Comments on Long-Term Structural Assessment for F-Tank Farm Facility
T-CLC-F-00421, *Structural Assessment of F-Area Tank Farm After Final Closure*[1]

Additional support is needed for the assumption of a grout monolith in the structural analysis of the grout-filled high level waste (HLW) tanks. DOE assumed that "all tanks are considered to be monoliths of grout" as a bounding assumption for estimating the "worst-case scenario" for the assessment of long-term structural integrity of the grout-filled HLW tanks. The assumption implies DOE assessment of the long-term integrity of the grout-filled tank systems is based on the structural behavior of a solid cylinder with the tank dimensions and mechanical properties of hardened grout, referred to hereafter as the "monolith". If the grout does not bond structurally with the tank system components (e.g., primary and secondary tanks, concrete vault, interior columns, and other features), the grout may increase the mass of the tank system without a commensurate effect on the structural stiffness. Accordingly, the DOE analysis could be inadequate as a bounding analysis. Based on a structural analysis (T-CLC-F-00421), DOE concluded that material degradation, seismic loads, and settlement would not cause cracking of the grout-filled waste tank in the F and H Tank Farm Performance Assessments (SRS-REG-2007-00002 and SRR-CWDA-2010-00128). Conclusions drawn from the structural analysis are risk-significant, because cracking (or a separation gap) could lead to: (i) limited conditioning of infiltrating groundwater by reducing grout due to flow through the cracks or gaps[2], (ii) more rapid corrosion of the steel liner than assumed in the PAs, and (iii) bypass flow through or around the basemat leading to significantly (1) less attenuation and (2) higher release rates of key radionuclides.

Several features, events and processes could invalidate the monolith assumption including the following: (i) grout shrinkage, and (ii) material degradation. Additionally, in DOE's (iii) seismic , and (iv) settlement analyses, the assumption that the grouted tank and vault system is a solid monolith may lead to an underestimation of the detrimental impacts associated with seismic-induced ground motion and settlement; as well as other events such as liquefaction, and calcareous zone dissolution. NRC staff provides the following comments and questions related to each of these areas:

i. Grout Shrinkage

Analyses of the grout-filled tank system based on the monolith assumption could be bounding if the grout bonds structurally with the primary tank, secondary containment shell, concrete vault, and interior columns and equipment. However, if gaps were to occur between the grout and tank-system components, such as could result if the grout undergoes net shrinkage after placement, then the grout may only contribute to the over-all mass of the tank system without commensurate effect on the stiffness. In the case where the grout is not structurally bonded, estimation of potential loss of structural integrity of the grout-filled tank system could include an analysis that considers the weight of grout but is based on the geometry and structural behavior of the non-grouted tank system.

ii. Material Degradation

It is not clear to NRC staff that the effects of steel corrosion are bounded by DOE's structural analysis in which DOE assumes the structure is a solid monolith of hardened grout. The DOE

[1] T-CLC-F-00421 is also referenced in the H-Tank Farm Facility PA and these comments and questions also apply to H-Area Tank Farm Facility.

[2] Conditioning of infiltrating groundwater to relatively high pH and low Eh due to the interaction of the groundwater with reducing grout used to fill the HLW tanks is important to maintaining low solubility of key radionuclides and is, therefore, risk-significant.

assumption appears to ignore the effects of structural gaps or cracks that could result from or increase due to corrosion of steel components or steel reinforcement. If gaps or cracks form in the grouted tank system, then the grout may only contribute to the over-all mass of the tank system without commensurate effect on the stiffness. In that case, analysis based on the DOE monolith assumption could be inadequate to bound potential undesirable structural behavior, such as cracking, of the grout-filled tank system.

In addition, the assumed compressive strength of the grout monolith might not adequately account for long-term degradation. In the structural analyses, although DOE does not take credit for reinforcing steel and assumes that the compressive strength of the grout monolith is 1800 psi. Additional support is needed for the assumption that degradation mechanisms will not cause a loss of strength resulting in a compressive strength of less than 1800 psi.

iii. Seismic Loading

It is not clear to NRC staff that DOE adequately accounts for the natural frequency of the grout-filled tank system in its conclusion that seismic ground motions will not be amplified in the system. If the grout does not bond structurally with the tank system components (e.g., primary and secondary tanks, concrete vault, and interior columns), then the grout may increase the mass of the tank system without a commensurate effect on the structural stiffness. If the grout does not bond well with the tank system components, the natural frequency of the grout-filled tank system could be significantly smaller than the natural frequency of the monolith assumed in DOE's analysis. Therefore, the analysis based on the monolith assumption could be inadequate for assessing potential amplification of seismic ground motion in the system.

It is also not clear to NRC staff that DOE adequately accounted for potential soil-structure interaction in its assumption that the surrounding soil will deform around the tank system without inducing large shear forces during seismic ground motion. The DOE assumption implies negligible shear resistance between the tank surface and surrounding soil and rigid-body natural frequency for the grout-filled tank system.

iv. Settlement

The effects of settlement from static and seismic loads, including liquefaction and soft zone settlement, on the structural integrity of the grout-filled tanks is not clear to NRC staff. The DOE assessment of potential effects of settlement is based on the assumption that the grout-filled tank system behaves as a monolith. The assumption could be inadequate to bound potential undesirable structural behavior of the tank if the interior grout were to contribute to the mass but has less effect on the stiffness of the tank system.

References

T-CLC-F-00421, Carey, S. A., *Structural Assessment of F-Area Tank Farm After Final Closure*, Savannah River Site, Aiken, SC, Rev. 0, December 18, 2007.

SRS-REG-2007-00002, *Performance Assessment for the F-Tank Farm at the Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 1, March 31, 2010.

SRR-CWDA-2010-00128, *Performance Assessment for the H-Area Tank Farm at the Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 1, November, 2012.