12/5/11 Draft

Legislative and Regulatory Incentives

for Investments in Water and Wastewater Solutions in the Industrial Sector

NORTH AMERICA

United States

There are currently five regulatory developments in the U.S. which could encourage or require investments in industrial water and wastewater related equipment:

1. Cooling Water Intake Rulemaking
2. Power Plant FGD Wastewater Rulemaking
3. Power Sector Coal Combustion Residue (CCR) Rulemakings
4. Hydraulic Fracturing Water Management Standards
5. Sustainability and Energy Efficiency Initiatives

1. Cooling Water Intake Rulemaking

Timeframe

- Cooling water intake standards are mandated by §316(b) of the Clean Water Act.
- The proposed rule was issued on March 28, 2011.
- The final rule must be issued by July 27, 2012, according to terms of a consent decree.
- The new rule will replace two existing rules, issued in 2004 and 2006, which were challenged in court and remanded to EPA for further action.
- Compliance will be required in 2015-2020, depending on a facility's permit cycle.

Purpose

The purpose of the cooling water intake rule is to reduce harm to aquatic life through:

- Impingement, where organisms are trapped against the outer part of a screening device of an intake structure and are unable to escape; and
- Entrainment, where organisms pass through a screening system and become entrained in the cooling system.

Affected Facilities

- The proposed rule would apply to facilities that withdraw more than 2 MGD of water and use at least 25% of the withdrawn water for cooling purposes.
- EPA estimates the rule will impact:
    - 671 power plants, representing 45% of the nation's electricity generating capacity
    - 591 manufacturing plants in five primary industrial categories
- Power plants are, by far, the biggest water users, representing 90% of the total design intake flow of all of the impacted facilities.

Table 1: Facilities Impacted by Proposed Cooling Water Intake Rule

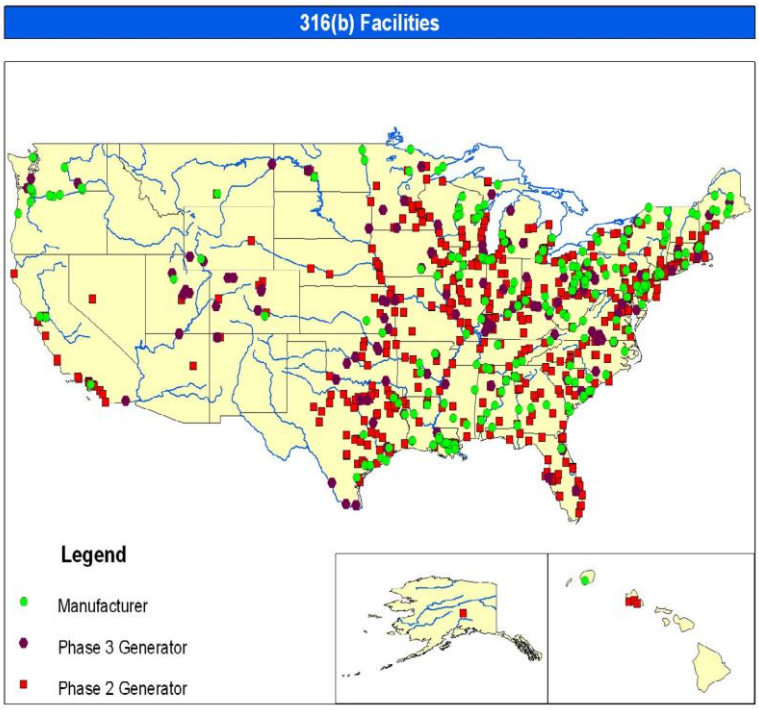
Industry	Estimated Number of Facilities	Total Design Intake Flow (MGD)	Average Design Intake Flow (MGD)
Pulp & Paper	227	11,944	69
Chemicals	185	12,400	126
Steel and Aluminum	95	9,444	131
Petroleum Refineries	39	3,259	96
Food Processing	38	2,073	52
Other Manufacturing	7	353	81
Total Manufacturers	**591**	**39,473**	**95**
Electric Generators	**671**	**370,126**	**555**
Total	**1,262**	**409,600**	**434**

Source: U.S. Environmental Protection Agency

Location of Affected Facilities

The majority of facilities affected by the proposed Cooling Water Intake Rule are located in the eastern half of the United States.

