Attachment A
Technology-based Effluent Limits
Flue Gas Desulfurization (FGD) Wastewater at Steam Electric Facilities

I. Background

In October 2009, the Environmental Protection Agency (EPA) completed a study of wastewater discharges from the steam electric power generating industry. EPA's Office of Water evaluated wastewater characteristics and treatment technologies, focusing to a large extent on wastewater from flue gas desulfurization (FGD) air pollution control systems and coal ash ponds because these sources comprise a significant fraction of the pollutants discharged by steam electric power plants[1]. Based on this study, EPA decided to begin a rulemaking to address pollutants and wastestreams not covered by existing regulations issued in 1982 (40 CFR Part 423)[2]. EPA expects to complete this rulemaking and promulgate revised effluent guidelines in late 2013. This document addresses how to establish technology-based effluent limits for flue gas desulfurization (FGD) wastewater discharged from steam electric facilities in NPDES permits issued until such time a revised effluent guideline is promulgated.

II. Requirement to Include Technology-Based Effluent Limitations in NPDES Permits

National Pollutant Discharge Elimination System (NPDES) permits must include effluent limitations as required by Clean Water Act (CWA) Section 301. 33 USC § 1342(a)(1). CWA section 301 requires that permits include limitations based on the application of statutorily-prescribed levels of technology ("technology-based effluent limitations"). 33 USC §§ 1311(b)(1)(A), 1311(b)(2)(A). Technology-based limitations constitute a minimum floor of controls that must be included in a permit, irrespective of the discharger's effect on the quality of the receiving water. American Petroleum Inst. v. EPA, 661 F.2d 340, 344 (5th Cir. 1981).

The CWA requires EPA to establish technology-based effluent guidelines that reflect levels of technology control for certain categories of point sources. 33 USC §§ 1311(b), 1314(b). These effluent guidelines, where applicable, form the basis for the technology-based effluent limitations that must be incorporated into NPDES permits for individual dischargers. 33 USC § 1342(a)(1)(A).

Where EPA has not promulgated technology-based effluent guidelines for a particular class or category of industrial discharger, or where the technology-based effluent guidelines do not address all wastestreams or pollutants discharged by the industrial discharger, EPA must establish technology-based effluent limitations on a case-by-case basis in individual NPDES

[1] U.S. EPA. *Steam Electric Power Generating Point Source Category: Final Detailed Study Report* (EPA 821-R-09-008). October 2009. Available at http://epa.gov/waterscience/guide/steam/finalreport.pdf.
[2] The Steam Electric Power Generating effluent limitations guidelines and standards (referred to in this report as "effluent guidelines") apply to a subset of the electric power industry, namely those plants "primarily engaged in the generation of electricity for distribution and sale which results primarily from a process utilizing fossil-type fuel (coal, oil, or gas) or nuclear fuel in conjunction with a thermal cycle employing the steam water system as the thermodynamic medium." The effluent guidelines are codified in the Code of Federal Regulations (CFR) at Title 40, Part 423 (40 CFR Part 423).

permits, based on its best professional judgment or "BPJ." EPA establishes such limitations pursuant to its authority under CWA section 402(a)(1) which authorizes EPA to include in permits "such conditions as the Administrator determines are necessary to carry out the provision of [the CWA]". 33 USC § 1342(a)(1)(B). Because Section 301 of the CWA requires technology-based effluent limitations as a minimum level of control, such case-by-case technology limitations are "necessary to carry out the provision of this chapter" prior to the development of an applicable effluent guidelines and therefore must be included in any NPDES permit issued under section 402(a), as provided in EPA's implementing regulations. *See* 40 CFR 125.3(a) ("Technology-based treatment requirements under section 301(b) of the Act represent the minimum level of control that must be imposed in a permit issued under Section 402 of the Act"). *See also* 40 CFR 122.44(a)(1); 125.3(c) and (d).

States authorized to implement the NPDES program act in the place of EPA for the purpose of issuing NPDES permits to dischargers. 33 USC § 1342(b). Although authorized states may include more stringent restrictions than the federal program, an authorized state must comply with specific minimum federal requirements of the NPDES program. 40 CFR 123.25. Therefore, an authorized state must include technology-based effluent limitations in its permits for pollutants not addressed by the effluent guidelines for that industry. 33 USC § 1314(b); 40 CFR 122.44(a)(1), 123.25,, 125.3. In the absence of an effluent guideline for those pollutants, the CWA requires permitting authorities to conduct the "BPJ" analysis discussed above on a case-by-case basis for those pollutants in each permit.

