Chapter 6: Facility Compliance Costs

Introduction

This chapter presents the estimated costs to facilities of complying with the final section 316(b) New Facility Rule. EPA developed costs at three levels: (1) unit costs of complying with the various requirements of this regulation, including costs of section 316(b) technologies and administrative costs; (2) facility-level costs for each projected in-scope facility; and (3) total facility compliance costs aggregated to the national level.

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Under the final New Facility Rule, facilities must comply with one of two alternative sets of permitting requirements (Track I and Track II).[1] Facilities choosing to comply with Track I permitting requirements would be required to meet flow reduction, velocity, and design and construction technology requirements. Facilities choosing to comply with Track II permitting requirements would be required to perform a comprehensive demonstration study to document that proposed technologies reduce the level of impingement and entrainment (I&E) to the same level that would be achieved by implementing the flow reduction, velocity, and design and construction technology requirements of Track I. The remainder of this chapter presents the estimated costs of compliance and the methodology and unit costs used to develop the estimates. The chapter is organized as follows:

- Section 6.1 presents the unit costs associated with various actions that facilities may take as part of the regulatory alternatives described above. The unit costs include average costs of implementing specific changes to a facility's cooling water intake structure (CWIS) or its cooling water system and are based on certain facility characteristics such as volume of flow. Unit costs are also estimated for administrative activities.
- Section 6.2 discusses compliance cost estimates for the 121 projected new facilities.
- Section 6.3 presents the estimated facility compliance costs aggregated to the national level.
- Section 6.4 presents an estimate of facility costs for two nuclear facilities and four coal facilities installing concrete cooling towers.
- Section 6.5 discusses the limitations and uncertainties in EPA's compliance cost estimates.

6.1 Unit Costs

Unit costs are estimated costs of certain activities or actions, expressed on a uniform basis (i.e., using the same units), that a facility may take to meet the regulatory requirements. Unit costs are developed to facilitate comparison of the costs of

[1] See *Chapter 1: Introduction and Overview* for a summary of this rule's requirements.

different actions. For this analysis, the unit basis is dollars per gallon per minute ($/gpm) of cooling water intake flow. All capital and operating and maintenance (O&M) costs were estimated in those units. These unit costs are the building blocks for developing costs at the facility and national levels.

Individual facilities will incur only a subset of the unit costs, depending on the extent to which they would have already complied with the requirements as originally designed (in the baseline) and on the compliance response they select. The unit costs presented in this section are engineering cost estimates, expressed in year 2000 dollars. More detail on the development of these unit costs is provided in the *Technical Development Document for the Final Regulations Addressing Cooling Water Intake Structures for New Facilities* (*Technical Development Document*).

6.1.1 Section 316(b) Technology Costs

New facilities that in their original designs do not comply with the section 316(b) New Facility Rule framework would have to implement one or more technologies to reduce (I&E). These technologies reduce I&E through one of three general methods:

- reducing the design intake flow;
- reducing the design intake velocity; or
- implementing other design and construction technologies (referred to as "other technologies") to reduce I&E.

The remainder of Section 6.1.1 discusses specific section 316(b) technologies and their respective costs.

a. Reducing design intake flow

New facilities have a number of alternatives for reducing their intake flow to meet the rule's requirements. Under Track I, facilities must reduce their intake flow, at a minimum, to a level commensurate with that which could be obtained by use of a closed-cycle recirculating system. Under Track II, facilities have the opportunity to demonstrate that alternative technologies will reduce impingement and entrainment to the same levels that would be achieved under Track I. EPA therefore developed cost estimates based on switching to recirculating systems.

By switching to a recirculating system, it is possible for a new facility to reduce its intake flow to less than two MGD and therefore be exempt from the final section 316(b) New Facility Rule. For some facilities, the cost of reducing the intake flow such that they are exempt from regulation under section 316(b) may be lower than that of any other compliance response.

Switching to a recirculating system involves redesigning the proposed facility to replace the planned once-through cooling system. Cooling towers are by far the most common type of recirculating system. EPA therefore assumed that all planned facilities switching to recirculating systems will use cooling towers. This is also consistent with the requirement of the final section 316(b) New Facility Rule to reduce intake flow to a level commensurate with that which could be obtained by use of a closed-cycle recirculating system.

Cooling tower configurations differ with respect to design characteristics, such as the type of air flow (either natural or mechanical draft), the materials used in tower construction (redwood, fiberglass, steel, and/or concrete), and whether water is recirculated or discharged to a receiving water body after cooling (only configurations that recirculate water will be useful in meeting the Track I regulatory requirements).

The cost of installing cooling towers and their associated intakes and equipment is largely determined by the volume of cooling water needed, the material used to construct the tower (e.g., redwood, fiberglass), and the special features of the tower (e.g., plume abatement). The volume of water needed for cooling depends on the following factors: source water temperature and quality; the type of airflow in the cooling tower (i.e., whether it is natural or mechanical draft); type and make of equipment to be cooled (e.g., coal fired equipment, natural gas powered equipment); and the plant size/generating capacity (e.g., 50 megawatt vs. 800 megawatt).

EPA estimated capital costs for recirculating wet cooling towers with redwood construction and splash fill. EPA chose to use redwood for its estimate over fiberglass because although EPA's records show that the standard cooling tower installation for recently constructed facilities is fiberglass, the cost of installing fiberglass is negligibly lower than the costs of installing redwood. EPA believes that the use of redwood reflects a conservative estimate. For purposes of cost estimation, EPA considered reuse and recycling at manufacturing facilities to be equivalent to closed-cycle, recirculating cooling water systems at electric generators.

Table 6-1 presents estimated capital and installation costs for redwood cooling towers with splash fill, broken down by the volume of water used. To calculate estimated capital costs, EPA made the following assumptions:

- The wet tower approach was 10 ºF with a temperature rise of 20 ºF.
- Installation costs were estimated as 80% of cooling tower equipment costs, based on discussions with industry representatives.
- The recirculating cooling water flow was assumed to be equal to the baseline once-through flow when comparing these technologies.
- For electric generators, make-up water intake flow is 5% of cooling water flow for freshwater and 8% of cooling water flow for marine water. To account for other water uses and potential limitations on reuse/recycle at manufacturing facilities, these values are doubled to 10% (freshwater) and 16% (marine water) for manufacturers.