Figure 1: Map of Facilities Subject to Proposed Cooling Water Intake Rule



Source: U.S. Environmental Protection Agency
Phase 2 Generator: Large electricity generator, withdrawing 50 MGD or more of water
Phase 3 Generator: Small electricity generator, withdrawing less than 50 MGD

Compliance Options

New facilities: New facilities must employ a closed-loop cooling water system based on a 2001 regulation which would not be affected by the new rule.

Existing facilities: The proposed rule would require:

- Enhancement of intake structure screens or a lower intake velocity to reduce impingement
- A case-by-case review based on Best Professional Judgment (BPJ) to reduce entrainment
- For facilities that withdraw more than 125 MGD, a more comprehensive Entrainment Characterization Study would also be required

Many had feared that EPA would require closed-loop cooling systems in the new rule. However, EPA proposes not to require closed systems in most cases and identifies the following compliance options for consideration in a case-by-case review using BPJ:

- Cooling tower optimization measures
- Variable speed pumps/variable frequency drives
- Seasonal flow reductions (based on spawning periods or other biologically important time periods)
- Water reuse (such as reusing cooling tower water as process water in manufacturing)
- Alternative cooling water sources, such as effluent from a municipal wastewater treatment plant

Opportunities for Xylem

- Variable speed pumps
- Cooling water treatment equipment for reuse of water
- Pumps to transport effluent from municipal WWTP
- Gravity filters for tertiary treatment of effluent from municipal WWTP

2. Power Plant FGD Wastewater Rulemaking

Timeframe

- The existing effluent limitation guidelines (ELGs) for steam electric power plants were first adopted in 1974 and were last revised in 1982.
- EPA conducted a detailed study of wastewater streams from steam power plants in 2009, largely as a reaction to the ash impoundment failure at a TVA power plant in December 2008.
- As a result of the study, EPA decided to revise ELGs for steam power plants, focusing on two specific wastewater streams that are often stored in impoundments:
    - Flue gas desulfurization (FGD) wastewater
    - Wastewater from coal combustion residues (CCR)
- The proposed rule is expected to be issued in July 2012, with a final rule by January 2014.
- The rule will establish technology-based effluent limitations for FGD wastewater and water quality-based ELGs for CCR wastewaters.

Affected Facilities/FGD Wastewater

- Flue gas desulfurization (FGD) units, or scrubbers, are air pollution control devices designed to remove SO_2 from the flue gases from coal-fired power plants.
- There are two basic kinds of scrubbers.
    - Wet scrubbers use a lime or limestone based slurry stream to absorb the SO_2. Wet systems are more expensive than dry systems, but more effective at removing SO_2.

- Dry scrubbers spray a wet lime slurry into a spray dryer, but the solids content is calculated so that essentially all of the water evaporates. Dry scrubbers are typically used with only with lower sulfur coals, which are more expensive than other coals and limit a unit's fuel flexibility.

- Dry scrubbers do not generate a wastewater stream, so this rulemaking will apply only to coal-fired power plants with wet scrubbers.
- Table 2 indicates that at least 162 GW of generation capacity, or 50% of all coal-fired capacity, would be affected by an FGD wastewater rule as of 2010, based on EPA's estimates. That number would, increase to 231 GW or 62% of coal-fired capacity in 2020.

Table 2: Scrubbers on Coal-Fired Units in the U.S.

Type of Unit	Existing Capacity 2010 (GW)	Projected Capacity (2020) (GW)
Units with Wet FGD	162	231
Units with Dry FGD	22	37
Units without Scrubbers	134	103
Total Coal-Fired Units	**318**	**371**

Source: EPA's 2009 Steam Electric Wastewater Study

- However, EPA's 2009 study of FGD wastewater streams pre-dates two other final rules which will require scrubbers on nearly every coal-fired power plant in the country: the Cross-State Air Pollution Rule (CSAPR) finalized on July 7, 2011, and what is referred to as the Utility MACT rule for air toxics emissions, expected to be finalized in December 2011.
- The combined impact of the two air rules will mean that fewer units will be able to operate in 2020 without a scrubber. Consequently, we estimate that 290 – 300 GW of wet scrubbers will be in place in 2020.
- More stringent FGD wastewater standards, along with a dramatic increase in the number of FGD installations, could create a significant market for wastewater treatment and liquid transfer products and solutions.

