NRC Staff Comments on: "Industrial Wastewater Closure Module For The Liquid Waste Tanks 5F and 6F F-Area Tank Farm, Savannah River Site," SRR-CWDA-2012-00071, Revision 0, January 2013

Introduction

NRC staff offers the following public comments to SCDHEC to provide insight regarding aspects of tank cleaning, waste sampling, and characterization of residual contaminants that will be important to NRC staff in its role of monitoring DOE's ability to comply with the performance objectives of 10 CFR Part 61, in particular, the ALARA aspect of 10 CFR 61.41:

General Comments

1. The Tanks 5 and 6 closure module (SRR-CWDA-2012-00071, Rev. 0) provides a well-documented and comprehensive description of DOE efforts to retrieve waste from Type I Tanks 5 and 6 at F-Area Tank Farm facility (or FTF) to a relatively small residual heel volume.

2. NRC staff recognizes the challenges associated with the waste retrieval process particularly in light of the complex infrastructure associated with Type I tanks such as Tanks 5 and 6. Cleaning campaigns are iterative in nature with subsequent campaigns building on the existing knowledge base and previous lessons learned that are reflected in technology advancements and optimization of operational parameters over time. It was apparent from NRC staff's review, that there are numerous lessons to be learned from the Tanks 5 and 6 waste retrieval process that would likely improve the efficiency and effectiveness of future tank cleaning campaigns at FTF and H-Area Tank farm facility (HTF).

3. With regard to lessons learned from Tank 5 and 6 tank cleaning campaigns, NRC staff thinks a separate, comprehensive evaluation of (i) the effectiveness and limitations of various cleaning technologies employed during Tanks 5 and 6 waste retrieval campaigns, and (ii) alternative technologies that could be developed to overcome these limitations to facilitate future tank closures would be instructive. This would include a detailed evaluation of the following:

    a. An evaluation of the effectiveness of Submersible Mixing Pumps (SMPs) with respect to residual heel removal.
    b. A comparison of SMP efficiency and effectiveness to previously used technologies or readily available technologies.
    c. A comparison of efficiency and effectiveness of chemical sludge removal campaigns in Tanks 5 and 6, versus other tanks such as Tank 16 at the HTF.
    d. Development of lessons learned from chemical sludge removal campaigns including issues associated with oxalic acid (OA) to sludge heel ratios, OA concentrations, pH; waste agitation and mixing; OA residence times; equipment failures; and tank waste variability.
    e. An evaluation of tank waste transfer system capability and efficiency.

4. Based on NRC staff's review of the Tanks 5 and 6 closure module, DOE should consider the following prior to future tank cleaning:

   a. DOE should consider analyzing tank waste samples prior to chemical sludge removal to enable a more thorough and accurate analysis of key radionuclide[1] removal.
   b. DOE should consider conducting a more thorough analysis of operational parameters important to chemical sludge removal in the field including optimization of the quantity, rate, and characteristics of chemical additions; tank waste agitation and mixing; residence times; waste transfer technology; and waste processing.
   c. DOE should consider performing a comprehensive comparative analysis of various sluicing and waste transfer technologies to improve the effectiveness and efficiency of residual heel removal in future cleaning campaigns.
   d. DOE should continue to evaluate new and emerging technologies that may improve waste retrieval efforts in the future.

5. NRC will evaluate the arguments presented in the Tanks 5 and 6 Closure Module with respect to the costs and benefits of additional radionuclide removal within the context of the Tanks 5 and 6 Special Analysis (SRR-CWDA-2012-00106, Revision 1) and other documentation to determine the extent to which closure of Tanks 5 and 6 are consistent with as low as reasonably achievable (ALARA) requirements in 10 CFR 61.41 under Monitoring Factor 1.5 listed in NRC staff's FTF monitoring plan (ML12212a192). A separate technical review memorandum will be developed to document NRC staff's findings in this area.

