Mitigating Dust and Runoff in Fly Ash Storage

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INTRODUCTION

The history behind the Environmental Protection Agency (EPA) Final Rule on Coal Combustion Residuals (CCRs) is well known, largely due to several recent events caused by failing surface impounds, leading to billions of dollars in fines and settlements. These events are remembered for the effect on local communities, the massive economic impact on the companies and the long-term reputational damage to the industry as a whole.

The “Hazardous And Solid Waste Management System; Disposal Of Coal Combustion Residuals From Electric Utilities” (Final Rule) was proposed by the EPA to regulate the disposal of coal combustion residuals (CCRs) as solid waste under Subtitle D of the Resource Conservation and Recovery Act (RCRA).

This is the first time surface impounds, landfills and lateral expansions (“CCR Units”) have been regulated. These rules have not yet been implemented and are still under review by legislative committees at the federal level.

The rules face intense opposition from both environmentalists and legislators over two main points:

1) The declaration that CCRs (consisting of many different substances such as fly ash, silica, gypsum, cenospheres, trace metals, etc.) are a beneficial recyclable resource and are not toxic when treated and stored properly.

2) The ability to create new surface impounds under strict ground treatment and monitoring guidelines to avoid leaching.

Upon thorough examination of the new regulations surrounding CCR management, it has become clear that the EPA prefers—and is steering operators toward—dry landfills and “beneficial use” dry piles. Dry storage presents a new set of challenges, exposing companies to federal and state regulations regarding landfills, dust emissions and runoff.
DUST MANAGEMENT

The most common methods for controlling dust in large open-area applications such as dry ash storage are *surface wetting* and *airborne capture*. With surface suppression, the goal is to prevent dust problems by wetting the source before particles can become mobile. Airborne capture is more difficult, requiring some form of technology that can force the particles to the ground and keep them there.

At present, water (plain or chemically treated) is the only way to suppress dust emissions in an unenclosed area. Companies that attempt to control surface dust by using industrial sprinklers have found that the volume of water (as much as 500 gallons per minute) increased runoff and created the potential for leaching. This could put operations in violation of the Final Rule and existing regulations.

There is also the question of suppressing airborne particles. The low mass and small particle size of dry CCRs can allow dust to become airborne by simple disturbances from handling and natural air currents. Testing and field trials have shown that surface suppression using sprinklers may not mitigate fugitive particles from all sources, such as off-loading, conveyor transfer points and other disruptions of the bulk material. But the greatest drawback to dust suppression with sprinklers is droplet size: water droplets produced from hoses and sprinklers are simply far too large to have any meaningful effect on airborne dust particles, so any benefit is limited to dust on the ground.

There is an alternative technology, however, that has been proven to effectively suppress dust both at ground level and in the air, using just a fraction of the water required for large sprinklers. Atomized mist is currently used in a wide range of industries to control fugitive dust, including coal handling, petcoke, demolition, mining, scrap recycling, slag and many others. The technique relies on the principle of creating millions of tiny droplets of a specific size range and delivering them at relatively high velocity over a wide coverage area, inducing collisions with dust particles and driving them to the ground. It is one of the few technologies capable of delivering dust control by surface wetting AND airborne particle capture.

Available in a range of oscillating fan-driven models and low-turbulence designs, large units are able to cover as much as 280,000 square feet of area using less than 40 GPM of water. The technology is proving to be a viable alternative to existing and proposed suppression methods for fly ash dust, helping to reduce runoff, waste water and the potential for accidental release.