III. FGD Wastewater from Steam Electric Facilities

Wastewater Characteristics

The FGD system works by contacting the flue gas stream with a liquid slurry stream containing a sorbent. The contact between the streams allows for a mass transfer of sulfur dioxide as it is absorbed into the slurry stream. Other pollutants in the flue gas (e.g., metals, nitrogen compounds, chloride) are also transferred to the scrubber slurry and leave the FGD system via the scrubber blowdown. Depending upon the pollutant, the type of solids separation process and the solids dewatering process used, the pollutants may partition to either the solid phase (i.e., FGD solids) or the aqueous phase. FGD wastewaters generally contain significant levels of pollutants, including bioaccumulative pollutants such as arsenic, mercury, and selenium. The FGD wastewaters also contain significant levels of chloride, total dissolved solids (TDS), total suspended solids (TSS), and nitrogen compounds.

Many of the pollutants found in FGD wastewater cause environmental harm and can potentially present a human health risk. These pollutants are of particular concern because they can occur in quantities (i.e., total mass released) and/or concentrations that cuase or contribute to in-stream excursions of EPA recommended water quality criterion for aquatic life or human health protection. In addition, some pollutants in the FGD wastewater present an ecological threat due to their tendency to persist in the environment and bioaccumulate in organisms. Several constituents present in FGD wastewater (e.g., arsenic, mercury, selenium) can readily bioaccumulate in exposed biota. This bioaccumulation is of particular concern due to the potential for impacting higher trophic levels, local terrestrial environments, and transient species in addition to the aquatic organisms directly exposed to the wastewater. Aquatic systems with long residence times and exposure to bioaccumulative pollutants often experience persistent environmental effects and suffer from long recovery times.

The Steam Electric Power Generating effluent limitations guidelines and standards promulgated in 1982 include wastewater from wet FGD systems under the "catch-all" category of "low-volume wastes." 40 C.F.R. 423.11(b). However, the 1982 rulemaking did not establish best available technology economically achievable (BAT) limits for FGD wastewaters because EPA lacked the data necessary to characterize pollutant loadings from these systems. *See* the Development Document[3] for the 1982 effluent guidelines at p. 248 (noting that "[a]dditional studies will be needed to provide this data and to confirm the current discharge practices in the industry"). Accordingly, EPA determined that BAT limits for the FGD wastestream were outside the scope of the rulemaking, and explicitly reserved the development of such limits for a future rulemaking. *See* the Federal Register preamble for the 1982 effluent guidelines, 47 Fed. Reg. at 52291 (Nov. 19, 1982); Development Document at pp. 3, 7.

Technologies for Treating FGD Wastewater

Addressing the variety of pollutants present in FGD wastewater typically requires several stages of treatment to remove the suspended solids, particulate and dissolved metals, and other pollutants present. Historically, power plants have relied on settling ponds to treat FGD wastewater because NPDES permits generally focused on controlling suspended solids for this waste stream. In recent years, physical/chemical treatment systems and other more advanced systems have become more widely employed as effluent limits for metals and other pollutants have been included in permits. However, many power plants continue to employ settling ponds as their treatment technology, and often commingle the pond effluent with waste streams of significantly higher flows (e.g., ash transport water and cooling water).

Settling ponds use gravity to remove solid particles (i.e., suspended solids) from the wastewater. Metals in FGD wastewater are present in both soluble (i.e., dissolved) and particulate form. The metals that are present mostly in particulate form can usually be removed by a well-operated settling process that has a sufficiently long residence time. However, other pollutants such as selenium, boron, and magnesium, are present mostly in soluble form and are not effectively and reliably removed by wastewater settling ponds. For metals present in both soluble and particulate forms (such as mercury), the settling pond will not effectively remove the dissolved fraction. Technologies more advanced than settling ponds are available and more effective at removing both soluble and particulate forms of metals, and for removing other pollutants such as nitrogen compounds and total dissolved solids. Therefore, although each permit is case-specific, EPA expects as a general matter that settling ponds are unlikely to represent the BAT for control of pollutants in FGD wastewater, given that more effective treatment technologies have been demonstrated to reduce pollutants in FGD wastewater.