<u>Detailed Comments</u>

1. SRR-CWDA-2012-00071, Rev. 0 (page 37)[2] provides details related to the effective cleaning radius of Submersible Mixing Pumps (SMPs) used to retrieve waste from Tanks 5 and 6. Prior testing indicated that the effective cleaning radius (ECR) of an SMP would be 50 feet (15 m) (M-CLC-G-00349). SRR-CWDA-2012-00071, Rev. 0 (page 75) indicates that the ECR for the SMPs is closer to 30 foot (9 m). Given the apparent underperformance of two (2) SMPs in retrieving waste from Tanks 5 and 6, DOE should provide a separate evaluation discussing whether it is cost-effective to continue to use SMPs for heel removal or if other technologies (or sets of technologies) could be more effectively deployed in the future.

   a. SMPs were expected to be an improvement over slurry pumps that had previously been used to retrieve tank waste. LWO-LWE-2007-00017 indicates that four (4) slurry pumps took six (6) hours to get the sludge level down to 1 to 2 inches (3 to 5 cm) with a water to waste ratio of 5:1. Although it was estimated that two (2) SMPs would be just as effective as four (4) slurry pumps in Type I tanks, after the SMPs were deployed it became clear that 3 to 4 SMPs were actually needed in Tanks 5 and 6 to mobilize the residual heel from all areas of the tank floors. It is not clear that

[1] NRC uses the term "key radionuclide" synonymously with the term "highly radioactive radionuclide" used in the National Defense Authorization Act for Fiscal Year 2005 (NDAA).
[2] Page numbers pertain to the Tanks 5 and 6 closure module (SRR-CWDA-2012-00071, Rev. 0) unless otherwise noted.

the SMPs out-performed the slurry pumps or if other factors contributed to underperformance of the SMPs.

b. Reference documentation indicates that a minimum liquid level of around 30-45 inches (0.8 to 1.1 m) is needed to prevent cavitation and aerosolizaton of waste during SMP operation. It would be helpful if DOE differentiated the relative effectiveness of SMPs to other types of slurry pumps for (i) bulk sludge removal, versus, (ii) residual heel removal.
c. Hydrolancing of Tank 6 is discussed briefly in SRR-CWDA-2012-00071, Rev. 0 (page 77). Additional details could be provided regarding the effectiveness (or lack thereof) of hydrolancing. If hydrolancing was relatively ineffective, DOE should indicate if hydrolancing might be improved and utilized in the future or if other sluicing technologies are available to mobilize residual heels. DOE should also indicate if improvements to the waste transfer system could be made in the future to increase the effectiveness of sluicing technologies.
d. It would be helpful for DOE to discuss what types of pumps were used in Tank 16 chemical sludge removal or other factors that may have contributed to more efficient waste retrieval in Tank 16 versus in Tanks 5 and 6.
e. SRR-CWDA-2012-00071, Rev. 0 (page 57) indicates that waste aerosolization may occur above a liquid level of 30 inches for SMPs. Because the SMPs could not be operated at lower liquid levels, ineffective mixing during acid strike 2 in Tanks 5 and 6 appears to have contributed to the formation of solids during chemical cleaning. DOE should clarify if other types of pumps are available during chemical cleaning to increase mixing and mitigate solids formation during chemical sludge removal in the future.

2. SRR-CWDA-2012-00071, Rev. 0 (page 37) indicates that the SMP installed in Riser 1 could not be lowered to the tank floor due to interference with existing cooling coils that were covered by a sludge mound at the time of installation. The cooling coil cutter was not implemented and the pump was left suspended directly above the sludge level. The SMP was later lowered to the horizontal cooling coil level (around 13 inches) to slurry the sludge after the mound under Riser 1 was mobilized to an area near Risers 3 and 5 (page 40). Although installation of the SMP under Riser 1 was credited with lowering the large mound under Riser 1 during mechanical sludge removal, the height of the SMP above the tank floor may have affected final solids accumulation following mechanical feed and bleed. LWO-LWE-2006-00128 indicates that the SMP design calls for placement 8 inches above or on the tank bottom. SRR-CWDA-2012-00071, Rev. 0 (page 59) indicates that the 16 inches between the SMP pump and the bottom of the tank during mechanical feed and bleed may be responsible for the solids accumulation under Riser 1. It would be helpful for DOE to comment on the feasibility (including the expected benefit) of cutting the cooling coils under Riser 1 to allow the pump to be lowered to the tank floor during final stages of cleaning.

