; steel nails and spikes from purchased materials	122	3	2.5%
3316	Cold-Rolled Steel Sheet, Strip, and Bars	Cold-rolling steel sheets and strip from purchased hot-rolled sheets; cold-drawing steel bars and steel shapes from hot-rolled steel bars; producing other cold finished steel	57	9	16.4%
3317	Steel Pipe and Tubes	Production of welded or seamless steel pipe and tubes and heavy riveted steel pipe from purchased materials	130	7	5.7%
Total Steel Products			***309***	***20***	***6.4%***
Other Sectors					
3313	Electrometallurgical Products, Except Steel	Ferro and nonferrous metal additive alloys by electrometallurgical or metallothermic processes, including high percentage ferroalloys and high percentage nonferrous additive alloys	***6***	***2***	***30.4%***
Total Steel (SIC 331)					
Total SIC Code 331[a]			**476**	**62**	**13.0%**

[a] Individual numbers may not add up due to independent rounding.

Source: U.S. EPA, 2000; Executive Office of the President, 1987

The responses to the Detailed Questionnaire indicate that two main steel sectors account for the largest numbers of section 316(b) facilities: (1) Steel Mills (SIC code 3312) and (2) Steel Products (SIC codes 3315, 3316, and 3317). Of the 62 section 316(b) facilities in the steel industry, 40, or 65 percent, are steel mills, and 20, or 32 percent, are steel products facilities. The remainder of the steel industry profile therefore focuses on these two industry sectors.

4D.1 Domestic Production

Steel is one of the dominant products in the U.S. industrial metals industry. For most of the twentieth century the U.S. steel industry consisted of a few large companies utilizing an integrated steelmaking process to produce the raw steel used in a variety of commodity steel products. The integrated process requires very large capital investment to process coal, iron ore, limestone, and other raw materials into molten iron, which is then transformed into finished steel products (S&P, 2001). In recent decades, the integrated steel industry has undergone a dramatic downsizing as a result of increased steel imports, decreased consumption by the auto industry, and the advent of "minimills" (S&P, 2001).[1] While the traditional integrated facilities using basic oxygen furnaces (BOF) still account for a substantial percent of U.S. steel mill product production, the share of electric arc furnace (EAF) facilities using scrap steel as an input has grown steadily.[2] The range of products produced by EAFs has expanded over time. Initially, EAFs produced primarily lower-quality structural materials. Starting in the 1990s, EAFs began producing higher quality sheet products as well. All recent capacity additions have been at EAF facilities.

Basic steel mill products include carbon steel, steel alloys, and stainless steel. Steel forming and finishing operations may take place at facilities co-located with steelmaking or at separate facilities. These operations take steel (in the form of blooms, billets, and slabs) and use heating, rolling or drawing, pickling, cleaning, galvanizing, and electroplating processes in various combinations to produce finished bars, wire, sheets, and coils (semifinished steel products). Establishments that produce hot rolled products, along with basic BOF and EAF steelmaking facilities, are included in SIC 3312. SICs 3315, 3316, and 3317 perform additional processing of steel bars, wires, sheets, and coils (including cold-rolling of sheets) to produce steel products for a variety of end-uses (U.S. EPA, 1995).

The steel industry is the fourth largest energy-consuming sector. Energy costs account for approximately 20 percent of the total cost to manufacture steel. Steelmakers use coal, oil, electricity, and natural gas to fire furnaces and run process equipment. Minimill producers require large quantities of electricity to operate the electric arc furnaces used to melt and refine scrap metal, while integrated steelmakers are dependent on coal for up to 60 percent of their total energy requirements (McGraw-Hill, 1998).

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[1] Large integrated producers include such companies as Bethlehem Steel, LTV, and U.S. Steel. Nucor is the largest U.S. minimill producer.

[2] Production from open hearth furnaces, which dominated production until the early 1950s, ended in 1991. BOF facilities have traditionally been referred to as integrated producers, because they combined iron-making from coke, production of pig iron in a blast furnace, and production of steel in the BOF. In recent years, some facilities have closed their coke ovens. These BOF facilities are no longer fully integrated.

a. Output

Steel mill products are sold to service centers (which buy finished steel, often process it further, and sell to a variety of fabricators, manufacturers, and construction industry clients), to vehicle producers, and to the construction industry. The rapid growth in sales of heavy sports utility vehicles contributed to increased steel consumption in the U.S. in the 1990s. Efforts to increase the fuel efficiency of vehicles has eroded steel's position in the automotive market as a whole, however, as aluminum and plastic has replaced steel in many automotive applications. Other end-uses for steel include a wide range of agricultural, industrial, appliance, transportation, and container applications. Use of steel in beverage cans has been largely replaced by aluminum.

Table 4D-2 shows trends in production from the two major groups of steel producers: BOF and EAF facilities.

Table 4D-2: Steel Production by Type of Producer

Year	Steel Production		Percent from BOF	Percent from EAF
	Million MT	% Change		
1990[a]	89.7	n/a	59.1%	37.3%
1991[b]	79.7	-11.1%	60.0%	38.4%
1992	84.3	5.8%	62.0%	38.0%
1993	88.8	5.3%	60.6%	39.4%
1994	91.2	2.7%	60.7%	39.3%
1995	95.2	4.4%	59.6%	40.4%
1996	95.5	0.3%	57.4%	42.6%
1997	98.5	3.1%	56.2%	43.8%
1998	98.6	0.1%	54.9%	45.1%
1999	97.4	-1.2%	53.7%	46.3%
2000	106	8.8%	53.8%	46.2%
Total Percent Change 1990-2000	18.2%			
Average Annual Growth Rate change	1.7%			
Jan-July 2000	68.5	n/a	53.8%	46.2%
Jan-July 2001	60.1	-12.3%	53.2%	46.8%

[a] 3.5 percent of 1990 production was from open hearth furnaces.
[b] 1.6 percent of 1991 production was from open hearth furnaces.

Source: *AISI, 2001b; USGS, 2000; USGS, 1997; USGS, Iron and Steel Statistical Compendium.*

This table shows the cyclical nature of basic steel production, with variations in growth from year to year reflecting general U.S. and world economic conditions, a world oversupply of steel capacity, the competitive strength of imports, and trends in steel's share of the automotive and other end-use markets for steel sectors. The U.S. steel industry went through a difficult restructuring process in the 1980s and early 1990s, including the closing of a number of inefficient mills, substantial investment in new technologies, and reductions in the labor force. The U.S. became a world leader in low-cost production, lead by the minimill producers. While U.S. demand for steel was strong in the late 1990s, however, there was a dramatic increase in low-price imports in 1998 which lead to a number of U.S. steel bankruptcies and steelworker layoffs. This import crisis resulted from the Asian financial crisis, with the associated decline in Asian demand for steel and currency devaluations. The President initiated the Steel Action Program in response to the crisis, focusing on strong enforcement of trade laws through the World Trade Organization and bilateral efforts to address market-distorting practices abroad.[3] The industry began to show signs of recovery in the second half of 1999, and by early 2000 capacity utilization recovered to above 90 percent and earnings were up for most major steel companies (U.S. DOC, 2000). Softness in the U.S. economy starting in 2000 resulted in significant decreases in steel demand, however. As a result, U.S steel production declined by 12 percent in the first seven months of 2001 compared with the same period in 2000 (AISI, 2001b and 2001c; S&P, 2001).

Value of shipments and ***value added*** provide measures of the value of output that can be compared with other industries.[4] Historical trends provide insight into the overall economic health and outlook for an industry. Value of shipments is the sum of the receipts a manufacturer earns from the sale of its outputs. It is an indicator of the overall size of a market or the size of a firm in relation to its market or competitors. Value added is used to measure the value of production activity in a particular industry. It is the difference between the value of shipments and the value of inputs used to make the products sold.

Using the relevant producer price index, value of shipments and value added for steel mills and steel products were adjusted for the changes in steel product prices. Figure 4D-1 presents trends in constant-dollar value of shipments and value added for steel mills and steel products. Value of shipments and value added from SIC 3312 (basic steel) declined in the early 1990s, and recovered through 1997, prior to the 1998 import crisis. Value of shipments and value added for steel products (SICs 3315, 3316 and 3317) were less volatile, increasing gradually over the period 1990 through 1997.

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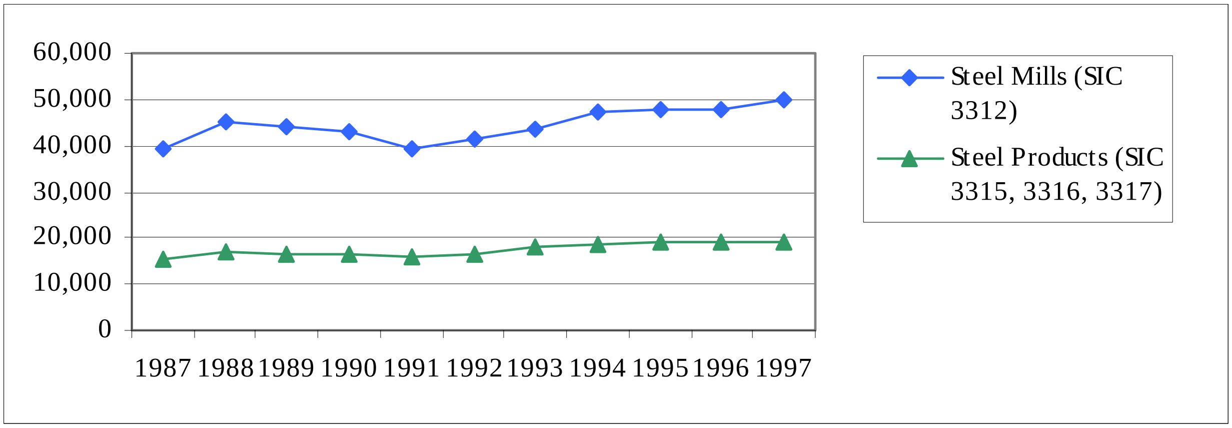
[3] World steel trade is characterized by noncompetitive practices in a number of countries, which have resulted in substantial friction over trade issues since the late 1960s. Since 1980, almost 40 percent of the unfair trade practice cases investigated in the U.S. have been related to steel products (U.S. DOC, 2000).

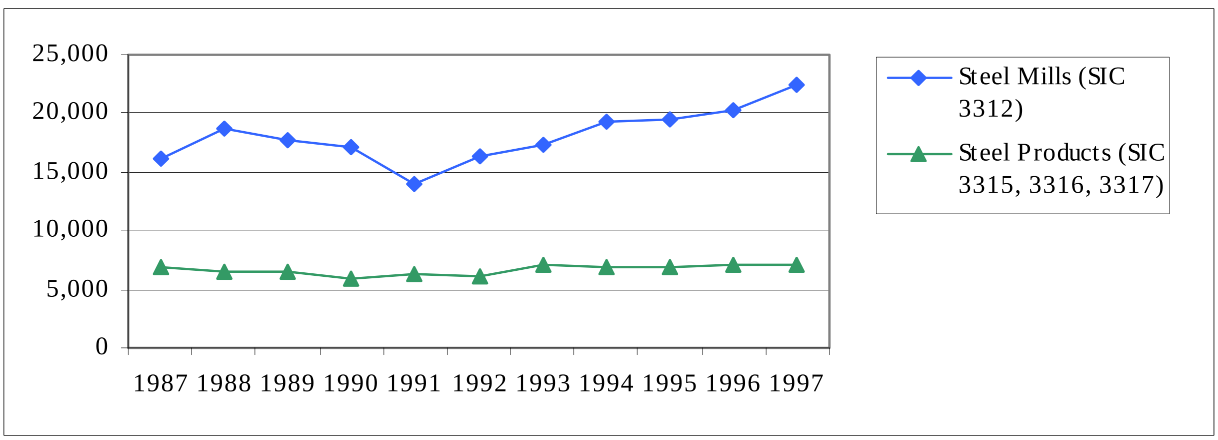
[4] Terms highlighted in bold and italic font are further explained in the glossary.

Figure 4D-1: Real Value of Shipments and Value Added for Profiled Steel Industry Sectors (in millions, constant $2000)

Value of Shipments



Value Added



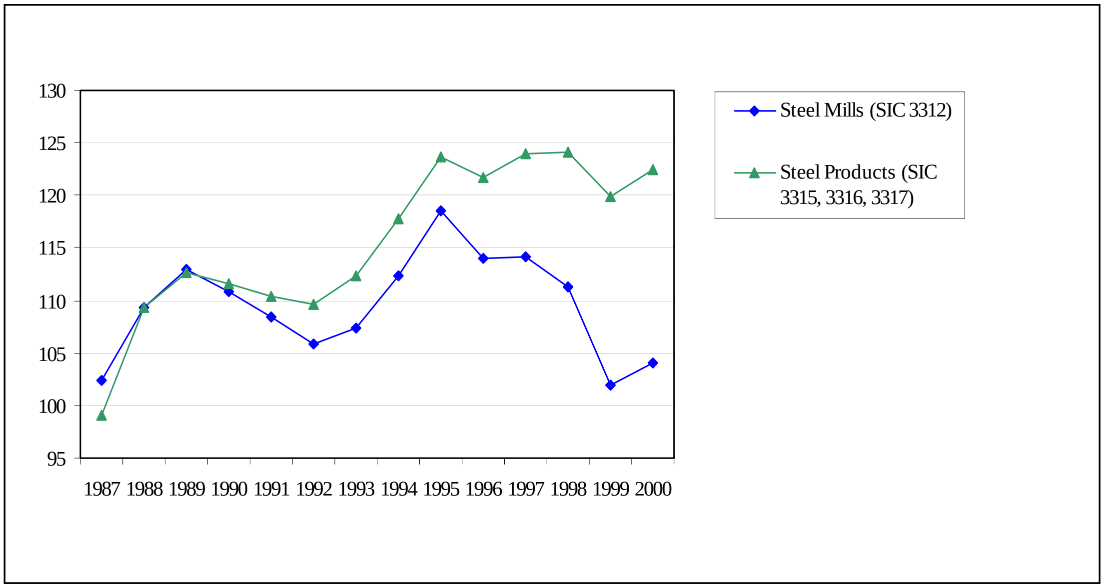
Source: U.S. DOC, 1988-1991 and 1993-1996; US. DOC, 1987, 1992, 1997.

b. Prices

The ***producer price index*** (PPI) is a family of indexes that measure price changes from the perspective of the seller. It is an indicator of product prices and is used to inflate nominal monetary values to constant dollars. This profile uses PPIs at the 4-digit SIC code level to convert nominal values to 2000 dollars.

Figure 4D-2 below shows that prices increased from 1987 to 1989 and then decreased in the early 1990s, due to a depressed domestic economy and the resulting decline in the demand for steel. Prices rebounded sharply through 1995 before eroding again, due to the global oversupply and increases in exports discussed earlier. Basic steel prices declined sharply with the growth of imports in the late 1990s, recovered in 2000, but have dropped again in 2001 with the decline in demand for steel (S&P, 2001; AISI, 2001a).

Figure 4D-2: Producer Price Index for Profiled Steel Industry Sectors



Source: BLS, 2000.

c. Number of facilities and firms

The number of steel mills fluctuated significantly between 1989 and 1998, as the U.S. industry underwent a substantial restructuring. Table 4D-3 shows substantial decreases in the number of facilities in 1992 and 1993 due to a significant decrease in the global demand for steel products and the resulting overcapacity. This decrease was followed by a significant recovery in 1995 and 1996. The import crisis in 1998 ultimately led to bankruptcy for a number of U.S. producers, including LTV and most recently Bethlehem Steel (S&P, 2001).

In contrast to the volatility and overall decrease in the number of steel mills, the number of facilities in the Steel Products sector has remained relatively stable for the past ten years, with only small decreases between 1994 and 1997.

Table 4D-3: Number of Facilities in the Profiled Steel Industry Sectors

Year	Steel Mills (SIC 3312)		Steel Products (SIC 3315, 3316, 3317)	
	Number of Facilities	Percent Change	Number of Facilities	Percent Change
1989	476	n/a	784	n/a
1990	497	4.4%	776	-1.0%
1991	531	6.8%	807	4.0%
1992	412	-22.4%	831	3.0%
1993	343	-16.7%	833	0.2%
1994	339	-1.2%	804	-3.5%
1995	391	15.3%	791	-1.6%
1996	483	23.5%	770	-2.7%
1997	297	-38.5%	727	-5.6%
1998	346	16.9%	801	10.2%
Total Percent Change 1989-1998	*-27.3%*		*2.2%*	
Average Annual Growth Rate	*-3.5%*		*0.2%*	

Source: U.S. SBA, 2000.

The trend in the number of firms over the period between 1990 and 1998 has been similar to the trend in the number of facilities in both industry sectors. The number of firms in the Steel Mill sector decreased from a high of 433 in 1991 to a low of 216 in 1997, before increasing slightly in 1998. According to the American Iron and Steel Institute (AISI), 23 U.S. steel companies either declared bankruptcy or ceased operations entirely through September 2001 since 1997, as a result on the continuing trade crisis (AISI, 2001a). The number of firms in the Steel Products sector has also decreased steadily in recent years from its peak of 661 in 1992, reflecting consolidation in ownership of capacity.

Table 4D-4 shows the number of firms in the two profiled steel sectors between 1990 and 1998.

Table 4D-4: Number of Firms in the Profiled Steel Industry Sectors

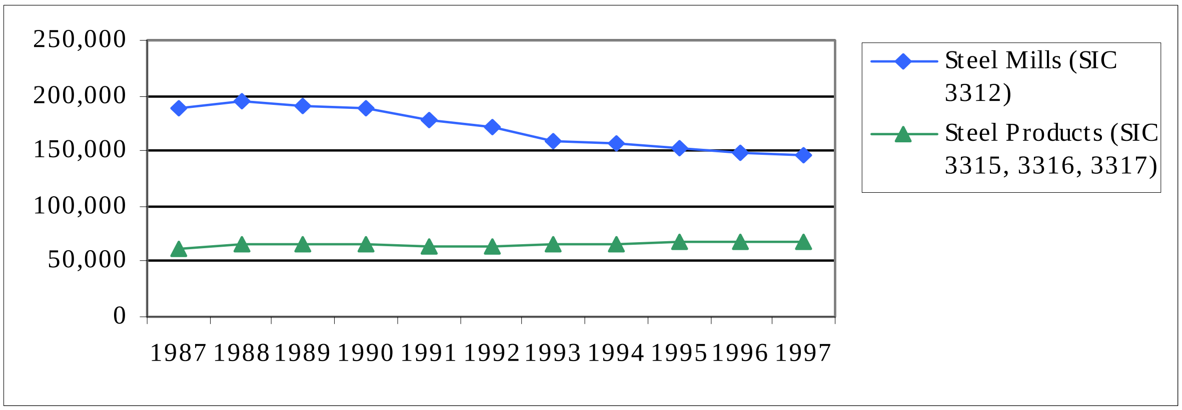
Year	Steel Mills (SIC 3312)		Steel Products (SIC 3315, 3316, 3317)	
	Number of Firms	Percent Change	Number of Firms	Percent Change
1990	408	n/a	597	n/a
1991	433	6.1%	635	6.4%
1992	321	-25.9%	661	4.1%
1993	261	-18.7%	641	-3.0%
1994	258	-1.1%	618	-3.6%
1995	309	19.8%	607	-1.8%
1996	397	28.5%	583	-4.0%
1997	216	-45.6%	544	-6.7%
1998	267	26.3%	541	-0.6%
Total Percent Change 1990-1998	*-34.6%*		*-9.4%*	
Average Annual Growth Rate	*-5.2%*		*-1.2%*	

Source: U.S. SBA, 2000.

d. Employment and productivity

Employment is a measure of the level and trend of activity in an industry. Figure 4D-3 below provides information on employment from the Annual Survey of Manufactures for the Steel Mills and Steel Products sectors. The figure shows that employment levels in the Steel Mills industry decreased by a total of 23 percent between 1987 and 1997. Employment is a primary cost component for steelmakers, accounting for approximately 30 percent of total costs (McGraw-Hill, 1998). Lowering labor costs enabled the steel mills to improve profitability and competitiveness given the limited opportunity to raise prices in the competitive market for steel products. The steady declines in employment reflect the decreasing number of steel mill facilities and firms, in conjunction with aggressive efforts to improve worker productivity in order to cut labor costs and improve profits (McGraw-Hill, 1998). Employment declined further as a result of the 1998 import crisis, with almost 26,000 U.S. steelworkers reportedly losing their jobs (AISI, 2001a). Employment in the Steel Products sector over the period 1987-1997 showed a steady positive trend.

Figure 4D-3: Employment for Profiled Steel Industry Sectors



Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, 1997.

Table 4D-5 presents the change in value added per labor hour, a measure of ***labor productivity***, for the Steel Mill and Steel Products sectors between 1987 and 1997. Labor productivity at steel mills has increased substantially over this time period. Value added per labor hour increased 66 percent between 1987 and 1997. This increase reflects the efforts by steel mills to improve worker productivity in order to cut labor costs and improve profits. Much of the increase in labor productivity can be attributed to the restructuring of the U.S. steel industry and the increased role of minimills in production. Minimills are capable of producing rolled steel from scrap with substantially lower labor needs than integrated mills (McGraw-Hill, 1998). Labor productivity in the steel products sector has also fluctuated, but decreased 3 percent overall from 1987 to 1997.

Table 4D-5: Productivity Trends for the Profiled Steel Industry Sectors (in millions, constant $2000)

Year	Steel Mills (SIC 3312)				Steel Products (SIC 3315, 3316, 3317)			
	Value Added	Production Hours (millions)	Value Added/Hour		Value Added	Production Hours (millions)	Value Added/Hour	
			Number	Percent Change			Number	Percent Change
1987	16,067	306	53	n/a	6894	108	64	n/a
1988	18,608	324	57	8%	6480	94	69	8%
1989	17,815	348	51	-11%	6420	112	57	-17%
1990	17,177	315	55	8%	5939	93	64	12%
1991	13,990	279	50	-9%	6274	106	59	-8%
1992	16,303	277	59	18%	6160	87	71	20%
1993	17,358	268	65	10%	7078	109	65	-8%
1994	19,212	266	72	11%	6829	91	75	15%
1995	19,495	263	74	3%	6857	114	60	-20%
1996	20,192	260	78	5%	7158	134	54	-10%
1997	22,347	253	88	13%	7,010	113	62	15%
Total Percent Change 1987-1997	*39.1%*	*-17.3%*	*66.0%*		*1.7%*	*4.6%*	*-3.1%*	
Average Annual Growth Rate	*3.4%*	*-1.9%*	*5.2%*		*0.2%*	*0.5%*	*-0.3%*	

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

e. Capital expenditures

Steel production is a relatively capital intensive process. Capital-intensive industries are characterized by large, technologically complex manufacturing facilities which reflect the economies of scale required to manufacture products efficiently. The integrated production process requires large capital investments of approximately $2,000 per ton of capacity for plants and equipment to support the large-scale production capacities needed to keep unit costs low. The nonintegrated process employed in minimills is significantly less capital intensive with capital costs of approximately $500 per ton of capacity (McGraw-Hill, 1998).

New capital expenditures are needed to modernize, expand, and replace existing capacity to meet growing demand. Capital expenditures in the Steel Mills and the Steel Products sectors between 1987 and 1997 are presented in Table 4D-6 below. The table shows that, while capital expenditures in the Steel Products sector have fluctuated dramatically from one year to the next, the level of capital expenditures by Steel Mills more than doubled between 1987 and 1997. The majority of this increase was realized in the late 1980s and early 1990s, when capital expenditures increased by a total of 131 percent from 1987 to 1991. This substantial increase coincides with the advent of thin slab casting, a technology that allowed minimills to compete in the market for flat rolled sheet steel. The significant decreases in capital expenditures by steel mills that followed this expansion reflects the bottoming out of the demand for steel products in the early 1990s. The recovery in capital expenditures in the mid 1990s reflected increased demand and high utilization rates (McGraw-Hill, 1998). The import crisis of the late 1990s has put pressure on the domestic industry, and expenditures for new capacity are likely to have decreased since 1997 (McGraw-Hill, 2000).

Table 4D-6: Capital Expenditures for the Profiled Steel Industry Sectors (in millions, constant $2000)

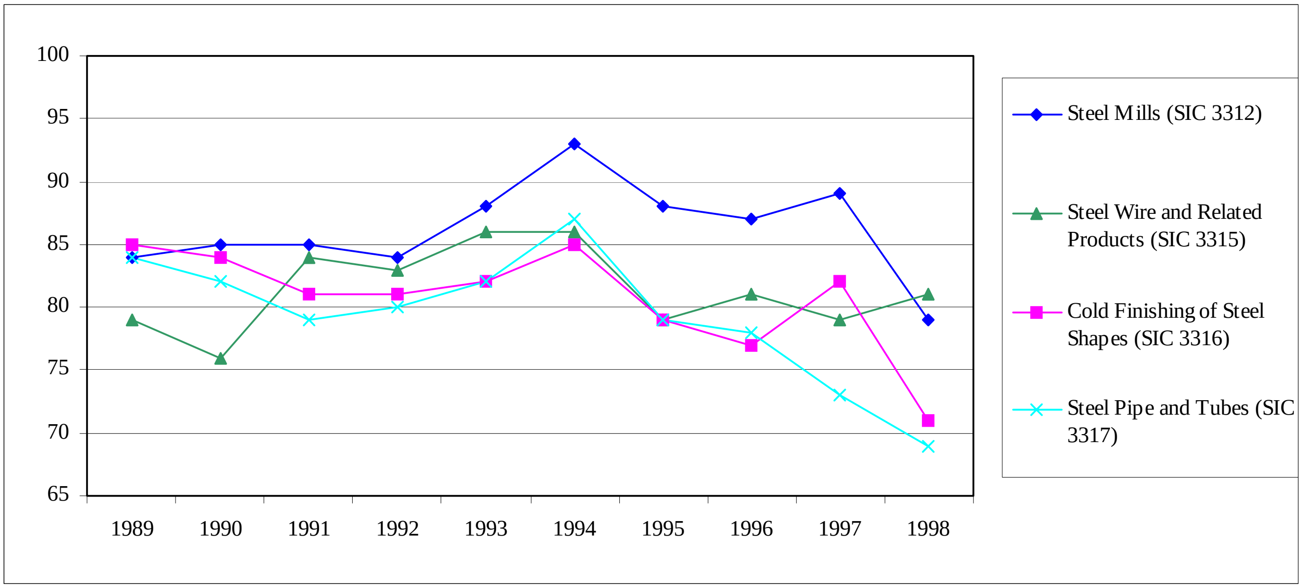
Year	Steel Mills (SIC 3312)		Steel Products (SIC 3315, 3316, 3317)	
	Capital Expenditures	Percent Change	Capital Expenditures	Percent Change
1987	1,241	n/a	661	n/a
1988	1,801	45.1%	479	-27.5%
1989	2302	27.8%	556	16.1%
1990	2400	4.3%	575	3.4%
1991	2868	19.5%	434	-24.5%
1992	2175	-24.2%	458	5.5%
1993	1724	-20.7%	498	8.7%
1994	2420	40.4%	554	11.2%
1995	2414	-0.2%	528	-4.7%
1996	2573	6.6%	587	11.2%
1997	2,513	-2.3%	590	0.5%
Total Percent Change 1987-1997	*102.5%*		*-10.7%*	
Average Annual Growth Rate	*7.3%*		*-1.1%*	

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

f. Capacity utilization

Capacity utilization measures actual output as a percentage of total potential output given the available capacity and is used as a key barometer of an industry's health. Capacity utilization is an index used to identify potential excess or insufficient capacity in an industry which can help to project whether new investment is likely. Figure 4D-4 presents the capacity utilization index from 1989 to 1998 for the 4-digit SIC codes that make up the Steel Mill and Steel Products sectors. As shown in the figure, the index follows similar trends in each SIC code. For all sectors, capacity utilization peaked in 1994 and has decreased through most of the late 1990s. This trend reflects the over-capacity in the U.S. steel industry that has followed the substantial capacity additions in the late 1980s and early 1990s and increased imports throughout the 1990s.

Figure 4D-4: Capacity Utilization Rates (Fourth Quarter) for Profiled Steel Industry Sectors



Source: U.S. DOC, 1989-1998.

4D.2 Structure and Competitiveness

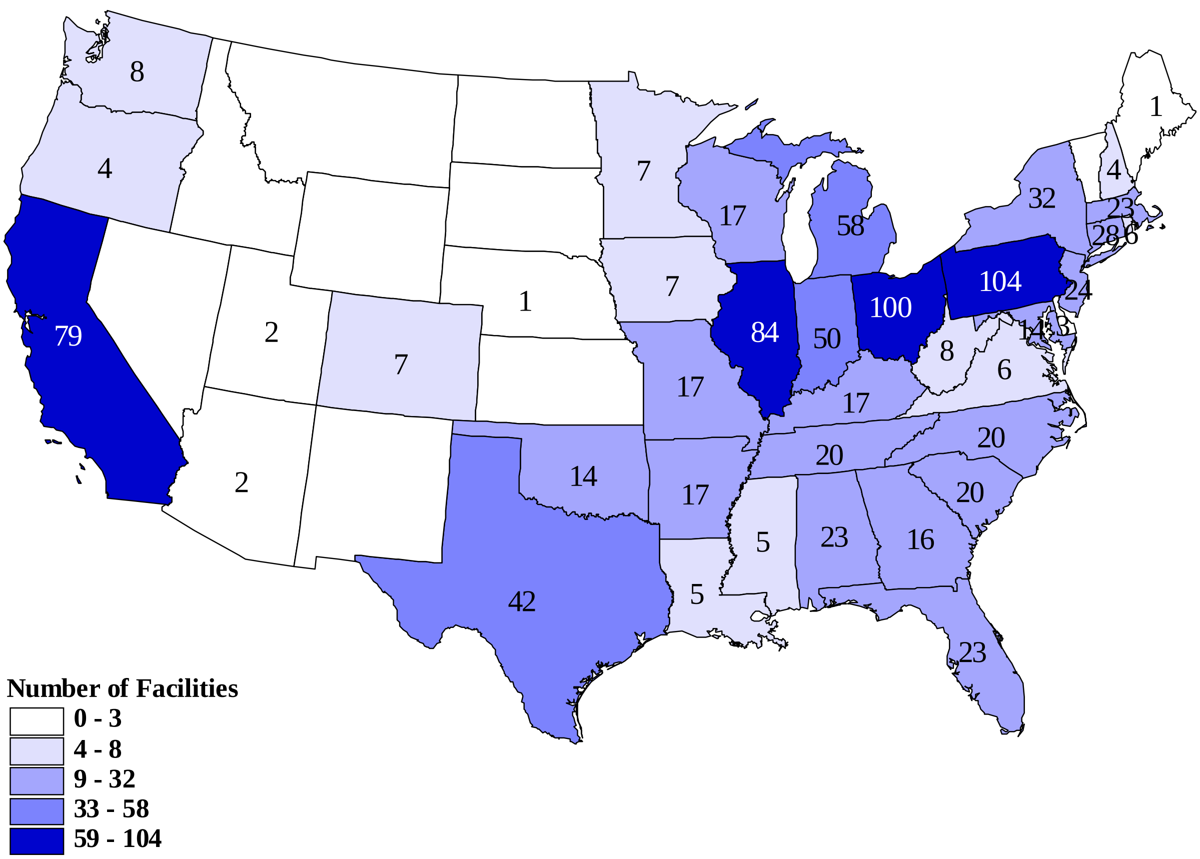
The companies that manufacture steel operate in a highly capital intensive industry. The steel mill industry is comprised of two different kinds of facilities, integrated mills and minimills. The integrated steelmaking process requires expensive plant and equipment purchases that will support production capacities ranging from two million to four million tons per year. Until the early 1960s integrated steelmaking was the dominant method of steel manufacturing in the U.S. Since then, the integrated steel business has undergone dramatic downsizing due to competition from minimills and imports. These trends have reduced the number of integrated steelmakers (S&P, 2000). Minimills vary in size, from capacities of 150,000 tons at small facilities to larger facilities with annual capacities of between 400,000 tons and two million tons. Integrated companies have significant capital costs of approximately $2,000 per ton of capacity compared with minimills' $500 per ton. Because minimills do not require as much investment in capital equipment as integrated steelmakers, minimills have been able to lower prices, driving integrated companies out of many of the commodity steel markets (S&P, 2000). The advent of minimills, with their lower initial capital investments, has made it easier for firms to enter the market.

a. Geographic Distribution

Steel mills are primarily concentrated in the Great Lakes Region (New York, Pennsylvania, Ohio, Indiana, Illinois, and Michigan). Historically, mill sites were selected for their proximity to water (both for transportation and for use in cooling and processing) and the sources of their raw materials, iron ore and coal. The geographic concentration of the industry has begun to change as minimills can be built anywhere where electricity and scrap are available at a reasonable cost and where a local market exists (U.S. EPA, 1995). The Steel Products sector is concentrated in the Great Lakes region and California. Ohio, Illinois, Pennsylvania, Michigan, and California manufactured 41 percent of all steel products in the U.S.

Figure 4D-5 below shows the distribution of U.S. steel mills and steel products facilities.

Figure 4D-5: Geographical Distribution of Facilities in the Profiled Steel Industry Sectors



Source: U.S. DOC, 1987, 1992, and 1997.

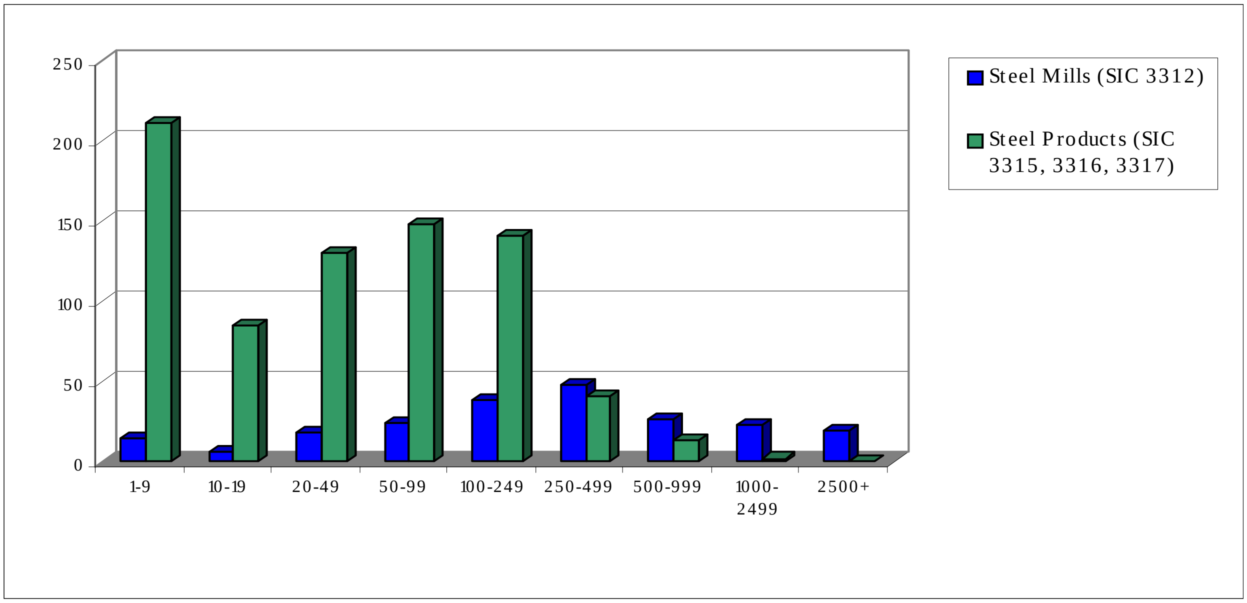
b. Facility size

Seventy-one percent of all steel mills employed 100 or more employees in 1992, as shown in Figure 4D-6. The vast majority, approximately 98 percent, of industry value of shipments in the same year was produced by facilities with more than 100 employees. Facilities with more than 1,000 employees accounted for approximately 69 percent of all steel mill shipments. Data from the 1997 Census of Manufactures for Iron and Steel Mills (NAICS 331111), which is roughly comparable to the SIC 3312 data shown in Figure 4D-6, shows that the 11 percent of facilities with more than 1,000 employees accounted for 63 percent of industry value of shipments in 1997, reflecting growth in the role of minimills from 1992 to 1997.

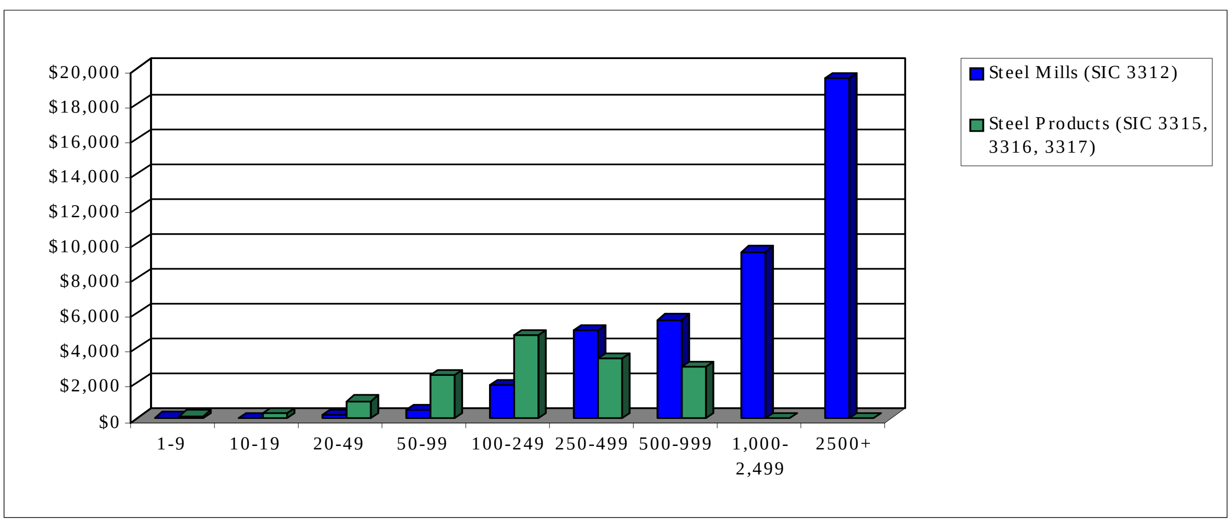
The Steel Products sector is characterized by smaller facilities than steel making, with only 26 percent of facilities in the steel product industry employing 100 or more employees in 1992. While the majority of facilities in the Steel Products sector employed less than 100 people, most of the output from this sector was produced at the largest facilities. Figure 4D-6 shows that steel products facilities with more than 100 employees accounted for approximately 74 percent of the industry's 1992 value of shipments.

Figure 4D-6: Value of Shipments and Number of Facilities by Employment Size Category for the Profiled Steel Industry Sectors

Number of Facilities, 1992



1992 Value of Shipments (in millions)



Source: U.S. DOC, 1987, 1992, and 1997.

c. Firm size

The Small Business Administration (SBA) defines small firms in the profiled steel industries according to the firms' number of employees. Firms in both Steel Mills (SIC 3312) and Steel Products (SIC 3315, 3316, and 3317) are defined as small if they have 1,000 or fewer employees. Table 4D-7 below shows the distribution of firms, facilities, and receipts by the employment size of the parent firm.

The size categories reported in the Statistics of U.S. Businesses (SUSB) do not coincide with the SBA small firm standard of 1,000 employees. It is therefore not possible to apply the SBA size thresholds precisely. The SUSB data presented in Table 4D-6 show that in 1997, 141 of 216 firms in the Steel Mills sector had less than 500 employees. Therefore, at least 65 percent of firms in this sector were classified as small. These small firms owned 143 facilities, or 48 percent of all facilities in the sector, and accounted for 5 percent of industry receipts. In contrast, the 75 largest firms that employ over 500 employees own 52 percent of all facilities in SIC 3312 and are responsible for 95 percent of all industry receipts. Some of these 75 firms may be defined as small under SBA Standards.

Of the 544 ultimate parent firms with facilities that manufacture steel products, 435, or 80 percent, employ fewer than 500 employees, and are therefore considered small businesses. Small firms own 65 percent of facilities in the industry and account for 28 percent of industry receipts. The 109 larger firms that employ over 500 employees own 109 of the 727 facilities in SIC codes 3315, 3316, and 3317 and are responsible for 72 percent of all industry receipts. Again, some of these 109 firms may be classified as small under the SBA Standards.

Table 4D-7: Number of Firms, Facilities, and Estimated Receipts in the Profiled Steel Industry Sectors by Employment Size Category, 1997

Employment Size Category	Steel Mills (SIC 3312)			Steel Products (SIC 3315, 3316, 3317)		
	Number of Firms	Number of Facilities	Estimated Receipts (in millions, constant $2000)	Number of Firms	Number of Facilities	Estimated Receipts (in millions, constant $2000)
0-19	74	74	277	211	211	348
20-99	31	31	116	128	136	1,453
100-499	36	38	2,204	96	126	3,516
500+	75	154	49,018	109	254	13,922
Total	*216*	*297*	*51,615*	*544*	*727*	*19,240*

Source: U.S. SBA, 2000.

d. Concentration and Specialization Ratios

Concentration is the degree to which industry output is concentrated in a few large firms. Concentration is closely related to entry barriers with more concentrated industries generally having higher barriers.

The four-firm ***concentration ratio*** (CR4) and the ***Herfindahl-Hirschman Index*** (HHI) are common measures of industry concentration. The CR4 indicates the market share of the four largest firms. For example, a CR4 of 72 percent means that the four largest firms in the industry account for 72 percent of the industry's total value of shipments. The higher the concentration ratio, the less competition there is in the industry, other things being equal.[5] An industry with a CR4 of more than 50 percent is generally considered concentrated. The HHI indicates concentration based on the largest 50 firms in the industry. It is equal to the sum of the squares of the market shares for the largest 50 firms in the industry. For example, if

[5] Note that the measured concentration ratio and the HHF are very sensitive to how the industry is defined. An industry with a high concentration in domestic production may nonetheless be subject to significant competitive pressures if it competes with foreign producers or if it competes with products produced by other industries (e.g., plastics vs. aluminum in beverage containers). Concentration ratios based on share of production are therefore only one indicator of the extent of competition in an industry.

an industry consists of only three firms with market shares of 60, 30, and 10 percent, respectively, the HHI of this industry would be equal to 4,600 ($60^2 + 30^2 + 10^2$). The higher the index, the fewer the number of firms supplying the industry and the more concentrated the industry. An industry is considered concentrated if the HHI exceeds 1,000.

The Steel Mills (SIC 3312) and Steel Products sectors (SICs 3315, 3316, 3317) are considered competitive, based on standard measures of concentration. The CR4 and the HHI for all the relevant SIC codes are below the benchmarks of 50 percent and 1,000, respectively. The concentration ratios presented in Table 4D-8 indicate that the majority of the output generated in these industry sectors is not concentrated in a few large firms. Moreover, the table shows that each of the industry sectors has became more competitive between 1987 and 1992.

The ***specialization ratio*** is the percentage of the industry's production accounted for by primary product shipments. The ***coverage ratio*** is the percentage of the industry's product shipments coming from facilities from the same primary industry. The coverage ratio provides an indication of how much of the production/product of interest is captured by the facilities classified in an SIC code.

The specialization and coverage ratios in Table 4D-8 show that steel mills (SIC 3312) are highly specialized in the production of steel products. These establishments also account for virtually all of the steel mill product produced in the U.S. Steel Product establishments classified in SIC codes 3315, 3316, and 3317 are also highly specialized, although 20 percent of production in SIC code 3316 are products classified in a different industry. Establishments in SIC codes 3316 and 3317 account for over 95 percent of U.S. production of their primary products, and SIC 3315 accounts for 88 percent. More recent data from the 1997 Census of Manufactures (based on NAICS codes) shows similar specialization and coverage ratios for these industries.

Table 4D-8: Selected Ratios for the Profiled Steel Industry Sectors

SIC Code	Year	Total Number of Firms	Concentration Ratios					Specialization Ratio	Coverage Ratio
			4 Firm (CR4)	8 Firm (CR8)	20 Firm (CR20)	50 Firm (CR50)	Herfindahl-Hirschman Index		
Steel Mills									
3312	1987	271	44%	63%	81%	94%	607	98%	97%
	1992	135	37%	58%	81%	96%	551	98%	97%
Steel Products									
3315	1987	274	21%	34%	54%	78%	212	96%	88%
	1992	271	19%	32%	54%	80%	201	96%	88%
3316	1987	156	45%	62%	82%	95%	654	80%	94%
	1992	158	43%	60%	81%	96%	604	80%	95%
3317	1987	155	23%	34%	58%	85%	242	91%	92%
	1992	166	19%	31%	53%	80%	194	95%	97%

Source: U.S. DOC, 1987, 1992, 1997.

e. Foreign trade

The global market for steel continues to be extremely competitive. From 1945 until 1960, the U.S. steel industry enjoyed a period of tremendous prosperity and was a net exporter until 1959. However, by the early 1960s, foreign steel industries had thoroughly recovered from World War II and had begun construction of new plants that were more advanced and efficient than the U.S. integrated steel mills. Foreign producers also enjoyed lower labor costs, allowing them to take substantial market share from U.S. producers. This increased competition from foreign producers, combined with decreased consumption in some key end use markets, served as a catalyst for the restructuring and downsizing of the U.S. steel industry. The industry has emerged from this restructuring considerably smaller, more technologically advanced and internationally competitive (S&P, 2000).

This profile uses two measures of foreign competition: ***export dependence*** and ***import penetration***. Export dependence is the share of value of shipments that is exported. Import penetration is the share of implied domestic consumption met by imports. Table 4D-9 presents trade statistics for the profiled steel industry sectors from 1990 to 2000. The table shows that while the trend in export dependence has been relatively stable, import penetration has been increasing since the early 1990s. Historically, the U.S. steel industry has exported a relatively small share of shipments when compared to steel industries in other developed nations (McGraw-Hill, 2000). U.S. exports rose in 1995 to the highest level since 1941, but steel exports only accounted for only 7 percent of shipments that year. Imports as a percentage of implied domestic consumption rose to an estimated 30 percent in 1998, from 18 percent in the early 1990s. This increase in imports reflects excess steel capacity worldwide and the competitiveness of foreign steel producers, as described previously. The AISI reports that imports have continued high through August 2001, although 26 percent lower than during the first eight months of 2000 (reflecting a decline in U.S. demand for steel), after the three highest annual import volumes in the period 1998 through 2000 (AISI, 2001a).

Table 4D-9: Import Share and Export Dependence: Steel Mill Products (in thousand metric tons)

Year	Raw Steel Production	Imports	Exports	Shipments	Implied Domestic Consumption[a]	Import Penetration[b]	Export Dependence[c]
1990	89,700	15,600	3,900	77,100	88,800	18%	5%
1991	79,700	14,400	5,760	71,500	80,140	18%	8%
1992	84,300	15,500	3,890	74,600	86,210	18%	5%
1993	88,800	17,700	3,600	80,800	94,900	19%	4%
1994	91,200	27,300	3,470	86,300	110,130	25%	4%
1995	95,200	22,100	6,420	88,400	104,080	21%	7%
1996	95,500	26,500	4,560	91,500	113,440	23%	5%
1997	98,500	28,300	5,470	96,000	118,830	24%	6%
1998	98,600	37,700	5,010	92,900	125,590	30%	5%
1999	97,400	32,400	4,920	96,300	123,780	26%	5%
2000[d]	106,000	36,800	6,000	105,000	135,800	27%	6%
Total Percent Change 1990-2000	*18.2%*	*135.9%*	*53.8%*	*36.2%*	*52.9%*		
Average Annual Growth Rate	*1.7%*	*9.0%*	*4.4%*	*3.1%*	*4.3%*		

[a] Calculated by EPA as shipments + imports - exports.
[b] Calculated by EPA as imports divided by implied domestic consumption.
[c] Calculated by EPA as exports divided by shipments.
[d] Estimated

Source: USGS, 2001; USGS, 1999, USGS, 1997; USGS, 1994; USGS, Historical Statistics for Mineral Commodities in the US.

4D.3 Financial Condition and Performance

The steel industry is generally characterized by relatively large plant sizes and technologically complex production processes which reflect the economies of scale required to manufacture steel efficiently. Because of the high fixed costs associated with steel manufacturing operations, larger production volumes are required to spread these costs over a greater number of units in order to maintain profitability. ***Operating margins*** for steel producers can be volatile due to changes in raw material costs, energy costs, and production levels relative to capacity (S&P, 2001).

Table 4D-10 presents trends in operating margins for steel mills and steel products manufacturers. The table shows that operating margins were relatively stable in both industry sectors between 1987 and 1997. The decrease in operating margins for steel mills and, to a lesser extent, steel products producers in 1991 resulted from a worldwide decrease in steel consumption (McGraw-Hill, 1998).

Table 4D-10: Operating Margins for the Profiled Steel Industry Sectors (in millions, constant $2000)

Year	Steel Mills (SIC 3312)				Steel Products (SIC 3315, 3316, 3317)			
	Value of Shipments	Cost of Materials	Payroll (all employees)	Operating Margin	Value of Shipments	Cost of Materials	Payroll (all employees)	Operating Margin
1987	$39,209	$23,251	$6,528	24.1%	$15,217	$9,830	$2,022	22.1%
1988	$45,284	$27,430	$6,693	24.6%	$16,845	$10,850	$2,055	23.4%
1989	$44,084	$26,678	$6,597	24.5%	$16,378	$10,730	$1,988	22.3%
1990	$43,172	$26,269	$6,885	23.2%	$16,393	$10,804	$2,081	21.4%
1991	$39,158	$24,748	$6,664	19.8%	$15,959	$10,598	$2,088	20.5%
1992	$41,537	$24,984	$6,923	23.2%	$16,722	$10,891	$2,231	21.5%
1993	$43,401	$26,073	$6,786	24.3%	$17,981	$11,599	$2,343	22.5%
1994	$46,994	$28,054	$6,748	25.9%	$18,744	$11,954	$2,302	23.9%
1995	$47,892	$28,725	$6,589	26.3%	$18,990	$12,309	$2,297	23.1%
1996	$47,538	$29,859	$6,805	22.9%	$18,850	$12,152	$2,370	23.0%
1997	$49,777	$29,699	$6,789	26.7%	$18,947	$11,989	$2,414	24.0%
Total Percent Change 1987-1997	*27%*	*28%*	*4%*		*25%*	*22%*	*19%*	
Annual Average Growth Rate	*2.4%*	*2.5%*	*0.4%*		*2.2%*	*2.0%*	*1.8%*	

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

The sharp decline in prices caused by the import surge in 1998 and low operating rates resulted in reduced profitability for U.S. producers. The industry reported an operating loss of $51 million in the first half of 1999, compared with an operating profit of $537 million in the first half in the first half of 1998. Federal legislation was passed in August 1999 authorizing federal loan guarantees of up to $1 billion to the steel industry, to allow steel companies to borrow at market rates to modernize their plants (McGraw-Hill, 2000). Standard & Poor's reported that low operating rates, decreased volume, and lower product prices again led to operating losses for the eight largest steelmakers in the first quarter of 2001, compared with operating profits in the first quarter of 2000. As of June 2001, eight U.S. steel producers had gone bankrupt in the prior two years, including LTV and Trico Steel (a minimill joint venture), (S&P, 2001).

4D.4 Facilities Operating Cooling Water Intake Structures

In 1982, the Primary Metals industries as a whole (including Nonferrous and Steel producers) withdrew 1,312 billion gallons of cooling water, accounting for approximately 1.7 percent of total industrial cooling water intake in the United States. The industry ranked 3rd in industrial cooling water use, behind the electric power generation industry, and the chemical industry (1982 Census of Manufactures).

This section presents information from EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* on existing facilities with the following characteristics:

- they withdraw from a water of the United States;
- they hold an NPDES permit;
- they have a design intake flow of equal to or greater than two MGD;
- they use at least 25 percent of that flow for cooling purposes.

These facilities are not "new facilities" as defined by the section 316(b) New Facility Rule and are therefore not subject to this regulation. However, they meet the criteria of the rule except that they are already in operation. These existing facilities therefore provide a good indication of what new facilities in these sectors may look like. The remainder of this section refers to existing facilities with the above characteristics as "section 316(b) facilities."

a. Cooling water uses and systems

Information collected in EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* found that an estimated 40 out of 158 steel mills (25 percent) and 19 out of 312 steel product manufacturers (6 percent) meet the characteristics of a section 316(b) facility.

Minimills use electric-arc-furnace (EAF) to make steel from ferrous scrap. The electric-arc-furnace is extensively cooled by water and recycled through cooling towers (U.S. EPA, 1995). This is important to note since most new steel facilities are minimills.

Steel section 316(b) facilities use cooling water for a combination of purposes, including contact and non-contact production line or process cooling, electricity generation, and air conditioning:

- All section 316(b) steel mills use cooling water for production line (or process) contact or noncontact cooling. The other major uses of cooling water by steel mills are air conditioning (69 percent), electric generation (43 percent), and other uses (40 percent).

