Liner Design Documentation and Certification – Scrubber Solids Pond No. 3

Sherburne County (Sherco) Generating Plant
Northern States Power Company (dba Xcel Energy, Inc.)
Becker, Minnesota

Prepared for:

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Certification

I hereby certify under penalty of law that this report was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based upon my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

____________________________ June 15, 2016

John R. McCain, PE Date

License No. 21835

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1.0 Introduction

This report presents documentation and certification of the liner design for Scrubber Solids Pond No. 3 (Pond 3) at the Sherburne County Generating Plant (Sherco) in Becker, Minnesota. Pond 3 is an "existing" (i.e. received coal combustion residuals both before and after October 14, 2015) coal combustion residual (CCR) surface impoundment. This report addresses the requirements of 40 CFR Section 257.71, Liner Design Criteria for Existing CCR Surface Impoundments.

2.0 Summary of Liner Design Criteria

Pond 3 was designed and constructed with an alternative composite liner over the entire pond footprint ("base liner"), covering all surrounding earth likely to be in contact with CCR. The Pond 3 containment system also includes a five-foot-thick compacted clay barrier layer embedded within the perimeter embankment and inclined over the base liner ("inclined clay barrier"). The base liner and inclined clay barrier both qualify as "liners" according to the requirements of §257.71, as documented and certified herein.

2.1 Base Liner

The base liner is an alternative composite liner consisting of a geosynthetic clay liner (GCL) overlain by a 60-mil high-density polyethylene (HDPE) geomembrane. According to §257.71(a)(1)(iii), in order for Pond 3 to be considered a "lined" surface impoundment for purposes of regulation under 40 CFR Part 257, this alternative liner design must meet the requirements of §257.70(c) and §257.70(b)(1) through (4). The requirements of §257.70(c) are paraphrased below:

- An alternative liner must consist of an upper geomembrane barrier layer and a lower non-geomembrane barrier layer
- The upper geomembrane barrier layer must be a minimum 60-mil thick if HDPE
- The lower non-geomembrane barrier layer must restrict the liquid flow rate to no greater than that provided by two feet of compacted soil with an hydraulic conductivity of $1x10^{-7}$ cm/s.
- The liquid flow rate of the lower barrier layer must be calculated using Darcy's Law for gravity flow through porous media; the calculation must be certified by a qualified professional engineer.
- The alternative liner must meet the requirements of §257.70(b)(1) through (4).

The requirements of §257.70(b)(1) through (4) are paraphrased below:

- Alternative liner materials must have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients, contact with CCR or leachate, climatic conditions, and stress of installation and operation.
- Liner materials must provide sufficient interface shear resistance to prevent slope failure.

- Liner materials must be installed on a stable foundation.
- Liner materials must be installed to cover all surrounding earth that is likely to be in contact with CCR or leachate.

Documentation of compliance of the base liner with the requirements of §257.70(c) and §257.70(b)(1) through (4) is provided in Section 3 below.

2.2 Inclined Clay Barrier

As stated above, the "inclined clay barrier" is a 5-foot-thick compacted clay layer embedded within the Pond 3 perimeter embankment and inclined over the base liner. According to §257.71(a)(1)(i), in order for Pond 3 to be considered a "lined" surface impoundment for purposes of regulation under 40 CFR Part 257, the inclined clay barrier must be at least two feet thick with an hydraulic conductivity of no more than $1x10^{-7}$ cm/s. Documentation of compliance of the inclined clay barrier with the requirements of §257.71(a)(1)(i) is provided in Section 4 below.

3.0 Base Liner Evaluation

This section evaluates compliance of the existing Pond 3 base liner (alternative composite liner) with the applicable requirements of §257.70. Specifically, the alternative composite liner must satisfy the requirements of §257.70(c)(1) through (3) and §257.70(b)(1) through (4). The following subsections address each requirement.

3.1 Compliance with §257.70(c)(1)

The Pond 3 alternative composite liner consists of an upper component that is a 60-mil thick HDPE geomembrane liner, and a lower component that is a GCL. Specifications for the geomembrane and GCL products are contained in McCain – Technical Specifications (June 2002). The Pond 3 base liner was constructed in three phases. The first phase (Pond 3N) occurred in 2004, the second phase (Pond 3N additional slope liner) occurred in 2008, and the third phase (Pond 3S) occurred in 2010. GCL products used in Pond 3N consist of CLAYMAX 200R (25% floor coverage) and BENTOMAT ST (75% floor coverage) on the pond floor; and BENTOMAT DN and Bentofix NWL on the pond slopes. GCL products used in Pond 3S consist of Bentoliner EC on the pond floor and Bentoliner NWL on the pond slopes.