3. SRR-CWDA-2012-00071, Rev. 0 (page 47) indicates that the mechanical sludge removal campaigns using SMPs in Tank 5 had been optimized to the extent practicable and a new cleaning technology, oxalic acid, was implemented to reduce the sludge volume further. It is not clear that additional waste removal would not have occurred if an SMP was installed under riser 5. It would be helpful for DOE to provide additional information regarding the practicality of installing an SMP or other pump under Riser 5 including a discussion of any related challenges. Page 152 provides only a brief

mention of the practicality of the addition of a fourth SMP including mention of financial and schedule costs and uncertain benefit. Additional details regarding the practicality of installation of a fourth SMP would be helpful.

Mechanical sludge removal campaigns in Tank 6 were accomplished with two (2) SMPs. Mounds remained under Risers 1 and 5 following the mechanical sludge removal phase due to the limited effective cleaning radius of the SMPs. A decision was made to add a third SMP to facilitate waste retrieval in Tank 5. It is not clear why an additional SMP or two SMPs were not added to Tank 6 to facilitate waste retrieval during mechanical sludge removal. SRR-CWDA-2012-00071, Rev. 0 (page 94) indicates that a third SMP was added to Tank 6 later, during mechanical feed and bleed. It would be useful if DOE could provide criteria for limiting/expanding the use of SMPs in various circumstances.

4. SRR-CWDA-2012-00071, Rev. 0 (page 47) discusses testing of oxalic acid with Tank 16 waste. This testing was the basis for DOE initial estimates that oxalic acid would be effective in removing the residual heel of tanks treated with oxalic acid in FTF to 1/16 inch (0.2 cm) or approximately 150 gallons (570 L) of waste in Type I tanks. Although volume reduction may not be a good indicator of oxalic acid effectiveness, the volume of waste prior to and following oxalic acid treatments in Tanks 5 remained relatively unchanged at around 3500 gallons (13 m^3). Although oxalic acid treatment appeared to be relatively more effective in Tank 6 compared to Tank 5 owing to a lower effective pH following the first acid strike in Tank 6, the volume remaining in Tank 6 following oxalic acid treatment was similarly around 3500 gallons (13 m^3).

WSRC-TR-2003-00401 provides information on the types of waste streams from F and H Canyons. Tank 5 and 6 waste is expected to be primarily PUREX high heat waste header (HHW), while Tank 16 waste is H-Canyon Modified (HM) waste. The high effectiveness of oxalic acid treatment in Tank 16 appears to be quite different than that for Tanks 5 and 6. DOE reasons that factors such as higher than expected pH following acid addition, extent of mixing, equipment failures, etc. may have led to less than optimal treatment of Tanks 5 and 6 waste with oxalic acid.

a. SRR-CWDA-2012-00071, Rev. 0, and supporting references refer to use of sludge simulants and cleaning demonstrations prior to Tanks 5 and 6 chemical sludge removal. It would be helpful if DOE summarized or provided references to work conducted to specifically study and optimize oxalic acid dissolution of Tanks 5 and 6 waste components including dissolution of various non-radiological and radiological constituents present in Tank 5 and 6 waste. For example, NRC obtained WSRC-STI-2007-00192 that characterizes Tank 5 waste prior to chemical treatment in an internet search.
b. If DOE intends to continue to use oxalic acid to treat tank wastes, DOE should perform additional testing of oxalic acid effectiveness in treating the specific type of waste expected to be present in tanks targeted for chemical sludge removal with oxalic acid.
c. If DOE intends to continue to use oxalic acid to treat tank wastes, DOE should continue to optimize field parameters important to oxalic acid performance. A critical evaluation of the differences in oxalic acid delivery, waste agitation, waste transfer, and other factors that led to more successful use of oxalic acid in Tank 16 compared to Tank 5 and 6 would be informative.

5. Has DOE performed additional evaluation of chemical cleaning since WSRC-TR-2003-00401 was issued? For example, WSRC-TR-2003-00401 notes (page 30) that Savannah River Technology Center (SRTC) conducted additional studies utilizing actual tank waste sludge at high cleaning solution to sludge ratios but that the work resides in draft (unissued) documents awaiting additional funding to complete. Additionally, several presentations were made at the Waste Processing Technology Exchange in Atlanta, Georgia in November 2010 related to chemical cleaning. A list of the work performed since the 2003 report or a reference summarizing this work would be helpful in understanding the state of technology advancement and potential deployment.