Table 6-1: Capital and Installation Costs for Redwood Cooling Towers with Splash Fill ($2000)

Flow (gpm)	Total Capital Cost
2,000-18,000	$170,000-$1,308,000
22,000-36,000	$1,589,000-$2,557,000
45,000-67,000	$3,169,000-$4,630,000
73,000-102,000	$5,019,000-$6,851,000
112,000-204,000	$7,463,000- $12,608,000

Source: Based on cost curves (U.S. EPA, 2001a).

EPA also estimated O&M costs for cooling towers. These O&M costs tend to be driven by factors such as:

- the size of the cooling tower,
- the material from which the cooling tower is built,
- various features of the cooling tower,
- the source of make-up water,
- the disposition of blowdown water, and
- the tower's remaining useful life (maintenance costs increase as useful life diminishes).

To calculate estimated annual O&M costs, EPA made the following assumptions:

- For small cooling towers, five percent of capital costs is attributed to chemical costs and routine maintenance. To account for economies of scale, that percentage is gradually decreased to two percent for the largest cooling tower. This assumption is based on documented discussion with cooling tower vendors.
- Evaporative loss is assumed to be 80% of make-up water intake flow.
- Make-up water was assumed to come from a water of the U.S., and disposal of blowdown was assumed to be either to a pond or back to the original water source, at a combined cost of $0.50/1000 gallons.
- Maintenance costs are 15 percent of capital costs, averaged over a 20-year period, based on documented discussion with cooling tower vendors.

In addition, EPA applied an energy penalty cost to those electric generators switching to recirculating systems to account for reductions of energy or capacity produced because of adoption of recirculating cooling tower systems. These reductions in performance are associated with reduced turbine efficiencies due to higher back pressures associated with cooling towers, as well as with power requirements to operate cooling tower pumps and fans. EPA's costing methodology for performance penalties is based on the concept of lost operating revenue due to a mean annual performance penalty. EPA estimated the mean annual performance penalty for recirculating cooling tower systems as compared to once-through cooling systems. EPA then applied this mean annual penalty to the annual revenue estimates for each facility projected to install a recirculating cooling tower technology as a result of the rule. It should be noted that EPA took a conservative approach and double-

counted some parts of the energy penalty, since fan and pump power costs were included in both the energy penalty and the cooling tower O&M costs.

Cost curves developed based on the above assumptions and used to estimate costs can be found in the *Technical Development Document*, along with further details on the development of estimated costs.

b. Reducing design intake velocity

A facility not in compliance with the velocity criteria established by the final section 316(b) New Facility Rule may need to alter its CWIS to reduce the design intake velocity. This reduction can be achieved by branching the intake into a greater number of openings/pipes, installing velocity caps, or constructing a passive screen system.

For the final section 316(b) New Facility Rule, EPA did not estimate costs for reducing design intake velocity as a separate line item, but instead included these costs in the costs of implementing other design and construction technologies to reduce I&E, as discussed in the following section.

c. Implementing other design and construction technologies to reduce I&E

Facilities may have to employ additional technologies that reduce I&E, depending on their CWIS location and velocity. EPA assumed that the baseline technology for electric generators would be traveling screens with an intake velocity of 1.0 ft/s, and that the baseline technology for manufacturing facilities would be trash racks. EPA assumed that facilities would add traveling screens with fish handling features, with an intake velocity of 0.5 ft/s, as a way to limit I&E. This is a conservative assumption, since such technologies are among the more expensive technologies available for reducing I&E.

Vertical traveling screens contain a series of wire mesh screen panels that are mounted end to end on a band to form a vertical loop. As water flows through the panels, debris and fish that are larger than the screen openings are caught on the screen or at the base of each panel in a basket. As the screen rotates, each panel passes through a series of spray wash systems that remove debris and fish from the basket. The first system is a low pressure spray wash which is used to release fish to a bypass/return trough. Once the fish have been removed, a high pressure jet spray wash system is used to remove debris. As the screen continues to rotate, the clean panels move down and back into the water to screen intake flow.

Two components were analyzed in estimating total capital costs associated with the installation of traveling screens with fish handling features: equipment costs and installation costs. Equipment costs for a basic traveling screen with fish handling features include costs for screens constructed of carbon steel coated with epoxy paint, a spray system, a fish trough, housings and transitions, continuous operating features, a drive unit, frame seals, and engineering. Installation costs include costs for site preparation and earthwork, clearing the site, excavation, paving and surfacing, and structural concrete work and underwater installation (personnel, equipment, and mobilization, including the cost of a barge equipped with a crane and the crew to operate it).

Table 6-2 presents the total capital costs associated with the installation of traveling screens with fish baskets. Costs are presented for screen panels of various widths and for selected well depths. Well depth includes the height of the structure above the water line and can exceed water depth by a few to tens of feet. Capital costs for traveling screens with fish handling features were calculated based on vendor estimates and information from *Heavy Construction Cost Data 1998* (R.S. Means, 1997) and Paroby (1999). Cost curves used to estimate costs can be found in the *Technical Development Document*, along with further details on the development of estimated costs.

O&M costs for traveling screens vary by type, size, and mode of operation of the screen. Based on discussions with industry representatives, EPA estimated that the annual O&M cost factor ranges between eight percent of total capital cost for the smallest traveling screen (with and without fish baskets) and five percent for the largest traveling screen, since O&M costs do not increase proportionateley with screen size. See the *Technical Development Document* for further information on O&M costs.

Table 6-2: Capital Costs for Traveling Screens with Fish Handling Features ($2000)[a]				
Well Depth (ft)	Screening Basket Panel Width (ft)			
	2	5	10	14
10	$93,000	$135,500	$207,500	$292,500
25	$132,750	$199,250	$315,250	$465,000
50	$196,500	$294,750	$470,250	$664,250
75	$260,500	$391,750	$604,750	$853,250
100	$345,000	$489,750	$739,250	$1,037,000

Source: Based on cost curves (U.S. EPA 2001a).