Physical/chemical treatment (i.e., chemical precipitation) is used to remove metal compounds from wastewater. Chemicals are added to the wastewater in a series of reaction

[3] U.S. EPA. *Development Document for Effluent Limitations Guidelines and Standards and Pretreatment Standards for the Steam Electric Power Generating Point Source Category* (EPA 440/1-82/029). November 1982.

tanks to convert soluble metals to insoluble metal hydroxide or metal sulfide compounds, which precipitate from solution and are removed along with other suspended solids. An alkali, such as hydrated lime, is typically added to adjust the pH of the wastewater to the point where metals precipitate out as metal hydroxides. Coagulants and flocculants are often added to facilitate the settling and removal of the newly-formed solids. Plants striving to maximize removals of mercury and other metals will also include sulfide addition (e.g., organosulfide) as part of the process. Adding sulfide chemicals in addition to the alkali provides even greater reductions of heavy metals due to the very low solubility of metal sulfide compounds, relative to metal hydroxides. Sulfide precipitation has been widely used in Europe and is being installed at multiple locations in the United States. Approximately thirty U.S. power plants include physical/chemical treatment as part of the FGD wastewater treatment system; about half of these plants employ both hydroxide and sulfide precipitation in the process. This technology is capable of achieving low effluent concentrations of various metals and the sulfide addition is particularly important for removing mercury; however, physical/chemical treatment systems are not effective at removing selenium, nitrogen compounds, and certain metals that contribute to high concentrations of total dissolved solids in FGD wastewater (e.g., calcium, magnesium, sodium).

Seven power plants in the U.S. are operating or constructing treatment systems that follow physical/chemical treatment with a biological treatment stage to supplement the metals removals with substantial additional reductions of nitrogen compounds and/or selenium. Three of these systems use a fixed film anoxic/anaerobic bioreactor optimized to remove selenium from the wastewater. The bioreactor alters the form of selenium, reducing selenate and selenite to elemental selenium which is then captured by the biomass and retained in treatment system residuals. [4] The conditions in the bioreactor are also conducive to forming metal sulfide complexes to facilitate additional removals of mercury, arsenic, and other metals. In addition, the anoxic conditions in the bioreactor remove nitrates by denitrification, and if necessary the bioreactor can be modified to include a step to nitrify and remove ammonia. Four power plants operate the treatment system with the biological stage optimized for nitrogen removal by using a sequencing batch reactor to nitrify and denitrify the wastewater and produce very low concentrations of both ammonia and nitrates. This bioreactor design can also be operated to change the chemical form of selenium to promote its removal, but selenium removal by these systems has not yet been quantified.

Physical/chemical treatment systems can achieve low effluent concentrations for a number of pollutants, and reduce concentrations even further when combined with biological treatment systems, as described above and in EPA's October 2009 report. However, these technologies have not been effective at removing substantial amounts of boron and pollutants such as sodium and magnesium that contribute to high concentrations of total dissolved solids. Another FGD wastewater treatment technology that can address these pollutants, as well as removing the pollutants treated by physical/chemical and biological technologies, is vapor-

[4] Two other power plants (in addition to the seven biological treatment systems) operate treatment systems that incorporate similar biological treatment stages, but with the biological stage preceded by settling ponds instead of a physical/chemical treatment stage. Although the primary treatment provided by such settling ponds at these plants is less effective at removing metals than physical/chemical treatment, these plants nonetheless further demonstrate the availability of the biological treatment system and its effectiveness at removing selenium and nitrates.

compression evaporation. This technology uses an evaporator to produce a concentrated wastewater stream and a reusable distillate stream. The concentrated wastewater stream is either disposed of or further processed to produce a solid by-product and additional distillate. The distillate stream can be reused as makeup water by the plant. One U.S. plant and six Italian plants are using this technology to treat FGD wastewater from their coal-fired generating units. Additional treatment systems of this design are projected to begin construction soon. The operation of the vapor-compression evaporation technology, which is commonly referred to by the term zero liquid discharge, is described in more detail in EPA's October 2009 report.

Additional information about the characteristics and treatment of FGD wastewater and EPA's environmental assessment of these wastes is presented in Chapters 4 and 6, respectively, of the October 2009 report.

IV. Effluent Limits for Internal FGD Waste Streams

Under 40 CFR part 122.45(h), in situations where an NPDES permit effluent limitations or standards imposed at the point of discharge are impractical or infeasible, effluent limitations or standards may be imposed on internal waste streams before mixing with other waste streams or cooling water streams. Limitations on internal waste streams may be necessary, such as in situations where the wastes at the point of discharge are so diluted as to make monitoring impracticable, or the interferences among pollutants would make detection or analysis impracticable.

