November 19, 2008

MEMORANDUM TO: Patrice Bubar, Deputy Director
Environmental Protection
and Performance Assessment Directorate
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

THRU: Christepher McKenney, Acting Chief **/RA/**
Low-Level Waste Branch
Environmental Protection
and Performance Assessment Directorate
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

FROM: David Brown, Sr. Project Manager **/RA/**
Low-Level Waste Branch
Environmental Protection
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Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

SUBJECT: OCTOBER 14, 2008, MEETING SUMMARY: DEPARTMENT OF ENERGY'S PERFORMANCE ASSESSMENT FOR THE F-TANK FARM, SAVANNAH RIVER SITE

On October 14, 2008, U.S. Nuclear Regulatory Commission (NRC) and Center for Nuclear Waste Regulatory Analyses staff met with staff from the U.S. Department of Energy, Washington Savannah River Company, and Savannah River Nuclear Solutions, to discuss the DOE's "Performance Assessment for the F-Tank Farm, Savannah River Site," SRS-REG-2007-0002, which was provided to NRC for review on August 25, 2008. I am attaching the meeting summary for your use.

Docket No.: PROJ0734
Enclosure: Meeting Summary

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| **OFC** | FSME | FSME |
| **NAME** | DBrown | CMcKenney |
| **DATE** | 11/13/08 | 11/19/08 |

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A Summary of Meeting: Department of Energy's "Performance Assessment for the F-Tank Farm, Savannah River Site," SRS-REG-2007-0002, Rev. 0, dated June 27, 2008

Date: October 14, 2008

Place: U.S. Nuclear Regulatory Commission
One White Flint North, Room O-3B4
Rockville, MD 20852

Attendees: See Attachment 1.

Purpose:

The purpose of the meeting was for the Department of Energy (DOE) and its contractors, Washington Savannah River Company (WSRC), and Savannah River Nuclear Solutions (SRNS), to provide both an overview of the Performance Assessment (PA) for the F-Tank Farm, Savannah River Site, SRS-REG-2007-0002, and a detailed description of the waste release model contained therein. This meeting also afforded an opportunity for staff of the Nuclear Regulatory Commission (NRC) and its contractor, the Center for Nuclear Waste Regulatory Analyses (CNWRA) to ask initial clarifying questions regarding the PA methodology and results.

Discussion:

After introductions and brief opening remarks, Mr. Kent Rosenberger of SRNS delivered a presentation entitled, "Overview of Savannah River Site F-Tank Farm," SRNS-J2100-2008-00005. Mr. Rosenberger's presentation slides are provided as Attachment 2. In his presentation, Mr. Rosenberger described the location of the F-Tank Farm on the Savannah River Site, and provided a brief description of high-level waste tank designs and ancillary equipment that are located in F-Tank Farm. Mr. Rosenberger also summarized the stakeholder input scoping meetings that were held between DOE, NRC, the Environmental Protection Agency and South Carolina Department of Health and Environmental Control (SCDHEC) since February 2007.

Immediately following Mr. Rosenberger's presentation, Mr. Mark Layton delivered a presentation entitled, "F-Tank Farm Performance Assessment Overview," SRNS-J2100-2008-00007. At the request of NRC and CNWRA staff, Mr. Layton focused his presentation on the waste release model described in the PA. Mr. Layton's presentation slides are provided as Attachment 3. NRC and CNWRA staff asked questions throughout Mr. Layton's presentation. Mr. Layton provided an overview of the modeling approach in the PA, a description of the major modeling segments, modeling results, and an overview of the uncertainty/sensitivity analysis.

Mr. Layton described the hybrid assessment approach used in the FTF PA. This hybrid approach relies on two styles of assessment: a deterministic evaluation to establish a base case using single parameter sensitivity analyses (referred to as Tank Configuration A in the FTF PA); and a stochastic evaluation for uncertainty and sensitivity analyses. Mr. Layton further explained the modeling process, including the integration of up to four computer codes in an Integrated Site Conceptual Model (ISCM) for the FTF PA. The ISCM has three components, including a closure cap model, vadose zone model, and saturated zone model. As shown in Figure 4.3-1 of the FTF PA, the computer codes HELP and PORFLOW were used by DOE for the deterministic evaluation of closure cap infiltration and vadose and saturated zone flow and transport. GoldSim was used for the stochastic evaluation to investigate model parameter importance and uncertainties in risk calculations that are more difficult to evaluate with codes such as PORFLOW that are more resource intensive to execute and/or do not have all of the components of the risk assessment incorporated into one platform. Because of the differences in models available in GoldSim versus other codes such as PORFLOW in some cases GoldSim used information from other codes as input to the stochastic analysis. For example, GoldSim does not solve flow equations and therefore PORFLOW flow model output on the range of flow regimes was an input to the GoldSim model. A module developed for GoldSim was also used for assessment of intruder and public dose in both the deterministic and probabilistic calculations. CAP88-PC was used to calculate doses from airborne releases, which were calculated by PORFLOW and result from the vapor phase radionuclide diffusion to the surface. Mr. Layton described the advantage of this hybrid approach, in terms of being able to use the deterministic approach to improve the stochastic model, and vice-versa.