6.1.2 Administrative Costs

Compliance with the final section 316(b) New Facility Rule requires facilities to carry out certain administrative functions. These functions are either one-time requirements (compilation of information for the initial NPDES permit) or recurring requirements (compilation of information for NPDES permit renewal, and monitoring and record keeping). This section describes each of these administrative requirements and their estimated costs.

a. Initial NPDES permit application

The final section 316(b) New Facility Rule requires all new facilities subject to this regulation to submit information regarding the location, construction, design, and capacity of their proposed CWIS as part of their initial NPDES permit application. Some of these activities are already required under the current case-by-case CWIS permitting procedures, so to some extent this rule is over-costed. Certain activities are required of all facilities, while others depend on whether a facility is following Track I or Track II, as identified below. Activities and costs associated with the initial permit application include:

- ***start-up activities:*** reading and understanding the rule; mobilizing and planning; and training staff;
- ***general permit application activities:*** developing drawings that show the physical characteristics of the source water; developing a description of the CWIS's configuration; developing a facility water balance diagram; developing a narrative of operational characteristics; submitting materials for review by the Director; and keeping records;
- ***source water body flow information activities:*** collecting information characterizing flow; performing engineering calculations; submitting materials for review by the Director; and keeping records;
- ***source water body baseline characterization activities:*** identifying available data and documenting efforts; compiling and analyzing existing data; submitting materials for review by the Director; and keeping records;
- ***remote monitoring device capital and O&M costs:*** installation of remote monitoring device;
- ***CWIS flow reduction requirement activities (Track I only):*** developing information characterizing CWIS flow; performing engineering calculations; submitting data and analysis for review; and keeping records;
- ***CWIS velocity requirement activities (Track I only):*** developing a narrative description; performing engineering calculations; submitting data and analysis for review; revising analysis based on state review; and keeping records;
- ***design and construction technology plan (Track I only):*** developing a narrative description; performing engineering calculations; submitting data and analysis for review; and keeping records;
- ***comprehensive demonstration study plan (Track II only):*** developing description of historical studies that will be used; listing source water body and CWIS data; developing a source water baseline biological characterization sampling plan; developing a verification monitoring plan; submitting data and plans for review; revising plans based on state review; and keeping records;
- ***source water body baseline biological characterization study (Track II only):*** performing biological sampling; developing a profile of source water body biota; identifying critical species; developing a report based on results of the study; submitting data and study report for review; revising the study based on state review; and keeping records;

- ***source water body baseline biological characterization study capital and O&M costs (Track II only):*** laboratory analysis of samples;
- ***evaluation of potential CWIS effects (Track II only):*** developing a statement of the baseline against which comparative analyses will be made; performing engineering calculations for efficacy projections; performing impingement and entrainment pilot studies; submitting data and analysis for review; and keeping records;
- ***impingement and entrainment pilot study capital and O&M costs (Track II only):*** purchasing, installing and operating pilot study technology; and laboratory analysis of samples.

Table 6-3 lists the estimated maximum costs of each of the initial NPDES permit application activities described above. The specific activities that a facility will have to undertake depend on the facility's source water body type and the permitting track it follows. Certain activities are expected to be more costly for marine facilities than for freshwater facilities. Some activities will apply to all facilities, while other activities will apply depending on whether the facility is following Track I or Track II. The maximum cost a facility that is required to implement all the activities would incur for its initial NPDES permit application is estimated to be $1,007,059 under Track II and $82,548 under Track I.

Table 6-3: Cost of Initial NPDES Permit Application Activities ($2000)

Activity	Estimated Cost per Permit			
	Track I (Recirculating)		Track II (Once-Through)	
	Freshwater	Marine	Freshwater	Marine
Start-up activities[a]	$1,635	$1,635	$1,635	$1,635
General permit application activities[a]	$5,098	$5,098	$5,098	$5,098
Source water body flow information activities[a]	$3,110	$3,110	$3,110	$3,110
Source water body baseline biological characterization activities[a]	$9,725	$9,725	$9,725	$9,725
Remote monitoring device capital and O&M costs	$51,000	$51,000	---	---
CWIS flow reduction requirement activities (Track I only)[a]	$3,661	$3,661	---	---
CWIS velocity requirement activities (Track I only)[a]	$5,428	$5,428	---	---
Design and construction technology plan (Track I only)[a]	$2,890	$2,890	---	---
Comprehensive demonstration study plan (Track II only)[a]	---	---	$14,563	$14,563
Source water body baseline biological characterization study (Track II only)[b]	---	---	$229,619	$287,845
Source water body baseline biological characterization study capital and O&M costs (Track II only)[b]	---	---	$118,500	$199,230
Evaluation of potential CWIS effects (Track II only)[a]	---	---	$112,651	$135,642
Impingement and entrainment pilot study capital and O&M costs (Track II only)[a]	---	---	$321,600	$350,210
Total Initial NPDES Permit Application Cost	$82,548	$82,548	$816,502	$1,007,059

[a] The costs for these activities are incurred in the year prior to the permit application.
[b] The costs for these activities are incurred in the three years prior to the permit application.

Source: U.S. EPA 2001b.

b. NPDES permit renewal

Each new facility operating a CWIS will have to apply for a NPDES permit renewal every 5 years. (Many times a NPDES permit is administratively continued for a period of time beyond the permit expiration date.) Permit renewal requires collecting and submitting the same type of information as required for the initial permit application. EPA expects that facilities can use some of the information from the initial permit. Building upon existing information is expected to require less effort than developing the data the first time.

Table 6-4 lists the estimated costs of each of the NPDES repermit application activities. Certain activities are expected to be more costly for marine facilities than for freshwater facilities. Some activities will apply to all facilities, while other activities will apply depending on whether the facility is following Track I or Track II. The maximum cost a facility that is required to implement all the renewal activities would incur for its NPDES permit renewal is estimated to be $44,953 under Track II and $15,094 under Track I.

Table 6-4: Cost of NPDES Repermit Application Activities ($2000)

Activity	Estimated Cost per Permit			
	Track I (Recirculating)		Track II (Once-Through)	
	Freshwater	Marine	Freshwater	Marine
Start-up activities[a]	$471	$471	$471	$471
General permit application activities[a]	$2,475	$2,475	$2,475	$2,475
Source water baseline biological characterization activities[a]	$5,146	$5,146	$5,146	$5,146
CWIS flow reduction requirement activities[a]	$2,595	$2,595	$2,595	$2,595
CWIS velocity requirement activities[a]	$3,425	$3,425	$3,425	$3,425
Design and construction technology plan (Track I only)[a]	$982	$982	---	---
Comprehensive demonstration study plan (Track II only)[a]	---	---	$6,433	$6,433
Source water baseline biological characterization study (Track II only)[a]	---	---	$16,966	$17,407
Evaluation of potential CWIS effects (Track II only)[a]	---	---	$7,001	$7,001
Total NPDES Permit Renewal Application Cost	$15,094	$15,094	$44,512	$44,953

[a] The costs for these activities are incurred in the year prior to the application for a permit renewal.

