NRC Staff Comments on: "Industrial Wastewater Closure Module for the Liquid Waste Tank 16 H-Area Tank Farm, Savannah River Site," SRR-CWDA-2013-00091, Revision 0, February 2015,

Introduction

NRC staff offers the following public comments to SCDHEC to provide insight regarding aspects of waste retrieval operations, inventory development, and assessment of risk associated with residual waste remaining in the tank and annulus of Tank 16H at the time of closure. NRC staff considers these important to the assessment of compliance with the performance objectives in 10 CFR Part 61, Subpart C, including the as low as is reasonably achievable (ALARA) aspects of 10 CFR 61.41.

It is important to note that NRC staff evaluates DOE's Closure Module conclusions that support the 10 CFR 61.41 ALARA requirements within the context of the Tank 16H Special Analysis (SRR-CWDA-2014-00106), because the Tank 16H Special Analysis provides final risk estimates that are important to understanding the benefits of additional radionuclide removal. The NRC staff's review of the Tank 16H Special Analysis is conducted under Monitoring Factor 1.1 "Final Inventory and Risk Estimates" listed in NRC staff's monitoring plan (ML12212A192). NRC staff's Tank 16 Special Analysis review findings will be documented in a technical review report to be issued later in fiscal year 2015. The NRC staff's review and conclusions with respect to the 10 CFR 61.41 ALARA requirement is conducted under Monitoring Factor 1.5, "Waste Removal (As it Impacts ALARA)" listed in NRC staff's monitoring plan (ML12212A192). Results of NRC staff's review of DOE's ALARA demonstration may be discussed in a future onsite observation or documented in a separate technical review report.

The NRC staff recognizes the unique characteristics of Tank 16H primary tank and annulus waste. For example, the extent of primary tank leakage into the Tank 16H annulus and subsequent sandblasting to inspect the tank liner is unique. The addition of sand into the annulus leaving behind what DOE describes as less soluble sodium aluminosilicate compounds may have made it more difficult to remove waste from the annulus. Within the tank itself, DOE indicates that it performed multiple cleaning campaigns on Tank 16H with the intent of providing data and experience to evaluate various cleaning technologies as opposed to expediting waste removal.

Waste residing within the primary Tank 16H seems to have been very effectively cleaned; much more than other tanks. DOE indicates this is due to removal of the sludge when it was relatively young, but this may provide insight into more effective ways to treat the waste to allow better cleaning in other tanks. Some of NRC staff's questions and comments on the Closure Module are based on that concept. On the other hand, waste remaining in the annulus from primary tank leakage appears to have been more problematic to remove and therefore, NRC staff offers several questions and comments related to the final inventory and risk estimates primarily focused on revised waste volume estimates.

General Comments

1. Lessons Learned from Cleaning Effectiveness of Tank 16H Primary Tank

Although not a concern for Tank 16H, NRC staff provided comments on the Tanks 5 and 6 Closure Module (ML13081A051) with regard to the differences in level of waste retrieval achieved in the primary tank of Tank 16H versus other tanks that have been cleaned to date (e.g., Tank 5, 6, 18 and 19). Although DOE made a reasonable attempt to address the general comment about differences in level of waste retrieval achieved in the various tanks that have been cleaned to date, only general observations were provided. For example, the Closure Module indicates that physical and chemical changes occur in the settled sludge over time that make it more difficult to suspend; however it is not clear if this observation is supported with any specific data from waste characterization, testing, or other analysis. The Closure Module goes on to state that more recent safety measures have led to a decrease in the effectiveness of technologies used to retrieve waste from the tanks. However, it is not clear what changes have been made to technologies or what safety measures have been employed that have led to a reduction in the effectiveness of waste retrieval operations at other tanks versus Tank 16H. Additional information related to physical and chemical characteristics of fresh versus aged waste, as well as differences in the characteristics of various tank farm waste streams, would be helpful to NRC staff in better understanding the costs associated with additional waste retrieval. Furthermore, additional information related to changes in technologies or safety measures employed that led to less effective waste removal over time, would be helpful to NRC staff in better understanding the differences in waste retrieval for Tank 16H versus other tanks that have been cleaned or that will be cleaned in the future. Finally, any lessons learned from previous experience that could be used to improve waste retrieval in the future would be beneficial in demonstrating compliance with ALARA criteria in 10 CFR 61.41.

2. Comments Related the Cleaning of the Tank 16H Primary Tank

The Closure Module summarizes the cleaning campaigns to remove residual sludge from Tank 16H. It appears from the volume estimates provided that the four chemical removal campaigns were marginally effective at removing waste from the tanks (i.e., 5,250 gallons of residual sludge remained at the start and approximately 3,680 gallons remained at the end of oxalic acid treatment). On the other hand, DOE indicates that after the final rinse in Tank 16H that the remaining volume was reduced from 3,680 gallons (after oxalic acid treatments) to 330 gallons - a value significantly lower than residual volumes remaining in other tanks following cleaning to date and significantly lower than the volume remaining following chemical cleaning of Tank 16H. Because volume estimates may not provide the most accurate information on the effectiveness of oxalic acid effectiveness, does DOE have any additional information (e.g., waste sample analysis before and after chemical cleaning) that would help evaluate the effectiveness of the oxalic acid strikes? Could DOE explain if the use of oxalic acid altered the physical characteristics of the waste to make it more

