Navigating the New Steam Electric Power Effluent Limitation Guidelines

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ABSTRACT

In 1974 the U.S. Environmental Protection Agency (EPA) first issued the steam electric power effluent limitation guidelines (ELGs) 40 CFR Part 423 designed to regulate the wastewaters discharged from coal, gas, oil, and nuclear power plants. Today this regulation, which was last updated in 1982 and which now regulates wastewater discharges from approximately 1,200 electricity generators across the U.S., is undergoing update by the EPA to take into consideration the best available treatment technologies and current research on the impact of various contaminants on the environment.

This paper will provide a brief background on the steam electric power ELGs and the findings of the 2009 EPA wastewater study that determined the need for the guideline update. It will detail the types of facilities and wastewater streams that will be impacted by the rule update and the timing for final rule issuance and implementation. Finally, it will explore the options available to impacted facilities to comply with the new ELG requirements.

INTRODUCTION

In 1972, the U.S. Congress passed the Clean Water Act (CWA) designed to ‘‘restore and maintain the chemical, physical, and biological integrity of the Nation’s waters” [(1)]. The CWA introduced the National Pollutant Discharge Elimination System (NPDES) for point source dischargers and granted the EPA the authority to establish national limits and guidelines for a number of different categories of point source dischargers including power generating facilities. On October 8, 1974 the EPA published the initial issuance of the ELGs and standards for the Steam Electric Power Generating Point Source Category. Facilities regulated under this category (40 CFR Part 423) are plants whose primary purpose is to generate electricity for sale and distribution and who produce this electricity from a process utilizing a fossil (coal, oil, gas) or nuclear fuel in a thermal cycle with water/steam as the thermodynamic fluid. It currently provides limitations for conventional (pH, TSS, etc.), toxic (metals, organics, etc.), and non-conventional (nutrients, TDS, etc.) pollutants and regulates a number of wastewater streams including once-through cooling water, cooling tower blowdown, fly ash and bottom ash transport waters, metal cleaning wastes, coal pile runoff, and low-volume waste sources. The regulation was amended and updated several times over the next decade in 1977, 1978, and 1980 with the most recent update in 1982.

On June 7, 2013, the EPA officially published new proposed ELGs and standards for the Steam Electric Power Generating Point Source Category in the Federal Register. The rule provides for increased regulation of discharges from both new and existing power plant wastewater sources to surface water bodies and to publicly-owned treatment works (POTWs). Although the EPA is required to review the rule on an annual basis, the current proposed update to the power plant ELG regulation is the first proposed amendment in over 30 years.

BACKGROUND ON THE PROPOSED UPDATE

Since the last update in 1982, much has changed in the power generation industry, specifically in the area of air pollution control. In 1982 flue gas desulfurization (FGD) systems were not common equipment at coal fired power plants and coal gasification (IGCC) plants and flue gas mercury control (FGMC) systems were virtually unheard of. During the EPA’s annual review of all industry ELGs in 2005, they recognized that, given the large scale changes to the power industry wastewater profile and the fact that the power industry ranked high in discharges of both toxic and non-conventional pollutants, further investigation into whether an update was required to the guidelines for this industry was warranted. Thus, a detailed study was initiated in 2005 to evaluate the need for an amendment to the power plant ELG regulations.

The EPA issued the final detailed study report in the fall of 2009 and determined that there was a need to update the existing power plant ELGs. In developing this final report, the EPA collected information on power plant wastewater characteristics and treatment technologies via site visits, surveys, public records, and sampling programs. They focused primarily on coal fired power plants and the wastewaters produced by wet FGD systems, ash collection and conveyance systems, coal combustion residual (CCR) leachates, coal pile runoff, low volume wastes, and metal cleaning wastes, wastewater streams that they believed comprised a significant portion of the toxic pollutant discharges from the facilities. The end result is the current proposed ELG amendment published in draft form on April 19, 2013 and officially published in the Federal Register on June 7, 2013 which proposes revised guidelines for treatment of and additional regulation of FGD wastewaters, fly ash transport water, bottom ash transport water, CCR leachate, FGMC wastewater, IGCC wastewater, and non-chemical metal cleaning wastes. The final version of the amendment to the ELGs is scheduled for issuance by May 22, 2014. Refer to Appendix 1 for a graphical depiction of the current power plant ELG timeline.

PROPOSED RULE AND ITS IMPLICATIONS

In developing the proposed amendment to the power plant ELGs, the EPA considered eight different regulatory options (Option 1, Option 3a, Option 2, Option 3b, Option 3, Option 4a, Option 4, and Option 5) with each subsequent option obtaining an increasingly greater level of pollutant reduction than its predecessor. Of the eight evaluated options, the EPA identified four of these options (Option 3a, Option 3b, Option 3, and Option 4a) as preferred or recommended

options for regulation and proposed numerical limits for various water quality constituents as part of these options. Appendix 2 presents a summary of the EPA's preferred or recommended options for regulation.