6. SRR-CWDA-2012-00071, Rev. 0 (page 49) discusses effectiveness of oxalic acid on removal of key radionuclides. "Unlike the MSR campaigns, heel removal with chemical techniques may selectively remove certain species. If the chemical sludge removal (CSR) campaigns removed only inert material and left the radionuclides behind it would not be beneficial to waste removal. As a result of the testing in 1977, it was found that Strontium-90 dissolved in OA at about the same rate as sludge. This was important because Strontium-90 made up a large percentage of the radioactivity in the sludge. Testing also showed that Plutonium-239 was largely insoluble in the sludge, but small sample sizes made this testing difficult." WSRC-TR-2003-00401 cites results from the Tank 16 demonstration study (DPSP-80-17-23) that found that Sr-90 concentrations in the residual heel following chemical cleaning were 3 times higher than the original sludge prior to chemical cleaning (Pu-239 concentrations were 2 times higher).

   a. Did DOE evaluate the concentrations of key radionuclides in residual sludge directly prior to and following chemical cleaning to provide a more accurate estimate of the effectiveness of oxalic acid treatment in removing individual key radionuclides? Note: NRC staff is aware of the mass balance estimates provided in SRNL-STI-2009-00492 that is based on process samples (liquid waste transfers from Tank 6 and a single solid sample from Tank 5) taken during and following chemical sludge removal.
   b. SRR-CWDA-2012-00071, Rev. 0 (page 53) discusses removal estimates based on process sampling results from SRNL-STI-2009-00492; however, the estimates are expected to be fairly uncertain. Does DOE have plans to sample tanks prior to chemical cleaning in the future to provide better estimates chemical sludge removal effectiveness and removal efficiencies?

7. SRR-CWDA-2012-00071, Rev. 0 (page 50) discusses the addition of well water and oxalic acid in Tank 5. An equivalent of 4 weight percent oxalic acid was used in lieu of the WSRC-TR-2003-00401 recommended 8 weight percent. A lower weight percent resulted from use of additional water to ensure a sufficient liquid level for SMP operation while maintaining an acid to sludge ratio less than 20:1 as required by the operating plan. The quantity of water added to the tank is thought to have resulted in a less than optimal pH and chemical treatment campaign. It would be helpful for DOE to comment on whether it would be feasible to use another pumping technology with less stringent liquid level constraints or if the acid to heel ratio could be increased in future cleaning campaigns.

8. With regard to chemical cleaning of Tank 5, it is not clear why the SMP in Riser 1 was not run after the first chemical strike (SRR-CWDA-2012-00071, Rev. 0, page 50). LWO-

LWE-2008-00227 indicates that the SMP associated with Riser 1 was not electrically connected during chemical cleaning, but no further explanation is provided.

9. SRR-CWDA-2012-00071, Rev. 0 (page 52) discusses chemical sludge removal campaign 2 in Tank 5.

   a. The basis for the 13:1 oxalic acid to heel ratio used in campaign 2 in lieu of the 20:1 ratio used in campaign 1 is not clear. U-ESR-F-00024 provides the operational plan for Tank 5 chemical sludge removal but a basis for the lower ratio of oxalic acid to heel volume does not appear to be provided in this reference.
   b. It is not clear why the operating plan (U-ESR-F-00024) calls for no SMP mixing in campaign 2. If it is due to lower liquid level in campaign 2 that prevented SMP operation, are other pumps available to handle lower liquid levels or could liquid additions be made to the tank to allow SMP operation, if needed?
   c. It is not clear from the closure module why the heel was soaked for 54 days with oxalic acid prior to transfer to Tank 7. LWO-LWE-2008-00428, Rev. 2 (page 5) indicates that equipment failure in Tank 7 delayed the transfer. It would be helpful for DOE to provide details regarding the equipment failure in Tank 7 in the closure module. It would also be helpful with respect to future planning if DOE could comment on whether contingencies could be put in place to handle equipment failures that might compromise the effectiveness of cleaning campaigns in the future.
   d. It would be helpful for DOE to comment on whether it would be feasible to make adjustments to the operating plan for chemical sludge removal when campaigns are less effective than anticipated (e.g., much less than the expected 70 percent waste removal estimate was achieved after oxalic acid strike 1 in Tank 5 but no adjustments appear to have been made in subsequent strikes). A discussion of DOE's use of contingency plans to handle equipment failures and other potential problems that might arise would be helpful.

