Cooling Water Intake Structures: Summary of EPA's Proposed Rule

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Summary

Thermoelectric generating plants and manufacturing facilities withdraw large volumes of water for production and, especially, to absorb heat from their industrial processes. Water withdrawals by power producers and manufacturers represent more than one-half of water withdrawn daily for various uses in the United States. Although water withdrawal is a necessity for these facilities, it also presents special problems for aquatic resources. In particular, the process of drawing surface water into the plant through cooling water intake structures (CWIS) can simultaneously pull in fish, shellfish, and tiny organisms, injuring or killing them. Congress enacted section 316(b) of the Clean Water Act (CWA) specifically to address CWIS.

Regulatory efforts by the Environmental Protection Agency (EPA) to implement section 316(b) have a long and complicated history over 35 years, including legal challenges at every step by industry groups and environmental advocates. Currently most new facilities are regulated under rules issued in 2001, while rules for existing facilities were challenged and remanded to EPA for revisions. In response to the remands, in March 2011 EPA proposed national requirements affecting approximately 1,150 existing electric powerplants and manufacturing facilities. Publication of the CWIS proposal in the *Federal Register* on April 20 triggered a public comment period that ends on August 18, 2011. EPA is under a court-ordered schedule to issue a final CWIS rule by July 27, 2012. Even before release, the proposed regulations were highly controversial among stakeholders and some Members of Congress. The issue for Congress has been whether a stringent and costly environmental mandate could jeopardize reliability of electricity supply in the United States. Many in industry feared, while environmental groups hoped, that EPA would require installation of technology called closed-cycle cooling that most effectively minimizes the adverse environmental impacts of CWIS, but also is the most costly technology option.

The EPA proposal declined to mandate closed-cycle cooling universally and instead favors a less costly, more flexible regulatory option. EPA's recommended approach would essentially codify current CWIS permitting procedures for existing facilities, which are based on site-specific determinations and have been in place administratively for some time because of legal challenges to previous rules. EPA acknowledges that closed-cycle systems reduce the adverse effects of CWIS to a greater extent than other technologies, but in the proposed rule it rejected closed-cycle cooling as a uniform requirement at existing facilities. The agency based that conclusion on four factors: additional energy needed by electricity and manufacturing facilities to operate cooling equipment and adverse consequences to reliability of energy delivery (i.e., energy penalty), additional air pollutants that would be emitted because fossil-fueled facilities would need to burn more fuel as compensation for the energy penalty, land availability concerns in some locations, and limited remaining useful life of some facilities such that retrofit costs would not be justified.

Although specifics are unknown for now, the general tone of stakeholders' comments on the proposed rule can be anticipated. Industry groups are likely to view the proposal favorably, at least in general terms. Environmental advocates, on the other hand, are likely to be critical of the proposal for not mandating stricter technological options that will provide greater protection of aquatic resources. States will be responsible for most permitting actions to implement the rule. Since many states are coping with constrained budgets, some may favor a regulatory approach that requires them to make fewer case-by-case decisions, thus imposing less administrative cost.

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Introduction

Thermoelectric generating plants and many manufacturing facilities withdraw large volumes of water for use in production and, especially, to absorb waste heat from their industrial processes. Water withdrawals by electric generating plants, used primarily for cooling, are the largest category by sector in the United States—201 billion gallons per day (BGD)—while water withdrawals by industrial facilities, used both for production and cooling, are 18 BGD. Together, water withdrawals by manufacturers and electricity generators represent more than one-half of the 410 billion gallons of water withdrawn daily for various uses in the United States.[1]

Withdrawing water from streams, rivers, lakes, and coastal waters is a necessity for most electricity generating and manufacturing facilities, but facilities that require water for cooling also present special problems for aquatic resources. For example, the direct release of heated water after circulation through a powerplant or manufacturing facility can harm aquatic life in a stream or lake. And the process of drawing surface water into the plant or facility can simultaneously pull fish, shellfish, and tiny organisms into the plant, generally killing them. In recognition of such impacts, Congress included section 316 in the 1972 Federal Water Pollution Control Act (the law is commonly known as the Clean Water Act, or CWA[2]) specifically to address the potential problems of heat discharges[3] and cooling water intake structures.

Cooling water intake structures (CWIS) can cause two types of adverse environmental impacts. First, impingement occurs when fish, invertebrates, and other aquatic life are trapped on equipment such as screens at the entrance to the CWIS. The force of the intake water traps the organisms against the screen, and they are unable to escape. Second, entrainment occurs when small aquatic organisms, eggs, and larvae pass through the intake screening system and are drawn into the cooling mechanism, travel through the cooling system pumps and tubes, and then are discharged back into the source water. Impingement and entrainment injure or kill large numbers of aquatic organisms at all life stages. In turn, reducing impingement and entrainment mortality rates is likely to increase the number of fish, shellfish, and other aquatic organisms in affected waters.[4] CWA section 316(b) authorizes regulation of CWIS in order to protect such organisms from being harmed or killed.

The Environmental Protection Agency (EPA) has been engaged in regulatory efforts to implement section 316(b) for 35 years. Most recently, in March 2011, EPA proposed national requirements to be implemented through CWA discharge permits to minimize adverse environmental impact of cooling water intake structures at existing electricity generating and manufacturing facilities.

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[1] Joan F. Kenny, Nancy L. Barber, and Susan S. Hutson et al., *Estimated Use of Water in the United States in 2005*, U.S. Department of the Interior, U.S. Geological Survey, Circular 1344, 2009.

[2] 33 U.S.C. 1251 et seq.

[3] Regulation of thermal discharges, under CWA section 316(a), is not part of the regulatory proposal discussed in this report and is not discussed here. Regulations to implement this provision are found at 40 CFR 125.70. See section VII-D-7 of the proposed rule for discussion of thermal discharge impacts of cooling water systems.

[4] CWIS impacts on aquatic biota do not occur in isolation from other stressors, such as degraded water and sediment quality, low dissolved oxygen, eutrophication, and habitat loss or modification. Effects of these manmade stressors on local biota may contribute to or compound the local impact of CWIS impingement and entrainment mortality. See generally, U.S. Environmental Protection Agency, *Environmental and Economic Benefits Analysis for Proposed Section 316(b) Existing Facilities Rule*, EPA 821-R-11-002, March 28, 2011. Hereinafter, Environmental Benefits Analysis.

Even before release, the proposed regulations were highly controversial among stakeholders and some Members of Congress. The issue for Congress has been whether a stringent and costly environmental mandate could jeopardize reliability of electricity supply in the United States. Many industry stakeholders feared, while environmental groups hoped, that EPA would require installation of technology called closed-cycle cooling[5] that most effectively minimizes impingement and entrainment, but also is the most costly technology option.[6] However, as discussed in this report, the EPA proposal declined to mandate closed-cycle cooling universally and instead proposed a less costly, more flexible regulatory option. EPA's recommended option would require uniform impingement mortality standards at all affected facilities and case-by-case determination of entrainment controls for all facilities. Publication of the proposal in the *Federal Register* on April 20 triggered a public comment period that ends on August 18, 2011.[7] Thereafter, EPA will review the public comments and, under a court-ordered schedule, will issue a final rule by July 27, 2012.

Background

The primary goal of the CWA is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[8] To further this goal, the act prohibits the "discharge of any pollutant by any person" unless a statutory exception applies; the primary exception is procurement of a CWA permit.[9] Under the law, EPA or an authorized state agency can issue a permit for the discharge of any pollutant provided that the discharge complies with the conditions of the CWA.[10] The act requires technology-based solutions to minimize adverse environmental impacts of pollutant discharges, and sections 301 and 306 require EPA to develop technology-based effluent limitation guidelines for existing sources and performance standards for new sources, respectively, that are used as the basis for restrictions specified in discharge permits.[11]

[5] Throughout this report, the terms "closed-cycle," "recirculating," and "cooling tower" will be used interchangeably. The term "closed-loop cooling" also is commonly used.

[6] The North American Electric Reliability Corporation (NERC), in an October 2010 report, concluded that implementation of four EPA rules, including a 316(b) rule, could result in a loss of up to 19% of fossil-fuel-fired steam capacity in the United States by 2018, with the potential for "significantly deteriorating future … system reliability." However, NERC incorrectly assumed that EPA would mandate closed-cycle cooling for all power plants and on that basis concluded that the 316(b) rule would be the most costly of the rules that it analyzed. North American Electric Reliability Corporation, *2010 Special Reliability Scenario Assessment: Resource Adequacy Impacts of Potential U.S. Environmental Regulations*, October 2010, http://www.nerc.com/files/EPA_Scenario_Final.pdf.

[7] U.S. Environmental Protection Agency, "National Pollutant Discharge Elimination System—Cooling Water Intake Structures at Existing Facilities and Phase 1 Facilities," 76 *Federal Register* 22,174-22,228, April 20, 2011. Hereinafter, CWIS Proposal. In this proposal, the public comment period was due to end on July 19. On July 14, EPA announced that EPA was extending this deadline to August 18, 2011, at the request of stakeholders.

