

February 15, 2013

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SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION DECEMBER 6, 2012, ONSITE  
OBSERVATION VISIT REPORT FOR THE SAVANNAH RIVER SITE SALTSTONE  
DISPOSAL FACILITY (DOCKET NO. PROJ0734)

Dear Ms. Blanco:

The enclosed report describes the U.S. Nuclear Regulatory Commission (NRC) onsite observation visit on December 6, 2012, at the Savannah River Site (SRS) Saltstone Disposal Facility (SDF). The visit was conducted in accordance with Section 3116(b) of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA), which requires NRC to monitor certain disposal actions taken by the U.S. Department of Energy (DOE) for the purpose of assessing compliance with the performance objectives set out in 10 CFR Part 61, Subpart C. The activities conducted during the visit were consistent with those described in the NRC monitoring plan for salt waste disposal at SRS (dated May 3, 2007) and the NRC staff guidance for activities related to waste determinations (NUREG-1854, dated August 2007).

On every onsite observation visit to SRS, NRC is focused on assessing compliance with four performance objectives in 10 CFR Part 61, Subpart C: (1) protection of the general population from releases of radioactivity (§61.41), (2) protection of individuals from inadvertent intrusion (§61.42), (3) protection of individuals during operations (§61.43), and (4) stability of the disposal site after closure (§61.44).

On April 30, 2012, NRC issued both a Technical Evaluation Report (TER) [available via the NRC's Agencywide Documents Access and Management System (ADAMS) at Accession Number ML121020140] and a Type IV Letter of Concern [ML120650576] pertaining to waste disposal at the SRS. The TER concluded that NRC did not have reasonable assurance that salt waste disposal at the SDF met the performance objective §61.41. The Type IV Letter of Concern formally communicated NRC's concerns to both DOE and the South Carolina Department of Health and Environmental Control.

DOE provided responses to the Type IV Letter to NRC in two submittals. These submittals included an updated technetium-99 (Tc-99) inventory projection for the newly constructed SRS saltstone disposal structures<sup>1</sup>; and information about DOE Case K and K1 uncertainty and sensitivity analyses. In August 2012, NRC issued a letter of acknowledgement [ML12213A447] stating that a letter to the U.S. Congress (Type II) is not needed at this time. Based on the NRC's TER analyses and DOE's revised Tc-99 inventory, the staff determined that, if DOE's new projected Tc-99 inventory for the newly constructed disposal structures is correct, then it is unlikely that the salt waste disposal would cause an off-site peak dose exceeding the requirements of §61.41 (i.e., 0.25 mSv/yr (25 mrem/yr)).

The December 2012 onsite observation visit focused on the technical concerns described in the NRC 2012 TER. There are no new open issues resulting from that visit. Open issues that had been identified earlier have been rolled into the concerns identified by NRC in the 2012 TER. All NRC concerns will be rolled into the monitoring factors in the revised monitoring plan that is being drafted by NRC.

The observation addressed a subset of the concerns raised in the 2012 TER. During the observation, staff was encouraged by DOE's progress in a research plan that will provide useful information about risk-significant aspects related to SDF performance. The DOE and NRC continue to work in the monitoring process to resolve all outstanding issues that led to issuance of the Type IV Letter of Concern. In accordance with the requirements of NDAA, NRC will continue to monitor DOE disposal actions at SRS.

Shortly before the observation, DOE requested a public meeting for January 2013 to discuss a revised model with updated parameterization in addition to continued discussions about progress in research related to the concerns identified in the NRC's TER. In addition to DOE providing details about its revised model, some of the technical documents discussed during this observation were discussed in the January 17, 2013 public meeting. For details of the January 17, 2013 public meeting, please refer to the meeting summary at ADAMS Accession Number ML13025A038.

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<sup>1</sup> Inventory projections described in DOE's response to NRC's Type IV Letter are listed in reference to Disposal Structures (Cells) 2A, 2B, 3A, 3B, 5A, and 5B. Throughout this report, these structures will be referred to as the "newly constructed" saltstone disposal structures.

