How Will U.S. EPA’s Final CCR Rule Impact Past, Current, and Future Disposal Operations?

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Conference: 2015 World of Coal Ash – (www.worldofcoalash.org)

Key Words: coal, ash, CCR, USEPA, final rule, disposal, cost, compliance, options, risk

Introduction

Recycling, Reusing, and Repurposing all coal combustion byproducts is the objective. However if some portion requires disposal, EPA’s Final CCR Rule, issued on December 19, 2014 (pre-publication version), may financially impact your past, present, and future disposal operations. If the State in which your generating stations are located do not have CCR regulations that meet EPA’s final rule, you’ll need to make decisions and prepare documentation for your former and ongoing ash impoundments and landfills.

Managers at coal fired power plants need to know:

1. Alternatives – close in place or excavate and dispose;
2. Decisions to make and actions to take;
3. Factors that affect decisions to minimize risk;
4. Costs of alternatives and required documentation; and,
5. How to transition in compliance with the new rule.

Final Rule new facility disposal requirements and costs are understood. The critical question is “how to convert your current disposal operation with minimum disruption and expense?” Within this question you need to determine what decisions you face and actions are required. Making timely decisions and taking action are essential to ensure a smooth transition to Rule compliance.
The Final Rule contains a complex web of requirements that may or may not apply to your site(s), and required documentation with specific time frames and reporting obligations. Each existing CCR disposal or processing/treatment site in the U. S. may have a unique set of requirements based on the Rule. You need to know exactly what documentation is required and when deadlines occur to maintain compliance. The compliance starting whistle is the date of Rule publication in the Code of Federal Regulations (pending as of submittal date of this technical paper).

This paper provides a decision making framework for your past, current, and anticipated CCR disposal and processing facilities, explains factors to be evaluated, gives a range of unit costs for alternatives, and offers engineering solutions for compliance, transition, and to best utilize your existing disposal site.

Whether your operation is wet or dry bottom/fly ash/FGD byproducts, above or below grade, permanent disposal or treatment and transfer, your basic options for your existing sites during the transition period include:

**EXISTING ACTIVE CCR DISPOSAL SITES**

- Close and cap your current disposal operation in place or relocate CCRs to a compliant site

**NEW CCR DISPOSAL SITES**

- Transition the existing site to comply with new requirements or develop a new separate compliant disposal facility

In addition to comparing the various costs of alternatives, several other environmental criteria will influence your ultimate decision. Regardless of whether your existing disposal site is lined, monitored, or impacts groundwater, the best alternative may be to combine these options by continuing to use your existing disposal site, close in place and continue to operate in compliance with the new Rule, above and adjacent to the former disposal area.
Decisions you will need to make over the next several months and years are not only dependent on the Final Rule and your existing site conditions but also on existing rules in your state, and the pending Effluent Limitation Guidelines (ELG) for waste water discharge, due to be published in September 2015. These two rules are interrelated and will affect each other. If your state’s rules are less stringent than EPA’s proposal you may be required to comply with the Federal Final Rule. If your state’s rules are more stringent, it’s not likely they will be reducing existing standards to EPA’s requirements.

Currently across the U. S. the States’ CCR regulations range from no rules in place in some states to double liner and double leachate collections systems in others, with multiple variations between those extremes. According to U. S. EPA, approximately 17 states have regulations similar to the Final Rule leaving 33 states to come up to regulatory speed.

This paper offers potential answers and solutions to the following questions you may have about your operation including:

- The rules that apply to your site (who’s)
- Decisions you will need to make about your existing site and relevant factors (why)
- Options for future disposal sites (where)
- Ways to minimize overall expenditures (how), and
- Actions you must take for your disposal site (what)
- Establishing a compliance schedule (when)

Most importantly this paper provides a starting point and framework, including factors to help make decisions, and establishes a direction to evaluate your own CCR disposal site and options to comply with the Final Rule.
**Existing and New Disposal Site Requirements**

During continued disposal of your existing site if it is not compliant with the Rule, you will eventually be required to cease operations, construct a closure cover cap, and install groundwater monitoring wells, within the time frames spelled out in the Rule. The Rule defines many conditions that trigger mandatory closure. For new disposal sites, siting prohibitions include flood plains, wetlands, special habitats, separation from groundwater, and seismically active areas. Each of these limiting criteria is fairly well understood except the seismic condition, which will be addressed in the next section.

Construction of new sites require clay and membrane liners, leachate collection, and the same closure and monitoring requirements associated with existing sites that continue operations during the interim time frame (more than 6 months after CFR publication).

