Coal Combustion Residual Beneficial Use Evaluation: Fly Ash Concrete and FGD Gypsum Wallboard

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Executive Summary

Purpose

The goal of this document is to use sound science based on accepted and standard practices to determine whether the United States Environmental Protection Agency ("EPA" or "the Agency") should support the beneficial use of coal fly ash in concrete and flue gas desulfurization (FGD) gypsum in wallboard. Coal fly ash used as a direct substitute for portland cement in concrete (hereafter referred to as "fly ash concrete") and FGD gypsum used as a replacement for mined gypsum in wallboard (hereafter referred to as "FGD gypsum wallboard") are the two largest encapsulated beneficial uses of coal combustion residuals (CCRs) in the United States.

In addition, this document provides an example of how to conduct similar analyses using EPA's *Methodology for Evaluating Encapsulated Beneficial Uses of Coal Combustion Residuals* (US EPA, 2013a). This example also demonstrates an appropriate level of documentation for such analyses.

Conclusions

Based on the analysis set forth in this document, the evaluation concludes that environmental releases of constituents of potential concern (COPCs) from CCR fly ash concrete and FGD gypsum wallboard during use by the consumer are comparable to or lower than those from analogous non-CCR products, or are at or below relevant regulatory and health-based benchmarks for human and ecological receptors.

The beneficial use of CCRs, when conducted in an environmentally sound manner, can contribute significant environmental and economic benefits. Environmental benefits can include reduced greenhouse gas emissions, reduced need for disposing of CCRs in landfills, and reduced use of virgin resources. Economic benefits can include job creation in the beneficial use industry, reduced costs associated with CCR disposal, increased revenue from the sale of CCRs, and savings from using CCRs in place of other more costly materials.

Based on the conclusion of the analysis in this document stated above, and the available environmental and economic benefits, EPA supports the beneficial use of coal fly ash in concrete and FGD gypsum in wallboard. The Agency believes that these beneficial uses provide significant opportunities to advance Sustainable Materials Management (SMM).

Background

Beneficial use of industrial materials has the potential to provide economic benefits, preserve virgin resources, and avoid negative environmental impacts associated with the acquisition and processing of virgin materials. Beneficially using these materials presents significant opportunities to advance SMM and the Agency's SMM Program. The SMM Program supports the productive and sustainable use/reuse of resources throughout all stages of their lifecycles, from resources acquisition through disposal. The SMM Program seeks to avoid or minimize impacts to the environment while accounting for economic

efficiency and social considerations. CCRs are one of the industrial materials produced in the greatest quantity each year. The beneficial use of CCRs when conducted in a manner protective of human health and the environment can advance these SMM goals.

While the beneficial use of CCRs has been shown to have economic and material benefits, the environmental impacts associated with their use must also be considered. To do this, EPA's Office of Solid Waste and Emergency Response (OSWER) developed the *Methodology for Evaluating Encapsulated Beneficial Uses of Coal Combustion Residuals* (US EPA, 2013a). While in this document the Agency has used the methodology to evaluate the beneficial use of CCRs in certain encapsulated uses, this methodology can be useful to states, tribes, local governments, the public, and the regulated community for making informed decisions about any encapsulated beneficial uses of CCRs. The methodology has undergone an independent external letter peer review. A summary of the comments received from peer reviewers is available in the document *Peer Review Summary Report: Independent External Peer Review of the Preliminary Draft Report Methodology for Evaluating Encapsulated Beneficial Uses of Coal Combustion Residuals* (US EPA, 2012a). Responses to these comments are available in the document *Responses to External Peer Review Comments: Methodology for Evaluating Encapsulated Beneficial Uses of Coal Combustion Residuals* (US EPA, 2013b).

