EFFLUENT LIMITATIONS GUIDELINE COMPLIANCE: FLUE GAS DESULFURIZATION (FGD) WASTEWATER

White Paper

Abstract | *One of the major compliance hurdles introduced by the recently finalized Effluent Limitations Guidelines (ELGs) is the treatment of Flue Gas Desulfurization (FGD) wastewater. FGD wastewater flow and quality vary from station to station. Treatment to achieve ELG compliance often requires a unique and customized solution to reduce cost, schedule, and equipment footprint. This white paper, authored by David Weakley II, PE, Assistant Engineering Manager at GAI Consultants, outlines seven steps to serve as a starting point for stations gearing up for ELG compliance for FGD wastewater. The steps include creating and verifying a station water balance; understanding the existing FGD wastewater system; identifying and evaluating constituents of concern; evaluating FGD treatment options; assessing applicable technologies through pilot testing; selecting a treatment technology; and developing delivery documents, including all applicable permits, drawings, and specifications.*

Introduction

In the modern age of coal-fired power generation, Flue Gas Desulfurization (FGD) is commonplace. The EPA requires the use of FGD scrubber systems on coal-fired facilities to reduce air pollution via removal of sulfur dioxide (SO2) and heavy metals from the flue gas. Wet FGD scrubber systems produce a purge stream of wastewater laden with suspended solids, heavy metals, chlorides, and sulfates—this wastewater requires treatment prior to discharge. Many variables affect the wastewater's characteristics, including source coal chemistry, scrubber design, scrubber operation, makeup water chemistry, boiler design, and boiler operation. This large number of variables creates unique wastewater at every coal-fired power plant, and each source must be treated to the levels specified by the Effluent Limitations Guidelines (ELGs), as well as the site-specific National Pollutant Discharge Elimination System (NPDES) permit.

For more information on the ELGs and what they mean for the coal power industry, be sure to download this guideline document that outlines the new contaminant concentrations that stations must meet and the proposed timelines for compliance. In addition to the site-specific NPDES requirements, the final ELG requirements for existing FGD wastewaters include:

FGD Wastewater Constituent (Existing Sources)	30 Day Average	Daily Maximum
Arsenic	8 ppb	11 ppb
Mercury	356 ppt	788 ppt
Selenium	12 ppb	23 ppb
Nitrite — Nitrate	4.4 ppm	17 ppm

ppm = parts per million (milligram / Liter)
ppb = parts per billions (milligram / Liter)
ppt = parts per trillion (nanogram / Liter)

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Many wet FGD scrubber systems already have wastewater treatment systems in place. However, achieving the levels listed above to comply with the ELG requirements may not be feasible without additional polishing treatment or construction of a zero liquid discharge (ZLD) system. There are many paths to ELG compliance for FGD wastewater. At many coal-fired facilities, there are tight budgets, compressed schedules, and reduced manpower, so it is critical to select the correct path towards FGD wastewater compliance.

Step 1: Create and Verify the Station Water Balance
Priority number one for ELG compliance is to create and verify the station's water balance. Please refer to our previous installment for more discussion on the benefits of having an accurate, up-to-date station water balance. If a working water balance has already been developed, further steps may be taken to improve its accuracy and completeness. Helpful additions to the water balance include minimum, average, and peak flowrates through pump stations and pipelines. Historical flow data should be verified periodically to ensure that operating conditions are represented accurately. Additional details should also be included for standard operation, partial outage, and full outage conditions. Each of these scenarios may have dramatically different water consumption patterns, and all possible operating configurations should be evaluated.

Step 2: Understand the Existing FGD Wastewater Treatment System
In addition to the station water balance, it is important to understand the operation and capabilities of the existing FGD wastewater treatment system. This step primarily consists of evaluating reference documents, water samples, system performance, and input from wastewater treatment plant operators. The following list provides a starting point for understanding an existing FGD wastewater treatment system:

1. FGD wastewater treatment system design documents
    a. Process flow diagrams (PFDs)
    b. Piping and instrumentation diagrams (P&IDs)
    c. General arrangements (GAs) and site plans
    d. Capacity of individual equipment
    e. Design water quality and performance guarantees
    f. Design and actual flowrates
    g. Chemical dosing rates
2. Flow sampling and monitoring
    a. Influent water
    b. Effluent water
    c. Sludge removal
    d. Recycle water (if applicable)
3. Water quality sampling and monitoring
    a. Influent raw wastewater
    b. Effluent after physical/chemical treatment
    c. Effluent after biological treatment (if applicable)