**Seismic Considerations**

The Final Rule establishes a seismic standard restricting construction of new CCR disposal sites in areas where the peak earthquake acceleration is greater than 2% probability of 0.1g in 50 years. Refer to Exhibit 1. This may be the least understood requirement. This standard may raise several issues for your next disposal site. The applicable seismic map of the US can be found on the USGS website. This restrictive condition covers approximately 1/3 of the US but it doesn’t mean you can’t build a disposal site in one of these zones.
The rationale for this requirement, from a stability perspective, is based in part on the physical characteristics of CCR particles. The fly ash component generally consists of smooth silica spheres ranging in size from 1 to 10 micrometres. Refer to Exhibit 2. Bottom ash particles are much larger and angular but still somewhat round, and FGD byproduct particles are crystalline but still tubular. These particles are not unlike marbles or well rounded beach sand and tend to roll around each other when compressed, exhibiting low strength. Blending the different size CCR improves stability by smaller particles bedding in voids between the larger particles and compaction and strength to a certain degree is improved but the resulting material still has the characteristic of relatively low compressive strength compared to compacted engineered soil fill. In both saturated and unsaturated conditions, vibration can cause the particles to slide over each other and flow, requiring reduction of steep side slopes to maintain stability.
For existing disposal sites where the containment dikes are constructed with CCRs, sufficient seismic activity could cause slope failure and release of contained materials. If disposal sites have CCRs stacked far above the top of the containment dikes, seismic activity could cause the mounded material to slump over the dike walls. If soils beneath the site are unstable and have similar physical characteristics to CCR, they may liquefy during an earthquake and allow the stored CCRs to be released. Refer to Exhibit 3.
What this criteria means to new disposal sites is that the dikes need to be constructed of earthen materials and demonstrated by calculations to be stable at the local seismic standard. It also means stacking CCRs above the containment dikes with steep slopes may be limited as the angle of repose of the materials reduces when seismic events induce vibration. Finally, constructing a disposal site on top of unstable in-situ soils should only be done if the underlying soil can be made or demonstrated to be sufficiently stable under the proposed loading conditions and during a seismic event.
The resulting future compliant disposal site in seismic areas is likely to be more below surrounding grade, have less steep side slopes, constructed with reinforced dikes, and placed on stable soil. The standard doesn’t prohibit construction in these more seismically active areas but it does increase disposal costs by limiting site selection, potentially require more costly containment dikes, and not allowing vertical filling with steep side slopes, thus reducing containment volumes. This requirement may also limit vertical and horizontal CCR disposal site expansions of existing facilities.

**Most Asked Questions**

The most frequent question being asked by power generators is divided into three basic parts: “How much is this going to cost, what should I do with my existing facility, and how can I develop a future disposal site?” The first part of the question further breaks down by asking “What are the costs of closing my site in place as allowed in the Rule versus excavating existing disposal sites and transporting to a new compliant facility?”

The second part of the question, “what should I do with my existing site?” is a bit more complicated. The answer to “what should I do?” will be based on more than the cost difference between options of excavation or closure. Additional factors and conditions that will guide your decision include: geologic conditions below your site, groundwater elevations, existing known groundwater contamination, original disposal site construction techniques, wet or dry storage, location of the property limits relative to the disposal area, seismic risk, your state’s current and the new CCR disposal site regulations, and your current disposal permit requirements if the original permit is “grandfathered” until a new site is constructed. How you can develop future disposal capacity is dependent of the physical characteristics of you property.

Arriving at the best answers for your site(s) is a complex process and unique for every setting. The questions are complex but in addition to cost, the decision may be based on the level of short and long term environmental risk your company is willing to accept.
Existing Site Options, Costs, and Decision Factors

The cost of disposal at a new compliant site and transport of CCRs can generally be estimated based on the construction, operation, and long-term care/monitoring requirements spelled out in the Rule. Estimated disposal costs are in the range of $15 to 20 per ton or per yard of CCR. This unit price is based on costs at existing sites in states that currently have regulations similar to the EPA proposal, detailed cost estimates for proposed facilities, and comparison with typical municipal waste landfills operating under similar rules. Each of these sources produced comparable unit cost results.

This leaves the question of what to do with your existing site and what will it cost? The basic choice is whether to close in place by installing a cover system compliant with the Rule or to remove CCRs to a compliant site.