[8] CWA section 101(a) (33 U.S.C. 1251(a)).

[9] CWA section 301 (33 U.S.C. 1311) and CWA section 402 (33 U.S.C. 1342).

[10] CWA section 402. The CWA vests permitting authority with EPA, but allows the agency to authorize qualified states to do so in lieu of EPA. Currently, 46 states have been authorized to issue CWA permits, and EPA is the permitting authority in other states (i.e., Idaho, Massachusetts, New Hampshire, and New Mexico), the District of Columbia, and all U.S. Territories except the Virgin Islands.

[11] CWA section 301, and CWA section 306 (33 U.S.C. 1316).

Section 316, the provision concerned with thermal discharges and cooling water intake structures, cross-references both sections 301 and 306.[12] Section 316(b) provides in full—

> Any standard established pursuant to section 301 or section 306 of this Act and applicable to a point source shall require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact.

EPA's efforts to implement section 316(b) have a long and complicated history, including legal challenges at every step by industry groups and environmental advocates (for details, see the **Appendix**). In summary, however, CWIS regulation involves three rulemaking phases. These regulatory requirements are applied to individual facilities through discharge permits issued by EPA or an authorized state agency.

- Phase I, issued in 2001, covers CWIS at new facilities,
- Phase II, issued in 2004, covers large existing electric generating plants, and
- Phase III, issued in 2006, covers certain existing facilities (manufacturing facilities and small electric generating plants) and new offshore and coastal oil and gas extraction facilities.

EPA's March 2011 proposal stems from legal challenges to the Phase II rules (including a Supreme Court ruling in 2009) and the Phase III rules.[13] Eventually, EPA determined that the most efficient regulatory approach would be to consolidate the regulations for existing facilities in a single proposal. In November 2010, EPA signed a settlement agreement with environmental group plaintiffs regarding rulemaking dates for establishing CWIS technology-based standards for existing facilities. EPA agreed to propose standards by March 14, 2011, and to take final action by July 27, 2012. On March 15, the parties agreed to an amendment to extend the date for the proposed rule to March 28, 2011. The 2012 deadline for a final rule is unchanged. EPA proposed the regulations on March 28; the proposal was published in the *Federal Register* on April 20.

Cooling Water System Technology

Most power generators and manufacturing facilities use various types of water-based systems to cool power production processes[14] or manufacturing equipment.[15] On average, existing power

[12] 33 U.S.C. 1326.

[13] The current regulatory proposal does not address the Phase III rules for new offshore and coastal oil and gas facilities. The proposal does address one provision of the Phase I rules, which is discussed below (see "Phase I Restoration Measures").

[14] According to the Department of Energy—

> At nuclear and fossil-fuel power plants, electricity is produced by heating purified water to create high-pressure steam. The steam is expanded in turbines, which drive the generators that produce electricity. After leaving the turbines, the steam passes through a condenser that has multiple tubes and a large surface area. A large volume of cool water circulates through the tubes, absorbing heat from the steam. As the steam cools and condenses, the temperature of the cooling water rises.

U.S. Department of Energy, Office of Fossil Energy, *Energy Penalty Analysis of Possible Cooling Water Intake Structure Requirements on Existing Coal-Fired Power Plants*, October 2002, p. 13.

[15] Manufacturers withdraw water both for on-site power production (like electric utilities) and for process water that is used directly in an industrial process (e.g., water used as raw material in a product). Process water is more typically (continued...)

generators use 85% of withdrawn water for cooling, while manufacturing facilities on average use 52% of withdrawn water for cooling.[16] As defined in the proposed rule, "cooling water" is water used for equipment cooling, evaporative cooling tower makeup, and dilution of waste heat.[17] Most facilities use either once-through cooling or recirculating cooling (also known as closed-loop or closed-cycle). The basic designs are illustrated in **Figure 1**.

Once-through cooling refers to cooling systems in which untreated water is withdrawn from a source, circulated through heat exchangers, and then returned to a surface-water body. Large amounts of water—typically in the range of tens of millions to billions of gallons per day—are needed for once-through cooling. The vast majority of it is returned to the stream or lake, but at higher temperatures. The discharged water also may contain chemicals or pollutants from the cooling process. Once-through systems are used by 63% of electric generators and 48% of manufacturers subject to EPA's proposed rule.[18]

Recirculating, or closed-cycle, cooling systems receive their cooling water from and return it to a cooling tower and basin, cooling pond, or cooling lakes. Water is withdrawn from a source, circulated through heat exchangers, cooled using ponds or towers, and then recirculated. Some water is removed from the recirculating system as a blowdown stream to control the buildup of suspended and dissolved solids. Amounts of water that are lost to evaporation, blowdown, and leakage are replaced with new withdrawal, usually from surface water bodies. Closed-cycle systems are used by 26% of electric generators and 20% of manufacturers subject to the proposed rule. There also are combination systems, facilities with multiple cooling water systems that use both once-through and closed-cycle cooling; combination systems account for another 9% of electric generators and 21% of manufacturers.[19]

(...continued)

associated with manufacturers than electric plants.

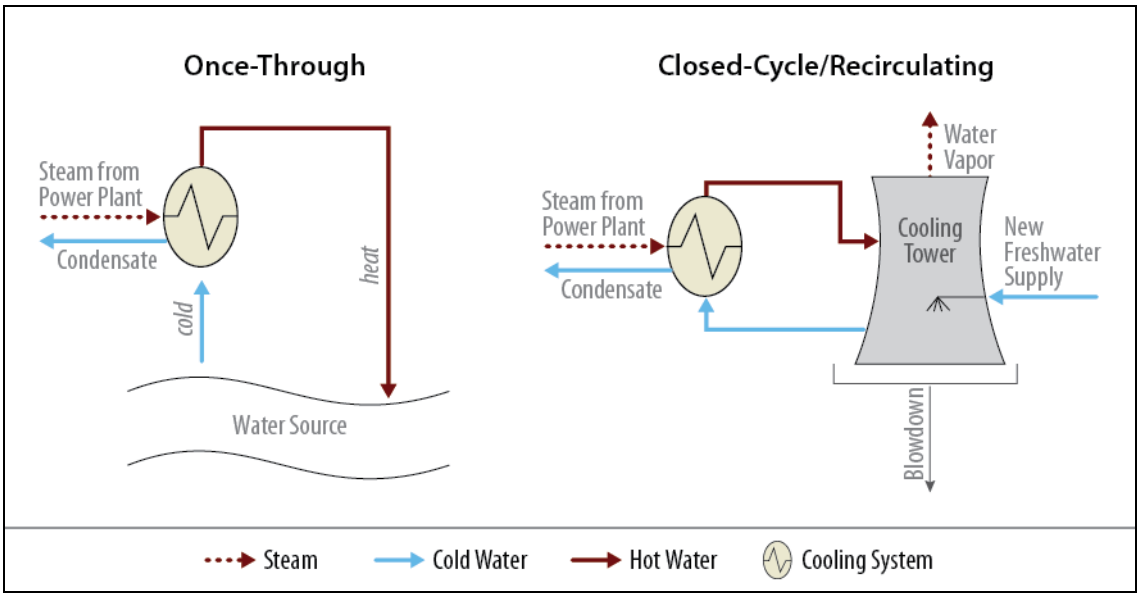
[16] CWIS Proposal p. 22,217.

[17] Cooling water is further subcategorized into either water that does not come into contact with any industrial materials, equipment or processes (non-contact cooling water) or water that comes in direct contact with hot equipment or heated materials and often requires treatment to remove pollutants such as metals before it may be discharged (contact cooling water). Ibid., p. 22,189.

[18] Ibid., p. 22,190, Exhibit IV-1.

[19] CWIS Proposal, p. 22,191. In some cases, the closed-cycle system uses cooling ponds, rather than cooling towers. The focus of EPA's regulatory proposal is cooling towers as an alternative to once-through cooling systems.

Figure 1. Once-Through and Closed-Cycle Wet Cooling System Designs



Source: Prepared by CRS, from North American Electric Reliability Corporation, "2010 Special Reliability Scenario Assessment: Resource Adequacy Impacts of Potential U.S. Environmental Regulations," October 2010, p. 46.

There are two main types of closed-cycle systems. Both reduce the quantity of water that must be withdrawn: they achieve flow reductions of 97.5% for freshwater and 94.9% for saltwater sources, compared with once-through cooling systems, according to EPA.[20] In a wet cooling tower system, water that has absorbed waste heat transfers that heat through evaporation into the surrounding air and recirculates the water to continue the cooling process. In dry cooling tower systems, waste heat is transferred completely through convection and radiation, rather than evaporation. Dry cooling towers are much larger and therefore more expensive—reportedly five to 10 times more expensive—than wet cooling towers. Because dry cooling towers virtually eliminate the need for cooling water withdrawals, they have been used as part of newly constructed cooling systems in areas with limited water supplies, such as the arid southwest of the United States.[21]

Regardless of the plant design, a facility with a once-through cooling system will always withdraw more water, but evaporate (that is, consume, or remove water from the immediate environment) less water than a closed-cycle system. There are other types of tradeoffs between the two systems. Closed-cycle systems are more expensive to construct and operate. Once-through systems minimize evaporative losses and make facilities more energy efficient, because large amounts of power are not needed to operate cooling towers and condensers. However, their use is potentially limited during low-flow conditions, such as drought. Also, because they withdraw large quantities of water, once-through systems will have greater potential impacts on aquatic life.