The ELG limits to be imposed focus primarily on coal fired power plants and the impact to the plant can vary depending on plant size. In general, the amendment specifically notes that oil fired plants and coal fired plants rated at less than 50 MW are exempt. The four EPA preferred options also make varying recommendations for regulation based on plant size: particularly in the categories of bottom ash transport water and FGD wastewater.

There are several overriding themes throughout the proposed amendment that apply widely to all or to multiple wastewater streams that are considered for additional regulation under the proposed ELG amendment. First of all, it is important to note that the limits that will be issued by the EPA next year as part of the ELG amendment are really just the minimum level of pollutant regulation that permit writers will be expected to require. In addition to the ELG technology based effluent limits (TBEL), a facility may be required to meet other water quality based effluent limits (WQBEL) such as total maximum daily loads (TMDLs) or other local or watershed regulations that dictate more stringent limits on the pollutants regulated under the ELGs (such as tighter mercury or selenium discharge limits) or regulation of additional pollutants (such as boron or chloride restrictions) to protect the water quality of the receiving stream. Secondly, the proposed amendment specifically prohibits comingling of certain wastewaters for dilution prior to discharge. Comingling is permitted for treatment purposes, for instance it is acceptable to treat leachate and FGD wastewater in a common wastewater treatment facility, but the more stringent of the individual stream limits must be met prior to discharge of the common treated effluent. The proposed ELG amendment also contains an anti-circumvention provision that dictates internal monitoring points for compliance prior to reuse/recycle of the treated wastewater internally within the facility. Thirdly, the proposed amendment seeks to redefine the existing category of low volume waste. Several wastewater streams (FGD wastewater, gasification wastewater, leachate, and FGMC wastewater) which are currently regulated under the umbrella of low volume wastewater streams are proposed to be removed from that category and regulated individually. Finally, the EPA has proposed a voluntary incentive program that grants additional time to comply with the new ELG regulations for facilities that take certain additional steps to reduce their impact on the environment. An additional two years to comply can be granted if a facility agrees to dewater, close, and cap all CCR surface impoundments (except leachate impoundments). An additional five years to comply may be granted if a facility commits to eliminate all wastewater discharges to surface waters other than cooling waters (cooling tower/pond blowdown or once-through cooling water discharge).

The sections that follow discuss each of the seven wastewater streams (FGD wastewater, fly ash transport water, bottom ash transport water, CCR leachate, FGMC wastewater, IGCC wastewater, and non-chemical metal cleaning wastes) that the ELG proposes additional regulation for in the amendment in depth and details the various limits that are being considered as part of the regulation.

FGD WASTEWATER

Since 1982 when the ELG was last updated, many power generating facilities have installed FGD systems to remove sulfur dioxide from plant flue gas streams to meet the requirements of Clean Air Act (CAA) regulations and air emissions permits. There are both wet and dry FGD system designs. The dry system designs produce a dry powdered product that is suitable for landfill, but no wastewater stream. The wet system designs typically produce a calcium sulfite or calcium sulfate (gypsum) solid cake that is sold or landfilled as well as liquid wastewater streams (purge, wash waters, etc.) that need to be treated and disposed of. Based on EPA survey data, the majority (approximately 77%) of the FGD systems that are currently in operation or are currently planned for construction are wet designs[(1)].

FGD wastewater is defined by the EPA to include "any process wastewater generated specifically from the wet flue gas desulfurization scrubber system, including any solids separation or solids dewatering processes"[(1)] and, therefore, provide potential additional regulation of not only wet FGD purge streams but also process wastewaters from gypsum or calcium

sulfite dewatering/processing activities. FGD wastewater is currently regulated in the existing ELG regulation under the category of low volume waste. The proposed amendment effective removes FGD wastewater from the category of low volume waste, creates a new category for regulation of this wastewater stream, and sets discharge limits for mercury, selenium, arsenic, and nitrite-nitrate. FGD wastewater is currently regulated under the existing ELG regulation the same for existing and new sources. The current technology standard is treatment via impoundment, in both cases, and limits are dictated for total suspended solids (TSS) and oil and grease.

Under the proposed ELG amendment, quite a few different options are presented for the future regulation of FGD wastewater. For all new sources, new numerical limits for arsenic, mercury, selenium, and nitrite-nitrite are proposed (see Table 1 below). For existing sources, the limits, technology basis, and size of units impacted all vary from option to option. Under Option 3a, limits for TSS and oil and grease under the current regulation still apply and state permit writers are left to use their best professional judgment (BPJ) in setting other limits for FGD wastewaters. Under Option 3b, however, the TSS and oil and grease limits still apply, but facilities with a scrubbed capacity of 2,000 MW or more would also be subject to the limits listed in Table 1. The technology basis for treatment of FGD wastewater for facilities with a scrubbed capacity of 2,000 MW or more under this option is chemical precipitation followed by biological treatment. For facilities with a scrubbed capacity of less than 2,000 MW, impoundment remains the technology basis. It should be noted that chemical precipitation, for the purposes of FGD wastewater treatment under the proposed ELG amendment is specified as the alkali-sulfide process including multi-stage chemical injections to achieve hydroxide precipitation, iron co-precipitation, and sulfide precipitation.

