

US EPA ARCHIVE DOCUMENT

Memorandum

To: Stephen Hoffman, USEPA

From: Joe Klein, PE, Senior Geotechnical Engineer
Jerry Strauss, PE, Project Manager

Date: March 18, 2011

Re: Ash Pond Stability and Hydraulic Analysis
Coal Combustion Residue Impoundment Assessment Program
Alliant Energy/Interstate Power and Light Co.
Burlington Generating Station, Burlington, IA

Under the USEPA Structural Integrity Assessment for Coal Combustion Residue (CCR) Management Units, Dewberry was directed by EPA to perform an assessment of the Interstate Power & Light/Burlington Plant in Burlington, Iowa. Dewberry reviewed data received from the utility and performed a plant site visit to visually observe the CCR impoundments.

Dewberry's draft *Coal Combustion Waste Impoundment, Round 7 – Dam Assessment Report, Burlington Generating Station (Site 017)* concluded that the structural soundness and hydrologic/hydraulic safety of the impoundments were POOR. The rating was based on the lack of engineering data verifying adequate slope stability factors of safety, and that impoundment capacities were capable of storing the design precipitation event without overtopping the dikes. The report recommended that Interstate Power & Light perform/provide a slope stability analysis and hydrologic/hydraulic analyses.

Review comments provided by Alliant Energy included a February 3, 2011 report *Ash Pond Slope Stability and Hydraulic Analysis, Burlington Generating Station, Burlington IA* prepared by Aether DBS. Based on Aether's findings, Alliant Energy requested that the structural soundness and hydrologic safety rating in the report be changed. Data presented in the engineering report does not support the requested change for the reasons presented below.

Slope Stability – Burlington Plant Impoundments

Numerical analyses were conducted to assess the stability of four embankments under two loading conditions – static (long term), and design seismic event. The calculated safety factors presented in the Aether DBS report are provided in Table 1 along with the minimum recommended slope stability safety factors from the US Corps of Engineers.

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Table 1: Slope Stability Safety Factors

Load Condition	Embankment	Minimum Required Safety Factor	Calculated Safety Factor
Static (Long Term)	Ash Seal Pond	1.5	1.6
	Main Pond		2.1
	Upper Ash Pond		2.1
	Economizer Ash Pond		1.1
Design Seismic Event	Ash Seal Pond	>1.0	1.2
	Main Pond		1.0
	Upper Ash Pond		1.5
	Economizer Ash Pond		0.7

The results indicate that the calculated Slope Stability Safety Factor for the Economizer Ash Pond is less than the required minimum for both long-term static loading and design seismic loading. The calculated Slope Stability Safety Factor for the Main Ash Pond is less than the required minimum for design seismic loading.

Economizer Ash Pond

The Economizer Ash Pond receives sluiced economizer ash discharged to a small pond atop the economizer ash pile. Water from the Economizer Ash Pond is routed to the Upper Ash Pond. The Economizer Ash pile is about 20 feet above the Upper Ash Pond embankment crest. The Aether DBS report states that the Economizer Ash Pond embankment was analyzed as ash.

The analysis data show that ash in the embankment was assigned a unit weight of 130 pounds per cubic foot (pcf) and an angle of internal friction (ϕ) of 28° . Ash behind the embankment section was assigned a unit weight of 120 pcf and ϕ of 25° . As construction data were not provided, the basis for the increase in unit weight and ϕ used in the analysis is not clear.

The report concludes that the calculated static factor of safety is less than the required minimum, and that a failure of the embankment could discharge water and ash into the Upper Ash Pond, possibly overtopping the Upper Ash Pond embankment. The analysis does not assess the structural stability of the Upper Ash Pond embankment under the condition of increased lateral load and potential scour, caused by overtopping, which could result from a failure of the Economizer Ash Pond embankment.

Based on the slope stability factor of safety of 2.1 for the Upper Ash Pond under static, long-term loading conditions, the impact on the Upper Pond embankment of an Economizer Ash embankment failure is likely not critical. However, the decrease in the Upper Ash Pond slope stability factor of safety to 1.5 under seismic loading conditions and the 0.7 factor of safety for the Economizer Pond embankment indicates a higher potential for progressive failure of the impoundment system.

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The Aether DBS report concludes that although liquefaction of the Economizer Ash Pond embankment could result in the Upper Ash Pond embankment being overtopped, the size of the Lower Ash Pond is such that it is unlikely anything other than water would flow into the Mississippi River. Under ideal conditions that might occur, however evaluation under less than ideal conditions may lead to an alternate conclusion. The less than ideal conditions are:

- Lower Ash Pond is flooded by backwater from Mississippi River high water levels. This was the condition at the time of Dewberry site visit, or
- Failure of the Upper Ash Pond embankment due to the impact of and overtopping by water and ash in the event of liquefaction of the Economizer Ash Pond embankment.

