FOUR CORNERS POWER PLANT
LINER DOCUMENTATION § 257.72
RETURN WATER POND (RWP)
FC_LinerDoc_013_20190513

Liner Design Criteria	Liner Documentation
§ 257.72 (a) New CCR surface impoundments and lateral expansions of existing and 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 *(b) A composite liner must consist of two components; the upper component consisting of, at a minimum, a 30-mil geomembrane liner (GM), and the lower component consisting of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1x10^{-7} centimeters per second (cm/sec). GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. The GM or upper liner component must be installed in direct and uniform contact with the compacted soil or lower liner component. The composite liner must be:* *(1) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;* *(2) Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component including on slopes;* *(3) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and* *(4) Installed to cover all surrounding earth likely to be in contact with the CCR or leachate.*	The Return Water Pond (RWP) is designed with an alternative composite liner that meets the requirements of § 257.70 (c). The alternative composite liner will be overlain by a geosynthetic drainage layer ("net") and an upper 60-mil HDPE geomembrane that work together to lower the hydraulic head acting on the alternative composite liner system. For purposes of compliance to the CCR Rule, the lower 60-mil HDPE liner and the underlining geosynthetic clay liner (GCL) comprise the "alternative composite liner" system. The upper component of the alternative composite liner is a 60-mil HDPE geomembrane. The lower component is a Cetco Resistex 200 FLW9 geosynthetic clay liner (GCL), which is a dry-blended, polymer-treated GCL with a manufacturer specification maximum hydraulic conductivity (k) of 3 x 10^{-9} cm/sec and a reported thickness (t) of 0.7 cm. Using Equation 1 in § 257.70(c)(2), the liquid flow rate (Q) was calculated as Q = 35.7 cm^3/sec for the GCL, compared to a calculated Q = 40.5 cm^3/sec for two feet of 1 x 10^{-7} cm/sec compacted soil; in the calculations, the pond surface area (A) was calculated at 6.7 acres, hydraulic conductivity (k) and thickness (t) for the GCL were obtained from manufacturer specifications, liner thickness (t) was 60.96 cm for two feet of compacted soil, and the hydraulic head (h) acting on the GCL was limited to 30 cm, which is the maximum head to be allowed by the overlying LCRS. The alternative composite liner is constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients, physical contact with CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation. The pond will have 3:1 side slopes, a gently sloping base, and a maximum depth of 13.0 feet. The configuration and application of liner materials in the RWP are well-demonstrated and conventional. When exposed to a composite leachate prepared from Four Corners CCR and FGD, the Cetco Resistex 200 FLW9 GCL component exhibited a long-term (more than 9,000 hours) hydraulic conductivity (ASTM D5887) of 7.6 x 10^{-10} cm/sec, indicating no loss of performance relative to when exposed to CCR/FGD leachate. In daily operation, the alternative composite liner system will be subjected only to hydrostatic loading and loads from workers standing on the liner during CCR muck out. The alternative composite liner is constructed of materials that provide appropriate shear resistance between the upper and lower components to prevent sliding on slopes. The HDPE is textured to increase friction between the geomembrane and the GCL; both components are anchored by an anchor trench. Sliding of the liner components is not considered to be a possible failure mechanism. The alternate composite liner is founded on a minimum 1-foot thick over-excavated layer that is compacted to at least 95% of the maximum dry density as per Standard Proctor ASTM D698. In addition, a minimum of 1-foot below the over-excavation, subgrade is scarified and compacted to at least 95% of the maximum dry density as per Standard Proctor ASTM D698. The native formation below the compacted soil is underlain by sandstone and interbedded shale. The sandstone and interbedded shale are assessed to be competent and capable of supporting the loads and stresses of pond construction and operation. The alternative composite liner covers the entire surface impoundment surface and extends beyond the top of the embankments into an anchor trench. The pond embankments include 2 feet of freeboard.
§ 257.70 (c) If the owner or operator elects to install an alternative composite liner, all of the following requirements must be met: (1) 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 1x10^{-7} cm/sec. GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. If the lower component of the alternative liner is compacted soil, the GM must be installed in direct and uniform contact with the compacted soil. (2) The owner or operator must obtain certification from a qualified professional engineer that the liquid flow rate through the lower component of the alternative composite liner is no greater than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of 1x10^{-7} cm/sec. The hydraulic conductivity for the two feet of compacted soil used in the comparison shall be no greater than 1x10^{-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 this section, which is derived from Darcy's Law for gravity flow through porous media.	

Certification Statement 40 CFR § 257.72(c) – Design of the Liner for a New CCR Surface Impoundment

CCR Unit: Arizona Public Service; Four Corners Power Plant; Return Water Pond

I, David E. Mickanen, being a Registered Professional Engineer in good standing in the State of New Mexico, 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 the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the documentation as to whether the construction of the CCR Unit meets the requirements of 40 CFR § 257.72(a) is accurate.

David E. Mickanen, P.E.
Printed Name

May 13, 2019
Date