<u>amenable to removal in the final rinse, and/or if use of the slurry pumps (SLPs), operational parameters, or extent of the final rinse are responsible for the significantly reduced final volume (high final removal rates)? If DOE thinks that the physical properties of the relatively fresh Tank 16H waste made it more amenable to waste removal in the final rinse, could DOE provide supporting information such as the rheological or other characteristics of the waste that differ from other tanks' waste that made it more amenable to waste retrieval?</u>

3. ***<u>Comments Related to the Costs and Benefits of Additional Radionuclide Removal from the Tank 16H Annulus</u>***

As will be described in greater detail in a technical review report related to NRC staff's review of the Tank 16H Special Analysis, NRC staff does not think that DOE has adequately evaluated the potential risk associated with Tank 16H waste, particularly waste located in the annulus of Tank 16H. <u>Therefore, the benefits of additional radionuclide removal may be underestimated.</u>

With regard to the costs associated with additional radionuclide removal, the Closure Module indicates when discussing the mechanical cleaning options for the annulus that "The project team proposed that the dry retrieval approach could reduce environmental risks (from process leakage) and…" <u>Could DOE explain if release of waste into the environment was a concern for Tank 16H and, therefore, a basis for not implementing additional technologies to remove waste? If leakage into the environment is a risk, then the Closure Module should be clear to indicate the risk, as it would be a significant factor in DOE's demonstration of removal to the maximum extent practical (i.e., release of radioactivity to the environment would be a major cost of ceasing additional waste removal and should be factored into the cost-benefit analysis).</u>

4. ***<u>Comments Related to Tank 16H Annulus Radionuclide Sampling and Analysis</u>***

The Closure Module indicates that, in order to address the uncertainty associated with the final annulus residual volume estimate, the individual sample proportions used for the composite samples were varied based on the volumetric uncertainty. <u>Could DOE clarify the individual sample proportions used for the composite samples, including a discussion of volume uncertainty and effect on inventory estimates? Considering that the total volume was revised from 3,300 gallons to 1,900 gallons, were the individual sample proportions for compositing derived from the depth information for the 3,300 gallon estimate or the new depth information for the revised 1,900 gallon estimate?</u>

5. ***<u>Comments Related Final Volume Estimates of the Tank 16H Annulus</u>***

The volume estimate for Tank 16H in the H-Area Tank Farm Performance Assessment was 3,300 gallons (SRR-LWE-2012-00039), which was revised to be 1,900 gallons (U-ESR-H-00113). The 3,300 gallons was informed by the four samples taken from the annulus in 2011 in addition to visual observation. The volume reduction of about 42% is stated to be a result of new information gained from the 2013 sampling effort (5 samples from annulus and 6 samples from the duct), as well as new photographs taken in 2013. Based on NRC staff's detailed review of the Closure Module and associated references, documentation could be more transparent on how the revised volume was determined. NRC staff offers several detailed comments related to (1) the sampling method used to determine material heights, (2) the use of photographic evidence and landmarks to assign material heights, and (3) interpolation method used to assign material heights in areas where no sample or visual observations are available.

Attachment 1 contains NRC staff's detailed comments related to technology selection, technology effectiveness, costs and benefits of additional radionuclide removal, and inventory development. NRC staff plan to discuss these comments with the U.S. Department of Energy during a future teleconference and/or onsite observation visit. NRC staff is providing SC DHEC these comments to support the general comments above that summarize our more detailed comments provided in the attachment.

ATTACHMENT 1

1. **<u>Lessons Learned from Cleaning Effectiveness of Tank 16H Primary Tank</u>**

1.1 DOE makes a reasonable attempt to address an NRC comment on the Tanks 5 and 6 Closure Module (ML13081A051) with regard to the differences in success of waste retrieval operations in the primary tank of Tank 16H versus other tanks. However, additional detail would be helpful. The Closure Module (page 23) draws a distinction between waste retrieval operations at Tank 16H and other tanks:

> "The Tank 16H waste removal may have been more successful than waste removals recently performed in other tanks because the sludge removal was started relatively quickly. For example, sludge removal from Tank 12H was performed 34 years after the last waste receipt; a dormant period five times longer than what elapsed in Tank 16H. <u>Experience</u> has shown that if more time is allowed for physical and chemical changes to occur in settled sludge, the more difficult it [*the sludge*] will be to suspend."

- o *Could DOE describe in more detail the physical and chemical changes that occur in aged, settled sludge that makes it more difficult to suspend?*
- o *Could DOE elaborate on its <u>experience</u> that shows that aged waste is more difficult to remove than fresh waste?*
- o *Could DOE offer any lessons learned or operational approaches that can be taken in the future to make the waste more amenable to retrieval at the time of closure based on its previous experience?*
- o *Would X-Ray Diffraction (XRD) and Scanning Electron Microscopy and Energy Dispersive Spectroscopy (SEM/EDAX) analysis of the recalcitrant sludge in other tanks give indications of changes that take place with aging that seem to make the materials resistant to removal?*

1.2 DOE indicates in the Closure Module (page 23) that more recent safety measures have led to a decrease in the effectiveness of technologies used to retrieve waste from the tanks,

> "In addition, because Tank 16H waste removal efforts were performed more than 30 years ago, many of the current safeguards related to nuclear safety, such as preventing waste aerosolization, were either not in place or were not as restrictive at that time. These safeguards have been established or modified over time as new information on waste characteristics has evolved and lessons learned from throughout the nuclear industry have been implemented. Therefore, the extraordinary success described in Section 3.1 for the primary tank cleaning may not be indicative, or possible for future waste removal efforts on other tanks."