- Ninety-five percent (18 facilities) of section 316(b) steel product facilities use cooling water for production line (or process) contact or noncontact cooling. Other major uses of cooling water for steel product facilities include other uses (79 percent), air conditioning (33 percent), and electric generation (6 percent).

Table 4D-11 shows the distribution of existing section 316(b) facilities in the profiled steel sectors by type of water body and cooling system. The table shows that most of the existing section 316(b) facilities employ a combination of a once-through and recirculating system (25, or 41%) or a once through system (20, or 33%). The largest proportion of existing facilities draw water from a freshwater stream or river (49, or 82%).

Table 4D-11: Number of Section 316(b) Facilities in the Profiled Steel Industry Sectors by Water Body Type and Cooling System Type

Water Body Type	Cooling Systems								Total
	Recirculating		Combination		Once-Through		Unknown		
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	
Steel Mills (SIC 3312)									
Freshwater Stream or River	3	10%	10	32%	12	40%	5	18%	30
Great Lake	0	0%	9	88%	1	12%	0	0%	10
Total [†]	***3***	***8%***	***18***	***46%***	***13***	***33%***	***5***	***13%***	***40***
Steel Products (SIC 3315, 3316, 3317)									
Freshwater Stream or River	6	33%	6	33%	6	33%	0	0%	19
Lake or Reservoir	0	0%	0	0%	0	0%	1	100%	1
Total [†]	***6***	***31%***	***6***	***31%***	***6***	***31%***	***1***	***6%***	***20***
Total for Profiled Steel Industry (SIC 3312, 3315, 3316, 3317)									
Freshwater Stream or River	9	19%	16	32%	19	38%	5	11%	49
Great Lake	0	0%	9	88%	1	12%	0	0%	10
Lake or Reservoir	0	0%	0	0%	0	0%	1	100%	1
Total [a]	***9***	***16%***	***25***	***41%***	***20***	***33%***	***7***	***11%***	***60***

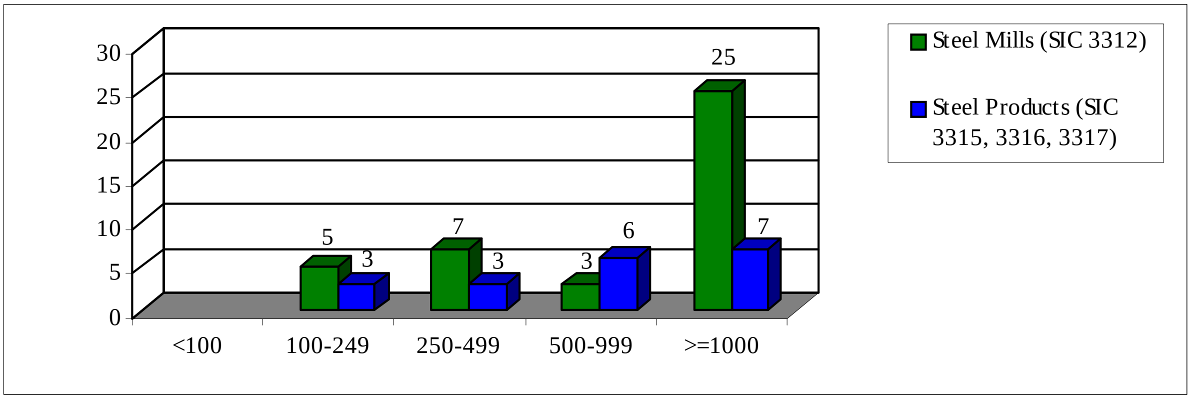
[a] Individual numbers may not add up to total due to independent rounding.

Source: U.S. EPA, 2000.

b. Facility size

The distribution of employment for section 316(b) facilities for steel mills and steel products tends to be larger than the distribution for their respective industries. Sixty-three percent of 316(b) steel mills employ over 1,000 people. None of the 316(b) steel product manufacturers employ less than 100 people.

Figure 4D-7: Number of Section 316(b) Facilities in the Profiled Steel Industry Sectors by Employment Size



Source: U.S. EPA, 2000.

d. Firm size

EPA used the Small Business Administration (SBA) small entity size standards to determine the number of existing section 316(b) profiled steel industry facilities owned by small firms. Table 4D-12 shows that of the 40 section 316(b) steel mills, 6, or 16 percent, are owned by small firms. There are three section 316(b) steel product facilities that are owned by a small firm.

Table 4D-12: Number of Section 316(b) Facilities by Firm Size for the Profiled Steel Sectors

SIC Code	Large		Small		Total
	Number	% of SIC	Number	% of SIC	
Steel Mills (SIC 3312)					
3312	***34***	***84%***	***6***	***16%***	***40***
Steel Products (SIC 3315, 3316, 3317)					
3315	3	100%	0	0%	3
3316	6	67%	3	33%	9
3317	7	100%	0	0%	7
Total†	**17**	**84%**	**3**	**16%**	**20**
Total for Profiled Steel Facilities (SIC 3312, 3315, 3316, 3317)					
Total[a]	**51**	**84%**	**9**	**16%**	**60**

[a] Individual numbers may not add up to total due to independent rounding.

Source: *U.S. EPA, 2000; D&B, 2001.*

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4E ALUMINUM (SIC 333/5)

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified two 4-digit SIC codes in the nonferrous metals industries (SIC codes 333/335) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws equal to or greater than two million gallons per day (MGD) from a water of the United States, and uses at least 25 percent of its intake flow for cooling purposes. (Facilities with these characteristics are hereafter referred to as "section 316(b) facilities".) For each of the two SIC codes, Table 4E-1 below provides a description of the industry sector, a list of products manufactured, the total number of detailed questionnaire respondents (weighted to represent national results), and the number and percent of section 316(b) facilities.

Table 4E-1: Section 316(b) Facilities in the Aluminum Industries (SIC 333/335)

SIC	SIC Description	Important Products Manufactured	Number of Weighted Detailed Questionnaire Survey Respondents		
			Total	Section 316(b) Facilities	
				No.	%
3334	Primary Production of Aluminum	Producing aluminum from alumina and in refining aluminum by any process	31	11	35.8%
3353	Aluminum Sheet, Plate, and Foil	Flat rolling aluminum and aluminum-base alloy basic shapes, such as rod and bar, pipe and tube, and tube blooms; producing tube by drawing	57	6	10.9%
Total			***88***	***17***	***19.6%***

Source: U.S. EPA, 2000; Executive Office of the President, 1987.

4E.1 Domestic Production

Commercial production of aluminum using the electrolytic reduction process, known as the Hall-Heroult process, began in the late 1800s. The production of primary aluminum involves mining bauxite ore and refining it into alumina, one of the feedstocks for aluminum metal. Direct electric current is used to split the alumina into molten aluminum metal and carbon dioxide. The molten aluminum metal is then collected and cast into ingots. Technological improvements over the years have improved the efficiency of aluminum smelting, with a particular emphasis on reducing energy requirements. There is currently no commercially viable alternative to the electrometallurgical process (Aluminum Association, 2001).

Almost half of all U.S.-produced aluminum (48 percent of U.S. output in 2000) comes from recycled scrap. Recycling consists of melting used beverage cans and scrap generated from operations. Recycling saves approximately 95 percent of the energy costs involved in primary smelting from bauxite (S&P, 2001). In contrast to the steel industry, aluminum minimills have had limited impact on the profitability of traditional integrated aluminum producers. Aluminum minimills are not able to produce can sheet of the same quality as that produced by integrated facilities. They are able to compete only in production of commodity sheet products for the building and distributor markets, which are considered mature markets. According to Standard & Poor's, construction of new minimill capacity is unlikely given the potential that added capacity would drive down prices in the face of slow growth in the markets for minimill products (S&P, 2001). No secondary smelters (included, along with secondary smelting of other metals, in SIC code 3341) were reported in EPA's detailed questionnaire. These facilities are therefore not addressed in this profile.

Facilities in SIC code 3353 produce semifabricated products from primary or secondary aluminum. Examples of semifabricated aluminum products include (Aluminum Association, undated):

- sheet (cans, construction materials, and automotive parts);
- plate (aircraft and spacecraft fuel tanks);
- foil (household aluminum foil, building insulation, and automotive parts);
- rod, bar, and wire (electrical transmission lines); and
- extrusions (storm windows, bridge structures, and automotive parts).

U.S. aluminum companies are generally vertically integrated. The major aluminum companies own large bauxite reserves, mine bauxite ore and refine it into alumina, produce aluminum ingot, and operate the rolling mills and finishing plants used to produce semifabricated aluminum products (S&P, 2001).

a. Output

The largest single source of demand for aluminum is the transportation sector, primarily the manufacture of motor vehicles. Demand for lighter, more fuel efficient vehicles has led to increased demand for aluminum in auto manufacturing, at the expense of steel (S&P, 2001). Until five years ago, containers were the largest U.S. market for aluminum. Production of beverage cans is a major use of aluminum sheet, and aluminum has almost entirely replaced steel in the beverage can market. Other major uses of aluminum include construction (including aluminum siding, windows, and gutters) and consumer durables (USGS, 2001).

Demand for aluminum reflects the overall state of the domestic and world economies, as well as long-term trends in materials use in major end-use sectors. Because aluminum production involves large fixed investments and capacity adapts only slowly to fluctuations in demand, the industry has experienced alternating periods of excess capacity and tight supplies. The early 1980s were a period of oversupply, high inventories, excess capacity, and weak demand. By 1986, excess capacity had been closed, inventories were low, and demand increased dramatically. The early 1990s were affected by reduced U.S. demand and by the dissolution of the Soviet Union, which resulted in dramatic increases in Russian exports of aluminum. By the mid-1990s, global production had declined, demand rebounded, and aluminum prices rebounded. Subsequent increases in production reflected an overall increase in the demand for aluminum with stronger domestic economic growth, driven by increased consumption by the transportation, container, and construction sectors. The economic crises in Asian markets in the later 1990s, along with growing Russian exports, again resulted in a period of oversupply, although U.S. demand for aluminum remained strong. Sales to the automotive sector were at record levels in 1999 and 2000. Demand has declined starting in 2000, however, reflecting slower growth in both the U.S. and the world economy. In addition, there has been a major decrease in production from primary smelters affected by the Pacific Northwest energy crisis (Aluminum Association, 1999; USGS, 1999; USGS, 1998; USGS, 1994; Value Line, 2001).

Table 4E-2 shows trends in output of aluminum by primary aluminum producers and recovery of aluminum from old and new scrap. Secondary production grew from 37 percent to almost half of total domestic production over the period from 1990 to 2000. Of the total secondary production in 2000, 1,430 thousand metric tons (MT) or 42 percent, is from old scrap (discarded aluminum products), as opposed to new scrap (from manufacturing). Primary production of aluminum has showed a small net decrease over the 10-year period, and declined sharply in the first half of 2001 compared to the same period in 2000. This decrease reflects reduced domestic and world demand for aluminum, and curtailed production at a number of Pacific Northwest mills caused by the California energy crisis (S&P 2001; USGS, 2001a).

Table 4E-2: Quantities of Aluminum Produced

Year	Aluminum Ingot			
	Primary Production		Secondary Production (from old & new scrap)	
	Thousand MT	% Change	Thousand MT	% Change
1990	4,048	n/a	2,390	n/a
1991	4,121	1.8%	2,290	-4.2%
1992	4,042	-1.9%	2,760	20.5%
1993	3,695	-8.6%	2,940	6.5%
1994	3,299	-10.7%	3,090	5.1%
1995	3,375	2.3%	3,190	3.2%
1996	3,577	6.0%	3,310	3.8%
1997	3,603	0.7%	3,550	7.3%
1998	3,713	3.1%	3,440	-3.1%
1999	3,779	1.8%	3,750	9.0%
2000	3,688	-2.4%	3,460	-7.7%
Total percent change 1990-2000	-8.9%		*44.8%*	
Average annual growth rate	-0.9%		*3.8%*	
Jan-July 2000	2,202	n/a	2,070	n/a
Jan-July 2001	1,592	-27.7%	1,820	-12.1%

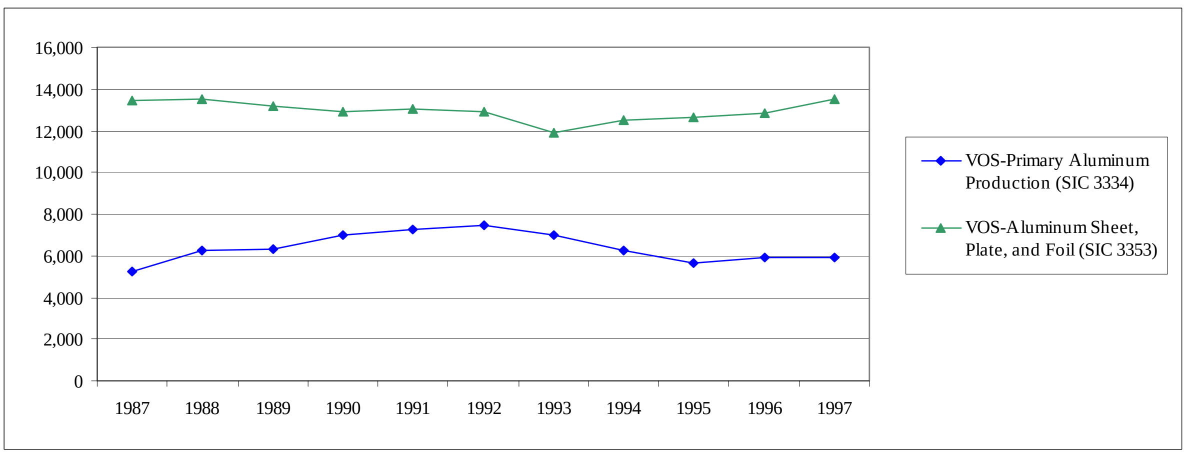
Source: USGS, 2001b; USGS, 1999; USGS, 1994;.

Value of shipments and ***value added*** are two measures of the value of manufacturing output.[1] Historical trends provide insight into the overall economic health and outlook for an industry. Value of shipments is the sum of the receipts a manufacturer earns from the sale of its outputs. It is an indicator of the overall size of a market or the size of a firm in relation to its market or competitors. Value added is used to measure the value of production activity in a particular industry. It is the difference between the value of shipments and the value of inputs used to make the products sold.

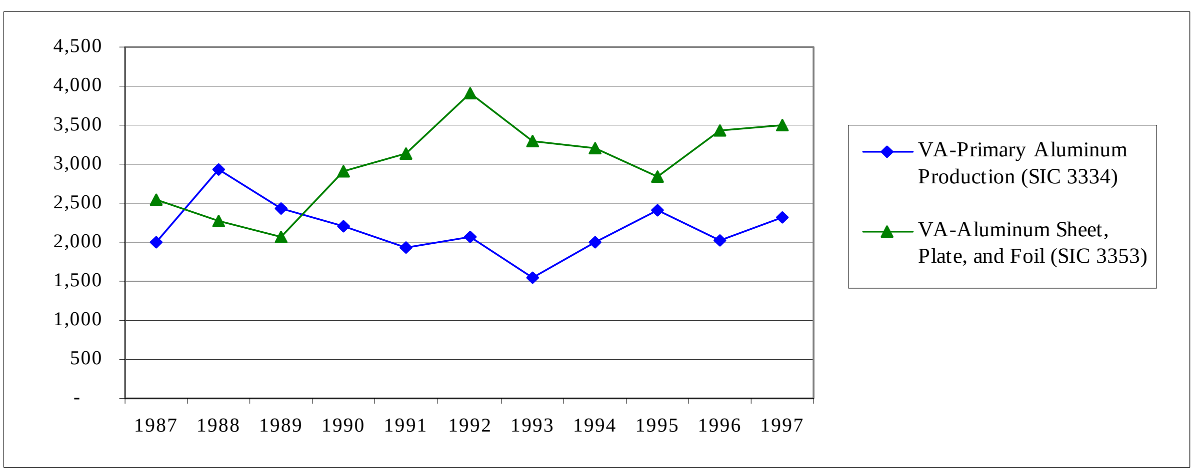
Figure 4E-1 presents trends in real value of shipments and real value added for the primary aluminum, and aluminum sheet, plate, and foil sectors between 1987 and 1997. The producer price index for the 4-digit SIC code is used to inflate the nominal monetary values to constant 2000 dollars, as discussed in the following sub-section on prices.

Figure 4E-1: Real Value of Shipments and Value Added for Profiled Aluminum Sectors (in millions, constant $2000)

Real Value of Shipments



Real Value Added



Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992 and 1997.

[1] Terms highlighted in bold and italic font are further explained in the glossary.

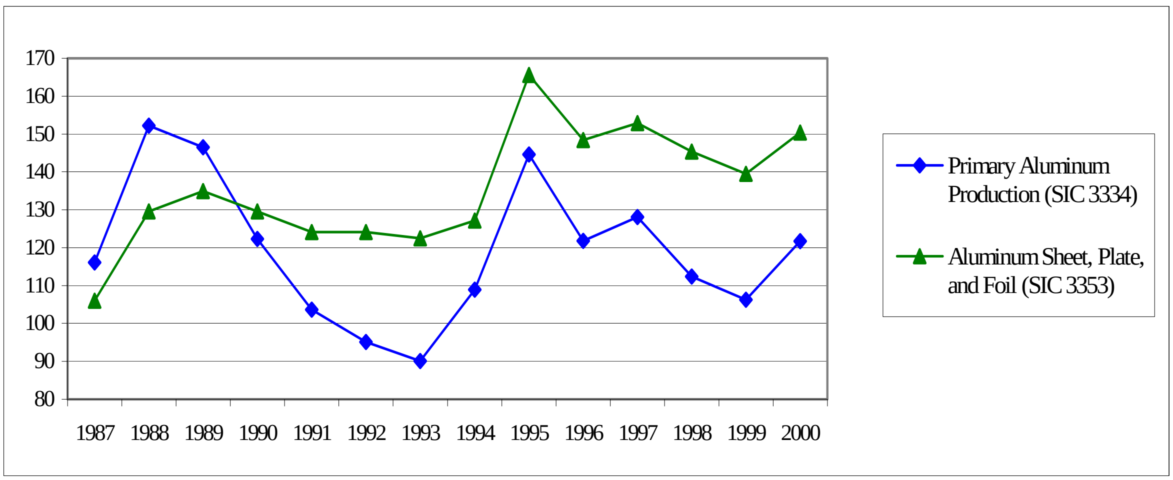
The real value of primary aluminum shipments shows generally the same pattern as the quantity data shown in Table 4E-2. Trends in production reflect trends in demand for aluminum, growth since 1990 in the percentage of domestic demand provided by imports, and increasing secondary production of aluminum, which substitutes in some but not all markets for primary production. Real value added by aluminum production excludes the value of purchased materials and services (including electricity), and shows more fluctuation since 1990 than real value of shipments.

Demand for semifinished aluminum products reflects demand from the transportation, container, and building industries. Real value of shipments of aluminum sheet, plate, and foil declined from the late 1980s through 1993, and then recovered. Demand for semifinished products has been affected by strong growth in both the container and packaging sector and the auto sector (S&P, 2001).

b. Prices

Figure 4E-2 shows the ***producer price index*** (PPI) for the 4-digit SIC code for the profiled aluminum sectors. The PPI is a family of indexes that measure price changes from the perspective of the seller. This profile uses the PPI to convert nominal monetary values to constant dollars. Sharp changes in prices reflect the cyclical nature of this industry and major changes in world markets.

Figure 4E-2: Producer Price Indexes for Profiled Aluminum Sectors



Source: BLS, 2000.

The price trends shown for primary aluminum in Figure 4E-2 reflect the fluctuations in world supply and demand discussed in the previous section. During the early 1980s, the aluminum industry experienced oversupply, high inventories, excess capacity, and weak demand, resulting in falling prices for aluminum. By 1986, much of the excess capacity had been permanently closed, inventories had been worked down, and worldwide demand for aluminum increased dramatically. This resulted in price increases through 1988, as shown in Figure 4E.2.

In the early 1990s, the dissolution of the Soviet Union had a major impact on aluminum markets. Large quantities of Russian aluminum that formerly had been consumed internally, primarily in military applications, were sold in world markets to generate hard currency. At the same time, world demand for aluminum was decreasing. The result was increasing inventories and depressed aluminum prices.

The United States and five other primary aluminum producing nations signed an agreement in January 1994 to curtail global output, in response to the sharp decline in aluminum prices. At the time of the agreement, there was an estimated global overcapacity of 1.5 to 2.0 million metric tons per year (S&P, 2000).

By the mid-1990s, production cutbacks, increased demand, and declining inventories led to a sharp rebound of prices. Prices declined again during the late 1990s, when the economic crises in Asian markets reduced the demand for aluminum (USGS, 2001b). During 2000, prices rebounded sharply despite the continuing trend of high Russian production and exports. The improved market for aluminum reflects strong worldwide demand and a decrease in U.S. production (S&P, 2001).

c. Number of facilities and firms

Data compiled by the U.S. Geological Survey suggest that the number of primary aluminum facilities and the number of firms that own them has remained fairly constant over the period 1995 through 1995, as shown in Table 4E-3.

Table 4E-3: Primary Aluminum Production - Number of Companies and Number of Plants

Year	Number of Companies	Number of Plants
1995	13	22
1996	13	22
1997	13	22
1998	13	23
1999	12	23
2000	12	23

Source: USGS, 2001a.

Statistics of U.S. Businesses covers a larger number of facilities classified under SIC 3334 than do the USGS data, and also provide data on SIC 3353 (Aluminum Sheet, Plate, and Foil). These data, shown in Table 4E-4 and 4E-5, show more fluctuation in the number of establishments and the number of firms.

Table 4E-4 shows that the number of primary aluminum facilities decreased by 30 percent between 1991 and 1995, with the majority of this decrease, 27 percent, occurring between 1991 and 1993. The number of facilities in the aluminum sheet, plate, and foil sector has shown a more consistent trend, increasing each year except in 1993.

Table 4E-4: Number of Facilities for Profiled Aluminum Sectors

Year	Primary Aluminum Production (SIC 3334)		Aluminum Sheet, Plate, and Foil (SIC 3353)	
	Number of Establishments	Percent Change	Number of Establishments	Percent Change
1989	56	n/a	61	n/a
1990	54	-3.6%	64	4.9%
1991	57	5.6%	73	14.1%
1992	52	-8.8%	73	0.0%
1993	44	-15.4%	63	-13.7%
1994	41	-6.8%	69	9.5%
1995	40	-2.4%	76	10.1%
1996	51	27.5%	81	6.6%
1997	34	-33.3%	91	12.3%
Total Percent Change 1989-1997	*-39.3%*		*49.2%*	
Average Annual Growth Rate	*-6.0%*		*5.1%*	

Source: U.S. SBA, 2000.

The trend in the number of firms over the period between 1989 and 1997 has been similar to the trend in the number of facilities in both industry sectors. Table 4E-5 presents SUSB information on the number of firms in each sector between 1989 and 1997.

Table 4E-5: Number of Firms for Profiled Aluminum Sectors

Year	Primary Aluminum Production (SIC 3334)		Aluminum Sheet, Plate, and Foil (SIC 3353)	
	Number of Firms	Percent Change	Number of Firms	Percent Change
1990	38	n/a	43	n/a
1991	41	7.9%	53	23.3%
1992	36	-12.2%	53	0.0%
1993	33	-8.3%	45	-15.1%
1994	30	-9.1%	47	4.4%
1995	30	0.0%	51	8.5%
1996	40	33.3%	56	9.8%
1997	23	-42.5%	66	17.6%
Total Percent Change 1990-1997	*-39.5%*		*53.5%*	
Average Annual Growth Rate	*-6.9%*		*6.3%*	

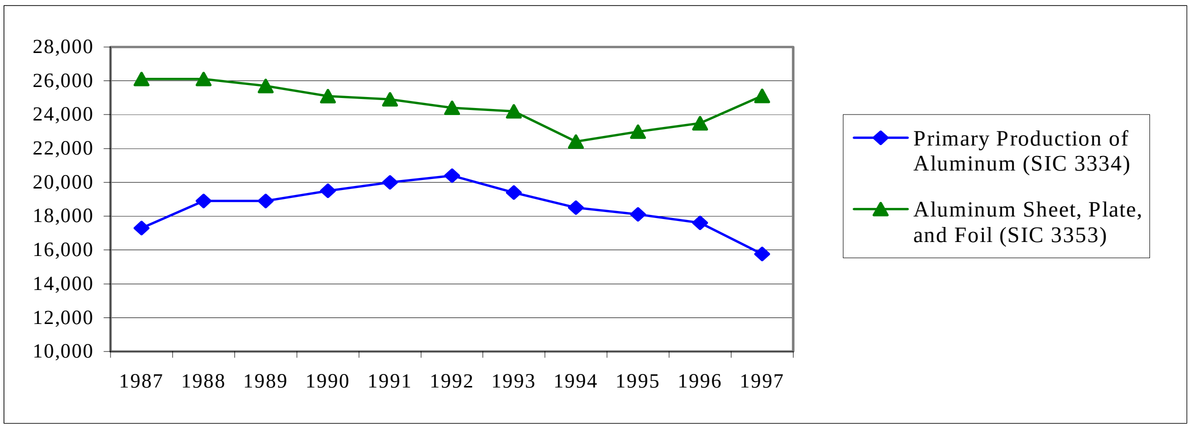
Source: U.S. SBA, 2000.

d. Employment and productivity

Figure 4E-3 below provides information on employment from the Annual Survey of Manufactures for the primary aluminum and aluminum sheet, plate, and foil sectors. Trends in primary aluminum facility employment reflect both trends in production and producers' efforts to improve labor productivity to compete with less labor-intensive minimills (McGraw-Hill, 2000). The figure shows that employment in the primary aluminum production sector has declined steadily since 1992, even in years of increased production.

Employment in the aluminum sheet, plate, and foil sector declined from 1987 through 1994, yet rose after that. There were 26,100 people employed in the aluminum sheet sector in 1987 but only 22,400 in 1994. Employment in this sector increased from its lowest level in 1994 steadily through 1997.

Figure 4E-3: Employment for Profiled Aluminum Sectors



Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

Table 4E-6 presents the change in real value added per labor hour, a measure of ***labor productivity***, for the primary aluminum and aluminum sheet, plate, and foil sectors between 1987 and 1997. The trend in labor productivity in both sectors has shown a fair amount of volatility over this period, reflecting variations in capacity utilization. Real value added per hour in the primary aluminum sector decreased 47 percent between 1988 and 1993 but showed a 23 percent net increase over the entire period 1987 and 1997. Real value added per hour in the aluminum sheet, plate, and foil sector saw substantial increases in the early 1990s, improving by 48 percent between 1989 and 1992 and 33 percent between 1988 and 1997.

Table 4E-6: Productivity Trends for Profiled Aluminum Sectors

Year	Primary Production of Aluminum (SIC 3334)				Aluminum Sheet, Plate, and Foil (SIC 3353)			
	Value Added (in millions, constant $2000)	Production Hours (millions)	Value Added/Hour		Value Added (in millions, constant $2000)	Production Hours (millions)	Value Added/Hour	
			$2000	Percent Change			$2000	Percent Change
1987	1,992	28	72	n/a	2,540	40	63	n/a
1988	2,929	32	92	27%	2,274	41	55	-13%
1989	2,435	30	80	-12%	2,079	41	51	-8%
1990	2,195	32	68	-15%	2,911	40	73	44%
1991	1,936	32	60	-12%	3,127	39	80	8%
1992	2,060	32	64	6%	3,914	40	98	23%
1993	1,550	29	53	-16%	3,305	39	86	-13%
1994	2,007	27	75	40%	3,199	37	88	2%
1995	2,419	28	85	15%	2,824	38	74	-15%
1996	2,019	29	71	-17%	3,422	39	88	19%
1997	2,311	26	89	25%	3,507	42	84	-5%
Total Percent Change 1987-1997	*16.0%*	*-7.1%*	*23.6%*		*38.1%*	*5.0%*	*33.3%*	
Average Annual Growth Rate	*1.5%*	*-0.7%*	*2.1%*		*3.3%*	*0.5%*	*2.9%*	

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

e. Capital expenditures

Aluminum production is a highly capital-intensive process. Capital expenditures are needed to modernize, replace, and when market conditions warrant, expand capacity. Environmental requirements also require major capital expenditures. Possible measures required to reduce greenhouse gas (GHG) emissions may require significant expenditures by aluminum producers.

Capital expenditures in the primary aluminum and aluminum sheet, plate, and foil sectors between 1987 and 1997 are presented in Table 4E-7 below. The table shows that capital expenditures in the primary aluminum sector increased throughout the early 1990s, peaking in 1992. This period of increased capital investment was followed by a significant decrease of 54 percent between 1993 and 1995. These decreases resulted from the production cutbacks and capacity reductions implemented in response to oversupply conditions prevalent in the market for aluminum.

Capital expenditures in the aluminum sheet, plate, and foil sector have also fluctuated considerably between 1987 and 1997, with the highest in 1990, two years earlier than the primary aluminum sector. Producers of aluminum sheet, plate, and foil reduced capital expenditures by 47 percent between 1988 and 1997.

Table 4E-7: Capital Expenditures for Profiled Aluminum Sectors (in millions, constant $2000)

Year	Primary Aluminum Production (SIC 3334)		Aluminum Sheet, Plate, and Foil (SIC 3353)	
	Capital Expenditures	Percent Change	Capital Expenditures	Percent Change
1987	182	n/a	623	n/a
1988	117	-35.5%	608	-2.4%
1989	151	28.7%	615	1.2%
1990	187	23.7%	791	28.5%
1991	244	30.4%	687	-13.1%
1992	275	12.9%	507	-26.3%
1993	226	-18.0%	296	-41.5%
1994	135	-40.2%	324	9.3%
1995	128	-5.5%	344	6.2%
1996	207	62.1%	406	17.9%
1997	240	16.0%	329	-18.9%
Total Percent Change 1987-1997	*31.9%*		*-47.2%*	
Average Annual Growth Rate	*2.8%*		*-6.2%*	

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

f. Capacity utilization

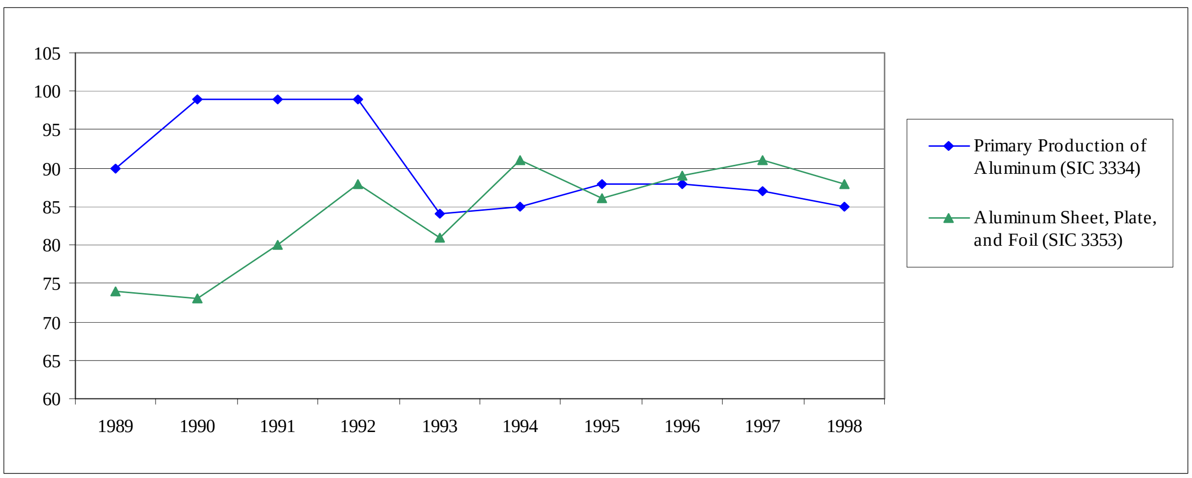
Capacity utilization measures actual output as a percentage of total potential output given the available capacity. Capacity utilization reflects excess or insufficient capacity in an industry and is an indication of whether new investment is likely.

Figure 4E-4 presents the capacity utilization index from 1989 to 1998 for the primary aluminum and aluminum sheet, plate, and foil sectors. The figure shows that for most of the 1990s, the primary aluminum industry was characterized by excess capacity. The capacity utilization index for this sector was near 100 percent between 1990 and 1992, and then decreased sharply in 1993 as large amounts of Russian aluminum entered the global market for the first time (McGraw-Hill, 1999). Capacity utilization remained low through 1996, reflecting the continued oversupply in the global aluminum market.

There continues to be a substantial amount of idled capacity in the U.S. that could be brought on-line as demand improves, which is likely to limit construction of new capacity and to limit price increases for aluminum (S&P, 2001). There has not been any new smelter capacity constructed in the United States since 1980 (McGraw-Hill, 1999). Deregulation of the U.S. power industry may encourage some smelter expansions in the U.S., if electricity prices decrease significantly once electricity markets are deregulated.

Capacity utilization in the aluminum sheet, plate, and foil sector has fluctuated but has grown overall between 1989 and 1998. This positive trend is largely driven by the continued strength of rolled aluminum products, which account for more than 50 percent of all shipments from the aluminum industry. Increased consumption by the transportation sector, the largest end-use sector for aluminum sheet, plate, and foil, is responsible for bringing idle capacity into production (McGraw-Hill 1999).

Figure 4E-4: Capacity Utilization Rates (Fourth Quarter) for Profiled Aluminum Sectors



Source: U.S. DOC, 1989-1998.

4E.2 Structure and Competitiveness

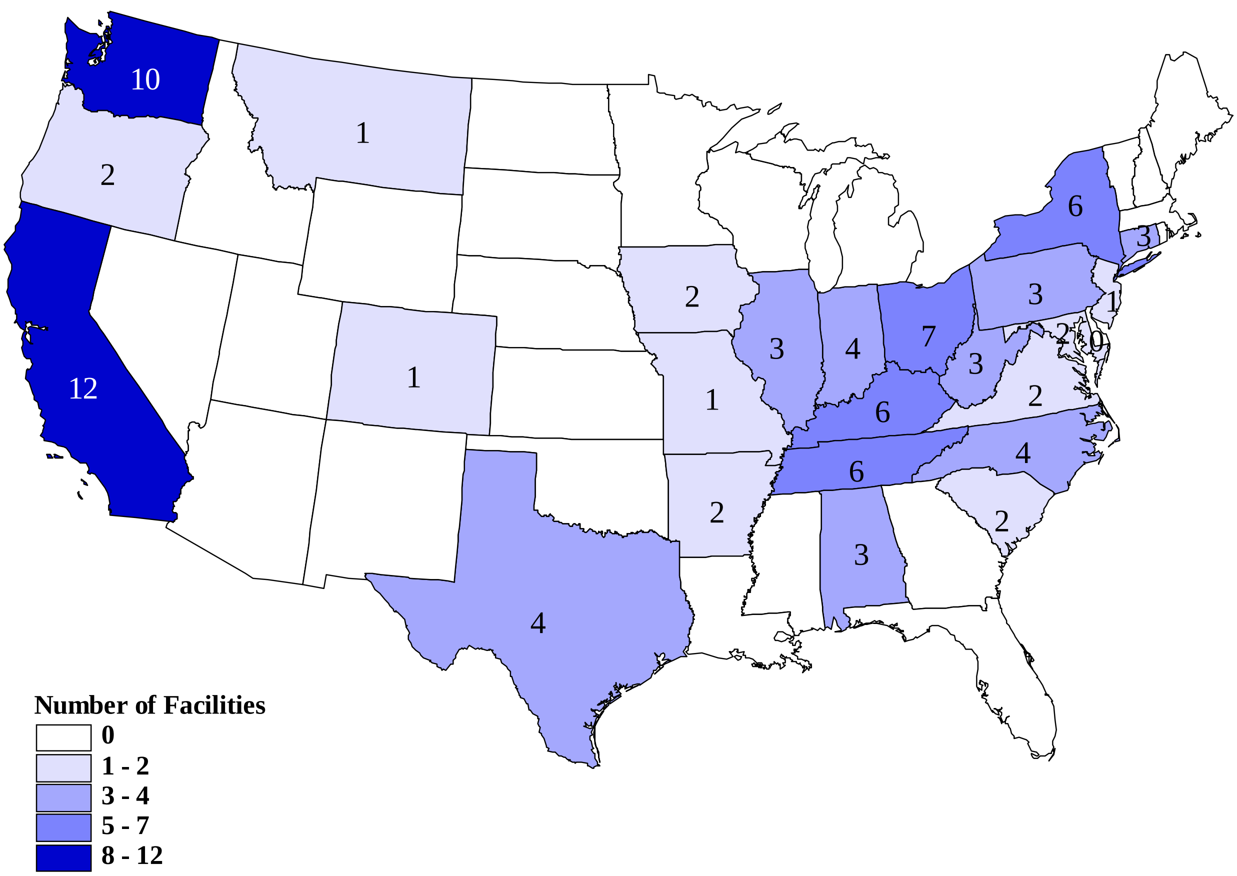
Aluminum production is a highly-concentrated industry. A number of large mergers among aluminum producers have increased the degree of concentration in the industry. For example, Alcoa (the largest aluminum producer) acquired Alumax (the third largest producer) in 1998 and Reynolds (the second largest producer) in May 2000. Some sources speculate that, with increased consolidation resulting from mergers, aluminum producers might refrain from returning idle capacity to production as demand for aluminum grows, which could reduce the cyclical volatility in production and aluminum prices that has characterized the industry in the past (S&P, 2000).

a. Geographic distribution

The cost and availability of electricity is a driving force behind decisions on the location of new or expanded smelter capacity. The primary aluminum producers (SIC 3334) are generally located in the Pacific Northwest (OR, MT, WA) and the Ohio River Valley (IL, IN, KY, MI, MO, OH, PA), where they are usually abundant supplies of hydroelectric and coal-based energy. In 1998, approximately 39 percent of the domestic production capacity was located in the Pacific Northwest and 32 percent in the Ohio River Valley. The aluminum sheet, plate, and foil industry is located principally in California and the Appalachian Region (Alabama, Kentucky, Maryland, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia).

Figure 4E-5 shows the distribution of all facilities in both profiled aluminum sectors (primary smelters and aluminum sheet, plate, and foil producers), based on the 1992 Census of Manufactures.

Figure 4E-5: Number of Facilities by State for Aluminum Sectors (SIC 3334 and 3353)



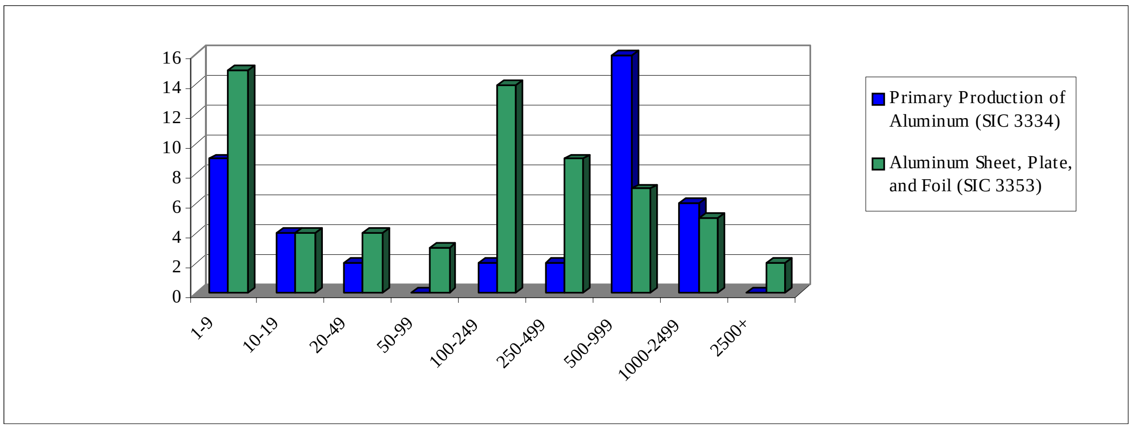
Source: U.S. DOC, 1987, 1992, and 1997.

b. Facility size

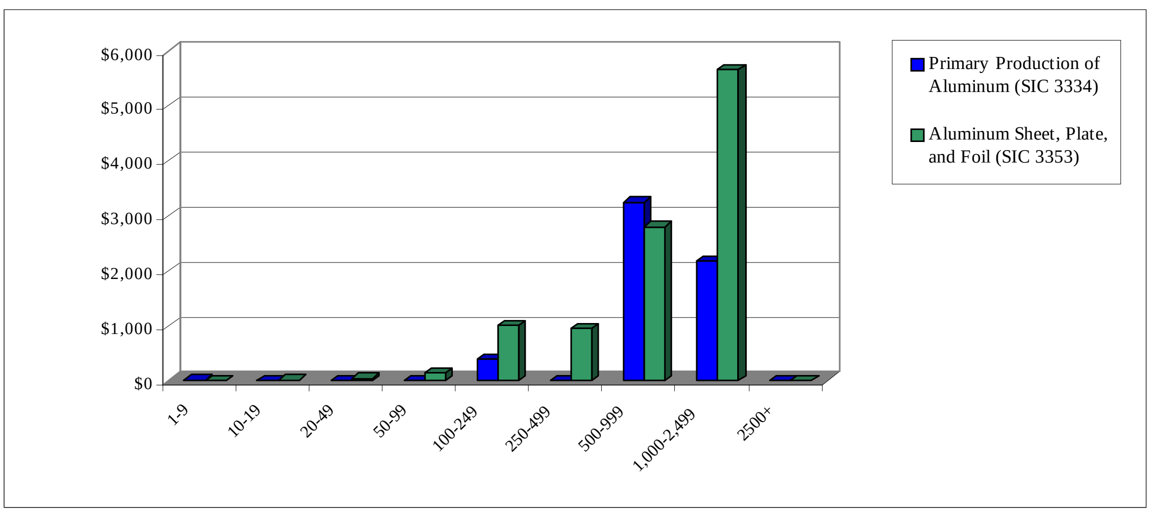
Facility size can be expressed by the number of employees and/or by the total value of shipments, with the most accurate depiction of size being a combination of both. Census data by SIC code include numerous small facilities (less than 10 employees) for the profiled aluminum sectors, as shown in Figure 4E-6. These facilities may or may not be production facilities. Value of shipments, however, are dominated by large establishments (greater than 500 employees) for both primary aluminum production and aluminum sheet, plate, and foil industries. Figure 4E-6 shows that 93 percent of the value of shipments for the primary aluminum production industry is produced by establishments with more than 250 employees. Approximately 88 percent of the value of shipments for the aluminum sheet, plate, and foil industry is produced by establishments with more than 250 employees. Establishments in the primary aluminum production and the aluminum sheet, plate, and foil sectors with more than 1,000 employees are responsible for approximately 37 and 53 percent of all industry shipments, respectively.

Figure 4E-6: Value of Shipments and Number of Facilities in 1992 by Employment Size Category for Profiled Aluminum Sectors

Number of Facilities



1992 Value of Shipments (in millions)



Source: U.S. DOC, 1987, 1992, and 1997.

c. Firm size

The Small Business Administration (SBA) defines a small firm for SIC codes 3334 and 3353 as a firm with 1,000 or fewer and 750 or fewer employees, respectively. The Statistics of U.S. Businesses (SUSB) provide employment data for firms with 500 or fewer employees and do not specify data for companies with 500-750 employees for SIC 3353 and 500-1000 for SIC 3334. Therefore, based on the data for firms with up to 500 employees,

- 8 of the 23 firms in the Primary Aluminum Production sector (SIC 3334) had less than 500 employees. Therefore, at least 35 percent of firms are classified as small. These small firms owned 8 facilities, or 24 percent of all facilities in the sector.
- 49 of the 66 firms in the Aluminum Sheet, Plate and Foil sector (SIC 3353) had less than 500 employees. Therefore, at least 74 percent of firms are classified as small. These small firms owned 49 facilities, or 54 percent of all facilities in the sector.

Table 4E-8 below shows the distribution of firms, facilities, and receipts in SIC 3334 and 3353 by the employment size of the parent firm. While there are some very small firms in each four-digit SIC code, it is unlikely that these small firms operate the facilities that are most likely to be affected by the section 316(b) requirements.

Table 4E-8: Number of Firms, Establishments and Estimated Receipts by Employment Size Category for the Profiled Aluminum Sectors, 1997

Employment Size Category	Primary Aluminum Production (SIC 3334)			Aluminum Sheet, Plate, and Foil (SIC 3353)		
	Number of Firms	Number of Facilities	Estimated Receipts ($2000 millions)	Number of Firms	Number of Facilities	Estimated Receipts ($2000 millions)
0-19	5	5	31	28	28	44
20-99	2	2	13	12	12	93
100-499	1	1	6	9	9	428
500+	15	26	6,003	17	42	12,603
Total	*23*	*34*	*6,053*	*66*	*91*	*13,168*

Source: U.S. SBA, 2000.

d. Concentration and Specialization Ratios

Concentration is the degree to which industry output is concentrated in a few large firms. Concentration is closely related to entry barriers with more concentrated industries generally having higher barriers.

The four-firm ***concentration ratio*** (CR4) and the ***Herfindahl-Hirschman Index*** (HHI) are common measures of industry concentration. The CR4 indicates the market share of the four largest firms. For example, a CR4 of 72 percent means that the four largest firms in the industry account for 72 percent of the industry's total value of shipments. The higher the concentration ratio, the less competition there is in the industry, other things being equal.[2] An industry with a CR4 of more than 50 percent is generally considered concentrated. The HHI indicates concentration based on the largest 50 firms in the industry. It is equal to the sum of the squares of the market shares for the largest 50 firms in the industry. For example, if an industry consists of only three firms with market shares of 60, 30, and 10 percent, respectively, the HHI of this industry would be equal to 4,600 ($60^2 + 30^2 + 10^2$). The higher the index, the fewer the number of firms supplying the industry and the

[2] Note that the measured concentration ratio and the HHF are very sensitive to how the industry is defined. An industry with a high concentration in domestic production may nonetheless be subject to significant competitive pressures if it competes with foreign producers or if it competes with products produced by other industries (e.g., plastics vs. aluminum in beverage containers). Concentration ratios based on share of domestic production are therefore only one indicator of the extent of competition in an industry.

more concentrated the industry. An industry is considered concentrated if the HHI exceeds 1,000.

The four largest firms in primary aluminum production accounted for 59 percent of total U.S. primary capacity in 1992. Consolidation in the industry since the early 1990s has increased concentration. With the merger of Alcoa, Inc. and Reynolds in May 2000, the single merged company accounts for 56 percent of domestic primary aluminum capacity, and the four largest U.S. producers control 74 percent of the domestic capacity reported at the end of 1999 (USGS, 1999). The three largest firms accounted for 62 percent of U.S. primary capacity (Alcoa Inc. for 44 percent, Reynolds for almost 11 percent, and Kaiser Aluminum Corp. for almost 7 percent) (S&P, 2001).[3]

The ***specialization ratio*** is the percentage of the industry's production accounted for by primary product shipments. The ***coverage ratio*** is the percentage of the industry's product shipments coming from facilities from the same primary industry. The coverage ratio provides an indication of how much of the production/product of interest is captured by the facilities classified in an SIC code. The reported ratios in Table 4E-9 indicate that establishments classified in SIC's 3334 and 3353 are highly specialized in production of aluminum and aluminum products, and that these establishments account for virtually all of the aluminum and semifinished aluminum product produces in the U.S.

Table 4E-9: Selected Ratios for the Profiled Aluminum Sectors

SIC Code	Year	Total Number of Firms	Concentration Ratios					Specialization Ratio	Coverage Ratio
			4 Firm (CR4)	8 Firm (CR8)	20 Firm (CR20)	50 Firm (CR50)	Herfindahl-Hirschman Index		
3334	1987	34	74%	95%	99%	100%	1934	95%	100%
	1992	30	59%	82%	99%	100%	1456	n/a	99%
3353	1987	39	74%	91%	99%	100%	1719	96%	98%
	1992	45	68%	86%	99%	100%	1633	96%	98%

Source: U.S. DOC, 1987, 1992, and 1997.

[3] Alcoa Inc. and Reynolds merged in May 2000, following approval by the U.S. Department of Justice.

e. Foreign trade

U.S. aluminum companies have a large overseas presence, which makes it difficult to analyze import data. Reported import data may reflect shipments from an overseas facility owned by a U.S. firm. The import data therefore do not provide a completely accurate picture of the extent to which foreign companies have penetrated the domestic market for aluminum.

Table 4E-10 shows trends in export dependence and import share for aluminum ingot, semifabricated products and scrap combined, since 1990. Imports of primary aluminum rose dramatically in both 1993 and 1994, primarily due to the large exports from Russian producers. Representatives of major aluminum producing countries met in late 1993 and 1994 to address the excess global supply of primary aluminum. Those discussions resulted in the Russian Federation's agreement to reduce production by 500,000 MTs per year, and plans for other producers to cut their production and to assist Russian producers to improve their environmental performance and stimulate the development of internal demand for the Russian production (USGS Minerals Yearbook, 1994). Nonetheless, imports have continued to represent a substantial and growing proportion of U.S. demand. Exports of aluminum and aluminum products combined have remained at approximately 30 percent of domestic production since the mid-1990s, increasing slightly by 2000.

Table 4E-10: Import Share and Export Dependence: Aluminum Ignot, Semifinished, and Scrap (in thousand metric tons)

Year	Production (Primary + Recycled from Old Scrap)	Imports for Consumption	Exports	Apparent Consumption[a]	Imports as a Share of Apparent Consumption[b]	Exports as a Percent of Production[c]
1990	5,407	1,514	1,659	5,264	28.8%	30.7%
1991	5,441	1,490	1,760	5,040	29.6%	32.3%
1992	5,652	1,730	1,450	5,730	30.2%	25.7%
1993	5,325	2,540	1,210	6,600	38.5%	22.7%
1994	4,799	3,380	1,370	6,880	49.1%	28.5%
1995	4,885	2,980	1,610	6,300	47.3%	33.0%
1996	5,147	2,810	1,500	6,610	42.5%	29.1%
1997	5,133	3,080	1,570	6,720	45.8%	30.6%
1998	5,213	3,550	1,590	7,090	50.1%	30.5%
1999	5,349	4,000	1,640	7,740	51.7%	30.7%
2000[d]	5,300	4,200	1,750	7,900	53.2%	33.0%
Total Percent Change 1990-2000	*-2.0%*	*177.4%*	*5.5%*	*50.1%*		
Average Annual Percent Change	*-0.2%*	*10.7%*	*0.5%*	*4.1%*		

[a] Calculated by USGS as domestic primary metal production + recovery from old aluminum scrap + net import reliance. Net import c reliance calculated by USGS as imports - exports + adjustments for Government and industry stock changes.
[b] Calculated by EPA as imports divided by apparent consumption.
[c] Calculated by EPA as exports divided by domestic production (primary + recovery from old aluminum scrap)
[d] Estimated

Source: USGS, 2001a; USGS, 1999; USGS, 1997; USGS, 1994; USGS, Historical Statistics for Mineral Commodities in the US .

Table 4E-11 shows trends in exports and imports separately for aluminum metal and alloys and for semifinished products separately. This table shows that imports have grown substantially in both categories between 1993 and 2000, but that the composition of exports has shifted from primary aluminum (exports of which have declined substantially) to semifinished (exports of which have grown substantially over the period shown). Exports and imports of both product categories declined sharply in the first half of 2001, due to the reduction in demand in the U.S. and abroad.

Table 4E-11: Trade Statistics for Aluminum and Semifabricated Aluminum Products (in thousand metric tons)

Year	Metals and Alloys, Crude		Plate, Sheets, Bars, Strip, etc.	
	Import Quantities	Export Quantities	Import Quantities	Export Quantities
1993	1,840	400	400	594
1994	2,480	339	507	719
1995	1,930	369	622	812
1996	1,910	417	498	760
1997	2,060	352	562	882
1998	2,400	265	649	893
1999	2,650	318	735	907
2000	2,490	273	791	907
Total Percent Change 1993-2000	*35.3%*	*-31.8%*	*97.8%*	*52.7%*
Average Annual Growth Rate	*4.4%*	*-5.3%*	*10.2%*	*6.2%*
Jan-June 2000	1,340	145	398	456
Jan-June 2001	1,210	102	336	426
Percent Change 2000-2001	*-9.7%*	*-29.7%*	*-15.6%*	*-6.6%*

Source: USGS, 2001b; USGS, 1999; USGS, 1994.

4E.3 Financial Condition and Performance

The production of primary aluminum is an electrometallurgical process, which is extremely energy intensive. Electricity accounts for approximately 30 percent of total production costs for primary aluminum smelting. The aluminum industry is therefore a major industrial user of electricity, spending more than $2 billion annually. The industry has therefore pursued opportunities to reduce its use of electricity as a means of lowering costs. In the last 50 years, the average amount of electricity needed to make a pound of aluminum has declined from 12 kilowatt hours to approximately 7 kilowatt hours. (Aluminum Association, undated).

Like integrated steel mills, aluminum manufacturers require very large capital investments to transform raw material into finished product. Because of the high fixed costs of production, earnings can be very sensitive to production levels, with high output levels relative to capacity needed for plants to remain profitable.