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4. Consider variability of flow and raw water quality during the following situations
    a. Full operation, full load
    b. Full operation, reduced load
    c. Partial outage, full load
    d. Partial outage, reduced load
    e. Full outage
5. Correlate flowrates and influent raw wastewater quality with station loads and operating conditions
6. FGD wastewater treatment plant operator input

Step 3: Identify and Evaluate the Constituents of Concern
Complete an evaluation to determine the probable new FGD wastewater limits, assessing the following sources of input:

- Existing NPDES permit (e.g., metals, pH, TSS, and oil and grease)
- ELG rule (e.g., arsenic, mercury, selenium, and nitrite-nitrate)
- Potential future limits
    - Water quality based effluent limits (WQBELs)
    - Total maximum daily loads (TMDLs)

After making an agreed-upon list of probable effluent requirements, perform an evaluation to determine which constituents can be met using the existing treatment system, and which constituents are problematic.

Step 4: Evaluate FGD Wastewater Treatment Options
After evaluating the current state of the existing treatment plant and identifying the constituents of concern, complete an evaluation of available treatment technologies. The evaluation should include the following parameters:

- Capital expenditure
- Operational and maintenance expenditure
- Performance guarantees
- Implementation schedule
- Footprint
- Ease of operation
- Life expectancy of the station
- Station's typical operation method (base load station vs. peaking station)
- Sludge or brine disposal methods

The ELG rule states that the best available technology (BAT) is physical/chemical treatment followed by biological treatment. Alternatively, a ZLD system may be installed. Following is a list of applicable technologies for treating FGD wastewater to the ELG's required levels:

- Treatment for discharge
    - Fixed film biological
    - Zero valent iron
    - Ion exchange

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- ZLD treatment
  - Reverse osmosis
  - Brine concentrators
  - Brine crystallizers
  - Flue gas spray dryer
  - Evaporation ponds
  - Solidification

Step 5: Assess Applicable Technologies through Pilot Testing
Use the information gathered in Steps 3 and 4 to narrow down the applicable treatment options. Every FGD wastewater is unique and requires individual consideration when selecting treatment options. For this reason, it is difficult to judge the efficacy of treatment without a pilot study. Bench studies can be implanted inexpensively to narrow the field of applicable technologies for a station's FGD wastewater treatment plant. An on-site pilot study has several advantages:

- Mitigates risk for performance guarantees
- Allows the technology to treat actual wastewater produced by the station in real time, accounting for flow or constituent spikes and variations
- Dials in design parameters (e.g., how many membranes, how many trains, and what temperature)
- Allows for higher precision in cost estimating and budgeting

Step 6: Select a Treatment Technology
Following evaluation of treatment options and completion of a successful pilot study, select a treatment technology for application and provide final summaries for the following:

- Design basis and performance guarantees
- Treatment technology
- Approved treatment vendors
- Scope of work
- Footprint and location
- Project and permit schedule
- Capital expenditures
- Operational and maintenance expenditures

Step 7: Develop Delivery Documents
Projects of this magnitude can be delivered in several ways. It is often a case-by-case decision of the primary stakeholder to decide the project delivery method and the delivery documents. Typical delivery documents include:

- Division of responsibility
- Process flow diagrams (PFDs)
- Piping and instrumentation diagrams (P&IDs)
- Process calculations
- Philosophy of operations
- General arrangements (GAs) and site plans

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- Geotechnical reports
- Civil calculations, specifications, and drawings
- Structural calculations, specifications, and drawings
- Electrical calculations, specifications, and drawings
- Mechanical calculations, specifications, and drawings
- Equipment datasheets
- Valve and instrument index
- Quality assurance and quality control documents (QA/QC)
- Project schedule
- Permit application and support

Conclusion

Through a logical progression of assessing the existing system, evaluating treatment options, performing pilot studies, selecting a technology, and delivering the project, optimized ELG compliance is achievable. There are many options for compliance and a unique solution is often required for each station. By following the seven steps outlined above, power stations will be better positioned to comply with the ELG requirements.

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For questions or additional information on FGD Wastewater, contact Senior Engineering Manager Arica DiTullio at 412.399.5455.

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