Technical Reviewer Detailed Field Notes
February 2-3, 2016, Tuesday and Wednesday

Status of Tank Farm Closure:

1. The U.S. Department of Energy (DOE) is in the process of updating the System Plan and tank closure schedule. The DOE is currently in negotiations with the State on the schedule.

2. Began grouting Tank 12 in January 2016.

Update on Follow-up Action from July 2015 Onsite Observation:

1. The DOE discussed a follow-up action item 5 from the July 28-29, 2015, Onsite Observation Visit (OOV), lessons learned associated with partial discharge of a Tank 6 grout truck that may not have contained sufficient aggregate. As an additional quality assurance check, the construction discipline engineer can make a call at any time to stop discharge if grout behavior seems suspect. Although, initially the grout looked acceptable, at some point during placement in the tank, the grout looked to be runnier than typical. When questioned by the U.S. Nuclear Regulatory Commission (NRC) staff to confirm if aggregate was in the grout, the DOE indicated that there some aggregate but the grout did not have sufficient aggregate. The DOE stopped placement of grout from that truck. The DOE determined that no changes in procedures were needed as the quality control check worked as intended. The DOE did emphasize in training what to look for during the quality control check based on this example. The NRC staff inquired about efforts of the batch plant to further investigate the apparent error in preparation of the grout. The batch plant didn't find any problems with the computer system used to make the formulation, and the batch plant observes preparation of each load. In response to an NRC question, the DOE also indicated that it is not aware that the batch plant ever had this problem before, and indicated that the DOE was unaware of this problem happening at the site previously. Action item: The DOE will provide the date of the rejected load so we can review the video. Barry Mullinax from the South Carolina Department of Health and Environmental Control (SCDHEC) indicated that you could see a difference in the behavior of the grout.

Tank 16H Grouting:

1. Prior to the onsite observation, the NRC staff reviewed video of Tank 16H grouting provided by the DOE as a follow-up action to the July 28-29, 2015, OOV. The NRC inquired about the Tank 16 grouting schedule provided by the DOE in SRR-CWDA-2015-00170 that accompanied the video. Specifically, footnote 4 related to use of clean cap grout in the primary of Tank 16H was missing from the schedule. The DOE indicated that footnote 4 should have been associated with September 3rd on the Tank 16H grout schedule.

2. The NRC staff also noted that on one day, it appeared that grouting was performed both in the annulus and in the primary tank, although the calendar was coded yellow, indicating that only primary tank grouting occurred on that day. The NRC clarified in the out-brief that the day in question was June 16, 2015.

Enclosure 2

3. The NRC indicated that based on its observations of grout video on August 31, 2015, the grout looked different than typical bulk fill grout. The grout was extremely flowable, with no mounding, and behaved much more like a Newtonian fluid.

4. The final configuration report is due in the second quarter of calendar year 2016. The DOE will send the report to the NRC when complete.

Tank 12H Grouting:

1. The DOE discussed similarities and differences in Tank 12H (Type I tank) versus Tank 16H (Type II tank). Differences include the size of support columns and relation of the water table aquifer to the tank top. Similarities include presence of cooling coils and annulus. Barry Mullinax, SCDHEC, also suggested that the taller risers in Type I tanks could make a big difference with respect to momentum to drive grout into the tank.

2. It took approximately 800 trucks to grout Tank 16H; it will take approximately 565, 8 yd^3 to grout the smaller volume Tank 12H. Approximately, 25 to 30 trucks will be used to grout Tank 12H per day. The same spread of 26-30 inches slump will be used for Tank 12H. One difference in the grout formulation is the use of grade 120 ground blast furnace slag in lieu of grade 100. The DOE performed an evaluation and determined that use of Grade 120 slag is consistent with inputs and assumptions contained in the Tank Farm PA's. The NRC staff requested a copy of the Unreviewed Waste Management Question Evaluation (UWMQE) that includes information on: wet chemistry test, flow test, compressive strength, bleed, and heat of hydration charted over time.

3. The DOE is using the same formulation for Tank 16H cooling coils, a master flow 816 grout product, mixed with grout, fly ash, and slag.

4. The DOE agreed to send the NRC three documents related to Tank 12H grouting, including the following: grout strategy, closure assurance plan, and subcontractor surveillance plan.

5. The Tank 12H risers are 9-10 ft. tall. Risers 1, 3, 5, and 8 will be used to grout the tank and all have spray chambers. Two risers in the annulus are being used to grout the annulus: east and west. There are nine total risers in the primary and 4 total risers in the annulus.

6. The NRC noted that Tanks 5F and 6F ventilation ducts were filled internal to the ventilation duct and that the DOE planned to use the same approach in Tank 12H. On the other hand, the DOE noted that the poor condition (had holes in it and was degraded) of the Tank 16H duct work was the reason why they chose to grout the ventilation duct from outside of the duct and allow grout to enter the duct through the open registers at the top of the duct. The DOE also indicated that the presence of waste in the ventilation duct was also a consideration (i.e., could block the flow of grout into the duct).

7. The NRC staff indicated that they would like to discuss filling of the annulus duct in a future teleconference. For example, the NRC has questions about the filling of the ventilation duct as it was difficult to observe the infilling of grout in the duct in video provided by the DOE.

8. The DOE indicated that they will alternate between the primary and annulus. Primary grout filling is needed to support the cooling coils before cooling coil grouting. There is some flexibility with the order of the lifts. For example, there can be up to an 8-ft. difference between the primary and annulus grout height. The annulus can be 6-ft. higher than the primary.

9. The NRC inquired about how many cameras are being used in the primary. The DOE indicated that the center riser, and risers 1, 3, 5, and 8 have cameras in them. The DOE also indicated that there is a camera positioned outside of the tank at the slick line and grout pump. There is also an observation camera at the tank top. There are annulus cameras in the east and west. The DOE can also put an annulus camera in the south, although this option is not available for the north riser.

10. There are three TK70 grout pumps used to pump grout into the tank. Batch tickets are checked before the truck moves into position. On the first truck the DOE performs an information slump test. If it passes, they move on to the official testing. The DOE tests after every 100 cubic yards.

11. In response to an NRC question, the DOE indicated that they work with the batch plant to get the slump correct at the beginning of the day without the need to add excess water at the site.

12. The NRC indicated that based on observation of the Tank 16H grout video, it seemed like more than 30 truckloads of grout were discharged into the tank. Non-continuous flow and repeated stoppages made it difficult to count the number of trucks. The NRC inquired if there were any breaks in the grouting. The DOE indicated that it takes about 7 minutes to discharge the full content of grout from a truck. There was discussion about the need to evenly distribute grout to the tank to prevent mounding, and the potential for mounding to have been related to repeated starting and stopping of grout discharge.

13. The DOE is trying to avoid plugging of the slick line and has to meter the grout to make sure long delays do not occur. If trucks are slow to arrive, the DOE must slow down rates to keep grout flowing until the next truck arrives.

14. With respect to annulus grouting, the DOE will use the same bulk fill that was used to fill the annulus with the east and west risers. The DOE mentioned that it may need to use a more flowable grout for the ventilation duct which it will fill through the vertical inlet section of the duct.

15. The DOE uses a commercial grout skid to fill the cooling coils. The DOE mixes 150 gallons of cooling coil grout using a Super Sak. Grout is metered into the cooling coils. Intact cooling coils are flushed to a separate tank. Grout is pushed through the coil until

grout is seen coming out. For the failed coils, they pump grout from the supply and return side until they see it coming out in the tank. On the group tour, the DOE indicated that they collect chromate water and excess grout in totes. Damaged cooling coils are flushed during cleaning prior to grouting but some chromate water may also come out when grouting the damaged coils.

16. Equipment fill is prepared in small batches. There are only small openings for the equipment fill. The DOE pre-mixes all of the dry ingredients. Water is added to the dry Master Flow. There is a short life before the equipment grout sets up. The DOE adds water at the appropriate time for mixing. Grout is metered via gravity flow using a hose. A vent at the top of the grouting is used to assess when the equipment has been filled. The volume of grout used is recorded.

17. The DOE skipped Lifts 2 and 3, and were doing Lift 4. During the tour, when asked about skipping lifts 2 and 3, the DOE explained that there is still water in the annulus of Tank 12 due to groundwater in-leakage (9 inches or so) and they are waiting for the water to evaporate prior to grouting. Dehumidifiers and fans were taken out of service and the DOE is having to use a less efficient system to dry the annulus. There was some water remaining in the primary (started out with the 3500 gallons and the DOE indicated that it took about 1 year to evaporate). Some pools of water remain in the tank and they try and avoid the ponded water based on the results of the grout drop test report that show that segregation can occur if grout is dropped on standing water.

18. The DOE forecasts Tank 12H grouting to be complete by April.

19. The DOE indicated when questioned by the NRC that 90 minutes and 300 revolutions would be cause to reject a load of grout.

Tank 16 inventory

1. The NRC staff discussed the Tank 16H inventory technical review report. The NRC explained the focus of the review was on waste sampling and volume estimates, and in particular what was thought to be a risk-significant inventory in the annulus. The technical review supported Monitoring Factors (MF) 1.2 and 1.3 in NRC staff's SRS Tank Farm Monitoring Plan related to residual waste sampling and volume. Eventually the NRC hopes to close MFs 1.2 and 1.3 and perform a more cursory review of inventory when we review how the inventory is used in the Special Analysis (SA) prepared for the tank undergoing closure (Special Analyses are reviewed under MF 1.1, "Final Inventory and Risk Estimates").