Operating margin measures the relationship between revenues and operating costs. Relatively small changes in output or prices can have large positive or negative impacts on operating margins, given the high fixed capital costs in the aluminum industry (S&P, 2000). Operating margins do not reflect the changes of capital costs, however, and therefore are only a rough measure of profitability.

Table 4E-12 below shows trends in operating margins for the primary aluminum and aluminum sheet, plate, and foil sectors between 1987 and 1997. The table shows considerable volatility in the trends for each sector. Operating margins for the primary aluminum sector decreased between 1988 and 1993, reflecting the conditions of oversupply in the market that led to decreasing shipments from U.S. producers (McGraw-Hill, 2000). The increase in value of shipments from 1987 to 1992 is attributed to the increase in payroll and cost of materials. The operating margin Lower prices for aluminum were responsible for lower material costs for the aluminum sheet, plate, and foil sector and a modest increase in operating margins between 1989 and 1992.

Table 4E-12: Operating Margins for the Profiled Aluminum Sectors (in millions, constant $2000)

Year	Primary Aluminum Production (SIC 3334)				Aluminum Sheet, Plate, and Foil (SIC 3353)			
	Value of Shipments	Cost of Materials	Payroll (all employees)	Operating Margin	Value of Shipments	Cost of Materials	Payroll (all employees)	Operating Margin
1987	$5,247	$3,196	$596	27.7%	$13,475	$11,126	$1,294	7.8%
1988	$6,242	$3,335	$535	38.0%	$13,516	$11,518	$1,118	6.5%
1989	$6,348	$3,931	$596	28.7%	$13,179	$10,778	$1,107	9.8%
1990	$6,999	$4,821	$746	20.5%	$12,906	$10,075	$1,185	12.8%
1991	$7,275	$5,331	$911	14.2%	$13,056	$9,482	$1,212	18.1%
1992	$7,485	$5,409	$1,031	14.0%	$12,905	$8,814	$1,229	22.2%
1993	$6,984	$5,424	$983	8.3%	$11,875	$8,460	$1,257	18.2%
1994	$6,238	$4,248	$790	19.2%	$12,506	$9,710	$1,160	13.1%
1995	$5,620	$3,281	$627	30.5%	$12,637	$9,910	$936	14.2%
1996	$5,928	$3,832	$749	22.7%	$12,812	$9,155	$1,094	20.0%
1997	$5,914	$3,522	$672	29.1%	$13,531	$9,939	$1,180	17.8%

Source: U.S. DOC, 1988-1991 and 1993-1996; U.S. DOC, 1987, 1992, and 1997.

4E.4 Facilities Operating Cooling Water Intake Structures

In 1982, the Primary Metals industries as a whole (including Steel and Non-ferrous producers) withdrew 1,312 billion gallons of cooling water, accounting for approximately 1.7 percent of total industrial cooling water intake in the United States. The industry ranked 3rd in industrial cooling water use, behind the electric power generation industry, and the chemical industry (1982 Census of Manufactures).

This section presents information from EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* on existing facilities with the following characteristics:

- they withdraw from a water of the United States;
- they hold an NPDES permit;
- they have a design intake flow of equal to or greater than two MGD;
- they use at least 25 percent of that flow for cooling purposes.

These facilities are not "new facilities" as defined by the section 316(b) New Facility Rule and are therefore not subject to this regulation. However, they meet the criteria of the rule except that they are already in operation. These existing facilities therefore provide a good indication of what new facilities in these sectors may look like. The remainder of this section refers to existing facilities with the above characteristics as "section 316(b) facilities."

a. Cooling water uses and systems

Information collected in EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* found that 11 out of 31 primary aluminum producers (35 percent) and 6 out of 57 aluminum sheet, plate, and foil manufacturers (11 percent) meet the characteristics of a section 316(b) facility. Aluminum section 316(b) facilities use cooling water for a combination of purposes, including contact and noncontact production line or process cooling, electricity generation, and air conditioning:

- All section 316(b) primary aluminum producers use cooling water for production line (or process) contact or noncontact cooling. Thirty percent also use cooling water for air conditioning, 11 percent use cooling water for electricity, and 60 percent have other uses for cooling water.

- All section 316(b) aluminum sheet, plate, and foil manufacturers use cooling water for production line (or process) contact and noncontact cooling. Fifty percent use cooling water for air conditioning, and 50 percent have other uses for cooling water.

Table 4E-13 shows the distribution of existing section 316(b) facilities in the profiled aluminum sector by type of water body and cooling system. The table shows that three-quarters of the section 316(b) facilities employ either a once-through cooling system (13, or 76%) and one-quarter use a recirculating system (4, or 24%). Ten of the 11 section 316(b) primary aluminum producers obtain their cooling water from a freshwater stream or river. The other section 316(b) primary producer draws from a lake or reservoir. All of the section 316(b) aluminum sheet, plate, and foil manufacturers obtain their cooling water from either a freshwater stream or river. Ninety-four percent (16 facilities) of all section 316(b) aluminum facilities withdraw their cooling water from a freshwater stream or river.

Table 4E-13: Number of Section 316(b) Facilities by Water Body Type and Cooling System Type for the Profiled Aluminum Sectors

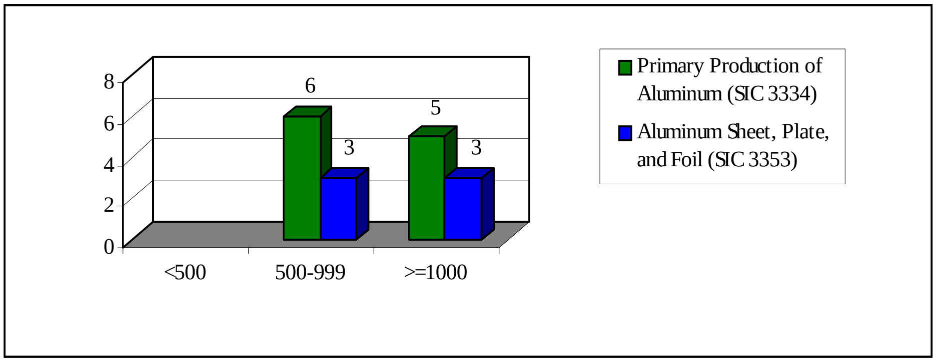
Water Body Type	Cooling System						
	Recirculating		Combination		Once-Through		Total
	Number	% of Total	Number	% of Total	Number	% of Total	
Primary Production of Aluminum (SIC 3334)							
Freshwater Stream or River	0	0%	0	0%	10	100%	10
Lake or Reservoir	1	100%	0	0%	0	0%	1
Total	*1*	*9%*	*0*	*0%*	*10*	*91%*	*11*
Aluminum Sheet, Plate, and Foil (SIC 3353)							
Freshwater Stream or River	3	50%	0	0%	3	50%	6
Total	*3*	*50%*	*0*	*0%*	*3*	*50%*	*6*
Total for Profiled Aluminum Facilities (SIC 3334, 3353)							
Freshwater Stream or River	3	19%	0	0%	13	81%	16
Lake or Reservoir	1	100%	0	0%	0	0%	1
Total	**4**	**24%**	**0**	**0%**	**13**	**76%**	**17**

Source: U.S. EPA, 2000.

b. Facility Size

Figure 4E-7 shows the number of section 316(b) facilities by employment size category for the profiled aluminum sectors. All of the establishments in both SIC codes employ over 500 people, and 45 percent of primary aluminum producers and 50 percent aluminum sheet, plate, and foil manufacturers employ over 1,000 employees.

Figure 4E-7: Number of Section 316(b) Facilities by Employment Size for the Profiled Aluminum Sectors



Source: U.S. EPA, 2000.

c. Firm Size

EPA used the Small Business Administration (SBA) small entity size standards to determine the number of existing section 316(b) profiled aluminum industry facilities owned by small firms. Firms in the Primary Production of Aluminum sector (SIC 3334) are defined as small if they have 1000 or fewer employees; firms in the Aluminum Sheet, Plate, and Foil sector (SIC 3353) are defined as small if they have 750 or fewer employees. Table 4E-14 shows that all of the section 316(b) primary aluminum producers are owned by large firms. The same is true for all the section 316(b) aluminum sheet, plate, and foil producers.

Table 4E-14: Number of Section 316(b) Facilities by Firm Size for the Profiled Aluminum Sectors

SIC Code	Large		Small		Total
	Number	% of SIC	Number	% of SIC	
3334	11	100%	0	0%	11
3353	6	100%	0	0%	6
Total	*17*	*100%*	*0*	*0%*	*17*

Source: U.S. EPA, 2000; D&B, 2001.

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Chapter 5: Baseline Projections of New Facilities

INTRODUCTION

Facilities regulated under the final section 316(b) New Facility Rule are new greenfield and stand-alone electric generators and manufacturing facilities that operate a new cooling water intake structure (CWIS) or a CWIS whose design capacity is increased, require a National Pollutant Discharge Elimination System (NPDES) permit, have a design intake flow of equal to or greater than two million gallons per day (MGD), and use at least 25 percent of their intake water for cooling purposes. The overall costs and economic impacts of the final rule depend on the number of new facilities subject to the rule and on the planned characteristics (i.e., construction, design, location, and capacity) of their CWISs. The projection of the number and characteristics of new facilities represents baseline conditions in the absence of the rule and identifies the facilities that will be subject to the final section 316(b) New Facility Rule.

CHAPTER CONTENTS

This chapter presents forecasts of the number of new electric generators and manufacturing facilities subject to the final section 316(b) New Facility Rule that will begin operating between 2001 and 2020. The chapter consists of three sections. Section 5.1 presents the methodology and results of estimating the number and characteristics of new electric generating facilities. Section 5.2 presents the methodology and results of estimating the number of new manufacturing facilities. Each section discusses uncertainties about the estimated number and type of facilities that will be constructed in the future. The final section summarizes the results of the new baseline projections of facilities.

5.1 NEW ELECTRIC GENERATORS

EPA estimates that 83 new electric generators subject to the final section 316(b) New Facility Rule will begin operation between 2001 and 2020. Of these, 69 are new combined-cycle facilities and 14 are new coal facilities.[1] This projection is based on a combination of national forecasts of new steam electric capacity additions and information on the characteristics of specific facilities that are planned for construction in the near future or that have been constructed in the recent past. Using these two types of information, EPA developed model facilities that provide the basis for estimating costs and economic impacts for electric generators throughout the remainder of this document.

[1] Combined-cycle facilities use an electric generating technology in which electricity is produced from otherwise lost waste heat exiting from one or more gas (combustion) turbines. The exiting heat is routed to a conventional boiler or to a heat recovery steam generator for utilization by a steam turbine to produce electricity. This process increases the efficiency of the electric generating unit.

5.1.1 Projected Number of New Facilities

EPA used four main data sources to project the number and characteristics of new steam electric generators subject to the final rule: (1) the Energy Information Administration's (EIA) *Annual Energy Outlook 2001* (AEO2001); (2) Resource Data International's (RDI) *NEWGen Database*, (3) EPA's section 316(b) industry survey of existing facilities; and (4) EIA's Form EIA-860A and 860B databases. The diagram in Figure 5-1 below presents the steps and data inputs required for EPA's estimate of the number of new in-scope electric generators. Also included are the values and the data sources of each input.

Figure 5-1: Estimation of the Number of New Steam Electric Generators, 2001 - 2020

Variable	Value		Source	
	Combined Cycle	Coal	Combined Cycle	Coal
Total Capacity Additions	203,985 MW	21,813 MW	AEO2001	
×				
% of Capacity Additions from New Facilities	87.7%	76.1%	NEWGen Database	
=				
Capacity Additions from New Facilities	178,894 MW	16,599 MW	Calculation	
÷				
Avg. Capacity New Facilities	741 MW	475 MW	NEWGen Database	EIA-860A and EIA-860B Databases
=				
Total # of New Facilities	241	35	Calculation	
×				
In-Scope %	28.6%	40.5%	EPA Research of NEWGen Facilities	§ 316(b) Industry Survey
=				
# New In-Scope Facilities	69	14	Calculation	

Source: U.S. EPA analysis, 2001.

The following sections provide detail on each data source used in this analysis and the calculations necessary to derive the numbers presented in the diagram. The final subsection, 5.1.1.e, summarizes how EPA combined the information from the different data sources to calculate the number of new combined-cycle and coal facilities.

a. Annual Energy Outlook 2001

The Annual Energy Outlook (AEO) is published annually by the U.S. Department of Energy's Energy Information Administration (EIA) and presents forecasts of energy supply, demand, and prices. These forecasts are based on results generated from EIA's National Energy Modeling System (NEMS, U.S. DOE, 2000a). The NEMS system generates projections based on known levels of technological capabilities, technological and demographic trends, and current laws and regulations. Other key projections are made regarding the pricing and availability of fossil fuels, levels of economic growth, and trends in energy consumption. The AEO projections are used by Federal, State, and local governments, trade associations, and other planners and decision-makers in both the public and private sectors. EPA used the most recent forecast of capacity additions between 2001 and 2020 (presented in the AEO2001) to estimate the number of new combined-cycle and coal-fired steam electric plants.

The AEO2001 presents forecasts of both planned and unplanned capacity additions between 2001 and 2020 for eight facility types (coal steam, other fossil steam, combined-cycle, combustion turbine/diesel, nuclear, pumped storage/other, fuel cells and renewables). EPA has determined that only facilities that employ a steam electric cycle require significant quantities of cooling water and are thus potentially affected by the final section 316(b) New Facility Rule. As a result, this analysis considers capacity additions associated with coal steam, other fossil steam, combined-cycle, and nuclear facilities only. In its Reference Case, the AEO2001 forecasts total capacity additions of 370 GW from all facility types between 2001 and 2020.[2] Coal steam facilities account for 22 GW, or 6 percent of the total forecast, and combined-cycle facilities account for 204 GW, or 55 percent. The remaining capacity additions, 39 percent of the total, come from non-steam facility types. Based on all available data in the rulemaking record, EPA projects no new additions for nuclear and other fossil steam capacity.

Table 5-1 below presents the forecasted capacity additions between 2001 and 2020 from the Reference Case of the AEO2001. Section 5.A.2 in the Appendix to this chapter contains additional information on the AEO forecast, including capacity additions by year; Section 5.A.5 contains information on the distribution of the forecasted combined-cycle capacity additions by North American Electric Reliability Council (NERC) region.

Table 5-1: AEO2001 Capacity Addition Forecasts by Facility Type (2001 - 2020)

Facility Type	Capacity Addition (MW)	Percent of Total Additions
Coal Steam	21,813	6%
Other Fossil Steam[a]	0	0%
Combined-Cycle	203,985	55%
Nuclear	0	0%
Total Steam Electric Capacity Additions	***225,798***	***61%***
Combustion Turbine/Diesel	136,085	37%
Pumped Storage/Other[b]	0	0%
Fuel Cells	289	< 1%
Renewable[c]	8,209	2%
Total Capacity Additions	**370,381**	**100%**

[a] Includes oil-, gas-, and dual-fired capability.
[b] Other includes methane, propane gas, and blast furnace gas for utilities; and hydrogen, sulfur, batteries, chemicals, fish oil, and spent sulfite liquor.
[c] Includes conventional hydroelectric, geothermal, wood, wood waste, municipal solid waste, other biomass, solar thermal, photovoltaics, and wind power.

Source: Adapted from U.S. DOE, 2001a (Supplement Table 72)

[2] Among other model parameters, the AEO2001 Reference Case assumes economic growth of 3 percent and electricity demand growth of 1.8 percent.

b. NEWGen database

The NEWGen database is created and regularly updated by Resource Data International's (RDI) Energy Industry Consulting Practice. The database provides detailed facility-level data on electric generation projects, including new (greenfield and stand-alone) facilities and additions and modifications to existing facilities, proposed over the next several years. Information in the NEWGen database includes: generating technology, fuel type, generation capacity, owner and holding company, electric interconnection, project status, on-line dates, and other operational details. The majority of the information contained in this database is obtained from trade journals, developers, local authorities, siting boards, and state environmental agencies.

EPA used the February 2001 version of the NEWGen database to develop model facilities for the economic analysis of electric generators. Specifically, the database was used to:

- calculate the percentage of total combined-cycle capacity additions and the percentage of total coal capacity additions derived from new (greenfield and stand-alone) facilities;
- estimate the in-scope percentage of new combined-cycle facilities; and
- determine the technical, operational, and ownership characteristics of new in-scope combined-cycle facilities.

The first step in the NEWGen database analysis was to identify the electric generation projects of interest to the final section 316(b) New Facility Rule. EPA screened the database by state, project status, and facility type to eliminate projects that are out of the scope of this rule. The next subsection presents EPA's screening analysis. The following subsections present a description of each of the three uses of the NEWGen database listed above.

❖ *NEWGen screening analysis*

The February 2001 version of the NEWGen database contains 941 electric generation projects. EPA screened each of these facilities with respect to the following criteria:

- ***State:*** Only facilities located within the United States are affected by the final section 316(b) New Facility Rule. EPA did not consider facilities located in Canada or Mexico in this analysis.

- ***Project status:*** EPA considered only those projects that are "Under Construction," "Operating," in "Early Development," or in "Advanced Development." The analysis did not consider projects that were "Canceled" or "Tabled" because those projects are unlikely to be completed.

- ***Facility type:*** Only facilities that employ a steam electric cycle use substantial amounts of cooling water and are therefore of interest to the analysis of the final section 316(b) New Facility Rule. Since the AEO2001, discussed in Section 5.1.1.a above, only predicts steam electric capacity additions at combined-cycle and coal steam facilities, EPA's analysis only considered these two types of projects listed in the NEWGen database.[3]

Of the 941 projects in the NEWGen database, 383 combined-cycle facilities and 26 coal facilities passed these three screening criteria. EPA furthermore differentiated between projects at "New Plants" (i.e., greenfield or stand-alone) and those at "Existing Facilities." Table 5-2 summarizes the results of the screening analysis.

[3] Facility types considered for the combined-cycle analysis include "Comb Cycle," "CC/Cogen," and "CT/Cogen." Facility types considered for the coal analysis include "Coal Boiler" and "Coal Boiler/Cogen."

Table 5-2: Number of New Projects Identified in the NEWGen Screening Analysis

Facility Type	New Plants [a]	Existing Facilities	Total
Combined-Cycle	320	63	383
Coal	16	10	26
Total	336	73	409

[a] The number of new plants include facilities in scope and out of scope of the New Facility Rule.

Source: RDI, 2001.

❖ *Percentage of capacity additions derived from new facilities*

The first step in estimating the capacity additions derived from new facilities is to determine their share of the projected total new capacity of both new facilities and existing facilities (see diagram in Figure 5-1 above). The NEWGen database provides this information for both combined-cycle and coal facilities. Together, new facilities and existing facilities with capacity additions constitute all of the proposed capacity additions associated with combined-cycle and coal facilities. Table 5-3 below presents the size of the new and existing facilities identified in the screening analysis as well as the percentage of total capacity associated with new and existing facilities of each type. The table shows that for both combined-cycle and coal facilities, the vast majority of capacity additions, 88 percent and 76 percent, respectively, come from new facilities.

Table 5-3: Share of Capacity Additions from New (Greenfield and Stand-alone) Facilities

Facility Type	Number of Facilities		Steam Capacity (MW)		Percent of Total Capacity	
	New	Existing	New	Existing	New	Existing
Combined-Cycle	320	63	223,868	31,531	**87.7%**	12.3%
Coal	16	10	9,339	2,930	**76.1%**	23.9%

Source: RDI, 2001.

While information on both new and existing plants as well as both combined-cycle and coal plants was used to determine the percentage of capacity additions derived from new (greenfield and stand alone) facilities, all subsequent analyses of the NEWGen database only consider the **320 new combined-cycle plants**. Projects at “Existing Facilities,” which may include capacity additions and modifications, will be addressed under the Phase II or Phase III section 316(b) rules for existing facilities (to be proposed in February of 2002 and June of 2003, respectively) and are therefore not of interest to the analysis of the final section 316(b) New Facility Rule. In addition, because the total number of new coal plants identified in the NEWGen database (16) is small, EPA found it more reliable to use the section 316(b) Industry Survey, described in Section 5.1.1.c below, to estimate the in-scope percentage, capacity, and technology characteristics for coal plants subject to the final section 316(b) New Facility Rule. The survey included far more facilities over a longer period of time, providing better information on the characteristics of coal plants.

❖ *In-scope percentage of new combined-cycle facilities*

Identification of facilities within the scope of the final section 316(b) New Facility Rule requires information on the source and quantity of cooling water used by each of the 320 new combined-cycle facilities that passed the screening analysis. Only limited information on cooling water use was available in the NEWGen database. As a result, EPA obtained cooling water information through extensive research of public data sources such as state permitting authorities and public utility departments. This research revealed information on cooling water use for 199 of the 320 new combined-cycle facilities.[4]

Each of the 199 greenfield or stand-alone combined-cycle facilities for which cooling water information was available was subsequently screened with respect to the following criteria to identify those facilities in scope of the final section 316(b) New Facility Rule:

- ***Cooling Water Source:*** The facility withdraws from a water of the United States;
- ***New or Modified CWIS:*** The facility uses a new or modified CWIS;[5]
- ***NPDES Permit:*** The facility holds or requires an NPDES permit; and
- ***Design Intake Capacity:*** The facility has a design intake capacity equal to or greater than two million gallons per day (MGD).

The analysis of the permit applications showed that 57 of the 199 facilities with cooling water information, or 28.6 percent, meet all four criteria, and thus fall within the scope of the final section 316(b) New Facility Rule. Table 5-4 presents the results of this analysis. The table also provides an indication of why each of the remaining 142 facilities was determined to be out of scope of the final rule. The table indicates that the vast majority (93 percent) of the 142 out of scope facilities do not withdraw from waters of the U.S. For more information on cooling water sources of the 199 facilities, see Section 5.A.3 in the Appendix to this chapter.

Table 5-4: In Scope Status of NEWGen Combined-Cycle Facilities

In Scope Status	Number of Facilities	Percent of Facilities
In Scope	57	28.6%
Out of Scope	142	71.4%
Does not withdraw from waters of the U.S.[a]	*132*	*93.0%*
Existing CWIS with no increase in design capacity	*7*	*4.9%*
No NPDES permit	*2*	*1.4%*
Design intake flow less than 2 MGD	*1*	*0.7%*

[a] Includes 22 facilities that employ a dry cooling technology.

Source: U.S. EPA analysis of information from state permitting authorities, 2001, and RDI, 2001.

Most of the remaining discussion of the NEWGen database analysis focuses on the 57 in-scope combined-cycle facilities. The average steam capacity (in MW) of the 199 facilities with cooling water information is required to estimate the total number of projected new combined-cycle facilities. Table 5-5 below summarizes the proposed average steam electric generating capacity of the 199 NEWGen facilities, by in-scope status. The table shows that the average capacity of all 199 facilities is 741 MW (the average capacity for in-scope facilities is 747 MW, while the average for out of scope facilities is 739 MW).

[4] Facilities for which cooling water information is not available are not disregarded when determining overall impacts from the final rule. The methodology of estimating the number of new combined-cycle facilities is based on the overall new capacity projected by the AEO2001, and the distribution of characteristics of facilities for which cooling water information was available (see Section 5.1.1.e below). EPA applied those percentages to an estimate of the number of new facilities based on energy demand to determine the number of in-scope facilities. The total number of facilities that may experience costs and an economic impact under the final section 316(b) New Facility Rule is therefore independent of the absolute number of NEWGen facilities for which cooling water information is available.

[5] A modified CWIS is an existing CWIS whose design intake capacity is increased to accommodate the additional cooling water needs of the new facility.

Table 5-5: Average Size of NEWGen Combined-Cycle Facilities

In Scope Status	Number of Facilities	Steam Capacity (MW)	Average Steam Capacity (MW)
In Scope	57	42,563	747
Out of Scope	142	104,892	739
Total	199	147,455	**741**

Source: U.S. EPA analysis of information from state permitting authorities, 2001, and RDI, 2001.

❖ *Characteristics of in-scope NEWGen facilities*

The final use of the NEWGen database in the analysis of new combined-cycle facilities was to characterize the facilities' cooling water use characteristics. The costing analysis for the final section 316(b) New Facility Rule depends in part on two factors: the facility's cooling water source (i.e., freshwater or marine water) and its baseline cooling system type (i.e., once-through or recirculating system).[6] Table 5-6 presents the distribution of the 57 in-scope facilities by these two characteristics. For more information on the types of water bodies from which the 57 NEWGen facilities propose to withdraw cooling water, see Section 5.A.4 in the Appendix to this chapter.

Table 5-6: In-Scope NEWGen Combined-Cycle Facilities by Water Body Type and Cooling System Type

	Recirculating		Once Through		Unknown		Total	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Marine	3	5%	3	5%	3	5%	9	16%
Freshwater	33	58%	0	0%	15	26%	48	84%
Total	***36***	***63%***	***3***	***5%***	***18***	***32%***	***57***	***100%***

Source: U.S. EPA analysis of information from state permitting authorities, 2001, and RDI, 2001.

Table 5-6 shows that the majority of in-scope facilities, 36, or 63 percent, propose to use a recirculating cooling system in the baseline, while only three facilities, or five percent, plan to build a once-through system. For 18 facilities, or 32 percent, the cooling system type was unknown.[7] Forty-eight of the 57 in-scope facilities propose to withdraw from a freshwater source, while nine will withdraw from a marine source.

c. Section 316(b) Industry Survey of Existing Facilities

The NEWGen database discussed in the previous section contained information on only 16 new (greenfield and stand-alone) coal facilities. EPA believes that information from EPA's section 316(b) industry survey of existing facilities (U.S. EPA, 2000) was more reliable for estimating characteristics of new coal facilities projected over the 2001-2020 analysis period because it included far more plants over a longer time period.

- The **screener questionnaire** was sent to 1,050 nonutility plants and 1,550 manufacturing facilities in January 1999.
- The **detailed questionnaire** was sent to 280 utility electric generation plants, 52 nonutility electric generation plants, and 320 manufacturing plants in January 2000.

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[6] Marine sources of cooling water include oceans, estuaries, and tidal rivers. Facilities using marine sources of cooling water may not always achieve the high recycle rates obtainable by using freshwater for cooling. Thus, facilities using marine waters may have higher costs associated with pumping greater volumes of make-up water.

[7] How these 18 facilities were integrated into the analysis is described in Section 5.1.2.a below.

- The **short technical questionnaire** was sent to 637 utility plants that did not receive a detailed questionnaire in January 2000.

All three survey instruments requested technical information, including the facility's in-scope status, cooling system type, intake flow, and source water body. In addition, the screener questionnaire and the detailed questionnaire also requested economic and financial information. For more information on the three survey instruments, see *Information Collection Request; Detailed Industry Questionnaires: Phase II Cooling Water Intake Structures* (U.S. EPA, 1999).

EPA used the following survey data on coal plants constructed during the past 20 years to project the number and characteristics of new (greenfield and stand-alone) coal facilities:[8]

- **In-scope status:** The three survey instruments identified 111 unique coal-fired facilities that began commercial operation between 1980 and 1999. Of the 111 facilities, 45, or 40.5 percent, would be in scope of the final section 316(b) New Facility Rule if they had been new facilities.[9]
- **Water body type:** Of the 45 in scope facilities, 42 withdraw cooling water from a freshwater body while three withdraw from a marine water body.
- **Cooling system type:** The 45 in scope facilities have the following cooling system types: 28 recirculating, nine once-through, four recirculating with a cooling lake or pond, and four with a combination system.

In developing model coal facilities, EPA only considered those existing survey plants that have a once-through system, a recirculating system, or a recirculating system with a cooling lake or pond. Table 5-7 below presents the distribution of the 41 in-scope facilities that meet these cooling system criteria by water body type and cooling system type.

Table 5-7: Survey Coal Facilities by Water Body Type and Cooling System Type

	Recirculating		Recirculating with Lake		Once-Through		Total	
	No.	%	No.	%	No.	%	No.	%
Marine	3	7%	0	0%	0	0%	3	7%
Freshwater	25	61%	4	10%	9	22%	38	93%
Total	***28***	***68%***	***4***	***10%***	***9***	***22%***	***41***	***100%***

Source: U.S. EPA analysis, 2001.

d. EIA databases

In addition to the section 316(b) industry survey of existing facilities, EPA used two of EIA's electricity databases in the analysis of projected new coal plants: Form EIA-860A, *Annual Electric Generator Report – Utility* and Form EIA-860B, *Annual Electric Generator Report – Nonutility* (U.S. DOE, 1998a; U.S. DOE, 1998b). EPA used these databases for three purposes:

- **Identify which of the surveyed electric generators are "coal" plants:** EPA used the prime mover and the primary energy source, reported in the EIA databases, to determine if a surveyed facility is a coal plant. Only plants that only have coal units were considered in this analysis.
- **Identify coal plants constructed during the past 20 years:** Both EIA databases request the in-service date of each unit. Of the surveyed facilities, 111 coal-fired plants began commercial operation between 1980 and 1999.

[8] Coal plants constructed during the past 20 years were identified from Forms EIA-860A and EIA-860B. See discussion in subsection 5.1.1.d below.

[9] For convenience, these 45 existing facilities that would be subject to the final section 316(b) New Facility Rule if they were *new* facilities, are referred to as the 45 "in-scope" facilities, although as existing facilities, they will not in fact be subject to the rule.

- **Determine the average size of new coal plants:** The 111 identified coal plants have an average nameplate rating of 475 MW.[10]

e. Summary of the number of new facilities

EPA estimated the number of projected new combined-cycle and coal plants using information from the four data sources described in subsections 5.1.1.a to 5.1.1.d above. EPA used the U.S. Department of Energy's estimate of new capacity additions (combined-cycle: 204 GW, coal: 22 GW) and multiplied it by the percentage of capacity additions that will be built at new facilities (combined-cycle: 88%, coal: 76%) to determine the new capacity that will be constructed at new facilities (combined-cycle: 179 GW, coal: 17 GW). EPA then divided this value by the average facility size (combined-cycle: 741 MW, coal: 475 MW) to determine the total number of potential new facilities (combined-cycle: 241, coal: 35; both in scope and out-of-scope of the section 316(b) New Facility Rule). Finally, based on EPA's estimate of the percentage of facilities that meet the two MGD flow threshold (combined-cycle: 28.6%, coal: 40.5%), EPA estimates there will be 69 new in-scope combined-cycle facilities and 14 new coal facilities over the 2001–2020 period. These calculations are summarized in Figure 5-1 at the beginning of Section 5.1.1.

5.1.2 Development of Model Facilities

The final step in the baseline projection of new electric generators was the development of model facilities for the costing and economic impact analyses. This step required translating characteristics of the analyzed combined-cycle and coal facilities into characteristics of the 83 projected new facilities. The characteristics of interest are: (1) the type of water body from which the intake structure withdraws (freshwater or marine water); (2) the facility's type of cooling system (once-through or recirculating system); and (3) the facility's steam electric generating capacity. The following two subsections discuss how EPA developed model facilities for combined-cycle and coal facilities, respectively.

a. Combined-cycle facilities

EPA's analysis projected 69 new in-scope combined-cycle facilities. Cooling water and economic characteristics of these 69 facilities were determined based on the characteristics of the 57 in-scope NEWGen facilities.[11] EPA developed six model facility types based on the 57 facilities' combinations of source water body and type of cooling system. Within each source water body/cooling system group, EPA created between one and three model facilities, depending on the number of facilities within that group and the range of their steam electric capacities. For example, there were 48 NEWGen facilities that plan to withdraw from a freshwater body and build a recirculating system. Their steam electric capacities ranged from 165 MW to 1,600 MW. EPA sorted the 48 facilities by their capacity and divided them into three groups of approximately equal size. For each group, the average facility size was calculated. The model facility based on the NEWGen facilities in the first group represents freshwater/recirculating facilities with a relatively small generating capacity (439 MW); the second model facility represents freshwater/recirculating facilities with a medium generating capacity (699 MW); and the third model facility represents freshwater/recirculating facilities with a relatively large generating capacity (1,061 MW). The same approach was taken to develop model facilities that withdraw from a marine water body and/or plan to install a once-through system.

Based on the distribution of the 57 NEWGen facilities by source water body group, cooling system type, and size group, EPA determined how many of the 69 projected new facilities are represented by each of the six model facility types. Table 5-9 below presents the six model facility types, their estimated steam electric capacity, the number of NEWGen facilities upon which each model facility type was based, and the number of projected new facilities that belong to each type. Section 5.A.6 in the Appendix to this chapter provides more detail on the 57 NEWGen facilities and the model facility assignment of the 69 projected new facilities.

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[10] The average capacity for in-scope coal facilities is 763 MW, while the average for out-of-scope coal facilities is 278 MW.

[11] As shown in Table 5.6 above, EPA could determine the water body type for all 57 in-scope facilities but did not have information on the cooling system type for 18 facilities. Since all freshwater facilities with a known cooling system type propose to build a recirculating system, EPA assumed that the 15 freshwater facilities with an unknown cooling system type will also build a recirculating system. For marine facilities, EPA assumed that two of the three facilities with an unknown system type would build a recirculating system in the baseline while one would build a once-through system.

Table 5-9: Combined-Cycle Model Facilities

Model Facility Type	Cooling System Type	Source Water Body	Steam Electric Capacity (MW)	Number of NEWGen Facilities	Number of Projected New Facilities
CC OT/M-1	Once-Through	Marine	1,031	4	5
CC R/M-1	Recirculating	Marine	489	4	5
CC R/M-2	Recirculating	Marine	1,030	1	1
CC R/FW-1	Recirculating	Freshwater	439	15	18
CC R/FW-2	Recirculating	Freshwater	699	17	21
CC R/FW-3	Recirculating	Freshwater	1,061	16	19
Total				**57**	**69**

Source: U.S. EPA analysis, 2001.

b. Coal facilities

EPA's analysis projected 14 new in-scope coal facilities. The same approach was used to assign cooling water and economic characteristics to these 14 facilities as was used for combined-cycle facilities (see discussion in the previous section). EPA determined the characteristics of the 14 projected new coal facilities based on the characteristics of the 41 existing in-scope coal facilities presented in Table 5-7 above. EPA developed eight model facility types based on the 41 facilities' source water body and their type of cooling system. Within each source water body/cooling system group, EPA created between one and three model facilities, depending on the number of facilities within that group and the range of their steam electric capacities. Based on the distribution of the 41 survey facilities by source water body group, cooling system type, and size group, EPA determined how many of the 14 projected new coal facilities are represented by each of the eight model facility types. Table 5-10 below presents the eight model facility types, their estimated steam electric capacity, the number of survey facilities upon which each model facility type was based, and the number of projected new coal facilities that are represented by each type. Section 5.A.7 in the Appendix to this chapter provides more detail on the 14 survey facilities and the model facility assignment of the 14 projected new coal facilities.

Table 5-10: Coal Model Facilities

Model Facility Type	Cooling System Type	Source Water Body	Steam Electric Capacity (MW)	Number of Existing Survey Facilities	Number of Projected New Facilities
Coal R/M-1	Recirculating	Marine	812	3	1
Coal OT/FW-1	Once-Through	Freshwater	63	3	1
Coal OT/FW-2	Once-Through	Freshwater	515	5	1
Coal OT/FW-3	Once-Through	Freshwater	3,564	1	1
Coal R/FW-1	Recirculating	Freshwater	173	10	3
Coal R/FW-2	Recirculating	Freshwater	625	7	3
Coal R/FW-3	Recirculating	Freshwater	1,564	8	3
Coal RL/FW-1	Recirculating with Lake[a]	Freshwater	660	4	1
Total				**41**	**14**

[a] For this analysis, recirculating facilities with cooling lakes are assumed to exhibit characteristics like a once-through facility.

Source: U.S. EPA analysis, 2001.

5.1.3 Summary of Forecasts for New Electric Generators

EPA estimates that a total of 276 new steam electric generators will begin operation between 2001 and 2020. Of the total number of new plants, EPA projects that 83 will be in scope of the final section 316(b) New Facility Rule. Sixty-nine are expected to be combined-cycle facilities and 14 coal-fired facilities. Table 5-11 summarizes the results of the analysis.

Table 5-11: Number of Projected New Electric Generators (2001 to 2020)

Facility Type	Total Number of New Facilities	Facilities In Scope of the Final Rule						
		Recirculating		Recirc. with Lake		Once-Through		Total
		Freshwater	Marine	Freshwater	Marine	Freshwater	Marine	
Combined-Cycle	241	58	6	0	0	0	5	69
Coal	35	9	1	1	0	3	0	14
Total	276	67	7	1	0	3	5	83

Source: U.S. EPA analysis, 2001.

5.1.4 Uncertainties and Limitations

There are unavoidable uncertainties associated with EPA's estimation of the number of new electric generators that will be subject to the final section 316(b) New Facility Rule. While 20-year projections about economic and technological trends are always challenging, this is particularly the case for the electric generating industry which is in the middle of a major restructuring as the result of ongoing industry deregulation. In this analysis, EPA has used the best information available to reasonably estimate the costs and economic impacts of this rule. This analysis employs the following assumptions:

- **The AEO2001 accurately forecasts new capacity additions.** EPA believes that the AEO2001, developed using the Department of Energy's (DOE) National Energy Modeling System (NEMS), represents the best information on future capacity trends currently available. Its results are well reviewed and documented, publicly available, and widely accepted. However, new technology developments, changes in energy costs, or economic growth rates different from those projected in AEO2001 could result in different actual capacity trends.[12]

- **Future combined-cycle facilities will be the same size as NEWGen combined-cycle facilities planned for the near future.** The average size of the analyzed NEWGen combined-cycle facilities is 741 MW. EPA believes that this estimate is reasonable because it is consistent with DOE's forecast of the average size of a new combined-cycle unit of approximately 360 MW (U.S. DOE, 2000b, Table 43).[13] According to DOE, new combined-cycle facilities generally have more than one unit (Beamon, 2001a). If new facilities had two units on average, the average new combined-cycle facility would have a generating capacity of approximately 720 MW.

- **Future coal facilities will be the same size as coal facilities constructed during the past 20 years.** The average size of the analyzed coal facilities is 475 MW, which is somewhat smaller than DOE's forecast of the size of a new coal facility (U.S. DOE, 2000b, Table 43).[14] DOE estimates that a new coal unit would be 400 MW and that a coal facility would generally have more than one unit (Beamon, 2001b). However, using a smaller average size would result in an overestimate of the number of new coal facilities, not an underestimate. The results of EPA's analysis are therefore conservative.

- **Future facilities will have the same cooling water characteristics as the analyzed existing facilities.** EPA estimates that 28.6 percent of new combined-cycle facilities and 40.5 percent of new coal facilities will be subject to the final section 316(b) New Facility Rule as a result of their cooling water characteristics. In addition, EPA estimates that 93 percent of all new combined-cycle facilities and 71 percent of all new coal facilities will install a recirculating system in the baseline. EPA believes that the high projected use of recirculating systems reflects a trend towards increasing consciousness in many parts of the country of the value of aquatic resources and the need to conserve water. As a result, EPA expects that these characteristics are not short-term phenomena that are tied to economic conditions but represent developments that are likely to continue beyond the current business cycle. The Agency therefore believes that the projected number of new in-scope facilities and their projected cooling system types are realistic.

For the reasons listed above, EPA has a fairly high degree of confidence in its overall projection of the number of new electric generation facilities.

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[12] The Department of Energy (DOE) believes that there has been a change in the forecast of new capacity additions since the publication of the AEO2001. In specific, DOE believes that 185 GW of new combined-cycle capacity (instead of 204 GW) and 30 GW of new coal capacity (instead of 22 GW) will begin operation between 2001 and 2020. EPA recalculated the projected number of new combined-cycle and coal facilities using these alternative projections. This re-analysis resulted in an decrease in the number of combined-cycle facilities from 241 to 219. The number of in-scope combined-cycle facilities decreased from 69 to 63. The total number of coal facilities increased from 35 to 48. The number of in-scope coal facilities increased from 14 to 19. The six in-scope combined-cycle facilities that are no longer projected are all estimated to employ recirculating systems in the baseline. Of the five additional coal facilities, four are estimated to operate a recirculating system and one a once-through system in the baseline. This change in capacity forecasts would further result in an increase in the total annualized cost for new coal facilities from $21.4 to $23.7 million and a decrease in the total annualized cost for new combined-cycle facilities from $13.3 to $12.8 million. Overall annualized costs for the final rule would increase from $47.7 to $49.5 million. See Chapter 6: Facility Compliance Costs for the calculation of annualized costs incurred under the final rule.

[13] DOE projects three types of new combined-cycle units: integrated coal-gasification combined-cycle (428 MW), conventional gas/oil combined-cycle (250 MW), and advanced oil/gas combined-cycle (400 MW). The average size of all three types is approximately 360 MW.

[14] DOE only projects one type of new coal unit: conventional pulverized coal (400 MW).

5.2 NEW MANUFACTURING FACILITIES

EPA estimates that 38 new manufacturing facilities subject to the final section 316(b) New Facility Rule will begin operation between 2001 and 2020. Of the 38 facilities, 22 are chemical facilities, ten are steel facilities, two are petroleum refineries, two are paper mills, and two are aluminum facilities.[15] The projection is based on a combination of industry-specific forecasts and information on the characteristics of existing manufacturing facilities.

As described in Chapter 4, the recent slowdown in the U.S. economy has not yet been fully reflected in published forecasts for various industries. The Congressional Budget Office is continuing to forecast modest GDP growth for 2002 and after, but acknowledges that there is substantial uncertainly in its forecasts. To the extent that overall economic growth is overstated by current forecasts, the industry-specific growth rates used in this chapter may also be overstated, which will result in an overstatement of the number of new facilities that will be subject to requirements of the final section 316(b) New Facility Rule.

5.2.1 Methodology

EPA used several steps to estimate the number of new manufacturing facilities subject to the final rule. For each industry sector, EPA:

- identified the SIC codes with potential new in-scope facilities;
- obtained industry growth forecasts;
- determined the share of growth from new (greenfield and stand-alone) facilities;
- projected the number of new facilities;
- determined cooling water characteristics of existing facilities; and
- developed model facilities.

The remainder of this section briefly outlines each of these six steps. Section 5.2.2 describes the baseline projections of new manufacturing facilities for each of the five industry sectors.[16]

a. SIC codes with potential new in-scope facilities

EPA used results from the section 316(b) *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* to identify the SIC codes within each of the five industry sectors that are likely to have one or more new (greenfield and stand-alone) facilities subject to the final section 316(b) New Facility Rule. SIC codes that were included in this analysis are those that, based on the Detailed Industry Questionnaire, have at least one existing facility that meets the in-scope criteria of the final rule. Facilities meet the in-scope criteria of the final rule if they:

- use a CWIS to withdraw from a water of the U.S.;
- hold an NPDES permit;
- withdraw at least two million gallons per day (MGD); and
- use 25 percent or more of their intake flow for cooling purposes.[17]

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[15] Data on industrial water use, presented in Chapter 2, showed that the Paper and Allied Products (SIC 26), Chemicals and Allied Products (SIC 28), Petroleum and Coal Products (SIC 29), and Primary Metals (SIC 33) industry sectors account for more than 90 percent of the water used for cooling purposes in the manufacturing sector. Other industry sectors draw relatively small volumes of water for cooling purposes, and it is unlikely that significant numbers of facilities in these industries will exceed the two MGD threshold. This baseline projection of new manufacturing facilities and the subsequent economic analyses therefore focus on these four sectors.

[16] This analysis divides the Primary Metals sector (SIC 33) into two subsectors: steel (SIC 331) and aluminum (SIC 333/335). Section 5.2.2 therefore discusses five separate sectors, not four.

[17] For convenience, existing facilities that meet the criteria of the final section 316(b) New Facility Rule are referred to as "existing in-scope facilities" or "in-scope survey respondents." As existing facilities, they will not in fact be subject to the rule. However, they would be subject to the final section 316(b) New Facility Rule if they were *new* facilities.

For each SIC code with at least one in-scope survey respondent, EPA estimated the total number of facilities in the SIC code (based on the sample weighted estimate from EPA's section 316(b) industry survey of existing facilities), and the number and percentage of in-scope survey respondents.

b. Industry growth forecasts

Forecasts of the number of new (greenfield and stand-alone) facilities that will be built in the various industrial sectors are generally not available over the 20-year time period required for this analysis. Projected growth rates for value of shipments in each industry were used to project future growth in capacity. A number of sources provided forecasts, including the annual *U.S. Industry Trade & Industry Outlook (2000)*, the *Assumptions to the Annual Energy Outlook 2001*, and other sources specific to each industry.[18] EPA assumed that the growth in capacity will equal growth in the value of shipments, except where industry-specific information supported alternative assumptions.

c. Share of growth from new facilities

There are three possible sources of industry growth: (1) construction of new (greenfield and stand-alone) facilities; (2) higher or more efficient utilization of existing capacity; and (3) capacity expansions at existing facilities. Where available, information from industry sources provided the basis for estimating the potential for construction of new facilities. Where this information was not available, EPA assumed as a default that 50 percent of the projected growth in capacity will be attributed to new facilities. This assumption likely overstates the actual number of new (greenfield and stand-alone) facilities that will be constructed.

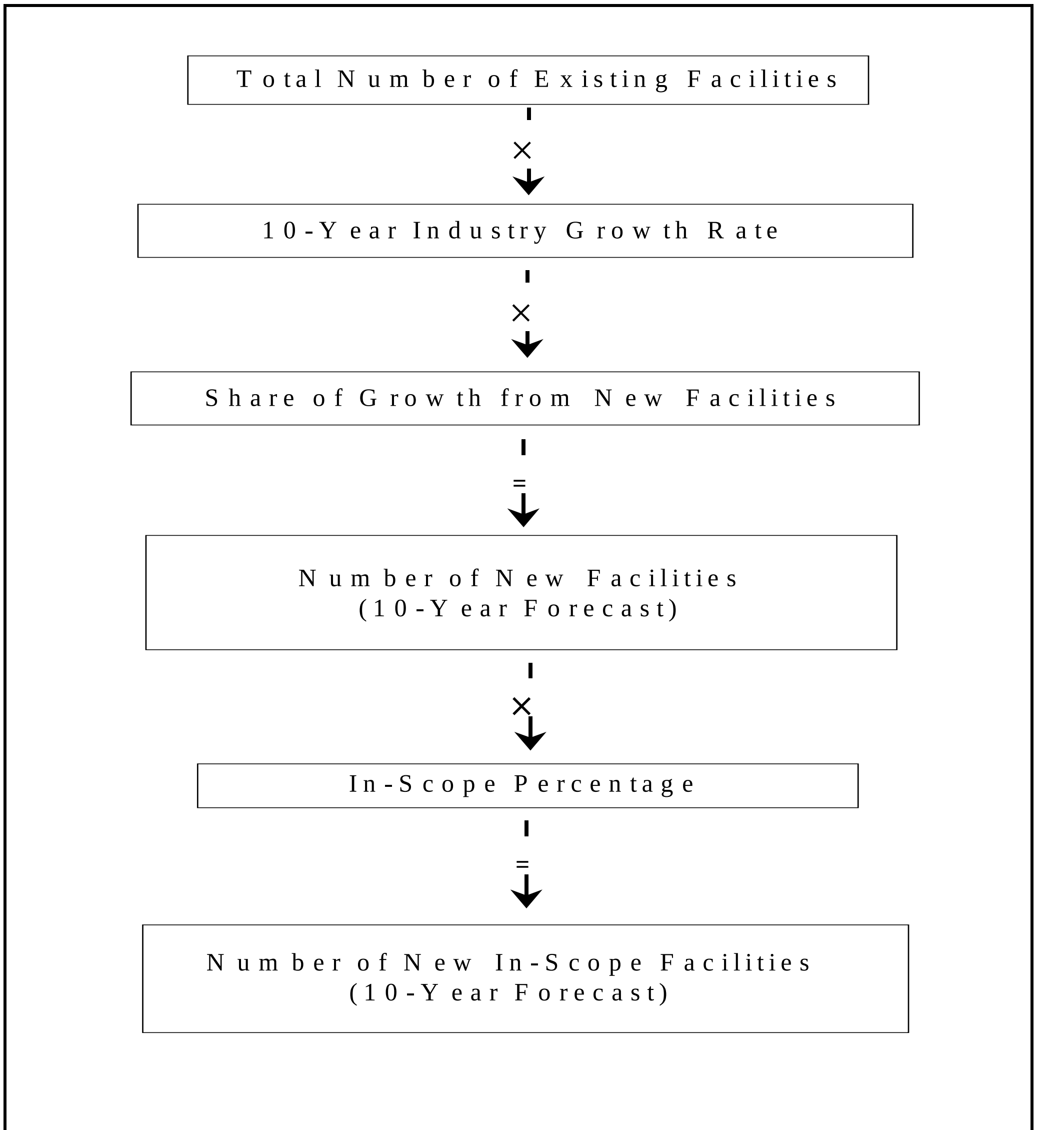
d. Projected number of new facilities

EPA projected the number of new facilities in each SIC code by multiplying the total number of existing facilities by the forecasted 10-year growth rate for that SIC code. The resulting value was then multiplied by the share of growth from new facilities to derive the total number of new facilities over ten years. However, not all of the projected new facilities will be subject to requirements of the final section 316(b) New Facility Rule. Information on the likely water use characteristics of new facilities that will determine their in-scope status under the final rule is generally not available for future manufacturing facilities. EPA assumed that the characteristics of new facilities will be similar to the characteristics of existing survey respondents (i.e., the percentage of new facilities subject to the final rule would be the same as the percentage of existing facilities that meet the rule's in-scope criteria). Using this assumption, EPA calculated the number of new in-scope facilities by multiplying the 10-year forecast of new facilities by the in-scope percentage of existing facilities. To derive the 20-year estimate, both the estimated total number of new facilities and the estimated number of new in-scope facilities were doubled. This approach most likely overstates the number of new facilities that will incur regulatory costs, because new facilities may be more likely than existing ones to recycle water and to use cooling water sources other than a water body of the U.S.

The diagram in Figure 5-2 below presents the steps and data inputs required for EPA's 10-year projection of the number of new manufacturing facilities in each SIC code.

[18] The Reference section at the end of this chapter presents a complete list of the data sources used in this baseline projection.

Figure 5-2: Estimation of the Number of New Manufacturing Facilities, 2001 - 2010



Source: *U.S. EPA analysis, 2001.*

e. Cooling water characteristics of existing in-scope facilities

EPA used information from EPA's section 316(b) *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* to determine the characteristics of the in-scope survey respondents. The survey requested technical information, including the facility's cooling system type, source water body, and intake flow in addition to economic and financial information.[19] Cooling water characteristics of interest to the analysis are the facility's baseline cooling system type (i.e., once-through or recirculating system) and its cooling water source (i.e., freshwater or marine water). In addition, the facility's design intake flow was used in the costing analysis.

[19] For more information on the survey instrument, see *Information Collection Request; Detailed Industry Questionnaires: Phase II Cooling Water Intake Structures* (U.S. EPA, 1999).

f. Development of model facilities

The final step in the baseline projection of new manufacturing facilities was the development of model facilities for the costing and economic impact analyses. This step required translating characteristics of the existing in-scope facilities into characteristics of the projected new facilities. Again, the characteristics of interest are: (1) the facility's type of cooling system in the baseline (once-through or recirculating system) and (2) the type of water body from which the intake structure withdraws (freshwater or marine water). EPA developed one model facility for each cooling system/water body combination within each 4-digit SIC code. Based on the distribution of the in-scope survey respondents by cooling system type and source water body, EPA assigned the projected new in-scope facilities to model facility types.

5.2.2 Projected Number of New Manufacturing Facilities

a. Paper and Allied Products (SIC 26)

❖ ***SIC codes with potential new in-scope facilities***

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified five 4-digit SIC codes in the Paper and Allied Products industry (SIC code 26) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws at least two million gallons per day (MGD) from a water of the U.S., and uses 25 percent or more of its intake flow for cooling purposes. Table 5-12 below presents the total number of existing facilities, the number of in-scope questionnaire respondents, and the in-scope percentage for each of the five SIC codes.

Table 5-12: Section 316(b) Facilities in the Paper and Allied Products Industry (SIC 26)

SIC Code	SIC Description	Total Number of Existing Facilities	In-Scope Survey Respondents	
			No.	%
2611	Pulp Mills	60	26	43.6%
2621	Paper Mills	290	74	25.4%
2631	Paperboard Mills	190	43	22.4%
2676	Sanitary Paper Products	4	2	50.0%
2679	Converted Paper and Paperboard Products, Not Elsewhere Classified	19	3	14.2%
	Total SIC 26	**562**	**147**	**26.1%**

Source: U.S. EPA, 2000; OMB, 1987.

EPA analyzed these industry segments to estimate the number of new in-scope facilities in the Paper and Allied Products Industry.

❖ ***Projected growth in shipments***

Shipments of pulp and paper products are closely tied to the overall state of the U.S. and world economies. The growth in sales will be linked to increased foreign demand as exports continue to be the major end use. Industry sources project the following growth rates for the different segments of the market (McGraw-Hill, 2000):

- Pulp mill shipments (SIC code 2611) are expected to increase by 1.75 percent annually over the 5-year period 2000 through 2004, with most of the growth representing increased exports.
- Shipments from the paper and paperboard mills sector (SIC codes 2621 and 2631) are expected to increase by about 1.8 percent annually from 2000 through 2004.
- No specific forecasts for sanitary paper products (SIC codes 2676 and 2679) are available. EPA therefore assumed that between 2001 and 2020, shipments from these facilities will grow at the same rate as the overall U.S. GDP, or 3.0 percent annually (U.S. DOE, 2000b).

❖ *Share of growth from new facilities*

According to the S&P Paper and Forest Products Industry Survey (S&P, 2000), most sectors of the paper industry have been consolidating in an attempt to achieve profit growth in a mature industry. Many companies have shut down some older, less cost-efficient plants, but are reluctant to invest in major new capacity that would lead to oversupply in the market. Most companies that have increased operating capacity in recent years have taken over existing mills rather than construct new mills. Those firms that cannot find a merger partner or an acquirable mill are often modernizing existing facilities rather than constructing a major new facility.

According to the annual capacity survey released in late 2000 by the American Forest & Paper Association (AF&PA), U.S. capacity to produce paper and paperboard will increase by an annual average of 0.7 percent over the period 2001 to 2003 (S&P, 2000). This increase is well below the average annual rate of 2.1 percent during the previous 10 years. The AF&PA survey cites several factors to explain the slow growth in capacity, including a highly competitive trade environment for some grades, competing demands for the industry's capital, and mill and machine shutdowns. Although most conditions influencing the industry are conducive to some growth, certain grades are experiencing reduced demand. Standard and Poor's estimates that six percent of U.S. containerboard capacity was shut down between late 1998 and early 1999 (S&P, 2000). The recent decline in investment in new capacity is likely to continue. Any growth in production in the pulp, paper, and paperboard mill sectors (SIC codes 2611, 2621, and 2631) will likely result from increased efficiency at existing facilities, reopening of capacity that is currently idle, or perhaps rebuilding or expanding existing facilities (Stanley, 2000; Jensen, 2000). Therefore, EPA assumed that none of the projected growth in these industries would result from new (greenfield and stand-alone) facilities.

Substantial growth has occurred in the secondary fiber deink sector since 1990. The number of deink facilities has grown from 43 (1990) to about 77 over the past ten years. The sanitary paper products sector (SIC 2676) potentially includes deink facilities and may therefore experience construction of new greenfield and stand-alone facilities. EPA does not expect these new deink facilities to be in scope of the final section 316(b) New Facility Rule, however, because evidence suggests that cooling water intake flows of stand-alone deink facilities are well below the two MGD minimum flow threshold of the final section 316(b) New Facility Rule (Wisconsin Tissues, 1999) The existing facilities in SIC 2676 identified in the detailed questionnaire all have intake flows substantially above two MGD, and are therefore likely to be in the non-deink part of SIC 2676. No growth is projected for new non-deink facilities in SIC 2676.

❖ *Projected number of new facilities*

Table 5-13 presents the number of existing facilities in the five analyzed SIC codes, the projected industry growth (annual growth rate and compounded growth rate over ten years), the share of growth from new facilities, and the number of projected new facilities (total and in-scope). To calculate the number of projected new facilities, EPA applied the industry-specific 10-year growth rate and the percentage of capacity growth from new facilities to the total number of existing facilities. Based on its research, EPA believes that none of the projected growth in these industries would result from new (greenfield and stand-alone) facilities. However, in comments on the proposed section 316(b) New Facility Rule, the American Forestry and Paper Association (AF&PA) stated that one or two new greenfield and stand-alone paper mills are expected to be built over the next decade. In response to this comment, EPA assumed that two new in-scope paper mills (SIC code 2621) would be subject to the final section 316(b) New Facility Rule.

Table 5-13: Projected Number of New Paper Facilities (SIC 26)										
SIC Code	Total Number of Existing Facilities	Projected Industry Growth Rate			Estimated Number of New Facilities[b]					
					10-Year Forecast (2001-2010)			20-Year Forecast (2001-2020)[c]	
		Annual	Over 10 Years[a]	Share of Growth from New Facilities	Total	In-Scope Percentage	In-Scope	Total	In-Scope
2611	60	1.75%	18.94%	0.0%	0	43.6%	0	0	0
2621	290	1.80%	19.53%	0.0%	1	--	1	2	2
2631	190	1.80%	19.53%	0.0%	0	22.4%	0	0	0
2676[d]	4	3.00%	34.39%	0.0%	0	50.0%	0	0	0
2679	19	3.00%	34.39%	0.0%	0	14.2%	0	0	0
Total	**562**				**1**	**26.1%**	**1**	**2**	**2**

[a] Total percentage growth over 10 years, based on the forecasted annual growth rate [(1 + Annual Rate)^{10} - 1].
[b] EPA's forecast methodology does not project any new in-scope facilities for this SIC code. This projection is based on a comment submitted by the AF&PA.
[c] Equal to 2 * the 10-Year Forecast.
[d] Facilities in this SIC code are assumed to be facilities other than deink facilities.

Source: U.S. EPA analysis, 2001.

❖ *Characteristics of existing facilities*

EPA used information from EPA's section 316(b) *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* to estimate characteristics of the new in-scope manufacturing facilities projected over the 2001-2020 analysis period. The survey requested technical information, including the facility's cooling system type, source water body, and intake flow in addition to economic and financial information.

EPA used the following survey data on existing in-scope paper mills (SIC code 2621) to project characteristics of the two new (greenfield and stand-alone) facilities:[20]

- **Cooling system type:** There were 74 existing in-scope paper mills. These 74 facilities have the following cooling system types: 36 once-through, three recirculating, 13 combination system, and 21 other system types.
- **Water body type:** Of the 74 in-scope facilities, 71 withdraw cooling water from a freshwater body while two withdraw from a marine water body. One paper mill withdraws water from both a freshwater and marine water body.

In developing model manufacturing facilities, EPA only considered those existing survey plants that have a once-through system, a recirculating system, or a combination system. For this analysis, EPA classified facilities with a combination system as once-through and facilities withdrawing from both water body types as marine, providing for a conservative estimate. Table 5-14 below presents the distribution of the 53 in-scope facilities that meet these cooling system criteria by cooling system type and source water body.

[20] The numbers in this section may not add up to totals because the survey facilities are sample-weighted and rounded.

Table 5-14: Existing Paper Mill Facilities by Water Body Type and Cooling System Type (SIC 2621)										
SIC	Recirculating				Once-Through				Total	
	Freshwater		Marine		Freshwater		Marine			
	No.	%	No.	%	No.	%	No.	%	No.	%
2621	3	6%	0	0%	47	88%	3	5%	53	100%

Source: U.S. EPA, 2000; U.S. EPA analysis, 2001.

❖ ***Development of model facilities***

This analysis assumes that two new in-scope paper mills (SIC code 2621) will begin operation during the next 20 years. The distribution of existing facilities across water body and cooling system types showed that 88 percent of all existing in-scope paper mills operate a once-through system and withdraw from a freshwater body. EPA therefore assumed that both projected new in-scope paper mills will be freshwater facilities with a once-through system. Table 5-15 below presents the model facility type, the number of in-scope survey facilities upon which the model facility type was based, and the number of projected new facilities that belong to that model type.

Table 5-15: SIC 26 Model Facilities					
Model Facility Type	SIC Code	Cooling System Type	Source Water Body	Number of In-Scope Survey Respondents	Number of New In-Scope Facilities
MAN OT/F-2621	2621	Once-Through	Freshwater	47	2

Source: U.S. EPA analysis, 2001.

b. Chemicals and Allied Products Industry (SIC 28)

❖ ***SIC codes with potential new in-scope facilities***

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified fifteen 4-digit SIC codes in the Chemicals and Allied Products Industry (SIC 28) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws at least two million gallons per day (MGD) from a water of the U.S., and uses 25 percent or more of its intake flow for cooling purposes. Table 5-16 below presents the total number of existing facilities, the number of in-scope questionnaire respondents, and the in-scope percentage for each of the 15 SIC codes.

SIC Code	SIC Description	Total Number of Existing Facilities	In-Scope Survey Respondents	
			No.	%
2812	Alkalies and Chlorine	28	20	68.7%
2813	Industrial Gases	110	4	3.9%
2816	Inorganic Pigments	26	4	16.7%
2819	Industrial Inorganic Chemicals, Not Elsewhere Classified	271	33	12.2%
2821	Plastics Material and Synthetic Resins, and Nonvulcanizable Elastomers	305	15	4.8%
2823	Cellulosic Manmade Fibers	7	1	17.9%
2824	Manmade Organic Fibers, Except Cellulosic	36	9	24.1%
2833	Medicinal Chemicals and Botanical Products	33	3	9.9%
2834	Pharmaceutical Preparations	91	4	4.7%
2841	Soaps and Other Detergents, Except Speciality Cleaners	36	4	12.0%
2865	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	59	4	7.3%
2869	Industrial Organic Chemicals, Not Elsewhere Classified	364	48	13.1%
2873	Nitrogenous Fertilizers	60	9	14.4%
2874	Phosphatic Fertilizers	41	1	2.9%
2899	Chemicals and Chemical Preparations, Not Elsewhere Classified	162	4	2.7%
	Total SIC 28	**1,629**	**164**	**10.0%**

Table 5-16: Section 316(b) Facilities in the Chemicals and Allied Products Industry (SIC 28)

Source: U.S. EPA, 2000; OMB, 1987.

EPA analyzed each of these 15 industry segments to estimate the number of new in-scope facilities in the Chemicals and Allied Products Industry.

❖ *Projected growth in shipments*

The Kline *Guide to the U.S. Chemical Industry* projects that shipments of the products from the chemical industry will generally follow the pattern of overall industrial growth over the next decade (Kline, 1999). The American Chemistry Council (previously known as Chemical Manufacturers Association (CMA)) reported that most chemical companies have been experiencing tough competition, with strong downward pressure on pricing, the loss of some export markets, and growing over-capacity. In response to an uncertain outlook for global chemical demand, firms are accelerating the pace of restructuring, joint ventures and mergers. Industry consolidation, competition, and continuing globalization has led to excess capacity for many products and generally lower profitability than in the past (S&P, 2001b). Chemicals industry performance is cyclical, reflecting trends in domestic and foreign economies, input prices, and fluctuations in operating rates. The industry's performance was strong through most of 2000, but fell sharply at the end of 2000 and early 2001, due to rising feedstock and energy prices, lower manufacturing demand, and lower operating rates. (S&P, 2001b). Forecasts of growth vary by sector, with lower growth forecast for commodity chemicals and higher growth expected for plastics. In particular, , industry sources project the following growth rates for value of shipments in different chemicals market segments:

- Shipments of industrial gases (SIC code 2813) are projected to grow at a rate of 2.8 percent annually through 2003, while the rest of the inorganic chemicals sector (SIC code 281) will grow at a rate of 1.9 percent annually (Kline, 1999).[21]

- Shipments in the plastics industry (SIC code 2821) are forecasted to grow by more than 4 percent annually through 2003 (McGraw-Hill, 2000; Kline, 1999).

- Research at proposal showed that man-made fibers production (SIC codes 2823 and 2824) is expected to grow by 1.9 percent annually through 2000 (McGraw-Hill, 1999). Since that forecast, growth in the man-made fiber industry has slowed down to no growth in the value of industry shipments between 1998 and 1999 (McGraw-Hill, 2000). In the absence of a newer growth projection, EPA continued to use the original annual growth estimate of 1.9 percent for the final rule analysis.

- Medicinal chemicals shipments (SIC code 2833) are expected to grow by 2.8 percent per year through 2003. The growth will be fueled by increased demand for new products (McGraw-Hill, 2000).

- Research at proposal showed that growth in shipments of U.S. pharmaceutical products (SIC 2834) are projected to average “in the mid-single digits” for five years (McGraw-Hill, 1999). A more current forecast predicts the industry to have a positive growth rate for the next five years (McGraw-Hill, 2000). Since no more specific information was available, EPA continued to use the original annual growth estimate of 5 percent for SIC 2834 for the final rule analysis.

- Shipments of soaps and detergents (SIC 2841) are projected to increase by 2.4 percent per year through 2003 (Kline, 1999).

- Basic petrochemical shipments (SIC 2865) are expected to grow by 3.3 annually through 2003 (Kline, 1999). S&P forecasts that long-term shipment growth for ethylene, the largest-volume organic chemical produced in the U.S., will grow 3 to 4 percent annually (S&P, 2001b). This is consistent with Kline’s forecast that the entire industry will grow by 3.3 percent annually.

- Shipments of industrial organic chemicals not elsewhere classified (SIC 2869) are projected to increase by almost 3 percent annually through 2004 (McGraw-Hill, 2000).

- Shipments of fertilizers are projected to increase by 2.4 percent annually through 2003 (Kline, 1999). The fertilizer industry (SICs 2873 and 2874) reflects a modest projected growth in the underlying American farm economy (McGraw-Hill, 2000).

- Shipments of miscellaneous chemicals (SIC 2899) are expected to increase by 3 percent annually through 2003 (McGraw-Hill, 2000).

[21] SIC code 281 is officially titled “Industrial Inorganic Chemicals.” However, to avoid confusion with SIC code 2819, “Industrial Inorganic Chemicals, Not Elsewhere Classified,” this chapter will refer to SIC code 281 as the “Inorganic Chemicals sector.”

❖ ***Share of growth from new facilities***

In their comments on the proposed section 316(b) New Facility Rule, the American Chemistry Council commented that EPA overestimated the number of new in-scope chemical facilities in the proposal analysis because the percent of growth that comes from new facilities (50 percent) was overstated. The comment did not provide an alternative estimate. For this analysis, EPA therefore reduced its estimate by half and assumed that the growth in capacity that will come from new chemical facilities will be 25 percent.[22]

❖ ***Projected number of new facilities***

Table 5-17 presents the number of existing facilities in the 15 analyzed SIC codes, the projected industry growth (annual growth rate and compounded growth rate over ten years), the share of growth from new facilities, and the number of projected new facilities (total and in-scope). To calculate the number of projected new facilities, EPA applied the industry-specific 10-year growth rate and the percentage of capacity growth from new facilities to the total number of existing facilities. EPA then applied the in-scope percentage (based on information from the section 316(b) *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures*) to the 10-year forecast of new facilities to derive the projected number of new in-scope facilities over 10 years. Both the number of new facilities and the number of new in-scope facilities were doubled to calculate the 20-year projection. EPA estimates that 282 new facilities will be constructed in the relevant SIC code 28 segments over the next 20 years. Of these, 22 are expected to be in scope of the final section 316(b) New Facility Rule. Eight of the in-scope facilities are expected to produce industrial organics (SIC code 2869), four are plastics manufacturing facilities (SIC code 2821), and four are industrial inorganic chemical facilities (SIC code 2819). In addition, two new in-scope facilities are projected in each of the following sectors: alkalies and chlorine (SIC code 2812), pharmaceutical preparations (SIC code 2834), and nitrogenous fertilizers (SIC code 2873).

[22] EPA also estimated the projected number of new chemical facilities if 37.5 percent (the midpoint between 25 percent used for the final rule analysis and 50 percent used for the proposal analysis) of growth was assumed to come from new facilities. Using this alternative assumption would increase the number of projected new chemical facilities from 22 to 40. Total annualized costs for chemical facilities would increase from $6.8 million to $11.1 million. Overall annualized costs for the final rule would increase from $47.7 million to 52.0 million. See *Chapter 6: Facility Compliance Costs* for the calculation of annualized costs incurred under the final rule.

Table 5-17: Projected Number of New Chemical Facilities (SIC 28)										
SIC Code	Total Number of Existing Facilities	Projected Industry Growth Rate			Estimated Number of New Facilities					
					10-Year Forecast (2001-2010)			20-Year Forecast (2001-2020)[d]		
		Annual	Over 10 Years[a]	Share of Growth from New Facilities	Total[b]	In-Scope Percentage	In-Scope[c]	Total	In-Scope	
2812	28	1.9%	20.7%	25.0%	1	68.7%	1	2	2	
2813	110	2.8%	31.8%	25.0%	9	3.9%	0	18	0	
2816	26	1.9%	20.7%	25.0%	1	16.7%	0	2	0	
2819	271	1.9%	20.7%	25.0%	14	12.2%	2	28	4	
2821	305	4.0%	48.0%	25.0%	37	4.8%	2	74	4	
2823	7	1.9%	20.7%	25.0%	0	17.9%	0	0	0	
2824	36	1.9%	20.7%	25.0%	2	24.1%	0	4	0	
2833	33	2.8%	31.8%	25.0%	3	9.9%	0	6	0	
2834	91	5.0%	62.9%	25.0%	14	4.7%	1	28	2	
2841	36	2.4%	26.8%	25.0%	2	12.0%	0	4	0	
2865	59	3.3%	38.4%	25.0%	6	7.3%	0	12	0	
2869	364	3.0%	34.4%	25.0%	31	13.1%	4	62	8	
2873	60	2.4%	26.8%	25.0%	4	14.4%	1	8	2	
2874	41	2.4%	26.8%	25.0%	3	2.9%	0	6	0	
2899	162	3.0%	34.4%	25.0%	14	2.7%	0	28	0	
Total	**1,629**				**0**	**10.0%**	**11**	**282**	**22**	

[a] Total percentage growth over 10 years, based on the forecasted annual growth rate [(1 + Annual Rate)^{10} - 1].
[b] Equal to Total Number of Existing Facilities * 10-Year Growth Rate * Share of Growth from New Facilities.
[c] Equal to Estimated Number of New Facilities * In-Scope Percentage.
[d] Equal to 2 * the 10-Year Forecast.

Source: U.S. EPA analysis, 2001.

❖ *Characteristics of existing facilities*

EPA used information from EPA's section 316(b) *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* to estimate characteristics of the new in-scope chemical facilities projected over the 2001-2020 analysis period. The survey requested technical information, including the facility's cooling system type, source water body, and intake flow in addition to economic and financial information.

EPA used the following survey data on existing chemical facilities to project characteristics of the 22 new (greenfield and stand-alone) facilities:[23]

- **Cooling system type:** There were 128 existing in-scope chemical facilities in the sectors with projected new in-scope facilities. These 128 facilities have the following cooling system types: 70 once-through, 23 combination system, 17 recirculating, 13 with other system types, and four that have unknown system types.
- **Water body type:** Of 128 in-scope chemical facilities, 109 withdraw cooling water from a freshwater body and 17

[23] The numbers in this section may not add up to totals because the survey facilities are sample-weighted and rounded.

withdraw from a marine water body. One facility withdraws from both a freshwater and marine water body.

In developing model manufacturing facilities, EPA only considered those existing survey plants that have a once-through system, a recirculating system, or a combination system. For this analysis, EPA classified facilities with a combination system as once-through and facilities withdrawing from both water body types as marine, providing a conservative estimate. Table 5-18 below presents the distribution of the 111 in-scope facilities that meet these cooling system criteria by water body type and cooling system type.

Table 5-18: Existing Chemical Facilities by Water Body Type and Cooling System Type (SIC 28)

SIC Code	Recirculating				Once-Through				Total	
	Freshwater		Marine		Freshwater		Marine			
	No.	%	No.	%	No.	%	No.	%	No.	%
2812	4	28%	0	0%	6	36%	6	36%	15	100%
2819	5	14%	0	0%	16	47%	13	39%	33	100%
2821	0	0%	0	0%	10	100%	0	0%	10	100%
2834	0	0%	0	0%	4	100%	0	0%	4	100%
2869	4	11%	0	0%	35	89%	0	0%	39	100%
2873	4	50%	0	0%	4	50%	0	0%	9	100%
Total	17	16%	0	0%	75	67%	19	17%	111	100%

Source: U.S. EPA, 2000; U.S. EPA analysis, 2001.

❖ *Development of model facilities*

EPA projected that 22 new in-scope chemical facilities will begin operation during the next 20 years. Based on the distribution of the in-scope survey respondents across water body and cooling system types, EPA assigned the 22 new facilities to 10 different model facility types, by SIC code:

- ***SIC code 2812:*** EPA projects that two new in-scope facilities will begin operation during the next 20 years. The distribution of existing in-scope facilities across water body and cooling system types showed that 36 percent of the existing facilities operate a once-through system and withdraw from a freshwater body and 36 percent operate a once-through system and withdraw from a marine body. EPA therefore projected one new once-through/freshwater facility and one new once-through system/marine facility.

- ***SIC code 2819:*** Four new industrial inorganic chemicals, not elsewhere classified facilities are projected to begin operation during the 20-year analysis period. The distribution of existing facilities across water body and cooling system types showed that 47 percent of the existing in-scope facilities operate a once-through system and withdraw from a freshwater body, 39 percent operate a once-through system and withdraw from a marine water body, and 14 percent operate a recirculating system and withdraw from a freshwater body. EPA therefore projected two new once-through/freshwater facilities and two new once-through/marine facilities.

- ***SIC code 2821:*** EPA projects that four new in-scope facilities will begin operation during the next 20 years. The distribution of existing facilities across water body and cooling system types showed that all existing in-scope plastics material and synthetic resins, and nonvulcanizable elastomer facilities operate a once-through system and withdraw from a freshwater body. EPA therefore assumed that all four projected new in-scope facilities will be freshwater facilities with a once-through system.

- ***SIC code 2834:*** EPA projects that two new in-scope facilities will begin operation during the next 20 years. The distribution of existing facilities across water body and cooling system types showed that all existing in-scope pharmaceutical preparation facilities operate a once-through system and withdraw from a freshwater body. EPA therefore assumed that both projected new in-scope facilities will be freshwater facilities with a once-through system.

- ***SIC code 2869:*** Eight new facilities in the Industrial Organic Chemical, Not Elsewhere Classified sector are projected to begin operation during the 20-year analysis period. The distribution of existing facilities across water body and cooling system types showed that 89 percent of the existing facilities operate a once-through system and withdraw from a freshwater body and 11 percent operate a recirculating system and withdraw from a freshwater body. Therefore EPA projected seven new once-through/freshwater facilities and one new recirculating/freshwater facility.

- ***SIC code 2873:*** EPA projected that two new in-scope nitrogenous fertilizer facilities will begin operation in the next 20 years. The distribution of existing facilities across water body and cooling system types showed that 50 percent of the existing facilities operate a recirculating system and withdraw from a freshwater body and 50 percent operate once-through systems and withdraw from a freshwater body. EPA therefore projected one new recirculating/freshwater facility and one new once-through/freshwater facility.

Table 5-19 below presents the model facility type, the number of in-scope survey facilities upon which the model facility type was based, and the number of projected new facilities that belong to that model type.

Table 5-19: SIC 28 Model Facilities

Model Facility Type	SIC	Cooling System Type	Source Water Body	Number of Existing In-Scope Facilities	Number of Projected New Facilities
MAN OT/M-2812	2812	Once-Through	Marine	6	1
MAN OT/F-2812	2812	Once-Through	Freshwater	6	1
MAN OT/M-2819	2819	Once-Through	Marine	13	2
MAN OT/F-2819	2819	Once-Through	Freshwater	16	2
MAN OT/F-2821	2821	Once-Through	Freshwater	10	4
MAN OT/F-2834	2834	Once-Through	Freshwater	4	2
MAN OT/F-2869	2869	Once-Through	Freshwater	35	7
MAN RE/F-2869	2869	Recirculating	Freshwater	4	1
MAN OT/F-2873	2873	Once-Through	Freshwater	4	1
MAN RE/F-2873	2873	Recirculating	Freshwater	4	1
Total				**102**	**22**

Source: U.S. EPA analysis, 2001.

c. Petroleum and Coal Products (SIC 29)

❖ ***SIC codes with potential new in-scope facilities***

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified one 4-digit SIC code in the Petroleum and Coal Products Industry (SIC 29) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws at least two million gallons per day (MGD) from a water of the U.S., and uses 25 percent or more of its intake flow for cooling purposes. Table 5-20 below presents the total number of existing facilities, the number of in-scope questionnaire respondents, and the in-scope percentage for SIC code 2911.

Table 5-20: Section 316(b) Facilities in the Petroleum and Coal Products Industry (SIC 29)

SIC Code	SIC Description	Total Number of Existing Facilities	In-Scope Survey Respondents	
			No.	%
2911	Petroleum Refining	163	31.3	19.2%

Source: U.S. EPA, 2000; OMB, 1987.

EPA analyzed the petroleum refining industry to estimate the number of new in-scope facilities.

❖ ***Projected growth in shipments***

The Energy Information Administration (EIA) forecasts that U.S. petroleum consumption will increase by 6.3 million barrels (bbl) a day between 1999 and 2020. Approximately 96 percent of the projected demand growth results from increased consumption of "light products," including gasoline, diesel, heating oil, jet fuel, and liquified petroleum gases. Additional petroleum imports are expected to fill the projected widening gap between supply and consumption. Petroleum imports are projected to be about 64 percent of total consumption in 2020 (U.S. DOE, 2000a).

No forecasts of shipments specific to petroleum refineries are available. Therefore, EPA assumed that shipments from this industry will grow at the same 3.0 percent annual rate as forecast for overall GDP (U.S. DOE, 2000b).

❖ ***Share of growth from new facilities***

EIA projects that domestic refinery capacity (SIC code 2911) will grow from 16.5 million bbl per day in 1999 to between 18.2 million bbl per day (low economic growth case) and 18.8 million bbl per day (high economic growth case) in 2020. This expansion will result from expanded capacity at existing refineries. No new refineries are likely to be constructed in the U.S. due to financial and legal constraints (U.S. DOE, 2000a).

❖ ***Projected number of new facilities***

Table 5-21 presents the number of existing facilities in the analyzed SIC code, the projected industry growth (annual growth rate and compounded growth rate over ten years), the share of growth from new facilities, and the estimated number of new facilities (total and in-scope). At proposal, EPA projected that there would be no new petroleum refineries constructed in the U.S. over the analysis period. The petroleum industry commented that the assumption of no new petroleum refineries over the next 20 years is invalid. Even though the *Annual Energy Outlook 2001* still projects no new refineries during the next 20 years, EPA nevertheless revised this estimate and made the conservative assumption that two new in-scope petroleum refineries will be subject to in the final section 316(b) New Facility Rule.

Table 5-21: Projected Number of New Petroleum Refinery Facilities (SIC 2911)

SIC Code	Total Number of Existing Facilities	Projected Industry Growth Rate			Estimated Number of New Facilities[b]				
					10-Year Forecast (2001-2010)			20-Year Forecast (2001-2020)[c]	
		Annual	Over 10 Years[a]	Share of Growth from New Facilities	Total	In-Scope Percentage	In-Scope	Total	In-Scope
2911	163	3.0%	34.4%	0.0%	1	--	1	2	2

[a] Total percentage growth over 10 years, based on the forecasted annual growth rate $[(1 + \text{Annual Rate})^{10} - 1]$.
[b] EPA's forecast methodology does not project any new in-scope facilities for this SIC. This projection is based on a comment submitted by the petroleum industry.
[c] Equal to 2 * the 10-Year Forecast.

Source: U.S. EPA analysis, 2001.

❖ *Characteristics of existing facilities*

EPA used information from EPA's section 316(b) *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* to estimate the characteristics of the new in-scope petroleum refineries assumed over the 2001-2020 analysis period. The survey requested technical information, including the facility's in-scope status, cooling system type, source water body, and intake flow in addition to economic and financial information.

EPA used the following survey data on existing petroleum facilities to project characteristics of the two new petroleum facilities:[24]

- **Cooling system type:** There were 31 existing in-scope petroleum refineries. These 31 facilities have the following cooling system types: 15 recirculating, 10 combination system, 5 once-through, and one other.
- **Water body type:** Of the 31 in-scope facilities, 26 withdraw cooling water from a freshwater body and five withdraw from a marine water body.

In developing model manufacturing facilities, EPA only considered those existing survey plants that have a once-through system, a recirculating system, or a combination system. For this analysis, EPA classified facilities with a combination system as once-through facilities, providing a conservative estimate. Table 5-22 below presents the distribution of the 30 in-scope facilities that meet these cooling system criteria by water body type and cooling system type.

Table 5-22: Existing Petroleum Facilities by Water Body Type and Cooling System Type (SIC 2911)

SIC Code	Recirculating				Once-Through				Total	
	Freshwater		Marine		Freshwater		Marine			
	No	%	No	%	No	%	No	%	No	%
2911	15	50%	0	0%	9	29%	6	21%	30	100%

Source: U.S. EPA, 2000; U.S. EPA analysis, 2001.

❖ *Development of model facilities*

EPA projected that two new in-scope petroleum refineries (SIC code 2911) will begin operation during the next 20 years. The distribution of existing facilities across water body and cooling system types showed that 50 percent of the existing petroleum refineries operate a recirculating system and withdraw from a freshwater body and 29 percent operate once-through systems and withdraw from a freshwater body. EPA therefore assumed that the two new projected facilities would have those characteristics. Table 5-23 below presents the model facility type, the number of in-scope survey facilities upon which the model facility type was based, and the number of projected new facilities that belong to that model type.

Table 5-23: SIC 29 Model Facilities

Model Facility Type	SIC Code	Cooling System Type	Source Water Body	Number of Existing In-Scope Facilities	Number of Projected New Facilities
MAN OT/F-2911	2911	Once-Through	Freshwater	9	1
MAN RE/F-2911	2911	Recirculating	Freshwater	15	1
Total				**24**	**2**

Source: U.S. EPA analysis, 2001.

[24] The numbers in this section may not add up to totals because the survey facilities are sample-weighted and rounded.

d. Steel (SIC 331)

❖ ***SIC codes with potential new in-scope facilities***

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified five 4-digit SIC codes in the Steel Works, Blast Furnaces, and Rolling and Finishing Mills Industries (SIC 331) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws at least two million gallons per day (MGD) from a water of the U.S., and uses 25 percent or more of its intake flow for cooling purposes. Table 5-24 below presents the total number of existing facilities, the number of in-scope questionnaire respondents, and the in-scope percentage for each of the five SIC codes.

Table 5-24: Section 316(b) Facilities in the Steel Industry (SIC 331)

SIC Code	SIC Description	Total Number of Existing Facilities	In-Scope Survey Respondents	
			No.	%
3312	Steel Works, Blast Furnaces (Including Coke Ovens), and Rolling Mills	161	40	24.9%
3313	Electrometallurgical Products, Except Steel	6	2	30.4%
3315	Steel Wiredrawing and Steel Nails and Spikes	122	3	2.5%
3316	Cold-Rolled Steel Sheet, Strip, and Bars	57	9	16.4%
3317	Steel Pipe and Tubes	130	7	5.7%
	Total SIC 331	**476**	**62**	**13.0%**

Source: U.S. EPA, 2000; OMB, 1987.

EPA analyzed each of these five industry segments to determine the number of new in-scope facilities in the Steel Industry.

❖ ***Projected growth in shipments***

Demand for North American steel is expected to increase over the long term. Steel shipments are expected to rise at a 1 to 2 percent annual rate through 2004, assuming continued moderate economic growth (McGraw-Hill, 2000).

❖ ***Share of growth from new facilities***

Industry-specific information on the potential for the construction of new facilities was not available. EPA therefore assumed that 50 percent of the projected growth in shipments in all potentially-affected steel industries will result from new facilities.

❖ ***Projected number of new facilities***

Table 5-25 presents the number of existing facilities in the analyzed SIC code, the projected industry growth (annual growth rate and compounded growth rate over ten years), the share of growth from new facilities, and the number of projected new facilities (total and in-scope). To calculate the number of projected new facilities, EPA applied the industry-specific 10-year growth rate and the percentage of capacity growth from new facilities to the total number of existing facilities. EPA then applied the in-scope percentage (based on information from the section 316(b) *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures*) to the 10-year forecast of new facilities to derive the projected number of new in-scope facilities over 10 years. Both the number of new facilities and the number of new in-scope facilities were doubled to calculate the 20-year projection. EPA estimates that 78 new facilities will be constructed over the next 20 years, of which 10 will be in scope of the final section 316(b) New Facility Rule.

Table 5-25: Projected Number of New Iron and Steel Facilities (SIC 331)

SIC Code	Total Number of Existing Facilities	Projected Industry Growth Rate			Estimated Number of New Facilities				
					Ten Year Forecast (2001-2010)			Twenty Year Forecast (2001-2020)[d]	
		Annual	Over 10 Years[a]	Share of Growth from New Facilities	Total[b]	In-Scope Percentage	In-Scope[c]	Total	In-Scope
3312[e]	161	1.5%	16.1%	50.0%	13	24.9%	3	26	6
3313	6	3.0%	34.4%	50.0%	1	30.4%	0	2	0
3315	122	1.5%	16.1%	50.0%	10	2.5%	0	20	0
3316	57	1.5%	16.1%	50.0%	5	16.4%	1	10	2
3317	130	1.5%	16.1%	50.0%	10	5.7%	1	20	2
Total	476				39	**13.0%**	5	78	10

[a] Total percentage growth over 10 years, based on the forecasted annual growth rate [(1 + Annual Rate)^{10} - 1].
[b] Equal to Total Number of Existing Facilities * 10-Year Growth Rate * Share of Growth from New Facilities.
[c] Equal to Estimated Number of New Facilities * In-Scope Percentage.
[d] Equal to 2 * the 10-Year Forecast.
[e] Recent growth in new steelmaking capacity has been in minimills. The success of the thin slab caster/flat rolling mill is expected to result in the addition of 8 million tons of new minimill steel capacity in the U.S. between 2001 and 2003 (S&P, 2001a). While new low-cost minimills have been starting up, some antiquated, less efficient integrated mills have been shut down and other integrated producers have increased output efficiencies at their existing blast furnaces during the late 1990's (McGraw-Hill, 1999). EPA therefore assumes that all new facilities in the basic steel sector will be new minimills rather than new integrated mills.

Source: U.S. EPA analysis, 2001.

❖ *Characteristics of existing facilities*

EPA used information from EPA's section 316(b) *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* to estimate characteristics of the new in-scope steel facilities projected over the 2001-2020 analysis period. The survey requested technical information, including the facility's cooling system type, source water body, and intake flow in addition to economic and financial information.

EPA used the following survey data on existing steel facilities to project characteristics of the 10 new steel facilities:[25]

- **Cooling system type:** There are 57 existing in-scope steel facilities. These 57 facilities have the following cooling system types: 21 combination systems, 20 once-through, 9 recirculating, and 7 other system types.
- **Water body type:** All 57 facilities withdraw cooling water from a freshwater body.

In developing model manufacturing facilities, EPA only considered those existing survey plants that have a once-through system, a recirculating system, or a combination system. For this analysis, EPA classified facilities with a combination system as once-through facilities, providing a conservative estimate. Table 5-26 below presents the distribution of the 50 in-scope facilities that meet these cooling system criteria by water body type and cooling system type.

[25] The numbers in this section may not add up to totals because the survey facilities are sample-weighted and rounded.

Table 5-26: Existing Steel Facilities by Water Body Type and Cooling System Type (SIC 331)

SIC	Recirculating				Once-Through				Total	
	Freshwater		Marine		Freshwater		Marine			
	No	%	No	%	No	%	No	%	No	%
3312	3	9%	0	0%	32	91%	0	0%	35	100%
3316	3	33%	0	0%	6	67%	0	0%	9	100%
3317	3	50%	0	0%	3	50%	0	0%	6	100%
Total	9	18%	0	0%	41	82%	0	0%	50	100%

Source: U.S. EPA, 2000; U.S. EPA analysis, 2001.

❖ *Development of model facilities*

EPA projected that 10 new in-scope steel facilities will begin operation during the next 20 years. Based on the distribution of the in-scope survey respondents across water body and cooling system types, EPA assigned the 10 new facilities to six different model facility types, by SIC code:

- ***SIC code 3312:*** Six steel mills are projected to begin operation during the 20-year analysis period. The distribution of existing facilities across water body and cooling system types showed that 91 percent of the existing facilities operate a once-through system and withdraw from a freshwater body and nine percent operate a recirculating system and withdraw from a freshwater body. Therefore EPA projected five new once-through/freshwater facilities and one recirculating/freshwater facility.

- ***SIC code 3316:*** EPA projected that two new in-scope cold-rolled steel sheet, strip, and bar facilities will begin operation in the next 20 years. The distribution of existing facilities across water body and cooling system types showed that 67 percent of the existing facilities operate a once-through system and withdraw from a freshwater body and 33 percent operate a recirculating system and withdraw from a freshwater body. EPA therefore projected one once-through/freshwater and one recirculating/freshwater facility.

- ***SIC code 3317:*** EPA projected that two new in-scope steel pipe and tube facilities will begin operation in the next 20 years. The distribution of existing facilities across water body and cooling system types showed that 50 percent of the existing facilities operate a recirculating system and withdraw from a freshwater body and 50 percent operate once-through systems and withdraw from a freshwater body. EPA therefore assumed that the two new projected facilities would have those characteristics.

Table 5-27 below presents the model facility type, the number of in-scope survey facilities upon which the model facility type was based, and the number of projected new facilities that belong to that model type.

Table 5-27: SIC 331 Model Facilities					
Model Facility Type	**SIC Code**	**Cooling System Type**	**Source Water Body**	**Number of Existing In-Scope Facilities**	**Number of Projected New Facilities**
MAN OT/F-3312	3312	Once-Through	Freshwater	32	5
MAN RE/F-3312	3312	Recirculating	Freshwater	3	1
MAN OT/F-3316	3316	Once-Through	Freshwater	6	1
MAN RE/F-3316	3316	Recirculating	Freshwater	3	1
MAN OT/F-3317	3317	Once-Through	Freshwater	3	1
MAN RE/F-3317	3317	Recirculating	Freshwater	3	1
Total				**50**	**10**

Source: U.S. EPA analysis, 2001.

e. Aluminum (SIC 333/335)

❖ ***SIC codes with potential new in-scope facilities***

EPA's *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* identified two 4-digit SIC codes in the nonferrous metals industries (SIC codes 333/335) with at least one existing facility that operates a CWIS, holds a NPDES permit, withdraws at least two million gallons per day (MGD) from a water of the U.S., and uses 25 percent or more of its intake flow for cooling purposes. Table 5-28 below presents the total number of existing facilities, the number of in-scope questionnaire respondents, and the in-scope percentage for the two SIC codes.

Table 5-28: Section 316(b) Facilities in the Aluminum Industries (SIC 333/335)				
SIC Code	**SIC Description**	**Total Number of Existing Facilities**	**In-Scope Survey Respondents**	
			No.	**%**
3334	Primary Production of Aluminum	31	11	34.3%
3353	Aluminum Sheet, Plate, and Foil	57	6	11.1%
	Total SIC 333, 335	**88**	**17**	**19.2%**

Source: U.S. EPA, 2000; OMB, 1987.

EPA analyzed these two industry segments to determine the number of new in-scope facilities in the Aluminum Industry.

❖ ***Projected growth in shipments***

Total shipments for all sectors of the aluminum industry are expected to increase 2.5 percent annually from 1999 through 2004 (McGraw-Hill, 2000). EPA therefore assumed that shipments of primary aluminum smelters (SIC 3334) and aluminum sheet, plate, and foil (SIC 3353) will increase at an annual rate of 2.5 percent.

❖ ***Share of growth from new facilities***

Domestic production is expected to increase as idled capacity is reactivated. The U.S. is responsible for approximately 40 percent of the idle capacity worldwide (McGraw-Hill, 2000). The 1998 capacity utilization rate of 88 percent was well below the 1987 rate of approximately 97 percent. The U.S. aluminum industry requires substantial amounts of capital to mine bauxite, handle materials, and operate smelters, rolling mills, and finishing plants. It would be extremely difficult for a new facility to enter this industry and operate as a vertically integrated firm (S&P, 2001a). These conditions make it likely that any capacity increases will involve using existing capacity or expansions at existing facilities, rather than the construction of new greenfield and stand-alone facilities. No new primary smelters have been constructed in the U.S. since 1980 (McGraw-Hill, 2000). According to Standard & Poor's, construction of new minimill capacity is also unlikely given the potential that added capacity would drive down prices in the face of slow growth in the markets for minimill products (S&P, 2001a). EPA therefore assumed that all projected growth in primary aluminum shipments (SIC 3334) will result from using the currently-idled capacity or from expansions at existing facilities. In the absence of specific information for SIC code 3353, EPA assumed that half of the growth in shipments would result from new facilities, rather than from idled capacity or expansions at existing facilities.

❖ *Projected number of new facilities*

Table 5-29 presents the number of existing facilities in the analyzed SIC code, the projected industry growth (annual growth rate and compounded growth rate over ten years), the share of growth from new facilities, and the number of projected new facilities (total and in-scope). To calculate the number of projected new facilities, EPA applied the industry-specific 10-year growth rate and the percentage of capacity growth from new facilities to the total number of existing facilities. EPA then applied the in-scope percentage (based on information from the section 316(b) *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures*) o the 10-year forecast of new facilities to derive the projected number of new in-scope facilities over 10 years. Both the number of new facilities and the number of new in-scope facilities were doubled to calculate the 20-year projection. EPA estimates that 16 new facilities may be constructed in the relevant aluminum sectors, over the next twenty years. Of these, two new Aluminum Sheet, Plate and Foil facilities (SIC code 3353) are expected to be in scope of the final section 316(b) New Facility Rule.

Table 5-29: Projected Number of New Aluminum and Other Nonferrous Metal Facilities (SIC 333,335)

SIC Code	Total Number of Existing Facilities	Projected Industry Growth Rate			Estimated Number of New Facilities				
					Ten Year Forecast (2001-2010)			Twenty Year Forecast (2001-2020)[d]	
		Annual	Over 10 Years[a]	Share of Growth from New Facilities	Total[b]	In-Scope Percentage	In-Scope[c]	Total	In-Scope
3334	31	2.5%	28.0%	0.0%	0	34.3%	0	0	0
3353	57	2.5%	28.0%	50.0%	8	11.1%	1	16	2
Total	88				8	**19.2%**	1	16	2

[a] Total percentage growth over 10 years, based on the forecasted annual growth rate [(1 + Annual Rate)^{10} - 1].
[b] Equal to Total Number of Existing Facilities * 10-Year Growth Rate * Share of Growth from New Facilities.
[c] Equal to Estimated Number of New Facilities * In-Scope Percentage.
[d] Equal to 2 * the 10-Year Forecast.

Source: U.S. EPA analysis, 2001.

❖ *Characteristics of existing facilities*

EPA used information from EPA's section 316(b) *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* to estimate characteristics of the new in-scope aluminum facilities projected over the 2001-2020 analysis period. The survey requested technical information, including the facility's cooling system type, source water body, and intake flow in addition to economic and financial information.

EPA used the following survey data on existing aluminum facilities to project characteristics of the two new aluminum facilities:[26]

- **Cooling system type:** There were six existing in-scope aluminum facilities in SIC code 3353. Three of these

[26] The numbers in this section may not add up to totals because the survey facilities are sample-weighted and rounded.

facilities have a recirculating system and three have a once-through system.

- **Water body type:** All six of the in-scope aluminum facilities withdraw cooling water from a freshwater body.

Table 5-30 below presents the distribution of the six in-scope facilities that meet these cooling system criteria by water body type and cooling system type.

Table 5-30: Existing Aluminum Facilities by Water Body Type and Cooling System Type (SIC 3353)

SIC Code	Recirculating				Once-Through				Total	
	Freshwater		Marine		Freshwater		Marine			
	No	%	No	%	No	%	No	%	No	%
3353	3	50%	0	0%	3	50%	0	0%	6	100%

Source: U.S. EPA, 2000; U.S. EPA analysis, 2001.

❖ ***Development of model facilities***

EPA projected that two new in-scope aluminum facilities will begin operation in the next 20 years. The distribution of existing facilities across water body and cooling system types showed that 50 percent of the existing aluminum facilities operate a recirculating system and withdraw from a freshwater body and 50 percent operate once-through systems and withdraw from a freshwater body. EPA therefore assumed that the two new projected facilities would have those characteristics. Table 5-31 below presents the model facility type, the number of in-scope survey facilities upon which the model facility type was based, and the number of projected new facilities that belong to that model type.

Table 5-31: SIC 3353 Model Facilities

Model Facility Type	SIC Code	Cooling System Type	Source Water Body	Number of Existing In-Scope Facilities	Number of Projected New Facilities
MAN OT/F-3353	3353	Once-Through	Freshwater	3	1
MAN RE/F-3353	3353	Recirculating	Freshwater	3	1
Total				**6**	**2**

Source: U.S. EPA analysis, 2001.

5.2.3 Summary of Forecasts for New Manufacturing Facilities

EPA estimates that a total of 380 new manufacturing facilities will begin operation between 2001 and 2020. Thirty-eight of these are expected to be in scope of the final section 316(b) New Facility Rule. Of the 38 facilities, 22 are chemical facilities, ten are steel facilities, two are petroleum refineries, two are paper mills, and two are aluminum facilities. Table 5-32 summarizes the results of the analysis.

Table 5-32: Number of Projected New Manufacturers (2001 to 2020)

Facility Type	Total Number of New Facilities	Facilities In Scope of the Final Rule				
		Recirculating		Once-Through		Total
		Freshwater	Marine	Freshwater	Marine	
Paper and Allied Products (SIC 26)	2	0	0	2	0	2
Chemicals and Allied Products (SIC 28)	282	2	0	17	3	22
Petroleum Refining And Related Industries (SIC 29)	2	1	0	1	0	2
Blast Furnaces and Basic Steel Products (SIC 331)	78	3	0	7	0	10
Aluminum Sheet, Plate, and Foil (SIC 3353)	16	1	0	1	0	2
Total	**380**	**7**	**0**	**28**	**3**	**38**

Source: U.S. EPA analysis, 2001.

5.2.4 Uncertainties and Limitations

There are uncertainties in EPA's projections of the number of new manufacturing facilities that will be subject to the final section 316(b) New Facility Rule. EPA's results depend on several key assumptions:

- **Industry growth forecasts are accurate.** For most industries, EPA used 5-year growth forecasts developed in late 2000. EPA assumed that the projected growth will continue over the next 10 years. EPA then doubled this estimate to project the number of new facilities over the next 20 years. There are two main uncertainties associated with this approach. First, predicting growth over a 20-year time period is always uncertain. Applying a 5-year forecast to a 20-year analysis period therefore introduces uncertainty. Second, the economy has recently experienced a substantial slow-down. This development has not been reflected in the industry forecasts used for this analysis. It is therefore likely that the analysis presented in this chapter overstates the number of new manufacturing facilities that will be subject to the final § 316(b) New Facility Rule, at least for the near term.

- **EPA accurately predicted the share of industry growth from new (greenfield and stand-alone) facilities.** While 5 year forecasts of industry shipments are available for most of the relevant industries, forecasts of the likely growth in capacity and numbers of new facilities are less readily available. Those that are available generally apply only for the next few years. For the steel sectors and the aluminum sheet, plate, and foil sector, no industry-specific information on new facility construction was available. EPA made the assumption that 50 percent of future growth in these sectors will occur at new (greenfield and stand-alone) facilities.[27] This assumption was likely to be conservative when EPA proposed this rule. With the recent economic slow-down, new facility construction has become even less likely. EPA therefore believes that the analysis in support of this rule overstates the number of new manufacturing facilities that will be subject to the final § 316(b) New Facility Rule over the next 20 years.

- **Future manufacturing facilities will have the same size as the analyzed survey facilities.** EPA's methodology for estimating the number of new (greenfield and stand-alone) facilities rests on the assumption that future facilities will have the same size as existing ones in the same SIC code. If future facilities are likely to be either larger or smaller than existing facilities, EPA's estimate will overstate or understate, respectively, the number of new facilities.

[27] The steel sectors and the aluminum sheet, plate, and foil sectors account for 12 of the 38 projected in-scope manufacturing facilities.

- **Future facilities will have the same cooling water characteristics as the analyzed survey facilities.** EPA's forecasts assume that the characteristics of new facilities that determine their regulatory status under the final rule will be the same as those of the existing facilities in the same industries. A variety of factors may lead new facilities to use municipal or ground water instead of a water of the U.S. or to recycle the process water more often than do existing facilities. Thus, this assumption may overstate the number of new facilities.

5.3 Summary of Baseline Projections

EPA estimates that over the next 20 years a total of 656 new greenfield and stand-alone facilities will be built in the industry sectors analyzed for this final regulation. Two hundred and seventy-six of these new facilities will be steam electric generating facilities and 380 will be manufacturing facilities. As Table 5-33 shows, only 121 of the 656 new facilities are projected to be in scope of the final section 316(b) New Facility Rule, including 83 electric generators, 22 chemical facilities, 12 primary metals facilities, two new pulp and paper, and two petroleum facilities.

Table 5-33: Projected Number of New In-Scope Facilities (2001 to 2020)

SIC	SIC Description	Projected Number of New Facilities	
		Total	**In-Scope**
	Electric Generators		
SIC 49	Electric Generators	276	83
	Manufacturing Facilities		
SIC 26	Paper and Allied Products	2	2
SIC 28	Chemicals and Allied Products	282	22
SIC 29	Petroleum Refining And Related Industries	2	2
SIC 33	Primary Metals Industries		
SIC 331	Blast Furnaces and Basic Steel Products	78	10
SIC 333 SIC 335	Primary Aluminum, Aluminum Rolling, and Drawing and Other Nonferrous Metals	16	2
Total Manufacturing		*380*	*38*
Total		**656**	**121**

Source: U.S. EPA analysis, 2001.

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Appendix to Chapter 5

This Appendix presents additional, more detailed information on the data sources, calculations, and results of the projection of new facilities subject to the final section 316(b) New Facility Rule.

5.A.1 Background

The electric power industry is currently experiencing a rapid expansion due to the transition from a highly regulated monopolistic industry to a more competitive industry. This expansion has contributed to a surge in the number of generating plants being planned or under construction. As discussed in other parts of this EA, only steam electric facilities use substantial amounts of cooling water and were considered for this analysis. The AEO2001 and the NEWGen data show a trend toward combined-cycle generating technologies. This trend may reflect the transition toward competitive pricing for electricity. In competitive markets, prices will reflect the interaction of supply and demand for electricity. During most time periods, the price of electricity will be set by the generating unit with the highest operating costs needed to meet spot market demand (i.e., the "marginal cost" of production). The lower capital and operating cost usually associated with gas generation technologies may be one reason for the trend toward combined-cycle generating technology employed by new facilities.

The NEWGen data and the section 316(b) Industry Survey data also show a trend away from the use of waters of the U.S. as a source of cooling water. EPA believes this trend reflects the increased competition for water and an increasing awareness of the need for water conservation. As a result, the projected number of new electric generators subject to this rule is low, despite the expected expansion in new generating capacity.

5.A.2 Annual Energy Outlook 2001

As described in Section 5.1.1.a, EPA used a forecast of capacity additions between 2001 and 2020 (presented in the AEO2001) to estimate the number of new combined-cycle and coal-fired plants. The AEO2001 projects both planned and unplanned capacity additions between 2001 and 2020 for eight facility types (coal steam, other fossil steam, combined-cycle, combustion turbine/diesel, nuclear, pumped storage/other, fuel cells and renewables).

Table 5.A-1 below presents AEO2001's forecast of total annual capacity additions between 2001 and 2020. The total forecasted capacity additions represent the sum of all planned and unplanned capacity additions for each year and each technology type. In addition, the table presents EPA's distribution of the projected 276 new combined-cycle and coal plants, as well as the projected 83 new in-scope combined-cycle and coal plants over the 20-year analysis period. This distribution is proportionate to the distribution of new combined-cycle and coal capacity additions over the 20 years.

Table 5.A-1: Total Annual Additions and Number of New Plants (2001-2020)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2001 - 2010
Total Annual Additions (in megawatts of capacity)											
Coal Steam	0	0	0	0	2,397	5,031	7,457	2,244	920	465	**18,514**
Other Fossil Steam[a]	0	0	0	0	0	0	0	0	0	0	**0**
Combined-Cycle	1,540	456	0	7,282	15,110	16,997	14,406	16,431	14,485	14,237	**100,943**
Combustion Turbine/Diesel	8,316	9,126	10,507	6,725	19,209	5,541	15,358	4,204	6,646	3,086	**88,719**
Nuclear Power	0	0	0	0	0	0	0	0	0	0	**0**
Pumped Storage/Other[b]	0	0	0	0	0	0	0	0	0	0	**0**
Fuel Cells	0	0	4	4	5	9	18	27	36	45	**147**
Renewable[c]	913	371	282	1,057	777	520	832	689	659	508	**6,607**
Total Additions	10,769	9,953	10,793	15,069	37,498	28,097	38,071	23,593	22,745	18,342	**216,931**
Number of New Plants											
Coal Steam - Total	0	0	0	0	5	8	12	4	1	1	**31**
Coal Steam - In-Scope	0	0	0	2	3	5	1	1	0	0	**12**
Combined-Cycle - Total	2	1	0	7	18	20	17	19	17	17	**118**
Combined-Cycle - In-Scope	0	0	0	1	5	6	5	6	5	5	**33**
Total In-Scope	0	0	0	3	8	11	6	7	5	5	**45**
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2011 - 2020**
Total Annual Additions (in megawatts of capacity)											
Coal Steam	500	182	184	0	157	0	239	336	816	885	**3,299**
Other Fossil Steam [a]	0	0	0	0	0	0	0	0	0	0	**0**
Combined-Cycle	10,723	11,862	10,766	12,878	9,050	10,885	8,948	10,876	9,302	7,752	**103,042**
Combustion Turbine/Diesel	4,399	2,418	6,217	1,487	6,650	3,964	5,185	6,501	6,523	4,023	**47,367**
Nuclear Power	0	0	0	0	0	0	0	0	0	0	**0**
Pumped Storage/Other[b]	0	0	0	0	0	0	0	0	0	0	**0**
Fuel Cells	55	65	0	0	0	21	0	0	0	0	**142**
Renewable[c]	440	436	61	70	107	186	62	63	91	88	**1,602**
Total Additions	16,117	14,964	17,228	14,434	15,963	15,056	14,434	17,776	16,732	12,747	**157,462**
Number of New Plants											
Coal Steam - Total	1	0	0	0	0	0	0	1	1	1	**4**
Coal Steam - In-Scope	0	0	0	0	0	0	0	0	1	1	**2**
Combined Cycle - Total	13	14	13	15	11	13	11	13	11	9	**123**
Combined Cycle - In-Scope	4	4	4	4	3	4	3	4	3	3	**36**
Total In-Scope	4	4	4	4	3	4	3	4	4	4	**38**

[a] Includes oil-, gas-, and dual-fired capability.

