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October 15, 2018

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

Engineer's Certification of Seismic Impact Zone Demonstration
Peabody Ash Pond
EPA Final CCR Rule
TVA Kingston Fossil Plant
Drakesboro, Kentucky

1.0 PURPOSE

The purpose of this document is to certify that the Seismic Impact Zone Demonstration for the TVA Paradise Fossil Plant Peabody Ash Pond is in compliance with the Seismic Impact Zone Location Restriction Demonstration specified in the Final EPA CCR Rule at 40 CFR §257.63(a). Presented below are the project background, summary of findings, limitations and certification.

2.0 BACKGROUND

As required by 40 CFR §257.63 of the EPA Final CCR Rule, by October 17, 2018, the owner or operator of an existing surface impoundment must demonstrate either that the unit is not located in a seismic impact zone or that the unit's structural components are designed to resist the maximum horizontal acceleration in lithified earth material for the site.

3.0 SUMMARY OF FINDINGS

In support of the above demonstration, AECOM has determined that the Peabody Ash Pond at the Paradise Fossil Plant (PAF) in Drakesboro, Kentucky, is located within a Seismic Impact Zone, (defined as an area with a Maximum Horizontal Acceleration of 0.1g). A report detailing the demonstration procedure of the Seismic Impact Zone Demonstration is attached to this document.

In accordance with 40 CFR §257.63, the results of the engineering assessment performed on the surface impoundment have determined that the unit meets the appropriate factors of safety and is structurally sound. These factors of safety indicate the surface impoundment's structural components have been designed to resist the maximum horizontal acceleration in lithified earth.

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4.0 CERTIFICATION

I, Nicholas Golden, being a Professional Engineer in good standing in the State of Kentucky, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this certification has been prepared in accordance with generally accepted engineering practices; that the information contained herein is accurate as of the date of my signature below; and that Peabody Ash Pond meets the requirements of 40 CFR § 257.63(a).

SIGNATURE _____ DATE 10/15/18

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ATTACHMENTS: Engineer's Certification of Seismic Impact Zone Demonstration (40 CFR §257.63) for Coal Combustion Residuals (CCR) Existing Surface Impoundment – Peabody Ash Pond

COAL COMBUSTION PRODUCT DISPOSAL PROGRAM

TENNESSEE VALLEY AUTHORITY – PARADISE FOSSIL PLANT
PEABODY ASH POND
DRAKESBORO, KENTUCKY

ENGINEER'S CERTIFICATION SEISMIC IMPACT ZONE DEMONSTRATION (40 CFR §257.63) FOR COAL COMBUSTION RESIDUALS (CCR)

EXISTING SURFACE IMPOUNDMENT

Prepared for

Tennessee Valley Authority
1101 Market Street
Chattanooga, TN 37402-2801

October 15, 2018 – Rev 0

Prepared by

AECOM

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1.0 INTRODUCTION

1.1 OBJECTIVE

The purpose of this demonstration is to evaluate compliance with *40 CFR § 257.63* of the Environmental Protection Agency Final Coal Combustion Residual Rule (EPA Final CCR Rule). This Seismic Impact Zone Location Restriction Demonstration is based on existing documentation such as construction drawings, record drawings, and any other pertinent data and/or investigations to support historic conditions and operations at Peabody Ash Pond at the Tennessee Valley Authority (TVA) Paradise Fossil Plant (PAF).

1.2 RULE REQUIREMENTS

40 CFR §257.63(a) *New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in seismic impact zones unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site.*

40 CFR §257.63(b) *the owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the demonstration meets the requirements of paragraph (a) of this section.*

40 CFR §257.63(c) *The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either (c)(1) or (2) of this section*

40 CFR §257.63(c)(1) *For an existing surface impoundment, the owner or operator must complete the demonstration on later than October 17, 2018.*

1.3 SITE DESCRIPTION

PAF is located in Drakesboro, Kentucky, along the west bank of the Green River and State Route 176. The plant sits inside the eastern border of Muhlenberg County as depicted below in **Figure 1**. The Peabody Ash Pond is an active unlined Coal Combustion Residuals (CCR) surface impoundment, approximately 120 acres, that manages process water flow and CCR waste during power generation. Peabody Ash Pond is located in the southeast corner of PAF. The pond currently serves as a waste water treatment and fly ash pond. An internal divider dike separates the main pond from the stilling pond located on the north end of the impoundment.