DRY STORAGE: CCR LANDFILLS VS. PILES

According to the Final Rule, “CCR disposal currently occurs at over 310 active on-site landfills, averaging over 120 acres in size with an average depth of over 40 feet, and at over 735 active on-site surface impoundments, averaging over 50 acres in size with an average depth of 20 feet.” [Final Rule pg. 7] That means the average individual surface impound is roughly the size of 38 full-length football fields.
Many in the coal burning utility industry have already examined the Final Rule and made comments regarding every element that affects specific operations. In the comments section regarding the broad definitions of these terms, the EPA clarified its intent and generally settled on the side of dry storage with reasonable environmental dust and runoff mitigation. (Figure 1)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Existing CCR Landfills</th>
<th>New CCR Landfills and Lateral Expansions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location Restrictions:</td>
<td>☑ $257.64</td>
<td>☑ $257.60 - $257.64</td>
</tr>
<tr>
<td>Placement Above the Uppermost Aquifer</td>
<td>☑ $257.60</td>
<td>☑ $257.60</td>
</tr>
<tr>
<td>Wetlands</td>
<td>☑ $257.61</td>
<td>☑ $257.62</td>
</tr>
<tr>
<td>Fault Areas</td>
<td>☑ $257.63</td>
<td>☑ $257.64</td>
</tr>
<tr>
<td>Seismic Impact Zones</td>
<td>☑ $257.64</td>
<td>☑ $257.64</td>
</tr>
<tr>
<td>Unstable Areas</td>
<td>☑ $257.64</td>
<td>☑ $257.64</td>
</tr>
<tr>
<td>Design Requirements:</td>
<td>☑ $257.70</td>
<td>☑ $257.70</td>
</tr>
<tr>
<td>Composite Liner</td>
<td>☑ $257.70 (b &amp; c)</td>
<td>☑ $257.70</td>
</tr>
<tr>
<td>Leachate Collection and Removal System</td>
<td>☑ $257.70 (d)</td>
<td>☑ $257.70</td>
</tr>
<tr>
<td>Groundwater Monitoring and Corrective Action</td>
<td>☑ $257.90 - $257.98</td>
<td>☑ $257.90 - $257.98</td>
</tr>
<tr>
<td>Weekly Inspections</td>
<td>☑ $257.84 (a)</td>
<td>☑ $257.84 (a)</td>
</tr>
<tr>
<td>Annual Inspections</td>
<td>☑ $257.84 (b)</td>
<td>☑ $257.84 (b)</td>
</tr>
<tr>
<td>Fugitive Dust Controls</td>
<td>☑ $257.80</td>
<td>☑ $257.80</td>
</tr>
<tr>
<td>Run-on, Run-off Controls</td>
<td>☑ $257.81</td>
<td>☑ $257.81</td>
</tr>
<tr>
<td>Surface Water Protection¹</td>
<td>☑ $257.3-3</td>
<td>☑ $257.3-3</td>
</tr>
<tr>
<td>Closure Requirements</td>
<td>☑ $257.100 - $257.103</td>
<td>☑ $257.100 - $257.103</td>
</tr>
<tr>
<td>Post-Closure Care</td>
<td>☑ $257.104</td>
<td>☑ $257.104</td>
</tr>
<tr>
<td>Recordkeeping Requirements</td>
<td>☑ $257.105</td>
<td>☑ $257.105</td>
</tr>
<tr>
<td>Notification Requirements</td>
<td>☑ $257.106</td>
<td>☑ $257.106</td>
</tr>
<tr>
<td>Publicly Accessible Internet Site Requirements</td>
<td>☑ $257.107</td>
<td>☑ $257.107</td>
</tr>
</tbody>
</table>

¹ ✔ = required, ☑ = not required.
² In existing regulations at 40 CFR part 257, subpart A.

Source: EPA, Hazardous And Solid Waste Management System Final Rule, 2014

Figure 1

CCR PILE LOCATION GUIDELINES

To define location, it's helpful to look at how the EPA has chosen to define the difference between CCR Landfill ("non-containerized" CCR Pile) and CCR Pile.

CCR Landfill – [RCRA § 257.73] According to the EPA Final Rule document, CCR that is “non-containerized” is placed in direct contact with the ground for on-site storage/disposal, or off-site beneficial use (sold or recycled). As shown in Figure 2, with direct ground contact, the EPA says the CCR is exposed to run-on and run-off, and leachate thus poses the same concerns for ground water contamination as a surface impound.
According to the EPA Final Rule, “containerized” does not mean contained in a tank or enclosed storage facility, rather that “concrete measures have been adopted to control exposures to human health and the environment. (Figure 2) This could include placement of the CCR on an impervious base such as asphalt, concrete, or a geomembrane; leachate and runoff collection; and walls or wind barriers.”

**Figure 2**

**LANDFILL LOCATION RESTRICTIONS**

The Final Rule specifically states, “To ensure there will be no reasonable probability of adverse effects on health or the environment from the disposal of CCR in CCR landfills, CCR surface impoundments, and all lateral expansions of CCR landfills and CCR surface impoundments (together ‘CCR units’), this final rule establishes five location restrictions.”

**Figure 3**
The five locations are (Figure 3):

**Above the uppermost aquifer** – [Final Rule pg. 213, RCRA § 257.60] The final rule defines an aquifer as the geologic formation nearest the natural ground surface. Upper limit is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season.

**In wetlands** – [Final Rule pg. 219] Wetlands generally include swamps, marshes, bogs and areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions.

**Within fault areas** - [Final Rule pg. 226, RCRA § 257.62] The CCR unit (existing or proposed) cannot come within 60 meters (200 feet) of a fault that has had displacement in Holocene time (roughly the last 10,000 years).

**In seismic impact zones** - [Final Rule pg. 231, RCRA § 257.63] CCR units are prohibited from occupying an area having a 2% or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth’s gravitational pull (g), will exceed 0.10 g in 50 years.

**In unstable areas** - [Final Rule pg. 233, RCRA § 257.64(a)] Natural unstable areas include those areas that have poor soils for foundations, areas susceptible to mass movements and karst terrains (erosion zones).

CCR Landfill locations are treated as equal to surface impounds in the eyes of the EPA. “Beneficial use” storage and transport carries a lower risk of non-compliance. By creating a low-cost controlled surface area on which the CCR is piled, along with appropriate run-on/runoff control and dust mitigation, a more beneficial logistical location for storage and transport can be achieved.