With regard to use of the PORFLOW computer code, NRC and CNWRA staff asked about the calibration of the groundwater flow model; how solubility limits are applied in PORFLOW for individual radionuclides; and how PORFLOW handles the differences in subsurface transport behavior between parent and daughter radionuclides. In response, SRNS and WSRC staff explained that section 4.4.4.1 of the PA addresses vadose zone and aquifer model validation; explained the conservative nature of the way PORFLOW handles solubility limits (i.e., solubility limits are applied to each radionuclide independently, without regard to the presence of other isotopes of the same element that may be present – which tends to overpredict the aqueous phase concentration of elements such as uranium and plutonium); and explained that PORFLOW is able to compute variable flow and transport properties for parent and daughter radionuclides. This exchange between meeting participants was typical of NRC and CNWRA staff technical questions that were asked, and the answers that were provided by DOE and its contractors, throughout Mr. Layton's presentation.

As noted on slide 9 of Mr. Layton's presentation, DOE modeled waste tanks and ancillary equipment independently. For ancillary equipment, over 45,000 linear feet of steel transfer line and numerous vessels were modeled as instantaneously failing at the time of 25% pitting penetration for "in soil" 0.116 inch thick stainless steel at year 510 post-closure, with the radionuclide inventory released to the surrounding soil spread throughout the entire FTF. NRC asked about the impact of spreading the auxiliary equipment inventory over a larger area than represented by the individual sources (e.g., line sources representing the piping). DOE explained that the auxiliary equipment risk is much lower than the tank risk and that the individual contribution of the largest discrete source results in a peak in the dose curves that could be scaled to determine the bounding risk from the auxiliary equipment. NRC staff requested clarification of PA section 3.3.3, "Ancillary Equipment Inventory," in which DOE provides a description of the calculation used to generate the estimated concentrations of radionuclides in Table 3.3-5.

Following a mid-morning break, Mr. Greg Flach of SRNS described the approach to PORFLOW model validation, which is described in the PA beginning on page 419. Mr. Flach's presentation slides are included in Attachment 4. NRC staff inquired as to whether the validation approach for E-Area addresses potential variability in vadose zone properties between the E-area and the F-area. DOE explained that while the PORFLOW model validation exercise was for an E-Area model that the same vadose zone properties apply for FTF and would be applicable to the FTF model. NRC asked about some of the results of the validation exercise including differences between predictions versus monitoring results that may have indicated vertical versus lateral flow. DOE explained the difficulty in collecting measurements directly underneath the E-Area vaults with horizontal wells and indicated that the FTF vadose zone model predicts mainly vertical flow.

Mr. Layton continued his presentation after the validation discussion, starting with the section on "Modeling Segments" (Attachment 3, slide 10). The meeting participants discussed the time intervals for which calculations are performed by the various models. For example, for radionuclides that are more mobile in groundwater, calculations were performed for each year following a hypothetical release. The use of one-year time steps was deemed sufficient by DOE contractor staff to assure that peak concentrations would not be inaccurate due to numerical dispersion issues.

With regard to the modeling of features above the contamination zone, Mr. Layton noted that the steady-state flow of water through the closure cap is reached at year 3,500, which does not impact the results in the base case described in the PA (i.e., Tank Configuration A). Mr. Layton also explained that a notable characteristic of the PA is that the combination of the timing of both cementitious material degradation (both fill grout and tank vault concrete), and tank steel liner failure, taken together with the expected tank inventories (i.e., largest inventory for key radionuclides), and location of the Type IV tanks (i.e., closer to compliance point), which have relatively thin basemats, leads to a worst-case configuration for Type IV tanks that tends to dominate the PA results.

With regard to questions from NRC staff about the steel liner failure modeling, DOE stated that the effect of later tank liner failure is to cause the source term to be "pent up," which ultimately increases the potential downgradient concentration of radionuclides and increases the potential peak dose. Postulating earlier times of tank steel liner failure tends to reduce the calculated release rate of radionuclides, resulting in lower potential downgradient concentration of radionuclides and lower potential peak doses.