S. Blanco

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If you have any questions or need additional information regarding this report, please contact Nishka Devaser of my staff at (301) 415-5196.

Sincerely,

***/RA/ K. Hsueh for A. Mohseni***

Aby Mohseni, 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

Enclosure:  
NRC Onsite Observation Visit Report

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S. Blanco

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NRC Onsite Observation Visit Report

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**U.S. NUCLEAR REGULATORY COMMISSION DECEMBER 6, 2012, ONSITE  
OBSERVATION VISIT REPORT FOR THE SAVANNAH RIVER SITE SALTSTONE  
DISPOSAL FACILITY**

**EXECUTIVE SUMMARY:**

The U.S. Nuclear Regulatory Commission (NRC) staff conducted its 13<sup>th</sup> onsite observation visit, Observation 2012-02, to the Saltstone Disposal Facility (SDF) at the Savannah River Site (SRS) on December 6, 2012. On every onsite observation visit to SRS, NRC focuses on assessing compliance with four performance objectives in 10 CFR Part 61, Subpart C: (1) protection of the general population from releases of radioactivity (§61.41), (2) protection of individuals from inadvertent intrusion (§61.42), (3) protection of individuals during operations (§61.43), and (4) stability of the disposal site after closure (§61.44).

During Observation 2012-02, NRC focused on information regarding the April 30, 2012, NRC Technical Evaluation Report (TER) and associated Type IV Letter of Concern, where NRC concluded that it did not have reasonable assurance that salt waste disposal at the SDF met the performance objectives in 10 CFR Part 61, specifically §61.41. NRC performs monitoring activities in coordination with the State, so staff from the South Carolina Department of Health and Environmental Control (SC DHEC) also participated in this visit.

During Observation 2012-02, NRC staff and U.S. Department of Energy (DOE) staff (including DOE contractors, Savannah River Remediation (SRR) throughout this report), discussed salt waste processing and the details of recent research conducted by DOE, related to issues identified in NRC's TER. In addition, DOE provided NRC staff a brief tour of the SDF, including closer views of the newly constructed SRS saltstone disposal structures<sup>2</sup>. This report provides a description of the NRC activities during Observation 2012-02, including observations that NRC staff made during the visit.

There are no new Open Issues<sup>3</sup> resulting from Observation 2012-02. NRC staff received documents and a DOE presentation that pertained to the activities to be observed. The presentation that DOE provided to NRC staff and the documents provided by DOE for discussion at the observation are accessible via the NRC's document repository, the Agencywide Documents Access and Management System (ADAMS), via accession number ML12345A110.

Observation 2012-02 addressed a subset of the concerns raised in the 2012 TER. During the observation, staff was encouraged by DOE's progress in conducting research that provides useful information. The DOE and NRC continue to work in the monitoring process to resolve all outstanding issues that led to issuance of the NRC's Type IV Letter of Concern.

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<sup>2</sup> Inventory projections described in DOE's response to NRC's Type IV Letter are listed in reference to Disposal Structures (Cells) 2A, 2B, 3A, 3B, 5A, and 5B. Throughout this report, these structures will be referred to as the "newly constructed" saltstone disposal structures.

<sup>3</sup> The previous Open Issues are now rolled into the concerns identified by NRC in the 2012 TER. Those NRC concerns will be rolled into the monitoring factors in the revised monitoring plan that is being drafted by NRC.

A summary of NRC staff observations and conclusions in those areas is provided below:

- Previous Observation Follow-up

DOE provided a status of follow-up actions from the August 2012 observation (NRC, 2012e). This included a list of 14 items or topics, all of which were discussed, 11 of which were completed (closed), and 3 of which were discussed and an estimated completion date was provided. Discussions of the three remaining items will continue at the next onsite observation. Two new follow-up actions came from the discussion on Salt Batch 7 Tc-99 concentrations which will also be discussed at the next observation.