Under the Rule, the cost to construct a cover system will range from $150,000 to $250,000 per acre, depending on how complex the cover requirements are in your existing state’s regulations. Refer to Exhibit 4. The relative importance of this cost is a function of the depth of your CCR disposal site(s). A thin layer of CCRs such as 10 feet will cost substantially more to close on a per-ton or yard basis compared to one that is 40 feet thick. The complexity of the closure process is also dependent on what it takes to prepare the site to receive the final closure cover with the required slopes, drainage features, and creating stable containment dikes.
CCR excavation, transport, and disposal to a compliant site are equally complex tasks. Potential costs such as required dewatering and drying the CCRs in preparation for loading and transporting, transportation distance, disposal fee, feasibility of removing the material that may have been placed below the water table, and most importantly, the total volume to remove are all factors that impact the unit cost.

If you examine Records of Decision of both State and Federally-led Superfund and RCRA landfill sites corrective actions over the past 30 years, a clear precedent has been set. For large disposal sites, when a feasibility study is completed to compare costs and effectiveness of excavating and disposal versus closing in place, the removal option typically
becomes cost prohibitive. The exception to this precedent is removal of isolated hot spots containing buried drums of hazardous waste. Disposal site closure in place and controlling affected groundwater, if any, is by far the typical documented Record of Decision for sites with municipal and similar solid waste. If groundwater is impacted, additional remedial actions will likely be required.

The following table represents a basic comparison of the example factors and conditions and the likely preferred decision:

**EXISTING DISPOSAL SITE DECISION FACTORS**

<table>
<thead>
<tr>
<th>Factor/Condition</th>
<th>Close in Place</th>
<th>Remove and Dispose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Size</td>
<td>Large</td>
<td>Small</td>
</tr>
<tr>
<td>Compliant Site Distance</td>
<td>Far</td>
<td>Close Proximity</td>
</tr>
<tr>
<td>Subsurface Geology</td>
<td>Low Permeability Soil</td>
<td>Sands and Gravels</td>
</tr>
<tr>
<td>Groundwater Depth</td>
<td>Deep, Slow Migration</td>
<td>Shallow, Fast Migration</td>
</tr>
<tr>
<td>Buffer to Property Line</td>
<td>Large</td>
<td>Small</td>
</tr>
<tr>
<td>Original Construction</td>
<td>Liner</td>
<td>No Liner</td>
</tr>
<tr>
<td>Seismic Setting</td>
<td>Low Risk</td>
<td>High Risk</td>
</tr>
</tbody>
</table>

**Potential Costs of Decisions**

Comparison and balancing of costs against all of the factors that can affect your decision is challenging unless there is an overwhelming condition that controls or outweighs the others. The most important issue is that no two sites are alike because of all the variables that must be considered.

As a simplified example comparison, if a CCR fill is 10’ thick, the cost per yard of in place CCR, to install a compliant cover system is estimated in the range of $20. If that same 10’ high CCR site has a compliant disposal land fill on site, estimated cost of dewatering,
removal, and disposal could be in the range of $25 to $27 per yard. If the existing fill depth is greater than 10’, the in-place closure cost per yard becomes even more favorable when compared with the removal option.

**Additional Considerations**

The decision of removal versus close in place can be much more complex than the above example and there may be many other site-specific conditions to evaluate that could outweigh any of the example factors.

If you have a current groundwater monitoring program required by your state’s regulations, you may have several of these factors already evaluated: impacted groundwater, geologic conditions, and migration potential. Evaluating such factors will help you decide what quality level the final closure system should be if closure in place appears applicable for your site.

For comparison purposes, placing an impermeable cover on a disposal site can cut off additional rain water from percolating through the CCRs and transporting chemicals of concern toward the groundwater. Excavation and disposal removes the source. However with both of these options, if the ground water is already impacted, you will likely have to address contamination migration. The potential of contaminated groundwater controls must also be added to the overall costs with either decision.

To further reduce the ongoing risk of groundwater impacts, removal of leachate within the fill using extraction wells is very likely, regardless whether or not there is any current evidence of leachate migration from the fill area. If new monitoring wells required under the Rule identify groundwater impacts, other actions may be required such as groundwater containment or capture using cut off walls or extraction and treatment. The need for these potential remediation techniques are dependent on how far and how concentrated the groundwater impact extends, if the chemicals of concern are leaving your property, and if there are receptors down gradient – meaning private or public water supplies and surface water lakes or streams. Implementation of these remediation requirements is based on RCRA rules and actions that have been occurring since the late 1970s and early 1980s.
**Future Disposal Options**

If your generating plant is not being decommissioned, you know you will need additional disposal capacity. Your existing property and nearby properties may not meet the siting restrictions and may not be of sufficient size, requiring long CCR hauling distances for disposal. What you need to know is if there is a possibility to comply with the new Rules, close your existing sites and expand your future capacity with a single action. Refer to Exhibit 5.