- *Could DOE provide more specific information on the differences in operational parameters or types of technologies used during Tank 16H waste retrieval that led to more effective waste retrieval?*
- *Could DOE provide more specific information on how the implementation of additional safety measures lead to less effective waste removal over time?*

1.3 Also, the quote above states that certain safeguards, such as preventing waste aerosolization, were put in place to help protect workers. In describing worker doses from sluicing of annular waste, the Closure Module indicates (page 50):

> "The demonstration was also used to provide sufficient information to establish an estimated project dose projection for the workers executing the activities. Assuming no adverse incidents or unexpected releases, the total job would be approximately 14 person-rem, or approximately 10 mrem/hour per worker. [SRR-RPE-2013-00003]."

The reference SRR-RPE-2013-00003 provides a breakdown of the dose estimates for each activity required over each Riser or Inspection Port. However, SRR-RPE-2013-00003 does not contain information on the impact of waste aerosolization on worker dose.

- *Does DOE have specific information on the impact of aerosolization of the waste on worker dose/risk (e.g., information on worker doses when waste aerosolization controls were in place versus worker doses when waste aerosolization was not controlled and may have contributed to worker dose)?*
- *Could DOE otherwise provide information on the expected reduction in risk/dose to workers as a result of safety measures employed that reduced waste retrieval effectiveness to show how reduction in worker risk/dose offsets the potential increase in long-term risk/dose to members of the public in the future?*

2. <u>Detailed Comments Related to Removal Effectiveness of Technologies during Cleaning of the Primary Tank</u>

2.1 The Closure Module (page 37) states that during Chemical Sludge removal Campaign 2:

> "12,600 gallons of 4 wt% OA heated to 90°C were pumped directly to the Tank 16H primary tank floor to dissolve residual sludge, so that the activity removed from the sludge could be distinguished from activity removed from the coils and waste tank walls later by other acid sprays."

There does not seem to be an estimate of the sludge removed from the tank floor versus the coils.

- *Did DOE attempt to estimate the sludge removed from the tank floor versus the coils as described?*

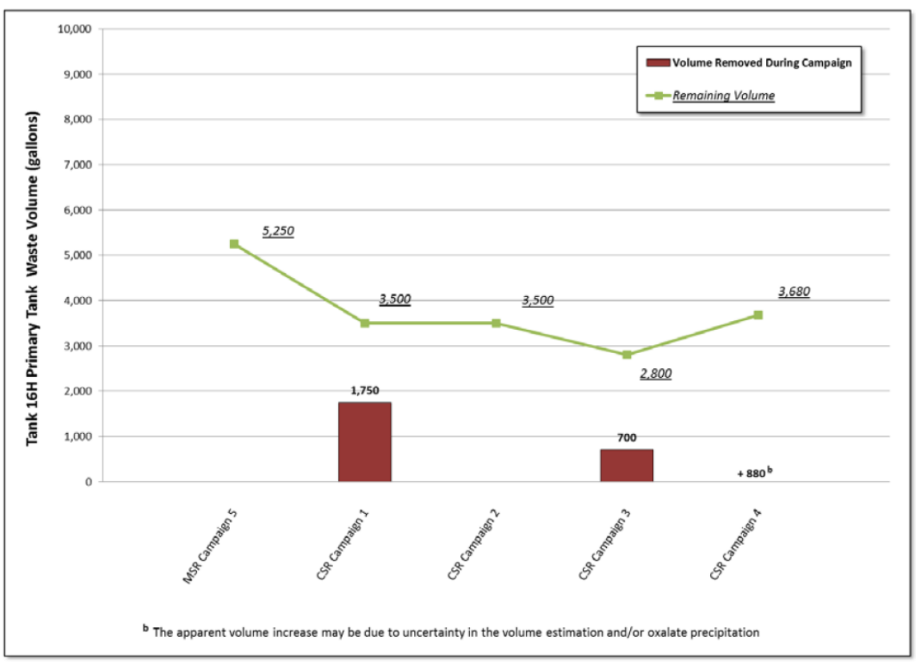
2.2 The Closure Module summarizes the cleaning campaigns to remove residual sludge from Tank 16H. The volume estimates provided suggest that the four chemical cleaning campaigns were marginally effective at removing waste from the tanks in comparison to the final rinse. From page 38:

> "The four CSR campaigns reduced the estimated residual heel volume in Tank 16H from approximately 5,250 gallons to approximately 3,680 gallons. [DPSP-80-17-23]"

Because of the uncertainty in volume estimates and the possible formation of oxalates leading to increases in volume, it is not clear that the volume estimates provided are a good indication of the effectiveness of oxalic acid (i.e., perhaps oxalic acid effectiveness is greater than the volume estimates suggest).

- *Does DOE have additional data to estimate the inventory before and after oxalic acid campaigns to provide a more informative evaluation of oxalic acid effectiveness (e.g., radionuclide concentration data before and after oxalic acid treatment)?*

Figure 3.1-12: Summary of Tank 16H Waste Removal During the CSR Campaigns



2.3 DPSP-80-17-23 describes various data that was collected between campaigns such as gamma radiation profiles using a probe, three samples taken after each campaign step, sections of a cooling water coil pipe which were measured for radiation intensity, heat measurements, and analysis of residue deposited in a sample pan after the water rinse. However, these data are not discussed in the Closure Module.

- *It would be helpful if DOE could also analyze the results of other data collection listed in DPSP-80-17-23 in the Closure Module to provide a more informative evaluation of the effectiveness of oxalic acid cleaning.*

2.4 DOE indicates that after the final SLP rinse in Tank 16H that the remaining volume was reduced from 3,680 gallons (after oxalic acid treatments) to 330 gallons - a value significantly lower than residual volumes remaining in other tanks following cleaning to date and significantly lower than the volume remaining following chemical cleaning of Tank 16H. The final rinse was described on page 40 as follows:

> "In August 1980, 34,000 gallons of 90°C heated water were sprayed through the four rotary sprayers remaining in Risers 1, 3, 4, and 7 and 22,000 gallons of 90°C heated water were sprayed through Riser 8. The SLPs were turned on and the pump in Riser 8 was indexed toward the mound that was observed after CSR Campaign 4. After four days of mixing, a sludge-slurry of 195,000 gallons was transferred to Tank 15H. An additional 56,000 gallons of water at 25° C were passed through the rotary spray jets to enable the SLPs to continue suspending the fast-settling sludge particles during the transfer [DPSP-80-17-23]".

- *Could DOE explain if the use of oxalic acid altered the physical characteristics of the waste to make it more amenable to removal in the final rinse, or if the final rinse is responsible for significantly reduced volume, or if, more specifically, the type of pump or method of operation of the pumps was responsible for the high removal rates from Tank 16H? If DOE thinks that the physical properties of the relatively fresh Tank 16H waste made it more amenable to waste removal, could DOE provide supporting information such as the rheological or other characteristics of the waste that differ from other tanks wastes?*

3. <u>Detailed Comments Related to Costs and Benefits of Additional Radionuclide Removal from Tank 16H Annulus</u>

3.1 The Closure Module, page 46, indicates when discussing the mechanical cleaning options for the annulus that "The project team proposed that the dry retrieval approach could reduce environmental risks (from process leakage) and…"

- *Could DOE explain if release of waste into the environment was a concern for Tank 16H and, therefore, a basis for not implementing additional technologies to remove waste? What efforts has DOE taken to identify the integrity of the secondary steel liner? An in-tact secondary liner is necessary to allow the addition of a significant volume of liquid to the annulus to remove additional waste. If leakage into the environment is a risk, then the Closure Module should be clear to indicate the risk, as it would be a significant factor in DOE's* *demonstration of removal to the maximum extent practical (i.e., release of radioactivity to the environment would be a major cost of ceasing additional waste removal and should be factored into the cost-benefit analysis).*

3.2 In describing hurdles associated with oxalic acid treatment of the annulus waste, the Closure Module (page 48) indicates:

"The SRNL analysis results for OA cleaning showed that the solids remaining after drying were sticky and formed large clumps. [SRNL-STI-2012-00178] This could pose potential processing problems with transferring and storing the material. The formation of a gel using 4 wt% OA for cleaning was also identified in 1980. [DPST-80-377] This issue would require resolution and testing before implementing OA cleaning. Furthermore, a preliminary documented safety analysis evaluation showed that adding OA to the annulus would present additional safety concerns and would require safety basis modifications that involve hazards assessments, expanded project safety documentation, readiness assessments, and a nuclear criticality safety evaluation." The Closure Module (page 49) also states, "…chemical cleaning using OA was discounted as an option because of the technology development hurdles and safety basis modifications needed to make it viable."

- *Could DOE provide the preliminary documented safety analysis evaluation and describe in more detail the specific safety concerns associated with use of oxalic acid in the annulus?*

3.3 In describing the costs and benefits of additional waste removal associated with Tank 16H, the Closure Module indicates on page 50:

"The HTF PA projected that the Tank 16H remaining waste contributed a small, nearly inconsequential, dose to a hypothetical future member of the public (MOP) (less than 0.2 mrem/year total effective dose equivalent [TEDE]). Therefore, implementation of the above strategy, with an expected efficiency of less than 50%, and an estimated 14 person-rem job dose would result in a projected dose reduction of less than 0.1 mrem/year."

- *As will be described in greater detail in a technical review report related to NRC staff's review of the Tank 16H Special Analysis, NRC staff does not think that DOE has adequately evaluated the potential risk associated with Tank 16H waste, particularly waste located in the annulus of Tank 16H. Therefore, the benefits of additional radionuclide removal may be underestimated.*

4. Detailed Comments Related to Tank 16H Annulus Radionuclide Sampling and Analysis

4.1 The Closure Module describes discrete samples in the primary tank and compositing of annulus samples for analysis and provides Figure 4.2-6 to illustrate sample locations (page 70). Page 72, Table 4.2-4, indicates that the samples were not composited within segments. Comments regarding intra-segment compositing made in the Tanks 5 and 6 inventory technical review report (ML13085A291) may not have been issued in time to be considered for Tank 16H sampling but should be considered in the future. The comments are quoted below:

> "With respect to segment variability, it is not clear why DOE does not pursue the option to composite within segments to preserve information on intra-segment variability. DOE analyzes three composite samples in triplicate for a total of nine analyses. DOE could obtain a subset of the total number of samples taken from each segment (e.g., set of two or three samples from a total of five or six samples taken from a particular segment) for composite analysis. This activity could be repeated three times to obtain sufficient data to perform a statistical analysis of intra-segment variability. This approach would serve to preserve information on individual segments that is currently lost in the current compositing scheme in which samples from the entire tank are composited for analysis. While additional compositing of segment samples or the need for additional segment samples to support segment compositing may incur additional costs, the same number of composites could undergo separations and analysis that may represent the bulk of the costs. The costs and benefits of intra-segment compositing should be evaluated. Intra-segment compositing could also be used to address any future NRC concerns regarding the extent to which accumulated mounds are different than other residual waste or differences in the effectiveness of chemical treatment within a mound."

4.2 The Closure Module describes the evaluation of six potential sampling strategies for Tank 16H on page 62:

> "The evaluation used the available information on the residual material distributions (segments) and volumes in the tank primary and annulus, accessibility for sampling, the SRNL statistical evaluation of the uncertainty associated with each sampling option, and applicability of the sampling options. [SRR-CWDA-2013-00035]"

On the May 16, 2013 teleconference during consultation, the NRC staff inquired about the basis for intra-segment compositing of samples in the annulus. The NRC staff asked DOE to clarify the basis for compositing from the various populations and to describe how the decision to combine samples from different populations impacts the 95th percentile Upper Confidence Limit (UCL95). DOE indicated that the UCL95 was not adversely impacted with the compositing approach. The reference SRR-CWDA-2013-00035 describes the impacts on the UCL95 for the mean concentration for the six options stating, "these evaluations assumed a 10% measurement standard deviation, and a spatial variance 50% of the true mean concentration". SRR-CWDA-2013-00035 also states that the calculations assumed "no significant variation among composite samples relative to measurement uncertainty”. It is not clear that SRNL-STI-2014-000321 addresses the issue raised in the Tanks 5 and 6 TRR.

- *Could DOE describe how the assumptions in SRNL-STI-2014-000321 used in calculating the expected UCL of the six options take into account the available information on the residual material distributions (three segments) and their differing material characteristics?*

4.3 Figure 4.2-6 shows six samples were taken from inside the duct and five samples from outside the duct. The Closure Module on page 71 explains that:

> “SRNL had retained custody of excess material remaining from the analysis of the four (4) annulus process samples collected in 2011….Therefore, only 11 new samples were planned in the annulus.”

The assignment of the 2011 samples into the three composite samples is described in Table 4.2-4. The depth measurements taken for volume estimation indicate that there is variability in the depth of the waste in the annulus as well as inside the duct. The Closure Module (on page 71 states:

> “Using the methodology described in the LWTRSAPP, the annulus sample densities and segment volumes were used to develop the sample compositing instructions to create the analytical samples. To address the uncertainty associated with the final annulus residual volume estimate, the individual sample proportions used for the composite samples were varied based on the volumetric uncertainty. Thus the analytical results reflected the volumetric uncertainty as well as the measurement, sampling, and material uncertainties. This compositing method was reviewed and supported by statistical experts in the Applied Computational and Statistics Group at SRNL. [SRNL-STI-2011-00323] The analytical results for the three composite samples allowed the overall uncertainty to be reflected in the confidence limits on the mean concentrations.”

- *Neither SRNL-STI-2011-00323 nor the LWTRSAPP, nor the Tank 16H Residual Sample Analysis Report (SRNL-STI-2014-00321, Revision 1) indicates the individual sample proportions used for the composite samples. Could DOE clarify which reference contains this information, including discussion of volume uncertainty and effect on inventory estimates? Considering that the total volume was revised from 3,300 gallons to 1,900 gallons, were the individual sample proportions for composting derived from the depth information for the 3,300 gallon estimate or the new depth information for the revised 1,900 gallon estimate?*

5. <u>Detailed Comments Related to Final Volume Estimate of the Tank 16H Annulus</u>

5.1 The Closure Module (page 60) discusses the annulus residuals volume determination. U-ESR-H-00113 “Tank 16 Final Residual Solids Determination and Uncertainty Estimate” summarizes the revised volume estimate for the Tank 16H annulus.

- *This document thoroughly describes the conceptual geometry assumptions, equations, and calculations used to come up with the final volume estimate from the individual height assignments. However, it could better describe the rationale behind the individual height estimates at the Stations, especially where measurements were not taken and visual landmarks are used. It could also better describe the uncertainty associated with the measured heights.*

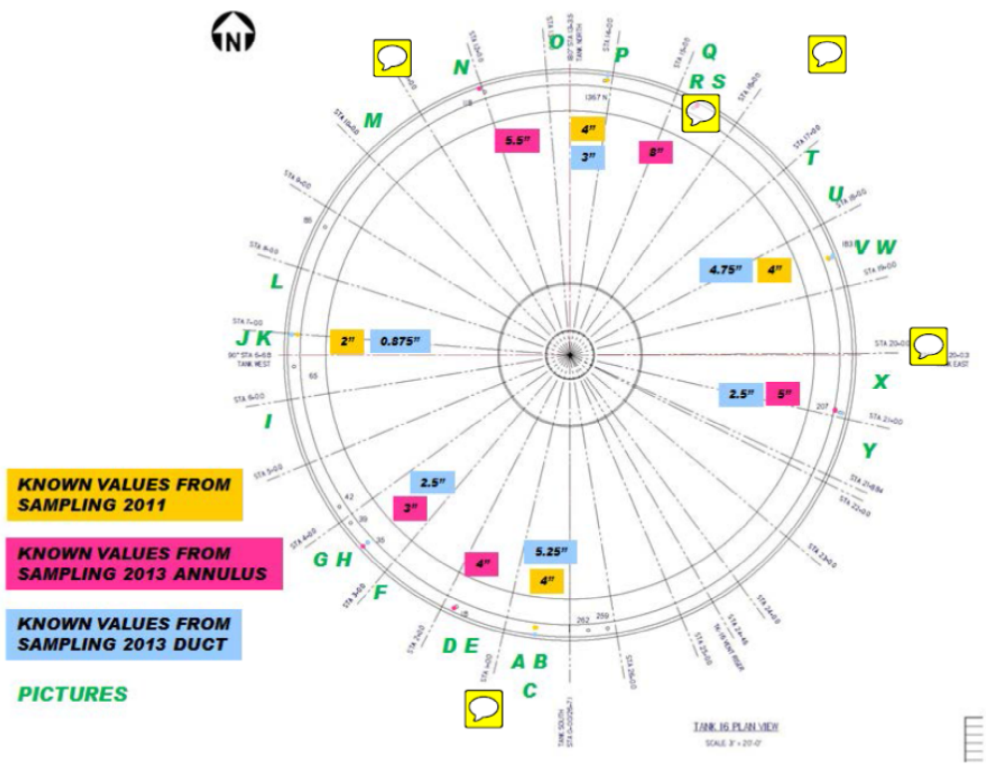
<u>Detailed Comments on the Use of Visual Observation to Estimate Waste Height</u>