2. The NRC staff concluded that the DOE did a generally good job on developing the inventory and appropriately executed the sampling analysis program and quality assurance program plans.

3. The NRC discussed its questions and comments on representativeness of samples and consideration of uncertainty. The NRC explained that this was the first time staff reviewed development of volume estimates of waste in the annulus and therefore had some questions and comments in that area.

4. To provide information on risk significance, the NRC explained inventory is in many cases linearly related to dose and is, therefore, risk-significant. The NRC estimated the uncertainty in the Tank 16H inventory was around a factor of 2 and was therefore of low to moderate risk-significance. The uncertainty in the Tank 16H inventory is not as risk-significant as uncertainty in waste release or solubility which is expected to be an order of magnitude or more.

5. The NRC indicated that although the final volume estimate is not made until sampling and there is little time to revise the sampling design so that it is more in line with the final volume estimate, it would be good to be have better volume estimates to ensure that the appropriate number of samples are taken from each strata based on the volumetric compositing scheme being employed by the DOE. The DOE acknowledged this concern and later indicated during the discussion of the Tank 12H inventory that they were able to adjust the number of samples taken from the mound behind the valve house that was larger than originally assumed.

6. Based on its review of inventory documentation, the NRC found that the DOE could have been more transparent on how the strata in the annulus of Tank 16H were selected. Strata represent areas of waste in the annulus that have similar characteristics; different strata may have different waste characteristics. For example, more and less soluble waste in the annulus represent different strata (e.g., DOE concluded that sand from sand blasting activities during tank inspection created sodium alumina silicates that generally have lower solubility, waste in the ventilation duct is less impacted from sand blasting activities and generally has higher solubility).

7. The DOE indicated that due to the leakage of waste from the primary to the annulus of Tank 16H, additional inspection ports were created to inspect the annulus that allow greater observation of the waste (Tank 16H is unique in this regard). Sampling the waste also provided a better volume estimate. Nonetheless, the NRC indicated that the southeast portion of the annulus had little to no observation.

8. The NRC indicated that because the three composites are analyzed in triplicate it is not clear that the samples should be treated as nine independent samples. The DOE stated that the triplicate samples are independent, because although the three samples came from the same composite they were different aliquots. At the out-brief, the NRC asked the DOE to clarify how triplicate samples are processed (e.g., processed/separations and split; or split and processed/separations) and the basis for treating the triplicate samples as independent in certain circumstances (based on ANOVA F test) when they came from the same composite sample.

9. The NRC questioned whether two samples in the annulus that were supposed to be obtained from the top and bottom of a mound were actually obtained. The two samples were expected to be vertically heterogeneous. The DOE stated they had a very thin wall core tube and they were able to get down to the bottom but to get a core of that material was difficult. It would break off in the sampling equipment so engineering came up with the auger tool using a screw bit and they went to where the waste is supposed to be thickest to sample. So, what they ended up with is a ground up deposit of the whole

interval as opposed to a true core sample. Therefore, DOE was not able to assess vertical heterogeneity.

10. The NRC questioned whether samples were obtained outside of the ventilation duct between the primary liner and ventilation duct as indicated in the sampling and analysis plan. The DOE indicated that samples taken outside of the ventilation duct were taken on the primary liner side of the duct. The DOE also indicated that waste should be homogeneous on both sides of the duct, because the sides are hydraulically connected. The NRC indicated that their seemed to be a significant height difference on either side of the duct (see technical review report text and example Figure 3, (Agencywide Documents Access and Management System (ADAMS) Accession Number ML15301A830). The DOE attempted to average the heights assigned based on visual observation. NRC indicated that if it was a sampled value then there was no adjustment to the assigned value. For points that were not sampled, the DOE indicated that they would typically go halfway between and occasionally adjust if something was observed. There was some discussion on the interpolation technique between samples. In some cases the interpolation did not appear to be linear (may have been based on visual observation) or was non-monotonic. The NRC indicated that the DOE should be more transparent in their documentation of how the heights are assigned at sampled locations (based on sample alone or sample and visual information) and how heights are assigned or calculated between measured values (e.g., based on interpolation between sampled values, visual information).

11. In the technical review report, the NRC indicated that it was not clear when visual evidence would be compelling enough to override the measured values or interpolated values between measured values (e.g., see Figure 1 in ML15301A830 that shows waste near the top of a 12-inch duct on one side of the duct [with a few inches of clearance under the duct] but with a waste height of 3-inches assigned at this location). The NRC also questioned the reliability of visual observation in the primary liner if the images were misleading with respect to waste height. The DOE indicated that the landmarks in the tank were more numerous. The DOE also stated that while they relied heavily on the measured values and the approximate linear interpolation between the values, they also used a camera to confirm the results. The DOE said that in the case of Figure 10, the photograph did not provide the same amount of detail as the video camera and when they were reviewing the camera they believed it supported their approximation of 3-inches for that location.

12. The NRC indicated that the uncertainty in marking the shaft of the auger when you reach the top of the waste is unclear. Error in the sampled values seemed to be biased in underestimating the inventory (e.g., there seems to be a potential to go into the waste with the auger or cutting tool biasing the height estimate low, whereas their might be much less uncertainty overestimating the height by marking the shaft early before the top of waste was reached because the auger would be hanging freely in space; the bottom of the waste is a hard surface and there may be low uncertainty associated with underestimating the height by marking the shaft early before the bottom of the waste is reached but even less uncertainty associated with overestimating the height based on going beyond the bottom of the duct or annulus floor). The DOE indicated that the camera was positioned to watch the auger approach the waste and when combined with

the feel of when the tip came into contact with the top of waste they knew when to mark the shaft. With respect to cutting the duct and drilling into the ventilation duct and potential to disaggregate the waste, the DOE indicated that they would use a 3” hole saw, drop in auger, position the camera to see where hole was cut, and could see inside, the angle was difficult but they never saw disaggregation of waste due to cutting; and typically saw clear vapor space. As an action item, the DOE agreed to provide video of annulus sampling.

13. Given the discussion regarding uncertainty in the height and consequently volume and inventory estimates, the NRC questioned the assignment of uncertainty in waste heights of +/- 0.5”, particularly the congruent estimate of uncertainty on the high and low side. The DOE stated that the uncertainty range was a qualitative measure arrived at by 3 people. NRC indicated the error could be underestimated, particularly on the plus side due to the biasing of the inventory low (error in marking the shaft seems to be more biased towards marking the shaft after the top of the waste had been reached [bias inventory low], and the inventory may be biased low due to sampling on the primary liner side where less waste appears to have accumulated following waste removal activities).

14. The NRC questioned when in the process the DOE determines there might be a significant inventory on the cooling coils noting that the cooling coil inventory was a surprise on Tank 12H after the tank had been cleaned and waste retrieval operations had been terminated. The DOE indicated that inventory on the cooling coils in Tank 12H was unexpected and indicated that no spray washing was conducted on Tank 12H, like there was on Tanks 5 and 6F. The DOE only saw contamination with high resolution images in Tank 12H.

Waste Release Experiments

1. The DOE indicated that the Task Technical and Quality Assurance Plan for waste release testing was updated to revision 3 (SRNL-RP-2013-00203, revision 3). The DOE took an action item to make sure that revision 3 was sent to NRC for review.

2. When questioned about whether the silica concentrations were sufficient in the experiments or whether they could affect the pH or Eh, the DOE indicated that there was silicon in the heel, grout components, and glass, and they did not think that the silica concentrations would significantly influence the results. The DOE agreed to perform a chemical analysis before and after characterization. The NRC noted that the Pu solubility report evaluated silica impacts in sensitivity analysis (see SRNL-STI-2012-00087, Rev. 0 that discusses the impact of silica on primarily pH transitions).

3. When the NRC inquired about DOE’s preparation of grout solids including curing times and processing of the samples, DOE indicated that mimicking the aging of grout is difficult to do. For example, it takes months to years to get all grout components oxidized and DOE must include additives to get the chemistry correct. The NRC mentioned grout minerology and sorption on grout surfaces as a variable, and that although Eh and pH are very important other factors may also influence waste release that may be studied later. The DOE indicated that the purpose of the experiments is to study the solubility of key radionuclides under conditions assumed in the modeling. The

NRC agrees that other questions can be answered at a later date, pending results of this research.

4. The NRC indicated that if the testing shows that the solubility of key radionuclides such as Pu is risk-significant, similar to results of the surrogate and scoping study results, then the DOE can show that the experimental conditions will not occur in the field (e.g., identify the solubility where Pu solubility is not risk-significant and is expected to occur in the field).

5. The NRC also expressed concern with the lack of collection of mechanistic information and the difficulty in extrapolating results to other conditions. There was some discussion regarding the DOE analysis of the residual waste following leaching experiments to identify potential mechanism for Pu retention.

6. The DOE indicated that after doing Tank 18F real waste testing they plan to perform additional work on Tank 12H residuals. When later asked why the DOE selected Tank 12H for follow-up work, the DOE indicated that this tank has had oxalic acid treatment and is one of the more risk-significant tanks in HTF. The NRC indicated that the tank also underwent Low Temperature Aluminum Dissolution and might not be representative of very many other tanks. Additional discussion may be needed on this issue.

7. With respect to surrogate waste testing results, DOE was unable to achieve the targeted reducing Eh. The NRC inquired about whether thermodynamics or kinetics was responsible for the inability to achieve endpoints. The DOE indicated that they do not think it is a kinetic limitation—the DOE waited a sufficient amount of time and the chemistry had stabilized.