- SDF Operation Details

DOE provided NRC staff with details of the disposal activities. During September and October 2012, approximately 4.2 million liters (1.1 million gallons) of salt waste was disposed into Saltstone Disposal Structure 2B from Tank 50. This is the first saltstone disposed of in the new design as presented in the 2009 Performance Assessment (PA) (SRR-CWDA-2009-00017).

- Technical Discussion – Performance Assessment Maintenance Research Activities

NRC and DOE staff discussed DOE Performance Assessment Maintenance Research Activities, including Operating Window Property Testing (SRNL-STI-2012-00558), Tc-99 Solubility and  $K_d$  Studies (PNL-21723 and SRNL-STI-2012-00596), Method Evaluation for Measuring Oxidation Front Movement (SRNL-STI-2012-00468, Rev. 0), Fracture Transport (SRNL-STI-2012-00267), Formed Core Sampling (SRNL-STI-2012-00551), Review of Concrete Biodeterioration (SRNL-STI-2012-00435), and Comparison of Wasteform Mixtures (SIMCO, 2012).

Of these topics, the most time was spent on the discussion of the operating window property testing and the Tc-99 solubility and  $K_d$  studies. Regarding the operating window property testing, the NRC staff asked several questions about the incorporation of flush water into the emplaced saltstone and the resulting saltstone properties. Regarding the Tc-99 solubility and  $K_d$  studies, the DOE staff indicated it expects to implement solubility limits for Tc-99 in future PA models and expects to have the peer-reviewed report supporting the chosen solubility limit values available in 2013.

## **1.0 BACKGROUND:**

Section 3116 of the National Defense Authorization Act for Fiscal Year 2005 (NDAA) authorizes DOE, in consultation with NRC, to determine that certain radioactive waste related to the reprocessing of spent nuclear fuel is not high-level waste, provided certain criteria are met. The NDAA also requires NRC to monitor DOE disposal actions related to those determinations to assess compliance with the performance objectives in 10 CFR Part 61, Subpart C.

To carry out its monitoring responsibility under the NDAA, NRC, in coordination with the State site regulator – SC DHEC, performs three types of activities: (1) technical reviews, (2) onsite observation visits, and (3) data reviews. Those activities focus on key assumptions identified in the NRC monitoring plan. Technical reviews generally focus on reviewing additional model support for assumptions that DOE made in its PA that are considered important to the DOE

compliance demonstration. Onsite observation visits generally are performed to: (1) observe the collection of data (e.g., observation of waste sampling used to generate radionuclide inventory data) and review the data to assess consistency with assumptions made in the waste determination; and (2) observe key disposal or closure activities related to technical review areas (e.g., slag/other material storage, grout formulation, preparation, or placements). Data reviews supplement technical reviews by focusing on monitoring data that may indicate future system performance or by reviewing records or reports that can be used to directly assess compliance with the performance objectives.

On March 31, 2005, DOE submitted to NRC the *Draft Section 3116 Determination for Salt Waste Disposal Savannah River Site* (DOE-WD-2005-001, Rev. 0) to demonstrate compliance with the NDAA criteria, including demonstration of compliance with the performance objectives in 10 CFR Part 61, Subpart C. In its consultation role, NRC staff reviewed the draft waste determination. In the TER issued in December 2005 (NRC, 2005), NRC documented the results of its review and concluded that there was reasonable assurance that the applicable criteria of NDAA could be met, provided certain assumptions made in the DOE analyses were verified via monitoring. Taking into consideration the assumptions, conclusions, and recommendations in the NRC 2005 TER, DOE issued the final waste determination in January 2006 (DOE-WD-2005-001, Rev. 1).