Source: U.S. EPA, 2001b.

c. Monitoring, record keeping, and reporting

All new facilities subject to the final section 316(b) New Facility Rule are required to monitor to show compliance with the requirements set forth in the rule. Facilities must keep records of their monitoring activities and report the results in a yearly status report. Monitoring, record keeping, and reporting activities and costs include:

- ***verification monitoring plan (Track II only):*** conducting technology performance monitoring; submitting monitoring results and study analysis; and keeping records (see § 125.86 (c)(2)(ii)(C));
- ***biological monitoring - impingement (Track I and II):*** collecting monthly samples for at least two (2) years after the initial permit issuance; identifying and enumerating organisms; and keeping records (see § 125.87(a)(1));
- ***biological monitoring - entrainment (Track I and II):*** collecting biweekly samples during the primary period of reproduction, larval recruitment, and peak abundance for at least two (2) years after the initial permit issuance;

identifying and enumerating organisms; and keeping records (see 125.87(a)(2));

- ***velocity monitoring (Track I and II):*** monitoring head loss across the cooling water intake screen or velocity at the point of entry through the device (other than an intake screen); correlating the head loss value with the design intake screen velocity; and keeping records (see § 125.87(b));
- ***visual or remote inspections (Track I and II):*** conducting weekly visual inspections or employing remote monitoring devices of all installed design and construction technologies (e.g., barrier nets, aquatic filter barrier systems, and fish handling return systems); and keeping records (see § 125.87(c));
- ***yearly status report activities:*** detailing biological monitoring results; detailing velocity monitoring results; reporting on visual or remote inspection; compiling and submitting the report; and keeping records (see § 125.88(b)).

Table 6-5 lists the estimated costs of each of the monitoring, record keeping, and reporting activities described above. The specific activities that a facility will have to undertake depend on the facility's source water body type and the permitting track it is following. Certain activities are expected to be more costly for marine facilities than for freshwater facilities. Some activities will apply to all facilities, while other activities will apply depending on whether the facility is following Track I or Track II. The maximum cost a facility will incur for its monitoring, record keeping, and reporting activities is estimated to be $109,383 under Track II and $96,396 under Track I.

Table 6-5: Cost of Annual Monitoring, Record Keeping, and Reporting Activities ($2000)

Activity	Estimated Cost			
	Track I (Recirculating)		Track II (Once-Through)	
	Freshwater	Marine	Freshwater	Marine
Verification monitoring (Track II only)	---	---	$4,304	$5,646
Biological monitoring (impingement)	$16,347	$20,890	$16,347	$20,890
Biological monitoring (entrainment)	$36,370	$45,035	$36,370	$45,035
Entrainment monitoring capital and O&M costs (Track II only)	$8,300	$10,640	$8,300	$10,640
Velocity monitoring	$5,093	$5,093	$5,093	$5,093
Weekly visual inspections	$667	$667	$8,259	$8,259
Remote monitoring capital and O&M costs	$250	$250	---	---
Yearly status report activities	$13,821	$13,821	$13,821	$13,821
Total Monitoring, Record Keeping, and Reporting Cost	$80,849	$96,396	$92,494	$109,383

Source: U.S. EPA, 2001b.

6.2 Facility-Level Costs

The cost estimates presented in this section are based on the unit costs presented in the previous section. EPA used 41 model facilities to develop cost estimates for the 121 facilities projected to begin operation between 2001 and 2020. EPA established a number of baseline scenarios, reflecting various baseline cooling water system types and water body types, so that the unit costs could be applied to the various model facilities to obtain facility-level costs.

In this analysis, the baseline technology represents an estimation of the technologies proposed to be constructed at new facilities independently of implementation of the final section 316(b) New Facility Rule. Specifically, the costs presented in the tables below represent the net increase in costs for each set of technology performance monitoring requirements as compared to the baseline technology. To calculate net costs, EPA first calculated the cost for the entire cooling system for the baseline technology combination, and then subtracted those costs from the calculated cost of the entire cooling system for

each compliance technology combination.

For purposes of cost estimation, EPA assumed that facilities that were projected to have recirculating baseline cooling water systems would follow Track I. EPA developed cost estimates for these facilities based on the assumption that they would already be installing cooling towers, and thus would only have to install design and construction technologies of traveling screens with fish return systems.

EPA assumed that facilities that were projected to have once-through baseline cooling water systems would follow Track II. EPA developed cost estimates for these facilities based on the assumption that they would perform comprehensive demonstration studies, but would still have to install cooling towers and design and construction technologies of traveling screens with fish return systems to meet the regulatory requirements. This is a conservative assumption that may overestimate compliance costs if a significant number of Track II facilities are able to demonstrate that their alternative technologies will reduce the level of impingement and entrainment to the same level that would be achieved by implementing the flow reduction, velocity, and design and construction technology requirements of Track I.

Some facilities were projected to have mixed once-through and recirculating baseline cooling water systems. EPA treated these facilities the same as facilities with baseline once-through cooling water systems. This represents a conservative approach since it will tend to overestimate the size of the baseline cooling water system that would have to be replaced, and thus overestimate the corresponding compliance cost. In addition, one coal facility that was projected to have a recirculating system with a cooling pond was treated as a once-through system in the baseline and costed to switch to a cooling tower.[2]

6.2.1 New Electric Generators

EPA used 14 model plants to develop costs for the 83 electric generator facilities projected to begin operation between 2001 and 2020. The first six model plants are combined-cycle facilities; the remaining eight model plants are coal-fired facilities. EPA developed these model facilities to reflect a range of low, medium, and high MW capacity facilities within each baseline scenario (baseline cooling system type and water body type).

EPA developed the model coal-fired facilities using cooling water intake structure survey data for coal-fired plants constructed within the last 20 years. EPA took design flow and facility characteristic (e.g., cooling water system type and water body type) data for these facilities from the Detailed Technical Questionnaire (DQ), Short Technical Questionnaire (SQ), and Screener survey databases. EPA assumed that, between these three survey databases, the entire universe of coal-fired power plants constructed within the last 20 years had been identified; therefore, survey weights were not used when developing flow estimates for these model facilities.

With the exception of monitoring costs, all cost components used either the design intake flow or the design cooling water flow (which was estimated from the design intake flow) as the input variable for deriving the facility cost. However, design intake flows were not available for the SQ and screener facilities; EPA therefore estimated design flows for these facilities, as described in the *Technical Development Document*.

EPA developed the model combined-cycle facilities using data from the NEWGen database of planned new electric generation facilities. The methodology used to develop the combined-cycle model facilities was similar to that used to develop the coal-fired model facilities and is described in detail in the *Technical Development Document*. However, the NEWGen facilities were not always consistent in how they reported their intake flows. Some NEWGen facilities reported design flows, some reported maximum flows, and some reported average flows. EPA assumed design flows to be equivalent to maximum flows, or to three times average flows. EPA based its model facility flow estimates on only those NEWGen facilities that reported their flows; NEWGen facilities that did not report flows were assumed to follow the same distribution as those that reported flow information.

