Comparison of Ameren Missouri's Coal Combustion Products (CCPs) Ponds with TVA's Kingston Ash Disposal Site

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On December 22, 2008, a major failure occurred in portions of the Ash Disposal Site at the Tennessee Valley Authority's (TVA's) Kingston Fossil Plant on the Emory River in Roane County, Tennessee. An estimated 5.4 million cubic yards of coal combustion products (CCPs), primarily wet fly ash, were released in a progressive chain reaction of failures of the containment dikes over a period of about one hour.[1] The TVA retained AECOM of Vernon Hills, Illinois to investigate the conditions prior to, and after, the failure to determine the most likely mode of failure and to evaluate effective solutions. AECOM issued a 10-volume report on June 25, 2009, that described the history of the construction of the ash disposal site, the geologic and geotechnical settings, and the factors that contributed to the failure.

How do the characteristics of the Kingston Ash Disposal Site/CCP pond compare with Ameren Missouri's disposal of CCPs in ponds at its Labadie, Meramec, Rush Island and Sioux coal-burning Energy Centers? There are significant differences between the Kingston site and Ameren Missouri's CCP ponds. The principal differences are summarized in the following sections:

WHAT IS AN "ASH POND?"

An "ash pond" or "ash disposal site" or "CCP pond" is basically a basin used to store CCPs. The basin is constructed by building an embankment above the existing ground surface, or excavating below the ground surface, or a combination of an embankment surrounding an excavation. The important characteristics that define a CCP pond are:

- The types of CCPs deposited in the pond.
- How the CCPs are deposited in the pond.
- The construction and stability of the embankment.
- The stability of the materials that are the foundation for the CCP pond.

Types of CCPs. Burning coal produces a variety of coal combustion products (CCPs). Fly ash is composed of very fine particles that are removed from the flue gas from the coal-burning boilers before the flue gas is discharged at the stack. Bottom ash is the partially-burned remains of the coal, usually partially vitrified, that collects and is periodically removed from the bottom of the boiler. Bottom ash is the size of sand or fine gravel, and is often beneficially reused. Fly ash and bottom ash are often stored separately, or may be mixed together and disposed of in CCP ponds. Various CCPs have different physical properties which can impact the stability of a CCP pond. Also, there are different types of fly ash. Eastern coals produce Type "F" fly ash, which is like a fine powder or very fine sand, and does not become bonded together. The western coal that Ameren Missouri currently uses produces Type "C" fly ash that has internal strength when mixed with water, analogous to cement.

Deposition of CCPs. CCPs are often deposited into ponds by mixing the CCPs with water to make a fluid mix (i.e. "slurry") that can be pumped to the pond. The CCPs settle out in the pond, and the excess water is removed or recycled. CCPs deposited using the slurry method, such as at Kingston,

[1] AECOM (2009), "Executive Summary for Root Cause Analysis of Kingston Dredge Cell Failure," Rev. 3, Report prepared for the Tennessee Valley Authority, June 25, 2009, 18 pages, available from TVA website www.tva.gov.

results in a loose mass that is saturated. CCPs may also be delivered "dry" to the disposal site, where the CCPs are mixed with relatively little water to convey the CCPs out into the pond. This can form a more stable mass than CCPs deposited by slurry. The CCPs deposited "dry" typically become cemented, particularly if Type "C" fly ash is deposited. Ameren Missouri uses the "dry" method at its Labadie, Rush Island, and Meramec Energy Centers.

Construction of Embankments. The embankments of CCP ponds are often constructed with compacted earthen materials, such as clays. The width of the embankment and the slopes of its sides are designed to be structurally stable, which are governed chiefly by the height of the embankment and the CCP in the pond. The physical properties of properly-dried and compacted fly ash and bottom ash make them suitable for constructing embankments for ponds, as well as other engineered fills such as roads and railroads.

Foundation Materials. The stability of the pond embankment is also impacted by the stability of the foundation materials. This is especially true where the CCPs are stacked above the height of the outside embankment. Most soils, or even CCPs, are suitable foundation materials if they are sufficiently dense or compacted. This determination of stability analysis is part of the overall design of the CCP pond.

SUMMARY OF AECOM'S REPORT ON KINGSTON FAILURE

According to AECOM's report, the Ash Disposal Site at Kingston was a complex series of ash ponds that were built on top of each other since the plant began operating in 1955. A dike of compacted earth ("Dike C") ran completely around the original ash pond, separating it from the Emory River and the Watts Bar Reservoir. The first stage of Dike C was completed in 1958. Before Dike C was completed, the ash flowed directly into the reservoir. AECOM found that a slurry of fly ash, soil and water was allowed to flow out from the plant and to settle on the floor of the future ash pond, creating a thin (less than about 6 inches thick) layer of "slimes," that is a small-grained material with a "slippery, viscous feel." AECOM found that this part of the pond foundation was a critical factor in its eventual failure in December 2008. The report indicated that the perimeter embankment was raised two times to create more room for CCPs, making the final depth of the ash pond behind Dike C about 35 to 45 feet, which was stable according to AECOM.