Under Option 3 and Option 4a, the limits in Table 1 apply to all facilities with a scrubbed capacity of 50 MW or more. The technology basis for Options 3 and 4a for facilities with a scrubbed capacity of 50 MW or more is also chemical precipitation followed by biological treatment. For facilities with a scrubbed capacity of less than 50 MW, impoundment remains the technology basis under Options 3 and 4a. Appendix 2 provides a summary table illustrating the four preferred options for regulation and the specified technology basis for each situation described above.

Table 1. Proposed FGD Wastewater Numerical Limits
New and Existing Sources

	30 Day Average	Daily Maximum
Arsenic, ppb	**6**	**8**
Mercury, ppt	**119**	**242**
Selenium, ppb	**10**	**16**
Nitrite-Nitrate, ppb as N	**130**	**170**

ASH TRANSPORT WATERS

Ash transport waters are defined by the EPA in the proposed amendment to include “any process wastewater that is used to convey fly ash or bottom ash from the ash collection equipment and has direct contact with the ash”[(1)]. It is worth noting, that bin overflow or bunker wastewater from bottom ash drag chain systems is not considered to be transport water since the water is not utilized as the transport medium. Rather this wastewater is still classified as a low volume waste stream under the proposed amendment.

Fly ash transport water is currently regulated in the existing ELG regulation differently for existing versus new sources. For existing sources, the technology standard is treatment via impoundment and limits are dictated for TSS and oil and grease. For new sources, discharge of fly ash transport waters is prohibited and dry handling is designated as the technology standard. Under all four of the EPA's preferred or recommended options in the proposed amendment, however, no distinction or variation in technology standard or limits is provided for existing versus new sources. The discharge of all fly ash transport water is prohibited. Dry handling is the proposed technology standard in all cases.

Bottom ash transport water, on the other hand, is currently regulated in the existing ELG regulation the same for existing and new sources. The current technology standard is treatment via impoundment, in both cases, and limits are dictated for TSS and oil and grease. As part of three of the four preferred proposed options for this wastewater stream (Option 3a, Option 3b, and Option 3), no change to the existing ELG regulation is recommended. Under the fourth and final preferred option for bottom ash transport water (Option 4a) the discharge of bottom ash transport water from units rated at greater than 400 MW would be prohibited with dry handling as the proposed technology standard in this case. For units rated at 400 MW or less, no change to the existing ELG regulation is recommended by Option 4a.

LEACHATE

Combustion residual leachate is defined by the EPA to include "leachate from landfills or surface impoundments containing residuals from the combustion of fossil or fossil-derived fuels"[(1)]. The term combustion residuals encompasses a variety of wastes from the combustion process including fly ash, bottom ash, boiler slag, and FGD waste residuals (such as calcium sulfite and gypsum). The leachate is the liquid that drains or leaches from the landfill or surface impoundment due to precipitation that enters the landfill or impoundment or due to liquids that are produced directly by the solids stored in the landfill or impoundment. It is also clarified by the EPA that the definition of leachate includes the terms seepage, leak, or leakage which are names commonly used to refer to leachate from surface impoundments.

Leachate is currently regulated in the existing ELG regulation under the category of low volume waste. The proposed amendment effectively removes leachate from the category of low volume waste and creates a new category for regulation of this wastewater stream. Leachate is currently regulated in the existing ELG regulation the same for existing and new sources. The current technology standard is treatment via impoundment, in both cases, and limits are dictated for TSS and oil and grease. Under the proposed amendment, no change is planned for regulation of leachate for existing sources either in terms of technology basis (impoundment is still the recommended technology basis) or to limits (only regulation for TSS and oil and grease is proposed) under the EPA's four preferred amendment options. However, for new leachate sources, additional limits for arsenic and mercury (see Table 2 below) are proposed with chemical precipitation as the technology basis.

Table 2. Proposed CCR Leachate Numerical Limits
New and Existing Sources

	30 Day Average	Daily Maximum
****Arsenic, ppb**	**6**	**8**
****Mercury, ppt**	**119**	**242**
TSS, ppm	**30**	**100**
Oil and Grease, ppm	**15**	**20**

****New Sources Only**

FLUE GAS MERCURY CONTROL WASTEWATERS

FGMC wastewaters are defined by the EPA in the proposed amendment to include "any process wastewater generated from an air pollution control system installed or operated for the purpose of removing mercury from flue gas."[1]. This category may include a fly ash collection system when fly ash and sorbents injected specifically for mercury removal are collected via a common particulate collection system. FGMC wastewater is currently regulated in the existing ELG regulation under the category of low volume waste. The proposed amendment effectively removes FGMC wastewater from the category of low volume waste and creates a new category for regulation of this wastewater stream. Under all four of the EPA's preferred or recommended options, the discharge of all FGMC wastewaters is prohibited. No distinction or variation in technology standard or limits is provided for existing versus new sources. Dry handling is the proposed technology standard in all cases.