8. The DOE indicated that the concentrations of Pu and U were much higher for oxidizing conditions. Uranium solubility was most sensitive to the inability to get to the low end Eh. Uranyl carbonate complexes are a concern for uranium.

9. The NRC inquired about scrubbing of CO_2 to control pH and its effect on carbonate concentrations. The DOE indicated that it adds in the solids and then makes adjustments to control pH (CO_2 scrubbing may be necessary to ensure that pH is not depressed for the two oxidized cases). The DOE also indicated that it is using large amounts of air to drive the system to the targeted conditions and that the amount of exposure may be unrealistic compared to what might be seen in the real system. The grout components (e.g., calcite) are expected to add sufficient carbonate to the system. The NRC will perform calculations to better understand the bicarbonate and carbonate concentrations in the presence of calcite and under the targeted conditions.

10. The DOE noted that the shielded cell has Pu contamination that may have contaminated Tank 18F samples previously and may contaminate sample in these experiments. The DOE indicated that it was using vent filters to prevent contamination of the samples. The NRC expressed concern with the filtering of Pu from the waste sample. There was some discussion on analysis of one or more filters that was not resolved during the visit. The DOE did express a willingness to perform a mass balance to make sure significant quantities of key radionuclides are not lost from the sample (e.g., all key radionuclide

mass should be accounted for in the remaining sample, and leachate). The DOE also indicated that it was analyzing blank samples to evaluate the contamination issue.

11. The DOE indicated that they plan to test a single sample, FTF-1, that has the highest actinide concentrations. The NRC questioned the switch from compositing samples to use of a single discrete sample. The DOE stated that the Tank 18F waste was expected to be homogeneous due to mixing via the sand Mantis used to sample. The DOE indicated that the wall sample was different than the floor sample. The DOE stated that the Fe concentrations were higher in the FTF-1 sample compared to the other samples. The NRC indicated that a higher Fe concentration in the sample may indicate a greater amount of co-precipitation of key radionuclides in the FTF-1 sample compared to other samples. The NRC indicated that an analysis of radiological and non-radiological constituents was necessary to assess whether the waste was homogeneous. The NRC will review the Tank 18F characterization report within a week and let the DOE know if we have any concerns with use of a single sample versus a composite sample.

12. The DOE indicated that they would like to keep the temperature at 20^{o} C to limit condensation, although modeling assumed a temperature of 25^{o} C. The SRNL researchers noted that ambient temperature in the reaction cells fluctuate (10^{o} C/daily and 20^{o} C/annually). The NRC indicated that CO_2 solubility might vary over that temperature range but variability introduced by that would probably not be important compared to other uncertainties.

13. The DOE performed scoping tests using Tank 18F samples under ORII conditions in air. The DOE didn't measure Eh but expected the conditions were probably close to the targets. Using the filter, Pu concentration was a little less and approaching the surrogate study concentration giving confidence that the issue with contamination is being managed well. The leachate dose rates would not limit the sample size. Detection limits are being assessed for reducing conditions pending results of blank analysis. Based on previous experience, the DOE could pull the samples out and analyze them in the hood, but the dose rates would be high.

14. The DOE is scheduled to start leach testing in February and issue a report on August 31, 2016.

Other research:

15. The DOE observed greater than 100 percent recovery of I during K_d testing, because of the quantity of I naturally present in South Carolina soils. Accordingly, the DOE will be looking at radionuclide spikes.

16. The DOE recently submitted a lysimeter testing report to the NRC for review. The DOE plans to pull sets of lysimeters between 2 and 3 years, 4 to 6 years, and one at 10 years for analysis. CRESP is analyzing the Pu lysimeters using SRS soils. There has been evidence of upward mobility of Pu due to wetting and drying cycles.

17. The DOE is in the process of updating the geochemical data package--SRNL-STI-2009-00473 (ML113320386) and will provide that to the NRC for review.

18. Belgium report on distribution coefficients in cementitious materials is being issued. The DOE should provide the report number so the NRC can obtain a copy.

19. The DOE is in the process of performing tank grout shrinkage testing using ASTM C-157. Four months of testing has been completed. The results show a shrinkage rate of 0.023 percent on a 30-inch specimen. Based on an annulus width of 30", the NRC staff later noted that this equates to approximately 175 µm of shrinkage. The test protocol includes fully submerged samples and samples cured in an almost 100 percent humidity environment. The NRC staff noted that shrinkage in the tanks could be greater due to the ventilation (DOE indicated ventilation was at 300 ft^3/min), which would reduce humidity. It is not clear how much the humidity would be reduced based on the ventilation. However, the NRC staff also noted that shrinkage can increase significantly as humidity decreases below 100 percent. The NRC staff noted that American Concrete Institute documents exist for modeling and calculating shrinkage, based on the specific characteristics of the cementitious materials.