In 1982, the TVA began construction of "dredge cells" (Cells 1, 2 and 3) on top of the original ash pond. Each cell was formed by dikes built with ash excavated from the existing ash pond and built on top of the ash in the original pond. Ash was then dredged and pumped into the cells as slurry. Therefore, the unstabilized ash in the original pond formed the foundation for the new dredge cells. The height of dredge Cell 2 was about 50 feet above Dike C when on December 22, 2008, a portion of Cell 2 failed, and a chain reaction resulted that led to the failure of the perimeter embankment and the uncontrolled release of the CCPs. According to AECOM's findings, TVA failed to improve the stability of the saturated ash prior to the construction of the dredged cells. Furthermore, because the ash was being pumped into the dredge cells, the entire height of saturated ash in the dredge cells and the original ash pond reached almost 90 feet. The deep saturation of the wet ash was the primary mechanism that caused the initial failure of Cell 2, which initiated the chain reaction that ultimately caused the failure of the perimeter Dike C.

AMEREN MISSOURI'S CCP PONDS

In reviewing the AECOM report, there are significant technical differences between the Kingston Ash Disposal Site and the CCP ponds operated by Ameren Missouri at its four Energy Centers. The most obvious and important difference between the Kingston Ash Disposal Site and Ameren Missouri's CCP ponds is the depth. The depth of the CCPs in Ameren Missouri's ponds is significantly less than the depth of the original ash pond at Kingston which was stable for more than 50 years before TVA began construction of the dredge cells on top of it. Set forth below is a summary of the key differences between Kingston and Ameren Missouri's ponds – differences that make Ameren Missouri's ponds significantly more stable than those at the Kingston site.

1. **The consistency of the material is different.** When Type "C" fly ash is placed in the ponds "dry" as described above, it becomes solid. When it is compacted in a fill, it becomes hard. Therefore, even if the perimeter embankments that form one of Ameren Missouri's CCP ponds were to fail, the CCPs inside the pond would not flow out of the pond as the loose, saturated fly ash at TVA's Kingston site did.

2. **Storage and stacking practices differ.** Ameren Missouri has not piled fly ash above the perimeter embankments that form the CCP ponds, except for low temporary piles used to dry the CCPs excavated from the ponds. This ash drying process is done in the interior of the pond where it will not affect the stability of the perimeter embankment. These piles actually help compress the CCPs in the pond, solidifying and stabilizing the ash in the pond. For example, Ameren Missouri has built a large construction area on the fly ash pond at the Sioux Energy Center. In addition, heavy coal trains run on a railroad track at the Meramec Energy Center that runs across old CCP ponds. Railroad loop tracks at several of Ameren Missouri's energy centers have been built using CCPs excavated from ponds.

3. **Solid foundation soil exists at Ameren Missouri's ponds, unlike at the Kingston site.** All of the embankments at Ameren Missouri's CCP ponds have been built on sound foundation soil; this greatly increases the stability of the embankments and ponds. Also, the continuous layer of "slimes" below the original ash pond at Kingston, – a critical part of the failure of the Kingston site - does not exist at Ameren Missouri's CCP ponds because the CCPs were never allowed to flow openly and to mix with the foundation soil; rather the CCPs have been deposited as sediment on top of the foundation soils. The perimeter embankments that were built at Kingston – both the second and third levels of the perimeter Dike C and the interior fly ash dikes – were built partially or entirely over loose, saturated fly ash in the original pond without improving the strength of the old fly ash. As mentioned above, the foundations of all ponds and embankments must be stable to avoid the type of failure that occurred at the Kingston site.

4. **Strong accountability exists at Ameren Missouri and was lacking at TVA.** An independent study by McKenna, Long & Aldridge, LLP (MLA) commissioned by the Board of Directors of TVA found that there was a "lack of clarity and accountability for ultimate responsibility" for

the ash disposal sites at TVA's power plants[2]. Also, MLA found a "lack of prevention priority and resources," and that the TVA was not proactive when there were evidences of problems at the site in 2003 and 2006. In sharp contrast, Ameren Missouri has formed a Dam Safety Group that is specifically responsible for the design, operation and regular inspections of the CCP disposal sites, and Ameren Missouri has hired independent engineering consultants to analyze the stability of its CCP ponds to guard against failures.

SUMMARY

Ameren Missouri's CCP ponds do not have the characteristics of the Kingston Ash Disposal Site that led to the Kingston site failure in December 2008; the principal difference being the CCP height. The CCP height at Kingston was almost 90 feet when the failure occurred. In addition, many of the properties of the CCPs in Ameren Missouri's ponds, and the characteristics of the ponds, result in a greater stability than existed at the Kingston Ash Disposal Site prior to its failure. Finally, Ameren Missouri has taken proactive measures to investigate the stability of its CCP ponds and to maintain stable, environmentally safe sites in the future through a strong Dam Safety Group that is specifically responsible for CCP and other dam sites.

[2] McKenna Long & Aldridge LLP (2009), "A Report to the Board of Directors of the Tennessee Valley Authority Regarding Kingston Factual Findings," submitted by R. William Ide III and Joseph O. Blanco, July 21, 2009, 32 pages.