[2] In some states, a cooling pond is considered a water of the U.S. In these states, a plant with such a cooling system would have to comply with the recirculating requirements of the final section 316(b) New Facility Rule. In those states where a cooling pond is not considered a water of the U.S., a plant would not have to comply with the recirculating requirements of this final New Facility Rule. This costing analysis made the conservative assumption that facilities with a cooling pond would have to comply with the recirculating requirements. These recirculating facilities with cooling ponds were therefore costed as if they had a once-through system in the baseline.

Table 6-6 summarizes the characteristics of the model electric generating facilities, and identifies the projected number of facilities to which they correspond.

Table 6-6: Baseline Characteristics for Model Electric Generators

Model Facility Type	Cooling System Type	Source Water Body	Steam Electric Capacity (MW)	Baseline Intake Flow (MGD)	Number of Projected New Facilities
CC OT/M-1	Once Through	Marine	1,031	613	5
CC R/M-1	Recirculating	Marine	489	8	5
CC R/M-2	Recirculating	Marine	1,030	18	1
CC R/FW-1	Recirculating	Freshwater	439	10	18
CC R/FW-2	Recirculating	Freshwater	699	12	21
CC R/FW-3	Recirculating	Freshwater	1,061	14	19
Coal OT/FW-1	Once-Through	Freshwater	63	64	1
Coal OT/FW-2	Once-Through	Freshwater	515	420	1
Coal OT/FW-3	Once-Through	Freshwater	3,564	1,550	1
Coal R/M-1	Recirculating	Marine	812	44	1
Coal R/FW-1	Recirculating	Freshwater	173	5	3
Coal R/FW-2	Recirculating	Freshwater	625	20	3
Coal R/FW-3	Recirculating	Freshwater	1,564	77	3
Coal RL/FW-1	Recirculating with Lake	Freshwater	660	537	1

Note: OT = Once-Through; R = Recirculating; RL = Recirculating with Lake; M = Marine; FW = Freshwater.

Source: U.S. EPA analysis, 2001.

EPA expects the following compliance responses:

- **once-through facilities** would install a cooling tower and install traveling screens with fish handling equipment (0.5 ft/s velocity), and
- **recirculating facilities** would install traveling screens with fish handling equipment (0.5 ft/s velocity).

More detailed information on each model facility, including its water body type, the expected compliance response of each facility, and the capital costs, if any, associated with the final rule can be found in the *Technical Development Document*.

Each facility subject to the final section 316(b) New Facility Rule will incur capital costs, annual O&M costs, and administrative costs. Administrative costs include one-time costs (initial permit application) and recurring costs (permit renewal, and monitoring, record keeping, and reporting), and depend on the facility's water body type and the permitting track the facility follows. In addition, facilities required to install a recirculating system will incur an energy penalty cost. Once again, as with the NPDES permit application requirements, some of these activities would be required anyway under the current case-by-case permitting procedures. Table 6-7 presents the estimated capital and O&M costs for the 14 model electric generators, as well as costs for the administrative activities and the energy penalty.

Table 6-7: Cost Estimates for Electric Generating Facilities (Unit Costs, $2000)

Model Facility Type	No. of New Facilities	One-Time Costs		Recurring Costs			
		Capital Technology	Initial Permit Application	O&M	Energy Penalty	Permit Renewal	Monitoring, Record Keeping, & Reporting
CC OT/M-1	5	$12,612,500	$1,007,000	$1,341,000	$619,250	$45,000	$109,500
CC R/M-1	5	$118,000	$82,500	$83,250	$0	$15,000	$96,500
CC R/M-2	1	$202,250	$82,500	$82,250	$0	$15,000	$96,500
CC R/FW-1	18	$129,250	$82,500	$71,750	$0	$15,000	$80,750
CC R/FW-2	21	$141,750	$82,500	$73,000	$0	$15,000	$80,750
CC R/FW-3	19	$162,250	$82,500	$73,000	$0	$15,000	$80,750
Coal OT/FW-1	1	$1,495,000	$816,500	$216,750	$231,250	$44,500	$92,500
Coal OT/FW-2	1	$10,242,750	$816,500	$925,000	$1,891,250	$44,500	$92,500
Coal OT/FW-3	1	$35,652,250	$816,500	$2,937,500	$13,088,250	$44,500	$92,500
Coal R/M-1	1	$486,750	$82,500	$90,250	$0	$15,000	$96,500
Coal R/FW-1	3	$97,500	$82,500	$71,750	$0	$15,000	$80,750
Coal R/FW-2	3	$222,750	$82,500	$71,750	$0	$15,000	$80,750
Coal R/FW-3	3	$790,500	$82,500	$86,250	$0	$15,000	$80,750
Coal RL/FW-1	1	$13,566,250	$816,500	$1,105,750	$2,423,750	$44,500	$92,500

Source: U.S. EPA, 2001a; U.S. EPA, 2001b.

6.2.2 New Manufacturing Facilities

EPA used 21 model plants to develop the costs for the 38 manufacturing facilities projected to begin operation between 2001 and 2020.

EPA developed the model manufacturing facilities using section 316(b) Industry Survey data for manufacturing facilities, regardless of their year of construction. Since facilities with the same Standard Industrial Classification (SIC) code generally have similar operations and generate similar products, EPA assumed that the characteristics of new facilities in a given SIC code will be similar to the characteristics of existing facilities in that same SIC code. Because the survey manufacturing facilities represent only a sampling of the total population of manufacturing facilities, survey weights were used in developing flow estimates for these model facilities.

To develop model manufacturing facilities, EPA first sorted the survey manufacturing facilities according to their 4-digit SIC codes. Within each 4-digit SIC code, EPA then grouped the facilities according to cooling system type (once-through vs. recirculating) and water body type (freshwater vs. marine) to yield a number of baseline scenarios. For each baseline scenario, EPA developed model facilities to reflect medium flow manufacturing facilities. The methodology that EPA used to develop the model facilities is described in detail in the *Technical Development Document*.

Table 6-8 summarizes the characteristics of the model manufacturing facilities, and identifies the projected number of facilities to which they correspond.