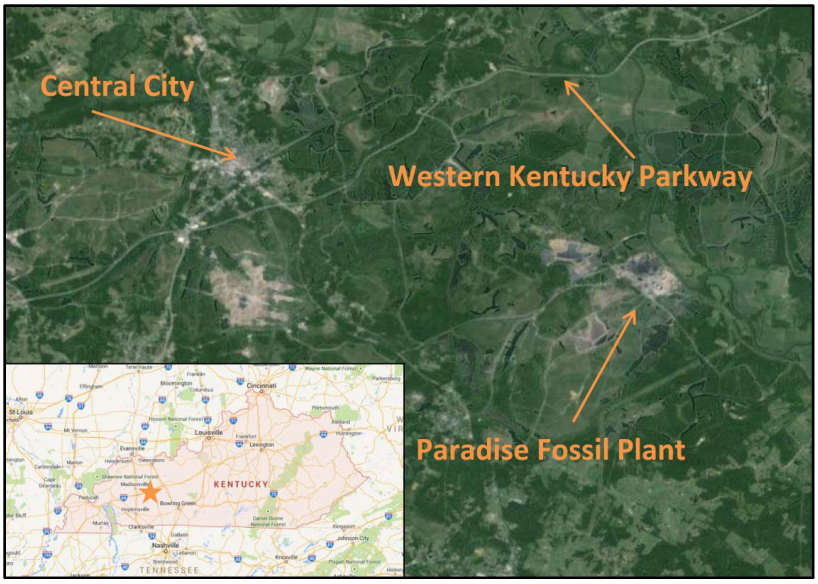

Figure 1. TVA PAF Site Location

TVA purchased the land on which the Peabody Ash Pond is built in the late 1980s. The land was previous used for strip mining activities that resulted in a mining pond made by dikes along the southern and eastern sides of what today is called the Peabody Ash Pond. The original dikes were at an elevation of 400 feet.

The dikes were raised to an elevation of 408 feet in 1997. In addition, a divider dike was built at this time, creating the Peabody Stilling Pond. Construction of the raised dike and Stilling Pond took place between February and September of 1997, with Peabody Ash Pond operations beginning immediately following construction. The original pond was known as the Ash Disposal Area and was later renamed to Peabody Ash Pond.

In 2006, a drainage ditch was constructed from the Gypsum Disposal Area Stilling Ponds to Peabody Ash Pond.

In 2014, an emergency spillway was constructed consisting of a rip-rap overflow in a depressed section of the eastern dike at a minimum elevation of 407.4 feet. **Figure 2** provides a current aerial of the site.

Figure 2. Site Overview

2.0 DEMONSTRATION

2.1 SITE STRATIGRAPHY AND GEOLOGIC SETTING

PAF lies within the Shawnee Hills section of the Interior Low Plateau Physiographic Province in Northwestern Kentucky and Carbondale Formation (TVA, Paradise CCR Management Operations Environmental Assessment).

The region is underlain by coal rich Pennsylvanian age bedrock formations. Strip mining operations have significantly altered the topography and geology within the vicinity of the plant and, as such, portions of the site are likely underlain by mine spoils. Geologic mapping indicates the plant and surrounding areas are underlain by the Sturgis and Carbondale Formations in general order of descending geology. The Sturgis Formation is described as consisting of interlayered medium- to coarse-grained micaceous sandstone, silty and clayey shale, coal, and underclay. The Carbondale Formation generally consists of cyclic sequences of fine-grained sandstone, sandy shale, coal, and silty underclay. Although not depicted on the geologic mapping, alluvial deposits are likely present along the banks of the Green River. The geologic mapping indicates this alluvium generally consists of gravel, sand, silt, and clay and may be as much as 90 feet thick.