5.2 The volume estimate in the Performance Assessment was 3,300 gallons (SRR-LWE-2012-00039), which was revised to be 1,900 gallons (U-ESR-H-00113). The 3,300 gallons was informed by the four samples taken from the annulus in 2011 in addition to visual observation. This reduction of about 42% is stated to be a result of the new information gained from the 2013 sampling effort (5 samples from annulus and 6 samples from the duct), as well as new photographs taken in 2013. Given the reduction in the revised estimate, one might expect all the *measured* sample height levels from 2013 to be lower than the *measured* heights from the samples in 2011, but this is not the case. As seen in the Figure A12-1: Annulus Sample Locations and Image Locations (SRR-LWE-2012-00039), some of the measured heights in 2013 were lower and some were higher. The overall estimate is lower, in part, because many of the *visual observation* heights that were assumed for the 3,300 gallon estimate were replaced by lower assumptions. In comparing the Figure from 2013 to that documenting the sampling from 2011, one can see that many of the visual observations are from the same locations. The Closure Module (page 60) states, “Video footage and photographs taken during the sampling were also used to estimate the waste thickness at other locations using visual landmarks (Table 4.1-2).” However, it does not appear that photographs presented in SRR-LWE-2014-00151 are used in all cases to assign waste heights.

- *The documentation in the Closure Module could better explain why many of the visual observations from 2011-2012 were replaced with new assumptions. It seems that the photo technology would not have changed much from 2011 to 2013 to yield such different results. The differences between the use of landmarks or visual assumptions applied in SRR-LWE-2012-00039 versus U-ESR-H-00113 could be better explained.* Specific examples are also provided in the following comments.

20. Attachment 12 – Annulus Sampling

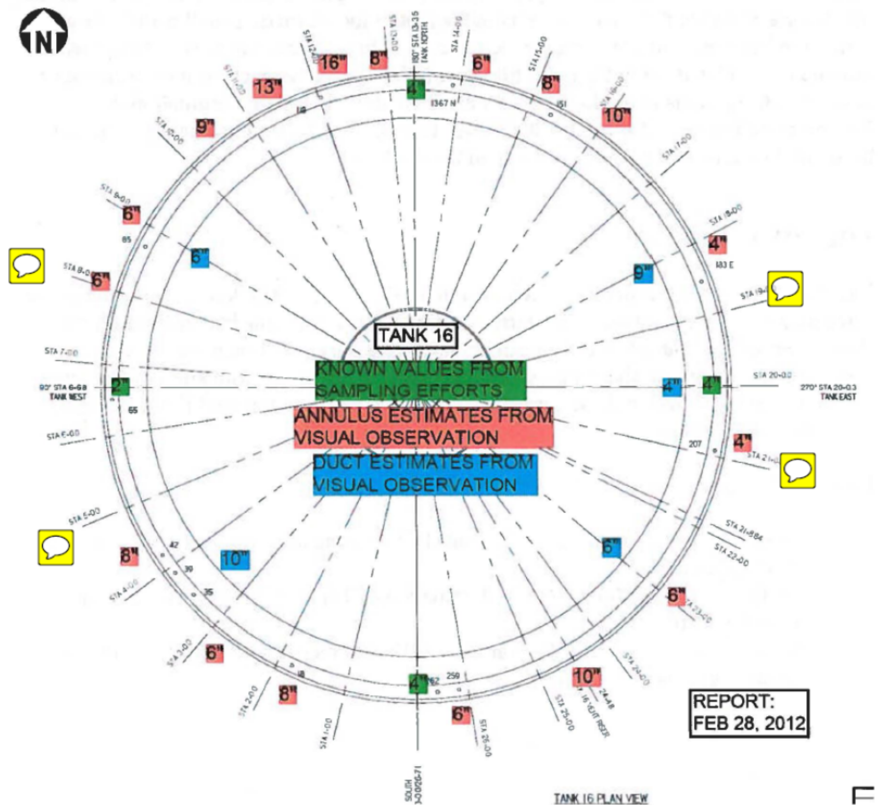
Figure A12-1: Annulus Sample Locations and Image Locations



Estimation of the Waste Material in the Tank 16 Annulus Following Sampling in November 2011

SRR-LWE-2012-00039
February 28, 2012

ATTACHMENT 1 – WASTE LEVEL ESTIMATES



5.3 DOE collected photos (near Stations 2, 3, 8, and 10 in both 2011 and 2013 and the depth estimates for waste outside the duct for these stations were reduced by about 50 percent in these locations.