[20] Ibid., p. 22,203.

[21] Ibid., pp. 22,199-22,200.

Technology for Impingement and/or Entrainment Control

Section 316(b) requires EPA to establish standards for CWIS that reflect the "best technology available [BTA] for minimizing adverse environmental impact." Because the two main adverse effects of CWIS are impingement and entrainment (I&E), EPA's regulatory proposal encompasses the best technology to minimize both of those effects. The proposal describes two basic approaches to reducing I&E.

> The first approach is flow reduction, where the facility installs technology or operates in a manner to reduce or eliminate the quantity of water being withdrawn…The second way to reduce I&E is to install technologies or operate in a manner that either a) gently excludes organisms or b) collects and returns organisms [back to the source water].[22]

EPA identified a number of technologies that can minimize impingement and/or entrainment mortality associated with CWIS, as described in the following text box, "Technology to Minimize Impingement and/or Entrainment Mortality."

[22] Ibid., p. 22,198.

Technology to Minimize Impingement and/or Entrainment Mortality

- The potential for impingement and entrainment is greatly minimized by using closed-cycle cooling systems, which withdraw less water than once-through systems.
- Flow reduction is commonly used to reduce impingement and entrainment. One approach to flow reduction is limiting the velocity of intake water to 0.5 feet per second or less to allow fish to swim away and escape the intake current.
- Screens are installed in front of water intakes and work by collecting or "impinging" fish and shellfish on the screen. They generally are either traveling screens, which rotate up and out of the water where debris and impinged organisms are removed from the screen surface by a high pressure spray wash, or cylindrical wedgewire screens, which act passively to block passage. The size of the screen mesh is an important consideration, because entrainment typically decreases as mesh size decreases. EPA believes that traveling screens are used by a large majority of electric generators (93%) and manufacturers (73%) that have CWIS.
- Barrier nets prevent impingement by fully encircling the intake area of water withdrawal to prevent fish and shellfish from coming in contact with intake structures and screens. Typically they have large mesh sizes that are designed to prevent impingement, but with no reduction in entrainment. Barrier nets are more effective than traveling screens to minimize shellfish impingement, because many types of shellfish grab hold of the traveling screen surface and are not removed by high pressure spray wash.
- Aquatic filter barriers are similar to barrier nets but are made of water-permeable fabric panels with small pores. Because they present a physical barrier to large and very small organisms, they can reduce both impingement and entrainment.
- Changing the water intake location from nearshore to far offshore areas that are less biologically productive can reduce impingement and entrainment. Most offshore intakes are fitted with a velocity cap, thus converting the direction of flow from vertical to horizontal, which triggers a physiological avoidance response in fish that reduces impingement. Re-location may be possible for facilities located on coasts but is not possible on many rivers and streams.
- In some cases, it may be possible to restrict a facility's operation so that water intake does not occur during spawning or other periods when large numbers of aquatic organisms are present near intake structures.

Source: CWIS Proposal, pp. 22,200-22,202.

As detailed below, EPA's current Phase I regulations for *new* facilities generally require closed-cycle cooling systems. Since promulgation of the Phase I rules in December 2001, 225 new units at power plants (and an unknown number of manufacturing facilities) have been built in compliance with the rules' requirement for closed-cycle cooling or equivalent alternative.[23]

For *existing* facilities, in the absence of nationwide regulations issued by EPA (because of legal challenges to the Phase II and III rules), permitting authorities make BTA determinations for CWIS on a case-by-case basis, using the permit writer's best professional judgment.[24] In a few states, permitting authorities have proposed or are requiring installation of closed-cycle cooling systems at existing facilities. For example, New York regulators proposed a policy in March 2010 to establish closed-cycle cooling or its equivalent as BTA for existing facilities, and they have used the draft policy as the basis for imposing strict cooling water requirements at the Indian

[23] U.S. Energy Information Administration, *Electric Power Annual 2009*, Table 5.1, Count of Electric Power Industry Power Plants, 2001 through 2009, November 2009, http://www.eia.doe.gov/cneaf/electricity/epa/epaxlfile5_1.pdf.

[24] In circumstances when national standards do not exist or do not apply, permit writers use their best professional judgment to determine applicable requirements for individual facilities.

Point Units 2 and 3 nuclear power facilities in the state.[25] Similarly, in May 2010, California regulators adopted a policy intended to require powerplants that use marine or estuarine waters as a source of cooling water to replace once-through cooling systems with closed-cycle systems.[26] At least two other states—Delaware and New Jersey—have recently proposed to issue permits for existing powerplants that would require closed-cycle cooling systems in order to reduce cooling water use and protect aquatic organisms.[27]

The EPA Proposal

Facilities Covered by the Proposal

From a biological perspective, the effect of intake structures on impingement and entrainment is identical whether a CWIS is associated with a powerplant or a manufacturing facility. Thus, the regulatory requirements in the EPA proposal announced in March would apply identically to all covered facilities. It does not differentiate requirements for existing power producers and existing manufacturing facilities, although it does propose different compliance schedules for manufacturers and powerplants (see "Compliance Schedule"). In total, the proposed rule would apply to approximately 1,150 facilities.

The universe of manufacturers affected by the proposal is 592 facilities; 575 of these are in six primary manufacturing industries. EPA estimates that the proposal would affect 26 aluminum manufacturers, 179 chemical manufacturers, 37 food manufacturers, 225 pulp and paper manufacturers, 39 petroleum manufacturers, 68 steel manufacturers, and 17 additional facilities in other categories (e.g., mining). Overall, these 575 represent 2% of all manufacturing facilities in the six industries. The percentage of facilities within these industries that are within the scope of the proposed rule ranges from less than 0.1% (food) to 38% (pulp and paper).[28] Small entities (with fewer than 500 employees) comprise 46% of the affected manufacturing facilities; the chemical manufacturing sector has the largest percentage of small manufacturing entities.

The universe of steam electric generators that would be affected is 559 facilities; 66 are nuclear plants, and the remainder are fossil-fuel plants. Of the total, 389 are owned by utilities that are engaged in generating, transmitting, and distributing electricity for sale in regulated markets (306 are investor-owned, 58 are publicly owned, and 25 are cooperatives), and 170 are owned by non-utilities.[29] Together, these facilities comprise approximately 11% of all steam electric generating facilities and over 45% of the electric power sector capacity in the United States.[30] Twenty-five of

[25] For information, see http://www.dec.ny.gov/animals/32847.html.

[26] For information, see http://www.swrcb.ca.gov/board_decisions/adopted_orders/resolutions/2010/rs2010_0020.pdf.

[27] See http://www.dnrec.delaware.gov/News/Pages/DNREC_to_require_95_percent_cooling_water_reduction_for_Indian_River_power_plant_permit.aspx, and http://www.state.nj.us/dep/newsrel/2010/10_0001.htm.

[28] CWIS Proposal, p. 22,191, Exhibit IV-2.

[29] Non-utility power producers generate electricity for their own use and/or for sale in nonregulated, wholesale markets (selling power to electric utilities for subsequent sale to consumers). Nonutility power producers include independent power producers and cogenerators (combined heat and power producers). See http://www.eia.doe.gov/cneaf/electricity/page/prim2/chapter2.html.

[30] The EPA proposal excludes 20 electric generators that already are required by state policies to comply with equivalent standards, as well as 39 electric generators and 76 manufacturing facilities that are projected to be baseline (continued...)

the plants are large (with more than 2,500 megawatts (MW) of generation capacity), while 214 (38%) generate less than 500 MW of electricity. Regionally, 31% of the affected powerplants are located in the Upper Midwest/Mid-Atlantic states, and 26% are located in the Southeast. These facilities represent 19% and 16% of electricity generation capacity in those regions, respectively.[31]

EPA's proposal describes four regulatory options. All would apply to power producers and manufacturers that withdraw over 2 MGD of water, at least 25% of which is used for cooling purposes. While nearly all water withdrawn by electricity generators is for cooling, manufacturers withdraw water for multiple purposes that include cooling and various direct industrial processes (e.g., water needed as a raw material or used as an ingredient in intermediate products). EPA believes that a significant amount of reduction, reuse, and recycling of water has already occurred in most manufacturing processes, in part due to other existing CWA requirements. Under the proposal, water used in a manufacturing process, either before or after it is used for cooling, would not be considered cooling water for purposes of determining the 25% threshold. Additionally, the proposal excludes cooling water obtained by manufacturers from a public water system, reclaimed water from wastewater treatment facilities, or treated effluent from the manufacturing facility that is reused.

