# CCR AND ELG: A JOINT APPROACH TO BOTTOM ASH MANAGEMENT

**Abstract |** *While both the Coal Combustion Residual (CCR) Rule and the Effluent Limitations Guidelines (ELGs) were developed separately, there are several common elements shared between the two regulations. By considering both rules concurrently, a unified, cost-effective solution can be engineered and constructed. Implementation of CCR and ELG rules generally coincides with a facility's National Pollution Discharge Elimination System (NPDES) Permit renewal schedule.*

*Optimizing a station's water balance by increasing water reuse/recycle and eliminating or reducing unnecessary wastewater streams can greatly reduce the capital expenditure requirements of environmental projects for CCR and ELG compliance. Achieving a zero liquid discharge (ZLD) bottom ash transport water system can be coupled with other station initiatives such as CCR leachate management and cooling tower blowdown management. Managing CCR landfills with respect to reducing leachate quantity and improving water quality can have significant effects on overall station compliance. Ash pond reconstruction (retrofit) or replacement activities can be considered to figure into the station's overall environmental compliance plan. Retrofit projects considered are raising pond beds, relining, and footprint reduction while replacement projects could be geotubes, drag chains or tank based systems.*

*This paper discusses methods and approaches to optimizing a coal fired power station's water balance, developing a ZLD system for bottom ash transport water, repurposing existing station ponds, and managing CCR solids. Additionally, this paper outlines cost-effective bottom ash management strategies that can be implemented to achieve regulatory compliance. By integrating engineering efforts associated with ELG and CCR compliance, capital project budgets can be greatly reduced.*

**White Paper**



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## Defining Ash Transport Water

Before delving further into approaches for achieving ELG and CCR compliance, it is important to identify the specific types of ash transport water as they are defined and the compliant management methods within each of the individual ELG and CCR rulings. The Final ELG Rule sets limits for pollutant discharge at coal fired steam generation power facilities and in turn requires a ZLD process for ash transport water. The rule is detailed in Article 40 CFR Part 423, and according to Section VI Part B.2 and B.3 of the ELG legislation, Fly Ash and Bottom Ash Transport Water are defined as follows:

### Fly Ash Transport Water

Plants use particulate removal systems to collect fly ash and other particulates from the flue gas in hoppers located underneath the equipment. Of the coal-, petroleum coke-, and oil-fired steam electric power plants that generate fly ash, most of them

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transport fly ash pneumatically from the hoppers to temporary storage silos, thereby not generating any transport water. Some plants, however, use water to transport (sluice) the fly ash from the hoppers to a surface impoundment. The water used to transport the fly ash to the surface impoundment is usually discharged to surface water as overflow from the impoundment after the fly ash has settled to the bottom.[1]

**Bottom Ash Transport Water**
Bottom ash consists of heavier ash particles that are not entrained in the flue gas and fall to the bottom of the furnace. In most furnaces, the hot bottom ash is quenched in a water-filled hopper. For purposes of this rule, boiler slag is considered bottom ash. Boiler slag is the molten bottom ash collected at the base of the furnace that is quenched with water. Most plants use water to transport (sluice) the bottom ash from the hopper to an impoundment or dewatering bins. The ash sent to a dewatering bin is separated from the transport water and then disposed. For both of these systems, the water used to transport the bottom ash to the impoundment or dewatering bins is usually discharged to surface water as overflow from the systems, after the bottom ash has settled to the bottom. Of the coal-, petroleum coke-, and oil- fired steam electric power plants that generate bottom ash, most operate wet sluicing handling systems.[1]

The Final CCR Rule regulates disposal of CCRs from coal fired power plants and is detailed in 40 CFR Part 257. This legislation states that "CCR surface impoundments are used to receive CCR that have been sluiced (flushed or mixed with water to facilitate movement), or wastes from wet air pollution control devices, often in addition to other solid wastes."[2] To keep ponds from being considered CCR surface impoundments, CCR must be removed from sluice water before it enters the pond.