10. SRR-CWDA-2012-00071, Rev. 0 (page 116) discusses characterization of cooling coils. Residual inventory is based on surface area of the cooling coils (SRR-CWDA-2012-0002) and analysis of two discrete samples taken from the tanks. NRC is concerned that the samples used to estimate the inventory of the cooling coils may not be representative of the 4 miles of cooling coils estimated to be present in the tanks. If sludge build-up occurs or is otherwise concentrated on certain discrete sections of the cooling coils that are not represented in the sampling, then the cooling coil inventory may be significantly underestimated. WSRC-TR-2003-00401 discusses treatment of cooling coils with oxalic acid coated with sludge and presents dose rate information for samples taken from Tank 16. It is not clear how the samples taken from Tank 5 compare to the samples taken from Tank 16. Similarly, it is not clear how DOE confirms that no sludge build-up exists on the miles of cooling coils present in the tanks. It would be helpful if DOE could provide additional detail regarding the effectiveness of oxalic acid washing or other technologies used to remove residual waste from cooling coils and how it confirms the effectiveness of deployment of these technologies. This should include a discussion on how DOE confirms damaged cooling coils are effectively cleaned to remove residual sludge that may be contained within the damaged cooling coils.

Clarifying Comments

1. SRR-CWDA-2012-00071, Rev. 0 (page 41) discusses the effectiveness of a 3rd SMP installed under Riser 1 in MSR Campaign 4 and 5. It is not clear why the addition of the 3rd SMP under Riser 1 was not as effective in MSR Campaign 3 and suddenly became effective essentially in MSR Campaign 5 (Campaign 4 was curtailed due to a tornado watch). See figure below. It would be helpful for DOE to comment on the uncertainty in the heel estimates and if the uncertainty could partially explain the relative effectiveness of MSR Campaign 5 compared to Campaign 3. Any additional insights on the increased effectiveness of Campaign 5 compared to Campaign 3 would be helpful.

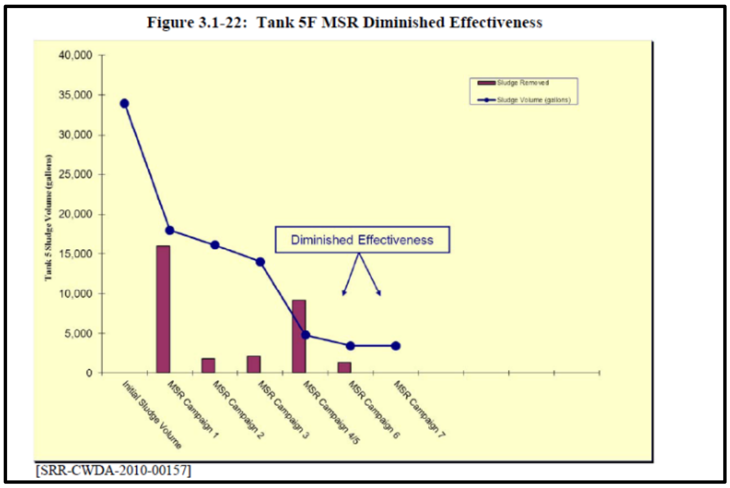

Figure 3.1-32 (page 46) of SRR-CWDA-2012-00071, Rev. 0.

2. SRR-CWDA-2012-00071, Rev. 0 (page 50, Figure 3.1-26), illustrates oxalic acid treatment steps. The criteria for SMP mixing is not clear. A footnote indicates that SMP mixing will occur, if planned. If mixing is not planned, steps that discuss mixing will be skipped. When is SMP mixing planned?

3. Recommendations are provided in SRNL-STI-2009-00492 and SRNL-STI-2009-00493 related to chemical sludge removal in Tanks 5 and 6 including the need for sludge washing to lower ionic strength prior to acid strikes. It is not clear how the efforts to dilute the sludge prior to oxalic acid addition in Tanks 5 and 6 differ from the recommendations in the SRNL reports.

4. SRR-CWDA-2012-00071, Rev. 0 (page 105) discusses annular cleaning of Tank 6. Similar activities were not performed in Tank 5 due to the significantly lower levels of contamination. It is not clear what quantity of annular contamination warrants cleaning.