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WHITE PAPER / **BOTTOM ASH MANAGEMENT**

INNOVATIONS IN BOTTOM ASH CONVERSION TECHNOLOGIES

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Coal-fired power plants affected by changes in coal combustion residual (CCR) management rules and effluent limitation guidelines (ELG) are required to make changes to bottom ash management systems. While some have implemented technologies to achieve compliance, others want to start planning. Here are the options.

Traditionally, bottom ash in coal-fired power plants has been captured by wet ash bottom hoppers located beneath boilers, then crushed and transported by a sluice system that conveys the ash to a surface impoundment or pond.

Impoundment breaches, spills, environmental stewardship and increased public awareness led the U.S. Environmental Protection Agency (EPA) to issue coal combustion residual (CCR) regulations and effluent limitation guidelines (ELG) guidelines in recent years. Bottom ash transport water is no longer eligible to be discharged and groundwater monitoring is now required for surface impoundments. If contamination is found, corrective action often involves pond closure along with other remediation measures. In short, the updated CCR and ELG rules force operators to consider handling and treatment of ash transport water in a new way. The new regulations, meanwhile, continue to be challenged in court by environmental groups, pro-coal groups and policymakers, resulting in delays to and modifications in rule language and enforcement. As the CCR rule progresses through the courts, plant owners and operators are assessing how to comply without certainty of what the final rule will state. This is leading them to consider project solutions that will minimize outage duration, capital cost, operation and maintenance (O&M), and risk.

These project drivers can lead to any of the following six alternatives.

Compact Submerged Conveyors — This technology uses existing infrastructure to help plants achieve CCR and ELG compliance quickly and with minimal operational impact. Compact submerged conveyor systems use the boiler's existing water-impounded hoppers and potentially the clinker grinders, ash gates and other existing equipment found on the bottom of the boiler, but replace the wet sluice pipe with compact, fully submerged drag chain conveyors. Bottom ash released from the hopper is transported and dewatered on these conveyors to a storage bunker. The quench water used in the process does not require a closed loop and can be discharged with other plant low-volume wastewaters under the currently stayed version of the ELG.

Capital costs are relatively low and outage durations are short because most existing equipment stays in place. The system's footprint is also small since the new conveyors are smaller than traditional equipment and require minimal new auxiliary equipment. Compact submerged conveyors can also be oriented at a relatively high incline, minimizing the need for modifications to or relocation of other equipment.

This alternative can be a good fit for plants that want to reduce initial capital costs, have limited space around the boiler bottom or have a relatively short expected life.

Pneumatic — To minimize future risk, some operators prefer to comply with the new CCR and ELG rules by converting their wet sluice conveying systems to completely dry solutions. In those cases, many are choosing pneumatic solutions that were originally developed and frequently used on smaller boilers. Pneumatic technologies call for existing bottom ash hoppers to be replaced with new dry hoppers, as well as a vacuum conveying system.

With these systems, the ash is cooled with auxiliary air, crushed, fed into a pneumatic conveying line and transported to a storage silo, where it remains until being conditioned and transported to a beneficial reuse facility or landfill. Because the dry hoppers are similar in size to existing water-impounded hoppers, and piping is more easily routed with a smaller cross section than conveyors, it may be easier to fit a pneumatic system on a congested plant footprint than other systems.

Being completely dry, pneumatic systems reduce the risks and project costs associated with transport water and transport water treatment. Plant owners can often achieve economies of scale by applying pneumatic technology at a multiunit site. Depending on the proximity of the boilers, ash from multiple boilers can be conveyed to a single silo.

Dry Belt/Tray Conveyors — Hybrid dry mesh belt/steel tray conveyors can be utilized to eliminate transport water from the ash management process. With these alternatives, coal ash is transported from a boiler to a loadout bin, silo or bunker via conveyor(s). These conveyors consist of a stainless steel mesh belt

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with steel/alloy trays — similar to the "pans" on an apron feeder, a heavy-duty belt system used in mining and other industries. The relatively slow-speed belt allows time for the material to cool with ambient or boiler fan air as it approaches the end of the ramp section.

After cooling, the ash is crushed and typically placed on a second conveyor for further conveyance and cooling. At the discharge of the final conveying section, the ash is either placed in a storage silo/bin or stacked on the ground. If it is stacked on the ground, conditioning equipment wets the ash to minimize dusting.

Like pneumatic systems, dry belt/tray conveying systems require complete removal and replacement of the legacy bottom ash hoppers.