The methodology establishes a series of five steps that can be used to determine whether environmental releases of COPCs from an encapsulated beneficial use product made with CCRs are comparable to or lower than those from an analogous product made without CCRs, or are at or below relevant regulatory and health-based benchmarks developed for human and ecological receptors, during use by the consumer. The methodology allows evaluation of the range of possible encapsulated beneficial uses for any CCR. As developed, the methodology is quite flexible. The party conducting the evaluation can choose to begin at the first step and follow the methodology in the order presented or, based on the type and amount of data available on the CCR and corresponding product, can choose to begin the evaluation at any other step of the methodology. If releases of COPCs from the CCR beneficial use are found to be comparable to or lower than those from an analogous non-CCR product, or are at or below relevant regulatory and health-based benchmarks at any step of the methodology, then no further evaluation is necessary for those particular COPCs.

Summary of the Analysis

The Agency used the methodology to evaluate the potential environmental impacts associated with fly ash concrete and FGD gypsum wallboard. These beneficial use products may be variable in their composition. However, this evaluation only addressed those products that meet relevant physical and performance standards established by voluntary consensus standard bodies; that conform to specific design criteria identified in this evaluation (e.g., ≤ a 40 percent fly ash replacement rate); and that incorporate fly ash and FGD gypsum from common pollution control devices used in the United States. This evaluation also did not address products that contain additional additives or industrial materials that may alter releases from the products. In this specific evaluation, the Agency began with the first step and followed subsequent steps in the order presented in the methodology. The findings at each step of this specific conservative evaluation are summarized below.

Step 1 (Literature Review and Data Collection): From the available literature, the evaluation identified the following releases that may occur during use of fly ash concrete and FGD gypsum wallboard: 1) generation of dust, 2) emanation to air, 3) leaching to ground and surface water, and 4) decay of naturally occurring radionuclides (also referred to simply as radioactive decay). In addition, this literature review found several existing evaluations to be of sufficient applicability and quality to rely upon in the current evaluation. For fly ash concrete, the findings from these evaluations were used to eliminate radioactive decay from further consideration. For FGD gypsum wallboard, the findings from these existing evaluations were used to eliminate all releases from further consideration, except for emanation to air. The evaluation then used the available literature to identify COPCs for each of the remaining releases.

Step 2 (Comparison of Available Data): The Step 2 evaluation used the data identified in Step 1 to compare releases from fly ash concrete and FGD gypsum wallboard to releases from their respective analogous products (i.e., portland cement concrete and mined gypsum wallboard) during use by the consumer. The evaluation found that concentrations of silver and manganese in dust from fly ash concrete were comparable to or lower than those in dust from portland cement concrete. The evaluation also found that concentrations of arsenic, cadmium, lead, molybdenum, and thallium in leachate from fly ash concrete and portland cement concrete were comparable. Therefore, the evaluation did not carry these COPCs forward for further consideration, but retained all other COPCs from fly ash concrete and FGD gypsum wallboard for further consideration.

Step 3 (Exposure Review): The Step 3 evaluation reviewed the releases carried forward from Step 2 to identify exposures that may occur during use of the product. Where multiple exposure pathways associated with a given release were identified, the evaluation retained only those pathways likely to drive exposures for further consideration. The evaluation did not eliminate any releases or associated COPCs at this step.

Step 4 (Screening Assessment): The Step 4 evaluation conducted a screening assessment for each exposure pathway carried forward from Step 3 of the evaluation. The evaluation used conservative (i.e., likely to overestimate exposures) environmental, fate and transport, and exposure data to estimate COPC exposures that may occur during use of the CCR beneficial use products. The evaluation then compared these conservative exposure concentrations to relevant screening benchmarks to determine whether to conduct more in-depth evaluation. At the end of this step, the evaluation found that all remaining COPCs were below relevant screening benchmarks. Therefore, this evaluation did not proceed to the final Step 5 (Risk Assessment).

Conclusion: At the end of Step 4 the analysis was concluded as all identified COPCs had been eliminated in Steps 1 through 4. Thus, based on application of the methodology and the lines of evidence set forth in this document, the evaluation concludes that environmental releases of COPCs from CCR fly ash concrete and FGD gypsum wallboard during use by the consumer are comparable to or lower than those from analogous non-CCR products, or are at or below relevant regulatory and health-based benchmarks for human and ecological receptors.