



**Cardinal Power Plant**

**Alternative Composite Liner Design Certification**

**Retrofitted South Pond - Bottom Ash CCR Impoundment**

**Issue Purpose: Use, Rev. 0**

**Issue Date: April 8, 2021**

**S&L Project No.: 13770-005/006**

PREPARED BY:

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## 1 APPLICABLE CCR REGULATION

To demonstrate compliance of the new composite liner system for the Retrofitted South Pond of the Cardinal Bottom Ash Pond Complex, the following excerpts from 40 CFR Part 257 Subpart D (“Federal CCR Rule”) are applicable:

- **§257.72(a):** New CCR surface impoundments...must be designed, constructed, operated, and maintained with either a composite liner or an alternative composite liner that meets the requirements of §257.70(b) or (c).
- **§257.70(c):** If the owner or operator elects to install an alternative composite liner, all of the following requirements must be met:
  - An alternative composite liner must consist of two components: the upper component consisting of, at a minimum, a 30-mil GM, and a lower component, that is not a geomembrane, with a liquid flow rate no greater than the liquid flow rate of two feet of compacted soil with a hydraulic conductivity of no more than  $1 \times 10^{-7}$  cm/sec. GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick.
  - The hydraulic conductivity for the two feet of compacted soil used in comparison [to the alternative composite liner’s lower component] shall be no greater than  $1 \times 10^{-7}$  cm/sec. The hydraulic conductivity of any alternative to the two feet of compacted soil must be determined using recognized and generally accepted methods. The liquid flow rate comparison must be made using Equation 1 of [§257.70(c)], which is derived from Darcy’s Law for gravity flow through porous media.

## 2 DEMONSTRATION

The alternative composite liner design of the Retrofitted South Pond at the Cardinal Power Plant is compliant with the referenced regulations as demonstrated by the following:

### **Upper Component:**

The alternative composite liner design includes an upper component that is a 60-mil HDPE geomembrane. This complies with §257.70(c)(1).

### **Lower Component:**

The alternative composite liner design includes a lower component that is a geosynthetic clay liner (GCL). The maximum allowable hydraulic conductivity specified for the GCL is  $1 \times 10^{-9}$  cm/sec, as determined by ASTM D5887 which is a recognized and generally accepted method for determining the hydraulic conductivity of a GCL. The following table presents the calculation of flow rate comparison.

	Compacted Soil Liner	GCL
Maximum Operating Water Elevation in Retrofitted South Pond	665 feet	665 feet
Retrofitted South Pond Floor Elevation	654 feet	652 feet
Hydraulic Head on Liner (Not Considering GM) (h)	11 feet	13 feet
Compacted Soil / GCL Bentonite Thickness (t)	2 feet	0.3 inch or 0.025 feet
Hydraulic Gradient through Liner ( $i = h / t$ )	$11 / 2 = 5.5$ (unitless)	$13 / 0.025 = 520$ (unitless)
Hydraulic Conductivity of Liner (k)	$10^{-7}$ cm/sec	$1 \times 10^{-9}$ cm/sec
Liquid Flow Rate per Unit Area ( $q = k \times ((h/t) + 1)$ )	$6.5 \times 10^{-7}$ cm/sec	$5.2 \times 10^{-7}$ cm/sec

Per the preceding table, the liquid flow rate through the GCL specified for the lower component of the alternative composite liner for the Retrofitted South Pond is less than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of  $1 \times 10^{-7}$  cm/sec. This complies with §257.70(c)(1).

### 3 CERTIFICATION

Per the preceding demonstration and pursuant to §257.70(c)(1), I certify that the liquid flow rate through the lower component of the alternative composite liner for the Retrofitted South Pond is no greater than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of  $1 \times 10^{-7}$  cm/sec.

I certify that the design of the alternative composite liner for the Retrofitted South Pond complies with the requirements of §257.72.

I certify that this Alternative Liner Certification was prepared by me or under my supervision and that I am a registered professional engineer under the laws of the State of Ohio.

Certified by: James T. Perry Date: April 8, 2021  
 04/08/2021