DOE submitted a revised PA to NRC in 2009 (SRR-CWDA-2009-00017). NRC reviewed SRR-CWDA-2009-00017, including holding public meetings, sending requests for additional information, and reviewing the DOE responses. On April 30, 2012, NRC issued both the TER (NRC, 2012a) and the Type IV Letter of Concern (NRC, 2012b). In the 2012 TER, NRC concluded that it did not have reasonable assurance that salt waste disposal at the SDF met the performance objectives in 10 CFR Part 61, specifically §61.41. The Type IV Letter of Concern formally communicated the NRC concerns to both DOE and the SC DHEC.

In July 2012, DOE responded to the Type IV Letter to NRC (DOE, 2012a; DOE, 2012b). DOE's response included information about an updated technetium-99 (Tc-99) inventory projection for the newly constructed disposal structures; and information about the DOE Case K and K1 uncertainty and sensitivity analyses. In response to DOE's submittal, NRC issued a letter of acknowledgement, dated August 31, 2012, stating that a (Type II) Letter to the U.S. Congress is not needed at this time. Based on the NRC's TER analyses and DOE's revised Tc-99 inventory, the staff determined that, if DOE's new projected Tc-99 inventory for the newly constructed disposal structures is correct, then it is unlikely to cause an off-site peak dose exceeding the requirements of §61.41 (i.e., 0.25 mSv/yr (25 mrem/yr)).

## **2.0 NRC ONSITE OBSERVATION VISIT ACTIVITIES:**

Observation 2012-02 began with a short briefing on the agenda and site safety procedures presented by DOE and attended by representatives from DOE, NRC, and SC DHEC. Discussions that followed included follow-up items from the August 2012 observation, details of the recent saltstone production run into Saltstone Disposal Structure (SDS) 2B, and research results from experiments conducted in accordance with DOE's performance assessment maintenance program (as they relate to issues identified in NRC's 2012 TER). This report summarizes those discussions.

Prior to Observation 2012-02, DOE provided NRC staff with a group of documents covering research related to issues identified in NRC's TER (NRC, 2012a). In addition, DOE also requested a public meeting for January 2013 to further discuss research and modeling related to the concerns identified in the NRC's TER. The discussion of these documents was limited because the documents were only provided for review one week in advance of the observation. Thus, this report does not necessarily represent a complete NRC review of these documents. Further discussion of each of these documents is included in the January 17, 2013 public meeting agenda.

At the start of the observation an additional topic was discussed that was not on the agenda. This was the introduction of a new term, "disposal structure", that could be used to designate both DOE "vaults" and "future disposal cells" in future documents, such as the revised Monitoring Plan or observation guidance. A saltstone disposal structure is a self-enclosed engineered barrier that is designed to limit the release of saltstone to the environment. A disposal structure may include one or more cells. In this and future NRC documentation related to the SDF, the term "disposal structure" refers to DOE "Vault 1", "Vault 4", and "future disposal cells." The term "disposal structure" could also be used to refer to potential new DOE designs for structures to contain saltstone. The DOE term "Saltstone Disposal Unit" typically denotes a set of disposal structures (e.g., Saltstone Disposal Unit 2 includes SDS 2A and 2B).

## 2.1 Previous Observation Follow-up:

### 2.1.1 Observation Scope:

Observation visits typically begin with a discussion of the status of action items from the previous visit. Thus, this portion of the observation report applies to items discussed in the previous onsite observation (NRC, 2012e).

### 2.1.2 Observation Results:

DOE provided an update on each of the follow-up actions discussed during the August 2012 observation. Each follow-up item is provided below. For more details, please review DOE's presentation from the observation (SRR-CWDA-2012-00165).

#### Completed Items from August Observation

- 2012-01-1. DOE to provide cure temperature profiles for field-emplaced saltstone (Explanation in SRNL-STI-2012-00558).
- 2012-01-2. DOE to provide analytical documents referenced in Table 1 from SRR-CWDA-2012-00095 (SRNL-I3100-2012-00062, X-ESR-H-00377, and SRR-LWE-2012-00130).
- 2012-01-3. DOE to clarify the interpretation of lysimeter concentration data as it relates to evaporation from the collection vessels (Explanation in SRR-CWDA-2012-00165).