GASIFICATION WASTEWATERS

In 1982 when the power plant ELGs were last updated, gasification facilities were still under development and no operating IGCC power plants existed. Today three of these types of facilities, which produce syngas from coal or petroleum coke and utilize it to fuel a combined cycle power plant, are currently in operation in the U.S. with a fourth facility under construction. The term gasification wastewaters is defined by the EPA in the proposed amendment as "any process wastewater generated from a system used to create synthesis gas from fuels such as coal or petroleum coke"[1]. Under this definition, the EPA includes for regulation under this category sour waters, grey waters, condensate generated from gas cooling, slag handling wastewater, stripper wastewater, air separation unit purge streams, and sulfur recovery unit purge or blowdown streams.

Gasification wastewaters are currently regulated in the existing ELG regulation under the category of low volume waste. The proposed amendment effectively removes gasification wastewater from the category of low volume waste, creates a new category for regulation of this wastewater stream, and sets discharge limits for mercury, total dissolved solids (TDS), arsenic, and selenium. The preferred or recommended options for regulation presented by the EPA in the proposed amendment are all consistent in their proposed technology standard and the proposed limits for treatment of this wastewater stream. No distinction or variation in technology standard or limits is provided for existing versus new sources. The proposed technology standard or basis for gasification wastewaters is thermal vapor-compression evaporation for all preferred options. The proposed numerical limits for arsenic, mercury, selenium, and TDS for gasification wastewaters for all four preferred options are shown in Table 3 below.

Table 3. Proposed Gasification Wastewater Numerical Limits
New and Existing Sources

	30 Day Average	Daily Maximum
Arsenic, ppb		**4**
Mercury, ppt	**1.29**	**1.76**
Selenium, ppb	**227**	**453**
Total Dissolved Solids, ppm	**22**	**38**

NON-CHEMICAL METAL CLEANING WASTES

The term non-chemical metal cleaning waste is defined by the EPA in the proposed amendment as "any wastewater resulting from the cleaning of any metal process equipment without chemical cleaning compounds, including, but not limited to, boiler tube cleaning, boiler fireside cleaning, and air preheater cleaning"[(1)]. This category covers wastewaters produced by a wide variety of power plant maintenance activities that may occur daily or may only occur once or twice a year such as soot blowing, economizer wash, precipitator wash, air-cooled condenser cleaning, air compressor cleaning, and condenser cleaning to name a few of the most common.

Under the existing ELG regulation promulgated in 1982, Best Practicable Control Technology Currently Available limits were assigned to metal cleaning wastes for TSS, oil and grease, copper, and iron; however, many permit writers have interpreted this assignment over the years to be for chemical metal cleaning wastes only and non-chemical metal cleaning wastes were frequently classified under the category of low volume waste in permits. The proposed amendment looks to provide a clarification of non-chemical metal cleaning wastes – that they are not low volume waste streams, but are metal cleaning wastes produced without the use of chemicals and should be classified as metal cleaning wastes in permits. In the proposed amendment, the EPA proposes to set limits and the technology standard for non-chemical cleaning wastes the same as the current limits and standard for metal cleaning wastes. However, for facilities that are currently permitted to discharge non-chemical metal cleaning wastes without regulation of iron and copper, the facilities may be exempted from the new iron and copper limits with approval. Table 4 below summarizes the proposed limits for non-chemical metal cleaning wastes detailed in the proposed ELG amendment.

Table 4. Proposed Non-Chemical Metal Cleaning Waste Numerical Limits New and Existing Sources

	30 Day Average	Daily Maximum
****Copper, ppm**	**1.0**	**1.0**
****Iron, ppm**	**1.0**	**1.0**
TSS, ppm	**30**	**100**
Oil and Grease, ppm	**15**	**20**

****Exception proposed for plants that currently do NOT have copper and iron limits**

COMPLIANCE APPROACHES AND STRATEGIES

DEFINING THE APPROPRIATE CATEGORY

Determining the appropriate category that a facility or unit falls into for compliance is the first challenge in developing a plan of attack – one must determine which limits will be applicable to their facility or unit. The EPA has established categories for technologies based on destination of the wastewater discharge - direct discharge or indirect discharge – and new or existing sources. Refer to Figure 1 below for a graphical illustration of the established categories. Indirect discharge refers to facilities or units that send their wastewater to another facility, particularly POTWs. Under this category there are pretreatment standards for existing sources (PSES) and pretreatment standards for new sources (PSNS). Direct discharge refers to facilities or units that discharge directly to a surface water body under an NPDES permit. Under this category there are separate treatment standards for new sources and existing sources. New sources are required to follow the new source performance standards (NSPS) which utilize the Best Available Demonstrated Control Technology (BADCT) as determined by the EPA as "the best and most