According to EPA, the 2 MGD/25% thresholds in the proposed rule would potentially cover 99.7% of water withdrawals by existing utilities and other industrial sources. The proposed thresholds would cover approximately 68% of manufacturers and 93% of power-generating facilities (100% of electric utilities and 70% of non-utilities).[32]

Regulatory Options

EPA evaluated four regulatory options to minimize impingement mortality and entrainment mortality by CWIS at existing facilities, which are summarized in **Table 1**. Each has varying costs and environmental benefits, as discussed below. Three would require the same impingement mortality standards (uniform impingement standards—traveling screens—for all existing facilities), but they differ with respect to the approach to controlling entrainment mortality. The fourth option would allow permitting authorities to establish both impingement and mortality controls on a case-by-case basis for facilities with water-intake flow between 2 MGD and 50 MGD and would require uniform controls for larger facilities. The agency's identified preference is Option 1. It would require uniform impingement mortality standards everywhere (i.e., traveling screens) and case-by-case determination of entrainment mortality controls for all facilities.

(...continued)

closures (having closed or are projected to close independent of the requirements in the proposed rule). CWIS Proposal, p. 22,190 and p. 22,220.

[31] U.S. Environmental Protection Agency, *Economic and Benefits Analysis for Proposed Section 316(b) Existing Facilities Rule*, EPA 821-R-11-003, March 28, 2011, p. 2H-17. Hereinafter, Economic Analysis.

[32] Ibid., p. 22,193.

Table 1. Analyzed Regulatory Options for Cooling Water Intake Structures

(All options would apply to facilities withdrawing over 2 million gallons per day (MGD) of water and using at least 25% of withdrawn water for cooling purposes.)

	Impingement Mortality Controls for Existing Facilities	Entrainment Mortality Controls for Existing Facilities	New Units at Existing Facilities	Estimated Annual Social Costs and Benefits (2009 $)[a]
Option 1	Uniform controls[b] everywhere	Case-by-case determination everywhere	Closed-cycle cooling[c]	$384 million costs/$18 million benefits
Option 2	Uniform controls everywhere	Closed-cycle cooling for facilities with DIF[d] > 125 MGD; case-by-case determination for smaller facilities	Closed-cycle cooling[c]	$4.463 billion costs/$121 million benefits
Option 3	Uniform controls everywhere	Closed-cycle cooling everywhere	Closed-cycle cooling[c]	$4.632 billion costs/$126 million benefits
Option 4	Uniform controls for facilities with DIF > 50 MGD; case-by-case determination for smaller facilities	Closed-cycle cooling for facilities with DIF > 50 MGD; case-by-case determination for smaller facilities	Closed-cycle cooling[c]	$327 million costs/$17 million benefits

Source: Compiled by CRS from CWIS Proposal, including Exhibit X-1, p. 22,262.

a. Social costs include federal and state government costs for administering the rule. Costs and benefits for Options 1,2 and 4 do not include costs or benefits associated with site-specific, case-by-case determinations. In addition, benefits for all options reflect monetized benefits only (e.g., increased harvest for commercial fisheries) but do not include non-monetized benefits (e.g., nonuse benefits that reflect human values associated with existence and bequest motives), which are difficult to quantify. Non-monetized benefits have potential to be significant, according to EPA, but the agency does not have the same confidence in those estimates as in monetized benefits estimates. Costs and benefits were annualized over 50 years and discounted at a 3% rate. See the proposal for cost and benefit estimates using a 7% discount rate.

b. BTA for impingement is modified traveling screens. EPA also would allow facilities to comply by reducing through-screen intake velocity to 0.5 ft/sec or less where available or feasible at the facility.

c. EPA alternatively would allow facilities to comply by reducing entrainment mortality to the equivalent of 90% of reductions achieved by closed-cycle cooling.

d. DIF = Design Intake Flow.

Based on evaluating the efficacy of technologies, their availability, and cost, EPA identified three best performing technologies in order to select the "best" technology for the proposed rule.

Impingement

For impingement mortality at existing facilities, EPA evaluated several possible technologies (see "Technology for Impingement and/or Entrainment Control") and, from them, proposed the use of modified traveling screens with a fish handling and return system, plus barrier nets for intake systems located on ocean or estuarine tidal waters. EPA also proposed reduced intake velocity as an alternative. The intake velocity alternative would be allowed if a facility could demonstrate that the through-screen design velocity does not exceed 0.5 feet per second, or could demonstrate that the actual average intake velocity does not exceed 0.5 feet per second. As shown in **Table 1**,

three of the regulatory options, including Option 1, would require these technologies at all covered facilities. Option 4 would require these technologies at facilities with water-intake flow of more than 50 MGD, while requirements for facilities with intake flow between 2 MGD and 50 MGD would be determined case-by-case by permitting authorities.

EPA estimates that half of all manufacturers and more than three-fourths of all electric generators may already meet some or all of the proposed requirements for reducing impingement mortality under the preferred option.[33]

Entrainment

According to EPA, BTA impingement control alone would reduce CWIS-related mortality at existing facilities by up to 31%. The agency's analysis determined that some existing facilities may be able to do more to reduce mortality by also controlling entrainment. As described previously, wet cooling towers reduce both impingement mortality and entrainment mortality. However, EPA could not identify cooling towers or any other single technology as BTA for entrainment mortality control at all existing facilities nationwide.

As shown in **Table 1**, EPA evaluated four options ranging from case-by-case determinations by permitting authorities for all covered facilities (Option 1, the agency's preference) to closed-cycle cooling for all covered facilities (Option 3). Options 2 and 4 combine closed-cycle cooling for some facilities, based on a threshold of water-intake flow, and case-by-case permitting for facilities below the threshold. Options 1, 2, and 4 would require permitting authorities to conduct a resource-intensive site-specific analysis of candidate BTA technologies for entrainment control for some or all covered facilities. This would involve analysis of the localized benefits of entrainment reductions along with the costs of controls. The agency acknowledges that the outcome of the analysis may be a determination that no other technologies beyond impingement controls are feasible and/or justified by their costs.

EPA concluded that closed-cycle cooling reduces impingement and entrainment mortality to a greater extent than other technologies. However, the agency determined that closed-cycle cooling is not the "best technology available" for the regulatory proposal, and it rejected closed-cycle cooling as the uniform basis for national entrainment controls at existing facilities. This conclusion is based on four factors discussed by EPA in the CWIS proposal.[34]

- There may be adverse consequences to the reliability of energy delivery on the local level from installing cooling towers. Retrofitting existing once-through cooling systems reduces output from the powerplant due to additional equipment (pumps and fans) that must be run to operate the cooling system. This is referred to as energy penalty. Retrofitting also is likely to involve extended downtime. During such periods, some geographic regions could experience electricity reliability problems, because existing transmission systems would not be able to transfer sufficient electricity to ensure reliability. Further, if required to retrofit, some operators will elect to close, or retire, existing facilities. The loss of efficiency and generating capacity means that less electricity is available to meet demand.

[33] CWIS Proposal, p. 22,248.

[34] Ibid., pp. 22,208-22,210.

- Fossil-fueled facilities would need to burn additional fuel to compensate for the energy required to operate cooling towers, thus emitting additional pollutants, including nitrogen oxides, sulfur dioxide, mercury and especially additional particulate matter formation associated with plume drifts. It may be difficult to obtain air permits for cooling towers at existing facilities located in nonattainment areas because of the need to identify emission offsets.
- Land availability concerns might limit the feasibility of installing cooling towers on a site-specific basis. This may affect 25% of facilities covered by the proposal, according to EPA.
- Under some circumstances, remaining useful life of a particular facility may not justify the cost of installing closed-cycle cooling.

Considering all four factors together, EPA concluded that closed-cycle cooling is not practically feasible in a number of circumstances, thus it is not possible to uniformly require that technology at existing facilities nationwide. However, the case-by-case evaluations contemplated under the preferred regulatory option would result in site-specific determinations of BTA that could justify closed-cycle cooling or other technologies, or it could result in requiring no additional controls for entrainment mortality.

New Units at Existing Facilities

The proposal also includes provisions that would apply to newly installed units built at existing facilities. These requirements are the same under all four regulatory options in the proposal—that is, impingement mortality requirements the same as those for existing facilities, and entrainment mortality reductions by installation of closed-cycle cooling systems, which EPA determined is the best performing technology. The latter is essentially the same requirement that applies to new facilities under the Phase I CWIS rules, defined as those that commence construction after January 17, 2002. EPA's rationale is similar, explaining that it is generally more feasible and cost-effective to install closed-cycle systems at brand new facilities (Phase I) and newly built units that increase operational capacity at an existing facility, than it is to retrofit the same technology at existing facilities. In contrast to retrofits, new units can have their CWIS optimized for cooling towers, reducing the size of the cooling towers, increasing their efficiency, and reducing energy requirements.[35] As with the Phase I rules, a facility could demonstrate compliance with this portion of the rule by establishing reductions in entrainment mortality for the new unit that are 90% of the reductions that would be achieved by closed-cycle cooling.