As shown on slide 14 of Attachment 3, Mr. Layton also described the modeling of engineered barrier degradation and radionuclide release in the waste tank contamination zone. Participants discussed how tank steel corrosion products and wall inventory are accounted for in the solubility model; and how the solubility controlled release model was applied for fast flow paths. Much of the discussion centered around the information in section 4.4.3 of the PA, "Evaluation of Integrated System Behavior." In this section of the FTF PA, the Configuration A (base case) and Configuration D (fast flow case) timelines associated with various model segments for the different tank types are provided in Tables 4.4-2 through 4.4-5.

With regard to the tank basemat, SRNS explained that basemat thickness is an important parameter in the PA. In response to questions about stress corrosion cracking in the basemat in the vicinity of support columns, WSRC and SRNS staff described the leaks that have been observed in Type I tanks only. No leaks have been observed in Type III or IIIA. One Type IV tank has a leak at a high elevation, which is caused from in-leakage attributable to percolating rainwater.

Just before breaking for lunch, DOE and WSRC staff took a question from Bill Lawless regarding whether the PA identifies a single geospatial point of compliance for the assessment. DOE and WSRC staff explained that the FTF PA provides assessment results for multiple points of assessment, including distances as small as 1 meter from the waste units for the intruder analysis, 100 meters from the circumferential boundary of the F-Area tanks, and out to the seep locations on Upper Three Runs Creek and Fourmile Branch.

After lunch, additional SRNS staff were available by teleconference to answer questions from the morning sessions. Drs. Denham, Subramanian, and Wiersma addressed NRC and CNWRA staff questions on the solubility-controlled release model, including why only two discrete pH values (i.e., pH values of 12 and 8) were considered, rather than a continuous range. The participants also discussed the basis for, and the importance of, using an analysis of Tank 18 dip samples as the basis for solubility limits in the release model. The discussion included consideration of why DOE used a distributed failure-time versus a simultaneous failure model for tank liner failure. The NRC and CNWRA staff also asked about the assumptions regarding corrosion caused by chloride and carbonation. NRC also commented on the decoupling of the cementitious material and steel liner modeling which may lead to a situation where the conceptual model for steel liner failure was inconsistent with the results of the cementitious material degradation modeling (e.g., concrete had degraded prior to the steel liner failure but steel liner modeling assumes diffusion-limited transport through in-tact concrete). The questions focused on the assumption that corrosion in chloride environments is uniform and that the corrosion rate is limited by the diffusion of oxygen, and the technical basis for the corrosion rate assumed under degraded concrete.

Mr. Subramanian described why the time-to-failure for the steel tank liner need only consider diffusive flow of oxygen, and not advective flow, in configuration D (fast flow path). In his view, the elevated diffusion coefficient used in the sensitivity study would account for, and bound, any advective flow. Mr. Subramanian also described the basis for the maximum generalized corrosion rate of 10 mils per year due to carbonation. The NRC and CNWRA also inquired about the potential for chloride-induced pitting corrosion as a mechanism for tank liner degradation and failure. Mr. Subramanian explained that, for carbon steel and concrete, chloride-induced corrosion is expected to be manifested as generalized corrosion, rather than pitting corrosion, under conditions in concrete. NRC emphasized the need for DOE to consider high risk / low probability consequences, such as coupling of steel liner failure with grout failure, in its analysis.

With regard to the timing of engineered barrier degradation, NRC staff asked if DOE had considered, in addition to the possibility of steel liner failure after the grout had already degraded, the possibility that the steel liner could fail before the grout fails hydrologically. (Section 4.4.2.4 of the PA, "Tank Configuration D," describes a configuration in which a fast flow path exists through the entire closed system). While this configuration was not modeled, DOE noted that failure of the tank grout prior to steel liner failure would have minimal impact on the flow regime through the system. SRNS also noted that an analysis of a fast flow path through the system (Configuration D) was included on page 640 of the FTF PA, "Base Case Parameters with Configuration D Flows and Failure Times and Rapid Transition to Oxidized Region III). These results of this "incredible scenario" are shown in Figures 5.6-45 and 5.6-46 of the FTF PA, in which indicates potential peak all-pathways doses above 65 mrem/year for Well 6.

Meeting participants also discussed the solubility-controlled releases of radionuclides from the closed tanks. SRNS explained that solubility models were developed using data contained in the Geochemists Workbench and solubility limits control the release rate of contaminants from the contaminated zone. Specifically, SRNS used the EQ3/6 thermodynamic database and thermo.v.06, which is a thermodynamic database developed by Lawrence Livermore National Laboratory, which also comes packaged in Geochemists Workbench. Participants discussed: why DOE used two discrete pH endpoints (pH=12.4 and pH=8.2) in the analysis of the range of radionuclide solubilities, and whether DOE had confidence that solubility constants did not increase at intermediate pH values; the basis for the distribution coefficient for iron (Fe) co-precipitation; and the assumption that iron co-precipitation is a controlling factor in the solubility of technetium.