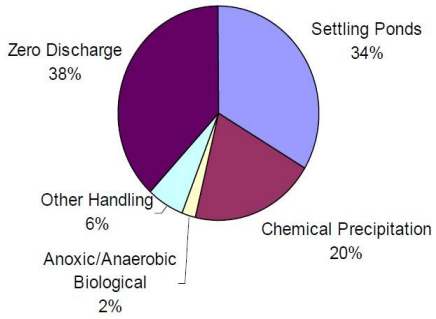
FGD Wastewater Characteristics

- FGD wastewater is generated from sludge dewatering and scrubber blowdown.
- Some metals and other constituents will be removed by a particulate removal device (fabric filter or electrostatic precipitator) located ahead of an FGD system. Other metals and pollutants will be transferred to the scrubber slurry and leave the FGD system via the scrubber blowdown.
- The primary pollutants of concern in FGD wastewater are:
  - Dissolved metals: selenium, boron, magnesium, manganese
  - Suspended metals: mercury, aluminum, chromium
  - Nitrogen compounds
  - Chloride
- Power plants typically have a permit which establishes effluent limitations at the point of discharge. FGD wastewater quantities represent a small fraction of a plant's overall wastewater, so pollutants in FGD wastewater streams become highly diluted, frequently below detection limits, at the point of discharge.
- In this rulemaking, EPA would regulate individual FGD wastewater streams as "internal discharge streams" prior to dilution by other plant wastewaters.

FGD Wastewater Treatment

- FGD wastewater is currently treated as follows:

Figure 2: FGD Wastewater Treatment Systems Among Plants Operating Wet FGD Systems



Source: EPA's 2009 Steam Electric Wastewater Study

- *Zero Discharge* is generally available only to plants that do not intend to sell the solid by-product as wallboard-grade gypsum. Since saleable gypsum has chloride limits, the wastewater will retain elevated levels of chlorides and cannot be recycled due to corrosion concerns. On the other hand, if the solids are landfilled, the system can be operated such that the solids entrain chlorides and the low-chloride wastewater can be recycled.
- *Settling Ponds* are not designed to remove dissolved metals. A new FGD wastewater regulation is likely to require more than a settling pond for treatment.
- *Chemical Precipitation* is not designed to reduce nitrogen compounds. A new FGD wastewater regulation is likely to require additional treatment for nitrogen.
- The proposed rule would set technology-based standards and EPA suggests that physical/chemical treatment combined with a biological treatment stage will be proposed.

FGD Wastewater Markets

- An FGD wastewater regulation will create a market for wastewater treatment and transfer solutions at existing units for the 34% of wet FGDs that rely solely on settling ponds, and for the additional 20% that use some form of chemical precipitation. The market for FGD wastewater solutions would correspond to 87 GW of capacity.

Table 3: Wet Scrubbers on Coal-Fired Units in the U.S.

Type of Treatment	Existing Capacity 2010 (GW)
Zero Discharge (38%)	62
Settling Ponds (34%)	55
Chemical Precipitation (20%)	32
Anoxic/Anaerobic Biological (2%)	4
Other Handling (6%)	9
Total Units with Wet FGD	**162**

- New wet FGD units are likely to be installed on an additional 128 GW of capacity in the next decade, assuming a total installed wet FGD capacity of 290 MW in 2020.
- EPA's 2009 Steam Electric Wastewater Study calculated a normalized scrubber purge flow rate of 578 gpd of FGD wastewater per megawatt. Using that figure, the potential amount of FGD wastewater purge flow impacted by an FGD rule is summarized in Table 4.

Table 4: Market for FGD Wastewater Solutions (2010-2020)

	Capacity (GW)	Purge Flow (MGD)
Retrofit Existing Wet FGD Wastewater	87	50.3
New FGD Wastewater Systems	128	74.0
Total	**215**	**124.3**

Opportunities for Xylem

- Biological treatment (anoxic/anaerobic systems to remove metals and nutrients)
  - Potential application of Xylem's denitrification system to FGD wastewaters
  - Compact, modular design particularly appealing for retrofits
- Pumps for new and upgraded FGD wastewater treatment systems

3. Power Sector Coal Combustion Residuals (CCR) Rulemakings

Regulatory Framework

There are two rulemakings underway or anticipated related to coal combustion residuals or "coal ash". Both are largely a reaction to the coal ash impoundment failure at a TVA power plant in December 2008.