efficient production processes and wastewater treatment technologies."[1] Existing sources, however, are regulated via two different mechanisms – the Best Practicable Control Technology Currently Available (BPT) or the Best Available Technology Economically Achievable (BAT). BPT is determined by the EPA based on the average of the best performing facilities in the industry. Groupings based on facility age, size, processes utilized, and other common characteristics are made in evaluating facilities to define BPT. As noted, this classification is generally set based on average performance of existing facilities, but the EPA may set more stringent BPT limits if the performance of those existing facilities is deemed inadequate based on technologies currently available in the industry. BAT performance standards are generally more stringent than BPT as the EPA evaluates available treatment technologies or processes rather than existing installed systems when setting this category. The costs associated with reaching BAT limits as well as equipment age and non-water quality environmental impacts (such as power consumption) are also considered. Despite the different criteria the EPA utilizes to determine BPT and BAT, BAT may be set equal to BPT as has been done for CCR leachate in the proposed new ELG amendment.

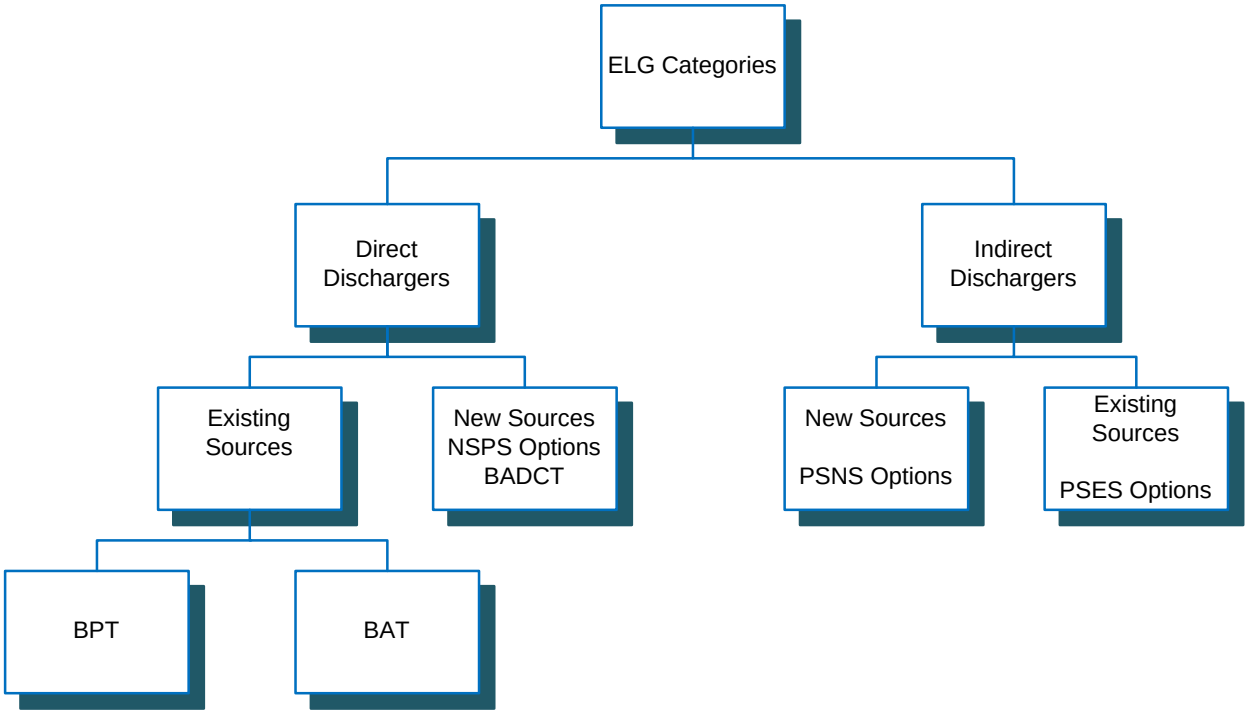

Figure 1. Steam Electric Power Generating Point Source Category ELG Categories

The definition of a "new source" is also one that facilities need to pay attention to when determining where their plant falls on the EPA's radar screen. A new source is defined by the EPA as a building, structure, facility, or installation generating wastewater that the construction of which began after the promulgation of the final ELG rule. The source is the part of the facility, whether it is a new power plant or a new piece of equipment, which generates a new wastewater stream such as a new wet FGD system. It does not refer to a new wastewater treatment system or upgrades to an existing wastewater treatment system as the treatment system is not considered to be the wastewater source.