**EXHIBIT 5**

**CCR SITE CONTINUED OPERATION**

If siting prohibitions restrict use of other areas on your property, consider a vertical expansion, if your site conditions are suitable. First, by filling and sloping your site’s final grades to promote drainage and placing the required closure cover that complies with the new liner criteria, you have effectively placed the beginning of a liner system for a new CCR disposal site above the existing operation. It’s understood that the expansion will likely need to be a dry fill but some sites may satisfy requirements that allow a wet fill vertical expansion. Don’t dismiss any possibility until it’s proven to not fit your site’s conditions.
By placing a cover on the existing fill and by finally installing an additional cover over the vertical expansion when complete, you've effectively provided two cover systems over the original disposal site, providing more protection than required, using minimum additional property. The airspace above your CCR disposal site may be the most valuable real estate available.

If siting prohibitions do not restrict construction of a new fill adjacent to the existing site, a horizontal expansion of a new site meeting the new liner requirements and filling over the side slopes of the existing fill area also allows use of the airspace above the existing site.

**Compliance Actions**

Imbedded in the last 150 pages of the 750 page pre-publication version of the Final Rule are specific required compliance actions and associated time frames. Implementation of these compliance actions will be impacted based on your State’s current regulations and how close they match the Final Rule, what requirements have you already satisfied, timing that your State adopts these requirements, and variations on how your State interprets each compliance issue. A general list of the compliance actions and the deadlines is as follows:

- Stop or continue disposal in a cell to classify as “inactive” or “active”   6 Months
- Develop fugitive dust control plan        6 Months
- Begin weekly inspections and documentation      6 Months
- Establish website and complete notifications       6 Months
- Begin initial annual inspection and documentation      9 Months
- Develop written closure plan       18 Months
- Develop written post-closure plan      18 Months
- Perform hazard ranking           18 Months
- Assess slope stability and safety factors     18 Months
- Run-on, Run off analysis/flood controls     18 Months
- Document active cell construction    18 Months
- Prepare and emergency action plan       24 Months
- Begin groundwater monitoring program with analysis, assessment, and corrective action plan    30 Months
• Evaluate seismic zone 42 Months
• Identify unstable impacts 42 Months
• Demonstrate separation to groundwater 42 Months
• Identify wetland impacts and environmental risks 42 Months
• Identify fault areas 42 Months

Note there are several subtle differences between dry landfills and surface impoundments that can be identified in the Rule.

The estimated costs to prepare and compile the required documentation and install monitoring wells, is highly variable depending on specific conditions at your generating station. The cost of compliance is also affected by what similar activities you’ve already completed, at least in part, as required by your existing States’ regulations.

The overall requirements are spelled out in the Final Rule but it will take the States’ to define specific detailed documents that need to be prepared. As these documents are developed, they are required to be posted on a publically accessible web site and submitted to the State agencies as requested. Actions you take now will affect what else you have to complete during this transition period.

It’s critical to understand that the overview of these documentation requirements defined in the Rule are very general and nonspecific. Many states have similar and regulations with intricate details of submittal requirements. Integrating the Rule with your State’s regulations will be needed to meet the intent of both agencies.

**Summary**

The decision making process to answer the question of “what should I do with my existing CCR disposal site?” is complex and unique for each facility.

The goal of this technical paper it to provide a basic understanding of how the new Rule will affect your site and the potential associated costs, depending on decisions you make, and actions you take. This is accomplished, in part, by defining a framework of factors to consider:
• When CFR Publication occurs; compliance schedule starts;
• Whose Rules will prevail for your site, state or federal;
• What factors to consider when deciding to remove VS close in place;
• Where your next disposal site may be located;
• What actions do you need to take; and,
• How to start the decision making process for your unique situation and critical factors to consider that impact cost and environmental risk.

Perhaps most importantly, it’s essential to understand that the solution(s) for your situation is unique and what’s right for one site may not be the best solution for others, even between two CCR disposal locations at your plant. There is no single optimum answer.

If appropriate for your site and there are no overruling factors, your best long term solution may be vertical expansion. Air space above your existing CCR operation might be your most valuable asset.

As a generating station owner/operator, your first actions need to be evaluation of current CCR disposal sites and development of estimate costs for alternatives and compliance requirements, including consideration of potential environmental risk. Second, you need to integrate this evaluation with the other pending rules such as the Effluent Limitation Guidelines (ELG). These two rules are interrelated and your response to the CCR Rule may affect how what needs to be done for compliance with the ELGs. Taking action to address one rule may require backtracking to comply with the other. Once overall potential plant modifications are decided for compliance with both rules, you’ll be ready to develop an integrated schedule to meet all your required objectives.

References: