Chapter 2: The §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 for minimizing adverse environmental impact. Based on this statutory language, §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 best technology available (BTA), §316(b) has been applied inconsistently, using a case-by-case approach, for some industries and has not been rigorously applied to many other industries.

The proposed §316(b) New Facility Rule addresses current §316(b) implementation problems by regulating new facilities that operate cooling water intake structures (CWIS), hold 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 in so far as relevant for purposes of this analysis.

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2.1 Overview of Facilities Subject to §316(b) Regulation

The proposed §316(b) New Facility Rule will apply to new ("greenfield") 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 §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 Manufacturing Industries*. 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 §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 §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

[1] Only facilities that use at least twenty-five percent of their intake flow for cooling purposes and withdraw more than two million gallons per day will be regulated under the proposed §316(b) New Facility Rule.

(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† (SIC Code)	Cooling Water Intake Flow††		
	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 & Coal Products (29)	590	0.8%	98.5%
Paper & Allied Products (26)	534	0.7%	99.2%
Additional 14 Categories†††	607	0.8%	100.0%

† The table is based on reported primary SIC codes.
†† 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.
††† 14 additional major industrial categories (major SIC codes) with effluent guidelines.

Sources: 1982 Census of Manufactures; DOE / EIA Form EIA-867 database.

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 and 3 million employees, and more than $1.2 trillion in sales and $120 billion in payroll. The four manufacturing sectors alone account for approximately 20 percent of total U.S. manufacturing sales and 12 percent of manufacturing employment. While existing facilities are not subject to the proposed §316(b) New Facility Rule, construction of new facility 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 proposed rule.

Table 2-2: Summary Economic Data for Major Industry Sectors Subject to §316(b) Regulation: Facilities, Employment, Estimated Revenue, and Payroll in Millions of 1999 Dollars

Sector (SIC)	Number of Facilities	Employment	Sales, Receipts, or Shipments ($ millions)	Payroll ($ millions)
Utilities & Nonutilities (49)	22,306	844,766	416,642	41,349
Paper & Allied Products (26)	6,509	623,799	165,861	24,640
Chemicals & Allied Products (28)	12,401	843,469	380,405	36,093
Petroleum & Coal Products (29)	2,136	106,863	155,308	4,877
Primary Metals (33)	6,559	509,730	83,488	15,622
All §316(b) Sectors	**49,911**	**2,928,627**	**1,201,704**	**122,581**
Total U.S. Manufacturing	377,673	17,633,977	3,899,538	586,359
§316(b) Manufacturing Sectors as a Percent of Total U.S. Manufacturing[††]	7.3%	11.8%	20.1%	13.9%

[†] Dollar values adjusted from 1997 to 1999 using Producer Price Indexes from the Bureau of Labor Statistics (Series: WPU09–Pulp, Paper, and Allied Products, WPU061–Industrial Chemicals, WPU057–Petroleum Products, Refined, WPU10–Metals and Metal Products, WPU054–Electric Power, WPU00000000–All Commodities).

[††] Only the four §316(b) manufacturing sectors (26, 28, 29, and 33) are included in the percentage. SIC 49 is not part of total U.S. manufacturing.

Sources: 1997 Economic Census: Advance Comparative Statistics for the U.S. 1987 SIC Basis (preliminary data).

2.1.2 New Facilities

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

a. New Steam Electric Generators

EPA identified new steam electric generators subject to the proposed §316(b) New Facility Rule using the following approach:

- EPA used the New Generation Capacity Information Service, or "NEWGen database," created and maintained by RDI Consulting (beta version as of January 2000) to identify planned steam electric generators.
- EPA used information from public sources to determine how many of the new steam electric generators would meet the new facility criteria of this rule.
- Since the NEWGen database does not cover the entire 20-year forecasting period, the identified new generators only represent a subset of all projected future steam electric generators. EPA used steam electric capacity forecasts from the Energy Information Administration's (EIA) Annual Energy Outlook 2000 to extrapolate additional facilities projected to begin operation between 2001 and 2020.

This approach resulted in an estimate of 40 new steam electric generators 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 proposed §316(b) New Facility Rule using a two-step approach:

- EPA first determined 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

[2] EPA identified significant users of cooling water at the 4-digit Standard Industrial Classification (SIC) code level, based on the §316(b) *Industry Screener Questionnaire: Phase I Cooling Water Intake Structures* (January 1999).

growth that would be met by new facilities (as opposed to expansions at existing facilities).

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

Based on this approach, EPA estimated that a total of 58 new manufacturing facilities in scope of the proposed §316(b) New Facility Rule will begin operation during the next 20 years. Forty-eight of these facilities are expected to be chemicals manufacturers and ten metals facilities.

Table 2-3 presents the estimated number of new in scope facilities by major sector and 4-digit 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	205	40
Manufacturing Facilities			
SIC 26	Paper and Allied Products	0	0
SIC 28	Chemicals and Allied Products	568	48
SIC 29	Petroleum Refining And Related Industries	2	0
SIC 33	Primary Metals Industries		
SIC 331	Blast Furnaces and Basic Steel Products	78	8
SIC 333 SIC 335	Primary Aluminum, Aluminum Rolling, and Drawing and Other Nonferrous Metals	22	2
Total Manufacturing		*670*	*58*
Total		**875**	**98**

Source: EPA Analysis, 2000.

EPA also engaged in a consultation process with industry associations and experts. Information obtained from these sources were generally consistent with the calculated estimates.

2.2 The Need for §316(b) Regulation

Section 316(b) provides that any standard established to address impacts from CWISs "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 CWISs has been established. As a result, many CWISs have been constructed on sensitive aquatic systems with capacities and designs that cause severe damage to the water bodies from which they withdraw water.

Several factors drive the need for this proposed national §316(b) regulation. 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 CWISs' 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, 1996b). The regulatory goals of §316(b) include the following:

- ensure that the location, design, construction, and capacity of a facility's CWIS reflect BTA for minimizing AEI;
- 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 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 CWISs' 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 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 extremely high.

c. Minimizing AEI

Review of the available literature and §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 the loss of or damage to 3 to 4 billion larvae and post larvae per year,[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 is a significant loss to the whole population of the affected species as well. Several studies estimating the impacts of entrainment on populations of key commercial or recreational fish predicted declines in population size. Studies focusing on entrainment mortality in the Hudson River predicted reductions in the year-class strength for 6 species ranging from 4 percent to 79 percent, depending on the species.[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, more recent, 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] In contrast, species abundance trends were relatively stable in coastal areas and portions of Narragansett Bay which are not influenced by the Brayton Point CWIS. 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

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[3] *Brunswick Nuclear Steam Electric Generating Plant of Carolina Power and Light Company Located near Southport, North Carolina, Historical Summary and Review of Section 316(b) Issues.* EPA Region IV, September 19, 1979.

[4] *Findings and Determination under 33 U.S.C. Section 1326, In the Matter of Florida Power Corporation Crystal River Power Plant Units 1, 2, and 3. NPDES Permit No. FL0000159.* EPA Region IV, December 2, 1986.

[5] *Impingement Losses at the D.C. Cook Nuclear Power Plant during 1975-1982 with a Discussion of Factors Responsible and Possible Impact on Local Populations*, Thurber, Nancy J. and David J. Jude. Special Report No. 115 of the Great Lakes Research Division. Great Lakes and Marine Waters Center. The University of Michigan. 1985.

[6] *Estimates of Entrainment Mortality for Striped Bass and Other Fish Species Inhabiting the Hudson River Estuary*, Boreman, John and Phillip Goodyear. American Fisheries Society Monograph 4:152-160, 1988.

[7] *Brunswick Nuclear Steam Electric Generating Plant of Carolina Power and Light Company Located near Southport, North Carolina, Historical Summary and Review of Section 316(b) Issues.* EPA Region IV, September 19, 1979.

[8] *Comparison of Trends in the Finfish Assemblages of Mt. Hope Bay and Narragansett Bay in Relation to Operations of the New England Power Brayton Point Station.* Mark Gibson, Rhode Island Division Fish and Wildlife, Marine Fisheries Office, June 1995 and revised August 1996.