Many power plants combine FGD wastewater with ash transport wastewater and/or cooling water prior to discharge, which can result in FGD wastewaters being diluted by several orders of magnitude prior to the final outfall. In addition, ash ponds typically contain a variety of wastes (e.g., ash transport water, coal pile runoff, landfill/pond leachate, etc.) that when mixed with the FGD wastewater may make the analysis to measure compliance with FGD wastewater technology-based effluent limits impracticable. Because of the high degree of dilution and the number of waste stream sources containing similar pollutants, NPDES permits may need to include effluent limits and monitoring requirements on the internal FGD waste stream to ensure effective control of the pollutants present in FGD wastewater.

V. Use of Sufficiently Sensitive Analytical Methods

EPA's October 2009 study demonstrated that the use of sufficiently sensitive analytical methods is critically important to detecting, identifying and measuring the concentrations of FGD pollutants. Where EPA has approved more than one analytical method for a pollutant, the Agency expects that applicants and permittees would select methods that are able to quantify the presence of pollutants in a given discharge at concentrations that are low enough to determine compliance with Water Quality Criteria. NPDES permit applicants should not use a less sensitive or less appropriate method, thus masking the presence of a pollutant in the discharge, when an EPA-approved method is available that can quantify the pollutant concentration at the lower levels needed for permit decision making. For purposes of permit applications and compliance monitoring, a method is "sufficiently sensitive" when (1) the method quantitation level is at or below the level of the applicable water quality criterion for the pollutant or (2) the method quantitation level is above the applicable water quality criterion, but the amount of pollutant in a facility's discharge is high enough that the method detects and quantifies the level of pollutant in the discharge.

It is essential that the Director make permitting decisions based on sufficiently sensitive data and, thus, sound science. The use of insufficiently sensitive analytical methods could lead the Director to make an incorrect determination about the presence or absence of a pollutant in an applicant's discharge. These assumptions, in turn, could result in the Director making an incorrect permitting decision. Additionally, requiring insufficiently sensitive analytical methods in permits for compliance monitoring purposes could result in an undetected exceedance of permit limits.

Due to advances in instrumentation since a method was developed and the benefit of experienced analysts, an analyst may achieve detection limits (MDLs) and minimum levels (MLs) lower than the published values. Thus, the Director should not rely solely on sensitivity measures, such as MDLs or MLs, in published methods. These measures only give an upper, not a lower, bound on capabilities. In addition, EPA provides analysts the flexibility to modify an approved method without EPA review. This flexibility allows a laboratory to demonstrate performance better than the published MDL or ML.

VI. Disclaimer

This guidance document does not change or substitute for any legal requirements, though it does provide clarification of some regulatory requirements. While EPA has made every effort to ensure the accuracy of the discussion in this document, the obligations of the regulated community are determined by the relevant statutes, regulations, or other legally binding requirements. This guidance document is not legally enforceable and does not confer legal rights or impose legal obligations upon any member of the public, EPA, states, or any other agency. In the event of a conflict between the discussion in this document and any statute or regulation, this document would not be controlling. The word "should" as used in this guidance document does not connote a requirement, but does indicate EPA's strongly preferred approach to assure effective implementation of legal requirements. This guidance may not apply in a particular situation based upon the circumstances, and EPA, states and Tribes retain the discretion to adopt approaches on a case-by-case basis that differ from the recommendations of this guidance document where appropriate. Permitting authorities will make each permitting decision on a case-by-case basis and will be guided by the applicable requirements of the CWA and implementing regulations, taking into account comments and information presented at that time by interested persons regarding the appropriateness of applying these recommendations to the particular situation. In addition, EPA may decide to revise this guidance document to reflect changes in EPA's approach to implementing the regulations or to clarify and update text.

VII. Contacts

If you have questions concerning this guidance, contact Linda Boornazian, Director of the Water Permits Division, at 202-564-0221 or your staff may contact Scott Wilson of the Industrial

Branch at 202-564-6087 or Wilson.js@epa.gov. For additional technical information about the pending rulemaking, contact Mary Smith, Director of the Engineering and Analysis Division, at 202-566-1056. For information about the characteristics or treatment of FGD wastewater, your staff may contact Ronald Jordan of the Engineering and Analysis Division at 202-566-1003 or jordan.ronald@epa.gov.