ATTACKING THE PLANT WASTEWATER CHALLENGE HOLISTICALLY

The challenge presented to plant owners and operators by the new ELG amendment is to

minimize discharge flow rate and treatment costs through optimization of plant processes and application of best available technology solutions at lowest total installed cost. But how does a plant go about attacking this problem on a holistic basis? First of all, plant owners and operators need to understand where they currently stand from a wastewater perspective. They need to evaluate the current situation at their facility or facilities by updating water/mass balances, conducting water quality sampling and flow measurement programs, and assessing current wastewater treatment systems. This work should begin as soon as possible to allow the plant to develop a detailed repository of historical data so they can accurately understand their wastewater picture under not only normal operating conditions, but also upset or off-design conditions such as reduced load or single unit (at a multiple unit facility) operations. Once a solid understanding of the current plant wastewater picture has been developed, the plant should begin an evaluation of existing processes. Identify areas for wastewater minimization or water reuse where practical. Evaluate existing wastewater treatment systems to see if they have the ability to meet the new expected treatment limits and if upgrade is a possibility or if replacement/new facilities will be required. The evaluation should be tackled by looking at the entire plant including the impact of other pending EPA regulations such as CCR and CAA rules. ELGs, CCR, and CAA rules are all intricately interlinked and a plant facilities' change in response to one rule can have a significant impact on another area of the plant impacted by a different rule.

Once the new regulation has been issued and the plant understands how the new rules will impact their NPDES or pretreatment permit, it is time to develop that plan of attack using all the data the plant has been collecting and evaluating. Water quality modeling via techniques such as the biotic ligand model or other metal toxicity or dilution type models may be something worth considering if a plant does receive or is expected to receive more stringent or additional contaminant limits in their NPDES permits due to WQBELs required to protect the local watershed. Models such as these can aid in assessing the true toxicity of contaminants such as metals to aquatic species and can be utilized to work with state permitting agencies to develop site specific water quality limits.

TREATMENT OPTIONS

The various treatment options applicable to treatment of the newly regulated wastewater streams are discussed in brief in the following sections.

Chemical Precipitation

Chemical precipitation plus biological treatment is specified as the technology basis for several of the preferred options for treatment of FGD wastewater. Chemical precipitation is also specified as the technology basis for leachate treatment for new sources. It should be noted that chemical precipitation, for the purposes of FGD wastewater and leachate treatment under the proposed ELG amendment is specified as the alkali-sulfide process. Currently, the alkali-sulfide process is one of the most widely utilized methods for treating wet FGD wastewaters. The process involves multi-stage chemical injections to achieve hydroxide precipitation, iron co-precipitation, and sulfide precipitation. Metal effluent concentrations in each stage vary depending on the solubility of metal species that are targeted for precipitation. Lowest concentrations, however, are typically achieved by precipitating metals in the sulfide form. For instance, consider the precipitation of dissolved mercury. In precipitation of mercury (Hg) as a metal hydroxide or as a metal sulfide, the solubility product of mercury (II) hydroxide $Hg(OH)_2$ is 3.2×10^{-26} while the solubility product of mercuric sulfide Hg_2S is 1.0×10^{-47}.

Two clarification steps are typically employed in this process scheme with primary suspended solids reduction and hydroxide precipitation occurring in the first clarification step and pH adjustment and sulfide precipitation occurring in the second clarification step. This sequence optimizes chemical consumption and reduces the utilization of expensive reagents, particularly sulfide reagents such as proprietary organosulfide products. Final media filtration commonly follows these precipitation sequences to ensure removal of fine suspended particles that may still contain oxides of metals. This process is effective for reduction of arsenic and mercury – two of the constituents targeted for regulation via numerical limits in FGD wastewaters; however, it is not effective for reduction of selenium or nitrite-nitrate, the other two constituents targeted for regulation via numerical limits in FGD wastewaters.

Biological Treatment

Chemical precipitation plus biological treatment is specified as the technology basis for several of the preferred options for treatment of FGD wastewater. Biological treatment systems are generally employed for reduction of selenium and nitrite-nitrate, two of the constituents targeted for regulation via numerical limits in FGD wastewaters, and therefore, are employed at a number of existing facilities downstream of a chemical precipitation process treating this wastewater stream. There are several different designs on the market today, but most designs include two major treatment components: an anoxic zone for denitrification and an anaerobic zone for selenium reduction. In the anoxic zone or stage, denitrifying bacteria biologically reduce nitrates and nitrites to nitrogen gas which is vented off. In the anaerobic zone or stage, sulfur reducing bacteria (SRB) biologically reduce selenates and selenites to elemental selenium which is insoluble and removed from the system with the biological solids. A clarification stage may be employed after the two zones to facilitate the solids removal. An aerobic zone may also be included as part of the system design to removed organic carbon and ammonia if required.

Zero Liquid Discharge

Thermal zero liquid discharge (ZLD) systems, while not yet a proven technology for treatment of FGD wastewater in the U.S., may offer an attractive alternative to treat and discharge systems. The preferred options proposed by the EPA do not propose ZLD as a technology basis; however, ZLD was considered under one of the non-preferred options – Option 5. The proposed ELG amendment, however, does include an incentive of an additional five years to comply for plants that commit to eliminating all wastewater discharges to surface waters from the facility, other than cooling waters, so evaluation of this option for a facility may be justified.