3.2 Compliance with §257.70(c)(2)

The GCL (lower component of the alternative composite liner) hydraulic conductivity must be no greater than 1.1×10^{-9} cm/s in order to of the GCL to produce a liquid flow rate no greater than the liquid flow rate through two feet of compacted soil with an hydraulic conductivity of $1x10^{-7}$ cm/s. The $1.1x10^{-9}$ cm/s value was calculated using Equation 1 from §257.70(c)(2) as shown in Carlson McCain – Analysis of GCL Equivalency to Two Feet of Compacted Clay (2016).

As reported in Carlson McCain – Analysis of GCL Equivalency to Two Feet of Compacted Clay (2016), the actual in-service hydraulic conductivity of the GCL has been determined to be between $1.1x10^{-10}$ cm/s (laboratory test result using actual pond water as permeant) and $7.3x10^{-10}$ cm/s (calculated value that considers the effects of confining pressure on GCL hydraulic conductivity). The hydraulic conductivity determinations were made using recognized and generally accepted methods.

The liquid flow rate through the GCL is thus no greater than the liquid flow rate through two feet of compacted soil with an hydraulic conductivity of $1x10^{-7}$ cm/s.

3.3 Compliance with §257.70(c)(3)

This section requires that the alternative composite liner meet the requirements specified in §257.70(b)(1) through (4). Those requirement are discussed in Sections 3.4 through 3.7 below.

3.4 Compliance with §257.70(b)(1)

The upper component of the alternative Pond 3 liner consists of the CCR Rule-prescribed 60-mil HDPE geomembrane. Further demonstration of appropriate chemical and physical properties for the geomembrane is therefore not provided herein. Compatibility of chemical and physical properties of the GCL are discussed in the following paragraphs.

3.4.1 Chemical Compatibility Characteristics of GCL

The GCL lower component of the Pond 3 liner has appropriate chemical characteristics as demonstrated by the index flux and hydraulic conductivity testing performed using actual scrubber pond water as the test permeant (CETCO (2003)). Low hydraulic conductivity of the GCL was maintained during the test, indicating chemical compatibility.

3.4.2 Physical Compatibility Characteristics of GCL

GCL products are specifically designed for deployment and use in the physical environment of waste containment facilities such as Pond 3. The physical conditions under which the alternative composite liner was constructed and is operating are entirely compatible with the strength and thickness characteristics of the GCL. The bounding geotextile component of the GCL and needle-punching and stich-bonding between upper and lower geotextiles provides for containment of the encapsulated bentonite layer and resistance for the stress of handling and deployment during construction. Needle-punching provides internal shear resistance for installation and operation on slopes as described in Section 3.5.

The maximum static operating head in Pond 3 will be approximately 70 feet. When filled with saturated scrubber solids, this head will apply a maximum pressure of approximately 345 kPa (50 psi), which has been demonstrated in both field and laboratory testing to be not only not damaging to the GCL, but in fact produces very low hydraulic conductivity. Construction quality assurance (CQA) was performed by independent, qualified personnel on a full-time basis during construction of the alternative liner (McCain – Construction Documentation and Prefill Certification Report (2004), McCain – Construction Certification Report (2009), and McCain – Construction Certification Report (2011)). CQA activities included ensuring that liner installation activities were conducted in a manner that prevents damage to liner materials and results in the liner system performing as designed. Specific CQA activities performed include:

- Subgrade inspection to ensure uniformity of slope and grade, absence of deleterious materials
- GCL deployment observation to ensure damage-free placement of the GCL on the prepared subgrade, proper overlap of GCL panel edges, proper placement of supplemental bentonite at panel overlaps where required, and absence of gaps, wrinkles, and puckers in GCL panels.
- Geomembrane deployment observation to ensure damage-free placement of the geomembrane over the GCL, proper overlap at geomembrane panel edges, proper seaming of geomembrane

panels, proper non-destructive testing of all seams, proper sampling rate and destructive testing of seam samples, patching of T-joints and destructive test sample locations, and general repairs.
- Cover soil placement observation to ensure that sufficient soil thickness was present between the construction equipment and liner and that no undue physical stress or damage was caused by construction equipment.
- Observation of electrical leak location testing upon completion of cover soil placement to ensure post-construction integrity of the upper geomembrane component of the composite liner system, and by inference, that the lower GCL component was also not damaged during construction.