- 2012-01-4. DOE to clarify the interpretation of data related to water that flows around the lysimeter cementitious samples (Explanation in SRR-CWDA-2012-00165, but the NRC staff notes that the interpretation of data obtained from the lysimeters is a challenging problem due to uncertainty in the flow of the water around the saltstone simulant).
- 2012-01-5. *NRC Action:* NRC to provide informal integrated priority list of monitoring factors to DOE.
- 2012-01-6. DOE to provide a document list<sup>4</sup>.
- 2012-01-7. DOE to provide SRR-CWDA-2012-00112.
- 2012-01-8. DOE to provide SDS 3A leachate collection construction details.
- 2012-01-9. DOE to provide the distance of the groundwater monitoring wells from SDSs 2A and 2B.
- 2012-01-10. DOE to define which aquifers the wells near SDSs 2A and 2B are screened in.
- 2012-01-11. DOE to provide information related to Tc-99 concentrations beyond Batch 7 and anticipated through 2015 (DOE will provide this when data becomes available). **During observation 2012-02, this action was rewritten as two new follow-up actions (see later list).**

*Items from August Observation to be Revisited*

- 2012-02-1. DOE to provide an estimate of the volume of water from environmental sources, if any, intruding into SDS 4 (Expected completion February 15, 2013).
- 2012-02-2. DOE to describe the expected surveillance and maintenance program for disposal structure penetrations after operations and prior to final site closure (Expected completion Fall 2013).
- 2012-02-3. DOE to describe the plans to maintain or close the drain water removal system after operations and prior to final closure (e.g., maintenance of instrumentation for liquid detection) (Expected completion Fall 2013).

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<sup>4</sup> Based on the experience both agencies have gained under NDAA monitoring, both NRC and DOE agreed that the updated monitoring plan will include a list of certain original and updated documents DOE will provide to NRC that are relevant to the NRC in performing its NDAA monitoring responsibilities. This "Document List" will be included in the appendix of the updated NRC monitoring plan.

### New Items from August Observation Follow-up Discussion

- 2012-02-4. **New Follow-up Action:** Discuss, as needed, the Salt Macro-batch 6 qualification sample report and any additional sampling reports related to Salt Batch 7 at January public meeting.
- 2012-02-5. **New Follow-up Action:** Add Salt Batch qualification sample reports on the routine document list in the revised NRC monitoring plan.

#### 2.1.3 Conclusions and Follow-up Actions:

The NRC staff will continue to monitor the progress of the *Items from August Observation to be Revisited* list of follow-up actions from the August 2012 observation. Five follow-up actions resulted from this site observation visit (visit 2012-02). The list is composed of the three items in the *Items from August Observation to be Revisited* list and two new actions born of the discussion regarding Tc-99 concentrations beyond Batch 7.

- 2012-02-1. DOE to provide an estimate of the volume of water from environmental sources, if any, intruding into SDS 4 (Expected completion February 15, 2013).
- 2012-02-2. DOE to describe the expected surveillance and maintenance program for disposal structure penetrations after operations and prior to final site closure (Expected completion Fall 2013).
- 2012-02-3. DOE to describe the plans to maintain or close the drain water removal system after operations and prior to final closure (e.g., maintenance of instrumentation for liquid detection) (Expected completion Fall 2013).
- 2012-02-4. NRC and DOE to discuss, as needed, the Salt Macro-batch 6 qualification sample report and any additional sampling reports related to Salt Batch 7 at January 2013 public meeting.
- 2012-02-5. NRC and DOE to add Salt Batch qualification sample reports on the routine document list in the revised NRC monitoring plan.