[b] Other includes methane, propane gas, and blast furnace gas for utilities; and hydrogen, sulfur, batteries, chemicals, fish oil, and spent sulfite liquor.

[c] Includes conventional hydroelectric, geothermal, wood, wood waste, municipal solid waste, other biomass, solar thermal, photovoltaics, and wind power.

Source: *U.S. DOE, 2000a; U.S. EPA analysis, 2001.*

5.A.3 Cooling Water Source Characteristics of New Combined-Cycle Facilities

The screening analysis of the NEWGen database and EPA's research of public data sources produced information on cooling water use for 199 new combined-cycle facilities. Table 5.A-2 below presents the number and capacity of these 199 facilities by cooling water source. The table shows that approximately two thirds of new combined-cycle facilities do not use waters of the U.S. for cooling purposes. For those facilities the most common alternative sources of cooling water are: municipal water (22 percent), groundwater (16 percent), gray water (12 percent),[28] and dry cooling (11 percent). The remaining facilities that do not use waters of the U.S. use either unknown or multiple non-surface sources of cooling water. The table also indicates that the average capacity per facility is relatively stable across the different cooling water sources, ranging from 643 to 907 MW. The average capacity for the 199 facilities is 741 MW.

Table 5.A-2: NEWGen Combined-Cycle Facilities by Cooling Water Source

Cooling Water Source	Number of Facilities	Percent of Facilities	Capacity (MW)	Percent of Capacity	Average Capacity per Facility
Water of the U.S.[a]	67	34%	49,760	34%	743
Municipal Water	44	22%	33,789	23%	768
Groundwater	32	16%	25,184	17%	787
Gray Water	23	12%	15,226	10%	662
Dry Cooling	22	11%	14,154	10%	643
unknown non-surface	5	3%	3,900	3%	780
multiple non-surface	6	3%	5,443	4%	907
Total	199	100%	147,455	100%	741

[a] Sixty-seven new combined-cycle facilities withdraw from a water of the U.S. However, 10 of these are not considered in scope of the final section 316(b) New Facility Rule because they do not meet one or more of the other in-scope criteria.

Source: EPA analysis of information from state permitting authorities, 2001.

5.A.4 Cooling Water Source Characteristics of In-Scope NEWGen Combined-Cycle Facilities

Of the 199 new combined-cycle facilities with cooling water information, 57 were determined to be in scope of the final section 316(b) New Facility Rule. Table 5.A-3 below presents the distribution of planned cooling water sources for the 57 new in-scope combined-cycle facilities. The table shows that the majority of in-scope facilities, 84 percent, plans to draw cooling water from freshwater sources, while the remaining 16 percent will withdraw water from marine sources.[29] In addition, the table indicates that 77 percent of in-scope facilities draw cooling water from rivers, both freshwater and tidal. The most common source of cooling water is freshwater rivers, with 65 percent of all in-scope facilities. The second most common surface water body types are tidal rivers, and lakes and reservoirs, with about 12 percent each.

[28] Gray water is treated effluent from sewage systems.

[29] Marine sources of cooling water include oceans, estuaries, and tidal rivers.

Table 5.A-3: In-Scope NEWGen Combined-Cycle Facilities by Cooling Water Source

Cooling Water Source	Number of Facilities	Percent of Facilities	Capacity (MW)	Percent of Capacity
Freshwater				
River	37	65%	28,000	66%
Lake/Reservoir	7	12%	5,030	12%
Canal	1	2%	265	1%
Multiple surface waters of the U.S.	2	4%	1,310	3%
Unknown surface water of the U.S.	1	2%	846	2%
Total Freshwater	***48***	***84%***	***35,451***	***83%***
Marine				
River	7	12%	4,682	11%
Canal	1	2%	1,030	2%
Unknown surface water of the U.S.	1	2%	1,400	3%
Total Marine	***9***	***16%***	***7,112***	***17%***
Total	**57**	**100%**	**42,563**	**100%**

Source: RDI, 2001.

5.A.5 Distribution of New Combined-Cycle Capacity by NERC Region

Figure 5.A-1 presents the distribution of projected new combined-cycle capacity additions by North American Electric Reliability Council (NERC) region. Figure 5.A.1 contains two graphs: The graph on the left presents the capacity of the 199 NEWGen combined-cycle facilities with available cooling water information. These are the facilities upon which EPA's analysis of new combined-cycle facilities is based. For comparison purposes, the graph on the right presents the combined-cycle capacity addition forecasts for 2001 to 2020 from the *Annual Energy Outlook 2001* (AEO2001).

- ***199 NEWGen combined-cycle facilities:*** The first graph shows that the largest share of capacity additions, approximately 24 percent, will be in WSCC (the Western Systems Coordinating Council). SERC (the Southeastern Electric Reliability Council) accounts for the second largest share with 21 percent. Only one NERC region, MAPP (the Mid-Continent Area Power Pool), did not have any planned NEWGen facility with known cooling water characteristics.[30]

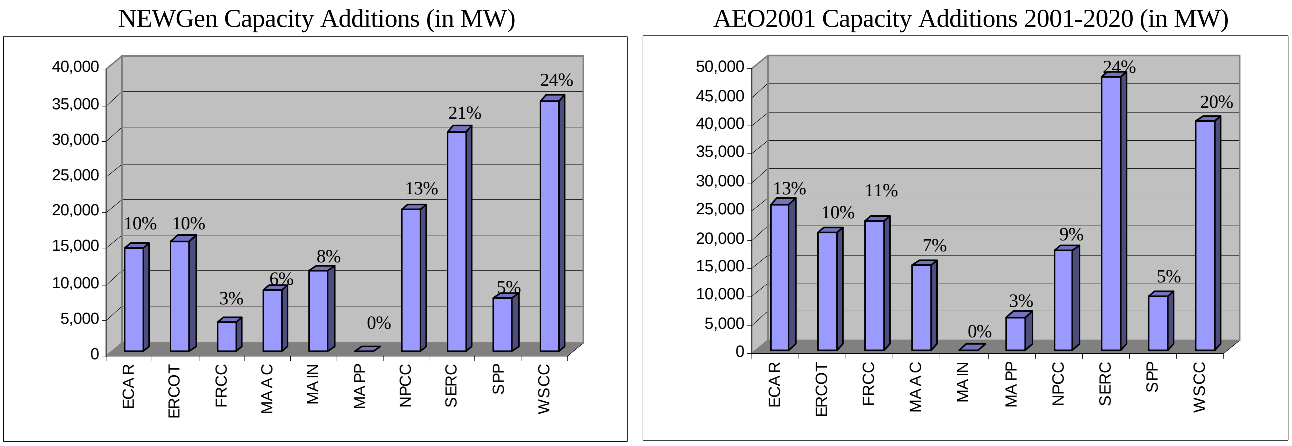
- ***AEO2001:*** The second graph shows that, similar to the NEWGen capacity additions, SERC (24 percent) and WSCC (20 percent) are the two regions with the largest combined-cycle capacity additions. The only region without projected new combined-cycle capacity is MAIN (the Mid-America Interconnected Network).

A comparison of the two graphs shows that the regional capacity distribution projected by the two data sources is very similar. Only for two of the ten NERC regions do the forecasts differ by 5 percent or more: (1) FRCC (the Florida Reliability Coordinating Council) only accounts for three percent of the capacity additions in the NEWGen database whereas it accounts for 11 percent in the AEO2001; and (2) MAIN does not have any combined-cycle capacity additions in the AEO2001

[30] The absence of new combined-cycle NEWGen facilities located in MAPP may be partially explained by the fact that the AEO2001 does not forecast new combined-cycle additions in MAPP until 2009, which is beyond the time-period covered by the NEWGen database.

whereas it accounts for 8 percent of the NEWGen capacity additions.

Figure 5.A-1: Distribution of New Combined-Cycle Capacity Additions by NERC Region[a]



[a] The NERC regions included in these graphs are: ECAR – East Central Area Reliability Coordination Agreement; ERCOT – Electric Reliability Council of Texas; FRCC – Florida Reliability Coordinating Council; MAAC – Mid-Atlantic Area Council; MAIN – Mid-America Interconnect Network; MAPP – Mid-Continent Area Power Pool; NPCC – Northeast Power Coordinating Council; SERC – Southeastern Electric Reliability Council; SPP – Southwest Power Pool; WSCC – Western Systems Coordinating Council.

Source: RDI, 2001; U.S. DOE 2000a; U.S. EPA analysis, 2001.

5.A.6 Development of Combined-Cycle Model Facilities

EPA's analysis projected 69 new in-scope combined-cycle facilities. The cooling water and economic characteristics of these 69 facilities were based on the 57 in-scope combined-cycle facilities identified from the NEWGen database. EPA developed six model facility types:

- ***Model Facility 1***, developed based on 15 freshwater/recirculating facilities with relatively small capacities (on average 439 MW);
- ***Model Facility 2,*** developed based on 17 freshwater/recirculating facilities with medium capacities (on average 699 MW);
- ***Model Facility 3,*** developed based on 16 freshwater/recirculating facilities with relatively large capacities (on average 1,061 MW);
- ***Model Facility 4,*** developed based on 4 marine/once-through facilities with an average size of 1,031 MW;
- ***Model Facility 5,*** developed based on 4 marine/recirculating facilities with relatively small capacities (on average 489 MW);
- ***Model Facility 6***, developed based on 1 marine/recirculating facility with a relatively large capacity (1,030 MW).

In general, the number of model facility types for each water body/cooling system combination depended on the number of NEWGen facilities with that combination of characteristics and their size distribution: EPA developed more model facilities for water body/cooling system combinations with a large number of NEWGen facilities and/or with a wide range of facility sizes.

Table 5.A-4 below presents the characteristics of the 57 new in-scope combined-cycle facilities (water body type, cooling system type, and actual steam-electric capacity) as well as the model facility by which they are represented and their model facility capacity.

Table 5.A-4: In-Scope NEWGen Facilities						
No.	NEWGen Facility	Water Body Type	Baseline CWS Type	Actual Steam Capacity (MW)	Model Facility ID	Model Steam Capacity (MW)
1	NEWGen 1	Freshwater	Recirculating	165	CC R/FW-1	439
1	NEWGen 2	Freshwater	Recirculating	265	CC R/FW-1	439
1	NEWGen 3	Freshwater	Recirculating	265	CC R/FW-1	439
1	NEWGen 4	Freshwater	Recirculating	343	CC R/FW-1	439
1	NEWGen 5	Freshwater	Recirculating	360	CC R/FW-1	439
1	NEWGen 6	Freshwater	Recirculating	493	CC R/FW-1	439
1	NEWGen 7	Freshwater	Recirculating	500	CC R/FW-1	439
1	NEWGen 8	Freshwater	Recirculating	503	CC R/FW-1	439
1	NEWGen 9	Freshwater	Recirculating	510	CC R/FW-1	439
1	NEWGen 10	Freshwater	Recirculating	510	CC R/FW-1	439
1	NEWGen 11	Freshwater	Recirculating	520	CC R/FW-1	439
1	NEWGen 12	Freshwater	Recirculating	520	CC R/FW-1	439
1	NEWGen 13	Freshwater	Recirculating	530	CC R/FW-1	439
1	NEWGen 14	Freshwater	Recirculating	544	CC R/FW-1	439
1	NEWGen 15	Freshwater	Recirculating	550	CC R/FW-1	439
2	NEWGen 16	Freshwater	Recirculating	600	CC R/FW-2	699
2	NEWGen 17	Freshwater	Recirculating	600	CC R/FW-2	699
2	NEWGen 18	Freshwater	Recirculating	600	CC R/FW-2	699
2	NEWGen 19	Freshwater	Recirculating	620	CC R/FW-2	699
2	NEWGen 20	Freshwater	Recirculating	620	CC R/FW-2	699
2	NEWGen 21	Freshwater	Recirculating	620	CC R/FW-2	699
2	NEWGen 22	Freshwater	Recirculating	640	CC R/FW-2	699
2	NEWGen 23	Freshwater	Recirculating	660	CC R/FW-2	699
2	NEWGen 24	Freshwater	Recirculating	673	CC R/FW-2	699
2	NEWGen 25	Freshwater	Recirculating	700	CC R/FW-2	699
2	NEWGen 26	Freshwater	Recirculating	750	CC R/FW-2	699
2	NEWGen 27	Freshwater	Recirculating	775	CC R/FW-2	699
2	NEWGen 28	Freshwater	Recirculating	800	CC R/FW-2	699
2	NEWGen 29	Freshwater	Recirculating	800	CC R/FW-2	699
2	NEWGen 30	Freshwater	Recirculating	800	CC R/FW-2	699
2	NEWGen 31	Freshwater	Recirculating	808	CC R/FW-2	699
2	NEWGen 32	Freshwater	Recirculating	825	CC R/FW-2	699
3	NEWGen 33	Freshwater	Recirculating	837	CC R/FW-3	1,061
3	NEWGen 34	Freshwater	Recirculating	846	CC R/FW-3	1,061
3	NEWGen 35	Freshwater	Recirculating	850	CC R/FW-3	1,061
3	NEWGen 36	Freshwater	Recirculating	850	CC R/FW-3	1,061
3	NEWGen 37	Freshwater	Recirculating	900	CC R/FW-3	1,061
3	NEWGen 38	Freshwater	Recirculating	975	CC R/FW-3	1,061
3	NEWGen 39	Freshwater	Recirculating	1,000	CC R/FW-3	1,061
3	NEWGen 40	Freshwater	Recirculating	1,000	CC R/FW-3	1,061
3	NEWGen 41	Freshwater	Recirculating	1,075	CC R/FW-3	1,061
3	NEWGen 42	Freshwater	Recirculating	1,086	CC R/FW-3	1,061
3	NEWGen 43	Freshwater	Recirculating	1,100	CC R/FW-3	1,061
3	NEWGen 44	Freshwater	Recirculating	1,130	CC R/FW-3	1,061
3	NEWGen 45	Freshwater	Recirculating	1,134	CC R/FW-3	1,061
3	NEWGen 46	Freshwater	Recirculating	1,200	CC R/FW-3	1,061

Table 5.A-4: In-Scope NEWGen Facilities						
No.	NEWGen Facility	Water Body Type	Baseline CWS Type	Actual Steam Capacity (MW)	Model Facility ID	Model Steam Capacity (MW)
3	NEWGen 47	Freshwater	Recirculating	1,400	CC R/FW-3	1,061
3	NEWGen 48	Freshwater	Recirculating	1,600	CC R/FW-3	1,061
4	NEWGen 49	Marine	Once-Through	750	CC OT/M-1	1,031
4	NEWGen 50	Marine	Once-Through	900	CC OT/M-1	1,031
4	NEWGen 51	Marine	Once-Through	1,075	CC OT/M-1	1,031
4	NEWGen 52	Marine	Once-Through	1,400	CC OT/M-1	1,031
5	NEWGen 53	Marine	Recirculating	440	CC R/M-1	489
5	NEWGen 54	Marine	Recirculating	448	CC R/M-1	489
5	NEWGen 55	Marine	Recirculating	525	CC R/M-1	489
5	NEWGen 56	Marine	Recirculating	544	CC R/M-1	489
6	NEWGen 57	Marine	Recirculating	1,030	CC R/M-2	1,030

Source: RDI, 2001; U.S. EPA analysis, 2001.

5.A.7 Development of Coal Model Facilities

The approach to developing coal model facilities was the same as that described for combined-cycle model facilities. EPA's analysis projected 14 new in-scope coal facilities. The cooling water and economic characteristics of these 14 facilities were based on the 41 existing coal facilities with "in-scope" characteristics identified from the section 316(b) Industry Survey. EPA developed eight coal model facility types.

- ***Model Facility 1,*** based on 10 freshwater/recirculating facilities with relatively small capacities (on average 173 MW);
- ***Model Facility 2,*** based on 7 freshwater/recirculating facilities with medium capacities (on average 625 MW);
- ***Model Facility 3,*** based on 8 freshwater/recirculating facilities with relatively large capacities (on average 1,564 MW);
- ***Model Facility 4,*** based on 4 freshwater/recirculating facilities with cooling lakes with an average size of 660 MW;
- ***Model Facility 5,*** based on 3 freshwater/once-through facilities with very small capacities (on average 63 MW);
- ***Model Facility 6,*** based on 5 freshwater/once-through facilities with medium capacities (on average 515 MW);
- ***Model Facility 7,*** based on 1 freshwater/once-through facility with a very large capacity (on average 3,564 MW);
- ***Model Facility 8***, based on 3 marine/recirculating facilities with an average size of 812 MW.

As with the combined-cycle analysis, the number of model facility types for each water body/cooling system combination depended on the number of survey facilities with that combination of characteristics and their size distribution: EPA developed more model facilities for water body/cooling system combinations with a large number of survey facilities and/or with a wide range of facility sizes.

Table 5.A-5 below presents the characteristics of the 41 coal survey facilities (water body type, cooling system type, and actual steam-electric capacity) as well as the model facility by which they are represented and their model facility capacity.

Table 5.A-5: Coal Survey Facilities with In-Scope Characteristics

No.	Survey Facility	Water Body Type	Baseline CWS Type	Actual Steam Capacity (MW)	Model Facility ID	Model Steam Capacity (MW)
1	Survey 1	Freshwater	Recirculating	58	Coal R/FW-1	173
1	Survey 2	Freshwater	Recirculating	58	Coal R/FW-1	173
1	Survey 3	Freshwater	Recirculating	95	Coal R/FW-1	173
1	Survey 4	Freshwater	Recirculating	96	Coal R/FW-1	173
1	Survey 5	Freshwater	Recirculating	114	Coal R/FW-1	173
1	Survey 6	Freshwater	Recirculating	140	Coal R/FW-1	173
1	Survey 7	Freshwater	Recirculating	182	Coal R/FW-1	173
1	Survey 8	Freshwater	Recirculating	240	Coal R/FW-1	173
1	Survey 9	Freshwater	Recirculating	330	Coal R/FW-1	173
1	Survey 10	Freshwater	Recirculating	417	Coal R/FW-1	173
2	Survey 11	Freshwater	Recirculating	450	Coal R/FW-2	625
2	Survey 12	Freshwater	Recirculating	509	Coal R/FW-2	625
2	Survey 13	Freshwater	Recirculating	566	Coal R/FW-2	625
2	Survey 14	Freshwater	Recirculating	664	Coal R/FW-2	625
2	Survey 15	Freshwater	Recirculating	721	Coal R/FW-2	625
2	Survey 16	Freshwater	Recirculating	726	Coal R/FW-2	625
2	Survey 17	Freshwater	Recirculating	736	Coal R/FW-2	625
3	Survey 18	Freshwater	Recirculating	1,010	Coal R/FW-3	1,564
3	Survey 19	Freshwater	Recirculating	1,147	Coal R/FW-3	1,564
3	Survey 20	Freshwater	Recirculating	1,300	Coal R/FW-3	1,564
3	Survey 21	Freshwater	Recirculating	1,429	Coal R/FW-3	1,564
3	Survey 22	Freshwater	Recirculating	1,627	Coal R/FW-3	1,564
3	Survey 23	Freshwater	Recirculating	1,700	Coal R/FW-3	1,564
3	Survey 24	Freshwater	Recirculating	1,700	Coal R/FW-3	1,564
3	Survey 25	Freshwater	Recirculating	2,600	Coal R/FW-3	1,564
4	Survey 26	Freshwater	Recirculating w. Lake	444	Coal RL/FW-1	660
4	Survey 27	Freshwater	Recirculating w. Lake	546	Coal RL/FW-1	660
4	Survey 28	Freshwater	Recirculating w. Lake	570	Coal RL/FW-1	660
4	Survey 29	Freshwater	Recirculating w. Lake	1,080	Coal RL/FW-1	660
5	Survey 30	Freshwater	Once-Through	50	Coal OT/FW-1	63
5	Survey 31	Freshwater	Once-Through	69	Coal OT/FW-1	63
5	Survey 32	Freshwater	Once-Through	70	Coal OT/FW-1	63
6	Survey 33	Freshwater	Once-Through	213	Coal OT/FW-2	515
6	Survey 34	Freshwater	Once-Through	261	Coal OT/FW-2	515
6	Survey 35	Freshwater	Once-Through	655	Coal OT/FW-2	515
6	Survey 36	Freshwater	Once-Through	721	Coal OT/FW-2	515
6	Survey 37	Freshwater	Once-Through	725	Coal OT/FW-2	515
7	Survey 38	Freshwater	Once-Through	3,564	Coal OT/FW-3	3,564
8	Survey 39	Marine	Recirculating	230	Coal R/M-1	812
8	Survey 40	Marine	Recirculating	848	Coal R/M-1	812
8	Survey 41	Marine	Recirculating	1,358	Coal R/M-1	812

Source: U.S. EPA 2000; U.S. EPA analysis, 2001.

Chapter 7: Economic Impact Analysis

INTRODUCTION

The final section 316(b) New Facility Rule applies to a number of industries, but only affects a small number of facilities in each industry. EPA estimates that in total over the next 20 years, the rule will apply to 121 new facilities. EPA conducted an analysis to assess whether it is likely that the final rule will have a significant economic impact on any of the 121 projected new facilities. This chapter presents EPA's analysis of economic impacts for these 121 new facilities. Later chapters consider impacts on small entities (Chapter 8) and on governments, electricity supply, and ratepayers (Chapter 9) as special cases.

The economic impact analysis is conducted at the facility-level. EPA assessed whether the facility-level results indicated the potential for significant impacts or if one firm owned multiple facilities that are affected by the rule. The facility-level analysis showed that nine of the 121 projected new facilities would have annual compliance costs of more than one percent of revenues. Only three of these nine facilities are expected to have a cost-to-revenue ratio of more than three percent. EPA therefore concludes that compliance with this regulation is both economically practicable and achievable at the facility-, firm-, industry and national levels.

The remainder of this chapter is organized as follows:

- Section 7.1 discusses the methodology used to assess economic impacts for the projected 83 new electric generators, including the approach for estimating the economic characteristics of the regulated facilities, the specific economic impact measures used, and the results of the analysis.
- Section 7.2 presents the economic impact analysis for the projected 38 new manufacturing facilities. This section discusses the same information as section 7.1 for electric generators.
- Section 7.3 provides a summary of the economic impact analysis at the facility-level.
- Section 7.4 discusses the potential for firm- and industry-level impacts as a result of the final section 316(b) New Facility Rule.
- Section 7.5 presents the impact analysis for the two nuclear case study facilities and four coal facilities for which costs were developed in *Chapter 6: Facility Compliance Costs*.

CHAPTER CONTENTS

7.1 NEW STEAM ELECTRIC GENERATORS

EPA projected that 83 new steam electric generators in scope of the final section 316(b) New Facility Rule will begin commercial operation within the next 20 years. The discussion in *Chapter 5: Baseline Projections of New Facilities* explained in detail how EPA developed six model combined-cycle facilities and eight model coal facilities for the costing and economic impact analyses. Each model facility is characterized by its combination of cooling system type (once-through or recirculating system) and source water body (freshwater or marine) as well as its steam electric generating capacity. Within each cooling system/source water body combination, EPA created between one and three model facilities, depending on the number of facilities within that group and the range of their steam electric capacities.

Table 7-1 below presents the 14 model facility types, their cooling system type, the source water body from which they withdraw cooling water, their estimated steam electric capacity, and the number of projected new in-scope facilities that belong to each type.

Table 7-1: Model Facilities for New Electric Generators

Model Facility Type	Cooling System Type	Source Water Body	Steam Electric Capacity (MW)	Number of Projected New Facilities
CC OT/M-1	Once Through	Marine	1,031	5
CC R/M-1	Recirculating	Marine	489	5
CC R/M-2	Recirculating	Marine	1,030	1
CC R/FW-1	Recirculating	Freshwater	439	18
CC R/FW-2	Recirculating	Freshwater	699	21
CC R/FW-3	Recirculating	Freshwater	1,061	19
Coal OT/FW-1	Once Through	Freshwater	63	1
Coal OT/FW-2	Once Through	Freshwater	515	1
Coal OT/FW-3	Once Through	Freshwater	3,564	1
Coal R/M-1	Recirculating	Marine	812	1
Coal R/FW-1	Recirculating	Freshwater	173	3
Coal R/FW-2	Recirculating	Freshwater	625	3
Coal R/FW-3	Recirculating	Freshwater	1,564	3
Coal RL/FW-1	Recirculating with Lake	Freshwater	660	1

Source: U.S. EPA analysis, 2001.

EPA used two economic impact measures for the 83 new electric generators: (1) the ratio of total annualized compliance costs to estimated revenues ("cost-to-revenue ratio") and (2) the ratio of initial compliance costs to the construction cost of the plant ("initial cost-to-plant construction cost ratio").

7.1.1 Annualized Compliance Cost to Revenue Measure

Calculating the annualized compliance cost to revenue measure requires the following information for each new in-scope steam electric generator:

- total annualized compliance costs and
- estimated annual revenues.

a. Annualized compliance costs

Estimating the ratio of annualized compliance cost to estimated revenues ("cost-to-revenue ratio") required discounting compliance costs that occur in the future and annualizing them over 30 years (the expected useful life of the compliance equipment).[1] *Chapter 6: Facility Compliance Costs* presented EPA's methodology for estimating model facility costs and annualizing them to determine the national cost of the final section 316(b) New Facility Rule. In contrast to the national cost estimate, which considered all costs incurred during the first 30 years *of the rule* (i.e., 2001 to 2030), the impact analysis presented in this chapter considers compliance costs incurred during the first 30 years *of each facility's life*.[2]

EPA estimated annualized compliance costs for the impact analysis by first calculating the present value of the stream of costs over the first 30 years of each facility's life, beginning with the year that the costs are incurred. The present value was determined as of the first year of operation of each facility.[3] This present value was then annualized over 30 years to derive the constant annual value of the stream of future costs. This calculation used a seven percent discount rate (see formulas in *Chapter 6: Facility Compliance Costs*, Section 6.3).

b. Estimated annual revenues

EPA estimated expected annual revenues by making assumptions about future electricity sales for each facility. This calculation used the following formula:

$$Rev_x = GenCap_x * ESF * Price$$

where:

Rev_x	=	Annual revenues of model facility x
$GenCap_x$	=	Generation capacity of model facility x (in MW)
ESF	=	Projected electricity sales factor (in MWh/MW)
Price	=	Projected electricity price (in \$2000)

Each component of this calculation is further explained below.

❖ *Generating capacity*

The generating capacities of the model facilities are the average capacities of the actual facilities upon which the model facilities are based (57 NEWGen facilities for the six combined-cycle model facilities; 41 existing section 316(b) Industry Survey facilities for the eight coal model facilities). *Chapter 5: Baseline Projections of New Facilities* and its appendix provide more detail on model facility development, including the generating capacity estimate.

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1 Annualizing compliance costs over the useful life of the equipment is in accordance with standard Agency practice.

2 Including 30 years of compliance costs for each facility (beginning when the costs are incurred) is a better indicator of potential facility-level impact than limiting costs to the first 30 years of the rule, which would exclude some out-year costs for facilities constructed later in the 30-year period.

3 Discounting compliance costs back to the first year of the facility's operation as opposed to the first year of the rule will increase the facility-level annualized cost for all facilities except those that begin operation in the first year.

❖ *Electricity sales factor*

EPA estimated the average amount of electricity sold per MW of generating capacity using forecasts from the Energy Information Administration's (EIA) *Annual Energy Outlook 2001* (U.S. DOE, 2000a). The calculation was made by dividing the total projected annual electricity sales between 2001 and 2010 by the total projected capacity over the same time period, using the following formula:

$$ESF = \frac{\sum_{t=2001}^{2010} Electricity\ Sold}{\sum_{t=2001}^{2010} GenCap}$$

where:

ESF	=	Projected electricity sales factor
Electricity Sold	=	AEO2001 annual electricity sales forecast (in MWh)
GenCap	=	AEO2001 annual generating capacity forecast (in MW)
t	=	Year of forecast (from 2001 to 2010)

EPA developed separate electricity sales factors for new coal facilities and new combined-cycle facilities. For coal facilities, EPA used the national forecast of electricity sales and generating capacity associated with coal energy sources only. However, electricity sales were not available for combined-cycle technologies. Therefore, EPA used the average electricity sales and capacity across all energy sources. EPA believes that this average is a reasonable approximation for combined-cycle facilities, which are primarily designed to supply peak and intermediate capacity but can also be used to meet baseload requirements (U.S. DOE, 2000a, p. 73). They are therefore likely to have dispatch frequencies close to the average for all facilities.[4]

❖ *Electricity price*

The final component needed to calculate annual revenues is the price of electricity. EPA used a national price of generation, excluding transmission and distribution charges, forecasted by the U.S. Department of Energy's *Policy Office Electricity Modeling System* (POEMS, U.S. DOE 1999). The generation price reflects the amount of revenue plants are likely to receive in a deregulated electricity market in which transmission and distribution services are separated from the generation function. POEMS forecasts electricity prices for several years into the future under a reference case and a competitive case. For this analysis, EPA took the U.S. average of six forecasted prices: the projections for 2005, 2010 and 2015, each under the reference case and the competitive case (U.S. DOE, 1999).[5]

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[4] The actual amount of electricity that is generated and sold by a facility depends on how often the facility's units are dispatched. Using the calculated factors may therefore over- or underestimate actual facility sales. The factors would *overestimate* electricity sales, and therefore estimated revenues, if the projected new electric generators were dispatched *less* than the average facility; they would *underestimate* sales and revenues if the new facilities were dispatched *more* than the average.

[5] EPA also considered using the EIA's *Annual Energy Outlook 2001* (AEO2001) forecasts, but the available AEO results do not distinguish the price of generation from the distribution and transmission charges.

c. Results

Table 7-2 presents the results of the annualized compliance cost to revenue analysis for the 83 new electric generators. Projected annual facility revenues range from approximately $14 million to $791 million and annualized compliance costs range from approximately $0.17 million to $19.1 million. The table shows that the cost-to-revenue ratio for the new electric generators ranges between 0.07 and 5.24 percent. Five of the model facility types which represent nine projected new facilities have an impact of greater than one percent. Of these nine facilities, three facilities (represented by three model facility types) have an impact of greater than three percent.

Table 7-2: Annualized Compliance Cost to Revenue Measure for New In-Scope Electric Generators ($2000 millions)

Model Facility Type	Steam Electric Capacity (MW)	Electricity Sales Factor	Annual Electricity Sales (MWh)	Price ($/MWh)	Estimated Annual Revenues	Annualized Compl. Cost	Annualized Compl. Cost/ Annual Revenues	No. of New In-Scope Facilities
CC OT/M-1	1,031	4,566	4,709,114	$32.62	$154	$3.2	**2.07%**	**5**
CC R/M-1	489	4,566	2,234,118	$32.62	$73	$0.20	**0.27%**	**5**
CC R/M-2	1,030	4,566	4,703,406	$32.62	$153	$0.20	**0.13%**	**1**
CC R/FW-1	439	4,566	2,002,373	$32.62	$65	$0.17	**0.26%**	**18**
CC R/FW-2	699	4,566	3,193,938	$32.62	$104	$0.18	**0.17%**	**21**
CC R/FW-3	1,061	4,566	4,846,963	$32.62	$158	$0.18	**0.11%**	**19**
Coal OT/FW-1	63	6,803	428,284	$32.62	$14	$0.73	**5.25%**	**1**
Coal OT/FW-2	515	6,803	3,503,722	$32.62	$114	$3.8	**3.33%**	**1**
Coal OT/FW-3	3,564	6,803	24,246,596	$32.62	$791	$19.1	**2.41%**	**1**
Coal R/M-1	812	6,803	5,524,323	$32.62	$180	$0.23	**0.13%**	**1**
Coal R/FW-1	173	6,803	1,177,021	$32.62	$38	$0.17	**0.44%**	**3**
Coal R/FW-2	625	6,803	4,249,202	$32.62	$139	$0.18	**0.13%**	**3**
Coal R/FW-3	1,564	6,803	10,641,153	$32.62	$347	$0.24	**0.07%**	**3**
Coal RL/FW-1	660	6,803	4,490,156	$32.62	$146	$4.8	**3.27%**	**1**

Source: U.S. DOE 1999; U.S. DOE, 2000a; U.S. EPA analysis, 2001.

To test the sensitivity of these result to changes in the price of electricity, EPA re-calculated these impacts using the lowest electricity price of any NERC region projected by POEMS.[6] This price was $25.38. A lower price reduces the annualized cost because it decreases the value of the energy penalty. However, it also reduces facility revenues. The overall effect is an increase in the cost-to-revenue ratio. Using this lower price would result in only slight increases in the cost-to-revenue ratios for the 83 projected new electric generators: the ratio would range between 0.09 percent and 6.27 percent, compared to 0.07 percent to 5.26 percent using the U.S. average. The number of facilities with impacts of greater than one percent and greater than three percent would remain the same. Based on this analysis, EPA concludes that the impact results are not very sensitive to changes in electricity prices and that even if these changes to the price of electricity occurred, compliance with this regulation is both economically practicable and achievable at the facility-, firm-, industry, and national levels.

[6] Similar to the main analysis, the price used in this sensitivity analysis is the average of the baseline and competitive cases for 2005, 2010, and 2015.

7.1.2 Initial Compliance Cost to Plant Construction Cost Measure

Calculating the initial cost-to-plant construction cost ratio requires the following information for each new in-scope steam electric generator:

- initial compliance costs, and
- plant construction costs.

a. Initial compliance cost

Initial compliance costs include the compliance costs of the final section 316(b) New Facility Rule that will be incurred before a new facility can begin operation. These are capital technology costs and initial permit application costs. EPA assumed that facilities would incur capital costs one year before operation begins. Facilities that choose Track II would begin incurring initial permit application costs three years before the start of operations, and Track I facilities one year before the start of operations. Since initial compliance costs are incurred at the same time as the plant construction costs, with which they are compared, it was not necessary to discount these costs or make any other adjustments to them.

b. Plant construction costs

EPA used the *Assumptions to the Annual Energy Outlook 2001* (U.S. DOE, 2000b) to estimate the total construction cost of the new electric generating facilities. Table 43 of the *Assumptions* presents the cost and performance characteristics of new generating technologies assumed in EIA's electricity forecasts. Technology-specific overnight capital costs were used in the analysis.[7] Overnight capital costs are the base costs estimated to build a plant in a hypothetical *Middletown, USA*. EPA calculated an average value for the projected new combined-cycle facilities, using the cost per kilowatt for three technologies: Advanced Gas/Oil Combined-Cycle, Integrated Coal-Gasification Combined-Cycle, and Conventional Gas/Oil Combined-Cycle. Table 43 presents only one value for coal facilities. The following overnight capital costs were used in the analysis:

- Average Combined Cycle $796/kW
- Conventional Pulverized Coal $1,121/kW

EPA adjusted the overnight capital costs to recognize that learning effects may reduce costs over time. Learning parameters are published in Table 45 of the *Assumptions*. As with the overnight capital costs, EPA calculated an average value for the projected new combined-cycle facilities, using the parameters for the three combined-cycle technologies (Advanced Gas/Oil Combined-Cycle, Integrated Coal-Gasification Combined-Cycle, and Conventional Gas/Oil Combined-Cycle). Table 45 presents only one value for coal facilities. The following parameters were used in the analysis:

- Average Combined Cycle 8.3 percent
- Conventional Pulverized Coal 5.0 percent

These parameters are the minimum total learning by 2020 and may overstate cost reductions for facilities constructed in the early years of the rule.

[7] EIA's overnight capital cost include contingency factors, but exclude regional multipliers and learning effects. Interest charges are also excluded. These represent costs of new projects initiated in 2000. EPA adjusted the overnight capital costs from 1999 to 2000 dollars using the Engineering News-Record Construction Cost Index. EPA did not make an adjustment for regional multipliers this analysis uses the U.S. average. No adjustment for interest charges was necessary because the compliance costs, to which the overnight capital costs are compared, also do not include interest charges. Adjustments for learning effects are discussed below.

c. Results

Table 7-3 presents the results of the economic impact analysis for the 83 new electric generators. The table shows that the initial cost-to-plant construction cost ratio for the new electric generators ranges between 0.03 and 3.45 percent. Four of the model facility types which represent eight projected new facilities have an impact of greater than one percent. Only one model facility type, which represents one projected new facility, has an impact of greater than three percent.

Table 7-3: Initial Compliance Cost to Construction Cost Measure for New In Scope Electric Generators ($2000)

Model Facility Type	Steam Electric Capacity (MW)	Plant Construction Cost ($/kW)[a]	Total Plant Construction Cost (mill.)	Initial Compl. Cost (mill.)	Compl. Cost/ Construction Cost	No. of New In-Scope Facilities
CC OT/M-1	1,031	$730	$753	$13.6	**1.81%**	**5**
CC R/M-1	489	$730	$357	$0.20	**0.06%**	**5**
CC R/M-2	1,030	$730	$752	$0.28	**0.04%**	**1**
CC R/FW-1	439	$730	$320	$0.21	**0.07%**	**18**
CC R/FW-2	699	$730	$511	$0.22	**0.04%**	**21**
CC R/FW-3	1,061	$730	$775	$0.24	**0.03%**	**19**
Coal OT/FW-1	63	$1,065	$67	$2.3	**3.45%**	**1**
Coal OT/FW-2	515	$1,065	$549	$11.1	**2.02%**	**1**
Coal OT/FW-3	3,564	$1,065	$3,796	$36.5	**0.96%**	**1**
Coal R/M-1	812	$1,065	$865	$0.57	**0.07%**	**1**
Coal R/FW-1	173	$1,065	$184	$0.18	**0.10%**	**3**
Coal R/FW-2	625	$1,065	$665	$0.31	**0.05%**	**3**
Coal R/FW-3	1,564	$1,065	$1,666	$0.87	**0.05%**	**3**
Coal RL/FW-1	660	$1,065	$703	$14.4	**2.05%**	**1**

[a] Plant Construction Cost = Overnight Capital Cost * (1- Learning Parameter).

Source: U.S. DOE, 2000b; U.S. EPA analysis, 2001.

7.2 New Manufacturing Facilities

EPA projected that 38 new manufacturing facilities in scope of the section 316(b) New Facility Rule will begin commercial operation within the next 20 years (see *Chapter 5: Baseline Projections of New Facilities*). The 38 new manufacturing facilities include 22 chemical facilities, 10 steel facilities, two aluminum facilities, two paper mills, and two petroleum refineries.

The discussion in *Chapter 5: Baseline Projections of New Facilities* explained in detail how EPA developed model manufacturing facilities for the costing and economic impact analyses. Within each 4-digit SIC code, EPA developed one model facility for each cooling system type/source water body combination with at least one projected new in-scope facility.[8]

[8] The four potential cooling system type/source water body combinations are (1) once-through/freshwater, (2) once-through/marine, (3) recirculating/freshwater, and (4) recirculating/marine.

EPA analyzed economic impacts for each of those model facilities.

EPA used annualized compliance costs as a percent of average annual revenues ("cost-to-revenue ratio") as a measure of economic impacts for manufacturing facilities. The comparison of initial compliance costs to plant construction costs used for electric generators could not be estimated for manufacturing facilities because information on facility construction cost is not readily available.

7.2.1 Annualized Compliance Cost to Revenue Measure

Estimation of the cost-to-revenue ratio requires the following information for each new in-scope manufacturing facility:

- total annualized compliance cost, and
- estimated annual revenues.

a. Annualized compliance cost

EPA used the same methodology to estimate annualized compliance costs for the projected new manufacturing facilities as was used for the new electric generators described above: EPA discounted compliance costs that occur in the future and annualizing them over 30 years (the expected useful life of the compliance equipment). *Chapter 6: Facility Compliance Costs* presented EPA's methodology for estimating model facility costs and annualizing them to determine the national cost of the final section 316(b) New Facility Rule. In contrast to the national cost estimate, which considered all costs incurred during the first 30 years *of the rule* (i.e., 2001 to 2030), the impact analysis presented in this chapter considers compliance costs incurred during the first 30 years *of each facility's life*.[9]

EPA estimated annualized compliance costs for the impact analysis by first calculating the present value of the stream of costs over the first 30 years of each facility's life. The present value was determined as of the first year of operation of each facility.[10] This present value was then annualized over 30 years to derive the constant equivalent annual value of the stream of future costs. This calculation used a seven percent discount rate (see formulas in *Chapter 6: Facility Compliance Costs*, Section 6.3).

❖ *Estimated annual revenues*

EPA estimated facility-level revenues for the 38 projected new facilities using information for existing facilities in the relevant industries. The Agency used results from the section 316(b) *Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures* to project revenues, using the following methodology:

- ***Calculating average revenues:*** EPA assumed that the financial characteristics of the existing in-scope facilities would be similar to the projected new facilities. To develop revenues for the model facilities, EPA calculated an average revenue for all of the existing facilities with the same characteristics as that model facility.[11]

- ***Supplement missing data, where necessary:*** Some of the existing in-scope facilities upon which the model facilities are based did not report revenues in the detailed industry questionnaire. For these facilities, EPA estimated facility revenues using firm-level revenues.[12] EPA multiplied firm revenues by the ratio of facility employment to firm employment, making the assumption that revenues per employee would be the same on the facility level as on the firm level.

[9] Including 30 years of compliance costs for each facility is a better indicator of potential facility-level impact than limiting costs to the first 30 years of the rule.

[10] Discounting compliance costs back to the first year of the facility's operation as opposed to the first year of the rule will increase the facility-level annualized cost for all facilities except those that begin operation in the first year.

[11] The same facilities were used to calculate the average flows of that model facility.

[12] EPA used firm-level revenues from the section 316(b) Industry Survey. For one facility, EPA used Dun and Bradstreet data because neither facility nor firm revenues were available from the survey (D&B, 2001).

Table 7-4 presents the results of the economic impact analysis for the 38 projected new manufacturing facilities. The table shows that the cost-to-revenue ratio for the 38 facilities ranges between 0.01 percent and 0.50 percent. No facilities are expected to have a cost-to-revenue ratio of greater than one percent. Based on the low values of this impact measure, EPA believes that the economic impacts of the final section 316(b) New Facility Rule on new manufacturing facilities will be minimal.

Table 7-4: Annualized Compliance Cost to Revenue Measure for New In-Scope Manufacturers ($2000 mill.)

Model Facility Type	SIC Code	Cooling System Type	Source Water Body	Total Annualized Compl. Cost[a]	Estimated Annual Revenues	Annualized Compl. Cost/ Revenues	No. of New In-Scope Facilities
MAN OT/F-2621	2621	Once-Through	Freshwater	$0.38	$234	**0.16%**	2
MAN OT/M-2812	2812	Once-Through	Marine	$1.6	$517	**0.30%**	1
MAN OT/F-2812	2812	Once-Through	Freshwater	$0.67	$943	**0.07%**	1
MAN OT/M-2819	2819	Once-Through	Marine	$0.45	$226	**0.20%**	2
MAN OT/F-2819	2819	Once-Through	Freshwater	$0.35	$104	**0.34%**	2
MAN OT/F-2821	2821	Once-Through	Freshwater	$0.64	$483	**0.13%**	4
MAN OT/F-2834	2834	Once-Through	Freshwater	$0.35	$70	**0.50%**	2
MAN OT/F-2869	2869	Once-Through	Freshwater	$0.46	$1,045	**0.04%**	7
MAN RE/F-2869	2869	Recirculating	Freshwater	$0.18	$956	**0.02%**	1
MAN OT/F-2873	2873	Once-Through	Freshwater	$0.42	$111	**0.38%**	1
MAN RE/F-2873	2873	Recirculating	Freshwater	$0.21	$415	**0.05%**	1
MAN OT/F-2911	2911	Once Through	Freshwater	$0.73	$1,562	**0.05%**	1
MAN RE/F-2911	2911	Recirculating	Freshwater	$0.18	$2,246	**0.01%**	1
MAN OT/F-3312	3312	Once-Through	Freshwater	$0.85	$1,076	**0.08%**	5
MAN RE/F-3312	3312	Recirculating	Freshwater	$0.77	$595	**0.13%**	1
MAN OT/F-3316	3316	Once-Through	Freshwater	$0.37	$118	**0.32%**	1
MAN RE/F-3316	3316	Recirculating	Freshwater	$0.20	$362	**0.05%**	1
MAN OT/F-3317	3317	Once-Through	Freshwater	$0.45	$222	**0.20%**	1
MAN RE/F-3317	3317	Recirculating	Freshwater	$0.18	$217	**0.08%**	1
MAN OT/F-3353	3353	Once-Through	Freshwater	$0.43	$444	**0.10%**	1
MAN RE/F-3353	3353	Recirculating	Freshwater	$0.18	$939	**0.02%**	1

[a] The total annualized compliance costs of all facilities, except the two facilities in SIC code 2812, are based on the assumption that initial permit costs and capital costs are incurred prior to the facility's operation. The two facilities in SIC code 2812, and other manufacturing facilities projected to begin operation during 2001, 2002, or 2003 would incur part of these costs concurrent with the first three years of operation.

Source: U.S. EPA analysis, 2001.

7.3 Summary of Facility-Level Impacts

The economic impact analysis for the final section 316(b) New Facility Rule shows that the requirements of this regulation would have minimal impacts on projected new electric generators and manufacturing facilities. Of the 121 projected facilities, only nine facilities are expected to incur annualized costs greater than one percent of revenues. Initial compliance costs compared to the plant construction costs are also expected to be small for electric generators. Table 7-5 summarizes the results of the impact analysis by industry sector.

Table 7-5: Compliance Costs and Economic Impacts by Sector

Sector	Number of Projected New In Scope Facilities	Total Annualized Compl. Cost/ Annual Revenues		Initial Compl. Cost/ Plant Construction Cost	
		Lowest	Highest	Lowest	Highest
SIC 49 Steam Electric Generating	83	0.07%	5.24%	0.03%	3.45%
SIC 26 Pulp & Paper	2	0.16%	0.16%		
SIC 28 Chemicals	22	0.02%	0.50%		
SIC 29 Petroleum	2	0.01%	0.05%		
SIC 331 Steel	10	0.05%	0.32%		
SIC 333/335 Aluminum	2	0.02%	0.10%		
Total	121	0.01%	5.24%		

Source: U.S. EPA analysis, 2001.

To test the sensitivity of these result to the length of the amortization period, EPA re-calculated the impact ratios using a 15-year amortization period. This 15-year period may more closely reflect the financing terms for some of the new in-scope facilities in the current market, especially for generators operating in deregulated electricity markets. The shorter amortization period only affects initial compliance costs, including capital costs and initial permitting costs. All other compliance costs are annual costs and are not affected by the amortization period.[13] Using a 15-year amortization period would result in two different impact ratio values for each facility during the 30-year analysis period: (1) a higher ratio for the first 15 years, which reflects full amortization of the capital costs and the initial permitting costs associated with the rule; and (2) a lower ratio which reflects the on-going costs over the second 15 years but does not include any charges for capital costs and initial permitting. EPA only calculated the first, higher, impact ratio in this sensitivity analysis.

For electric generators, reducing the amortization period to 15 years would result in only slight increases in the cost-to-revenue ratios. The ratio would range between 0.08 percent and 5.73 percent (compared to 0.07 percent to 5.24 percent using a 30-year amortization period). The number of facilities with impacts of greater than one percent and greater than three percent would remain the same.[14] For manufacturing facilities, the change in impacts from reducing the amortization period to 15 years would be equally small. The ratio would range between 0.01 percent and 0.57 percent (compared to 0.01 percent to 0.50 percent using the 30-year amortization period). No manufacturing facilities are expected to have a cost-to-revenue ratio of greater than one percent.

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[13] The only other compliance cost that is not an annual cost is the cost of repermitting. However, this cost is very minor and will not be incurred until five years after the facility begins operation. EPA does not expect this cost to be included in the initial 15-year loan arrangement and therefore annualized it over 30 years.

[14] The change in amortization period does not affect the initial cost-to-plant construction cost ratio because for this measure, compliance costs are not discounted and annualized.

Based on this analysis, EPA concludes that even if some facilities have to finance their debt over a shorter period of time, compliance with this regulation is both economically practicable and achievable at the facility-, firm-, industry-, and national levels.

7.4 Potential for Firm- and Industry-Level Impacts

The previous section presented EPA's estimate of facility-level impacts as a result of the final section 316(b) New Facility Rule. Given the low impacts on the facility-level, EPA did not conduct a formal impact analysis at the firm- or industry-levels. Based on the analysis presented in this chapter, EPA concludes that the final section 316(b) New Facility Rule will not cause impacts on the firms owning the projected new in-scope facilities or on their industries, for reasons discussed in this section.

The final rule is expected to increase the cost of the projected new in-scope facilities relative to other new facilities and to existing facilities. Annualized compliance costs as a percentage of revenues at the facility-level ranged from 0.07 to 5.24 percent for new electric generators and from 0.01 to 0.50 percent for new manufacturing facilities. Since firm revenues are always equal to or greater than facility-level revenues, the cost-to-revenue ratio at the firm-level cannot be higher than at the facility-level. In most cases, this ratio would be lower. EPA therefore concluded that significant firm-level impacts as a result of the final section 316(b) New Facility Rule are unlikely.

A rule that substantially increases the cost of new facilities could present a barrier to new entry, and constrain capacity growth in the affected industries. Barriers to new entry result in higher product prices in the long run and can retard valuable technological innovation. EPA concluded that the final rule is unlikely to discourage new entry, because the compliance costs associated with the final rule are small compared with the expected revenues of the projected facilities. Also, EPA expects that facilities will be able to secure financing for the capital costs associated with the rule because these costs represent such a small percentage of the overall plant construction costs. However, the rule may influence the design of cooling systems and choice of water sources of new facilities planning to use cooling water.

Given the small number of affected in-scope facilities relative to the size of the affected industries, EPA also concluded that impacts at the industry-level are very unlikely. The maximum costs incurred in any one year represent a very small percentage of total industry revenues at the 4-digit SIC level. The rule affects too small a portion of any industry to have observable impacts at the industry level. EPA therefore does not expect any impacts on industry productivity, competition, prices, output, foreign trade, or employment. EPA concluded that a detailed market analysis is not required for any of the affected industries, given the screening analysis results.

7.5 Additional Facility Analyses

EPA also estimated economic impacts for the six additional facilities costed in Section 6.4 of *Chapter 6: Facility Compliance Costs*. These six facilities include two large nuclear facilities (one with a once-through system and one a recirculating system in the baseline) and four coal facilities installing concrete cooling towers instead of redwood.

Table 7-6 presents the six facilities, for which EPA conducted additional facility analyses, their cooling system type, the type of water body from which they withdraw cooling water, and their estimated capacity.

Table 7-6: Characteristics of Six Additional Facilities			
Model Facility Type	**Cooling System Type**	**Source Water Body**	**Capacity (MW)**
Nuclear-1	Recirculating	Marine	2,708
Nuclear-2	Once-Through	Marine	2,666
Coal OT/FW-1	Once-Through	Freshwater	63
Coal OT/FW-2	Once-Through	Freshwater	515
Coal OT/FW-3	Once-Through	Freshwater	3,564
Coal RL/FW-1	Recirculating with Lake	Freshwater	660

Source: U.S. EPA analysis, 2001.

EPA used the same two economic impact measures for the six additional facility analyses as were used for the 83 projected new electric generators discussed in Section 7.1 above: (1) the ratio of total annualized compliance costs to estimated revenues ("cost-to-revenue ratio") and (2) the ratio of initial compliance costs to the construction cost of the plant ("initial cost-to-plant construction cost ratio").

7.5.1 Annualized Compliance Cost to Revenue Measure

Calculating the cost-to-revenue ratio requires total annualized compliance costs and estimated annual revenues for each of the six additional facilities. The same methodology described in Section 7.1.1 above was used to calculate annualized compliance costs and annual revenues for these six facilities.

Chapter 6: Facility Compliance Costs (Section 6.4) presents facility unit costs for each of the six facilities. EPA estimated annualized compliance costs for the impact analysis by first calculating the present value of the stream of costs over the first 30 years of each facility's life. The present value was determined as of the first year of operation of each facility. This present value was then annualized over 30 years to derive the constant equivalent annual value of the stream of future costs. This calculation used a seven percent discount rate (see formulas in *Chapter 6: Facility Compliance Costs*, Section 6.3).