20. There was some discussion between the NRC and the DOE on the impact of dehumidifiers on the relative humidity. The DOE later explained that in some cases you have a positive pressure in the annulus when you are applying heated air to dry out the annulus. In other cases, you have a negative pressure in the tank to prevent release of material outside of the tank.

NRC Contractor Center for Nuclear Waste Regulatory Analyses (CNWRA) Experiments:

1. With regard to the groundwater conditioning tests using SRS tank grouts, the CNWRA explained that synthetic SRS groundwater is circulated in the annular space around a grout core extracted from the intermediate-scale grout specimen prepared at CNWRA in previous testing. The CNWRA measured the DO, pH, and the Eh of the solution as groundwater circulated around the core. Both aerated and de-aerated water were used. The groundwater pH increased right away to 11 and 12. The CNWRA was never able to get the oxygen below 1 mg/L, oxygen was infusing into the flow system. The CNWRA also performed static tests reacting groundwater with 1 cm^3 tank grout samples, which were placed in a reaction vessel, sparged with oxygen free gas at extremely low dissolved oxygen concentrations. Over the course of a day the Eh decreased from +300 mV down to -100 to -200 mV and stabilized. The CNWRA is modifying the tubing in the flow tests to reduce diffusion of oxygen into the system and plans to conduct additional testing to study the impact of particle size on reactivity of the tank grout. The DOE agreed to provide vendor information on the 120 grade slag that will be used in future grouting operations at the tank farm.

2. The NRC summarized the acoustic emission work including ultrasonic property testing and an acoustic emission monitoring system to detect the location and distribution of cracks in a cementitious waste form. During the early stages of curing the attenuation in the grout made it difficult to acoustically monitor the hydration process. The CNWRA needs to obtain additional data to improve accuracy of the crack location algorithm. The CNWRA is testing both saltstone and tank grout. The saltstone curing environment significantly impacts the acoustic properties and the researchers found that the saltstone

grout took much longer to hydrate and harden compared to the tank grout. Additional testing and optimization is planned for FY2016 subject to funding.

Action Item 12:

1. The DOE clarified its response to Action Item 12 from the July 2015 OOV where the NRC questioned the assignment of chemical transition times for the contaminated zone in the DOE's probabilistic GoldSim model. The DOE indicated that the PORFLOW model for HTF has cases A-E; GoldSim has the same cases and considers flow variability through 72 flow cases. For example, for Configuration A, the model selects from a set of flow cases that represent variability of flow. The DOE indicated that GoldSim uses the chemical transition times extracted from PORFLOW.

2. The NRC stated that in the deterministic FTF and HTF PORFLOW models and for certain fast flow cases, the DOE assumed that the tank grout did not degrade rapidly compared to other cases, thereby facilitating fast flow through the fast pathway. In these cases, the fast flow pathway controlled the chemistry in the CZ. For other cases, the grout was assumed to degrade more rapidly, and matrix flow dominated flow through system allowing the tank grout to condition the groundwater flowing into the tank (i.e., the tank grout controlled the chemistry of the CZ). In the probabilistic HTF model, because the DOE varied the degradation times of the tank grout for each of the cases in the same manner it was no longer conceptually clear if the tank grout or the fast flow pathway should control the chemistry of the CZ. Furthermore, the DOE's response to Follow-up Action Item No. 12 seemed to indicate that the CZ was its own segment controlling its own chemistry. The DOE Indicated that this was not the intent and that it would further clarify its response to Action Item 12.

Tank 16 SA

1. The NRC asked if the DOE had any new information on higher than expected Sr-90 and I-129 concentrations in Tank 16H. The DOE explained that Sr-90 quickly infiltrated into the annulus before precipitating in the tank, explaining a higher concentration of Sr-90 in the annulus. However, the NRC indicated that it was talking about factor of 4 higher inventory in the primary liner and not a higher inventory in the annulus. The DOE explained that the Waste Characterization System may underestimate the inventories of certain radionuclides. With respect to I-129, this key radionuclide was not as soluble as the DOE had assumed leading to a higher inventory remaining in the tank. The DOE pointed out that they planned to increase estimated inventories for many radionuclides in the revised SA.

2. The NRC stated that there was also a concern with assignment of uncertainty ranges that bias the results low: a log uniform distribution is used with an inventory range of 100 times less and only 10 times higher, thereby skewing the statistics. However, the NRC agreed that since the DOE was not relying on the results of the probabilistic analysis to demonstrate compliance with the performance objectives this issue only affected the interpretation of results when using such metrics as peak of the mean.