Compliance Schedule

Compliance with the rule, when promulgated in 2012, will be required as soon as possible. For individual facilities, specific compliance deadlines will be set when the facility next seeks renewal of its existing CWA discharge permit; such permits are issued for five-year periods and then must be reissued by the permitting authority (state or EPA). Permitting agencies often allow facilities some time period to come into compliance with new requirements.

[35] Ibid., p. 22,196.

As proposed by EPA, for facilities already in compliance with the rule or needing to install technologies other than cooling towers, the compliance period is assumed to be a five-year period from 2013 to 2017. EPA expects that facilities required to install cooling towers for entrainment mortality control will do so over a longer period of time. Fossil-fuel electric power generating facilities would achieve compliance from 2018 to 2022, and nuclear power generating and manufacturing facilities would achieve compliance from 2023 to 2027.[36] Thus, 2028 will be the first year in which all covered existing facilities would be expected to have achieved compliance. A new unit installed at an existing facility would be required to comply when it begins operation.

Phase I Restoration Measures

The CWIS Phase I rules for new facilities included a provision that would have allowed facilities to use "restoration measures" or other mitigation such as restocking with fish bred in a hatchery, reclamation (for example, improving the habitat surrounding the intake structure), and migration barrier removal, as part of demonstrating that alternative technologies are comparable to closed-cycle cooling systems. A federal court invalidated this provision of the Phase I rules in 2004,[37] but EPA never removed the provision from the regulations. EPA now proposes to remove the restoration provisions from the Phase I rule. Phase I facilities still could demonstrate alternatives to cooling towers, but the change may reduce the alternatives available to some facilities.[38]

Costs and Benefits

Compliance Costs

Not surprisingly, much of the interest by stakeholders in EPA's CWIS proposal has been on costs of meeting new regulatory requirements, especially under a scenario in which EPA were to mandate cooling towers for all existing facilities (Option 3). Several reports and analyses have examined potential impacts of mandating cooling towers (as well as other environmental rules, in some cases) on powerplants and the adequacy/reliability of electricity supply that would result from such requirements.

Two Department of Energy (DOE) reports examined potential impacts of an across-the-board requirement that existing powerplants retrofit with closed-cycle cooling systems and concluded that the potential energy penalty of such a mandate could result in adverse effects on energy supplies. In a 2002 report, DOE said that, depending on the type of cooling tower installed (wet or dry) and weather conditions (peak summer demand or not), energy penalties ranging from 0.8% to 8.8% could occur. In a hypothetical worst-case scenario of retrofitting 100% of powerplants with cooling towers, a number of additional powerplants would have to be constructed to account for the energy penalty: 19 additional 400-megawatt plants if all retrofits were to wet cooling towers, or 66 new 400-megawatt plants if some portion were dry cooling

[36] EPA believes that permitting authorities would need to coordinate outages by multiple power generating facilities in a geographic area so as to minimize impacts on reliability of power generation. In these circumstances, EPA expects a facility could reasonably require as long as eight years to attain compliance. Ibid., p. 22,248.

[37] Riverkeeper, Inc. v. EPA, 358 F.3d 174 (2d Cir. 2004). See the **Appendix** for details.

[38] CWIS Proposal, p. 22,183.

towers.[39] In a related 2008 report, DOE concluded that a mandatory cooling tower rule for existing powerplants could result in a loss of generation capacity that could jeopardize adequate reserve capacity margins of electricity available to meet peak demand growth. This loss of generating capacity would be due to a combination of reduced operational efficiency[40] and early retirement of facilities that cannot or choose not to retrofit. Potentially vulnerable regions would include California, New York, New England, and the Mid-Atlantic states, according to DOE. The report estimated that 90% of facilities likely to retire are older oil- and natural gas-fired steam plants, which are not as likely to be used for baseload purposes as coal-fired plants.[41]

Other recent reports also have focused on potential electricity reliability problems that could occur if EPA were to mandate closed-cycle cooling everywhere.[42] It is important to recognize that potential impacts and scenarios described in these reports, including need for additional powerplant capacity, depend on a number of assumptions such as tight compliance deadlines, many of which differ greatly from EPA's proposal. Thus, while they indicate the types of issues (e.g., reliability) raised in anticipation of the current proposal—and which EPA has attempted to address in the proposal—they are not accurate predictors of impacts of the actual proposed rule.

Moreover, as described in this report, EPA has not proposed uniform closed-cycle cooling, which the agency acknowledged would be the most costly technology. Based on potential energy penalty and other factors, EPA has recommended site-specific determination of the need for entrainment mortality controls (Option 1), which might require cooling towers, or it might not. **Table 2** summarizes EPA's estimated annual costs of compliance under the four regulatory options considered in the CWIS proposal. For manufacturers and power producers, these costs include one-time technology costs of complying with the rule, one-time costs of installation downtime, annual operation and maintenance costs, recurring costs for permit renewal, and the value of electricity requirements for operating compliance technology.

For federal and state regulators, administrative costs for rule implementation include start-up activities, permit issuance and reissuance, analysis of entrainment studies, and annual monitoring. Implementation of EPA's proposed rule will depend significantly on the capacity of state regulatory agencies, many of which already are coping with constrained resources and budgets. EPA estimates that administrative costs for regulators would be the greatest under Options 1 and 4, because of higher costs to review monitoring reports and studies to determine if entrainment mortality controls are needed. In contrast, Options 2 and 3 assume closed-cycle cooling is required for some or all facilities. Thus, the need for regulators to review facilities' reports and studies and to make case-by-case determinations is much less under these options.[43] The

[39] U.S. Department of Energy, Office of Fossil Energy, National Energy Technology Laboratory, Argonne National Laboratory, *Energy Penalty Analysis of Possible Cooling Water Intake Structure Requirements on Existing Coal-Fired Power Plants*, October 2002, pp. 2-3.

[40] As described above, retrofitting an existing once-through system reduces output from the power plant due to additional equipment (pumps and fans) that must be run to operate the cooling system.

[41] U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability, *Electricity Reliability Impacts of a Mandatory Cooling Tower Rule for Existing Steam Generation Units*, October 2008. Baseload plants generally are operated continuously, in contrast to peaking plants that operate during periods of high electricity demand.

[42] See North American Electric Reliability Corporation, *2010 Special Reliability Scenario Assessment: Resource Adequacy Impacts of Potential U.S. Environmental Regulations*, October 2010, http://www.nerc.com/files/EPA_Scenario_Final_v2.pdf; and Metin Celebi, Frank Graves, and Gunjan Bathla, et al., *Potential Coal Plant Retirements Under Emerging Environmental Regulations*, The Brattle Group, December 8, 2010, http://www.brattle.com/_documents/uploadlibrary/upload898.pdf.

[43] Conversely, direct compliance costs for manufacturers and power producers are much higher under Options 2 and 3.

incremental administrative burden on state regulators also depends on the extent of the state's current practices for regulating CWIS. States that currently require limited analysis, monitoring, and reporting of CWIS impacts may require more permitting resources to implement EPA's rule, while states that currently require very detailed analysis may require fewer additional resources.[44]

Table 2. Annualized Social Cost of CWIS Regulatory Options

(millions of 2009 dollars)

	Option 1	Option 2	Option 3	Option 4
Direct Compliance Cost for Manufacturers	$61.31	$141.69	$172.92	$33.99
Direct Compliance Cost for Electric Generators	$318.77	$4,319.59	$4,457.79	$289.77
Total Direct Compliance Cost	**$380.08**	**$4,461.28**	**$4,630.71**	**$323.77**
State and Federal Administrative Cost	$3.71	$1.62	$0.92	$2.79
Total Social Cost	**$383.80**	**$4,462.90**	**$4,631.62**	**$326.55**

Source: CWIS Proposal, p. 22,218, Exhibit VII-3.

Notes: Costs are annualized over 50 years and discounted at a 3% rate. See the CWIS proposal for cost estimates using a 7% discount rate.

EPA first considered how many electric generation and manufacturing facilities subject to the proposed rule already have cooling towers installed and meet the water intake velocity requirement, and thus will not have any further technology requirements to meet. The agency determined that 27 manufacturing facilities and 39 power producers already have the cooling tower and IM technology required under Option 3 (out of 592 and 559 that are covered by the rule, respectively); thus, they are not expected to need to upgrade or incur compliance technology costs. Further, EPA estimates that 130 manufacturing plants and 92 electric generators already meet the IM technology requirements of Option 1. All of these facilities would still incur administrative costs required to demonstrate compliance with the proposed rule.[45]

Next, EPA evaluated costs for facilities that are not already in compliance with the proposed rule. For electric power producers, the agency analyzed potential closures/retirements, which it concluded would not be significant under Option 1 (the most flexible option), but would be more significant under Option 3 (the most stringent option). EPA estimated that Option 1 would result in full or partial closure of nine powerplant units by 2028, representing 1 gigawatt of power, or less than 0.2% of baseline electricity generation capacity by facilities covered by the rule, while Option 3 would result in 74 unit closures/retirements, or 17 gigawatts of power, or 3.6% of baseline electricity generation capacity in 2028.[46] The estimated nine closures under Option 1 are *net* closures. That is, overall 39 units would close, and 30 would *avoid* closure, because they are expected to become more attractive sources of electricity due to changes in the economics of

[44] Economic Analysis, p. 3-28. See Footnote 8 regarding state permitting authorities.