Main Pond

The Aether DBS report analysis results indicate that **substantial deformation may occur in the Main Pond embankment under the design seismic event** and that the deformations could lead to a release of pond contents. The report concludes that based on the low height of the pond and the volume of its contents relative to the distance from the Mississippi River, the release would likely be retained in a low lying area south of the pond. This conclusion assumes the release occurs near the western end of the embankment. However, if a release occurs near the eastern end of the south embankment, where the pond is somewhat higher and in close proximity to a drainage canal at the toe of the Ash Seal Pond embankment, the likelihood of material reaching the Mississippi River is increased.

Sand Layer Underlying the Embankments

The Aether DBS report identifies a layer of very loose sand and/or sandy silt underlying the embankments that may be subject to liquefaction during the design seismic event. The report indicates that **liquefaction of the sandy layer could result in an entire embankment sliding failure. Liquefaction of the base layer was not considered in the seismic analyses included in the report.**

Aether DBS Report Recommendations

The Aether DBS report provides three recommendations pertaining to the structural stability of the embankment slopes. The recommendations are:

- Re-route sluice water in both the Main Pond and Economizer Ash Pond to flow through the center of the ash fill in the pond.
- Further assess the critical section of the Economizer Ash Pond to determine if a clay embankment is present south of the ash crested area.
- Further assess the potential for soil liquefaction beneath the Main Ash Pond and Economizer Ash Pond embankments

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Hydrology and Hydraulics (H&H) – Burlington Plant Impoundments

H&H Findings

Aether DBS conducted an analysis of storm-water flow through the ash pond network. The analysis was based on the 1 percent recurrence interval (100-year event), 24-hour event consisting of 6.8 inches of precipitation. The analysis indicated that none of the embankments would be overtopped. However, at a peak discharge from the Main Pond of 18 cubic feet per second (CFS) freeboard is 0.8 feet. At a peak discharge from the Upper Ash Pond of 7 CFS the freeboard is 0.75 feet.

The report concludes that since the estimated freeboard is less than 1-foot at peak discharge, remedial measures to improve storage and/or drainage should be considered.

The report also discusses overtopping of the Upper Ash Pond embankment due to backwater from the Mississippi River during periods of very high water. The report concludes that the embankment has survived overtopping in prior occasions and so is expected to survive future events.

Aether DBS Recommendations for H&H

Aether DBS recommends that the outlet pipe from the Upper Ash Pond be increased in diameter to maintain a freeboard greater than 1-foot under the 100-year flow.

Aether DBS Conclusions

Aether DBS concludes that the ash ponds are in FAIR condition and only extreme hydrologic and/or seismic events could lead to economic or environmental impacts to areas outside the ash ponds.

Dewberry Findings and Issues

Dewberry generally agrees with the approach and analytical methods used in the Aether DBS Report, but has identified issues relative to the studies and associated results that need to be addressed. These issues are:

- **The potential for liquefaction of the loose sands underlying all or most ash management units.**
- **The slope stability of the Upper Ash Pond embankment under the conditions of a catastrophic failure of the Economizer Ash Pond embankment.**
- **Water, but not ash, would be released to the environment under a failure of the Economizer Ash Pond during backwater flooding of the Upper and Lower Ash Pond.**

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Dewberry Recommendations

Dewberry concurs that the limited conclusions in the Aether DBS report are valid. However, given the potential for a catastrophic failure under seismic conditions that would result in the contents of the Burlington CCR impoundments spilling into the Mississippi River, Dewberry recommends specific and immediate actions be taken by the utility at the Burlington plant, as follows.

Immediate:

- Perform a geotechnical exploration to define the location and extent of the loose sand layer. (Estimated Performance Time: 1 month)
 - The scope of field exploration should include:
 - A minimum of 10 soil test borings distributed along the crest of the Main Ash Pond, Economizer Ash Pond, and Upper Ash Pond.
 - Minimum boring depth of 50 feet.
 - Borings must include standard penetration tests or quasi-static cone penetration tests conducted in accordance with applicable ASTM standards.
 - The geotechnical exploration should include an evaluation of the liquefaction potential of loose sand beneath the embankments of the management units, and an evaluation of the impact of liquefaction on the management units.
 - Recommendations for improving or stabilizing the loose sand layer
- Perform a dam-break analysis based upon a catastrophic failure of the Economizer Ash pond. (Estimated Performance Time: 1 month)
- Develop specifications and contract documents and identify vendors for densification of the loose sand layer below the Management Units. The required relative density should be an output of the geotechnical exploration. (Estimated Performance Time: 6 weeks)
 - Include field quality control and results verification.

Short Term

- Perform a hydraulic study that verifies only water is released in the event of an economizer embankment failure. (Estimated Performance Time: Two weeks after completion of dam-break analysis)
- Bid and Award the contract for densification of the sand and other materials below the management units (Estimated Performance Time: 1 month)


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