- *In general, the potential discrepancies between the measurements and what is observed in the photos using the landmarks could be better addressed. For example, it would be helpful if the photographs from similar locations from both 2011 and 2013 could be analyzed side by side, with the landmarks and depth assumptions clearly labeled. Information available from the measured samples could be discussed in terms of how it relates to the landmarks in each of the photos with any ambiguous or conflicting observations explained. Could DOE explain the visual evidence that supports the reduction in height for waste outside the duct near Stations 2, 3, 8, and 10?*

5.4 It does not appear that photographs in SRR-LWE-2014-00151 are consistently used to assign waste heights when no sampling data is available for waste located inside the Tank 16H annulus duct. In reviewing the photo near Station 8+00 (Photo L in SRR-LWE-2014-00151, Rev 0), the waste inside the duct can be seen through the register. The duct diameter in this picture is 12 inches and it appears as if the waste in the duct may be at the same height as the waste outside of the duct. However, the 2013 estimate for the waste inside the duct was zero inches (Attachment 4, U-ESR-H-00113). (The estimate for the waste outside the duct at this location was revised from six inches in 2011 to two inches in 2013.) For comparison, in reviewing another photo with a register visible near Station 15+40 (Photos Q and R), there does not appear to be as much waste inside the ventilation duct, and yet three inches is assumed inside the duct at this Station 15+40 (Attachment 4, U-ESR-H-00113). Also, in photos near Station 0+00 (Photo A, B and C), where the inside of the duct is visible through a broken piece of the duct, there does not appear to be as much waste inside the duct as appears in Photo L, and yet the sample inside the duct measured 5.25 inches.

- *Could DOE explain the seeming inconsistencies in visual photos versus height assumptions and describe the visual evidence used in these photographs to support the heights?*

5.5 In reviewing the photo near Station 10 (Photo M in SRR-LWE-2014-00151, Rev 0), the waste appears to be near the top of the duct on the left side. The duct diameter at this location is 12 inches high (so the top of the duct sits at approximately 13.4 inches from the annulus floor) and yet the height assumption for the waste at Station 10 outside the duct was revised from 9 inches in 2011 to 3 inches in 2013 (Attachment 4, U-ESR-H-00113).

- *Could DOE describe the visual landmarks used in Photo M to support the height assumption at that location? Or, if instead, the height of the annulus waste near Station 10 is based on interpolation between nearby sampling locations, could DOE describe why the photographs near this Station were not used?*

5.6 At Station 9+00 the depth estimate was reduced from six inches to one inch, and at approximately Station 25+00 from ten inches to four inches. The 2011 estimates were based on visual observation according to the Figure in Attachment 1 of SRR-LWE-2012-00039. There do not seem to be new photos or samples for these Stations in 2013 to help inform the reduction in these estimates. Instead, it appears that the reduction seems to be a result of interpolation between 2013 measured sample heights.

- *Could DOE describe the basis for the reduction in estimate, or why the visual observations from 2011 were replaced by interpolated assumptions in 2013?*

5.7 The Closure Module (page 18) states that “Due to leakage from the Tank 16H primary tank into the annulus pan, thirteen additional annulus riser openings, or inspection ports (IPs), were added later to permit 100% annulus inspections.” The southeast portion of the annulus was not accessed in 2013 (Figure A12-1 SRR-LWE-2012-00039) but visual observations were made in 2011 from the southeast portion of the tank near Stations 21+00, 23+00, 24+48, and 26+00 (Attachment 1 of SRR-LWE-2012-00039).

- *The Closure Module could better explain the limitations in visual observation of the annulus and how this impacted the areas that required interpolation versus the use of landmarks in photos. It is not clear if DOE verified its determination of measured or interpolated waste heights based on visual landmarks, or how DOE used visual tools to estimate waste heights where no measured sampling data was available. Could DOE explain why the inspection ports to the southeast of the annulus could not be used for visual observation in 2013 or what efforts were made to obtain access to this portion of the annulus to verify waste heights? Could DOE explain other limitations in visual observation of the annulus that would prevent 100% visual annulus inspections?*

5.8 U-ESR-H-00113 (page 12) states that there were areas of the annulus that could not be inspected with a camera, "Visual observation of all of the annulus floor is unavailable at this time. Since solids were distributed around the annulus by way of liquid, it is reasonable to assume that solids elevation does not acutely change in areas that cannot be seen."

- *The measured sampling results show significant variability in waste annulus heights between stations located nearby (eight inches at Station 15+40 versus four inches at Station 13+67) making it difficult to determine whether the assumption that the waste heights are well correlated between sample locations is valid (U-ESR-H-00113 and SRR-LWE-2014-00151). DOE could use geostatistical tools to better understand correlation lengths and determine optimum sampling locations in future efforts.*

5.9 Table 4.1-2 (page 60) of the Closure Module lists landmarks used to evaluate annular waste heights. One of the landmarks listed is the duct air supply openings. It is not clear what air supply openings are being referred to that would constitute a vertically oriented feature that could provide information on waste height.

- *Please describe in more detail what air supply openings are being referred to or explain how the air supply openings are used as landmarks to gauge waste height.*

Detailed Comments on the Uncertainty of Measured Waste Heights in the Annulus

5.10 The Closure Module describes the process by which waste heights were estimated (page 66),

> "By measuring the height of the waste at the start of drilling, and the height when auger bit speed increased (indicating the material had been disaggregated) and penetration stopped (indicating the presence of a hard surface such as the annulus pan or duct bottom) the waste thickness was determined."