#### 2.2 Technical Discussion – Salt Waste Processing:

##### 2.2.1 Observation Scope:

NRC staff monitors salt waste processing, including qualification of salt batches. Salt waste processing and quality assurance are critical to grout quality. A discussion of grout quality includes the qualification of salt batches and grout production at SPF. Batch qualification ensures that the feed material is within tolerances acceptable to production, and production variables such as water to premix ration, dry feeds variability, and curing conditions, impact the performance of the waste form. Worker doses during salt waste grout processing and SDS operation are directly related to the performance objective for protection of individuals during operations (i.e., §61.43). Section 3.2.2, “Waste Sampling”, Section 3.2.3, “Vault Construction”<sup>5</sup>, Section 3.2.4, “Grout Formulation and Placement”, and Section 5, “Monitoring to Assess

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<sup>5</sup> “Vault” is a historical DOE term for a type of disposal structure.

Compliance with §61.43 – Protection During Operations” of the May 2007 monitoring plan (NRC, 2007a) provide details of the basis for NRC staff review areas.

### 2.2.2 Observation Results:

DOE provided an update of salt waste grout processing, including details of recent saltstone processing in SDS 2B. Approximately 4.2 million liters (1.1 million gallons) of salt waste was disposed into SDS 2B from Tank 50 in September and October of 2012. DOE stated that the SPF had operated for 19 days in October, completely processing all of the available feed in the SPF feed Tank (Tank 50). The following bullets provide a highlight of the discussion:

- DOE noted it planned to process more saltstone at the SPF in March 2013, but that this date may slip depending on the resolution of an operational issue at the Defense Waste Processing Facility.
- DOE stated there had been a seep through an electrical conduit on SDS 4 and that contamination was found on the exterior disposal structure wall. DOE noted that these types of conduits through the disposal structure walls will be sealed prior to site closure.
- DOE described improved technology for monitoring dry feeds batch data and showed data for approximately 2,700 batches that indicated limited variability in slag, fly ash, and cement values.
- DOE showed video of saltstone being poured into SDS 2B and a video survey of the inside of SDS 2B after saltstone had cured for approximately 3 days. The video showed condensation on the ceiling of the disposal structure, which indicated that saltstone was curing in a humid environment. DOE noted it would continue video surveys of the inside of SDS 2B and would continue to look for signs of condensation. DOE noted disposal had not yet begun in SDS 2A.
- DOE indicated that the elevation of the top surface of saltstone varied by approximately 3 inches across SDS 2B.
- DOE noted an upward trend in cesium content in the Z-area storm water runoff basin, which would be documented in the 2012 SRS annual environmental report. The NRC staff will continue to monitor radionuclide concentrations in the Z-area storm water runoff basin and evaluate implications for site performance.

Details, including plots on daily disposal operations can be found in DOE’s presentation (SRR-CWDA-2012-00165).

### 2.2.3 Conclusions and Follow-up Actions:

The NRC staff will continue to monitor SPF activities, including any changes in the SPF production schedule, as the SPF exits its current outage and DOE transfers saltstone grout to SDSs 2A, 3A, 3B, 5A, and 5B (i.e., all of the newly constructed disposal structures except 2B). There were no follow-up actions that resulted from this technical discussion.

## 2.3 Technical Discussion – Performance Assessment Maintenance Research Activities

### 2.3.1 Observation Scope:

DOE uses its performance assessment maintenance program to both satisfy DOE internal requirements and address technical topics in the NRC monitoring plan. As part of monitoring under the NDAA, NRC is responsible for reviewing updates to the DOE performance assessment. Section 3.1.2 “Oxidation of Saltstone,” Section 3.1.3, “Hydraulic Isolation of Saltstone,” and Section 3.1.4, “Model Support” of the May 2007 monitoring plan (NRC, 2007a) provide details of the basis for the NRC staff review areas.