Current ZLD options that have been investigated or are being investigated for FGD wastewaters include the following configurations:

- Brine Concentrator with Ash Conditioning or Spray Dryer
- Brine Concentrator -> Crystallizer -> Dewatering
- Full Softening -> Brine Concentrator -> Crystallizer -> Dewatering
- Partial Softening -> Brine Concentrator -> Crystallizer -> Dewatering

Emerging Treatment Options

A few other technologies have been utilized for targeted contaminant removal in FGD wastewaters and CCR leachate and a number more are under investigation and demonstration by various agencies, universities, and equipment/technology suppliers. Constructed wetlands, engineered system that use natural biological processes involving wetland vegetation, soils, and microbial activity to achieve reductions in the concentrations of metals, nutrients, and TSS in wastewater, have been implemented at three locations in the US[(4)]. Constructed wetlands offer an option for treatment that is natural and environmentally friendly. However, they do require that the plant have a significant acreage of land for installation of the system available. FGD wastewater is also required to be diluted with water from a low TDS source prior to treatment in the wetlands as these systems tend to have low chloride tolerance limits of less 4000 ppm Cl.

Other technologies that can potentially remove metals from FGD wastewaters include iron cementation, reverse osmosis, hybrid zero valence iron adsorption media, ion exchange, and electro-coagulation. These technologies are under investigation by Electric Power Research Institute (EPRI) and a number of other groups in laboratory or pilot scale studies. Ion exchange, however, has been utilized to remove boron from FGD wastewaters in full scale operation at one facility in the U.S.

ELG AND CCR RULE COORDINATION

On June 21, 2010 the EPA issued their proposed rule to regulate the disposal of CCR generated from the combustion of coal at electric utilities and by independent power producers. This proposed rule recommended additional regulation of CCR materials, including fly ash, bottom ash, boiler slag, and FGD solid wastes such as calcium sulfite and gypsum, based on concerns of pollution leaching from storage in surface impoundments and landfills and due to concerns of structural failure of impoundments. The proposed CCR rule

presents two options for additional regulation of CCR by classifying them as either "special wastes" under the existing Resource Conservation and Recovery Act (RCRA) Subtitle C that regulates hazardous wastes or by classifying them as non-hazardous wastes and subjecting them to regulation under RCRA Subtitle D[(2)]. Issuance of the final CCR regulation is still pending.

In the proposed ELG amendment documentation, the EPA admits that there is an intersection between the CCR rule and the ELG rule and that coordination and alignment of the two rules is in the best interest of all those impacted allowing for better coordination of planning activities by facilities. The ELGs will focus on regulation of leachate and water discharges from CCR surface impoundments and landfills; the CCR rule will focus on engineering design of CCR impoundments and landfills and the solid waste stored in those impoundments and landfills. Ultimately it is believed that the decisions related to regulation of leachate and ash transport waters that the EPA makes in conjunction with the ELGs will impact the decisions that they make in regards to final classification of CCR under RCRA Subtitle C or D. Also, the additional information collected during the ELG survey process regarding CCR impoundments, has led the EPA to believe that the risks from impoundments may have been overestimated during the original CCR review by an order of magnitude. Therefore, EPA current thinking is that the "revised risks coupled with ELG requirements that the agency might promulgate, could provide strong support for a conclusion that regulation of CCR disposal under RCRA Subtitle D would be adequate"[(1)].

Given the wide intersection of these two regulations, the EPA has announced that they intend to coordinate the implementation dates and timelines associated with the final versions of the two rules so facilities have sufficient time to evaluate and coordinate compliance with both rules in a synchronized manner. For instance, if the final ELG rule reflects proposed Option 4a which prohibits discharge of all fly ash transport water and bottom ash transport water for larger units, the conversion of plants to dry ash systems could impact pond and landfill closure plans. Voluntary adoption of plans to dewater, close, and cap CCR surface impoundment as part of the proposed ELG incentive program may also impact decisions in the CCR arena. A timeline for implementation of these regulations is anticipated to be established such that facilities can assess whether it makes sense to continue to operate CCR impoundments given the requirements under the new rules or whether it makes more economic sense to make other changes to facility equipment.

WHAT'S NEXT?

The final EPA ruling is currently scheduled for publication no later than May 22, 2014 with a scheduled July 1, 2017 implementation date. What that means is that power generating facilities will know what the final national rule will require next year (provided no additional delays occur), but permitting authorities will not begin incorporating the new ELG requirements into NPDES and pretreatment permits until after July 1, 2017. This will provide facilities a minimum of three years to comply. The plan is to have all permits updated within five years of the implementation date, or by July 1, 2022. All new sources will be immediately subject to the new rules, however, upon the implementation date (July 1, 2017).