EPA estimated expected annual revenues by making assumptions about future electricity sales for each facility. Expected annual revenues are calculated by multiplying generation capacity by an electricity sales factor and the electricity price. EPA estimated the average amount of electricity sold per MW of generating capacity using forecasts from EIA's *Annual Energy Outlook 2001* (U.S. DOE, 2000a). EPA used the national forecast of electricity sales and generating capacity associated with advanced nuclear facilities to estimate an electricity sales factor for the two nuclear facilities. For the coal facilities, EPA used the same estimates as were used for the model new coal facilities presented in section 7.1.1. EPA also used the same price forecasts presented in section 7.1.1.

Table 7-7 presents the results of the annualized compliance cost to revenue analysis for the six facilities. The table shows that the cost-to-revenue ratios for the recirculating and once-through nuclear facilities are 0.1 percent and 4.3 percent, respectively. The cost-to-revenue ratios are almost identical whether the coal facilities install concrete or redwood cooling towers, with impacts ranging from 2.4 percent to 5.3 percent for concrete towers and 2.4 to 5.2 percent for redwood towers.

Table 7-7: Annualized Compliance Cost to Revenue Measure for Six Additional Facilities ($2000 millions)

Model Facility Type	Steam Electric Capacity (MW)	Electricity Sales Factor	Annual Electricity Sales (MWh)	Price ($/MWh)	Estimated Annual Revenues	Annualized Compl. Cost	Annualized Compl. Cost/ Annual Revenues
Nuclear-1	2,708	7,616	20,624,616	$32.62	$673	$0.4	**0.1%**
Nuclear-2	2,666	7,616	20,304,736	$32.62	$662	$28.2	**4.3%**
Coal OT/FW-1	63	6,803	428,284	$32.62	$14	$0.7	**5.3%**
Coal OT/FW-2	515	6,803	3,503,722	$32.62	$114	$3.8	**3.4%**
Coal OT/FW-3	3,564	6,803	24,246,596	$32.62	$791	$19.2	**2.4%**
Coal RL/FW-1	660	6,803	4,490,156	$32.62	$146	$4.8	**3.3%**

Source: U.S. DOE 1999; U.S. DOE, 2000a; U.S. EPA analysis, 2001.

7.5.2 Initial Compliance Cost to Plant Construction Cost Measure

Calculating the initial cost-to-plant construction cost ratio requires initial compliance costs and plant construction costs for each of the six facilities. The same methodology and data sources as described in section 7.1.2 above were used to calculate initial compliance costs and plant construction costs for the two nuclear facilities. The four coal facilities have the same characteristics as the coal model new facilities described in section 7.1.2.

The overnight cost and the learning parameter for associated with advanced nuclear facilities are:

- Overnight cost $2,246/kW
- Learning parameter 10.0 percent

Table 7-8 presents the results of the economic impact analysis for the six facilities. The table shows that the initial cost-to-plant construction cost ratio for the recirculating and once-through nuclear facilities are 0.04 percent and 3.8 percent, respectively. The initial cost-to-plant construction cost ratio are slightly higher for the coal facilities installing concrete cooling towers with impacts ranging from 1.4 percent to 4.6 percent compared to impacts ranging from 0.96 percent to 3.5 percent when installing redwood cooling towers.

Table 7-8: Initial Compliance Cost to Construction Cost Measure for Six Additional Facilities ($2000)

Model Facility Type	Steam Electric Capacity (MW)	Plant Construction Cost ($/kW)[a]	Total Plant Construction Cost (mill.)	Initial Compl. Cost (mill.)	Compl. Cost/ Construction Cost
Nuclear-1	2,708	$2,021	$5,474	$2.4	**0.04%**
Nuclear-2	2,666	$2,021	$5,390	$204.1	**3.79%**
Coal OT/FW-1	63	$1,065	$67	$3.1	**4.62%**
Coal OT/FW-2	515	$1,065	$549	$15.9	**2.90%**
Coal OT/FW-3	3,564	$1,065	$3,796	$53.5	**1.41%**
Coal RL/FW-1	660	$1,065	$703	$20.4	**2.90%**

[a] Plant Construction Cost = Overnight Capital Cost * (1- Learning Parameter).

Source: U.S. DOE, 2000b; U.S. EPA analysis, 2001.

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Chapter 8: Regulatory Flexibility Analysis

INTRODUCTION

The Regulatory Flexibility Act (RFA) requires EPA to consider the economic impact a rule will have on small entities. The RFA requires an agency to prepare a regulatory flexibility analysis for any notice-and-comment rule it promulgates, unless the Agency certifies that the rule "will not, if promulgated, have a significant economic impact on a substantial number of small entities" (The Regulatory Flexibility Act, 5 U.S.C. § 605(b)).

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For the purposes of assessing the impacts of the section 316(b) New Facility Rule on small entities, EPA has defined small entity as: (1) a small business according to the Small Business Administration (SBA) size standards; (2) a small governmental jurisdiction that is a government of a city, county, town, school district, or special district with a population of less than 50,000; and (3) a small organization that is a not-for-profit enterprise that is independently owned and operated and is not dominant in its field. The SBA defines small businesses based on Standard Industrial Classification (SIC) codes and size standards expressed by the number of employees, annual receipts, or electric output (13 CFR §121.20). The small entity determination is made at the level of the parent entity.

To evaluate the potential impact of this rule on small entities, EPA determined which of the projected new in-scope facilities would be owned by a small entity. EPA used a "sales test" to determine the potential severity of economic impact on electric generators and manufacturing facilities owned by small entities. The test calculates annualized compliance cost as a percentage of total sales revenues. This analysis conducts the sales test at the facility-level.[1]

EPA's analysis showed that this regulation will not have a significant economic impact on a substantial number of small entities (SISNOSE). This finding is based on the limited number of small entities expected to incur compliance costs and the insignificant magnitude of compliance costs as a percentage of sales revenues.

The remainder of this chapter is organized as follows:

- Section 8.1 presents EPA's analysis of the entity size of the 121 projected new in-scope facilities.
- Section 8.2 presents the sales tests for all facilities owned by small entities.
- Section 8.3 summarizes the results of the RFA analysis.

[1] The sales test is equivalent to the cost-to-revenue measure described in *Chapter 7: Economic Impact Analysis.*

8.1 Number of New In-Scope Facilities Owned by Small Entities

EPA's baseline projection of new facilities identified 83 new electric generators and 38 new manufacturing facilities expected to incur costs under the final section 316(b) New Facility Rule (see *Chapter 5: Baseline Projections of New Facilities*). This section discusses the parent size analysis of new combined-cycle facilities, new coal facilities, and new manufacturing facilities separately.

8.1.1. Combined-Cycle Facilities

The small entity determination for new in-scope combined-cycle facilities was conducted in two steps:

- Determine the small entity status of the 57 in-scope NEWGen facilities.
- Extrapolate small entity information from the 57 in-scope NEWGen facilities to the 69 projected new in-scope facilities.

a. Small entity status of the 57 in-scope NEWGen facilities

EPA used the NEWGen database to identify the parent entities of the 57 in-scope NEWGen facilities. Several of these facilities are owned by more than one entity. For these facilities, EPA identified the entity that owns the largest share in the facility (the "majority owner"). Six of the 57 facilities have more than one majority owner. In addition, several entities own more than one of the 57 in-scope NEWGen facilities. In total, 38 entities own a majority share in at least one of the 57 facilities.

Table 8-1 shows that all but two parent entities are private businesses. One entity is a municipal marketing authority and one is a state government. For the purposes of the RFA analysis, states and tribal governments are not small governments (U.S. EPA, 1999). Table 8-1 also shows the SIC codes of each entity, where available, and the SBA standard for each SIC code (in terms of employment, sales revenues, or MWh output). The table then compares the SBA standard with the entity's economic data. The final column lists each entity's size.

EPA used the Dun & Bradstreet (D&B) database to obtain the parent entities' SIC codes, employment, and revenues. For entities in SIC code 4911, EPA used the Energy Information Administration (EIA) Form 861 database to determine electric output. Where the SIC code, the relevant employment or revenue data, or the electric output from Form EIA-861 was not available, EPA determined the entity size based on the projected future electricity generation of new facilities owned by each entity. EPA used the generating capacity of each new facility owned by the entities (adjusted by the entities' share of ownership) and multiplied it by the national capacity utilization forecast for combined-cycle facilities (see *Chapter 7: Economic Impact Analysis*, Section 7.1.1 for a description of the *Projected electricity sales factor* used to forecast generation).[2]

Table 8-1 shows that of the 38 entities with majority ownership in at least one in-scope NEWGen facility, only seven are estimated to be small. These seven small entities are highlighted in bold font.

[2] EPA estimated future generation solely based on the planned *future* facilities listed in the NEWGen database. Of the NEWGen facilities, EPA only included the 199 combined-cycle facilities for which cooling water information was available, because these facilities are more likely to be built than facilities about which permitting authorities had no information. EPA did not take into account existing facilities that will continue to operate or new facilities other than the 199 combined-cycle ones. This approach could overstate the number of small entities, to the extent that some entities would in fact be classified as large based on the size of their existing facilities or their future facilities that are not combined-cycle. On the other hand, some entities identified as large could in fact turn out to be small if they have little or no existing capacity and some of their projected capacity is not in fact built. While further research could therefore change the classification of individual facilities, EPA does not expect that the number of small entities is likely to be larger than estimated here. It should also be noted that the entity size of none of the higher cost facilities (i.e., facilities with a once-through baseline system) is based on projected future generation.

Table 8-1: Entities with Majority Ownership in at Least One In-Scope NEWGen Facility

Name of Entity	Type	SIC Code	SBA Small Entity Standard	Entity Value[a]	Entity Size
ABB Energy Ventures, Inc.	Private Business	3612	750 Emp.	20,000 Emp.	Large
American Electric Power Co., Inc.[b]	Private Business	4911	4 Million MWh	154,683,011 MWh	Large
Besicorp Group, Inc.	**Private Business**	**Unknown**	**Unknown**	***1,124,479 MWh***	**Small**
Calpine Corp.	Private Business	4911	4 Million MWh	*112,462,099 MWh*	Large
Cogentrix Energy, Inc.	Private Business	4911	4 Million MWh	*32,915,807 MWh*	Large
Consolidated Edison, Inc.	Private Business	4911	4 Million MWh	32,630,506 MWh	Large
Constellation Energy Group, Inc.[b]	Private Business	4911	4 Million MWh	34,048,817 MWh	Large
Dominion Resources, Inc.	Private Business	4911	4 Million MWh	75,568,214 MWh	Large
Dow Chemical Co.	Private Business	2821	750 Emp.	50,000 Emp.	Large
Duke Energy Corp.	Private Business	4911	4 Million MWh	80,638,873 MWh	Large
Dynegy, Inc.	Private Business	4924	500 Emp.	5,778 Emp.	Large
El Paso Energy Corp.	Private Business	4922	$5 Million Rev.	$21,950,000,000	Large
Empire State Newsprint	**Private Business**	**Unknown**	**Unknown**	***1,124,479 MWh***	**Small**
Energetix	Private Business	4911	4 Million MWh	*8,790,347 MWh*	Large
Entergy Corp.[b]	Private Business	4911	4 Million MWh	128,719,019 MWh	Large
Exelon Corp.[b]	Private Business	Unknown	Unknown	50,165,283 MWh	Large
Genpower	Private Business	4911	4 Million MWh	*7,881,630 MWh*	Large
GenTex Power Corporation	**Private Business**	**Unknown**	**Unknown**	***1,141,603 MWh***	**Small**
Ls Power	Private Business	Unknown	Unknown	*5,023,055 MWh*	Large
McCorkell & Associates	**Private Business**	**Unknown**	**Unknown**	***2,739,848 MWh***	**Small**
MidAmerican Energy Holdings Co.	Private Business	4911	4 Million MWh	*4,964,149 MWh*	Large
Municipal Electric Authority of Georgia	Municipal Marketing Authority	9631	n/a	10,699,564 MWh	Large
Newport Generation	Private Business	Unknown	Unknown	*7,306,262 MWh*	Large
PG&E Corp.	Private Business	4911	4 Million MWh	70,297,085 MWh	Large
Power Development Co.	**Private Business**	**Unknown**	**Unknown**	***1,242,065 MWh***	**Small**
Power Resource Group	Private Business	8748	$5 Million Rev.	$13,000,000	Large
PPG Industries, Inc.	Private Business	2851	500 Emp.	35,600 Emp.	Large
PPL Corp.	Private Business	Unknown	Unknown	*8,950,171 MWh*	Large
Public Service Enterprise Group, Inc.	Private Business	4911	4 Million MWh	*11,070,586 MWh*	Large
Smith Cogeneration, Inc.	**Private Business**	**4911**	**4 Million MWh**	***2,739,848 MWh***	**Small**
South Carolina Public Service Authority	State Government	n/a		n/a	n/a
Southern Company	Private Business	4911	4 Million MWh	*20,822,847 MWh*	Large
TECO Energy, Inc.	Private Business	4911	4 Million MWh	17,965,152 MWh	Large
Tenaska, Inc.	Private Business	Unknown	Unknown	*20,073,956 MWh*	Large
Tractebel Power, Inc.	Private Business	3674	500 Emp.	515 Emp.	Large
Westlake Energy	**Private Business**	**Unknown**	**Unknown**	***2,374,535 MWh***	**Small**
Wisconsin Energy Corp.[b]	Private Business	4911	4 Million MWh	29,608,736 MWh	Large
Xcel Energy, Inc.	Private Business	4911	4 Million MWh	*8,684,223 MWh*	Large

[a] The values presented in italics are based on the projected future generation of new facilities owned by the entity.

[b] The electric output for these entities is the output of the regulated utility companies each entity owns. The numbers ignore unregulated generating plants and may therefore understate total electric output at the holding company level.

Source: D&B Database, 2001; U.S. DOE, 1999; RDI, 2001.

The seven small entities identified in Table 8-1 own six of the 57 in-scope NEWGen facilities. Table 8-2 below presents the seven entities, the six in-scope facilities they own, and their ownership share in the facilities. The table also presents the facilities' cooling system type, cooling water source, capacity, and the model facility type that represents them (see *Chapter 5: Baseline Projection of New Facilities* for a detailed discussion of how EPA developed model facilities for the economic analysis).

The table shows that all six new in-scope NEWGen combined-cycle facilities owned by a small entity withdraw from a freshwater body. Five of the six facilities have a recirculating system, and one has an unknown system type. Four of the six facilities have relatively small generating capacities (550 MW or less), one has a medium capacity (600 MW), and one has a relatively large capacity (1,200 MW).

Table 8-2: In-Scope NEWGen Facilities Owned by Small Entities

Name of Entity	Share in Facility	Name of Facility	Cooling System Type	Water Body Type	Capacity (in MW)	Model Facility Type
Besicorp Group, Inc.	50%	Empire State Newsprint	Recirculating	Freshwater	493	CC R/FW-1
Empire State Newsprint	50%					
GenTex Power Corporation	50%	Lost Pines I	Recirculating	Freshwater	500	CC R/FW-1
McCorkell & Associates	50%	Kiamichi Energy Facility	Unknown[a]	Freshwater	1,200	CC R/FW-3
Power Development Co.	50%	Meriden Power	Recirculating	Freshwater	544	CC R/FW-1
Smith Cogeneration, Inc.	100%	Smith Pocola Energy Project	Recirculating	Freshwater	600	CC R/FW-2
Westlake Energy	100%	Kentucky [Westlake]	Recirculating	Freshwater	520	CC R/FW-1

[a] Based on its generating capacity of 1,200 MW and its reported design intake flow of 15.5 MGD, EPA assumed that this facility will operate a recirculating system.

Source: RDI, 2001; U.S. EPA analysis, 2001.

b. Extrapolation to the 69 projected new facilities

EPA's new facility forecast projected that 69 new in-scope combined-cycle facilities will begin operation between 2001 and 2020. *Chapter 5: Baseline Projection of New Facilities* presented the six model facility types that represent these 69 facilities for the costing and economic impact analyses. Table 8-3 below shows these six model facility types, the number of in-scope NEWGen facilities upon which the model facilities are based (by entity size), and the total projected number of new in-scope combined-cycle facilities (by entity size).

EPA estimated the entity size of the 69 new in-scope combined-cycle facilities based on the assumption that the share of all new facilities owned by a small entity is the same as the share of the 57 in-scope NEWGen facilities owned by a small entity.[3] This analysis was conducted at the model facility level. For example, of the 15 NEWGen recirculating/freshwater facilities with relatively small capacities (model facility type CC R/FW-1), 11 are owned by a large entity (73 percent) and four are owned by a small entity (27 percent). Applying these percentages to the 18 projected new facilities of that model type results in 13 facilities owned by a large entity and five facilities owned by a small entity. The same methodology was used for the other model facility types.

[3] This assumption is consistent with the model facility approach explained in *Chapter 5: Baseline Projection of New Facilities* and used in the costing and economic impact analyses. The model facility approach assumes that the characteristics of the projected new facilities are the same as those of the "actual" facilities analyzed in support of this regulation.

EPA projects that seven of the 69 projected new in-scope combined-cycle facilities (or 10.1 percent) will be owned by a small entity.[4]

Table 8-3: Combined-Cycle Model Facilities by Parent Entity Size

Model Facility Type	Cooling System Type	Source Water Body	Steam Electric Capacity (MW)	Number of In-Scope NEWGen Facilities				Number of Projected New In-Scope Facilities		
				Large		Potentially Small		Total	Large	Small
				#	%	#	%			
CC OT/M-1	Once-Through	Marine	1,031	4	100%	0	0%	5	5	0
CC R/M-1	Recirculating	Marine	489	4	100%	0	0%	5	5	0
CC R/M-2	Recirculating	Marine	1,030	1	100%	0	0%	1	1	0
CC R/FW-1	Recirculating	Freshwater	439	11	73%	4	27%	18	13	5
CC R/FW-2	Recirculating	Freshwater	699	16	94%	1	6%	21	20	1
CC R/FW-3	Recirculating	Freshwater	1,061	15	94%	1	6%	19	18	1
Total Combined-Cycle				**51**	**89%**	**6**	**11%**	**69**	**62**	**7**

Source: U.S. EPA analysis, 2001.

8.1.2 Coal Facilities

The small entity determination for new in-scope coal facilities was conducted using the same two steps as the analysis for combined-cycle facilities:

- Determine the small entity status of the 41 existing in-scope coal facilities identified in the section 316(b) Industry Survey.
- Extrapolate small entity information from the 41 existing in-scope facilities to the 14 projected new in-scope facilities.

a. Small entity status of the 41 existing in-scope coal facilities

EPA used publicly available information as well as the section 316(b) Industry Survey to identify the parent entities of the 41 existing in-scope coal facilities. EPA analyzed facilities owned by utilities and nonutilities separately, because different data are publicly available for the two types of electric generators.

❖ ***Utilities***

Twenty-nine of the 41 facilities are owned by utilities. These 29 facilities are owned by 26 entities. For facilities owned by investor-owned utilities, cooperatives, or municipal marketing authorities, EPA applied the SBA size standard for SIC code 4911 (4 million MWh of electric output). EPA obtained this information from the 1999 Form EIA-861. For facilities owned by a municipality, EPA used the size standard for government entities (population of 50,000). In addition, EPA determined that one of the 29 utility plants has recently been sold to a nonutility. The small entity determination for this firm was also based on the 4 million MWh threshold. As stated previously, states and tribal governments are not considered small governments for the purposes of the RFA analysis.

Table 8-4 presents the 26 entities that own one or more of the 29 existing in-scope coal facilities. The table also shows the type of each entity and the applicable SBA standard (in terms of MWh output or population), and compares the SBA standard

[4] This estimate is consistent with the percentage of NEWGen facilities owned by a small entity (six out of 57, or 10.5 percent).

with the entity's economic data. The final column lists each entity's size. The results in Table 8-4 show that of the 26 entities that own at least one of the 29 coal facilities, only one is estimated to be small. This entity is highlighted in bold font.

Table 8-4: Entities Owning at Least One Existing In-Scope Coal Facility (Utilities)

Name of Entity	Type	SBA Small Entity Standard	Entity Value	Entity Size
AES Corporation	Private Utility Company	4 mill. MWh	140,000,000 MWh	large
American Mun Power-Ohio, Inc.	Municipal Marketing Authority	4 mill. MWh	6,238,601 MWh	large
Appalachian Power Co.	Investor-owned Utility	4 mill. MWh	37,737,554 MWh	large
Carolina Power & Light Co.	Investor-owned Utility	4 mill. MWh	53,489,444 MWh	large
Central Power & Light Co.	Investor-owned Utility	4 mill. MWh	23,116,191 MWh	large
Cleco Corporation	Investor-owned Utility	4 mill. MWh	8,177,513 MWh	large
Entergy Arkansas Inc.	Investor-owned Utility	4 mill. MWh	31,123,876 MWh	large
Georgia Power Co.	Investor-owned Utility	4 mill. MWh	77,509,777 MWh	large
Grand River Dam Authority	State Government	n/a	5,200,178 MWh	large
Hoosier Energy R E C Inc.	Cooperative	4 mill. MWh	10,057,941 MWh	large
Indiana Michigan Power Co.	Investor-owned Utility	4 mill. MWh	25,920,410 MWh	large
Jacksonville Electric Authority	Municipality	50,000 People	695,877 People	large
City of Kansas City	Municipality	50,000 People	139,971 People	large
Kansas City Power & Light Co.	Investor-owned Utility	4 mill. MWh	15,477,138 MWh	large
LG&E Energy[a]	Holding Company	4 mill. MWh	40,391,415 MWh	large
MidAmerican Energy Co.	Investor-owned Utility	4 mill. MWh	21,852,303 MWh	large
Otter Tail Power Co.	Investor-owned Utility	4 mill. MWh	4,616,370 MWh	large
Reliant Energy HL&P	Investor-owned Utility	4 mill. MWh	72,106,898 MWh	large
San Antonio Public Service Bd	Municipality	50,000 People	1,147,213 People	large
Seminole Electric Coop Inc.	Cooperative	4 mill. MWh	11,959,412 MWh	large
South Carolina Electric&Gas Co.	Investor-owned Utility	4 mill. MWh	20,974,917 MWh	large
South Carolina Pub Serv Auth	State Government	n/a	20,285,462 MWh	large
Southwestern Electric Power Co.	Investor-owned Utility	4 mill. MWh	23,550,221 MWh	large
Texas Municipal Power Agency[b]	**Municipal Marketing Authority**	**4 mill. MWh**	**3,042,555 MWh**	**small**
Virginia Electric & Power Co.	Investor-owned Utility	4 mill. MWh	75,568,214 MWh	large
West Texas Utilities Co.	Investor-owned Utility	4 mill. MWh	7,621,638 MWh	large

[a] The electric output for this firm is the output of the regulated utility companies the firm owns. The numbers ignore unregulated generating plants and may therefore understate total electric output at the holding company level.
[b] This entity might not be classified as small if evaluated on a population served basis.

Source: U.S. EPA, 2000; U.S. DOE, 1999; U.S. Census Bureau, 2001.

The small entity identified in Table 8-4 above owns one of the 29 existing in-scope coal utility plants. This facility operates a recirculating system with a lake, withdraws water from a freshwater body, and has a generating capacity of 444 MW. Table 8-5 presents the characteristics of this facility and the model facility type that represents the facility.

Table 8-5: In-Scope Coal Facilities (Utilities) Owned by Small Entities					
Name of Entity	**Name of Facility**	**Cooling System Type**	**Water Body Type**	**Capacity (in MW)**	**Model Facility Type**
Texas Municipal Power Agency	Gibbons Creek	Recirculating with Lake	Freshwater	444	Coal RL/FW-1

Source: U.S. EPA, 2000; U.S. DOE, 1999; U.S. EPA analysis, 2001.

❖ ***Nonutilities***

The remaining 12 existing in-scope coal facilities are owned by a nonutility. EPA used data from the section 316(b) Industry Survey and from the D&B database to determine the size of the entities owning these 12 facilities. Since the survey data are confidential, this chapter only presents a summary of the entity size determination conducted for this analysis.

For each of the entities that own one of the 12 nonutilities, EPA determined the SIC code, the SBA small entity standard, and the economic information with which the SBA standard is compared. Table 8-5 below shows the distribution of the 12 facilities by their entity's SIC code and size. The table shows that two of the 12 nonutilities are owned by a small entity.

Table 8-6: Entities Owning at Least One Existing In-Scope Coal Facility (Nonutilities)				
Entity SIC Code	**SBA Small Entity Standard**	**Existing In-Scope Facilities**		
		Total	**Small**	**Large**
1542	$17,000,000	1	0	1
4911	4,000,000 MWh	7	1	6
4931	$5,000,000	2	0	2
4939	$5,000,000	1	1	0
4961	$9,000,000	1	0	1
Total		**12**	**2**	**10**

Source: U.S. SBA, 2000; U.S. EPA analysis, 2001.

The two small entities identified in Table 8-6 above each own one of the 12 existing in-scope coal nonutility plants. Both operate a recirculating system, withdraw water from a freshwater body, and have a generating capacity of less than 450 MW. Table 8-7 presents the characteristics of these two facilities and the model facility type that represents them.

Table 8-7: In-Scope Coal Facilities (Nonutilities) Owned by Small Entities			
Cooling System Type	**Water Body Type**	**Capacity (in MW)**	**Model Facility Type**
Recirculating	Freshwater	< 450	Coal R/FW-1
Recirculating	Freshwater	< 450	Coal R/FW-1

Source: U.S. EPA, 2000; U.S. EPA analysis, 2001.

b. Extrapolation to the 14 projected new facilities

EPA's new facility forecast projected that 14 new in-scope coal facilities will begin operation between 2001 and 2020. *Chapter 5: Baseline Projection of New Facilities* presented the eight model facility types that represent these 14 facilities for the costing and economic impact analyses. Table 8-8 below shows these eight model facility types, the number of existing in-scope coal facilities upon which the model facilities are based (by entity size), and the total projected number of new in-scope coal facilities (by entity size).

EPA estimated the entity size of the 14 new in-scope coal facilities based on the assumption that the share of all new facilities owned by a small entity is the same as the share of the 41 existing coal facilities owned by a small entity.[5] This analysis was conducted at the model facility level. For example, of the 10 existing recirculating/freshwater facilities with relatively small capacities (model facility type Coal R/FW-1), eight are owned by a large entity (80 percent) and two are owned by a small entity (20 percent). Applying these percentages to the three projected new facilities of that model type results in two facilities owned by a large entity and one facility owned by a small entity. The same methodology was used for the other model facility types.

EPA projects that one of the 14 projected new in-scope coal facilities (or 7.1 percent) will be owned by a small entity.[6]

Table 8-8: Coal Model Facilities by Parent Entity Size

Model Facility Type	Cooling System Type	Source Water Body	Steam Electric Capacity (MW)	Number of Existing In-Scope Coal Facilities				Number of Projected New In-Scope Facilities		
				Large		Potentially Small		Total	Large	Small
				#	%	#	%			
Coal OT/FW-1	Once-Through	Freshwater	63	3	100%	0	0%	1	1	0
Coal OT/FW-2	Once-Through	Freshwater	515	5	100%	0	0%	1	1	0
Coal OT/FW-3	Once-Through	Freshwater	3,564	1	100%	0	0%	1	1	0
Coal R/M-1	Recirculating	Marine	812	3	100%	0	0%	1	1	0
Coal R/FW-1	Recirculating	Freshwater	173	8	80%	2	20%	3	2	1
Coal R/FW-2	Recirculating	Freshwater	625	7	100%	0	0%	3	3	0
Coal R/FW-3	Recirculating	Freshwater	1,564	8	100%	0	0%	3	3	0
Coal RL/FW-1	Recirculating with Lake	Freshwater	660	3	75%	1	25%	1	1	0
Total Coal				**38**	**93%**	**3**	**7%**	**14**	**13**	**1**

Source: U.S. EPA analysis, 2001.

[5] This assumption is consistent with the model facility approach explained in *Chapter 5: Baseline Projection of New Facilities* and used in the costing and economic impact analyses. The model facility approach assumes that the characteristics of the projected new facilities are the same as those of the "actual" facilities analyzed in support of this regulation.

[6] This estimate is consistent with the percentage of existing in-scope coal facilities owned by a small entity (three out of 41, or 7.3 percent).

8.1.3 Manufacturing Facilities

The small entity determination for new in-scope manufacturing facilities was conducted using the same two steps as the analyses for combined-cycle and coal facilities:

- Determine the small entity status of the existing in-scope manufacturing facilities identified in the section 316(b) Industry Survey.
- Extrapolate small entity information from the existing in-scope facilities to the 38 projected new in-scope facilities.

a. Small entity status of the existing in-scope manufacturing facilities

EPA used data from the section 316(b) Industry Survey and from the D&B database to determine the size of the entities owning the existing in-scope manufacturing facilities. Since the survey data are confidential, this chapter only presents a summary of the entity size determination conducted for this analysis.

Table 8-9 shows each of the 4-digit SIC codes in which EPA projected a new in-scope manufacturing facility, the SIC description, and the SBA standard for each SIC code. The SBA standards for manufacturers are based on firm employment. To determine if a facility is owned by a small entity, EPA compared each facility's parent firm employment to its corresponding SBA threshold presented in table 8-9.

Table 8-9: SBA Thresholds for Manufacturing SIC Codes with New Facilities

SIC Code	SIC Code Description	SBA Small Entity Size Standard (Employees)
2621	Paper Mills	750
2812	Alkalies and Chlorine	1,000
2819	Industrial Inorganic Chemicals, N.E.C.	1,000
2821	Plastics Materials, Synthetic Resins, and Nonvulcanizable Elastomers	750
2834	Pharmaceutical Preparations	750
2869	Industrial Organic Chemicals, N.E.C.	1,000
2873	Nitrogenous Fertilizers	1,000
2911	Petroleum Refining	1,500
3312	Steel Works, Blast Furnaces (Including Coke Ovens), and Rolling Mills	1,000
3316	Cold-Rolled Steel Sheet, Strip, and Bars	1,000
3317	Steel Pipe and Tubes	1,000
3353	Aluminum Sheet, Plate, and Foil	750

Source: U.S. SBA, 2000.

b. Extrapolation to the 38 projected new facilities

EPA's new facility forecast projected that 38 new in-scope manufacturing facilities will begin operation between 2001 and 2020. *Chapter 5: Baseline Projection of New Facilities* presented the 21 model facility types that represent these 38 facilities for the costing and economic impact analyses. Table 8-10 below shows these 21 model facility types, the number of existing in-scope facilities upon which the model facilities are based (by firm size), and the total projected number of new in-scope manufacturing facilities (by firm size).

EPA estimated the firm size of the new in-scope manufacturing facilities based on the assumption that the share of all new facilities owned by a small firm is the same as the share of the existing facilities owned by a small firm.[7] This analysis was conducted at the model facility level. For example, of the 34 once-through/freshwater facilities in SIC 2869, 30 are owned by a large firm (88 percent) and four are owned by a small firm (12 percent). Applying these percentages to the seven projected new facilities of that model type results in six facilities owned by a large firm and one facility owned by a small firm. The same methodology was used for the other model facility types.

EPA projects that three of the 38 projected new in-scope manufacturing facilities (or 7.9 percent) will be owned by a small entity.[8] The three facilities owned by a small entity are expected to operate in the following industries: Industrial Organic Chemicals, N.E.C. (SIC code 2869); Steel Works, Blast Furnaces (Including Coke Ovens), and Rolling Mills (SIC code 3312); and Cold-Rolled Steel Sheet, Strip, and Bars (SIC code 3316).

[7] This assumption is consistent with the model facility approach explained in *Chapter 5: Baseline Projection of New Facilities* and used in the costing and economic impact analyses. The model facility approach assumes that the characteristics of the projected new facilities are the same as those of the "actual" facilities analyzed in support of this regulation.

[8] This estimate is consistent with the percentage of existing in-scope manufacturing facilities owned by a small entity (19 out of 230, or 8.3 percent).

Table 8-10: Manufacturing Model Facilities by Parent Firm Size

Model Facility Type	SIC Code	Cooling System Type / Source Water Body	Number of Actual In-Scope Facilities				Number of Projected New Facilities		
			Large		Potentially Small		Total	Large	Small
			#	%	#	%			
MAN OT/F-2621	2621	Once-Through / Freshwater	44	94%	3	6%	2	2	0
MAN OT/M-2812	2812	Once-Through / Marine	5	100%	0	0%	1	1	0
MAN OT/F-2812	2812	Once-Through / Freshwater	5	100%	0	0%	1	1	0
MAN OT/M-2819	2819	Once-Through / Marine	13	100%	0	0%	2	2	0
MAN OT/F-2819	2819	Once-Through / Freshwater	16	100%	0	0%	2	2	0
MAN OT/F-2821	2821	Once-Through / Freshwater	10	100%	0	0%	4	4	0
MAN OT/F-2834	2834	Once-Through / Freshwater	4	100%	0	0%	2	2	0
MAN OT/F-2869	2869	Once-Through / Freshwater	30	88%	4	12%	7	6	1
MAN RE/F-2869	2869	Recirculating / Freshwater	4	100%	0	0%	1	1	0
MAN OT/F-2873	2873	Once-Through / Freshwater	4	100%	0	0%	1	1	0
MAN RE/F-2873	2873	Recirculating / Freshwater	4	100%	0	0%	1	1	0
MAN OT/F-2911	2911	Once-Through / Freshwater	7	76%	2	24%	1	1	0
MAN RE/F-2911	2911	Recirculating / Freshwater	15	100%	0	0%	1	1	0
MAN OT/F-3312	3312	Once-Through / Freshwater	25	80%	6	20%	5	4	1
MAN RE/F-3312	3312	Recirculating / Freshwater	3	100%	0	0%	1	1	0
MAN OT/F-3316	3316	Once-Through / Freshwater	6	100%	0	0%	1	1	0
MAN RE/F-3316	3316	Recirculating / Freshwater	0	0%	3	100%	1	0	1
MAN OT/F-3317	3317	Once-Through / Freshwater	3	100%	0	0%	1	1	0
MAN RE/F-3317	3317	Recirculating / Freshwater	3	100%	0	0%	1	1	0
MAN OT/F-3353	3353	Once-Through / Freshwater	3	100%	0	0%	1	1	0
MAN RE/F-3353	3353	Recirculating / Freshwater	3	100%	0	0%	1	1	0
Total Manufacturers			**211**	**92%**	**19**	**8%**	**38**	**35**	**3**

Source: U.S. EPA, 2000; U.S. EPA analysis, 2001.

8.2 Sales Test for Facilities Owned by Small Entities

Each of the eleven projected new in-scope facilities owned by a small parent entity was further analyzed to evaluate the economic impact of this regulation. The analysis is based on the ratio of estimated annualized compliance costs to estimated annual revenues. Sales revenues required for the sales test were not available for all parent entities, so EPA could not evaluate the economic impact of the rule directly on the parent small entities. Instead, EPA assessed economic impact at the facility level.[9] EPA concluded that, in all cases, facility revenues are equal to or smaller than the parent entity revenues. Therefore, this approach will overstate the economic impact of this rule on the parent small entity.[10]

Table 8-11 lists each model facility type with at least one projected new facility owned by a small entity, the number of projected new facilities, estimated annual revenues, estimated annual compliance costs, and the ratio of estimated annual compliance costs to estimated annual revenues. The table shows that there are seven model types with projected facilities owned by a small entity. These seven model types represent 11 new facilities.

Table 8-11: Economic Impact Condition of Projected New Small Facilities

Model Facility	Number of Actual In-Scope Facilities	Number of Projected New Facilities Owned by Small Entities	Facility Information		
			Estimated Annual Revenues ($2000; mill.)	Estimated Annual Compliance Cost ($2000; mill.)	Ann. Compl. Cost/ Ann. Revenues
CC R/FW-1	4	5	$65	$0.17	0.26%
CC R/FW-2	1	1	$104	$0.17	0.17%
CC R/FW-3	1	1	$158	$0.18	0.11%
Coal R/FW-1	2	1	$38	$0.17	0.44%
MAN OT/F-2869	4	1	1,045	$0.46	0.04%
MAN OT/F-3312	6	1	$1,076	$0.82	0.08%
MAN RE/F-3316	3	1	$362	$0.19	0.05%
Total	**21**	**11**			

Source: U.S. EPA analysis, 2001.

Table 8-11 shows that the ratio of estimated annual compliance costs to estimated annual revenues for the 11 in-scope facilities owned by a small entity ranges from 0.04 percent to 0.44 percent. None of these facilities is expected to incur compliance costs in excess of one percent of revenues. Based on this analysis EPA determined that the parent small entities in the analyzed industries will not experience significant impacts as a result of complying with this rule.

In developing model facilities, EPA estimated compliance costs and revenues based on an average facility size. These averages may not reflect the true effects of the final rule on facilities owned by small entities. To test the sensitivity of the model facility approach used in this analysis, EPA also analyzed data for the actual facilities owned by small entities (NEWGen facilities or existing survey facilities). EPA compared the revenues and annualized compliance costs specific to each facility. This analysis was conducted for all 21 facilities owned by a small entity in each of the seven model facility types listed in Table 8-11.

The results of this analysis showed that impacts for the actual facilities were almost identical to impacts under the model facility approach. For combined-cycle facilities, impacts of the actual facilities ranged between 0.10 and 0.24 percent compared to between 0.11 and 0.25 for the model facilities. For coal facilities, impacts of the actual facilities ranged between 0.32 and 0.54 percent compared to 0.44 for the one model coal facility. Only for manufacturing facilities did the sensitivity analysis show slightly higher impacts: three of the actual facilities owned by a small entity had an impact of over one percent.

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[9] Facility-level revenues for electric generators were estimated using expected annual electricity generation and expected future prices of electricity. Compliance costs include the annualized equivalent of all costs incurred during the first 30 years of each facility's life. *Chapter 7: Economic Impact Analysis* provides details on the estimation of expected annual compliance costs and expected annual revenues for this analysis.

[10] In addition, the number of facilities owned by small entities may be overstated because it is based on the entity's *current employment*. Once the employment of the new facility is added to the entity's employment, the entity may no longer be considered small.

The other ten facilities had impact ratios of between 0.05 and 0.48 percent. EPA therefore concludes that the model facility approach provides a reasonable approximation of potential small entity impacts.

Table 8-12 presents the results of this sensitivity analysis.

Table 8-12: Impacts on Small Entities Using Actual Facility Data

Facility Type	Number of Actual Facilities Owned by Small Entities	Annualized Compliance Costs / Annual Revenues
Combined-Cycle	6	0.10% to 0.24%
Coal	2	0.32% to 0.54%
Manufacturers	13	0.05% to 1.62%

Source: U.S. EPA analysis, 2001.

8.3 Summary of Results

The RFA analysis for this final regulation shows that only 11 projected new facilities owned by small entities would be affected by the final section 316(b) New Facility Rule. Because none of these facilities will experience significant economic impact as a result of this regulation, EPA concluded that the small entity parents of these facilities will similarly not experience significant economic impact. Therefore, EPA certifies that the final section 316(b) New Facility Rule will not have a significant economic impact on a substantial number of small entities.

Table 8-13 summarizes the results of the RFA analysis.

Table 8-13: Projected Number of New Facilities Owned by a Small Entity

SIC Code	Facilities Owned by Small Entities	Compliance Cost as a Percent of Revenue	Number of Facilities Owned by a Small Entity with Significant Impact
Electric Generators			
n/a	***8***	***0.11% to 0.44%***	***0***
Manufacturing Facilities			
26 – Pulp & Paper	0	n/a	0
28 – Chemicals	1	0.04%	0
29 – Petroleum	0	n/a	0
33 – Metals	2	0.05% to 0.08%	0
Total Manufacturing	***3***	***0.04% to 0.08%***	***0***
Total	**11**	**0.04% to 0.44%**	**0**

Source: U.S. EPA analysis, 2001.

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Chapter 9: Other Economic Analyses

INTRODUCTION

This chapter presents several other economic analyses in support of the final section 316(b) New Facility Rule. These analyses address the analytic requirements of the following Acts and Executive Orders:

- Unfunded Mandates Reform Act (UMRA)
- E.O. 13132 – "Federalism"
- E.O. 13211 – "Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use"
- Paperwork Reduction Act (PRA)

In addition, this chapter presents the total social costs of the final rule.

CHAPTER CONTENTS

9.1 THE UNFUNDED MANDATES REFORM ACT (UMRA) OF 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires that Federal agencies assess the effects of their regulatory actions on state, local, and tribal governments and the private sector. Agencies must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with "Federal mandates" that may result in expenditures by state, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more in any one year (Section 202 of UMRA).[1]

Before promulgating a rule for which a written statement is needed, agencies must identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most cost-effective, or least burdensome alternative that achieves the objectives of the rule (Section 205). The provisions of Section 205 do not apply when they are inconsistent with applicable law. Agencies may adopt an alternative other than the least costly, most cost-effective, or least burdensome alternative if they publish with the final rule an explanation of why that alternative was not adopted (Section 205). Before establishing any regulatory requirements that may significantly or uniquely affect small governments, including tribal governments, agencies must develop a small government agency plan (Section 203). The plan must provide for notifying potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in the development of EPA regulatory proposals with significant Federal intergovernmental mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

UMRA specifies that a written statement is needed if either (1) the cost of a regulation to *state, local, and tribal governments* exceeds $100 million in any one year, or (2) the cost of a regulation to the *private sector* exceeds $100 million in any one

[1] Federal mandates include Federal regulations that impose enforceable duties on state, local, and tribal governments, or on the private sector, excluding those related to conditions of Federal assistance and participation in voluntary Federal programs.

year.[2] The following two subsections, 9.1.1 and 9.1.2, present the costs of the final section 316(b) New Facility Rule to the government and the private sector, respectively. Subsection 9.1.3 presents a summary of the results of the UMRA analysis.

9.1.1 Compliance Costs for Governments

Governments may incur two types of costs as a result of the final rule: (1) costs to comply with the rule for in-scope facilities owned by government entities; and (2) costs to implement the rule, borne by the responsible regulatory authorities. Both types of costs are discussed below.

a. Compliance costs for government-owned entities

Of the 121 new in-scope facilities subject to the final rule, only four are expected to be owned by a government entity. Two of these are expected to be state owned, one is projected to be owned by a municipality, and one by a municipal marketing authority.

EPA determined the number of projected new in-scope facilities owned by a government entity using ownership information presented in *Chapter 8: Regulatory Flexibility Analysis* and applying the same model facility approach used to determine the number of facilities owned by small entities. Using information from Tables 8-1 and 8-4, EPA first determined which of the existing in-scope facilities, upon which EPA's model facilities are based, are owned by a government entity.[3]

Table 9-1 below presents the government entities that own one or more of the existing facilities analyzed in support of the final rule. Table 9-1 also shows the facilities each government entity owns and the model facility type assigned to each facility. None of the existing in-scope nonutility or manufacturing facilities is owned by a government entity.

[2] The $100 million test is applied separately to governments and the private sector. The term "in any one year" refers to the maximum cost in a single year, not the annualized cost over the analysis period.

[3] EPA based the model facilities on facilities identified from the section 316(b) Industry Survey (for coal and manufacturing model facilities) and on facilities identified in the NEWGen database (for combined-cycle model facilities). While most of the NEWGen facilities are future planned facilities, this section will refer to in-scope survey facilities and in-scope NEWGen facilities as "existing in-scope facilities."

Table 9-1: Government Entities Owning at Least One Existing In-Scope Facility

Name of Entity	Type	Name of Facility	Model Facility Type
Combined-Cycle Facilities			
Municipal Electric Authority of Georgia	Municipal Marketing Authority	Wansley (Meag)	CC R/FW-1
South Carolina Public Service Authority	State Government	John S. Rainey Generating Station	CC R/FW-1
Coal Facilities			
American Mun. Power-Ohio, Inc.	Municipal Marketing Authority	Richard Gorsuch	Coal OT/FW-2
Grand River Dam Authority	State Government	GRDA	Coal R/FW-3
Jacksonville Electric Authority	Municipality	St. Johns River Power	Coal R/M-1
City of Kansas City	Municipality	Nearman Creek	Coal OT/FW-2
San Antonio Public Service Bd.	Municipality	J.K. Spruce	Coal RL/FW-1
South Carolina Public Service Authority	State Government	Cross	Coal R/FW-3
Texas Municipal Power Agency	Municipal Marketing Authority	Gibbons Creek	Coal RL/FW-1

Source: U.S. DOE, 1999; U.S. EPA analysis, 2001.

EPA estimated the number of projected new in-scope facilities owned by a government entity based on the assumption that the share of *new* in-scope facilities owned by a government entity is the same as the share of the *existing* in-scope facilities owned by a government entity.[4] This analysis was conducted at the model facility level. For example, of the 15 NEWGen recirculating/freshwater facilities with relatively small capacities (model facility type CC R/FW-1), 13 are owned by a private entity (87 percent) and two are owned by a government entity (13 percent). Applying these percentages to the 18 projected new facilities of that model type results in 16 privately-owned facilities and two government-owned facilities. The same methodology was used for the other model facility types.

Table 9-2 below shows the 14 electric generator model facility types, the number of existing in-scope facilities upon which the model facilities are based (by entity type), and the total projected number of new in-scope electric generators (by entity type). The table shows that two of the 69 projected new in-scope combined-cycle facilities (or 2.9 percent) and two of the 14 projected new in-scope coal facilities (or 14.3 percent) will be owned by a government entity.[5]

[4] This assumption is consistent with the model facility approach explained in *Chapter 5: Baseline Projection of New Facilities* and used in the costing and economic impact analyses. The model facility approach assumes that the characteristics of the projected new facilities are the same as those of the existing facilities analyzed in support of this regulation.

[5] This estimate is consistent with the percentage of existing electric generators owned by a government entity (two out of 57 NEWGen combined-cycle facilities, or 3.5 percent, and seven out of 41 survey coal facilities, or 17.1 percent).

Table 9-2: Electric Generators Model New Facilities by Parent Firm Type

Model Facility Type	Cooling System Type	Source Water Body	Steam Electric Capacity (MW)	Number of Existing In-Scope Facilities				Number of Projected New Facilities	
				Privately Owned		Government Owned		Privately Owned	Govern-ment Owned
				#	%	#	%		
Combined-Cycle Facilities									
CC OT/M-1	Once-Through	Marine	1,031	4	100%	0	0%	5	0
CC R/M-1	Recirculating	Marine	489	4	100%	0	0%	5	0
CC R/M-2	Recirculating	Marine	1,030	1	100%	0	0%	1	0
CC R/FW-1	Recirculating	Freshwater	439	13	87%	2	13%	16	2
CC R/FW-2	Recirculating	Freshwater	699	17	100%	0	0%	21	0
CC R/FW-3	Recirculating	Freshwater	1,061	16	100%	0	0%	19	0
Total Combined-Cycle Facilities				**55**	**96%**	**2**	**4%**	**67**	**2**
Coal Facilities									
Coal R/M-1	Recirculating	Marine	812	2	67%	1	33%	1	0
Coal OT/FW-1	Once-Through	Freshwater	63	3	100%	0	0%	1	0
Coal OT/FW-2	Once-Through	Freshwater	515	3	60%	2	40%	1	0
Coal OT/FW-3	Once-Through	Freshwater	3,564	1	100%	0	0%	1	0
Coal R/FW-1	Recirculating	Freshwater	173	10	100%	0	0%	3	0
Coal R/FW-2	Recirculating	Freshwater	625	7	100%	0	0%	3	0
Coal R/FW-3	Recirculating	Freshwater	1,564	6	75%	2	25%	2	1
Coal RL/FW-1	Recirculating with Lake	Freshwater	660	2	50%	2	50%	0	1
Total Coal Facilities				**34**	**83%**	**7**	**17%**	**12**	**2**

Source: U.S. EPA analysis, 2001.

Compliance costs for individual facilities were presented in *Chapter 6: Facility Compliance Costs*. The two new combined-cycle facilities are projected to begin operation in 2007 and 2016, respectively; the two new coal facilities are projected to begin operation in 2005 and 2006, respectively. The maximum aggregate costs for the four government-owned facilities in any one year is estimated to be $19.1 million in 2005.

b. Implementation costs for regulatory authorities

The requirements of section 316(b) are implemented through the National Pollutant Discharge Elimination System (NPDES) permit program. Forty-four states and one territory currently have NPDES permitting authority under section 402(b) of the Clean Water Act (CWA). EPA estimates that states and the one territory will incur four types of costs associated with implementing the requirements of the final section 316(b) New Facility Rule: (1) start-up activities; (2) issuing an initial NPDES permit for each new facility; (3) reviewing and reissuing a permit for each new facility every five years; and (4) annual activities.[6]

The start-up costs are incurred only once by each of the 45 regulatory authorities. The initial permitting costs, repermitting costs, and annual activities are incurred on a per-permit basis. The per-permit costs to the regulatory authorities depend on the compliance requirements of each facility: permits for facilities that already have a recirculating system in the baseline ("Track I" facilities) will cost less than permits for facilities that are proposed with a once-through system in the baseline ("Track II" facilities). Each state's actual burden associated with the administrative functions required by the final section 316(b) New Facility Rule will depend on the number of new in-scope facilities that will be built in the state during the 20-year analysis period.

The incremental burden will also depend on the extent of each state's current practices for regulating CWIS. (EPA recognizes that these States and this territory would be required to implement section 316(b) on a case-by-case basis in the absence of this rule.) States that currently require relatively modest analysis, monitoring, and reporting of impacts from CWIS in NPDES permits may require more permitting resources to implement the final rule than are required under their current programs. For states that are actively implementing section 316(b) requirements now, the final rule may actually reduce the burden on permit writers, by clarifying key concepts in the rule and by providing easily-applied criteria for some regulatory determinations.[7]

❖ ***Start-up activities***

All 44 states and the one territory with NPDES permitting authority are expected to undertake start-up activities to prepare for administering the provisions of the final section 316(b) New Facility Rule. Start-up activities include reading and understanding the rule, mobilization and planning of the resources required to address the rule's requirements, and training technical staff on how to review materials submitted by facilities and make determinations on the section 316(b) requirements for each facility's NPDES permit. In addition, permitting authorities are expected to incur other direct costs, e.g., for copying and the purchase of supplies. Table 9-3 shows that total start-up costs of $3,564 are expected to be incurred by each of the 44 states and one territory with NPDES permitting authority.

Table 9-3: Government Costs of Start-Up Activities (per Regulatory Authority)

Activity	Costs
Read and Understand Rule	$882
Mobilization/Planning	$1,534
Training	$1,098
Other Direct Costs	$50
Total[a]	**$3,564**

[a] Individual numbers may not add up to total due to independent rounding.

Source: U.S. EPA, 2001.

[6] The unit costs associated with implementing the requirements of the final section 316(b) New Facility Rule are documented in EPA's Information Collection Request (U.S. EPA, 2001).

[7] The available information on current implementation of the section 316(b) requirements by different regulatory authorities is insufficient to allow EPA to estimate the incremental costs of the final rule to the regulatory authorities with precision. EPA therefore made the conservative assumption that permitting authorities currently do not incur administrative costs of implementing section 316(b) requirements and that all costs for new facilities under the final section 316(b) New Facility Rule are incremental costs.

❖ *Issue initial NPDES permit*

The permitting authorities will have to include the requirements of the final section 316(b) New Facility Rule in the initial NPDES permit issued to each new in-scope facility. The activities involved in determining section 316(b) requirements include reviewing submitted documents and supporting materials, verifying data sources, consulting with facilities and the interested public, determining specific permit requirements, and writing the actual permit.

Table 9-4 below shows the activities that EPA anticipates will be necessary to issue initial permits and the estimated cost of each activity. Permits that require all of the components listed in Table 9-4 are expected to impose a cost per permit of $7,028 for Track I facilities and $27,323 for Track II facilities.

Table 9-4: Government Costs of Initial NPDES Permit Issuance (per Permit)[a]

Activity	Track I (Recirculating)	Track II (Once-Through)
Review CWIS Location and Design Data	$785	$785
Determine Compliance with Source Water Body Flow Information	$262	$262
Review Source Water Baseline Biological Characterization Data	$1,470	$1,470
Review Design and Construction Technology Plan	$1,305	
Determine Compliance with CWIS Velocity Requirements	$262	
Determine Compliance with CWIS Flow Reduction Requirements	$588	
Review Comprehensive Demonstration Study Plan		$1,176
Review Source Water Baseline Biological Characterization Study		$19,355
Review Evaluation of Potential CWIS Effects		$1,176
Review Verification Study		$743
Determine Monitoring Frequency	$262	$262
Determine Record Keeping and Reporting Frequency	$262	$262
Considering Public Comments	$1,176	$1,176
Issuing Permit	$239	$239
Permit Record Keeping	$118	$118
Other Direct Costs	$300	$300
Total[b]	**$7,028**	**$27,323**

[a] Actual per permit costs may be lower than the total cost because some facilities will not have to submit information on all compliance requirements.
[b] Individual numbers may not add up to total due to independent rounding.