### 2.3.2 Observation Results:

DOE Manual 435.1-1 (DOE, 2001a) requires DOE to implement a PA maintenance program to evaluate changes that could affect the performance, design, and operating bases for the SDF. DOE Order 435.1 (DOE, 2001b) states that the PA maintenance program must include the conduct of research, field studies, and monitoring needed to address uncertainties or gaps in existing data. In addition to fulfilling those internal DOE requirements, DOE uses PA maintenance activities to address technical topics in the NRC monitoring plan.

Prior to Observation 2012-02, DOE provided NRC staff with a group of documents covering research related to issues identified in NRC’s TER (NRC, 2012a). In addition, DOE also requested a public meeting for January 2013 to further discuss research and modeling related to the concerns identified in the NRC’s TER. The discussion of these documents was limited because the documents were only provided for review one week in advance of the observation. Thus, this report does not represent a complete NRC review of these documents. As necessary, further discussion of some of these documents may take place during the January 17, 2013 public meeting.

The bulleted list below provides a brief summary of NRC’s assessment following a limited review of each document and discussion with DOE during the observation. Follow-up actions resulting from discussion are **bolded**.

#### Operating Window Property Testing (SRNL-STI-2012-00558)

- It is unclear to NRC staff why the results in SRNL-STI-2010-00745 are not applicable to emplaced saltstone. In this study, the researchers appear to have appropriately controlled for water loss from the saltstone samples, so it does not appear that the high hydraulic conductivity values are due to the sample drying and cracking. NRC staff also noted that the correlation of the scanning electron micrograph results with the hydraulic conductivity measurements made the study results more persuasive. DOE staff suggested that in SRNL-STI-2010-00745 sample temperature had increased more rapidly than the emplaced saltstone temperature would increase during curing.
- DOE presented results (SRNL-STI-2012-00558; Table 3-6) showing little effect of liquid to premix ratio from approximately 0.59 to 0.64. NRC staff noted that beyond that range, the effect seemed greater (SRNL-STI-2012-00558; Table 3-6), and that the instantaneous liquid to premix ratios during system flushes (SRNL-STI-2012-00558; page A-2) was much greater than the tested range. The NRC staff expressed interest in understanding the volume of grout affected by the flush water. NRC and DOE discussed

the need to understand how much mixing occurs when the additional flush water is added to the system and how much of this water is captured by the sheet drain. NRC staff is concerned that this extra water may result in a high water to premix ratio that has not been evaluated in laboratory samples.

- During the meeting, NRC was shown graphs of thermocouple data from the curing of saltstone in SDSs 2B and 4. DOE provided an explanation of the constraints and availability of those data. **Because of the amount of thermocouple data that DOE has collected, DOE requested that NRC provide specific temporal and spatial details of the data to be supplied. NRC agreed to provide specific details in its request shortly after the observation.**

*Tc-99 Solubility and  $K_d$  Studies (PNNL-21723 and SRNL-STI-2012-00596)*

- DOE and NRC staff discussed one of the main conclusions of these research reports, which is that Tc release under reduced conditions should be modeled as solubility-controlled instead of with a  $K_d$  model. DOE stated that it is preparing a report that will summarize relevant studies related to Tc-99 release from saltstone and provide a basis for values to be used in a PA. DOE expects this report to be complete in January 2013. DOE also indicated that this report would undergo independent peer review.
- DOE staff suggested that an observed decrease in aqueous Tc-99 concentrations with time in laboratory samples (PNNL-21723; Figure 3.1) may be indicative of continued reaction with slag immobilizing Tc. The NRC staff noted that, after 14 days of reaction, the slope of the decrease in the Tc-99 concentrations with time in the non-slag control was similar to the decrease with time in the slag-containing samples. In addition, the concentrations of several species (e.g., K, Na), listed in the appendix, also show similar decreases in concentration after 14 days. Although the authors of the report addressed the changing Tc concentrations in terms of changing solution chemistry, NRC staff expressed interest in understanding whether the rate of decrease of the concentrations could be due to other mechanisms that could affect several species (e.g., dilution introduced by replacing sampled solution).
- NRC staff appreciates the difficulty in determining solubility values for a laboratory system that is (1) not at equilibrium, (2) sensitive to the changing chemical conditions, (3) not well characterized in the literature due to its unique chemical composition. Depending on the approach (i.e., solubility or sorption-controlled release of Tc-99) and values that DOE implements in their revised model, additional information may be requested in the future to better understand the results from this study.
- DOE stated the  $K_d$  values presented in SRNL-STI-2010-00668, Revision 0 were incorrect. The revised calculations will be included in Revision 1 of that document and the final values are included in SRNL-STI-2012-00596. **NRC requested receipt of SRNL-STI-2010-00668, Revision 1 when it becomes available.**
- NRC staff noted that the long equilibration time for precipitation of Tc-99 under reducing conditions and the rapid release of Tc under oxidizing conditions may indicate limited retention capability of the disposal structure concrete for Tc-99 in fast pathways.