**CONTAINMENT AND RUNOFF CONTROL**

The EPA says that without proper containment measures in place, surface impounds run the risk of “potential for loss of life, environmental damage and economic loss.” For this reason, the Final Rule regarding groundwater contamination, leachate control and structural containment of CCR Units will probably lead to closure of many of the remaining CCR surface impounds across the country, due to noncompliance and the cost of retrofit.

According to the Final Rule, “CCR would require ‘cradle-to-grave’ management and would be subject to requirements for, among other things, composite liners, groundwater monitoring, structural stability requirements, corrective action, closure, post-closure care and financial assurance.” These systems are to be inspected and tested on a weekly basis.
Construction, monitoring and upkeep of new CCR Units, over and above the acquisition of approved site locations, may be less cost-effective than CCR Pile storage/transport systems with a proactive dust and runoff control plan.

ANATOMY OF ATOMIZED MIST

One of the key elements in producing an effective atomized mist is the nozzles. Their physical characteristics affect such factors as droplet size, distribution, velocity, spray pattern, water flow rate and water pressure. No matter what source is used for dust suppression, the water is going to contain minerals and other dissolved solids, which build up on a microscopic level until eventually the accumulation will interfere with droplet production. Although cleaning of the nozzles typically requires just a few minutes each, this can be a problem if it shuts down operation while the maintenance is performed.

Some manufacturers have addressed this issue by designing a quick-release manifold bracket, which allows quick removal of the entire manifold. Many users are finding benefit in keeping a spare manifold with clean nozzles on hand to facilitate this periodic maintenance, allowing workers to change out the entire assembly in about five minutes. Once removed, the manifold that had been in service can be cleaned at the user’s convenience, ready for replacement the next time the nozzles show any accumulation of minerals or other build-up.

Another critical design element of atomized mist technology is the ducted fan, which is essentially a specially-engineered barrel with a high-speed fan inside, a bit like a jet engine. Fan-driven units include a vast range of sizes, from smaller units that deliver exceptional coverage of about 30,000 square feet up to massive designs nearly eight feet tall, which are capable of effective suppression over 280,000 square feet of area. They can be powered by highly-efficient, direct-drive electric motor or by diesel engine. Although electric-powered units deliver extremely reliable, low-maintenance performance, they do require a power source (such as a generator set). While diesel units are considered to be more self-contained, they require more frequent service and repair than the more straightforward electric design.

More recently, manufacturers of atomized mist technology have developed a number of low-turbulence designs for point-specific dust suppression. These can take the form of specially-engineered rings to surround conveyor discharge points, for example, allowing users to completely surround the outflow in a curtain of atomized mist. (Figure 4)
Low-turbulence designs are also available in the form of an engineered misting head, often mounted on a boom and aimed precisely at dust-generating activities. Like the fan-driven models, these units can be customized with a variety of nozzle shapes and sizes to accommodate specific dust types, particle behaviors or operating environments. The misting heads deliver an umbrella-shaped cloud of atomized droplets, projecting the mist about 30 feet (9.14 meters) under calm conditions.

CUSTOMIZATION

Fly ash dust is so fine and lightweight that it easily becomes airborne, and unless acted upon by some outside force, the particles can hang in the air for extended periods, resisting settling and potentially migrating off-site. To combat the problem, some suppliers of atomized misting equipment have designed their machines to be outfitted with optional dosing pumps, allowing material handlers to precisely meter in surfactants, tackifiers or other additives for superior particle control. Even very small amounts of a surfactant can reduce the contact angle of pure water by more than 50%, producing greater numbers of smaller droplets and improving particle control.

Machines can also be equipped with booster pumps that can increase just 10 psi (0.7 kg/sq. cm) of water pressure to 150 psi (10.55 kg/sq. cm) or more, which has a direct impact on performance. Some designs are available with optional filters that allow the use of non-potable water. If the equipment is well-engineered, the use of pressurized air should not be required to achieve efficient suppression, avoiding the need for compressors. Smaller units can usually be fed by a garden hose, while larger designs typically require a fire hose water supply. Some suppliers have also designed transportable atomized mist units, combining an electric dust suppression design with a water tank and gen set on a trailer, which can be hauled to job sites that lack convenient power and water sources.
CONCLUSION

The EPA has made it clear that CCR Landfills are preferable to surface impounds in that they run a lower risk of dike breach and groundwater seepage. Landfills introduce a new set of concerns regarding runoff and fugitive dust. However, an effective dust suppression plan with natural wind barriers and compliant irrigation, along with dust suppression technology that has been proven effective against fugitive particulates, can reduce the risk of violation leading to costly environmental remediation or CCR Unit closure.

REFERENCES


[3] Harrison, Kerry, University of Georgia, College of Agricultural and Environmental Sciences, Table 1, http://extension.uga.edu/publications/detail.cfm?number=B882#high pressure


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