According to the Article 40 CFR 423 Section VIII Part B.2 and B.3, fly ash must be dry handled and bottom ash transport water must be addressed in accordance with best practices:

**Fly Ash Transport Water**
The EPA requires zero discharge effluent limitations and standards for pollutants in fly ash transport water based on use of a dry handling system.[1]

**Bottom Ash Transport Water**
The EPA Requires zero discharge effluent limitations and standards for pollutants in bottom ash transport water based on one of two technologies: A dry handling system or a closed-loop system.[1]

## The Importance of Maintaining an Accurate Station Water Balance

Compliance with the ELG and CCR Final Rules begins with the development of an accurate station water balance. A water balance contains a complete description of all water flows into and out of the station and its associated processes including intermittent flows, outage operation scenarios and low volume flows. Many stations have a rudimentary water balance that was developed for permitting purposes. These water balances are often not detailed enough for use when making decisions regarding process modifications, and in most cases the water balance has not been updated since the most recent permit application submission or renewal. A suitable water balance should highlight all major water consumers (e.g., cooling tower make-up water and FGD scrubber feed water) and wastewater producers (e.g., cooling tower blowdown, FGD wastewater, ash transport water, ash leachate, and coal pile runoff).

Water balances can also be rendered inaccurate when stations no longer operate to meet their original design capacities. Stations that were originally designed as

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baseload plants may now be operating as peaking facilities, which typically only generate power for fewer than 45 days per year and only in extreme hot or cold weather conditions. Changes in station operation and typical water usage patterns go hand-in-hand, and many stations have not prepared an updated water balance based on current generation schedules.

The first step in verifying a station's water balance is to identify the basis for any existing water balance documentation. A preliminary understanding of the overall water balance can be refined by concurrently examining existing station drawings (e.g. process flow diagrams, piping and instrumentation diagrams, general arrangements drawing, and site plans) and flow data from previous permitting efforts, compliance reporting, and station project upgrades. The water balance should highlight the major water consumers (e.g., cooling tower make-up water and FGD scrubber feed water) and the major wastewater producers (e.g., cooling tower blowdown, FGD wastewater, ash transport water, ash leachate, and coal pile runoff).

The station's water balance should be confirmed by completing a walkthrough of the station with an experienced operator. Oftentimes there are a number of piping changes or contingencies that were implemented over the years which may not be captured on the various record drawings. Additionally, there are miscellaneous and minor source drains that can be overlooked in the overall station water balance which, if left out, can impact ELG compliance. Further, depending on the availability and reliability of station flow data, two major tools for updating and verifying a station's water balance include flow monitoring and tracer studies.

Flow monitoring can be accomplished by collecting and analyzing historic data from flow transmitters installed throughout the station's pipe networks. If there are too few flow transmitters to collect useful information or the instruments are suspected to be out of calibration, other flow monitoring options are available. Portable, temporary, clamp-on magnetic, or ultrasonic flow meters can be rented and installed at strategic locations throughout the station. Flowrates can also be estimated by monitoring pump suction and discharge pressures and using curve data provided by the pump manufacturer.

Tracer studies offer another alternative for plant managers to evaluate their station's typical water flow patterns. During a tracer study, an inert, non-toxic chemical or dye is injected into the water at a specific location, and monitoring points installed throughout the plant are used to determine the water's path, flowrate, and residence time in each unit process or storage location.

If a station already has a working water balance, 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 conditions may have dramatically different water consumption patterns, and all possible operating configurations should be evaluated.

After the water balance is established, a water quality sampling plan should be implemented to determine pollutant loadings throughout the station. This will aid plant managers in making decisions about future treatment options, confirm compliance with remaining outfalls as the water balance shifts, and identify areas that may require additional maintenance due to corrosion or scale.

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## Ash Filter Ponds

In most cases, the station's existing ash filter ponds are an integral component of their current water balance and are likely integrated into many of the different station processes which either draw make-up from or discharge into the ponds. These ponds are at the intersection of ELG and CCR compliance, and they are likely to be the center point for the necessary upgrades and process changes implemented to achieve both ELG and CCR compliance.

For most stations, the bottom ash transport water implications of the ELG Final Rule are a greater driving factor compared to fly ash transport water. Therefore, this paper focuses more specifically at achieving a ZLD ash transport water system for ELG compliance. The ELG Final Rule Section VI Part B.3 provides descriptions of two types of bottom ash handling technologies that can meet the ZLD requirement: (1) dry handling technologies that do not use any water, including systems such as dry vacuum or pressure systems, dry mechanical conveyor systems, and vibratory belt systems; and (2) wet systems that do not generate or discharge ash transport water, including mechanical drag systems (MDS), remote MDS, and complete-recycle systems.[1] Both of these methods described in the Final Rule are designed to limit and in some cases eliminate the use of ponds which would fall under CCR Final Rule definitions.

Oftentimes for peaking stations or less profitable stations, replacing the entire bottom boiler section with a dry mechanical conveyor or a remote drag chain is an expensive proposition that can jeopardize the future of the plant financially. Therefore, many stations are considering ZLD ash transport recycling processes which may still incorporate the use of ponds that may fall under CCR jurisdiction. Completing a full evaluation of the plant's assets, including tanks, clarifiers, ponds, pump stations and pipelines, as well as the station-specific requirements of the ELG and CCR regulations can help shape an integrated strategy for achieving environmental compliance.