Table 6-8: Baseline Characteristics of Model Manufacturing Facilities

Model Facility Type	SIC Code	Cooling System Type	Source Water Body	Baseline Intake Flow (MGD)	Number of Projected New Facilities
MAN OT/F-2621	2621	Once-Through	Freshwater	24	2
MAN OT/M-2812	2812	Once-Through	Marine	265	1
MAN OT/F-2812	2812	Once-Through	Freshwater	94	1
MAN OT/M-2819	2819	Once-Through	Marine	27	2
MAN OT/F-2819	2819	Once-Through	Freshwater	19	2
MAN OT/F-2821	2821	Once-Through	Freshwater	78	4
MAN OT/F-2834	2834	Once-Through	Freshwater	18	2
MAN OT/F-2869	2869	Once-Through	Freshwater	40	7
MAN RE/F-2869	2869	Recirculating	Freshwater	4	1
MAN OT/F-2873	2873	Once-Through	Freshwater	33	1
MAN RE/F-2873	2873	Recirculating	Freshwater	30	1
MAN OT/F-2911	2911	Once Through	Freshwater	105	1
MAN RE/F-2911	2911	Recirculating	Freshwater	8	1
MAN OT/F-3312	3312	Once-Through	Freshwater	124	5
MAN RE/F-3312	3312	Recirculating	Freshwater	85	1
MAN OT/F-3316	3316	Once-Through	Freshwater	23	1
MAN RE/F-3316	3316	Recirculating	Freshwater	12	1
MAN OT/F-3317	3317	Once-Through	Freshwater	39	1
MAN RE/F-3317	3317	Recirculating	Freshwater	4	1
MAN OT/F-3353	3353	Once-Through	Freshwater	35	1
MAN RE/F-3353	3353	Recirculating	Freshwater	6	1

Source: U.S. EPA analysis, 2001.

EPA expects the following compliance responses:

- **once-through facilities** would implement reuse/recycle and install traveling screens with fish handling equipment (0.5 ft/s velocity), and
- **recirculating facilities** would install traveling screens with fish handling equipment (0.5 ft/s velocity).

Table 6-9 presents the estimated capital, and O&M costs associated with the projected compliance response of each model manufacturing facility. In addition, each facility subject to the final section 316(b) New Facility Rule will incur administrative costs. These costs include one-time costs (initial permit application) and recurring costs (permit renewal, and monitoring, record keeping, and reporting), and depend on the facility's water body type and the permitting track the facility follows. More detailed information on each model facility, including its water body type, the expected compliance response, and the capital costs, if any, associated with the expected action can be found in the *Technical Development Document*.

Table 6-9: Cost Estimates for Manufacturing Facilities (Unit Costs, $2000)

Model Facility	No. of New Facilities	One-Time Costs		Recurring Costs		
		Capital Technology	Initial Permit Application	O&M	Permit Renewal	Monitoring, Record Keeping, & Reporting
MAN OT/F-2621	2	$882,000	$816,500	$143,750	$44,500	$92,500
MAN OT/M-2812	1	$7,492,000	$1,007,000	$814,250	$45,000	$109,500
MAN OT/F-2812	1	$2,706,500	$816,500	$333,750	$44,500	$92,500
MAN OT/M-2819	2	$1,050,250	$1,007,000	$173,500	$45,000	$109,500
MAN OT/F-2819	2	$742,250	$816,500	$127,250	$44,500	$92,500
MAN OT/F-2821	4	$2,279,250	$816,500	$290,500	$44,500	$92,500
MAN OT/F-2834	2	$720,750	$816,500	$125,250	$44,500	$92,500
MAN OT/F-2869	7	$1,307,000	$816,500	$189,000	$44,500	$92,500
MAN RE/F-2869	1	$127,250	$82,500	$75,000	$15,000	$80,750
MAN OT/F-2873	1	$1,118,000	$816,500	$168,500	$44,500	$92,500
MAN RE/F-2873	1	$449,750	$82,500	$84,250	$15,000	$80,750
MAN OT/F-2911	1	$2,957,000	$816,500	$358,250	$44,500	$92,500
MAN RE/F-2911	1	$183,750	$82,500	$77,000	$15,000	$80,750
MAN OT/F-3312	5	$3,428,250	$816,500	$405,500	$44,500	$92,500
MAN RE/F-3312	1	$4,179,750	$82,500	$345,000	$15,000	$80,750
MAN OT/F-3316	1	$852,250	$816,500	$140,750	$44,500	$92,500
MAN RE/F-3316	1	$269,000	$82,500	$82,250	$15,000	$80,750
MAN OT/F-3317	1	$1,277,250	$816,500	$185,750	$44,500	$92,500
MAN RE/F-3317	1	$127,250	$82,500	$75,000	$15,000	$80,750
MAN OT/F-3353	1	$1,169,500	$816,500	$173,500	$44,500	$92,500
MAN RE/F-3353	1	$167,250	$82,500	$77,000	$15,000	$80,750

Source: U.S. EPA, 2001a; U.S. EPA, 2001b.

6.3 Total Facility Compliance Costs

EPA estimated the national compliance costs for the final section 316(b) New Facility Rule based on the facility-level costs discussed in Section 6.2. The costs developed in this section represent the total compliance costs for new facilities expected to begin operation between 2001 and 2020.[3] EPA estimated total compliance costs over the first 30 years of the final rule (i.e., 2001 to 2030). Accordingly, the Agency considered all compliance costs incurred by each of the 121 facilities over this 30-year time period.[4]

6.3.1 Distribution of New In-Scope Facilities by Year

Table 6-10 below presents the distribution of the 121 new in-scope facilities by year of operation and facility type. The appendix to Chapter 5 described EPA's methodology for determining the on-line years of new in-scope electric generators. For manufacturing facilities, no information on when new facilities may be constructed was available. EPA therefore distributed facilities, by 2-digit SIC code (i.e., 26, 28, 29, and 33), making the following assumptions:

- 50 percent of the projected in-scope facilities will begin operation between 2001 and 2010; 50 percent will begin operation between 2011 and 2020;
- the first facility will begin operation in 2001;
- one facility will begin operation in each subsequent year until 50 percent of the facilities are assigned;
- the distribution of in-scope manufacturing facilities within the two 10-year periods is identical (i.e., if there are five new facilities in 2001, there will be five in 2011).

For example, EPA projected 12 new in-scope facilities in SIC code 33 (steel and aluminum). Following the methodology outlined above, EPA assumed that six facilities will begin operation between 2001 and 2010, and six will begin operation between 2011 and 2020. Within the first 10-year period, the first facility in SIC code 33 will begin operation in 2001. The remaining five will begin operation between 2002 and 2006. The six facilities assigned to the second 20-year period will begin operation between 2011 and 2016, one in each year.[5]

This methodology provides a conservative estimate of the national cost of the rule because more facilities are predicted to begin operation early in each 10-year period, resulting in less discounting and higher annualized costs. For the yearly distribution by cooling system and water body, see the Appendix to this chapter.