Dry solutions, including both dry belt/tray and pneumatic systems, are suited only for pulverized coal (PC) boilers. Slagging and cyclone style boilers require a wetted trough, at minimum, beneath them to cool the ash, which exits the boiler as molten slag and, if left dry, would quickly harden into lava-like rock.

Forward-looking operators might consider a dry belt/tray system that eliminates the bottom ash discharge by converting the bottom ash into fly ash. Commonly used in Europe, these ash recycling systems return the collected bottom ash to the boiler fuel stream, where it is milled by coal pulverizers, re-injected into the boiler and converted to a potentially more valuable fly ash product.

Submerged Drag Chain Conveyor — When the industry moved away from installing new ash ponds in the 1980s, submerged drag conveyor systems emerged as the standard in ash management for new coal-fired boilers. When space allows, they can be a good replacement option for aging wet sluice conveyor systems.

In these cases, the legacy hoppers, seal trough, crushers and pipes are removed from under the boiler and are replaced with a wet impounded conveyor. As the ash falls from the boiler, it is quenched by the water-filled upper trough of the submerged drag chain through a transition in the hopper, which fractures the ash into smaller, more manageable pieces. The ash settles to the bottom of the conveyor and is pulled along the bottom of the conveyor by flight/scraper bars. The ash is then pulled up a dewatering ramp that extends beyond the top of the water level.

Typically, the water level in the submerged conveyor extends all the way to the existing seal plate to provide a boiler seal and eliminate seal trough maintenance. The dewatered ash is dropped into a storage bunker where front end loaders place the material in trucks for hauling for beneficial reuse or for landfill placement.

The submerged drag chain conveyor is a proven design with many years of operation. Operators with existing installations are able to share parts across several units to save money and time, if needed.

Remote Dewatering Systems — These systems utilize the same basic technology as local drag chain conveyors, except in this case the conveyors are located remotely or away from the boiler. The existing ash sluicing system remains in service with this system. The sluice line that currently leads to the bottom ash impoundment is rerouted to a new submerged drag chain conveyor. There the ash settles out, is dragged up the ramp and dropped into a new bottom ash bunker. The sluice water discharged from the conveyor is sent back to the plant and reused again to convey bottom ash, making this a completely closed loop system.

Because these solutions use existing conveyance equipment and dewatering systems are constructed off-site, the outage time needed to complete the tie-in is short. Opportunities for economies of scale exist for plants with multiple coal units, with a single equipment island able to support tie-ins from multiple units. This approach is often preferred in areas where several coal-fired plants are retiring, and independent system operators place limits on outage lengths to help provide a reliable power supply. It is also often selected when other types of retrofit equipment cannot fit under the existing boiler.

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Operators considering this approach must also take the ELG bottom ash transport water regulations into account. Because water is used as the motive force for moving the ash, the water in this system is considered transport water. While existing regulations do not allow discharge of transport ash water, they do allow a stream to be sent to a wet scrubber, presuming the facility has one. Analysis of the system chemistry and current water balance should be made before sending ash transport water to a scrubber.

Settling Basins/Closed Loop Impoundments — While similar in many ways to remote submerged drag chain conveyor systems, these systems use a set of redundant basins or a lined bottom ash impoundment to capture ash. The existing ash sluicing system remains in service with this system. The line that currently transports ash to the impoundment is rerouted into the new basin structure where the ash settles out. The sluice water discharged from the basin is sent back to the plant and reused to again convey bottom ash.

As with remote dewatering systems, these solutions use existing conveyance equipment and dewatering systems that are constructed off-site, shortening the outage time needed to complete system tie-in. The water in this system is also considered transport water, which carries the same concerns described with the remote dewatering system.

Stormwater intake and cold weather operation should be significant considerations when weighing this option, as these issues often pose greater challenges than mechanical options.

THE BOTTOM LINE

Coal-fired plant operators pursuing bottom ash conversion projects now have several ash management technologies and options to choose from. Every plant has different design criteria and arrangements. Selecting the right one for the application requires careful consideration of the options in view of the legacy system, schedule and budget limitations, environmental risks and short- and long-term goals.

BIOGRAPHIES

CORY HANSEN, a material handling specialist at Burns & McDonnell, is experienced in bulk material handling at power generation facilities, including coal, gypsum, reagents, ash and biomass handling systems. He received a Bachelor of Science in mechanical engineering from South Dakota State University.

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