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Design requirements detailed in the CCR Final Rule may necessitate an engineering evaluation when considering retrofitting existing station ash filter ponds to become CCR compliant. A typical bottom ash sluice system conveys transport water and bottom ash to hydrobins ash filter ponds for additional solids settling. Ash filter ponds used as part of a bottom ash sluice system can be considered CCR surface impoundments when there is significant solids settling occurring in the ponds.

A hydrobin acts as an elevated clarifier that separates and dewaters bottom ash from the transport water. Water is separated from the bottom ash by an overflow weir and a decant cycle. Bottom ash slurry is pumped into the hydrobin, which contains an overflow weir for collection of decant water in addition to dewatering screens that allow liquid to drain from the solid material. Once the ash is dewatered the ash material it is then loaded into rail cars or trucks for landfill disposal. While hydrobins are capable of separating bulk solid material from the conveying liquid, overflow water and decant water produced during the dewatering process still may contain residual ash material, especially fine ash particles that require longer detention times for removal via gravity settling. These carryover ash particles (classified as CCR material) are typically removed in ash settling or ash filtering filter ponds.

Retrofitting an existing ash filter pond system to achieve compliance with the CCR rule is a complex process that may require a significant engineering design effort. In some cases, retrofitting an existing system of CCR impoundments may not be financially feasible. Under these circumstances, stations may elect to implement a more cost effective approach towards achieving CCR Final Rule compliance while still utilizing volume capacity of existing ash ponds within their ELG compliant ZLD bottom ash loop. The existing ash filter ponds will need to be dredged and cleaned of all CCR material in accordance with the CCR Final Rule. Additionally, stations should incorporate additional treatment steps into the existing ash sluice process for removal of fines carried over from the hydrobins prior to the pond. The ash filter ponds may still be used in the bottom ash ZLD system, but they should only contain "de minimis" (minimal) amounts of CCR material.

Two treatment options for removal of carryover ash particles from hydrobins include geotubes (filter bags made of geotextile material) or a clarifier followed by a sand filter. Geotube and clarifier/filter systems should also be supplemented with chemical addition, including coagulant/flocculant and pH control as necessary, for solids removal optimization. Incorporation of these treatment processes into the existing ash sluicing system can be combined with other engineering design elements to develop a ZLD system for management of bottom ash.

### Design a ZLD Bottom Ash System

As stations compare different CCR compliant alternatives and approaches to their existing ash ponds, it is imperative to take a step back and fully consider the ELG Final Rule implications at the station as well. The ELG Final Rule prohibits liquid discharges from ash sluicing systems. If stations have ruled out dry handling of ash material due to cost restrictions they must convert existing ash sluicing systems into a closed loop configuration and determine whether the ash ponds are needed for an ELG-compliant, ZLD system.

Under the ELG Final Rule, once any non-transport water source comes into contact with ash material or ash transport water it becomes part of the bottom ash system and must be managed accordingly. Therefore an accurate station water balance as described previously is a critical first step when evaluating options for ELG compliance and CCR ash pond management. This water balance will be the key for the station in isolating the ash sluice system by identifying all of the influent and effluent sources of water and also guide the development of a new overarching station water management solution.

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All uncontrolled influent streams into the bottom ash system will need to be either eliminated or managed effectively. This includes stormwater runoff, especially if any large existing CCR ash ponds are being incorporated. Although the bottom ash system, will need to periodically make-up water to the system to account for normal water losses (e.g. evaporation and moisture in dewatered ash), in developing a ZLD bottom ash system, the introduction of influent water supply needs to be engineered and controlled as to not overload the system.

If make-up water sources for the ZLD system with irregular flow patterns such as stormwater runoff are utilized, the system will need to be managed using ash ponds or additional surge/equalization tank capacity to ensure that water is always available when needed while still preventing potentially uncontrolled discharges. Sizing system storage capacity is also critical since any uncontrolled discharges from bottom ash systems will need to be stopped to comply with the ELG Final Rule. Currently, many bottom ash system overflows are diverted to permitted outfalls or to the station's industrial wastewater treatment system which will be in violation of the rule. With a detailed hydraulic analysis of the station's overall water balance and specifically the bottom ash sluice system, the station will be able to determine the station's ash sluicing needs, identify optimal make-up water sources and establish sufficient system storage requirements.