- *Coal combustion wastes:* Solid wastes from coal combustion are currently exempt from regulation under the Resource Conservation and Recovery Act (RCRA).
  - EPA issued a proposed rule on June 21, 2010, which would regulate CCRs under RCRA. A final rule is expected in early 2013.
  - The proposed regulations address the structural integrity of impoundments and would require lined impoundments and groundwater monitoring to detect leaching.
- *Coal combustion wastewater:*
  - The existing effluent limitation guidelines (ELGs) for steam electric power plants were first adopted in 1974 and were last revised in 1982.
  - EPA conducted a detailed study of wastewater streams from steam power plants in 2009 and decided to revise the ELGs, focusing on two specific wastewater streams that are often stored in impoundments:
    - Flue gas desulfurization (FGD) wastewater
    - Wastewater from coal combustion residues (CCR)
  - A proposed rule is expected to be issued in July 2012, with a final rule by January 2014.
  - Current ELGs regulate suspended solids and oil & grease. Unregulated pollutants include metals, nutrients, total dissolved solids and chlorides
  - The rule will establish water quality-based ELGs and is likely to establish additional wastewater monitoring, data collection and reporting requirements for developing numerical effluent limits for discharge permits.

Opportunities for Xylem

- Limited

4. Hydraulic Fracturing Water Management Standards

Xylem Study

- Xylem completed a thorough review of the market for treating produced water from shale gas hydro fracking operations in June 2011.
- The report projected the market for shale gas produced water treatment equipment in the U.S. to grow from $43 million in 2010 to:
    - $287 million in 2020, a CAGR of 21.0% over 10 years
    - $480 million in 2025, a CAGR of 17.5% over 15 years
- Xylem decided not to pursue the shale gas produced water treatment market at that time due to:
    - A relatively small potential market for water treatment equipment
    - An uncertain regulatory framework
    - Xylem's lack of knowledge regarding the specific application
    - An unclear route to market

Factors Emerging Since Xylem Study

- The federal regulatory framework is becoming more certain.
    - Currently, the management of produced water is regulated primarily by the states, with very little coordination or consistency between states.
    - The U.S. EPA is beginning to establish federal regulations for managing produced water from shale gas operations.
        - In March 2010, EPA began conducting a study of the impact of shale gas operations on drinking water. A draft report is expected in late 2012, with proposed regulations targeted for 2014.
        - The regulations would presumably set effluent discharge limitations and pretreatment standards for produced water, prompting greater investments in water treatment equipment.
- The state regulatory framework is becoming more certain.
    - West Virginia and Texas require disclosure of chemical additives used in hydro fracking operations. Colorado is considering a similar requirement.
    - New York and North Carolina are moving towards removing bans on shale gas operations. Water treatment requirements are likely to accompany removal of the bans.
    - New Jersey's legislature is seeking to prohibit sewage treatment plants from receiving produced water from fracking. Producers will have to invest in other treatment options.
- Global opportunities for shale gas operations are expanding.
    - The Energy Information Administration (EIA) increased its estimate of technically recoverable shale gas resources in the U.S. by 134% from 2010 to 2011, from 368 Tcf to 862 Tcf, and predicts that production will grow 5% per year through 2035. The EIA began tracking shale gas resources in 2008 and issued its first estimate of recoverable resources in 2009.
    - In April, EIA issued an assessment of shale gas basins in 32 countries around the world. Technically recoverable shale gas resources outside of the U.S. total 5,760

Tcf, almost seven times the U.S. reserves. The report identifies potentially significant resources in China, Australia, South Africa, Mexico, Canada, Argentina and Poland.

Opportunities for Xylem

- Potential application of modular treatment products for produced water treatment.
- Pumps for produced water.

The market may still be too small to pursue at this time, but Xylem should continue to consider water treatment and transport opportunities related to shale gas production.

5. Energy Efficiency and Sustainability Initiatives

Government Initiatives

- At least 27 states have established energy efficiency targets.
- California leads the country in energy efficiency and sustainability initiatives. Since 2008, California has been working with Lawrence Berkeley National Laboratory to evaluate energy efficiency and demand response opportunities at industrial wastewater treatment facilities in four industrial sectors (food processing, petroleum refining, electronics and cement). A 2009 report identifies equipment efficiency options including:
    - Variable speed and higher efficiency pumps
    - Variable speed drives for blowers
    - Fine bubble diffusers
- Demand response is an internet-based method of managing a customer's consumption of electricity in response to peak supply or market price conditions. The 2009 report identifies demand response strategies for industrial wastewater treatment, including:
    - Over-oxygenation, so that a treatment plant reduces aeration needs during a peak power demand period
    - Storage of untreated wastewater for processing during off-peak hours
    - Rescheduling processes, such as biosolids dewatering or filter backwashing, for off-peak hours

Corporate Initiatives

- At least 200 major companies in the U.S. have announced sustainability initiatives.
- The most successful address sustainability as an opportunity to improve processes throughout a manufacturing process. For industrial wastewater treatment, that means making manufacturing and process changes to reduce the amount of water used and wastewater generated and to increase the reuse of water.