[45] Economic Analysis, pp. 3-2 – 3-3, p. 12-1.

[46] CWIS Proposal pp. 22,232-22,234, Exhibit VII-13. EPA excluded from analysis 15 electricity plants expected to retire before the rule's scheduled promulgation in 2012 and an additional 39 facilities projected to close independent of the rule. EPA also excluded 19 powerplants in California that use coastal and estuarine waters for cooling and already are required by the state to comply with standards at least as stringent as the proposed EPA rule, thus are not expected to incur any additional costs for installation of compliance technology. Economic Analysis, p. 3-3.

electricity production across the full market. Similarly, under Option 3, 162 generating units are expected to *close*, and 88 units to *avoid* closure, for a net closure of 74 generating units. Under either Option 1 or Option 3, additional electricity generation supply that is anticipated to be built during the compliance period of the rule is expected to fully offset reductions from early retirements or closures.[47]

EPA also analyzed the electricity price impacts if utilities pass through all CWIS compliance costs to consumers. Looking across three consumer groups (industrial, commercial, and residential), under any of the regulatory options, industrial consumers are expected to experience the highest price increases, and residential consumers are expected to experience the lowest price increases.[48] On average, for a typical U.S. household, Option 1 results in the lowest average annual electricity increase per household, $1.41, while electricity price increases would be highest under Option 3, $17.60 on average. Regionally, under Option 1, average annual electricity cost increases would be lowest in the West ($0.05) and highest in the region that includes Nebraska, Kansas, Oklahoma and portions of adjacent states ($3.93). In contrast, under Option 3, average annual electricity cost increases would be lowest in the far West ($0.11) and highest in Texas ($26.52) and the Southeast ($27.88).[49]

For manufacturers, EPA evaluated how compliance costs would likely affect the financial health of facilities, including the potential for closures or financial stress short of closure. First, EPA analyzed baseline closures by manufacturers, that is, facilities in sufficiently weak financial condition before outlays for the regulation that they are likely to close independent of the rule. The agency concluded that 76 manufacturing facilities likely to be subject to the rule are baseline closures. The highest percentage of baseline closures are in the steel industry sector (32%).[50] EPA then evaluated impacts on remaining manufacturing facilities subject to the rule and concluded that none would close or incur employment losses as a result of any of the regulatory options, even the most stringent. Under Option 3, 17 facilities would be expected to incur moderate financial performance impacts, but not at a sufficient level to close (three chemical, three pulp and paper, and one petroleum facility). EPA also examined impacts of compliance costs in terms of manufacturers' revenue and concluded that the number and percentage of firms likely to incur costs greater than 3% of revenue under any of the options is small—only a single petroleum manufacturing facility—while 99% will incur costs of less than 1% of revenue.[51]

Uncertainties of Compliance Cost Estimates

There are a number of uncertainties about EPA's compliance cost estimates. First, it is important to recognize what is omitted from the agency's analysis. In particular, EPA makes no attempt to estimate manufacturers' and electricity generators' compliance costs associated with site-specific, case-by-case determinations under Options 1, 2, and 4. EPA believes that costs of these site-specific determinations are highly speculative, because permitting authorities will consider waterbody-specific data, local impacts, public comments, costs and benefits, land availability, grid reliability, and other factors. If those determinations result in few requirements for existing

[47] Economic Analysis, pp. 6-18 – 6-24.

[48] Ibid., p. 5-17.

[49] CWIS Proposal, pp. 22,227-22,228, Exhibit VII-10.

[50] Ibid., p. 22,220, Exhibit VII-4.

[51] Ibid., p. 22,222, Exhibit VII-6; Economic Analysis, p. 4-11.

facilities to install closed-cycle cooling, then actual compliance costs are likely to be close to EPA's estimates. However, if regulators make site-specific determinations that widely require retrofitting with cooling towers, compliance costs will be higher than costs shown in **Table 2**—perhaps much higher, depending on which option is promulgated.

Second, compliance costs for new generating units at existing facilities are not included in total compliance cost estimates because benefits associated with reduced I&E mortality at those facilities have not been estimated.[52]

Third, EPA recognizes a number of data limitations and other uncertainties. For example, for both electric generators and manufacturing facilities, EPA relied heavily on industry and facility data collected during previous phases of the CWIS rulemaking, and some of it may no longer reflect current circumstances of facilities, business conditions, or cooling water usage. Downtime schedules and cost estimates are uncertain. There may be economic and operating differences between analyzed facilities (based on sampling) and all affected facilities. Further, impacts of electricity cost increases to various consumer classes could be different based on the utility's applicable rate structures (for example, a structure that includes lifeline rates could moderate the impact of increased rates on lower income households).[53]

Estimated Benefits

None of the recent reports by DOE and other organizations described above addresses benefits of requiring CWIS controls, but EPA's proposal does. Environmental benefits would occur because of reductions in impingement and entrainment. EPA's analysis considered three categories of benefits: use benefits such as increased harvests of recreational and commercial fisheries, nonuse benefits such as improved ecosystem function, and reduced harm to threatened and endangered species. For each of the three categories of benefits, EPA concluded that the greatest percentage of benefits (compared with a baseline of eliminating all I&E mortality losses entirely) would result from Option 3, followed closely by Option 2, and then by Options 1 and 4 (see **Table 3**). As discussed below, the agency recognizes large uncertainties in its analysis. EPA estimated the economic benefits from the regulatory options using a range of valuation methods, depending on the benefit category, data availability, and other factors, and derived national benefit estimates from a series of U.S. regional studies.

By reducing I&E mortality rates, any of the options is likely to increase the number of fish, shellfish, and other aquatic organisms in affected bodies of water. In turn, this increased number of aquatic organisms directly improves the welfare of individuals who use the affected aquatic resources; this is referred to as "use benefit," such as increases to the value of recreational and commercial fisheries. EPA relied on a number of studies to estimate a "baseline" of aquatic organisms that are lost due to impingement and entrainment, in the absence of additional regulation, and then estimated reductions in losses likely to occur under various regulatory options. EPA's analysis of fish mortality found that Option 3 (uniform closed-cycle cooling) would result in the greatest reduction in I&E mortality (92% of fish deaths of age-one equivalent

[52] Economic Analysis, p. 11-10.

[53] Economic Analysis, pp. 3-25–3-26, 5-5, 5-14–5-15.

organisms would be avoided[54]), followed by Option 2 (91% of fish deaths avoided), Option 1 (28% of fish deaths avoided), and Option 4 (27.5% of fish deaths avoided).[55]

EPA estimated the economic benefits of its regulatory options on commercial and recreational fisheries. Total annualized recreational fishing benefits for the United States range from $15.3 to $44.9 million, and total annualized commercial fishing benefits range from $1.0 to $4.5 million, for total fishing benefits ranging from $16.3 to $49.5 million (see **Table 3**).

Reducing I&E mortality also improves the welfare of individuals independent of any specific use of the affected resources; this is referred to as "nonuse benefits" such as improved ecosystem function and resource bequest values.[56] Individuals may not use these resources directly, but they may value change in their status or quality. Monetizing nonuse benefits involves analytic methods which ask people to state their willingness to pay for particular ecological improvements, such as abundance of migratory fish species, and then attempts to calculate total values. For the current proposal, EPA estimated the nonuse benefits of increased abundance of winter flounder in the North Atlantic and Mid-Atlantic regions (see **Table 3**).

Finally, EPA estimated the benefits from improved protection of threatened and endangered (T&E) species, since I&E mortality may either lengthen population recovery time, or hasten the demise of the species. Threatened and endangered species are characterized by low population levels to begin with, and based on available data, EPA was unable to quantify effects on T&E populations from 316(b) regulation. However, EPA developed a qualitative database that assessed the geographic distribution of habitat of aquatic T&E species in relation to CWIS structures. EPA found 89 federally listed T&E species that overlap with at least one CWIS, including freshwater mussels, sea turtles, and marine and anadromous fish, and concluded that the primary value of T&E species is in the nonuse category. Nevertheless, because of data limitations, EPA was unable to quantify nonuse benefits of T&E species, so the estimates shown in **Table 3** are actually based on nonuse valuation techniques applied to two species of recreational fish in one U.S. region.[57]

[54] Age-one equivalent losses is an analytic method of standardizing the number of individuals of different ages to equivalent one-year-old fish.

[55] CWIS Proposal p. 22,239, Exhibit VIII-2.