Source: U.S. EPA, 2001.

❖ ***Review and reissue permit every five years***

NPDES permits are issued for five years. The permitting authority therefore has to reissue the permits for the new in-scope facilities every five years following initial permitting. Before reissuing a facility's permit, the regulatory authority must determine if there have been any changes in the facility's operations or in the physical or biological attributes of the source water body. Any changes should be evaluated to determine the need for additional, or more stringent, conditions in the permit.

The final section 316(b) New Facility Rule requires facilities to submit the same type of information for their permit renewal application as was required for the initial permit. The permitting authorities will therefore have to carry out the same type of administrative activities as during the initial permitting process. The burden of these activities is expected to be smaller for permit reissuance, however, because the permitting authority is already familiar with the facility's case and the type of information the facility will provide. The reduction in costs is expected to vary by the specific repermitting activities.

Table 9-5 shows the activities that EPA anticipates will be necessary to reissue permits and the estimated cost of each activity. Permits that require all of the components listed in Table 9-5 are expected to impose a cost per permit of $2,318 for Track I facilities and $6,392 for Track II facilities.

Table 9-5: Government Costs of Repermitting (per Permit)[a]

Activity	Track I (Recirculating)	Track II (Once-Through)
Review CWIS Location and Design Data	$236	$236
Determine Compliance with Source Water Body Flow Information	$79	$79
Review Source Water Baseline Biological Characterization Data	$441	$441
Review Design and Construction Technology Plan	$391	
Determine Compliance with CWIS Velocity Requirements	$79	
Determine Compliance with CWIS Flow Reduction Requirements	$176	
Review Comprehensive Demonstration Study Plan		$353
Review Source Water Baseline Biological Characterization Study		$4,015
Review Evaluation of Potential CWIS Effects		$353
Determine Monitoring Frequency	$79	$79
Determine Record Keeping and Reporting Frequency	$79	$79
Considering Public Comments	$353	$353
Issuing Permit	$72	$72
Permit Record Keeping	$35	$35
Other Direct Costs	$300	$300
Total[b]	**$2,318**	**$6,392**

[a] Actual per permit costs may be lower than the total cost because some facilities will not have to submit information on all compliance requirements.
[b] Individual numbers may not add up to total due to independent rounding.

Source: U.S. EPA, 2001.

❖ *Annual activities*

In addition to the start-up and permitting activities discussed above, permitting authorities will have to carry out certain annual activities to ensure the continued implementation of the requirements of the final section 316(b) New Facility Rule. These annual activities include reviewing yearly status reports, tracking compliance, determining monitoring scope reduction, and record keeping.[8]

Table 9-6 below shows the annual activities that will be necessary for each permit following the year of initial permitting and the estimated cost of each activity. A total cost of $1,720 is estimated for each permit per year.

Table 9-6: Government Costs for Annual Activities (per Permit)

Activity	Track I (Recirculating)	Track II (Once-Through)
Review of Yearly Report	$613	$613
Track Compliance	$524	$524
Determine Monitoring Scope Reduction	$409	$409
Keep Records	$124	$124
Other Direct Costs	$50	$50
Total[a]	**$1,720**	**$1,720**

[a] Individual numbers may not add up to total due to independent rounding.

Source: U.S. EPA, 2001.

EPA calculated total government costs of implementing the final section 316(b) New Facility Rule by aggregating the unit costs presented in Tables 9-3 to 9-6 based on the specific permitting requirements for each of the 121 new in-scope facilities. Table 9-7 presents the rule's estimated government implementation costs for 2001 to 2030. The table shows that the highest one-year implementation costs, $356,675, will be incurred in 2001, the first year of the final section 316(b) New Facility Rule. This cost is mainly the result of start-up activities for the 44 states and one territory with NPDES permitting authority, and initial permitting for seven facilities. The total present value of government implementation costs is estimated to be $2.9 million, or $234,370 per year when annualized over 30 years at a seven percent rate.[9]

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[8] Even though EPA assessed a cost to the regulatory authority of determining monitoring scope reduction, to be conservative, EPA assumed no reduction in monitoring scope when estimating facility compliance costs.

[9] Calculation of the present value assumes that costs are incurred at the end of the year.

Table 9-7: Total Government Implementation Costs by Year and Activity

Year	Start-Up Activities	Initial Permitting	Repermitting	Annual Activities	Total Costs
2001	$156,816	$191,260	$0	$8,599	$356,675
2002		$54,646	$0	$12,039	$66,685
2003		$61,674	$0	$15,478	$77,152
2004		$144,431	$0	$20,638	$165,069
2005		$117,897	$31,960	$36,116	$185,973
2006		$138,192	$12,784	$55,034	$206,010
2007		$96,813	$12,784	$73,951	$183,548
2008		$69,490	$15,103	$87,710	$172,303
2009		$82,757	$37,160	$99,748	$219,665
2010		$144,431	$65,610	$110,067	$320,108
2011		$62,462	$50,507	$125,545	$238,514
2012		$103,052	$39,479	$135,864	$278,395
2013		$62,462	$35,405	$146,183	$244,050
2014		$55,435	$59,218	$156,502	$271,155
2015		$62,462	$102,770	$165,101	$330,333
2016		$68,702	$68,491	$175,420	$312,613
2017		$55,435	$65,610	$182,299	$303,344
2018		$55,435	$53,389	$190,898	$299,722
2019		$35,140	$74,883	$199,497	$309,520
2020		$0	$120,754	$208,096	$328,850
2021		$0	$85,912	$208,096	$294,008
2022		$0	$81,276	$208,096	$289,372
2023		$0	$69,054	$208,096	$277,150
2024		$0	$86,475	$208,096	$294,571
2025		$0	$120,754	$208,096	$328,850
2026		$0	$85,912	$208,096	$294,008
2027		$0	$81,276	$208,096	$289,372
2028		$0	$69,054	$208,096	$277,150
2029		$0	$86,475	$208,096	$294,571
2030		$0	$120,754	$208,096	$328,850
Present Value @7%	**$146,557**	**$994,747**	**$488,967**	**$1,278,078**	**$2,908,349**
Annualized @7%	**$11,810**	**$80,160**	**$39,400**	**$103,000**	**$234,370**

Source: U.S. EPA analysis, 2001.

9.1.2 Compliance Costs for the Private Sector

The private sector incurs costs under the final section 316(b) New Facility Rule to comply with the requirements for in-scope facilities. Of the 121 new in-scope facilities subject to the final rule, 117 are estimated to be owned by a private entity. The privately-owned facilities include all 38 manufacturing facilities and 79 of the 83 electric generators.

Compliance costs for individual facilities were presented in *Chapter 6: Facility Compliance Costs*. Total annualized compliance costs for the 117 privately-owned facilities are estimated to be $43.8 million, discounted at seven percent. The maximum aggregate costs for all 117 facilities in any one year is estimated to be $71.2 million, incurred in 2005.

9.1.3 Summary of the UMRA Analysis

EPA has determined that the final rule will not contain a Federal mandate that will result in expenditures of $100 million or more for state, local, and tribal governments, in the aggregate, or for the private sector in any one year.

Table 9-8 summarizes the costs to comply with the rule for the 121 in-scope facilities and the costs to implement the rule, borne by the responsible regulatory authorities.

Table 9-8: Summary of Total Costs (in mill.)

Sector	Total Annualized Cost			Maximum One-Year Cost		
	Facility Compliance Costs	Government Implementation Costs	Total[a]	Facility Compliance Costs	Government Implementation Costs	Total[a]
Government Sector	$3.8	$0.2	$4.1	$19.0	$0.2	$19.2
Private Sector	$43.8	n/a	$43.8	$71.2	n/a	$71.2

[a] Individual numbers may not add up to totals due to independent rounding.

Source: U.S. EPA analysis, 2001.

Table 9-8 shows that total annualized costs of the section 316(b) New Facility Rule borne by governments is $4.1 million per year. The maximum one-year costs that will be incurred by government entities is expected to be $19.2 million ($19.0 million in facility compliance costs and $0.2 million in implementation costs), incurred in 2005. Total annualized costs borne by the private sector is estimated to be $43.8 million. The maximum one-year cost to the private sector is $71.2 million, incurred in 2005. Each of the maximum costs are below the $100 million UMRA threshold. EPA therefore concludes that the final section 316(b) New Facility Rule is not subject to the requirements of Sections 202 and 205 of UMRA.

9.2 Executive Order 13132

Executive Order 13132 on "Federalism" (64 FR 43255, August 10, 1999) requires EPA to develop an accountable process to ensure "meaningful and timely input by state and local officials in the development of regulatory policies that have federalism implications." "Policies that have federalism implications" is defined in the Executive Order to include regulations that have "substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government."

Under Section 6 of Executive Order 13132, EPA may not issue a regulation that has federalism implications, that imposes substantial direct compliance costs, and that is not required by statute, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by state and local governments, or EPA consults with state and local officials early in the process of developing the final regulation. EPA also may not issue a regulation that has federalism implications and that preempts state law, unless the Agency consults with state and local officials early in the process of developing the final regulation.

EPA determined that the final section 316(b) New Facility Rule does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. The rule will not impose substantial costs on states and localities. In addition, the rule is authorized by section 316(b) of the Clean Water Act. For these reasons, the requirements of Section 6 of the Executive Order do not apply to this rule.

9.3 Executive Order 13211

Executive Order 13132 on "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use" requires EPA to prepare a Statement of Energy Effects when undertaking regulatory actions identified as "significant energy actions." For the purposes of Executive Order 13211, "significant energy action" means (66 FR 28355; May 22, 2001):

> "any action by an agency (normally published in the Federal Register) that promulgates or is expected to lead to the promulgation of a final rule or regulation, including notices of inquiry, advance notices of proposed rulemaking, and notices of proposed rulemaking:
>
> (1) (i) that is a significant regulatory action under Executive Order 12866 or any successor order, and
>
> (ii) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or
>
> (2) that is designated by the Administrator of the Office of Information and Regulatory Affairs as a significant energy action."

For those regulatory actions identified as "significant energy actions," a Statement of Energy must include a detailed statement relating to (1) any adverse effects on energy supply, distribution, or use (including a shortfall in supply, price increases, and increased use of foreign supplies), and (2) reasonable alternatives to the action with adverse energy effects and the expected effects of such alternatives on energy supply, distribution, and use.

This rule is not a "significant energy action" as defined in Executive Order 13211 because it is not likely to have a significant adverse effect on the supply, distribution, or use of energy. The final section 316(b) rule could have a significant energy impact if it discouraged the construction of new electric generating capacity or if it significantly reduced the energy output from new facilities. EPA's analysis, presented in *Chapter 7: Economic Impact Analysis*, showed that the final rule is unlikely to discourage new entry, because compliance costs and economic impacts are expected to be very low. EPA therefore does not expect this rule to have adverse energy effects.

Track I of the final section 316(b) new facility rule requires facilities to install a recirculating system or other technologies that would reduce the design intake flow to a level commensurate with that of a recirculating system. For the purposes of this analysis, EPA assumed that facilities that do not already plan to install a recirculating system in the baseline will install a recirculating wet cooling tower to achieve compliance with the rule. EPA's analysis showed that five new combined-cycle facilities and four new coal facilities would be required to install a recirculating system as a result of the final rule (see analysis in *Chapter 5: Baseline Projections of New Facilities*).

Installation of a cooling tower imposes an "energy penalty," consisting of two components: (1) a reduction in unit efficiency due to increased turbine back-pressure, and (2) an increase in auxiliary power requirements to operate the recirculating wet cooling tower.[10] EPA estimates that the mean annual energy penalty for a new combined-cycle facility is 0.40 percent of generating capacity. For new coal facilities, the mean annual energy penalty is estimated to be 1.65 percent of generating

[10] EPA also considered the energy requirements of other compliance technologies, such as rotating screens, but found them insignificant and thus excluded them from this analysis.

capacity (see *Technical Development Document* for more information on EPA's determination of the energy penalty).[11]

EPA estimates that the installation of nine recirculating wet cooling towers would reduce available generating capacity by a maximum of 100 megawatts (MW) nationally. Table 9-9 below presents the model facilities which are assumed to install a cooling tower to comply with the final rule. The table also presents for each model facility type: the baseline generating capacity, the energy penalty, the estimated per facility reduction in available capacity as a result of the energy penalty, the estimated total number of new in-scope facilities; and the estimated national reduction in energy supply.

Table 9-9: New Electric Generator Model Facilities with Cooling Tower Requirements

Model Facility Type	Generating Capacity (MW)	Energy Penalty	Estimated Capacity Reduction (per Facility, in MW)	Total Number of Projected New Facilities	National Capacity Reduction (in MW)
CC OT/M-1	1,031	0.40%	4.1	5	21
Coal OT/FW-1	63	1.65%	1.0	1	1
Coal OT/FW-2	515	1.65%	8.5	1	8
Coal OT/FW-3	3,564	1.65%	58.8	1	59
Coal RL/FW-1[a]	660	1.65%	11	1	11
Total				**9**	**100**

[a] For this analysis, recirculating facilities with cooling lakes are assumed to exhibit characteristics like a once-through facility.

Source: U.S. EPA analysis, 2001.

The national capacity reduction of 100 MW presented in Table 9-9 is the *maximum* reduction as a result of this rule. This maximum reduction will be reached in 2017, when all nine facilities are estimated to have begun operation (see the Appendix to *Chapter 6: Facility Compliance Costs* for information on the on-line years of projected new in-scope facilities). The *average* capacity reduction during the 20-year analysis period (taking into account that some of these facilities will begin operation during the latter part of this period) is 74 MW annually. These estimates may be an overestimate due to the fact that some facilities may choose to comply with Track II by implementing technologies other than recirculating wet cooling towers.

EPA believes that the estimated reduction in available energy supply as a result of the final section 316(b) rule does not constitute a significant energy effect. During the period covered by EPA's new facility projection, 2001 to 2020, the Energy Information Administration (EIA) forecasts total new capacity additions of 370 gigawatts (GW) (1 GW = 1,000 MW) and an average available generating capability of 921 GW. Compared to the EIA forecasts, the estimated energy effect of the final rule is insignificant, comprising only 0.03 percent of total new capacity (100 MW/370 GW) and 0.008 percent of the average available generating capability (74 MW/921 GW).

❖ *Potential effects on rate payers*

In addition to estimating the expected reduction in available energy supply, EPA also considered potential effects of the final section 316(b) New Facility Rule on rate payers. For each model electric generation facility, EPA estimated the annualized compliance cost per KWh of generation.

Table 9-10 below shows that the maximum increase in electricity prices would be 0.17 cents per KWh for a small coal facility with a freshwater once-through system. The average price increase (weighted by the number of projected new facilities) would be 0.015 cents per KWh. This compares to national electricity price forecasts of between 7.4 to 8.0 cents per KWh for residential customers, 5.9 to 7.5 cents per KWh for commercial customers, 3.8 and 4.6 cents per KWh for industrial customers, and 4.5 to 5.4 cents per KWh for the transportation sector (DOE, 2000, Table 72). Even if the new facilities

[11] EPA estimates an energy penalty of 1.70 percent for new nuclear facilities. However, EPA does not project any new nuclear facilities to be built during the 20-year analysis period 2001-2020.

subject to the final rule could pass on their entire compliance cost to their customers, the average increase in electricity prices would only be between 0.2 percent for residential customers (0.015 / 8.0) and 0.4 percent for industrial customers (0.015 / 3.8). However, it is unlikely that the new projected facilities would be able to pass on all of their compliance costs since they are few in number and are therefore unlikely to have an effect on electricity prices.

Table 9-10: Potential Effects on Rate Payers

Model Facility Type	Total Number of Projected New Facilities	Generating Capacity (MW)	Estimated Generation (MWh)	Annualized Compliance Costs	Compliance Costs (Cents / KWh)
CC OT/M-1	5	1,031	4,709,114	$3,172,889	0.067
CC R/FW-1	18	439	2,002,373	$172,422	0.009
CC R/FW-2	21	699	3,193,938	$174,442	0.005
CC R/FW-3	19	1,061	4,846,963	$176,097	0.004
CC R/M-1	5	489	2,234,118	$198,353	0.009
CC R/M-2	1	1,030	4,703,406	$204,111	0.004
Coal OT/FW-1	1	63	428,284	$732,761	0.171
Coal OT/FW-2	1	515	3,503,722	$3,806,286	0.109
Coal OT/FW-3	1	3,564	24,246,596	$19,063,402	0.079
Coal R/FW-1	3	173	1,177,021	$169,857	0.014
Coal R/FW-2	3	625	4,249,202	$179,952	0.004
Coal R/FW-3	3	1,564	10,641,153	$240,082	0.002
Coal R/M-1	1	812	5,524,323	$235,244	0.004
Coal RL/FW-1	1	660	4,490,156	$4,787,302	0.107
				Weighted Average	**0.015**

Source: U.S. EPA analysis, 2001.

9.4 THE PAPERWORK REDUCTION ACT OF 1995

The Paperwork Reduction Act of 1995 (PRA) (superseding the PRA of 1980) is implemented by the Office of Management and Budget (OMB) and requires that agencies submit a supporting statement to OMB for any information collection that solicits the same data from more than nine parties. The PRA seeks to ensure that Federal agencies balance their need to collect information with the paperwork burden imposed on the public by the collection.

The definition of "information collection" includes activities required by regulations, such as permit development, monitoring, record keeping, and reporting. The term "burden" refers to the "time, effort, or financial resources" the public expends to provide information to or for a Federal agency, or to otherwise fulfill statutory or regulatory requirements. PRA paperwork burden is measured in terms of annual time and financial resources the public devotes to meet one-time and recurring information requests (44 U.S.C. 3502(2); 5 C.F.R. 1320.3(b)).

Information collection activities may include:

- reviewing instructions;
- using technology to collect, process, and disclose information;
- adjusting existing practices to comply with requirements;
- searching data sources;
- completing and reviewing the response; and
- transmitting or disclosing information.

Agencies must provide information to OMB on the parties affected, the annual reporting burden, the annualized cost of responding to the information collection, and whether the request significantly impacts a substantial number of small entities. An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a currently valid OMB control number.

EPA's estimate of the information collection requirements imposed by the final section 316(b) New Facility Rule are documented in the Information Collection Request (ICR) which accompanies this regulation (U.S. EPA, 2001).

9.5 SOCIAL COSTS OF THE FINAL RULE

The social costs of regulatory actions are the opportunity costs to society of employing scarce resources to reduce environmental damage. The largest component of economic costs to society generally is the estimated costs incurred by facilities for the labor, equipment, material, and other economic resources needed to comply with the final rule. Social costs also include the value of resources used by governments to implement the rule, including the costs of permitting, compliance monitoring, and enforcement activities. Finally, social costs include lost producers' and consumers' surplus that result when the quantity of goods and services produced decreases as a result of the rule.

The estimated total social cost of the final section 316(b) New Facility Rule is the sum of three cost components: (1) direct compliance costs to facilities subject to the regulation; (2) costs to permitting authorities of implementing the rule; and (3) costs to the federal government of overseeing rule implementation.

- ***Facility compliance costs*** are discussed in *Chapter 6: Facility Compliance Costs* and include technology costs, operating and maintenance costs, and permitting and monitoring costs.[12]

- ***State permitting costs*** are presented in Section 9.1.1(b) of this chapter and include start-up costs, costs for initial permit application review and permit development, repermitting costs, and costs for annual activities.

- ***Federal costs*** include the same types of costs as are incurred by states but are associated with reviewing the states' permitting actions.

Given the small number of new facilities that would incur costs under the final section 316(b) New Facility Rule, EPA expects only minimal reductions in output in the affected industries due to the final rule (see the discussions in *Chapter 7: Economic Impact Analysis* and on Executive Order 13211 in Section 9.3 of this chapter). Therefore, social costs are fully accounted for by the compliance costs incurred by the regulated facilities and the costs incurred by governments to implement the rule.

The total estimated social cost of the final section 316(b) New Facility Rule is approximately $47.9 million annually (using a seven percent discount rate and a 30 year discounting period). Direct facility compliance costs account for $47.7 million, or 99.5 percent, of the total. Annual state and federal implementation costs account for approximately $234,400 and $6,200, respectively. The present value of total social costs is $594.5 million, with facility compliance costs accounting for $591.5

[12] Direct compliance costs to facilities are often calculated differently for the economic impact analysis and the social cost estimation. Economic impact analyses often take into account the tax deductability of compliance costs to private businesses and differences between social and private opportunity costs of capital. The facility compliance costs estimated in Chapter 6, however, were not adjusted for tax effects. In addition, a single discount rate of seven percent is used in all parts of the analysis. Therefore, the costs presented in Chapter 6 represent the value to society of the resources used by facilities in compliance activities.

million, state implementation costs for $2.9 million, and federal costs for $0.08 million.

Table 9-11: Social Cost of the Final Section 316(b) New Facility Rule ($2000)

	Present Value	Annualized
Facility Compliance Costs	$591,542,800	$47,670,300
State Implementation Costs	$2,908,300	$234,400
Federal Costs	$77,500	$6,200
Total	**$594,528,600**	**$47,910,900**

Source: U.S. EPA analysis, 2001.

REFERENCES

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Chapter 10: Alternative Regulatory Options

INTRODUCTION

CHAPTER CONTENTS

EPA defined and evaluated a number of alternative best technology available (BTA) options for facilities subject to the final section 316(b) New Facility Rule. This chapter presents four alternative options that EPA considered for the final regulation and their costs:

- **(1) Water Body Type Option:** This option would establish technology-based performance requirements based on the type of water body from which the facility withdraws cooling water. Intake capacity limits based on closed-cycle recirculating wet cooling systems would be required only in estuaries, tidal rivers, the Great Lakes, and oceans.
- **(2) Dry Cooling Option:** This option would establish technology-based performance requirements based on a near-zero intake level for all electric generators. Manufacturing facilities would have the same requirements as under the final rule.
- **(3) Industry Two-Track Option:** This option is a variation of the two-track approach of the final rule, suggested by industry representatives. The option would establish technology-based performance requirements different from the final rule, but employ a similar fast track and a demonstration track approach.

In addition to recirculating requirements, all the options, except for the dry cooling option, would also require:

- a design through-screen velocity of 0.5 ft/s;
- location- and capacity-based flow restrictions proportional to the size of the water body (such as a requirement for streams and rivers allowing no more than five percent withdrawal of the mean annual flow);
- design and construction technologies to minimize impingement and entrainment and to maximize survival of impinged organisms;
- post-operational monitoring of impinged and entrained organisms;
- monitoring of the through-screen velocity; and
- periodic visual inspections of the intake structures.

10.1 WATER BODY TYPE OPTION

Under the first alternative regulatory option, EPA would establish requirements for minimizing adverse environmental impact (AEI) from cooling water intake structures (CWIS) based on the type of water body in which the intake structure is located, the location of the CWIS in the water body, the volume of water withdrawn, and the design intake velocity. EPA would establish additional requirements or measures for location, design, construction, or capacity that might be necessary for minimizing AEI. For intakes located in marine water bodies (i.e., estuaries, tidal rivers, oceans) and the Great Lakes, this option would require intake flow reduction commensurate with the level that can be achieved using a closed-cycle recirculating wet cooling system. For all other water body types, the only capacity requirements would be proportional flow reduction requirements. In all water bodies, velocity limits and a requirement to install design and construction technologies would apply.

This option would also include a requirement for all new facilities to complete a one-year baseline biological characterization study prior to submitting an application for a permit. This study would detail the potential design and construction technologies that would apply to all new facilities. EPA rejected this option primarily because the technology to reduce flow to a level commensurate with a closed-cycle recirculating wet cooling system is available and is economically practicable across all water body types.

Table 10-1 shows the estimated compliance costs of the Water Body Type Option. The present value of total compliance costs is estimated to be $450 million. The 83 electric generators account for $363 million of this total, and the 38 manufacturing facilities for $87 million. Total annualized cost for the 121 facilities is estimated to be $36 million. Of this, $29 million would be incurred by electric generators and $7 million by manufacturing facilities.

Table 10-1: National Costs of Compliance of Water Body Type Option

Industry Category (Number of Facilities Affected)	One-Time Costs		Recurring Costs				Total[a]
	Capital Technology	Initial Permit Application	O&M	Energy Penalty	Permit Renewal	Monitoring, Record Keeping & Reporting	
Total Compliance Costs (present value, in millions $2000)							
Electric Generators (83)	$62.3	$1.6	$80.2	$175.1	$1.0	$42.8	$363.0
Manufacturing Facilities (38)	$26.3	$0.8	$36.0	$0.0	$0.6	$23.7	$87.4
Total (121)[a]	**$88.6**	**$2.4**	**$116.2**	**$175.1**	**$1.6**	**$66.4**	**$450.3**
Annualized Compliance Costs (in millions $2000)							
Electric Generators (83)	$5.0	$0.1	$6.5	$14.1	$0.1	$3.4	$29.3
Manufacturing Facilities (38)	$2.1	$0.1	$2.9	$0.0	$0.0	$1.9	$7.0
Total (121)[a]	**$7.1**	**$0.2**	**$9.4**	**$14.1**	**$0.1**	**$5.4**	**$36.3**

[a] Individual numbers may not add up to total due to independent rounding.

Source: U.S. EPA, 2001a; U.S. EPA, 2001b; U.S. EPA analysis 2001.

10.2 Dry Cooling Option

The second alternative option considered by EPA would impose more stringent compliance requirements on the electric generating segment of the industry. It is based in whole or in part on a zero intake-flow (or nearly zero, extremely low-flow) requirement commensurate with levels achievable through the use of dry cooling systems. Dry cooling systems use either a natural or a mechanical air draft to transfer heat from condenser tubes to air. New manufacturing facilities would not be subject to these stricter requirements but would have to comply with the standards of the final rule.

This option would include very minor permitting requirements and require no baseline biological characterization study prior to submission of the application for a permit, due to the requirement of near-zero intake. However, it would carry high capital and operating and maintenance costs, and large energy penalty. While a dry cooling requirement may be appropriate in specific cases, EPA rejected this option as a national requirement because of the large per-facility costs.

Table 10-2 shows the estimated compliance costs under the Dry Cooling Option. The option is the most expensive of the regulatory alternatives considered by EPA. Under this option, the present value of total compliance costs is estimated to be approximately $6 billion. Total annualized cost for the 121 facilities is estimated to be $491 million. Manufacturing facilities would incur the same compliance costs as under the proposed rule, $13 million. The 83 electric generators, however, would face considerably higher costs with approximately $478 million annually, or $5.8 million per facility.

Table 10-2: National Costs of Compliance of Dry Cooling Option

Industry Category (Number of Facilities Affected)	One-Time Costs		Recurring Costs				Total[a]
	Capital Technology	Initial Permit Application	O&M	Energy Penalty	Permit Renewal	Monitoring, Record Keeping & Reporting	
Total Compliance Costs (present value, in millions $2000)							
Electric Generators (83)	$1,403.0	$0.2	$3,617.0	$907.4	$0.2	$0.0	$5,927.8
Manufacturing Facilities (38)	$47.2	$16.9	$71.5	$0.0	$1.8	$23.8	$161.1
Total (121)[a]	**$1,450.2**	**$17.1**	**$3,688.5**	**$907.4**	**$2.0**	**$23.8**	**$6,088.9**
Annualized Compliance Costs (in millions $2000)							
Electric Generators (83)	$113.1	$0.0	$291.5	$73.1	$0.0	$0.0	$477.7
Manufacturing Facilities (38)	$3.8	$1.4	$5.8	$0.0	$0.2	$1.9	$13.0
Total (121)[a]	**$116.9**	**$1.4**	**$297.2**	**$73.1**	**$0.2**	**$1.9**	**$490.7**

[a] Individual numbers may not add up to total due to independent rounding.

Source: U.S. EPA, 2001a; U.S. EPA, 2001b; U.S. EPA analysis 2001.

10.3 INDUSTRY TWO-TRACK OPTION

EPA also considered a two-track option as suggested by industry. A two-track option provides flexibility to the permittee in that the facility may choose to comply by meeting the specific technology-based performance requirements defined in the "fast track" (Track I), or by demonstrating the same level of performance as the Track I requirements under the "demonstration track" (Track II).

Under this regulatory option, a facility choosing Track I would install "highly protective" technologies in return for expedited permitting without the need for pre-operational or operational studies. Such fast-track technologies might include technologies that reduce intake flow to a level commensurate with a wet closed-cycle cooling system and that achieve an average approach velocity of no more than 0.5 ft/s, or any technologies that achieve a level of protection from impingement and entrainment within the expected range for a closed-cycle cooling system (with 0.5 ft/s approach velocity). This option was intended to allow facilities to use standard or new technologies that have been demonstrated to be effective for the species of concern, type of water body, and flow volume of the cooling water intake structure proposed for their use. Examples of candidate technologies include:

- wedgewire screens, where there is constant flow, as in rivers;
- traveling fine mesh screens with a fish return system designed to minimize impingement and entrainment; and
- aquatic filter barrier systems, at sites where they would not be rendered ineffective by high flows or fouling.

The operator of a proposed new facility would elect which set of technologies to install and validate its performance as necessary. In return, the permitting agency would not require additional section 316(b) protective measures for the life of the facility.

Track II would provide a facility that does not want to commit to any of the above technology options with an opportunity to demonstrate that site-specific characteristics, including the local biology, would justify another cooling water intake structure technology, such as once-through cooling. For these situations, the facility could demonstrate to the permitting agency, on the basis of site-specific studies, either that the proposed intake would not create an appreciable risk of AEI or, if it would create an appreciable risk of AEI, that the facility would install technology to "minimize" AEI.

EPA rejected the industry two-track approach because EPA prefers a more concrete and objective measure of BTA for minimizing AEI for the New Facility Rule than does the measure suggested by the industry.

Table 10-3 shows the estimated compliance costs under the Alternative Two-Track Option. Under this option, the present value of total compliance costs is estimated to be $309 million. The 83 electric generators account for $245 million of this total, and the 38 manufacturing facilities for $64 million. Total annualized cost for the 121 facilities is estimated to be $25 million. Of this, $20 million will be incurred by electric generators and $5 million by manufacturing facilities.

Table 10-3: National Costs of Compliance of Industry Two-Track Option

Industry Category (Number of Facilities Affected)	One-Time Costs		Recurring Costs				Total[a]
	Capital Technology	Initial Permit Application	O&M	Energy Penalty	Permit Renewal	Monitoring, Record Keeping & Reporting	
Total Compliance Costs (present value, in millions $2000)							
Electric Generators (83)	$27.1	$4.1	$31.4	$175.1	$1.3	$5.9	$244.8
Manufacturing Facilities (38)	$14.4	$9.0	$18.7	$0.0	$0.9	$20.7	$63.7
Total (121)[a]	**$41.5**	**$13.1**	**$50.1**	**$175.1**	**$2.2**	**$26.6**	**$308.5**
Annualized Compliance Costs (in millions $2000)							
Electric Generators (83)	$2.2	$0.3	$2.5	$14.1	$0.1	$0.5	$19.7
Manufacturing Facilities (38)	$1.2	$0.7	$1.5	$0.0	$0.1	$1.7	$5.1
Total (121)[a]	**$3.4**	**$1.1**	**$4.0**	**$14.1**	**$0.2**	**$2.1**	**$24.9**

[a] Individual numbers may not add up to total due to independent rounding.

Source: *U.S. EPA, 2001a; U.S. EPA, 2001b; U.S. EPA analysis 2001.*

10.4 Summary of Alternative Regulatory Options

Although the Agency considered numerous regulatory options during rule development, three primary regulatory options were evaluated in detail and costed. Two of the options would be less stringent and less expensive than the final rule; one option would be considerably more stringent and expensive. The final rule will cost facilities $48 million annually (see *Chapter 6: Facility Compliance Costs*). The least expensive option is the two-track option suggested by industry. This option would cost new electric generator and manufacturing facilities approximately $25 million annually but was rejected because the measure for minimizing AEI is not very concrete or certain. The other less expensive option is the water body type option which would require cooling towers for those facilities withdrawing from marine water bodies and the Great Lakes. This option would cost approximately $36 million annually but was rejected because the best technology available and economically practicable across all water body types is a closed-cycle recirculating wet cooling system. The dry cooling option is more stringent than the final rule. It is by far the most expensive option, costing approximately $491 million annually, and was rejected as a national requirement because of the high per-facility cost.

EPA selected the final rule because it meets the requirement of section 316(b) of the CWA that the location, design, construction, and capacity of CWIS reflect the BTA for minimizing AEI, and it is economically practicable.

Table 10-4 shows the annualized compliance costs for the electric generators and manufacturers associated with the final rule and the three other regulatory options discussed in this chapter. The options are presented in order of decreasing cost.

Table 10-4: National Costs of Compliance with Alternative Regulatory Options			
Regulatory Option	**Annualized Compliance Costs (in millions $2000)**		
	Electric Generators	**Manufacturing Facilities**	**Total**
Dry Cooling Option	$477.7	$13.0	$490.7
Final Rule	**$34.7**	**$13.0**	**$47.7**
Water Body Type Option	$29.3	$7.0	$36.3
Industry Two-Track Option	$19.7	$5.1	$24.9

[a] Individual numbers may not add up to total due to independent rounding.

Source: U.S. EPA analysis, 2001.

REFERENCES

U.S. Environmental Protection Agency (U.S. EPA). 2001a. *Information Collection Request for Cooling Water Intake Structures, New Facility Final Rule*. October 2001.

U.S. Environmental Protection Agency (U.S. EPA). 2001b. *Technical Development Document for the Final Regulations Addressing Cooling Water Intake Structures for New Facilities*. EPA-821-R-01-036. November 2001.

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Chapter 11: CWIS Impingement & Entrainment (I&E) Impacts & Potential Benefits

Introduction

This chapter presents data reported by existing facilities that indicate the magnitude of impingement and entrainment when once-through cooling is used. The data show that the numbers of organisms impinged and entrained under once-through cooling are nontrivial. EPA was unable to conduct a detailed, quantitative analysis of the potential economic benefits of using closed-cycle instead of once-through cooling because much of the information needed to quantify and value potential reductions in I&E was unavailable. At present, EPA has only general information about the location of potential new facilities, and in most cases details of facility and environmental characteristics are unknown. To overcome these limitations, this chapter presents examples of I&E rates and potential regulatory benefits based on a subset of existing facilities for which information was readily available. The focus is on fish species because very large numbers of fish are impinged and entrained compared to other aquatic organisms such as phytoplankton and benthic invertebrates.

The data presented are numbers of organisms that are directly impinged and entrained. While EPA recognizes that impingement and entrainment losses may result in indirect effects on populations and other higher levels of biological organization, this chapter focuses on impingement and entrainment because these are the direct biological impacts that result from withdrawal of cooling water by CWIS. The final section of the chapter presents information on the potential benefits of installing technologies to reduce impingement and entrainment. These benefits may be illustrative of the benefits that would occur at the estimated nine new facilities that would install the Track I flow reduction technology (closed-cycle cooling) as a result of this rule.

Chapter Contents:

The chapter

- summarizes factors related to intake location, design, and capacity that influence the magnitude of I&E;
- discusses CWIS I&E impacts for different water body types (rivers, lakes and reservoirs, the Great Lakes, oceans, and estuaries); and
- provides results from studies of existing facilities indicating the potential economic benefits of lower intake flows and other measures taken to reduce impingement and entrainment.

11.1 CWIS Characteristics that Influence the Magnitude of I&E

11.1.1 Intake Location

Two major components of a CWIS's location that influence the relative magnitude of I&E are (1) the type of water body from which a CWIS is withdrawing water, and (2) the placement of the CWIS relative to sensitive biological areas within the water body. EPA's regulatory framework is designed to take both of these factors into account.

Critical physical and chemical factors related to siting of an intake include the direction and rate of water body flow, tidal influences, currents, salinity, dissolved oxygen levels, thermal stratification, and the presence of pollutants. The withdrawal of water by an intake can change ambient flows, velocities, and currents within the source water body, which may cause organisms to concentrate in the vicinity of an intake or reduce their ability to escape a current.

In large rivers, withdrawal of water may have little effect on flows because of the strong, unidirectional nature of ambient currents. In contrast, lakes and reservoirs have small ambient flows and currents, and therefore a large intake flow can significantly alter current patterns. In addition, tidal currents in estuaries or tidally-influenced sections of rivers can carry organisms past intakes multiple times, thereby increasing their probability of entrainment.

Also, species with planktonic (free-floating) early life stages have higher rates of entrainment because they are unable to actively avoid being drawn into the intake flow.

Considerations in siting an intake to reduce the potential for I&E include intake depth and distance from the shoreline in relation to the physical, chemical, and biological characteristics of the source water body. In general, intakes located in nearshore areas (riparian or littoral zones) will have greater ecological impact than intakes located offshore, because nearshore areas are more biologically productive and have higher concentrations of organisms.

Siting of intake withdrawal in relation to the discharge site is also important because if intake withdrawal and discharge are in close proximity, entrained organisms released in the discharge can become re-entrained.

The magnitude of I&E in relation to intake location also depends on biological factors such as species' distributions and the presence of critical habitats within an intake's zone of influence.

11.1.2 Intake Design

Intake design refers to the design and configuration of various components of the intake structure, including screening systems (trash racks, pumps, pressure washes), passive intake systems, and fish diversion and avoidance technologies (U.S. EPA, 1976).

Design intake velocity has a significant influence on the potential for impingement (Boreman, 1977). The biological significance of design intake velocity depends on species-specific characteristics, such as fish swimming ability and endurance. These characteristics are a function of the size of the organism and the temperature and oxygen levels of water in the area of the intake (U.S. EPA, 1976). The maximum velocity protecting most small fish is 0.5 ft/s, but lower velocities will still impinge some fish and entrain eggs and larvae and other small organisms (Boreman, 1977). After entering the CWIS, water must pass through a screening device before entering the power plant. The screen is designed to prevent debris from entering and clogging the condenser tubes. Screen mesh size and velocity characteristics are two important design features of the screening system that influence the potential for impingement and entrainment of aquatic organisms that are withdrawn with the cooling water (U.S. EPA, 1976).

Conventional traveling screens have been modified to improve fish survival of screen impingement and spray wash removal (Taft, 1999). However, a review of steam electric utilities indicated that these alternative screen technologies are usually not much more effective at reducing impingement than the conventional vertical traveling screens used by most steam electric facilities (SAIC, 1994). An exception may be traveling screens modified with fish collection systems (e.g., Ristroph screens). Studies of improved fish collection baskets at Salem Generating Station showed increased survival of impinged fish (Ronafalvy et al., 1999).

Passive intake systems (physical exclusion devices) screen out debris and aquatic organisms with minimal mechanical activity and low withdrawal velocities (Taft, 1999). The most effective passive intake systems are wedge-wire screens and radial wells (SAIC, 1994). A new technology, the Gunderboom, which consists of polyester fiber strands pressed into a water-permeable fabric mat, has shown promise in reducing ichthyoplankton entrainment at the Lovett Generating Station on the Hudson River (Taft, 1999).

Fish diversion/avoidance systems (behavioral barriers) take advantage of natural behavioral characteristics of fish to guide them away from an intake structure or into a bypass system (SAIC, 1994; Taft, 1999). The most effective of these technologies are velocity caps, which divert fish away from intakes, and underwater strobe lights, which repel some species (Taft, 1999). Velocity caps are used mostly at offshore facilities and have proven effective in reducing impingement (e.g., California's San Onofre Nuclear Generating Station, SONGS).

Another important design consideration is the orientation of the intake in relation to the source water body (U.S. EPA, 1976). Conventional intake designs include shoreline, offshore, and approach channel intakes. In addition, intake operation can be modified to reduce the quantity of source water withdrawn or the timing, duration, and frequency of water withdrawal. This is an important way to reduce entrainment. For example, larval entrainment at the San Onofre facility was reduced by 50% by rescheduling the timing of high volume water withdrawals (SAIC, 1996).

11.1.3 Intake Capacity

Intake capacity is a measure of the volume or quantity of water withdrawn or flowing through a cooling water intake structure over a specified period of time. Intake capacity can be expressed as millions or billions of gallons per day (MGD or BGD), or as cubic feet per second (cfs). Capacity can be measured for the facility as a whole, for all of the intakes used by a single unit, or for the intake structure alone. In defining an intake's capacity it is important to distinguish between the *design* intake flow (the maximum possible) and the *actual* operational intake flow. For this regulation, EPA is regulating the total design intake flow of the facility.

The quantity of cooling water needed and the type of cooling system are the most important factors determining the quantity of intake flow (U.S. EPA, 1976). Once-through cooling systems withdraw water from a natural water body, circulate the water through condensers, and then discharge it back to the source water body. Closed-cycle cooling systems withdraw water from a natural water body, circulate the water through the condensers, and then send it to a cooling tower or cooling pond before recirculating it back through the condensers. Because cooling water is recirculated, closed-cycle systems generally use only 3.4% to 28.8% of the water used by once-through systems[1] (Kaplan, 2000). It is generally assumed that this will result in a comparable reduction in I&E (Goodyear, 1977). Systems with helper towers reduce water usage much less. Plants with helper towers can operate in once-through or closed-cycle modes.

Circulating water intakes are used by once-through cooling systems to continuously withdraw water from the cooling water source. The typical circulating water intake is designed to use 0.03-0.1 m^3/s (1.06-3.53 cfs, or 500-1500 gallons per minute, gpm) per megawatt (MW) of electricity generated (U.S. EPA, 1976). Closed-cycle systems use makeup water intakes to provide water lost by evaporation, blowdown, and drift. Although makeup quantities are only a fraction of the intake flows of once-through systems, quantities of water withdrawn can still be significant, especially by large facilities (U.S. EPA, 1976).

Assuming that organisms are uniformly distributed in the vicinity of an intake, the proportion of the source water flow

[1] The difference in water usage in cooling towers results from differences in source water (salinity) and the temperature rise of the system.

supplied to a CWIS is often used to derive a conservative estimate of the potential for adverse impact (e.g., Goodyear, 1977). For example, withdrawal of 5% of the source water flow may be expected to result in a loss of 5% of planktonic organisms. Although the assumption of uniform distribution may not always be met, when data on actual distributions are unavailable, simple mathematical models based on this assumption provide a conservative and easily applied method for predicting potential losses (Goodyear, 1977).

In addition to the relative quantity of intake flow, the potential for aquatic organisms to be impinged or entrained also depends on physical, chemical, and biological characteristics of the surrounding ecosystem and species characteristics that influence the intensity, time, and spatial extent of contact of aquatic organisms with a facility's CWIS. Table 11-1 lists CWIS characteristics and ecosystem characteristics that influence when, how, and why aquatic organisms may become exposed to, and experience adverse effects of, CWIS.

Table 11-1: Partial List of CWIS, Ecosystem, and Species Characteristics Influencing Potential for I&E

CWIS Characteristics[a]	Ecosystem and Species Characteristics

Location
‣ Depth of intake
‣ Distance from shoreline
‣ Proximity of intake withdrawal and discharge
‣ Proximity to other industrial discharges or water withdrawals
‣ Proximity to an area of biological concern
 	
Design
‣ Type of intake structure (size, shape, configuration, orientation)
‣ Design intake velocity
‣ Presence/absence of intake control and fish protection technologies
  ‣ Intake Screen Systems
  ‣ Passive Intake Systems
  ‣ Fish Diversion/Avoidance Systems
‣ Water temperature in cooling system
‣ Temperature change during entrainment
‣ Duration of entrainment
‣ Use of intake biocides and ice removal technologies
‣ Scheduling of timing, duration, frequency, and quantity of water withdrawal.
 	
Capacity
‣ Type of withdrawal — once-through vs. recycled (cooling water volume and volume per unit time)
‣ Ratio of cooling water intake flow to source water flow
	Ecosystem Characteristics (abiotic environment)
	‣ Source water body type
	‣ Water temperatures
	‣ Ambient light conditions
	‣ Salinity levels
	‣ Dissolved oxygen levels
	‣ Tides/currents
	‣ Direction and rate of ambient flows
	
	Species Characteristics (physiology, behavior, life history)
	‣ Density in zone of influence of CWIS
	‣ Spatial and temporal distributions (e.g., daily, seasonal, annual migrations)
	‣ Habitat preferences (e.g., depth, substrate)
	‣ Ability to detect and avoid intake currents
	‣ Swimming speeds
	‣ Mobility
	‣ Body size
	‣ Age/developmental stage
	‣ Physiological tolerances (e.g., temperature, salinity, dissolved oxygen)
	‣ Feeding habits
	‣ Reproductive strategy
	‣ Mode of egg and larval dispersal
	‣ Generation time

[a] All of these CWIS characteristics can potentially be controlled to minimize adverse environmental impacts (I&E) of new facilities.

If the quantity of water withdrawn is large relative to the flow of the source water body, a larger number of organisms will potentially be affected by a facility's CWIS.

11.2 Methods for Estimating Potential I&E Losses

11.2.1 Development of a Database of I&E Rates

To estimate the relative magnitude of I&E for different species and water body types, EPA compiled I&E data from 107 documents representing a variety of sources, including previous section 316(b) studies, critical reviews of section 316(b) studies, biomonitoring and aquatic ecology studies, and technology implementation studies. In total, data were compiled for 98 steam electric facilities (36 riverine facilities, 9 lake/reservoir facilities, 19 facilities on the Great Lakes, 22 estuarine facilities, and 12 ocean facilities). Design intake flows at these facilities ranged from a low of 19.7 to a high of 3,315.6

MGD.

EPA notes that most of these studies were completed by the facilities in the mid-1970s using methods that are now outmoded. A number of the methods used at that time probably resulted in an underestimate of losses. For example, many studies did not adjust I&E sampling data for factors such as collection efficiency. Because of such methodological weaknesses, EPA used these only to gauge the relative magnitude of impingement and entrainment losses. Any further analysis of the data should be accompanied by a detailed evaluation of study methods and supplemented with additional data as needed.

In order to understand the potential magnitude of I&E, EPA aggregated the data in the studies in a series of steps to derive average annual impingement and entrainment rates, on a per facility basis, for different species and water body types.

First, the data for each species were summed across all units of a facility and averaged across years (e.g., 1972 to 1976). Losses were then averaged by species for all facilities in the database on a given water body type to derive species-specific and water body-specific mean annual I&E rates. Finally, mean annual I&E rates were ranked, and rates for the top 15 species were used for the data presented below.

11.2.2 Data Uncertainties and Potential Biases

A number of uncertainties and potential biases are associated with the annual I&E estimates that EPA developed. Most important, natural environmental variability makes it difficult to detect ecological impacts and identify cause-effect relationships even in cases where study methods are as accurate and reliable as possible. For example, I&E rates for any given population will vary with annual changes in environmental conditions. As a result, it can be difficult to determine the relative role of I&E mortality in population fluctuations.

In addition to the influence of natural variability, data uncertainties result from measurement errors, some of which are unavoidable. Much of the data presented here does not account for the inefficiency of sampling gear, variations in collection and analytical methods, or changes in the number of units in operation or technologies in use.

Potential biases were also difficult to control. For example, many studies presented data for only a subset of "representative" species, which may lead to an underestimation of total I&E. On the other hand, the entrainment estimates obtained from EPA's database do not take into account the high natural mortality of egg and larval stages and therefore are likely to be biased upwards. However, this bias was unavoidable because most of the source documents from which the database was derived did not estimate losses of early life stages as an equivalent number of adults, or provide information for making such calculations.[2] In the absence of information for adjusting egg losses on this basis, EPA chose to include eggs and larvae in the entrainment estimates to avoid underestimating age 0 losses.

With these caveats in mind, the following sections present the results of EPA's data compilations. The data are grouped by water body type and are presented in summary tables that indicate the range of losses for the 15 species with the highest I&E rates based on the limited subset of data available to EPA. I&E losses are expressed as mean annual numbers on a per facility basis. Because the data do not represent a random sample of I&E losses, it was not appropriate to summarize the data statistically. It is also important to stress that because the data are not a statistical sample, the data presented here may not represent the true magnitude of losses. Thus, the data should be viewed only as general indicators of the potential range of I&E.

11.3 CWIS Impingement and Entrainment Impacts in Rivers

Freshwater rivers and streams are free-flowing bodies of water that do not receive significant inflows of water from oceans or bays. Current is typically highest in the center of a river and rapidly drops toward the edges and at depth because of increased friction with river banks and the bottom (Hynes, 1970; Allan, 1995). Close to and at the bottom, the current can become minimal. The range of flow conditions in undammed rivers helps explain why fish with very different habitat requirements can co-exist within the same stretch of surface water (Matthews, 1998).

[2] For species for which sufficient life history information is available, the Equivalent Adult Model (EAM) can be used to predict the number of individuals that would have survived to adulthood each year if entrainment at egg or larval stages had not occurred (Horst, 1975; Goodyear, C.P., 1978). The resulting estimate is known as the number of "equivalent adults."

In general, the shoreline areas along river banks support a high diversity of aquatic life. These are areas where light penetrates to the bottom and supports the growth of rooted vegetation. Suspended solids tend to settle along shorelines where the current slows, creating shallow, weedy areas that attract aquatic life. Riparian vegetation, if present, also provides cover and shade. Such areas represent important feeding, resting, spawning, and nursery habitats for many aquatic species. In temperate regions, the number of impingeable and entrainable organisms in the littoral zone of rivers increases during the spring and early summer when most riverine fish species reproduce. This concentration of aquatic organisms along river shorelines in turn attracts wading birds and other kinds of wildlife.

The data compiled by EPA indicate that fish species such as common carp (*Cyprinus carpio*), yellow perch (*Perca flavescens*), white bass (*Morone chrysops*), freshwater drum (*Aplodinotus grunniens)*, gizzard shad (*Dorosoma cepedianum*), and alewife are the main fishes harmed by CWIS located in rivers. Table 11-2 shows, in order of the greatest to least impact, the annual entrainment of eggs, larvae, and juvenile fish in rivers. Table 11-3 shows, in order of greatest to least impact, the annual impingement in the rivers for all age classes. These species occur in nearshore areas and/or have pelagic early life stages, traits that greatly increase their susceptibility to I&E.

Table 11-2: Annual Entrainment of Eggs, Larvae, and Juvenile Fish in Rivers

Common Name	Scientific Name	Number of Facilities	Mean Annual Entrainment per Facility (fish/year)	Range
common carp	*Cyprinus carpio*	7	20,500,000	859,000 - 79,400,000
yellow perch	*Perca flavescens*	4	13,100,000	434,000 - 50,400,000
white bass	*Morone chrysops*	4	12,800,000	69,400 - 49,600,000
freshwater drum	*Aplodinotus grunniens*	5	12,800,000	38,200 - 40,500,000
gizzard shad	*Dorosoma cepedianum*	4	7,680,000	45,800 - 24,700,000
shiner	*Notropis* spp.	4	3,540,000	191,000 - 13,000,000
channel catfish	*Ictalurus punctatus*	5	3,110,000	19,100 - 14,900,000
bluntnose minnow	*Pimephales notatus*	1	2,050,000	---
black bass	*Micropterus* spp.	1	1,900,000	---
rainbow smelt	*Osmerus mordax*	1	1,330,000	---
minnow	*Pimephales* spp.	1	1,040,000	---
sunfish	*Lepomis* spp.	5	976,000	4,230 - 4,660,000
emerald shiner	*Notropis atherinoides*	3	722,000	166,000 - 1,480,000
white sucker	*Catostomus commersoni*	5	704,000	20,700 - 2,860,000
mimic shiner	*Notropis volucellus*	2	406,000	30,100 - 781,000

Source: Hicks, 1977; Cole, 1978; Geo-Marine Inc., 1978; Goodyear, C.D., 1978; Potter, 1978; Cincinnati Gas & Electric Company, 1979; Potter et al., 1979a, 1979b, 1979c, 1997d; Cherry and Currie, 1998; Lewis and Seegert, 1998.

Table 11-3: Annual Impingement in the Rivers for All Age Classes Combined				
Common Name	**Scientific Name**	**Number of Facilities**	**Mean Annual Impingement per Facility (fish/year)**	**Range**
threadfin shad	*Dorosoma petenense*	3	1,030,000	199 - 3,050,000
gizzard shad	*Dorosoma cepedianum*	25	248,000	3,080 - 1,480,000
shiner	*Notropis* spp.	4	121,000	28 - 486,000
alewife	*Alosa pseudoharengus*	13	73,200	199 - 237,000
white perch	*Morone americana*	3	66,400	27,100 - 112,000
yellow perch	*Perca flavescens*	18	40,600	13 - 374,000
spottail shiner	*Notropis hudsonius*	10	28,500	10 - 117,000
freshwater drum	*Aplodinotus grunniens*	24	19,900	8 - 176,000
rainbow smelt	*Osmerus mordax*	11	19,700	7 - 119,000
skipjack herring	*Alosa chrysochons*	7	17,900	52 - 89,000
white bass	*Morone chrysops*	19	11,500	21 - 188,000
trout perch	*Percopsis omiscomaycus*	13	9,100	38 - 49,800
emerald shiner	*Notropis atherinoides*	17	7,600	109 - 36,100
blue catfish	*Ictalurus furcatus*	2	5,370	42 - 10,700
channel catfish	*Ictalurus punctatus*	23	3,130	3 - 25,600

Source: Benda and Houtcooper, 1977; Freeman and Sharma, 1977; Hicks, 1977; Sharma and Freeman, 1977; Stupka and Sharma, 1977; Energy Impacts Associates Inc., 1978; Geo-Marine Inc., 1978; Goodyear, C.D., 1978; Potter, 1978; Cincinnati Gas & Electric Company, 1979; Potter et al., 1979a, 1979b, 1979c, 1979d; Van Winkle et al., 1980; EA Science and Technology, 1987; Cherry and Currie, 1998; Michaud, 1998; Lohner, 1998.