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 tauton, 20,146 pounds of adult windowpane, and 96,507 pounds of adult winter flounder.

❖ ***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]

Studies of kelp beds in near-shore waters in the vicinity of the SONGS facility determined that operation of the CWIS resulted in an 80 hectare (197.68 acre) reduction in the area covered by moderate to high density kelp. This represents a 60 percent loss in area. Studies indicated that poor survival and lack of development of new kelp plants was the result of increased turbidity due to withdrawal of intake water at SONGS. The loss of kelp was also determined to be detrimental to fish communities associated with the kelp forests. For example, fish living close to the cobble bottom in the impact area experienced a 70 percent decline in abundance. Fish living in the water column in the impact areas had a 17 percent loss in abundance and a 33 percent decline in biomass relative to control populations. The abundance of large invertebrates in kelp beds also declined for many species, particularly snails.

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 §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 §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, 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 §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 §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

[9] Review of Southern California Edison, San Onofre Nuclear Generating Station (SONGS) 316(b) Demonstration. Prepared by SAIC, July, 20, 1993.

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. The resulting allocation of economic resources, the mix and quantity of goods and services provided by the economy, and *the quantity of AEI accompanying those activities* will yield a higher net economic welfare to society.

Requiring facilities to minimize their environmental impacts by reducing levels of I&E (i.e., a lower level of 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. This approach to addressing the problem of environmental externalities will generally result in improved economic efficiency and net welfare gains for society if the cost of reducing the activities causing environmental harm is less than the value of benefits to society from the reduced AEI.

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 CWISs have been documented since the first attempt at §316(b) regulation in the late 1970's, implementation of §316(b) to date has failed to address the market imperfections associated with CWISs effectively.

REFERENCES

Boreman, John and Phillip Goodyear. 1988. *Estimates of Entrainment Mortality for Striped Bass and Other Fish Species Inhabiting the Hudson River Estuary*. American Fisheries Society Monograph 4:152-160, 1988.

Gibson, Mark Gibson. 1996. *Comparison of Trends in the Finfish Assemblages of Mt. Hope Bay and Narragansett Bay in Relation to Operations of the New England Power Brayton Point Station.* Rhode Island Division Fish and Wildlife, Marine Fisheries Office, June 1995 and revised August 1996.

Science Applications International Corporation (SAIC). 1996. *Background Paper Number 2: Cooling Water Use of Selected U.S. Industries*. Prepared for U.S. EPA Office of Wastewater Enforcement and Compliance, Permits Division by SAIC, Falls Church, VA.

Science Applications International Corporation (SAIC). 1994. *Background Paper Number 3: Cooling Water Intake Technologies*. Prepared for U.S. EPA Office of Wastewater Enforcement and Compliance, Permits Division by SAIC, Falls Church, VA.

Science Applications International Corporation (SAIC). 1993. Review of Southern California Edison, San Onofre Nuclear Generating Station (SONGS) 316(b) Demonstration. July, 20, 1993.

Thurber, Nancy J. and David J. Jude. 1985. *Impingement Losses at the D.C. Cook Nuclear Power Plant during 1975-1982 with a Discussion of Factors Responsible and Possible Impact on Local Populations*, Special Report No. 115 of the Great Lakes Research Division. Great Lakes and Marine Waters Center. The University of Michigan.

U.S. Environmental Protection Agency (EPA) Region IV. 1986. *Findings and Determination under 33 U.S.C. Section 1326, In the Matter of Florida Power Corporation Crystal River Power Plant Units 1, 2, and 3. NPDES Permit No. FL0000159*. December 2, 1986.

U.S. Environmental Protection Agency (EPA) Region IV. 1979. *Brunswick Nuclear Steam Electric Generating Plant of Carolina Power and Light Company Located near Southport, North Carolina, Historical Summary and Review of Section 316(b) Issues.* September 19, 1979.

U.S. Environmental Protection Agency (EPA). 1976. *Development Document for Best Technology Available for the Location, Design, Construction, and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact*. Office of Water and Hazardous Materials, Effluent Guidelines Division, U.S. EPA, Washington, DC.