[56] Nonuse benefits, or values, are values that individuals place on goods or services that are not consumed directly, but because the amenity or resource simply exists. For discussion, see CRS Report RL30242, *Natural Resources: Assessing Nonmarket Values through Contingent Valuation*, by Joseph T. Breedlove and Ross W. Gorte.

[57] CWIS proposal, p. 22,245 Exhibit VIII-9.

Table 3. Annual National Social Benefits from Eliminating or Reducing I&E Mortality

(monetized benefit categories)

Regulatory Option	Recreational and Commercial Fishing Benefits (million 2009$)	Recreational and Commercial Fishing Benefits (percentage of baseline)	Nonuse Benefits (million 2009$)	Nonuse Benefits (percentage of baseline)	T&E Species Benefits (million 2009$)	T&E Species Benefits (percentage of baseline)	Total Benefits (million 2009$)	Total Benefits (percentage of baseline)
Baseline	$84.94	100.0%	$128.64	100.0%	$1.14	100.0%	$214.72	100.0%
Option 1	$16.61	19.6%	$0.52	0.4%	$0.50	43.9%	$17.63	8.2%
Option 2	$47.99	56.5%	$72.09	56.0%	$0.72	63.2%	$120.79	56.3%
Option 3	$49.46	58.2%	$75.48	58.7%	$0.72	63.2%	$125.65	58.5%
Option 4	$16.33	19.2%	$0.52	0.4%	$0.49	43.0%	$17.33	8.1%

Source: Calculations by CRS, from CWIS Proposal, Exhibits VIII-4, VIII-5. p. 22,242, Exhibit VIII-10, p. 22,247.

Notes: Baseline represents the annual economic benefit of eliminating I&E mortality losses entirely. Benefits estimates are annualized over 50 years and discounted at a 3% rate. See the CWIS proposal for benefits estimates using a 7% discount rate.

Uncertainties of Benefits Estimates

EPA acknowledges that quantifying and monetizing the benefits of reductions in I&E mortality losses is challenging because of a large number of uncertainties in approaches used to value benefits. Examples of uncertainty and limitations include not all ecological goods and services impacted by CWIS are modeled or monetized, or data is not always available at a national scale; simplifying assumptions used in order to make national-scale estimates may over- or underestimate losses and benefits; and species-specific quantitative estimates may not be precise. Further, there is little information and high uncertainty about the magnitude and importance of indirect and/or cumulative impacts of CWIS, particularly effects on lower trophic organisms or ecosystem functions, in part because the permitting process does not consider the additive or cumulative effects of other major manmade stressors such as habitat loss on aquatic organisms.[58]

> The combined effect of these uncertainties is of unknown magnitude or direction—that is, the estimates may over- or understate the anticipated national-level benefits. While EPA has no data to indicate that the results for each benefit category are atypical or unreasonable, EPA believes that some potentially significant benefit categories have not been fully monetized, and thus the national monetized benefits presented below likely underestimate total benefits, challenging the Agency's ability to base BTA decision making on the relationship of quantified costs and benefits alone.[59]

Nonuse benefits are sometimes measured by asking consumers about their willingness to pay for a particular good or service, and EPA expects to improve its benefits estimates by incorporating the results of a new national willingness to pay survey, anticipated to be available for inclusion in the final CWIS rule. The survey of U.S. households would seek to determine how much most ratepayers would be willing to pay to reduce fish losses and mitigate other aquatic concerns resulting from the use of CWIS, as a way to measure the benefits of the regulation. However, EPA's announcement of this survey in January 2011[60] was criticized by industry groups who said that the survey design makes inappropriate conclusions about the loss of life in fish populations due to CWIS, and thus is likely to overstate the benefits of strict regulation.[61]

Congressional Interest and Concluding Thoughts

Recent congressional interest in EPA's proposal has been in the context of potential impacts, individually and cumulatively, of EPA regulatory proposals involving air quality, climate change, water quality, and other issues on electric generating facilities and other sectors of the economy. For example, a number of recent legislative proposals have sought to restrict or prohibit EPA's regulatory authority in a number of areas.[62] Other legislation in the 112th Congress calls for study

[58] Environmental Benefits Analysis, p. 2-22.

[59] CWIS Proposal, p. 22,247.

[60] U.S. Environmental Protection Agency, "Agency Information Collection Activities; Submission to OMB for Review and Approval; Willingness to Pay Survey for §316(b) Existing Facilities Cooling Water Intake Structures (New)," 76 *Federal Register* 3883-3884, January 21, 2011.

[61] American Chemistry Council, American Forest & Paper Association, American Petroleum Institute, Utility Water Act Group, "Comments on ICR for Willingness to Pay Survey for §316(b) Existing Facilities Cooling Water Intake Structures," February 22, 2011.

[62] See CRS Report R41698, *H.R. 1 Full-Year FY2011 Continuing Resolution: Overview of Environmental Protection* (continued...)

of the cumulative impacts of EPA regulations—including the CWIS proposed rule—on the economy, especially on electric utilities.[63] Some suggest that upcoming EPA rules should be more attentive to costs, for consistency with President Obama's Executive Order 13563, providing for a retrospective review of existing significant regulations by agencies "to quantify anticipated present and future benefits and costs as accurately as possible."[64]

In December 2010, Congressman Upton, chairman of the House Energy and Commerce Committee in the 112th Congress, wrote to the EPA Administrator about the possible direction of EPA's CWIS proposal, since potential retrofit costs, if EPA were to mandate cooling towers everywhere, could be substantial, he said. He asked the Administrator to take all necessary time to "produce a well-reasoned, well-supported proposal" and to allow generous time for the public to comment on the proposal." [65] In response, the Administrator said that the proposal, when released, would be intended to reasonably accommodate site-specific circumstances while minimizing adverse environmental impacts, and would not be a "one-size-fits-all federal mandate." She wrote to the Congressman, "I do not want EPA to spend another five years litigating over cooling water intake structures."[66]

Viewed on a strict cost/benefit basis, none of the options in EPA's CWIS proposal would be justified. **Table 1** shows that under all of the options, estimated costs greatly exceed estimated economic benefits, even when allowing for conservative estimation of benefits and additional benefits that might be identified later in EPA's willingness to pay survey.

Still, the CWA does not require that the benefits of regulation exceed or even equal the costs. Moreover, the Supreme Court, in its ruling on the use of cost/benefit analysis in the development of 316(b) regulations, said that EPA has the discretion to consider costs, but is not required to do so.[67] In its current proposal, the agency clearly has done so, preferring a more flexible, less costly regulatory option than a more costly one that would provide greater reduction in I&E mortality (and greater economic benefits of reducing I&E mortality).

The period for public comment on EPA's proposal continues until August 18. Although specifics are unknown for now, the general tone of stakeholders' comments can be anticipated. Because the preferred option in the proposal would essentially formalize procedures that have been in place for some time, based on site-specific permitting decisions for existing facilities, industry groups are likely to view the proposal favorably, at least in general terms. Environmental advocates, on the other hand, are likely to be critical of the proposal for not mandating stricter technological options that will provide greater protection of aquatic resources and will promote timely

(...continued)

Agency (EPA) Provisions, by Robert Esworthy.

[63] The House Energy and Commerce Committee approved H.R. 2401, the Transparency in Regulatory Analysis of Impacts on the Nation Act, or TRAIN Act, on July 12. Similar legislation has been introduced in the Senate (S. 609). For discussion of a number of recent and pending EPA regulatory proposals that have drawn attention, see CRS Report R41561, *EPA Regulations: Too Much, Too Little, or On Track?*, by James E. McCarthy and Claudia Copeland.

[64] Executive Order 13563, "Improving Regulation and Regulatory Review," 76 *Federal Register* 3821, January 21, 2011.

[65] Honorable Fred Upton, letter to Lisa P. Jackson, Administrator of EPA, December 3, 2010, http://upton.house.gov/UploadedFiles/Upton_letter_to_Admin_Jackson_re_Cooling_Water_Intake_Structures.pdf.

[66] EPA Administrator Lisa P. Jackson, letter to Honorable Fred Upton, December 16, 2010, http://www.epa.gov/ocir/pdf/2010_1216_adm_jackson_upton.pdf.

[67] Entergy Corp. v. Riverkeeper, Inc., 556 U.S. 1498 (2009). See the **Appendix** for details.

permitting. Some states, who will be responsible for most permitting actions to implement the rule, also may favor a regulatory approach that requires fewer case-by-case decisions, thus less administrative cost to permitting authorities, such as Options 2 and 3. EPA's response to these likely concerns will be evident in a final rule, which is due by July 27, 2012.

Appendix. History of Regulating Cooling Water Intake Structures

Efforts to regulate cooling water intake structures have a lengthy regulatory and judicial history, spanning several decades, since Congress enacted CWA section 316(b) in 1972.