3. The NRC pointed out that multipliers are not applied for the sand pad inventory in the probabilistic analysis, even though there is uncertainty in these inventories. Regarding the primary sand pad inventory, the NRC acknowledges that the volume is likely conservative give that the DOE assumes the entire sand pad is saturated. However, the NRC pointed out that there is uncertainty in the concentrations given that the sand pad was never subjected to cleaning. The DOE believes that uncertainty in the sand pad inventory is appropriately managed and reiterated that Tank 16H has a unique inventory for the sand pad given the fast leak that took place.

4. Regarding the secondary sand pad inventory, the NRC commented that a volume of 26 gallons was a somewhat arbitrary number. The 26 gallons is based on an estimate from the DP-1358 report of 16 gallons being released into the environment, plus an arbitrarily assigned additional 10 gallons. The NRC staff pointed out that, although not necessarily realistic, the volume in the secondary sand pad could conservatively be bounded by the amount that was estimated to go above the secondary pan, which would equate to approximately 700 gallons. The DOE noted that the inventory in the sand pads may have been flushed from the annulus during pumping of groundwater that leaked into the annulus. Given the quantity of waste in the Tank 16H annulus and although some partitioning of waste into the aqueous phase may have reduced inventory, the NRC indicated that a significant inventory might remain in the sand pads.

5. The NRC pointed out that for Tanks 13H and 15H, the DOE assumes 100 gallons in the primary sand pad, and that future documentation should address whether this adequately bounds the uncertainty given that no multipliers are assumed for the sand pad inventory. The DOE responded that they will be able to approximate the extent of leakage into the annulus when visually inspecting the annulus of these tanks.

6. In response to the NRC's question regarding the origin of the mercury present in the tanks, the DOE explained that H-modified waste has more mercury in it. The DOE explained that they would expect 4 percent mercury using the uniform layer theory. The Reboul report (SRNL-STI-2012-00479) has information on waste processing. PUREX waste is also present in HTF as well. For example, Tanks 9F and 10F had PUREX waste, and Tanks 12H and 15H had Thorium campaigns.

7. In regard to evaluation of an alternative fast flow case for release of waste from the Tank 16H annulus, the NRC indicated that Tank 12H groundwater in-leakage data could be used to assess conductivity of tank vaults (e.g., 6-inches of water accumulated in the Tank 12H annulus over 5 days). Wang (1997) provides information on hydraulic conductivity as a function of aperture fractures due to shrinkage and could be used to assess flow through the grouted annulus. Shrinkage gaps of 50 microns would conduct water and 500 micron aperture would significantly conduct water through an otherwise in-tact system. There was some discussion about the Tank 16H shrinkage tests results and how that information could be used to assess potential hydraulic conductivity for the shrinkage gap in the Tank 16H annulus.

8. The NRC indicated that the limiting annulus fast flow case might be associated with the rise and fall of the water table that would lead to groundwater in-leakage and

subsequent drainage from the vault (gravity driven flow with a unit gradient might lead to significantly higher releases compared to saturated flow with a hydraulic gradient of 1).

9. The DOE indicated that they were preparing a new SA that could look at both of the scenarios as well as long-lived radionuclides.

10. It is unclear to the NRC staff what chemical form iodine may exist in the far-field of H-Tank Farm Facility following release from the engineered system and whether field studies represented conditions that might be expected in the far-field of the waste tanks.

11. The NRC indicated that the stability of more sorptive species iodate was unclear and that the experimental results did not always seem to be consistent with the field results. Depending on the amount of credit being taken and the risk-significance of change, additional information may be needed to increase support for the selected distribution coefficient for I. The NRC also indicated that averaging of K_ds may not be appropriate, although the NRC did indicate that as the difference in the K_ds of the two different species being modeled increases, the impact of averaging the K_ds becomes more pronounced. For example, if the K_ds being averaged is a factor of 3 or less, than averaging of the K_ds may not have as large of an impact as in a case where the K_ds differed by a factor of 10 or more. This is not to say that use of a single K_d of 0.3 versus a single K_d of 1 L/kg for a single species would not have a significant effect on the results.

12. The DOE stated that they still want to try to simulate the different species of Pu by assuming a different K_d for Pu. They suggested using a dummy radionuclide in GoldSim with a different K_d. The NRC pointed out that it's not just two species existing simultaneously - there is a conversion back and forth between multiple species happening over time based on conditions. You could have some Pu taken out of solution and then all the sudden it becomes mobile. It is difficult to model the reality so the DOE may have to make some bounding or simplifying assumptions.

13. The NRC pointed out that the chemical form of iodine in the tank is important to know, it might be some kind of mercury or silver iodine. The DOE stated that when they finish the solubility testing on Tank 18F, they would like to test Tank 12H samples and also switch to Sr-90 and I-129 instead of Tc-99. The DOE stated that they would move to Tank 12H, because Tank 12H is the most risk significant tank currently so they would do the solubility analysis on it before Tank 5F and 6F. The NRC pointed out that Tank 12H also had Low Temperature Aluminum Dissolution.