So what are the recommended next steps for facilities that expect to be impacted by the proposed ELG amendment?

First of all, plant owners and operators should develop a baseline and a plan of attack. Start by evaluating the current situation at your facilities by updating water/mass balances, conducting sampling and flow measurement programs, and assessing current wastewater treatment systems. Knowing where your starting point is and having a solid data history is important to determining what you may need to do to meet the new requirements.

Secondly, consider whether the proposed incentive programs are right for you. The EPA has proposed incentive programs with additional time to comply for facilities that voluntarily agree to dewater, close, and cap all CCR surface impoundments (2 years) or eliminate all wastewater discharges to surface waters other than cooling waters (5 years). Evaluate whether or not participation in these voluntary incentive programs makes sense at your facilities.

And finally, consider the impact of other pending regulations. The EPA has issued proposed

additional regulations for CCR, CWA §316(b), and flue gas air emissions. Evaluating the plant holistically by considering all pending environmental changes is important to developing the lowest cost and most practical combined solutions to meeting all a given facility's challenges.

REFERENCES

1. United States Environmental Protection Agency (2013). Proposed Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category*. Federal Register.* Volume *78, Number 110, Pages 34432-34542.*

2. United States Environmental Protection Agency (2010). Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals from Electric Utilities*. Federal Register.* Volume *75, Number 161, Pages 35127-35264.*

3. United States Environmental Protection Agency (2009). Steam Electric Power Generating Point Source Category: Final Detailed Study Report. EPA-821-R-09-008.

4. United States Environmental Protection Agency (2013). Technical Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category. EPA-821-R-13-002.

5. Chapman, C. A. and C. M. Layman (2007). 68th International Water Conference. Considerations Impacting the Technology Selection Process for FGD Purge Stream Wastewater Treatment Systems.

2014 Proposed Final Action - Implementation of proposed amendment (May 22 by Consent Decree)

June 7, 2013 - Proposed ELG Amendment issued

September 20, 2013 – Deadline for comment on proposed ELG Amendment

July 1, 2017 Implementation Date - Incentive programs available providing additional time (2 years or 5 years) to comply

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

2005 - EPA Annual Review of ELGs initiated detailed study of category wastewaters

September 2009 - Final Detailed Study Report released and EPA announces decision to proceed with amendment

2010 - EPA Survey of Existing Plants Conducted

June 2010 – Draft CCR Rule Issued

December 2010 - **Consent Decree** Defenders of Wildlife v. EPA Lawsuit; Consent decree entered into ruling with proposed dates for ELG amendment action

July 2017- July 2022 Permit Implementation Period - Permitting authorities incorporate final ELGs into NPDES and pretreatment permits with schedules for new limits to be applied "ASAP"

Appendix 1 – ELG Amendment Implementation Timeline

Increasingly Stringent Limits

	Current Rule	Option 3a	Option 3b	Option 3	Option 4a
FGD Wastewater	Impoundment Included as Low Volume Waste	BPJ determination	<2000 MW: BPJ determination ≥2000 MW: Chemical precipitation + Biological Treatment Hg, As, Se and nitrate-nitrite Limits	>50 MW: Chemical precipitation + Biological Treatment Hg, As, Se and nitrate-nitrite Limits	>50 MW: Chemical precipitation + Biological Treatment Hg, As, Se and nitrate-nitrite Limits
Fly Ash Transport Water	Impoundment	Dry handling No discharge	Dry handling No discharge	Dry handling No discharge	Dry handling No discharge
Bottom Ash Transport Water	Impoundment	Impoundment Limits equal to BPT	Impoundment Limits equal to BPT	Impoundment Limits equal to BPT	≤400 MW: Impoundment Limits equal to BPT >400 MW: Dry handling/ closed loop; No discharge
Coal Combustion Residual Leachate	Impoundment Included as Low Volume Waste	Impoundment Limits equal to BPT	Impoundment Limits equal to BPT	Impoundment Limits equal to BPT	Impoundment Limits equal to BPT
FGMC Wastewater	Impoundment Included as Low Volume Waste	Dry handling No discharge	Dry handling No discharge	Dry handling No discharge	Dry handling No discharge
Gasification Wastewater	Impoundment Included as Low Volume Waste	Vapor-compression evaporation Hg, As, Se, TDS Limits	Vapor-compression evaporation Hg, As, Se, TDS Limits	Vapor-compression evaporation Hg, As, Se, TDS Limits	Vapor-compression evaporation Hg, As, Se, TDS Limits
Nonchemical Metal Cleaning Wastes	Reserved for Future Consideration	Chemical precipitation Cu, Fe Limits	Chemical precipitation Cu, Fe Limits	Chemical precipitation Cu, Fe Limits	Chemical precipitation Cu, Fe Limits

Appendix 2 – Technology Basis and Proposed Limits for USEPA's Preferred ELG Regulatory Option