Even with regular system water make-up, the conversion of the bottom ash system to a ZLD configuration will increase the amount of fines and dissolved substances that accumulate within the system. It is imperative that stations control the cycles of concentration inside the ZLD bottom ash system to prevent catastrophic failures associated with abrasion, scaling and corrosion. The transport water chemistry can be managed through chemical addition to adjust pH or precipitate fines and / or through ELG-compliant blowdown opportunities for the bottom ash system.

Under the ELG Final Rule, bottom ash sluice water may be used for FGD scrubber make-up. If the station does not have a wet FGD scrubber system, it must rely on the entrained moisture in the dewatered bottom ash to serve as a primary form of blowdown. Other novel blowdown mechanisms such as using ash transport water for fly ash moisture conditioning or evaporation through station air heater outlet ducts are also options. The availability of compliant system blowdowns need to be considered when sizing closed loop ash sluicing system capacities. All of this should tie directly into the station's decision matrix in deciding how to manage CCR compliance with ELGs and determining whether clean closure of ash ponds is the best path forward.

## CCR Landfill Leachate Management and Reduction

Power stations are required to comply with Local, State and Federal environmental regulations simultaneously and these implications may oftentimes fall beyond those driven by the ELG and CCR Final Rules. That said, these initiatives regularly overlap one another, creating another opportunity for an integrated and holistic approach to environmental compliance. By planning appropriately, power stations can develop options for both CCR and bottom ash system modifications that decrease the costs associated with compliance efforts for other regulations such as CCR landfill leachate.

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Managing CCR landfill leachate is becoming a greater priority for power stations and offsite ash management sites. Landfill leachate can be utilized as make-up water for either the ZLD bottom ash system or wet FGD scrubber systems. Routing leachate to either of these locations minimizes the amount of water that needs to be treated for discharge. This could help balance the Station's total maximum daily loads (TMDLs) and National Pollution Discharge Elimination System (NPDES) requirements and reduce costs associated with design, construction, and operation of wastewater treatment processes at the power station.

After studying the station's water balance, it may become apparent that current leachate production rates exceed the combined make-up water capacities of the FGD scrubber and ZLD bottom ash. Steps may be taken to minimize leachate production, reducing the need for additional wastewater treatment equipment and mitigating risks associated with overloading the ZLD bottom ash or FGD scrubber systems.

Reducing landfill leachate production may result in lower operational and capital expenses, fewer liabilities, and fewer system components to operate and manage. Landfills may be developed in "cells" or smaller subsections that are capped and closed once they have been filled to reduce overall leachate production. Developing the landfill in cells means that only a small part of the total waste surface area is exposed to precipitation during rainfall events. This reduces the amount of potential leachate that must be treated/disposed.[3]

Further leachate volume reduction can be achieved by constructing berms within the cells to create several subcells. CCR material can be limited to only a subcell within the larger cell. This means that any precipitation falling on other subcells that do not yet contain CCR material can be considered stormwater rather than leachate and can be sent to the facility's stormwater management system. This greatly reduces the costs associated with handling and treating ash landfill leachate.[3]

The use of smaller subcells with reduced surface area for storage of CCR material can produce greater waste material depths than larger cells as they are being filled. This in turn decreases the rate that precipitation is able to infiltrate through the waste material, protecting the leachate collection pump from being overwhelmed during heavy storms. Finally, there are a few other operational considerations that may also be used to reduce the generation of leachate, including the use of temporary soil covers and temporary geosynthetic covers to further isolate subcells.[3] These options should be considered during station outages when new CCR material is not being deposited in the landfill for an extended period of time.

## Conclusion

The ELG and CCR Final Rules were developed separately, but there are a number of common elements that are shared by the two regulations. By combining efforts associated with ELG and CCR compliance, stations can save significant amounts of money associated with engineering, design, and construction. Effective strategies for ELG and CCR compliance should include development of an accurate station water balance, evaluation of existing CCR impoundments and necessary modifications, development a ZLD bottom ash system, and reduction of CCR landfill leachate production.

*For more information on CCR and ELG compliance and what it means for the coal power industry, contact Senior Engineering Manager Arica DiTullio at 412.399.5455.*

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### References

*[1] Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category, 80 Federal Register § Fly Ash Transport Water et seq. (2015).*

*[2] Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities, 80 Federal Register § Definition of CCR Surface Impoundment et seq. (2015).*

*[3] Foster, Veronica 07/01/2015 | Veronica. "Don't Let Leachate Derail Your CCR Landfill Plans." POWER Magazine. Electric Power, 01 July 2015. Web. 15 Mar. 2017.*