2.2 SEISMIC EVENTS

The US Geological Survey (USGS) information and geologic studies carried out by TVA indicate that PAF and the surrounding area may be subject to minor seismic events. Seismic events affecting the central portion of western Kentucky, thus the plant, primarily emanate from two zones of earthquake activity – the New Madrid Seismic Zone of the central Mississippi Valley and the Wabash Valley Seismic Zone located along the border between Illinois and southwestern Indiana. Although the majority of the events emanating from these zones are too small to be felt at the surface, the Wabash Valley Seismic Zone has produced three earthquakes within the last 20 years with magnitudes of 5 or greater, and the New Madrid

Seismic Zone produced a series of four earthquakes between December 1811 and early February 1812, each exhibiting estimated magnitudes on the order of 7.0 to 8.0 (Stantec 2009).

2.3 STRUCTURAL ANALYSIS

2.3.1 SPILLWAY STRUCTURAL INTEGRITY

Peabody Stilling Pond has three spillways that are used as the primary pond discharge devices. Each spillway consists of a foundation pad, a concrete junction box, a vertical 48" concrete riser topped with a metal skimmer device, and a horizontal 36" concrete culvert pipe. All water entering the spillway travels east and discharges into Jacob's Creek.

The spillway foundation consists of a reinforced concrete pad measuring 6.5 feet x 6.5 feet x 1.5 feet. Topping each pad is a hollow reinforced concrete box having 1 foot thick walls measuring 6 feet x 6 feet x 4 feet. The vertical 48" risers are class IV concrete pipes with 4" wall thickness. The structures are embedded in large diameter gravel/stone to approximately 1 foot below the top of the risers. The horizontal 36" Class IV concrete pipes have lengths from north to south of 404 feet, 392 feet and 416 feet, respectively.

An analysis of the existing spillway structures was performed using the design earthquake for 2% exceedance in 50 years. Analysis of the existing spillway structures has determined that the Peabody Ash Pond spillway structures will adequately resist the design earthquake required by 40 CFR §257.63(a).