[3] The national cost estimate presented in this chapter only accounts for *pre-tax, private costs* directly incurred by facilities. It does not represent total *social cost* of the final section 316(b) New Facility Rule.

[4] This approach does not account for all compliance costs incurred by the 121 projected in-scope facilities because the analysis disregards costs incurred after 2030. For example, for a facility estimated to begin operation in 2015, the analysis would only include the first 16 years of costs in the national aggregate.

[5] For SIC code 28 (chemical facilities), EPA projected 22 new in-scope facilities. In this case, EPA assigned two new facilities to the first year in each 10-year period, i.e., 2001 and 2011, and the remaining 18 facilities to the other 18 years.

Table 6-10: Number of Projected New In-Scope Generators by Year and Facility Type

Year of Operation	Electric Generators		Manufacturers				Total
	Combined-Cycle	Coal	SIC 26	SIC 28	SIC 29	SIC 33	
2001			1	2	1	1	5
2002				1		1	2
2003				1		1	2
2004	1			1		1	3
2005	5	2		1		1	9
2006	6	3		1		1	11
2007	5	5		1			11
2008	6	1		1			8
2009	5	1		1			7
2010	5			1			6
2011	4		1	2	1	1	9
2012	4			1		1	6
2013	4			1		1	6
2014	4			1		1	6
2015	3			1		1	5
2016	4			1		1	6
2017	3			1			4
2018	4			1			5
2019	3	1		1			5
2020	3	1		1			5
Total	**69**	**14**	**2**	**22**	**2**	**12**	**121**

Source: U.S. EPA analysis, 2001.

6.3.2 Present Value and Annualized Costs

EPA calculated the present value of each cost category using a seven percent discount rate. The following formula was used to calculate the present value of each year's cost:[6]

$$Present\ Value_x = \frac{Cost_{x,t}}{(1 + r)^t}$$

where:

$Cost_{x,t}$	=	Costs in category x and year t
x	=	Cost category
r	=	Discount rate (7% in this analysis)
t	=	Year in which cost is incurred (2001 to 2030)

Total present value for each cost component was derived by summing the present value of each year's cost. Finally, EPA calculated annualized costs using the following formula:

$$Annualized\ Cost_x = PV_x \times \frac{r \times (1 + r)^n}{(1 + r)^n - 1}$$

where:

x	=	Cost category
PV_x	=	Present value of compliance costs in category x
r	=	Discount rate (7% in this analysis)
n	=	Amortization period (30 years)

Table 6-11 presents the estimated national aggregate of facility compliance costs of the final section 316(b) New Facility Rule by cost category. The table shows that the total annualized cost for the 121 facilities is estimated to be $47.7 million. Of this, $34.7 million will be incurred by electric generators and $13 million by manufacturing facilities.

Table 6-11: Annualized Facility Compliance Costs (in millions $2000)

Industry Category (Number of Facilities Affected)	One-Time Costs		Recurring Costs				Total
	Capital Technology	Initial Permit Application	O&M	Energy Penalty	Permit Renewal	Monitoring, Record Keeping & Reporting	
Electric Generators (83)	$7.1	$0.7	$9.4	$14.1	$0.1	$3.2	$34.7
Manufacturing Facilities (38)	$3.8	$1.4	$5.8	$0.0	$0.1	$1.9	$12.9
Total (121)	**$10.9**	**$2.0**	**$15.2**	**$14.1**	**$0.3**	**$5.2**	**$47.7**

Source: U.S. EPA, 2001a; U.S. EPA, 2001b; U.S. EPA analysis, 2001.

[6] Calculation of the present value assumes that the cost is incurred at the end of the year.

6.4 Additional Facility Analyses

Estimating compliance costs for the section 316(b) New Facility Rule requires projecting the types of facilities that will be built in the future. EPA's projections do not include some facility types that could incur higher costs or more significant impacts than estimated here, if these types of plants were constructed. For example, the AEO2001 did not project any new nuclear capacity additions over the next 20 years. EPA therefore did not estimate compliance costs for nuclear facilities.

This section presents EPA's analysis of the cost of complying with the final section 316(b) New Facility Rule to two hypothetical nuclear plants. In addition, EPA tested the sensitivity of analysis results to the assumption that new in-scope coal facilities would install *redwood* cooling towers. EPA developed costs for four additional coal facilities, using the assumptions that they would install *concrete* cooling towers instead.

EPA made the following assumptions for the six additional facility analyses:

- **Nuclear-1:** This facility has a generating capacity of 2,708 MW. It has a concrete natural draft cooling tower in the baseline and plans to withdraw from a marine water body. Its design intake flow of 209 MGD is the maximum flow for a nuclear facility with a recirculating system reported in the 1995 Form EIA-767 database (U.S. DOE, 1995).

- **Nuclear-2:** This facility has a generating capacity of 2,666 MW. It has a once-through system in the baseline and plans to withdraw from a marine water body. Its design intake flow of 2,931 MGD is average flow of the top third of nuclear facilities with once-through systems reported in the 1995 Form EIA-767 database (U.S. DOE, 1995).

- The **four coal facilities** are similar to the four coal model new facilities estimated to install a cooling tower to comply with the final section 316(b) New Facility Rule (Coal OT/FW-1, Coal OT/FW-2,Coal OT/FW-3,and Coal RL/FW-1). They have identical characteristics to the model new facilities presented in section 6.2 above, except that they will install a concrete cooling tower instead of a redwood one.

Table 6-11 presents the unit costs for these six facilities.

Table 6-11: Unit Cost Estimates for Six Additional Facilities ($2000)

Model Facility Type	One-Time Costs		Recurring Costs			
	Capital Technology	Initial Permit Application	O&M	Energy Penalty	Permit Renewal	Monitoring, Record Keeping, & Reporting
Nuclear-1	$2,316,250	$82,500	$134,500	$0	$15,000	$96,500
Nuclear-2	$203,103,000	$1,007,000	$374,750	$11,261,500	$45,000	$109,500
Coal OT/FW-1	$2,280,500	$816,500	$158,000	$231,250	$44,500	$92,500
Coal OT/FW-2	$15,079,500	$816,500	$575,000	$1,891,250	$44,500	$92,500
Coal OT/FW-3	$52,726,750	$816,500	$1,725,000	$13,088,250	$44,500	$92,500
Coal RL/FW-1	$19,593,250	$816,500	$674,500	$2,423,750	$44,500	$92,500

Source: U.S. EPA, 2001a; U.S. EPA, 2001b; U.S. EPA analysis, 2001.