U-ESR-H-0013 page 11 describes how the depth was measured during sampling:

"The depth of the solids layer was determined by lowering an auger to the top of the solids layer and marking the shaft of the auger. The auger was then lowered through the solids layer and the shaft marked again. The difference in the initial and final marks indicated the depth of the solids layers."

The depth measurements taken during sampling seem to be relied upon heavily in the final volume estimate but the documentation lacks a discussion of the uncertainty associated with the measured depths. It would be helpful to know uncertainty of waste height measurements based on uncertainty in marking the auger at the point where the top of the waste is reached. It is not clear how one would know when the top of the waste is reached. It would be helpful if DOE could address the following questions in the documentation:

- *Is reaching the top of the waste based on visual observation, or some other indicator?*
- *How variable are the waste height measurements due to surface roughness? If the surface of the waste is rough or variable along the radius, then there may be significant uncertainty in the height measurement in roughly the same measurement location.*
- *How variable are the waste heights based on distance from the annulus wall or duct (i.e., does waste tend to accumulate on vertical surfaces)?*
- *It is not clear how one would determine when the top of the waste is reached in a duct where the duct itself is obstructing the view? How would one know when the auger reaches the top of waste in a duct in cases where a hole needs to be cut into the duct to sample (e.g., photograph H in SRR-LWE-2014-00151)?*
- *When the duct is corroded, how does DOE determine the waste height in the duct if the bottom of the duct has collapsed (photograph B in SRR-LWE-2014-00151)?*

5.11 Uncertainty in the waste height measurements appears significant. Several measurements do not appear to be correlated to the photographs (SRR-LWE-2014-00151). Specific examples are provided above under comments related to visual observations and some examples are repeated below.

- Waste under the duct register in photograph J (and nearby photograph L) looks much higher than the sampled value of 0.875 inches (and higher than the 0 inches assigned to the location depicted in photograph L).
- Waste appears to be located near the top of the duct in photographs H (2.5 inches), O (3 inches), P (3 inches), V (2.5 inches), and X (2.5 inches) but the waste heights assigned are much smaller than the duct diameters that are all > 12 inches.

    - *Could DOE describe the uncertainty in the measured heights given the apparent inconsistencies with landmarks in photographs?*

5.12 U-ESR-H-00113 also states that

"for other areas that were not sampled the solids depth was estimated based on the use of visual landmarks where possible. Where cameras were not able to be utilized to visually inspect the annulus, the solids depth was extrapolated from the nearest known areas."

It is not clear how heights are determined for Tank 16H annulus waste located inside the duct between Stations 20.70 and 00.30 in the absence of sample measurements and photographs (SRR-LWE-2014-00151).

- *The documentation could better explain the extrapolation method used for areas lacking sample or photographic data (e.g., it does not appear to be a linear interpolation based on segment length). In looking at the depth assumptions listed in the spreadsheet in Figure A4-1: Tank 16H Annulus Residual Solids Chart of U-ESR-H-00113, it appears that the measured heights were entered at the various stations and an approximate interpolation between those measured heights was assumed. Also, as stated above in the comments regarding visual observation, it is unclear how the photo observations and landmarks helped inform the interpolated values.*

5.13 DOE assigns high and low end waste heights to account for volume uncertainty (U-ESR-H-00113). Uncertainty in measurements based on sampling, photographic evidence, and interpolation should be different. However, it appears that uncertainty in the measurements is not based on the method used to assign the waste heights. For example, it appears that the uncertainty in the duct waste height values is always +/- 0.5 inches irrespective of assignment method. Furthermore, it is not clear that +/- 0.5 inches adequately accounts for uncertainty in the waste height measurements in the annulus duct based on measurement error, sample representativeness, access limitations, and extrapolation methods.

- *Please explain how DOE considers uncertainty in the Tank 16H annulus volume estimates and at what confidence level DOE expects the high end volume estimates bound the true waste volume.*

<u>Clarification Comments</u>

1. Page 26, DOE indicates, "The drawbacks for these types of jets were the large water volumes required to slurry the sludge (approximately five times the volume of sludge removed)…." Did DOE intend to state that approximately five times the volume of water was needed to remove the same volume of sludge?
2. Page 82, Why is 26 gallons or 2 percent in the secondary sand pad described as a conservative value?
3. Page 116, Figure 7.3-3 indicates that the height of the duct off the floor is 3 inches which seems to be different than the support channel height (which supports the duct) of 1.41 inches given in equations on page 53 of U-ESR-H-00113. Could DOE clarify the heights of the duct off the floor for the various duct diameters?

4. Page 42 displays a photograph of the Tank 16H Post Phase 4 cleaning (December 1980). On page 40, it is stated that "in January 2013, the primary tank residual solids volume was re-evaluated using high-definition photographs and a new mapping process developed for the waste tank closure project." It is not clear if the photograph in Figure 3.1-14 was taken in 1980 or if it is one of the new high-definition photographs taken in 2013. It would be helpful to see the comparison of the photo from 1980 with the high-definition photograph taken in 2013.
5. Equation (4) in the document SRNL-STI-2014-00321, page 75, is not clear. The terms with Y symbols are referred as "total of measured concentration results," and it is not clear how straight measures can be used to define an effective variance (labeled as MS_{Sample}) without computing differences. Could DOE define the Y symbols and include a simple example for the computations of MS_{Sample}?