Tank 12H Closure Module Addendum and SA:

1. In response to the NRC's question regarding use of GoldSim only for the Tank 12H SA, the DOE indicated that they didn't have many changes in the Tank 12H SA besides inventory, so they didn't see any reason not to use only the GoldSim. If you are just changing inventory, then you would only run the GoldSim model. This is not the plan for other Special Analyses in the future for other tanks, because the DOE would also be changing other things in the model in addition to inventory.

2. In regard to access limitations behind the valve house in tanks, the NRC inquired if there was any way to improve the accessibility of this section of the tank and to better estimate the residual volume in this section of the tank. The DOE indicated that they index and also try and create a circulating pattern around the valve house to clean that section of the tank. The DOE noted the difficulty in seeing back there due to no risers being present in that section of the tank and the array of cooling coils coming down that obstruct the view. The DOE stated that while they are cleaning it's difficult to see behind the valve house and the cameras are even further away than the pumps. However, as they do sample, they use the camera on the crawler and are able to adjust volumes accordingly. The NRC asked if the DOE is able to make adjustments to sample locations and to pull more or less from those areas. The DOE indicated that more samples could be taken based on the updated volume estimates during sampling.

3. The NRC inquired about the feasibility of use of crawlers to access that area of the tank (appeared to be effective at taking samples), the DOE indicated that they have a lot of difficulty getting the crawlers back there and actually had to hand off samples from one crawler to another. They ended up leaving two crawlers stranded in the tank and had to grout them in place.

4. The NRC stated that Figure 5.3-1 in the Closure Module Addendum has a peak dose at around 17K years that was not previously provided and is not acknowledged or discussed in the report. The peak dose is not associated with Tank 12H but the text introducing the figure indicates that the peak dose is from Tank 12H (peak dose within 10K years comes from Tank 12H while the overall peak dose presented on the figure within 20,000 years is 16 mrem/yr). The DOE indicated that the benchmarking results shown in Figures 5.6-24 through 5.6-28 in HTF PA revision 1 show the 17K year dose. After the NRC looked at these figures there was not sufficient information describing these results nor was the magnitude or the timing of dose similar to the peak shown in the CMA and the Tank 12 SA. In the out-brief, the NRC requested further clarification of this peak dose.

5. The NRC inquired about a statement in the Tank 12H SA that indicated that the tank was not driving the intruder dose in light of Figure 6.5-6 in the HTF PA that shows that the highest well dose next to a tank was associated with Tank 12H. The DOE indicated that Tank 12H might not necessarily be the driver for the 1-m boundary.

6. The NRC inquired about changes in the reporting of Minimum Detectable Concentrations (MDC) when there are insufficient number of detected samples or if all of the results are non-detect. The DOE used the highest MDC as "reasonably conservative" and used the lowest MDC as the "best estimate" for the radionuclide concentration. The NRC indicated that if there is a large range in the MDCs, then using the lowest MDC as the best estimate may underestimate the concentration (e.g., if a sample analysis had a relatively high MDC compared to another sample analysis for the same radionuclide, then the radionuclide concentration could have been lower than the relatively high MDC but higher than the lowest sample MDC. In those cases, the lowest sample MDC, which is used as the best-estimate, may underestimate the concentration).

7. In response to the NRC's inquiry on why the DOE didn't wash the Tank 12H cooling coils with OA or why OA wasn't effective on the cooling coils in Tank 12H, the DOE indicated that they didn't know why the cooling coil scale was there. The DOE is looking out for it on Tank 15H.

8. Tank 12H grout documentation reports being sent to the NRC as an action item.

9. When asked about the change in approach to using GoldSim for the Tank 12H SA and whether this approach would be taken in the future, the DOE indicated that they didn't have a lot of changes in this SA except for the inventory values and didn't see how it would hurt. The DOE plans to develop a new SA that will incorporate changes to the Tank 16H SA to include information on the alternative fast zone.

Outbrief:

The NRC added three Action Items to the list.

1. UWMQE on the use of clean closure cap grout in Tank 16H;

2. Want better explanation of what is meant by analyzing the three composite samples in triplicate. Why is analyzing in triplicate considered nine independent measurements?; and

3. Want better explanation of the 17K year peak in the Tank 12H closure module. Should also explain the inadvertent intruder dose.

The NRC noted that although the following are not action items, the following were items of note in the onsite observation:

1. Discussed the need to keep grout trucks in rotation to ensure that there are no breaks in the discharge of grout into the truck.

2. Discussed concern with the excess water in the annulus of Tank 12H and results of the grout drop test report that showed the potential for segregation and bleed water when dropping grout into standing water. Also concerned with groundwater in-leakage.