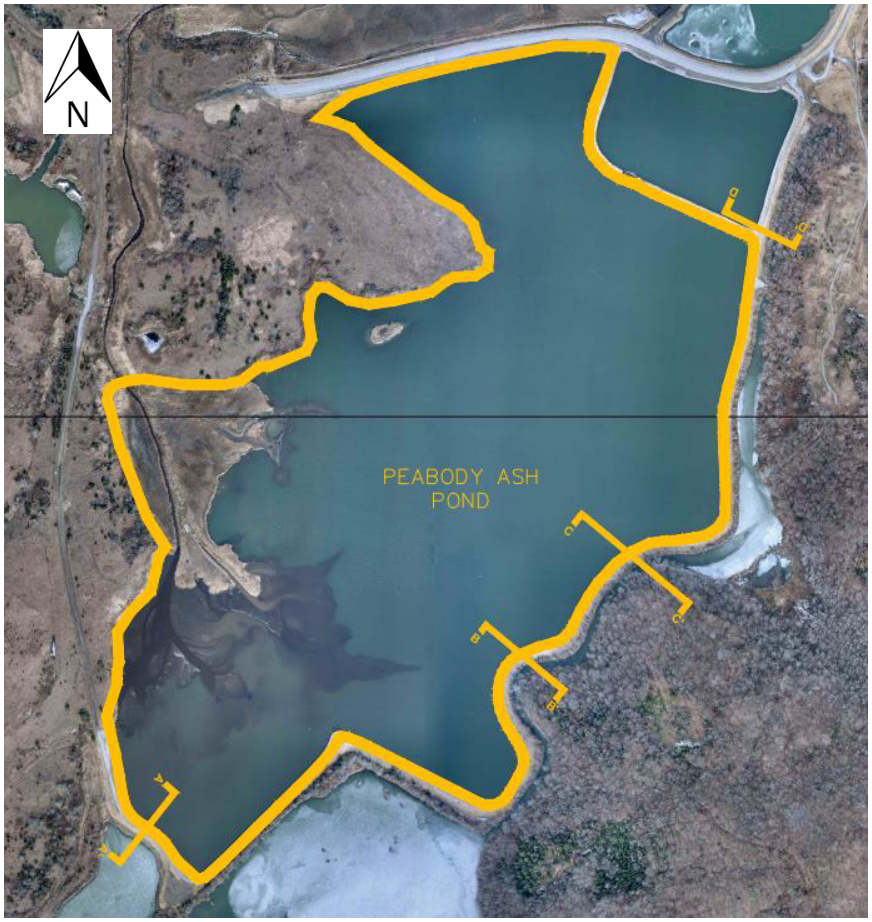

Figure 3. Peabody Ash Pond Critical Cross-Sections

2.3.2 SEISMIC FACTOR OF SAFETY

AECOM performed a static safety evaluation for the Peabody Ash Pond. Static and seismic slope stability of the system was evaluated. Slope stability analyses were performed for normal pool, flood pool, temporary loading, pseudo-static, and post-earthquake conditions at two cross sections. The design earthquake event that was simulated for the pseudo-static analysis has a probability of exceedance of 2% in 50 years, corresponding to a return period of approximately 2,475 years per the EPA Final CCR Rule requirements. For this analysis a peak ground acceleration value of 0.192 g was determined based on USGS mapping (PSH Degradation NEHRP BC Rock). This peak ground acceleration value exceeds the required seismic impact zone requirements.

In Geocomp's Initial Seismic Safety Factor Assessment, required by §257.73 of the EPA Final CCR Rule, Geocomp completed a subsurface and laboratory investigation, seismic stability evaluation, and liquefaction assessment for the Peabody Ash Pond. Geocomp's seismic stability evaluations associated with the Peabody Ash Pond utilized cross sections taken from a 2015

AECOM analysis. Four cross-sections were evaluated (**Figure 3**). Cross sections A-A' and C-C' were selected as the critical cross sections at the Peabody Ash Pond. Cross Section A-A' was the critical cross section for liquefaction factor of safety. Cross Section C-C' was the critical cross section for seismic factor of safety. The slope stability results were obtained with the two-dimensional limit equilibrium program Slope/W. The seismic and liquefaction factors of safety for the critical cross sections at PAF are summarized in **Table 1**. The minimum factors of safety reported in this table correspond to slip surfaces that could potentially result in the uncontrolled release of water and CCR materials from within the impoundment during or after the maximum design earthquake.

Table 1. Peabody Ash Pond Seismic Safety Factors for Critical Cross Sections

Critical Cross Section	EPA Criteria	Calculated FOS
A-A'	Seismic Factor of Safety (Pseudo-static stability)	1.91
	Liquefaction Factor of Safety (Post-earthquake stability)	1.48
C-C'	Seismic Factor of Safety (Pseudo-static stability)	1.76
	Liquefaction Factor of Safety (Post-earthquake stability)	1.91

Subsurface information taken from borings performed by Stantec in 2009 indicate the perimeter dike of Peabody is underlain by a continuous layer of potentially liquefiable ash that could result in seismic instability.

The seismic assessment at PAF resulted in a seismic factor of safety of 1.76 (§257.73(e)(1)(iii)) and a liquefaction factor of safety of 1.48 (§257.73(e)(1)(iv)). These results meet or exceed the minimum required seismic factor of safety of 1.00 and liquefaction factor of safety of 1.20.

3.0 CONCLUSIONS

In accordance with §257.63, the Peabody Ash Pond exceeds the minimum Factors of Safety, for both seismic and sudden drawdown, respectively. The existing surface water control systems have adequate stability to resist the maximum horizontal acceleration in lithified earth material for the site. Therefore, the site meets the requirements of 40 CFR §257.63.

4.0 REFERENCES

- 257-73(c) History of Construction at Paradise Fossil Plant Peabody Ash Pond, AECOM, 2016.
- 257-73(d) Structural Stability Assessment at Paradise Fossil Plant Peabody Ash Pond, AECOM, 2016
- 257-73(e) Safety Factor Assessment at Paradise Fossil Plant Peabody Ash Pond, AECOM, 2016.
- 257.73 Initial Seismic Safety Factor Assessment, GeoComp, 2016.
- Geotechnical Exploration and Analysis at Paradise Fossil Plant, AECOM, 2016.
- Paradise CCR Management Operations Environmental Assessment, Tennessee Valley Authority, 2017