EPA first promulgated a rule to implement the provision in 1976. That regulation was challenged by utility companies, and in 1977 a federal court determined that the agency had failed to adhere to the procedural requirements of the Administrative Procedure Act, thus invalidating the rule without reaching the merits of the regulations themselves.[68] EPA withdrew the remanded portions of the rule, but left intact those unremanded portions that required each permitting authority to use its best professional judgment to determine the best technology available for regulating cooling water intake structures. The agency published draft guidance for use in implementing 316(b)'s requirements through case-by-case, site-specific permit decisions. This draft guidance did not establish national standards based on the best technology available for minimizing adverse environmental impact of cooling water intake structures. Rather, it left decisions on the appropriate location, design, capacity, and construction of each facility to the appropriate permitting authority (EPA or a state).

This regulatory regime remained in effect but was challenged in 1993 by a coalition of individuals and environmental groups that sued EPA for failing to promulgate regulations under 316(b). In 1995, EPA entered into a consent decree which, as subsequently amended, set a multiphase timetable for regulations, first for new facilities and later for existing facilities.[69]

Phase I

In the first phase, in December 2001, EPA promulgated rules governing certain new, large cooling water intake structures.[70] These rules, called Phase I, apply to new facilities with water-intake flow greater than 2 million gallons per day (MGD), at least 25% of which is used for cooling. New facilities with smaller water-intake systems are regulated by permitting authorities on a site-by-site basis, not by EPA standards. For the largest new facilities, those with water-intake flow greater than 10 MGD, the Phase I rules require that their inflow be restricted to a level commensurate with what can be attained by a closed-cycle cooling water system. In addition, new facilities with water-intake flow between 2 MGD and 10 MGD may alternatively comply by reducing the volume and velocity of water removal to certain levels, and all new facilities may alternatively comply by demonstrating that the technologies employed will reduce adverse environmental impacts to a level comparable to a closed-cycle cooling system. These rules were challenged but were largely upheld in 2004.[71] However, the court invalidated a provision of the rules that would have allowed facilities to use "restoration measures" or other mitigation such as restocking with fish bred in a hatchery, reclamation (for example, improving the habitat

[68] Appalachian Power Co. v. Train, 566 F.2d 451 (4th Cir. 1977).

[69] Settlement Agreement among the United States Environmental Protection Agency, Plaintiffs in *Cronin, et al. v. Reilly*, 93 CIV. 314 (LTS) (SDNY), and Plaintiffs in *Riverkeeper, et al. v. EPA*, 06 CIV. 12987 (PKC) (SDNY), October 10, 1995.

[70] 66 *Federal Register* 65256, December 18, 2001.

[71] Riverkeeper, Inc. v. EPA, 358 F.3d 174 (2nd Cir. 2004). ("Riverkeeper I")

surrounding the intake structure), and migration barrier removal, as part of demonstrating that alternative technologies are comparable to closed-cycle systems. "Restoration measures correct for the adverse environmental impacts of impingement and entrainment, they do not minimize those impacts in the first place," the court said.[72]

Phase II

Next, in July 2006 EPA promulgated Phase II rules. They applied to existing facilities whose primary activity is the generation and transmission (or sale for transmission) of electricity, and whose water-intake flow is more than 50 MGD, at least 25% of which is used for cooling purposes. Over 500 facilities, accounting for approximately 53% of the nation's electric-power generating capacity, were covered by the Phase II rules.[73] EPA expressly declined to mandate adoption of closed-cycle cooling systems or equivalent reductions in impingement and entrainment, as it had required for new facilities under the Phase I rules. As justification, EPA cited the generally high costs of converting existing facilities to closed-cycle operations and the availability of other technologies approaching closed-cycle performance. Instead, the rules required Phase II facilities to reduce impingement and entrainment by specified ranges (e.g., 80% to 95%) from baseline, and the rules allowed issuance of site-specific variances from the national performance standards if a facility could demonstrate either that the costs of compliance would be significantly greater than costs considered by EPA in setting the standards, or would be significantly greater than the benefits of complying with the applicable performance standards. The Phase II rules allowed use of restoration measures to demonstrate compliance with the standards—even though a similar provision in the Phase I rules had been invalidated by a federal court.

Multiple parties challenged the Phase II rules. In 2007, the U.S. Second Circuit Court of Appeals—in an opinion authored by then-Circuit Court Judge Sonia Sotomayor—ruled the cost-benefit variance provision of the regulations to be unlawful. The court held that, while cost could be considered to determine benchmark technology or to engage in cost-effectiveness analysis, section 316(b) does not permit the use of cost-benefit analysis. The court also found that EPA had exceeded its authority by permitting existing plants to meet national performance standards by using restoration measures.[74]

Utility companies appealed this ruling to the Supreme Court, and the Court agreed to review the single question of whether section 316(b) authorizes use of cost-benefit analysis in determining best technology available for cooling water intake structures. The Court's ruling, in 2009, held that it is permissible to apply a cost-benefit analysis in determining the best technology available to minimize adverse environmental impacts and in providing for cost-benefit variances from those standards as part of the Phase II rules. The Court held that EPA has the discretion to consider costs and benefits under 316(b) but is not required to do so.[75] In September 2009, the Second Circuit granted the government's request to remand the Phase II rules for further review in light of the Supreme Court's ruling.

[72] Ibid., p. 189.

[73] 69 *Federal Register* 41576, July 9, 2004.

[74] Riverkeeper, Inc. v. EPA, 475 F.3d 83 (2nd Cir. 2007). ("Riverkeeper II")

[75] Entergy Corp. v. Riverkeeper, Inc., 556 U.S. 1498 (2009).

Phase III

Concurrent with the judicial consideration of the Phase II rules, in June 2006 EPA promulgated the final required 316(b) rules.[76] The Phase III rules apply to existing powerplants whose water-intake flow is between 2 MGD and 50 MGD and existing industrial facilities (including paper, chemical, petroleum, aluminum, and steel manufacturers) whose water-intake flow is greater than 2 MGD. For these existing facilities, EPA determined that uniform national performance standards would not be the most effective way to address cooling water intake structures, so the Phase III rules continue to rely on case-by-case decisions by permitting authorities. Phase III also applies to new offshore oil and gas extraction facilities that had been expressly excluded from Phase I. The rules specify requirements for new offshore oil and gas extraction facilities with water-intake flow of more than 2 MGD, at least 25% of which is used for cooling purposes; those not meeting that threshold also would continue to be authorized via case-by-case permitting.

Challenges to the Phase III rules were filed in several federal courts of appeals and were consolidated in the Fifth Circuit, but proceedings were stayed during the Supreme Court's consideration of the Phase II rules in *Entergy v. Riverkeeper*. After that decision, the government and environmental plaintiffs jointly asked the Fifth Circuit Court of Appeals to remand the existing facilities provisions of the Phase III rules to EPA, for consideration along with the remanded Phase II rules for existing large facilities, in light of the *Entergy* decision. The court approved this request in July 2010.[77]

Separately, environmental groups also had filed a challenge related to the existing facilities provisions of the Phase III rules in the same federal court that in 1995 had approved the consent decree providing for the multiphase promulgation of the 316(b) rules.[78] To settle that litigation, in November 2010 EPA entered into a consent decree that provides a schedule for proposing and promulgating combined Phase II and Phase III existing facilities regulations. In December 2010, the court approved a schedule that established a March 14, 2011, deadline for the agency to propose a revised cooling water intake rule. On March 15, EPA announced that parties to the litigation had agreed to EPA's request to delay release of the proposed rule until March 28.[79] Under the settlement agreement, EPA is required to promulgate a final rule by July 27, 2012.

After 1977 and prior to promulgation of the Phase I rules in 2001, applicable CWIS requirements for all facilities were developed on a case-by-case bases by permitting authorities, using best professional judgment. As a result of litigation involving all three phases of rulemaking since 2001 and court-ordered and government-requested remands, only certain facilities are subject to technology-based standards in EPA CWIS rules that remain in effect—new facilities with water-intake flow greater than 2 MGD (Phase I rules) and new offshore oil and gas facilities (Phase III). Until EPA promulgates revised rules, existing facilities of all sizes continue to be subject to requirements developed on a case-by-case basis by permitting authorities. Additionally, new

[76] 71 Federal Register 35006, June 16, 2006.

[77] At the same time, the Fifth Circuit rejected industry's challenge to the new facilities provisions of the Phase III rules. ConocoPhillips Co. v. EPA, No. 06-60662 (5th Cir., July 23, 2010).

[78] In that court (U.S. District Court for the Southern District of New York), environmental groups challenged what they termed EPA's "inaction" in the Phase III rule for existing facilities, which continues to allow case-by-case permitting.

[79] Amendment to Settlement Agreement among the United States Environmental Protection Agency, Plaintiffs in *Cronin, et al. v. Reilly*, 93 CIV. 314 (LTS) (SDNY), and Plaintiffs in *Riverkeeper, et al. v. EPA*, 06 CIV. 12987 (PKC) (SDNY), March 11, 2011.

facilities with water-intake flow of less than 2 MGD also are subject to case-by-case permitting, under provisions of the Phase I rules unchanged since 2001.

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