Capital costs for the nuclear facility with a recirculating system in the baseline (Nuclear-1) are $2.3 million. This is higher than the capital costs for coal and combined-cycle electric generators, which range from $97,500 to $790,600. For the nuclear facility with a once-through system in the baseline (Nuclear-2), capital costs are $203 million, compared to between $1.5 and $35.7 million for combined-cycle and coal facilities with once-through systems.

For coal plants installing concrete cooling towers, capital costs range from $2.3 million to $52.7 million compared to costs for equivalent facilities under the final rule which range from $1.5 million to $35.7 million and assume redwood cooling towers. Annual O&M costs are less expensive for coal facilities installing concrete cooling towers with costs ranging from $0.2 million to $1.7 million compared to $0.2 million to $2.9 million for redwood cooling towers. These six facilities are not expected to be constructed in addition to the 121 projected new in-scope facilities. Therefore, their costs were not added to the cost estimate in section 6.3.

6.5 Limitations and Uncertainties

EPA's estimates of the compliance costs associated with the final section 316(b) New Facility Rule are subject to limitations because of uncertainties about the number and characteristics of the new facilities that will be subject to the rule. Projecting the number of new facilities in different industries is subject to uncertainties about future industry growth rates and about the portion of new capacity that will come from new greenfield and stand alone facilities as opposed to expansions at existing facilities. This is especially the case when extending forecasts 20 years into the future.

To the extent possible, EPA used information on the characteristics of facilities that are now being planned to project the baseline characteristics of facilities affected by the rule. Information on these planned facilities and on the characteristics of existing facilities that have CWIS provided a basis for projecting the characteristics of new facilities beyond those for which plans are available. The estimated national facility compliance costs may be over- or understated if the projected number of new facilities is incorrect or if the characteristics of new facilities are different from those assumed in the analysis. In particular, the analysis may overestimate the number of facilities that will withdraw from a water of the U.S. and thus be subject to the final rule, given observed trends toward greater use of recirculating systems and away from the use of a water of the U.S. to provide cooling water.

Limitations in EPA's ability to consider a full range of compliance responses may result in an overestimate of facility compliance costs. The Agency was not able to consider certain compliance responses, including the costs of using alternative sources of cooling water and the cost of some methods of changing the cooling system design. Costs will be overstated if these excluded compliance responses are less expensive than the projected compliance response for some facilities.

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Appendix to Chapter 6

Section 6.3 above presented the distribution of new in-scope electric generator and manufacturing facilities over the 20-year forecast period 2001 to 2020. This appendix describes EPA's approach to assigning model facility characteristics to the yearly distribution of facilities and the results.

EPA assigned model facility types evenly over the years with projected new facilities. For example, EPA estimates that five of the 69 new, in-scope, combined-cycle facilities would install a cooling tower as a result of the rule. The cost analysis therefore assumes that the 1st, 16th, 30th, 44th, and 58th combined-cycle facility to begin operation will incur costs of a cooling tower. In addition, EPA estimates that three of the 14 new in-scope coal-fired facilities are planning to build a once-through system in the baseline. The cost analysis therefore assumes that the 1st, 6th, and 11th coal-fired facility to begin operation will incur costs of a cooling tower. One coal facility with a cooling pond is also assumed to require a cooling tower. This facility will be the 2nd to begin operation. EPA followed the same approach for new in-scope manufacturing facilities. In general, EPA always assigned the highest cost model facilities of each facility type to the facilities beginning operation first. This approach is conservative as the highest costs are discounted less, resulting in a higher annualized cost.

The following three tables present the distribution of new in-scope combined-cycle, coal, and manufacturing model facilities by year.

Table 6.A-1: Distribution of Projected New In-Scope Combined-Cycle by Year

On-Line Year	Once-Through	Recirculating					Total
	Marine	Freshwater			Marine		
		Small	Medium	Large	Small	Large	
2004	1						**1**
2005				4	1		**5**
2006		1	4			1	**6**
2007	1	3		1			**5**
2008			2	3	1		**6**
2009		3	2				**5**
2010	1	1		3			**5**
2011			2	1	1		**4**
2012		2	2				**4**
2013	1	2		1			**4**
2014				3	1		**4**
2015			3				**3**
2016		3	1				**4**
2017	1		1	1			**3**
2018		1	1	1	1		**4**
2019		1	1	1			**3**
2020		1	2				**3**
Total	**5**	**18**	**21**	**19**	**5**	**1**	**69**

Source: U.S. EPA analysis, 2001.

Table 6.A-2: Distribution of Projected New In-Scope Coal Facilities by Year

On-Line Year	Once-Through			Recirculating with Lake	Recirculating				Total
	Freshwater			Freshwater	Freshwater			Marine	
	Small	Medium	Large		Small	Medium	Large	Small	
2005			1	1					**2**
2006					1	1	1		**3**
2007		1			1	1	1	1	**5**
2008	1								**1**
2009							1		**1**
2019						1			**1**
2020					1				**1**
Total	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**14**

Source: U.S. EPA analysis, 2001.

Table 6.A-3: Distribution of Projected New In-Scope Manufacturing Facilities by Year

On-Line Year	2621	2812		2819		2821	2834	2869		2873		2911		3312		3316		3317		3353		Total
	OT	OT		OT		OT	OT	OT	R	OT	R	OT	R	OT	R	OT	R	OT	R	OT	R	
	F	F	M	F	M	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
2001	1	1	1									1		1								**5**
2002					1									1								**2**
2003				1										1								**2**
2004					1										1							**2**
2005				1										1								**2**
2006						1								1								**2**
2007						1																**1**
2008						1																**1**
2009						1																**1**
2010							1															**1**
2011	1						1	1					1			1						**5**
2012								1									1					**2**
2013								1										1				**2**
2014								1											1			**2**
2015									1											1		**2**
2016								1													1	**2**
2017								1														**1**
2018								1														**1**
2019										1												**1**
2020											1											**1**
Total	**2**	**1**	**1**	**2**	**2**	**4**	**2**	**7**	**1**	**1**	**1**	**1**	**1**	**5**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**38**

Notes: OT = Once-Through; R = Recirculating; F = Freshwater; M = Marine.

Source: U.S. EPA analysis, 2001.

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