Opportunities for Xylem

- Control systems integrated with variable speed pumps and variable speed drives for blowers
- Fine bubble diffusers
- Develop expertise in demand response systems
- Develop expertise in advising customers on processes to reduce wastewater generation or increase reuse of wastewaters, particularly in sectors where Xylem already has some expertise, such as the food and beverage industry

Countries without Specific Regulatory Incentives For Industrial Wastewater Treatment

NORTH AMERICA

Canada

- The Canadian water and wastewater treatment industry is fairly mature, with well established channels for equipment and service providers.
- Regulation of industrial wastewater treatment has evolved from "end-of-pipe" effluent quality limits in the 1970's to a more comprehensive pollution prevention approach today.
- Canada is perceived as a water-rich nation, but is devoting increased attention to water consumption and withdrawals. Charging for water withdrawals and requiring greater reuse have been discussed, but no specific directives appear on the horizon.
- The Canadian government proposed new regulations in March 2010 that would require secondary treatment at municipal wastewater treatment facilities. However, *no regulatory developments for industrial wastewater treatment are apparent*.

Mexico

- Roughly 43% of municipal wastewater is treated.
- But, less than 20% of Mexico's industrial wastewater is treated; of 4,340 MGD of total industrial wastewater flow, 840 MGD is treated.
- The Mexican government announced a goal of treating 100% of all industrial and municipal wastewaters by 2025.
- Given the lack of a regulatory framework and reliable enforcement mechanisms, achieving that goal seems unrealistic.
- In addition, given the huge investment involved, the government is likely to place a higher priority on increasing potable water and municipal sewage coverage than on industrial wastewater treatment.
- While there is a great need for industrial wastewater transport and treatment solutions in Mexico, *there is little regulatory incentive for industrial facilities to invest* in such solutions.

SOUTH AMERICA

Brazil

- Brazil is one of the fastest growing emerging economies in the world, achieving a GDP growth rate of 7.5% in 2010.
- In 2007, Brazil adopted new water and sanitation laws and initiated the Programa de Aceleração de Crescimento (PAC) or Growth Acceleration Program targeting US$350 billion for public infrastructure improvements in 2007-2010 (PAC 1) and an additional US$530 billion for 2011-2013 (PAC 2). Approximately US$4 billion per year is planned for municipal water and wastewater projects.
- Brazil's unprecedented investment in infrastructure will also mean growth in steel, cement and other infrastructure related sectors. Imports of water-related equipment grew by 40% in 2010. However, the focus of investment will clearly be on municipal water and wastewater

treatment and *there is little regulatory incentive for industrial facilities to invest* in such solutions.

Chile

- Regulations requiring improved treatment of industrial wastewaters created an incentive for greater investments in wastewater treatment solutions during a 2000-2007 timeframe.
    - In 2000, the National Commission of the Environment (CONAMA) established effluent limitation standards for industrial facilities, with compliance required by 2006.
    - The Superintendent of Health Services (SISS) is charged with enforcing the effluent standards. According to SISS, 78% of industrial facilities discharge to the sewer and approximately 62% were in compliance with the new standards by 2007. Of the 22% with direct discharges, 87% were in compliance by 2007.
- While not embodied in regulations, an emerging investment trend concerns the industrial use of fresh water, particularly in the mining industry.
    - The mining industry uses 13% of total available fresh water in Chile. With the growing mining industry and limited fresh water resources, the mining industry is turning to other sources of water, including:
        - Seawater desalination
        - Use of treated municipal wastewater
    - A limited market for industrial water supply solutions in the mining sector may exist for Xylem, but the size of the market is fairly small.

Colombia

- The Ministry of the Environment issued a new Decree in 2010 (Decree 3930) establishing a permitting and compliance regime for industrial wastewater sources. The Ministry also proposed effluent discharge limitations and monitoring parameters in 2010.
- The *impact of these proposals on industrial facilities, and the government's commitment to enforce them, are not yet clear*.

Peru

- Peru's national sanitation authority (SUNASS) plans to promote industrial wastewater treatment by implementing a system similar to Chile's, with water quality standards and a permitting and enforcement framework. SUNASS also plants to set up a trust fund to guarantee low interest financing for industrial wastewater investments. SUNASS representatives project that US$5 billion in industrial wastewater investments will be required.
- However, *the timing of this initiative, and the government's commitment to enforce it, are not yet clear*.