Mr. Layton also discussed insights that were obtained from the development of modeling segments. With regard to the basemat modeling segment, SRNS noted that the relatively thin Type IV tank basemats is important to the overall assessment results. SRNS summarized the important factors in the post-closure performance of the F-Tank Farm: proximity of the tank bottoms to the subsurface saturated zone; the thickness of the tank basemats; proximity of certain tanks to the downgradient point of assessment; and pessimistic assumptions regarding the inventory of the certain tanks (e.g., Type IV tanks).

During the last portion of the meeting, WSRC and SRNS described the dose modeling results in the PA. Attachments 5, 6, 7, and 8 are additional figures provided to NRC and CNWRA staff during the meeting. The participants discussed the dose results depicted in PA Figures 5.5-1 and 5.5-2 (Attachments 6 and 7), which show the future year of ancillary equipment failure (year 510), the future year of Type IV failure (year 3638), and the future year of Type I & III failure (year 12,750). Figure 5.5-4 of the PA (Attachment 8) shows the post-closure 20,000 year doses from ten radionuclides. Participants briefly discussed the contribution of radium-226 to the maximum dose, which is less than 2.6 mrem/year at about year 13,500, which is attributable to failure of the steel liners for tank Types I and III/IIIA.

Participants also discussed the intruder scenarios. NRC and CNWRA staff asked about the relatively high contribution of Cs-137 to the plant ingestion pathway, which was the dominant pathway for the chronic intruder, as compared to the direct dose pathway from contaminated soils. DOE agreed to provide additional information regarding the Cs-137 pathway dose contributions.

With regard to the sensitivity and uncertainty analyses, Mr. Layton described PA Figure 5.6-20, which shows the percentiles of dose results over the 10,000 year evaluation period. NRC and CNWRA staff asked about the model realization with the highest peak dose and asked for additional information on under what conditions did the largest peak doses occur.

Summary of items for which DOE agreed to provide additional information

1. In PA section 3.3.3, “Ancillary Equipment Inventory,” provide a description of the calculation used to generate the estimated concentrations of radionuclides in Table 3.3-5.
2. In section 4.4 of the PA, Table 4.4-1, clarify whether the diffusion coefficients listed in column 5 is for $CO_2$, rather than $Ca^{2+}$.
3. For the 1,000 realizations represented in Figure 5.6-20, provide the value of the maximum peak dose for any realization and attempt to describe what parameters or processes lead to the highest peak doses (e.g., higher Tc-99, Pu or U solubilities, waste release scenario D with preferential pathways through the system).
4. With regard to the calculation of chronic dose to the inadvertent intruder from well drill cuttings in Section 6.2 of the PA, explain the large dose contribution of Cs-137 to the plant ingestion pathway versus the external dose pathway (e.g., in the INL INTEC TFF and other performance assessments, Cs-137 contributes primarily to the external dose pathway).

October 14, 2008 Meeting: "Department of Energy's "Performance Assessment for the F-Tank Farm, Savannah River Site"

Meeting Attendees

| | |
|---|---|
| Anna Bradford | U.S. NRC |
| Andrea Kock | U.S. NRC |
| David Brown | U.S. NRC |
| Cynthia Barr | U.S. NRC |
| Christopher Grossman | U.S. NRC |
| Leah Spradley | U.S. NRC |
| George Alexander | U.S. NRC |
| Ali Simpkins | Center for Nuclear Waste Regulatory Analyses* |
| Lane Howard | Center for Nuclear Waste Regulatory Analyses |
| Cynthia Dinwiddie | Center for Nuclear Waste Regulatory Analyses* |
| David Pickett | Center for Nuclear Waste Regulatory Analyses* |
| Osvaldo Pensado-Rodriquez | Center for Nuclear Waste Regulatory Analyses* |
| Roberto Pabalan | Center for Nuclear Waste Regulatory Analyses* |
| Martin Letourneau | U.S. Department of Energy |
| Sherri R. Ross | U.S. Department of Energy |
| Ginger Dickert | Washington Savannah River Company |
| Kent Rosenberger | Savannah River Nuclear Solutions |
| Mark Layton | Savannah River Nuclear Solutions |
| Steve Thomas | Savannah River Nuclear Solutions |
| Tom Robinson | Savannah River Nuclear Solutions |
| Greg Flach | Savannah River Nuclear Solutions |
| Miles Denham | Savannah River Nuclear Solutions** |
| Karthick Subramanian | Savannah River Nuclear Solutions** |
| Bruce Wiersma | Savannah River Nuclear Solutions** |
| Bill Lawless | Public** |

* participated by video teleconference from San Antonio, TX
** participated by teleconference from South Carolina