3.5 Compliance with §257.70(b)(2)

The GCL products used on the sideslopes of Pond 3 are needle-punched, which provides internal shear strength suitable for the 3H:1V slopes upon which they were installed. The interface shear resistance between the lower bounding geotextile of the GCL and the sandy subgrade upon which it was installed, between the upper geotextile of the GCL and the overlying textured geomembrane, and between the textured geomembrane and the overlying sand buffer layer provides a factor of safety of 1.9 against sliding (Carlson McCain – Analysis of Interface Shear Resistance (2016)). Suitable shear resistance is thus provided for the liner system.

3.6 Compliance with §257.70(b)(3)

The Pond 3 liner system was installed upon native undisturbed and proof-rolled subgrade soils and engineered compacted fill. Subgrade compaction testing was performed and documented during construction (McCain – Construction Documentation and Prefill Certification Report (2004), McCain – Construction Certification Report (2009), and McCain – Construction Certification Report (2011)). Localized and global stability analyses were performed and demonstrate that the liner foundation is stable with a minimum factor of safety of 2.9 (McCain – Engineering Report (2002) and Spaulding – Stability of Pond Slopes at Sherburne County Plant (2005)).

3.7 Compliance with §257.70(b)(4)

The Pond 3 liner covers the entire footprint of the surrounding earth likely to be in contact with CCR or leachate (McCain – Permit Application Drawings (2002)).

4.0 Inclined Clay Barrier Evaluation

This section evaluates compliance of the existing Pond 3 inclined clay barrier with the applicable requirements of §257.70. Specifically, the inclined clay barrier must satisfy the requirements of §257.70(a)(1)(i) and §257.70(a)(2). The following subsections address each requirement.

The inclined clay barrier has been constructed in phases as a vertical development of Pond 3 over the base liner. As of the date of this report, the inclined clay barrier has been constructed to Elev. 1004 feet MSL. Future construction phase(s) will extend the inclined clay barrier to its ultimate height at Elev. 1010 ft. MSL. Dimensions (clay thickness) and hydraulic conductivity of the inclined clay barrier have been documented and certified as part of each phase of development. Documentation demonstrating compliance with §257.70(a)(1)(i) and §257.70(a)(2) is contained in the following documents:

- McCain – Construction Documentation and Prefill Certification Report (2004)

- McCain – Construction Certification Report (2009)
- McCain – Construction Certification Report (2011)
- Carlson McCain – Construction Certification Report (2013)
- Carlson McCain – Construction Certification Report (2014)
- Carlson McCain – Construction Certification Report (2015)

4.1 Compliance with §257.70(a)(1)(i)

The five-foot thickness of the inclined clay barrier was documented and certified as part of each phase of development by surveying the inner and outer faces of the inclined clay barrier during the construction process. The hydraulic conductivity of the inclined clay barrier was documented and certified during each phase of development by performing laboratory tests on extracted cores of the as-constructed clay barrier. Documentation is provided in the above-referenced documents.

4.2 Compliance with §257.70(a)(2)

The hydraulic conductivity of the inclined clay barrier was determined by laboratory testing in accordance with ASTM D 5084 – Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter. This is a recognized and generally accepted method for determining hydraulic conductivity of clay liners. Documentation of the use of this method is contained in the above-referenced documents.

5.0 Conclusion

Scrubber Solids Pond No. 3 at the Sherburne County Generating Plant is lined with a base liner (alternative composite liner) that complies with the requirements of 40 CFR §257.70(c), and with an inclined clay barrier that complies with the requirements of40 CFR §257.71(a)(1)(i). The documentation demonstrating that Pond 3 liners meet the requirements of §257.71(a)(1)(i) and (iii) is accurate, and Pond 3 is hereby certified as a “lined” surface impoundment.

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