11.4 CWIS Impingement and Entrainment Impacts in Lakes and Reservoirs

Lakes are inland bodies of open water located in natural depressions (Goldman and Horne, 1983). Lakes are fed by rivers, streams, springs, and/or local precipitation. Water currents in lakes are small or negligible compared to rivers, and are most noticeable near lake inlets and outlets.

Larger lakes are divided into three general zones — the littoral zone (shoreline areas where light penetrates to the bottom), the limnetic zone (the surface layer where most photosynthesis takes place), and the profundal zone (relatively deeper and colder offshore area) (Goldman and Horne, 1983). Each zone differs in its biological productivity and species diversity and hence in the potential magnitude of CWIS I&E impacts. The importance of these zones in relation to potential impacts of CWIS are discussed below.

The highly productive littoral zone extends farther and deeper in clear lakes than in turbid lakes. In small, shallow lakes, the littoral zone can be quite extensive and even include the entire water body. As along river banks, this zone supports high primary productivity and biological diversity. It is used by a host of fish species, benthic invertebrates, and zooplankton for feeding, resting, and reproduction, and as nursery habitat. Many fish species adapted to living in the colder profundal zone also move to shallower in-shore areas to spawn, e.g., lake trout (*Salmo namycush*) and various deep water sculpin species (*Cottus* spp.).

Many fish species spend most of their early development in and around the littoral zone of lakes. These shallow waters warm up rapidly in spring and summer, offer a variety of different habitats (submerged plants, boulders, logs, etc.) in which to hide or feed, and stay well-oxygenated throughout the year. Typically, the littoral zone is a major contributor to the total primary productivity of lakes (Goldman and Horne, 1983).

The limnetic zone accounts for the vast majority of light that is absorbed by the water column. In contrast to the high biological activity observed in the nearshore littoral zone, the offshore limnetic zone supports fewer species of fish and invertebrates. However, during certain times of year, some fish and invertebrate species spend the daylight hours hiding on the bottom and rise to the surface of the limnetic zone at night to feed and reproduce. Adult fish may migrate through the limnetic zone during seasonal spawning migrations. The juvenile stages of numerous aquatic insects — such as caddisflies, stoneflies, mayflies, dragonflies, and damselflies — develop in sediments at the bottom of lakes but move through the limnetic zone to reach the surface and fly away. This activity attracts foraging fish.

The deeper, colder profundal zone of a lake does not support rooted plants because insufficient light penetrates at these depths. For the same reason, primary productivity by phytoplankton is minimal. However, a well-oxygenated profundal zone can support a variety of benthic invertebrates or cold-water fish, e.g., brown trout (*Salmo trutta*), lake trout, and ciscoes (*Coregonus* spp.). With few exceptions (such as cisces or whitefish), these species seek out shallower areas to spawn, either in littoral areas or in adjacent rivers and streams, where they may become susceptible to CWIS.

Most of the larger rivers in the United States have one or more dams that create artificial lakes or reservoirs. Reservoirs have some characteristics that mimic those of natural lakes, but large reservoirs differ from most lakes in that they obtain most of their water from a large river instead of from groundwater recharge or from smaller creeks and streams.

The fish species composition in reservoirs may or may not reflect the native assemblages found in the pre-dammed river. Dams create two significant changes to the local aquatic ecosystem that can alter the original species composition: (1) blockages that prevent anadromous species from migrating upstream, and (2) altered riverine habitat that can eliminate species that cannot readily adapt to the modified hydrologic conditions.

Reservoirs typically support littoral zones, limnetic zones, and profundal zones, and the same concepts outlined above for lakes apply to these bodies of water. For example, compared to the profundal zone, the littoral zone along the edges of reservoirs supports greater biological diversity and provides prime habitat for spawning, feeding, resting, and protection for numerous fish and zooplankton species. However, there are also several differences. Reservoirs often lack extensive shallow areas along their edges because their banks have been engineered or raised to contain extra water and prevent flooding. In mountainous areas, the banks of reservoirs may be quite steep and drop off precipitously with little or no littoral zone. As with lakes and rivers, however, CWIS located in shallower water have a higher probability of entraining or impinging organisms.

Results of EPA's data compilation indicate that fish species most commonly affected by CWIS located on lakes and reservoirs are the same as the riverine species that are most susceptible, including alewife (*Alosa pseudoharengus*), drum (*Aplondinotus* spp.), and gizzard shad (*Dorsoma cepedianum*) (Tables 11-4 and 11-5).

Table 11-4: Annual Entrainment of Eggs, Larvae, and Juvenile Fish in Reservoirs and Lakes (excluding the Great Lakes)

Common Name	Scientific Name	Number of Facilities	Mean Annual Entrainment per Facility (fish/year)
drum	*Aplondinotus* spp.	1	15,600,000
sunfish	*Lepomis* spp.	1	10,600,000
gizzard shad	*Dorosoma cepedianum*	1	9,550,000
crappie	*Pomoxis* spp.	1	8,500,000
alewife	*Alosa pseudoharengus*	1	1,730,000

Source: Michaud, 1998; Spicer et al., 1998.

Table 11-5: Annual Impingement in Reservoirs and Lakes (excluding the Great Lakes) for All Age Classes Combined

Common Name	Scientific Name	Number of Facilities	Mean Annual Impingement per Facility (fish/year)	Range
threadfin shad	*Dorosoma petenense*	4	678,000	203,000 - 1,370,000
alewife	*Alosa pseudoharengus*	4	201,000	33,100 - 514,000
skipjack herring	*Alosa chrysochons*	1	115,000	---
bluegill	*Lepomis macrochirus*	6	48,600	468 - 277,000
gizzard shad	*Dorosoma cepedianum*	5	41,100	829 - 80,700
warmouth sunfish	*Lepomis gulosus*	4	39,400	31 - 157,000
yellow perch	*Perca flavescens*	2	38,900	502 - 114,000
freshwater drum	*Aplodinotus grunniens*	4	37,500	8 - 150,000
silver chub	*Hybopsis storeriana*	1	18,200	---
black bullhead	*Ictalurus melas*	3	10,300	171 - 30,300
trout perch	*Percopsis omiscomaycus*	2	8,750	691 - 16,800
northern pike	*Esox lucius*	2	7,180	154 - 14,200
blue catfish	*Ictalurus furcatus*	1	3,350	---
paddlefish	*Polyodon spathula*	2	3,160	1,940 - 4,380
inland (tidewater) silverside	*Menidia beryllina*	1	3,100	---

Source: *Tennessee Division of Forestry, Fisheries, and Wildlife Development, 1976; Tennessee Valley Authority, 1976; Benda and Houtcooper, 1977; Freeman and Sharma, 1977; Sharma and Freeman, 1977; Tennessee Valley Authority, 1977; Spicer et al., 1998; Michaud, 1998.*

11.5 CWIS Impingement and Entrainment Impacts in the Great Lakes

The Great Lakes were carved out by glaciers during the last ice age (Bailey and Smith, 1981). They contain nearly 20% of the earth's fresh water, or about 23,000 km^3 (5,500 cu. mi.) of water, covering a total area of 244,000 km^2 (94,000 sq. mi.). There are five Great Lakes: Lake Superior, Lake Michigan, Lake Huron, Lake Erie, and Lake Ontario. Although part of a single system, each lake has distinct characteristics. Lake Superior is the largest by volume, with a retention time of 191 years, followed by Lake Michigan, Lake Huron, Lake Erie, and Lake Ontario.

Water temperatures in the Great Lakes strongly influence the physiological processes of aquatic organisms, affecting growth, reproduction, survival, and species temporal and spatial distribution. During the spring, many fish species inhabit shallow, warmer waters where temperatures are closer to their thermal optimum. As water temperatures increase, these species migrate to deeper water. For species that are near the northern limit of their range, the availability of shallow, sheltered habitats that warm early in the spring is probably essential for survival (Lane et al., 1996a). For other species, using warmer littoral areas increases the growing season and may significantly increase production.

Some 80% of Great Lakes fish use the littoral zone for at least part of the year (Lane et al., 1996a). Of 139 Great Lakes fish species reviewed by Lane et al. (1996b), all but the deepwater ciscoes (*Coregonus* spp.) and deepwater sculpin (*Myxocephalus thompsoni*) use waters less than 10 m deep as nursery habitat.

A large number of thermal-electric plants located on the Great Lakes draw their cooling water from the littoral zone, resulting in high I&E of several fish species of commercial, recreational, and ecological importance, including alewife, gizzard shad, yellow perch, rainbow smelt, and lake trout (Tables 11-6 to 11-9).

Table 11-6: Annual Entrainment of Eggs, Larvae, and Juvenile Fish in the Great Lakes

Common Name	Scientific Name	Number of Facilities	Mean Annual Entrainment per Facility (fish/year)	Range
alewife	*Alosa pseudoharengus*	5	526,000,000	3,930,000 - 1,360,000,000
rainbow smelt	*Osmerus mordax*	5	90,500,000	424,000 - 438,000,000
lake trout	*Salmo namaycush*	1	116,000	---

Source: Texas Instruments Inc., 1978; Michaud, 1998.

Table 11-7: Annual Entrainment of Larval Fish in the Great Lakes by Lake

Lake	Number of Facilities	Total Annual Entrainment (fish/year)
Erie	16	255,348,164
Michigan	25	196,307,405
Ontario	11	176,285,758
Huron	6	81,462,440
Superior	14	4,256,707

Source: Kelso and Milburn, 1979.

Table 11-8: Annual Impingement of Fish in the Great Lakes for All Age Classes Combined

Common Name	Scientific Name	Number of Facilities	Mean Annual Impingement per Facility (fish/year)	Range
alewife	*Alosa pseudoharengus*	15	1,470,000	355 - 5,740,000
gizzard shad	*Dorosoma cepedianum*	6	185,000	25 - 946,000
rainbow smelt	*Osmerus mordax*	15	118,000	78 - 549,000
threespine stickleback	*Gasterosteus aculeatus*	3	60,600	23,200 - 86,200
yellow perch	*Perca flavescens*	9	29,900	58 - 127,000
spottail shiner	*Notropis hudsonius*	8	22,100	5 - 62,000
freshwater drum	*Aplodinotus grunniens*	4	18,700	2 - 74,800
emerald shiner	*Notropis atherinoides*	4	7,250	3 - 28,600
trout perch	*Percopsis omiscomaycus*	5	5,630	30 - 23,900
bloater	*Coregonus hoyi*	2	4,980	3,620 - 6,340
white bass	*Morone chrysops*	1	4,820	--
slimy sculpin	*Cottus cognatus*	4	3,330	795 - 5,800
goldfish	*Carassius auratus*	3	2,620	4 - 7,690
mottled sculpin	*Cottus bairdi*	3	1,970	625 - 3,450
common carp	*Cyprinus carpio*	4	1,110	16 - 4,180
pumpkinseed	*Lepomis gibbosus*	4	1,060	14 - 3,920

Source: Benda and Houtcooper, 1977; Sharma and Freeman, 1977; Texas Instruments Inc., 1978; Thurber and Jude, 1985; Lawler Matusky & Skelly Engineers, 1993a; Michaud, 1998.

Table 11-9: Annual Impingement of Fish in the Great Lakes by Lake

Lake	Number of Facilities	Total Annual Impingement (fish/year)
Erie	16	22,961,915
Michigan	25	15,377,339
Ontario	11	14,483,271
Huron	6	7,096,053
Superior	14	243,683

Source: Kelso and Milburn, 1979.

The I&E estimates of Kelso and Milburn (1979) presented in Tables 11-7 and 11-9 were derived using methods that differed in a number of ways from EPA's estimation methods, and therefore the data are not strictly comparable. First, the Kelso and Milburn (1979) data represent total annual losses per lake, whereas EPA's estimates are on a per facility basis. In addition, the estimates of Kelso and Milburn (1979) are based on extrapolation of losses to facilities for which data were unavailable using regression equations relating losses to plant size.

Despite the differences in estimation methods, when converted to an annual average per facility, the impingement estimates of Kelso and Milburn (1979) are within the range of EPA's estimates. For example, the average annual impingement of 675,980 fish per facility based on Kelso and Milburn's (1979) data is comparable to EPA's high estimate of 1,470,000 for alewife.

On the other hand, EPA's entrainment estimates include eggs and larvae and are therefore substantially larger than those of Kelso and Milburn (1979), which result from converting eggs and larvae to an equivalent number of fish. Because of the high natural mortality of fish eggs and larvae, entrainment losses expressed as the number that would have survived to become fish are much smaller than the original number of eggs and larvae entrained (Horst, 1975; Goodyear, 1978). Viewed together, the two types of estimates give an indication of the possible upper and lower bounds of annual entrainment per facility (e.g., an annual average of 8,018,657 fish based on Kelso and Milburn's data compared to EPA's highest estimate of 526,000,000 organisms based on the average for alewife).

11.6 CWIS Impingement and Entrainment Impacts in Estuaries

Estuaries are semi-enclosed bodies of water that have an unimpaired natural connection with the open ocean and within which sea water is diluted with fresh water derived from land. Estuaries are created and sustained by dynamic interactions among oceanic and freshwater environments, resulting in a rich array of habitats used by both terrestrial and aquatic species (Day et al., 1989). Because of the high biological productivity and sensitivity of estuaries, adverse environmental impacts are more likely to occur at CWIS located in estuaries than in other water body types.

Numerous commercially, recreationally, and ecologically important fish and shellfish species spend part or all of their life cycle within estuaries. Marine fish that spawn offshore take advantage of prevailing inshore currents to transport their eggs, larvae, or juveniles into estuaries where they hatch or mature. Inshore areas along the edges of estuaries support high rates of primary productivity and are used by numerous aquatic species for feeding and as nursery habitats. This high level of biological activity makes these shallow littoral zone habitats highly susceptible to I&E impacts from CWIS.

Estuarine species that show the highest rates of I&E in the studies reviewed by EPA include bay anchovy (*Anchoa mitchilli*), tautog (*Tautoga onitis*), Atlantic menhaden (*Brevoortia tyrannus*), gulf menhaden (*Brevoortia patronus*), winter flounder (*Pleuronectes americanus*), and weakfish (*Cynoscion regalis*) (Tables 11-10 and 11-11).

During spring, summer, and fall, various life stages of these and other estuarine fish show considerable migratory activity. Adults move in from the ocean to spawn in the marine, brackish, or freshwater portions of estuaries or their associated rivers; the eggs and larvae can be planktonic and move about with prevailing currents or by using selective tidal transport; juveniles actively move upstream or downstream in search of optimal nursery habitat; and young adult anadromous fish move out into the ocean to reach sexual maturity. Because of the many complex movements of estuarine-dependent species, a CWIS located almost anywhere in an estuary can harm both resident and migratory species as well as related freshwater, estuarine, and marine food webs.

Table 11-10: Annual Entrainment of Eggs, Larvae, and Juvenile Fish in Estuaries

Common Name	Scientific Name	Number of Facilities	Mean Annual Entrainment per Facility (fish/year)	Range
bay anchovy	*Anchoa mitchilli*	2	18,300,000,000	12,300,000,000 - 24,400,000,000
tautog	*Tautoga onitis*	1	6,100,000,000	---
Atlantic menhaden	*Brevoortia tyrannus*	2	3,160,000,000	50,400,000 - 6,260,000,000
winter flounder	*Pleuronectes americanus*	1	952,000,000	---
weakfish	*Cynoscion regalis*	2	339,000,000	99,100,000 - 579,000,000
hogchoker	*Trinectes maculatus*	1	241,000,000	---
Atlantic croaker	*Micropogonias undulatus*	1	48,500,000	---
striped bass	*Morone saxatilis*	4	19,200,000	111,000 - 74,800,000
white perch	*Morone americana*	4	16,600,000	87,700 - 65,700,000
spot	*Leiostomus xanthurus*	1	11,400,000	---
blueback herring	*Alosa aestivalis*	1	10,200,000	---
alewife	*Alosa pseudoharengus*	1	2,580,000	---
Atlantic tomcod	*Microgadus tomcod*	3	2,380,000	2,070 - 7,030,000
American shad	*Alosa sapidissima*	1	1,810,000	---

Source: U.S. EPA, 1982; Lawler Matusky & Skelly Engineers, 1983; DeHart, 1994; PSE&G, 1999.

Table 11-11: Annual Impingement in Estuaries for All Age Classes Combined

Common Name	Scientific Name	Number of Facilities	Mean Annual Impingement per Facility (fish/year)	Range
gulf menhaden	*Brevoortia patronus*	2	76,000,000	2,990,000 - 149,000,000
smooth flounder	*Liopsetta putnami*	1	3,320,000	--
threespine stickleback	*Gasterosteus aculeatus*	4	866,000	123 - 3,460,000
Atlantic menhaden	*Brevoortia tyrannus*	12	628,000	114 - 4,610,000
rainbow smelt	*Osmerus mordax*	4	510,000	737 - 2,000,000
bay anchovy	*Anchoa mitchilli*	9	450,000	1,700 - 2,750,000
weakfish	*Cynoscion regalis*	4	320,000	357 - 1,210,000
Atlantic croaker	*Micropogonias undulatus*	8	311,000	13 - 1,500,000
spot	*Leiostomus xanthurus*	10	270,000	176 - 647,000
blueback herring	*Alosa aestivalis*	7	205,000	1,170 - 962,000
white perch	*Morone americana*	14	200,000	287 - 1,380,000
threadfin shad	*Dorosoma petenense*	1	185,000	---
lake trout	*Salmo namaycush*	1	162,000	---
gizzard shad	*Dorosoma cepedianum*	6	125,000	2,058 - 715,000
silvery minnow	*Hybognathus nuchalis*	1	73,400	---

Source: Consolidated Edison Company of New York Inc., 1975; Lawler Matusky & Skelly Engineers, 1975, 1976; Stupka and Sharma, 1977; Lawler et al., 1980; Texas Instruments Inc., 1980; Van Winkle et al., 1980; Consolidated Edison Company of New York Inc. and New York Power Authority, 1983; Normandeau Associates Inc., 1984; EA Science and Technology, 1987; Lawler Matusky & Skelly Engineers, 1991; Richkus and McLean, 1998; PSE&G, 1999; New York State Department of Environmental Conservation, No Date.

11.7 CWIS Impingement and Entrainment Impacts in Oceans

Oceans are marine open coastal waters with salinity greater than or equal to 30 parts per thousand (Ross, 1995). CWIS in oceans are usually located over the continental shelf, a shallow shelf that slopes gently out from the coastline an average of 74 km (46 miles) to where the sea floor reaches a maximum depth of 200 m (660 ft) (Ross, 1995). The deep ocean extends beyond this region. The area over the continental shelf is known as the Neritic Province and the area over the deep ocean is the Oceanic Province (Meadows and Campbell, 1978).

Vertically, the upper, sunlit epipelagic zone over the continental shelf averages about 100 m in depth (Meadows and Campbell, 1978). This zone has pronounced light and temperature gradients that vary seasonally and influence the temporal and spatial distribution of marine organisms.

In oceans, the littoral zone encompasses the photic zone of the area over the continental shelf. As in other water body types, the littoral zone is where most marine organisms concentrate. The littoral zone of oceans is of particular concern in the context of section 316(b) because this biologically productive zone is also where most coastal utilities withdraw cooling water.

The morphology of the continental shelf along the U.S. coastline is quite varied (NRC, 1993). Along the Pacific coast of the United States the continental shelf is relatively narrow, ranging from 5 to 20 km (3 to 12 miles), and is cut by several steep-sided submarine canyons. As a result, the littoral zone along this coast tends to be narrow, shallow, and steep. In contrast, along most of the Atlantic coast of the United States, there is a wide, thick, and wedge-shaped shelf that extends as much as 250 km (155 miles) from shore, with the greatest widths generally opposite large rivers. Along the Gulf coast, the shelf ranges from 20 to 50 km (12 to 31 miles).

The potential for I&E in coastal areas can be quite high, not only because CWIS are located in the productive areas over the continental shelf where many species reproduce, but also because nearshore areas within bays, estuaries, wetlands, or coastal rivers provide nursery habitat. In addition, the early life stages of many species are planktonic, and tides and currents can carry these organisms over large areas. The abundance of plankton in temperate regions is seasonal, with greater numbers in spring and summer and fewer numbers in winter.

An additional concern for CWIS in coastal areas pertains to the presence of marine mammals and reptiles, including threatened and endangered species of sea turtles. These species are known to enter submerged offshore CWIS and can drown once inside the intake tunnel.

In addition to many of the species discussed in the section on estuaries, other fish species found in near coastal waters that are of commercial, recreational, or ecological importance and are particularly vulnerable to I&E include silver perch (*Bairdiella chrysura*), cunner (*Tautogolabrus adspersus*), several anchovy species, scaled sardine (*Harengula jaguana)*, and queenfish (*Seriphus politus*) (Tables 11-12 and 11-13).

Table 11-12: Annual Entrainment of Eggs, Larvae, and Juvenile Fish in Oceans

Common Name	Scientific Name	Number of Facilities	Mean Annual Entrainment per Facility (fish/year)	Range
bay anchovy	*Anchoa mitchilli*	2	44,300,000,000	9,230,000,000 - 79,300,000,000
silver perch	*Bairdiella chrysura*	2	26,400,000,000	8,630,000 - 52,800,000,000
striped anchovy	*Anchoa hepsetus*	1	6,650,000,000	---
cunner	*Tautogolabrus adspersus*	2	1,620,000,000	33,900,000 - 3,200,000,000
scaled sardine	*Harengula jaguana*	1	1,210,000,000	---
tautog	*Tautoga onitis*	2	911,000,000	300,000 - 1,820,000,000
clown goby	*Microgobius gulosus*	1	803,000,000	---
code goby	*Gobiosoma robustum*	1	680,000,000	---
sheepshead	*Archosargus probatocephalus*	1	602,000,000	---
kingfish	*Menticirrhus* spp.	1	542,000,000	---
pigfish	*Orthopristis chrysoptera*	2	459,000,000	755,000 - 918,000,000
sand sea trout	*Cynoscion arenarius*	1	325,000,000	---
northern kingfish	*Menticirrhus saxatilis*	1	322,000,000	---
Atlantic mackerel	*Scomber scombrus*	1	312,000,000	---
Atlantic bumper	*Chloroscombrus chrysurus*	1	298,000,000	---

Source: *Conservation Consultants Inc., 1977; Stone & Webster Engineering Corporation, 1980; Florida Power Corporation, 1985; Normandeau Associates Inc., 1994; Jacobsen et al., 1998; Northeast Utilities Environmental Laboratory, 1999.*

Table 11-13: Annual Impingement in Oceans for All Age Classes Combined

Common Name	Scientific Name	Number of Facilities	Mean Annual Impingement per Facility (fish/year)	Range
queenfish	*Seriphus politus*	2	201,000	19,800 - 382,000
polka-dot batfish	*Ogcocephalus radiatus*	1	74,500	---
bay anchovy	*Anchoa mitchilli*	2	49,500	11,000 - 87,900
northern anchovy	*Engraulis mordax*	2	36,900	26,600 - 47,200
deepbody anchovy	*Anchoa compressa*	2	35,300	34,200 - 36,400
spot	*Leiostomus xanthurus*	1	28,100	---
American sand lance	*Ammodytes americanus*	2	20,700	886 - 40,600
silver perch	*Bairdiella chrysura*	2	20,500	12,000 - 29,000
California grunion	*Caranx hippos*	1	18,300	---
topsmelt	*Atherinops affinis*	2	18,200	4,320 - 32,300
alewife	*Alosa pseudoharengus*	2	16,900	1,520 - 32,200
pinfish	*Lagodon rhomboides*	1	15,200	---
slough anchovy	*Anchoa delicatissima*	3	10,900	2,220 - 27,000
walleye surfperch	*Hyperprosopon argenteum*	1	10,200	---
Atlantic menhaden	*Brevoortia tyrannus*	3	7,500	861 - 20,400

Source: *Stone & Webster Engineering Corporation, 1977; Stupka and Sharma, 1977; Tetra Tech Inc., 1978; Stone and Webster Engineering Corporation, 1980; Florida Power Corporation, 1985; Southern California Edison Company, 1987; SAIC, 1993; EA Engineering, Science and Technology, 1997; Jacobsen et al., 1998.*

11.8 Summary of Impingement and Entrainment Data

The data evaluated by EPA indicate that fish species with free-floating, early life stages are those most susceptible to CWIS impingement and entrainment impacts. Such planktonic organisms lack the swimming ability to avoid being drawn into intake flows. Species that spawn in nearshore areas, have planktonic eggs and larvae, and are small as adults experience even greater impacts because both new recruits and the spawning adults are affected (e.g., bay anchovy in estuaries and oceans).

EPA's data review also indicates that fish species in estuaries and oceans experience the highest rates of I&E. These species tend to have planktonic eggs and larvae, and tidal currents carry planktonic organisms past intakes multiple times, increasing the probability of I&E. In addition, fish spawning and nursery areas are located throughout estuaries and near coastal waters, making it difficult to avoid locating intakes in areas where fish are present.

11.9 Potential Benefits of Section 316(b) Regulation

11.9.1 Benefits Concepts, Categories, and Causal Links

This section provides a qualitative description of the types of benefits that are expected from the section 316(b) New Facility Rule. Although valuing the changes in environmental quality that arise from the rule is a principal desired outcome for the Agency's policy assessment framework, time and data constraints do not permit a quantified assessment of the economic benefits of the final rule.

As noted in previous sections of this chapter, changes in CWIS design, location, or capacity can reduce I&E rates. These changes in I&E can potentially yield significant ecosystem improvements in terms of the number of fish that avoid premature mortality. This in turn is expected to increase local and regional fishery populations, and ultimately contribute to the enhanced environmental functioning of affected water bodies (rivers, lakes, estuaries, and oceans). Finally, the economic welfare of human populations is expected to increase as a consequence of the improvements in fisheries and associated aquatic ecosystem functioning. Potential ecological outcomes and related economic benefits from anticipated reductions in adverse effects of CWIS are identified below along with an explanation of the basic economic concepts applicable to the economic benefits, including benefit categories and taxonomies, service flows, and market and nonmarket goods and services.

11.9.2 Applicable Economic Benefit Categories

Key challenges in benefits assessment include uncertainties and data gaps, as well as the fact that many of the goods and services beneficially affected by the change in new facility I&E are not traded in the marketplace. Thus there are numerous instances — including this final section 316(b) rule for new facilities — when it is not feasible to confidently assign monetary values to some beneficial outcomes. In such instances, benefits are described and considered qualitatively. This is the case for the rule for new facility CWIS. At this time, there is only general information about the location of most new facilities, and in most cases details of facility and environmental characteristics are unknown. As a result, it is not possible to do a detailed analysis of potential monetary benefits associated with the final regulations.

11.9.3 Benefit Category Taxonomies

The term "economic benefits" here refers to the dollar value associated with all the expected positive impacts of the section 316(b) New Facility Rule. Conceptually, the monetary value of benefits is the sum of the predicted changes in "consumer and producer surplus." These surplus measures are standard and widely accepted terms of applied welfare economics, and reflect the degree of well-being derived by economic agents (e.g., people or firms) given different levels of goods and services, including those associated with environmental quality.[3]

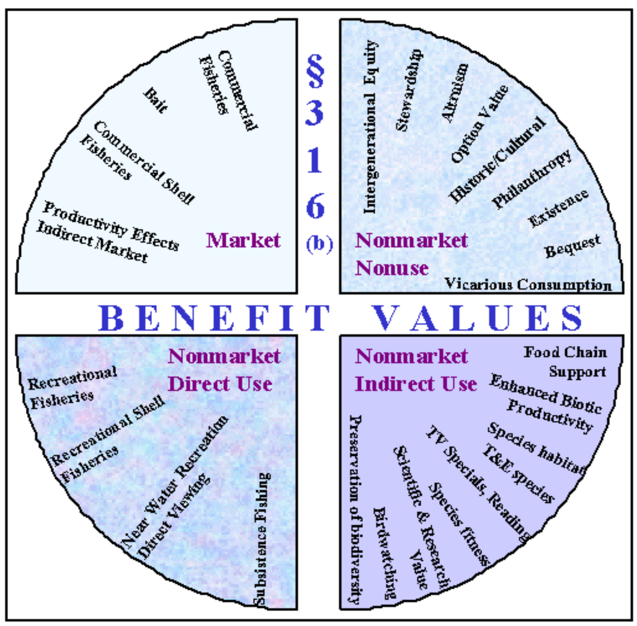
[3] Technically, consumer surplus reflects the difference between the "value" an individual places on a good or service (as reflected by the individual's "willingness to pay" for that unit of the good or service) and the "cost" incurred by that individual to acquire it (as reflected by the "price" of a commodity or service, if it is provided in the marketplace). Graphically, this is the area bounded from above by the demand curve and below by the market clearing price. Producer surplus is a similar concept, reflecting the difference between the market price a producer can obtain for a good or service and the actual cost of producing that unit of the commodity.

The economic benefits of activities that improve environmental conditions can be categorized in many different ways. The various terms and categories offered by different authors can lead to some confusion with semantics. However, the most critical issue is to try not to omit any relevant benefit, and at the same time avoid potential double counting of benefits.

One common typology for benefits of environmental programs is to divide them into three main categories: (1) economic welfare (e.g., changes in the well-being of humans who derive use value from market or nonmarket goods and services such as fisheries); (2) human health (e.g., the value of reducing the risk of premature fatality due to changing exposure to environmental exposure); and (3) nonuse values (e.g., stewardship values for the desire to preserve threatened and endangered species). For the section 316(b) New Facility Rule, however, this typology does not convey all the intricacies of how the rule might generate benefits. Further, human health benefits are not anticipated. Therefore, another categorization may be more informative.

Figure 11-1 outlines the most prominent categories of benefit values for the section 316(b) New Facility Rule. The four quadrants are divided by two principles: (1) whether the benefit can be tracked in a market (i.e., market goods and services) and (2) how the benefit of a nonmarket good is received by human beneficiaries (either from direct use of the resource, from indirect use, or from nonuse).

Figure 11-1: Section 316(b) Benefit Values



Market benefits are best typified by commercial fisheries, where a change in fishery conditions will manifest itself in the price, quantity, and/or quality of fish harvests. The fishery changes thus result in changes in the marketplace, and can be evaluated based on market exchanges.

Direct use benefits include the value of improved environmental goods and services used and valued by people (whether or not they are traded in markets). A typical nonmarket direct use would be recreational angling, in which participants enjoy a welfare gain when the fishery improvement results in a more enjoyable angling experience (e.g., higher catch rates).

Indirect use benefits refer to changes that contribute, through an indirect pathway, to an increase in welfare for users (or nonusers) of the resource. An example of an indirect benefit would be when the increase in the number of forage fish enables the population of valued predator species to improve (e.g., when the size and numbers of prized recreational or commercial fish increase because their food source has been improved). In such a context, the I&E impacts on a forage species will indirectly result in welfare gains for recreational or commercial anglers.

Nonuse benefits — also known as passive use values — reflect the values individuals assign to improved ecological conditions apart from any current, anticipated, or optional use by them. Some economists consider option values to be a part of nonuse values because the option value is not derived from actual current use, whereas other writers place it in a use category (because the option value is associated with preserving opportunity for a future use of the resource). For convenience, we place option value in the nonuse category.

11.9.4 Direct Use Benefits

Direct use benefits are the simplest to envision. The welfare of commercial, recreational, and subsistence fishermen is improved when fish stocks increase and their catch rates rise. This increase in stocks may be induced by reduced I&E of species sought by fishermen, or through reduced I&E of forage and bait fish, which leads to increases in populations of commercial and recreational species. For subsistence fishermen, the increase in fish stocks may reduce the amount of time spent fishing for their meals or increase the number of meals they are able to catch. For recreational anglers, more fish and higher catch rates may increase the enjoyment of a fishing trip and may also increase the number of fishing trips taken. For commercial fishermen, larger fish stocks may lead to increased revenues through increases in total landings and/or increases in the catch per unit of effort (i.e., lower costs per fish caught). Increases in catch may also lead to growth in related commercial enterprises, such as commercial fish cleaning/filleting, commercial fish markets, recreational charter fishing, and fishing equipment sales.

Evidence that these use benefits are valued by society can be seen in the market. For example, in 1996 about 35 million recreational anglers spent nearly $38 billion on equipment and fishing trip related expenditures (US DOI, 1997) and the 1996 GDP from fishing, forestry, and agricultural services (not including farms) was about $39 billion (BEA, 1998). Clearly, these data indicate that the fishery resource is very important. Although these baseline values do not give us a sense of how benefits change with changes in environmental quality such as reduced I&E and increased fish stocks, even a change of 0.1% would translate into potential benefits of $40 million per year.

Commercial fishermen. The benefits derived from increased landings by commercial fishermen can be valued by looking at the market in which the fish are sold. The ideal measure of commercial fishing benefits is the producer surplus generated by the marginal increase in landings, but often the data required to compute the producer surplus are unavailable. In this case, revenues may be used as a proxy for producer surplus, with some assumptions and an adjustment. The assumptions are that (1) there will be no change in harvesting behavior or effort, but existing commercial anglers will experience an increase in landings, and (2) there will be no change in price. Given these assumptions, benefits can be estimated by calculating the expected increase in the value of commercial landings, and then translating the landed values into estimated increases in producer surplus. The economic literature (Huppert, 1990) suggests that producer surplus values for commercial fishing have been estimated to be approximately 90% of total revenue (landings values are a close proxy for producer surplus because the commercial fishing sector has very high fixed costs relative to its variable costs). Therefore, the marginal benefit from an increase in commercial landings can be estimated to be approximately 90% of the anticipated change in revenue.

Recreational users. The benefits of recreational use cannot be tracked in the market. However, there is extensive literature on valuing fishing trips and valuing increased catch rates on fishing trips. While it is likely that nearwater recreational users will gain benefits, it is unlikely that swimmers would perceive an important effect on their use of the ecosystem. Boaters may receive recreational value to the degree that enjoyment of their surroundings is an important part of their recreational pleasure or that fishing is a secondary reason for boating. Passive use values to these and other individuals are discussed below.

Primary studies of sites throughout the United States have shown that anglers value their fishing trips and that catch rates are one of the most important attributes contributing the quality of their trips.

Higher catch rates may translate into two components of recreational angling benefits: an increase in the value of existing recreational fishing trips, and an increase in recreational angling participation. The most promising approaches for quantifying and monetizing these two benefits components are benefits transfer (as a secondary method) and random utility modeling or RUM (as a primary research method).

To estimate the value of an improved recreational fishing experience, it is necessary to estimate the existing number of angling trips or days that are expected to be improved by reducing I&E. As with the commercial fishing benefits, it is important to identify the appropriate geographic scope when estimating these numbers. Once the existing angling numbers have been estimated, the economic value of an improvement (consumer surplus) can be estimated. The specific approach for estimating the value will depend on the economic literature that is most relevant to the specific characteristics of the study site. For example, some economic studies in the literature can be used to infer a factor (percentage increase) that can be applied to the baseline value of the fishery for specific changes in fishery conditions. Other primary studies simply provide an estimate of the incremental value attributable to an improvement in catch rate.

In some cases it may be reasonable to assume that increases in fish abundance (attributable to reducing I&E) will lead to an increase in recreational fishing participation. This would be particularly relevant in a location that has experienced such a severe impact to the fishery that the site is no longer an attractive location for recreational activity. Estimates of potential recreational activity post-regulation can be made based on similar sites with healthy fishery populations, on conservative estimates of the potential increase in participation (e.g., a 5% increase), or on recreational planning standards (densities or level of use per acre or stream mile). A participation model (as in a RUM application) could also be used to predict changes in the net addition to user levels from the improvement at an impacted site. The economic benefit of the increase in angling days then can be estimated using values from the economic literature for a similar type of fishery and angling experience.

Subsistence anglers. Subsistence use of fishery resources can be an important issue in areas where socioeconomic conditions (e.g., the number of low income households) or the mix of ethnic backgrounds make such angling economically or culturally important to a component of the community. In cases of Native American use of impacted fisheries, the value of an improvement can sometimes be inferred from settlements in similar legal cases (including natural resource damage assessments, or compensation agreements between impacted tribes and various government or other institutions in cases of resource acquisitions or resource use restrictions). For more general populations, the value of improved subsistence fisheries may be estimated from the costs saved in acquiring alternative food sources (assuming the meals are replaced rather than foregone).

11.9.5 Indirect Use Benefits

Indirect use benefits refer to welfare improvements that arise for those individuals whose activities are enhanced as an indirect consequence of the fishery or habitat improvements generated by the final new facility standards for CWIS. For example, the rule's positive impacts on local fisheries may, through the intricate linkages in ecologic systems, generate an improvement in the population levels and/or diversity of bird species in an area. This might occur, for example, if the impacted fishery is a desired source of food for an avian species of interest. Avid bird watchers might thus obtain greater enjoyment from their outings, as they are more likely to see a wider mix or greater numbers of birds. The increased welfare of the bird watchers is thus a legitimate but indirect consequence of the final rule's initial impact on fish.

There are many forms of potential indirect benefits. For example, a rule-induced improvement in the population of a forage fish species may not be of any direct consequence to recreational or commercial anglers. However, the increased presence of forage fish may well have an indirect affect on commercial and recreational fishing values because it enhances an important part of the food chain. Thus, direct improvements in forage species populations may well result in a greater number (and/or greater individual size) of those fish that are targeted by recreational or commercial anglers. In such an instance, the relevant recreational and commercial fishery benefits would be an indirect consequence of the final rule's initial impacts on lower levels of the aquatic ecosystem.

The data and methods available for estimating indirect use benefits depend on the specific activity that is enhanced. For example, an indirect improvement to recreational anglers would be measured in essentially the same manner discussed under the preceding discussion on direct use benefits (e.g., using a RUM model). However, the analysis requires one additional critical step — that of indicating the link between the direct impact of the final rule (e.g., improvements in forage species populations) and the indirect use that is ultimately enhanced (e.g., the recreationally targeted fish). Therefore, what is typically required for estimating indirect use benefits is ecologic modeling that captures the key linkages between the initial impact of the rule and its ultimate (albeit indirect) effect on use values. In the example of forage species, the change in forage fish populations would need to be analyzed in a manner that ultimately yields information on responses in recreationally targeted species (e.g., that can be linked to a RUM analysis).

11.9.6 Nonuse Benefits

Nonuse (passive use) benefits arise when individuals value improved environmental quality apart from any past, present, or anticipated future use of the resource in question. Such passive use values have been categorized in several ways in the economic literature, typically embracing the concepts of existence (stewardship) and bequest (intergenerational equity) motives. Passive use values also may include the concept that some ecological services are valuable apart from any human uses or motives. Examples of these ecological services may include improved reproductive success for aquatic and terrestrial wildlife, increased diversity of aquatic and terrestrial wildlife, and improved conditions for recovery of threatened and endangered species.

Passive values can only be estimated in primary research through the use of direct valuation techniques such as contingent valuation method (CVM) surveys and related techniques (e.g., conjoint analysis using surveys). In the case of the final section 316(b) New Facility Rule, no primary research was feasible within the constraints faced by the Agency. If estimates were to be developed, EPA would need to rely on benefits transfer, with appropriate care and caveats clearly recognized.

One typical approach for estimating passive values is to apply a ratio between certain use-related benefits estimates and the passive use values anticipated for the same site and resource change. Freeman (1979) applied a rule of thumb in which he inferred that national-level passive benefits of water quality improvements were 50% of the estimated recreational fishing benefits. This was based on his review of the literature in those instances where nonuse and use values had been estimated for the same resource and policy change. Fisher and Raucher (1984) undertook a more in-depth and expansive review of the literature, found a comparable relationship between recreational angling benefits and nonuse values, and concluded that since nonuse values were likely to be positive, applying the 50% “rule of thumb” was preferred over omitting nonuse values from a benefits analysis entirely.

The 50% rule has since been applied frequently in EPA water quality benefits analyses (e.g., effluent guidelines RIAs for the iron and steel and pulp and paper sectors, and the RIA for the Great Lakes Water Quality Guidance). At times the rule has been extended to ratios higher than 50% (based on specific studies in the literature). However, the overall reliability and credibility of this type of approach is, as for any benefits transfer approach, dependent on the credibility of the underlying study and the comparability in resources and changes in conditions between the research survey and the section 316(b) New Facility Rule’s impacts at selected sites. The credibility of the nonuse value estimate also is contingent on the reliability of the recreational angling estimates to which the 50% rule is applied.

A second potential approach to deriving estimates for section 316(b) passive use values is to use benefits transfer to apply an annual willingness-to-pay estimate per nonuser household (e.g., Mitchell and Carson, 1986; Carson and Mitchell, 1993) to all the households with passive use motives for the impacted water body. The challenges in this approach include defining the appropriate “market” for the impacted site (e.g., what are the boundaries for defining how many households apply), as well as matching the primary research scenario (e.g., “boatable to fishable”) to the predicted improvements at the section 316(b)-impacted site.

For specific species, some nonuse valuation may be deduced using restoration-based costs as a proxy for the value of the change in stocks (or for threatened and endangered species the value of preserving the species). Where a measure of the approximate cost per individual can be deduced, and the number of individuals spared via BTA can be estimated, this may be a viable approach.

11.9.7 Summary of Benefits Categories

Table 11-14 displays the types of benefits categories expected to be affected by the section 316(b) New Facility Rule and the various data needs, data sources, and estimation approaches associated with each category. As described in sections 11.9.4 to 11.9.6, economic benefits can be broadly defined according to three categories: (1) direct use, (2) indirect use, and (3) nonuse (passive use) benefits. These benefits can be further categorized according to whether or not they are traded in the market. As indicated in Table 11-14, “direct use” benefits include both “marketed” and “nonmarketed” goods, whereas “nonuse” and “indirect use” benefits include only “nonmarketed” goods.

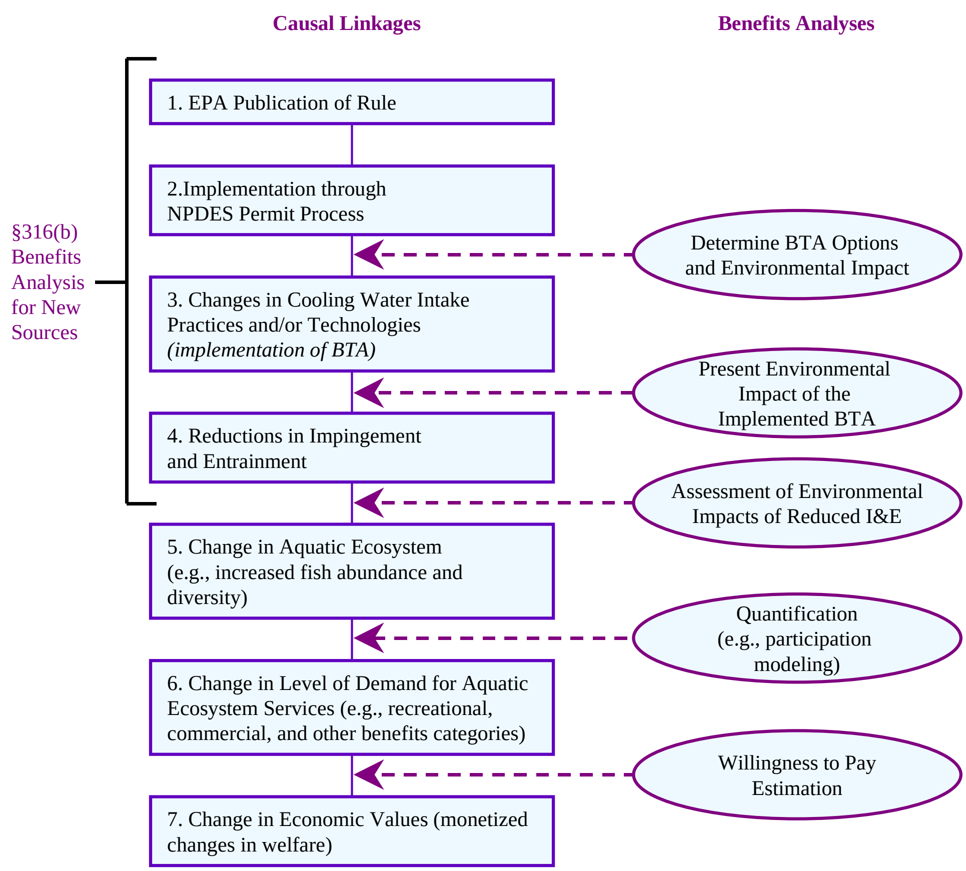
Table 11-14: Summary of Benefit Categories, Data Needs, Potential Data Sources, and Approaches

Benefits Category	Basic Data Needs	Potential Data Sources/Approaches
	Direct Use, Marketed Goods	
Increased commercial landings (fishing, shellfishing, and aquaculture)	▸ Estimated change in landings ▸ Estimated producer surplus	▸ Based on ecological modeling ▸ Based on available literature or 50% rule
	Direct Use, Nonmarketed Goods	
Improved value of a recreational fishing experience	▸ Estimated number of affected anglers ▸ Value of an improvement in catch rate, and possibly, value of an angling day	▸ Site-specific studies, national or statewide surveys ▸ Based on available literature
Increase in recreational fishing participation	▸ Estimated number of affected anglers or estimate of potential anglers ▸ Value of an angling day	▸ Site-specific studies, national or statewide surveys ▸ Based on available literature
Increase in subsistence fishing	▸ Estimated number of affected anglers or estimate of potential anglers ▸ Value of an angling day	▸ Site-specific studies, national or statewide surveys ▸ Based on available literature
	Nonuse and Indirect Use, Nonmarketed	
Increase in indirect values	▸ Estimated changes in ecological services (e.g., reproductive success of aquatic species) ▸ Restoration based on costs	▸ Based on ecological modeling ▸ Site-specific studies, national or statewide surveys
Increase in passive use values	▸ Apply stated preference approach, or benefits transfer	▸ Site-specific studies, national or statewide stated preference surveys

11.9.8 Causality: Linking the Section 316(b) Rule to Beneficial Outcomes

Understanding the anticipated economic benefits arising from changes in I&E requires understanding a series of physical and socioeconomic relationships linking the installation of Best Technology Available (BTA) to changes in human behavior and values. As shown in Figure 11-2, these relationships span a broad spectrum, including institutional relationships to define BTA (from policy making to field implementation), the technical performance of BTA, the population dynamics of the aquatic ecosystems affected, and the human responses and values associated with these changes.

Figure 11-2: Causal Linkages in the Benefits Analysis



The first two steps in Figure 11-2 reflect the institutional aspects of implementing the section 316(b) New Facility Rule. In step 3, the anticipated applications of BTA (or a range of BTA options) must be determined for the regulated entities. This technology forms the basis for estimating the cost of compliance, and provides the basis for the initial physical impact of the rule (step 4). Hence, the analysis must predict how implementation of BTAs (as predicted in step 3) translates into changes in I&E at the regulated CWIS (step 4). These changes in I&E then serve as input for the ecosystem modeling (step 5).

In moving from step 4 to step 5, the selected ecosystem model (or models) are used to assess the change in the aquatic ecosystem from the preregulatory baseline (e.g., losses of aquatic organisms before BTA) to the postregulatory conditions (e.g., losses after BTA implementation). The potential output from these steps includes estimates of reductions in I&E rates, and changes in the abundance and diversity of aquatic organisms of commercial, recreational, ecological, or cultural value, including threatened and endangered species.

In step 6, the analysis involves estimating how the changes in the aquatic ecosystem (estimated in step 5) translate into changes in level of demand for goods and services. For example, the analysis needs to establish links between improved fishery abundance, potential increases in catch rates, and enhanced participation. Then, in step 7, as an example, the value of the increased enjoyment realized by recreational anglers is estimated. These last two steps typically are the focal points of the economic benefits portion of the analysis. However, because of data and time constraints, this benefits analysis is limited to only the first four steps of the process.

11.10 Empirical Indications of Potential Benefits

The following discussion provides examples from existing facilities that offer some indication of the relative magnitude of monetary benefits that may be expected to result from the final new facility regulations.

The potential benefits of lower intake flows and 100% recirculation of flow are illustrated by comparisons of once-through and closed-cycle cooling (e.g., Brayton Point and Hudson River facilities). The potential benefits of additional requirements defined by regional permit directors are demonstrated by operational changes implemented to reduce impingement and entrainment (e.g., Pittsburg and Contra Costa facilities). The potential benefits of reducing losses of forage species are demonstrated by analysis of the biological and economic relationships among forage species and commercial and recreational fishery species (e.g., Ludington facility on Lake Michigan). Finally, the potential benefits of implementing additional technologies to increase survival of organisms impinged or entrained are illustrated by the application of modified intake screens and fish return systems (e.g., Salem Nuclear Generating Facility). These cases are discussed below.

An example of the potential benefits of minimizing intake flow is provided by data for the Brayton Point facility, located on Mt. Hope Bay in Massachusetts (NEPMRI, 1981, 1995; U.S. EPA, 1982). In the mid-1980s, the operation of Unit 4 at Brayton Point was changed from closed-cycle to once-through cooling, increasing flow by 48% from an average of 703 MGD before conversion to an average of 1045 MGD for the first 6 years post-conversion (Lawler, Matusky, and Skelly Engineers, 1993b). Although conversion to once-through cooling increased coolant flow and the associated heat load to Mt. Hope Bay, the facility requested the change because of electrical problems associated with Unit 4's saltwater spray cooling system (U.S. EPA, 1982). An analysis of fisheries data by the Rhode Island Division of Fish and Wildlife using a time series-intervention model indicated that there was an 87% reduction in finfish abundance in Mt. Hope Bay coincident with the Unit 4 modification (Gibson, 1996). The analysis also indicated that, in contrast, species abundance trends have been relatively stable in adjacent coastal areas and portions of Narragansett Bay that are not influenced by the operation of Brayton Pt.

Another example of the potential benefits of low intake flow is provided by an analysis of I&E losses at five Hudson River power plants. Estimated fishery losses under once-through compared to closed-cycle cooling indicated that an average reduction in intake flow of about 95% at the three facilities responsible for the greatest impacts would result in a 30-80% reduction in fish losses, depending on the species involved (Boreman and Goodyear, 1988). An economic analysis estimated monetary damages under once-through cooling based on the assumption that annual percent reductions in year classes of fish result in proportional reductions in fish stocks and harvest rates (Rowe et al., 1995). A low estimate of per facility damages was based on losses at all five facilities and a high estimate was based on losses at the three facilities that account for most of the impacts. Damage estimates under once-through cooling ranged from about $1.3 million to $6.1 million annually in 1999 dollars.

A third example demonstrates how I&E losses of forage species can lead to reductions in economically valued species. Jones and Sung (1993) applied a RUM to estimate fishery impacts of I&E by the Ludington Pumped-Storage plant on Lake Michigan. This method estimates changes in demand as a function of changes in catch rates. The Ludington facility is responsible for the loss of about 1-3% of the total Lake Michigan production of alewives, a forage species that supports valuable trout and salmon fisheries. Jones and Sung (1993) estimated that losses of alewife result in a loss of nearly 6% of the angler catch of trout and salmon each year. Based on RUM analysis, they estimated that if Ludington operations ceased, catch rates of trout and salmon species would increase by 3.3 to 13.7% annually, amounting to an estimated recreational angling benefit of $0.95 million per year (in 1999 dollars) for these species alone.

A fourth example indicates the potential benefits of operational BTA that might be required by regional permit Directors. Two plants in the San Francisco Bay/Delta, Pittsburg and Contra Costa, have made changes to their intake operations to reduce impingement and entrainment of striped bass (*Morone saxatilis*). These operational changes have also reduced incidental take of several threatened and endangered fish species, including the delta smelt *(Hypomesus transpacificus*) and several runs of chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*Oncorhynchus mykiss*). According to technical reports by the facilities, operational BTA reduced striped bass losses by 78% to 94%, representing an increase in striped bass recreational landings averaging about 100,000 fish each year (PG&E, 1996, 1997, 1998, 1999; Southern Energy California, 2000). A local study estimated that the consumer surplus of an additional striped bass caught by a recreational angler is $8.87 to $13.77 (Huppert, 1989). This implies a benefit to the recreational fishery, from reduced impingement and entrainment of striped bass alone, in the range of $887,000 to $1,377,000 annually. The monetary benefit of reduced impingement and entrainment of threatened and endangered species might be substantially greater.

The final example indicates the benefits of technologies that can be applied to maximize survival. In their 1999 permit renewal application, the Salem Nuclear Generating Station in the Delaware Estuary evaluated the potential benefits of dual-flow, fine-mesh traveling screens designed to achieve an approach velocity of 0.5 fps (PSEG, 1999). The facility estimated that use of this technology would have a total economic benefit of $3.64 million in 2000 dollars (Appendix F, Section IX, Table 12).

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