#### Method Evaluation for Measuring Oxidation Front Movement (SRNL-STI-2012-00468, Rev. 0)

- NRC stated that this research, which evaluated several methods for determining the rate of oxidation front movement in saltstone, appeared to be well designed and could provide important insights.
- NRC asked if this research report would be used to evaluate the rate of oxidation front movement that was assumed in the 2009 PA (SRR-CWDA-2009-00017). DOE stated that the samples in this study may have been compromised due to experimental artifacts and that this research focused on method evaluation.
- DOE discussed its strategy of creating one large batch of samples that could serve as the basis for multiple studies. NRC staff noted that the oxidation front study relied on Chromium- (Cr-spiked) samples and discussed the importance of having some non-Cr-spiked control samples so that it would be clear if any unexpected results were attributable to the Cr spike.

#### Fracture Transport (SRNL-STI-2012-00267)

- DOE described its approach of focusing on gas and liquid transport in fractures and then modeling the effects of different potential fractured saltstone states. NRC staff indicated it understood this approach. In response to NRC questions, DOE indicated it did not currently have a plan to develop additional support for predictions of saltstone fracturing for thousands of years after closure.
- DOE also stated that instead of attempting to design experimental studies to evaluate flow through fractures, due to the complexity of fracture networks (e.g., fracture aperture, spacing, orientation, connectedness), they would evaluate the effects of various modeled fracture networks on flow through saltstone.

#### Formed Core Sampling (SRNL-STI-2012-00551)

- DOE and NRC staff discussed the status of the development of the formed core sampling technique. The density and porosity of formed-core samples and core-drilled samples were comparable; however, the hydraulic conductivity measurements of the samples were not consistent, because of pouring sequence and curing conditions. DOE stated that the technique was not yet ready for deployment in the full-scale disposal structures.

#### Review of Concrete Biodeterioration (SRNL-STI-2012-00435)

- DOE discussed that saltstone grout is not expected to be impacted by microbial activity due to the high pH and osmotic pressures associated with the waste form. DOE also stated that biodegradation of the disposal structures is a possibility, but that there is limited organic material in the soils due to the depositional history of SRS.
- NRC staff noted the report conclusions which state that the disposal structures will be impacted to some degree by microbial activity, depending on the site-specific conditions. NRC staff also noted that DOE's disposal activities will alter the current environment and potentially provide energy sources for microorganisms.

### Comparison of Wasteform Mixtures (SIMCO, 2012)

- DOE discussed that the current formulation of 45% blast furnace slag: 45% fly ash: 10% cement had superior pore structure and transport properties relative to a previous formulation.
- DOE stated that there are no immediate impacts on PA from this review.

Following discussion of the technical reports, DOE stated that they would be providing additional documentation in preparation for the January 2013 public meeting. **DOE stated that they would be providing the modeling inputs change matrix from the FY13 Special Analysis to NRC shortly after the observation.**

#### 2.3.3 Conclusions and Follow-up Actions

Three follow-up actions resulted from these discussions:

- 2012-02-6. DOE to provide additional thermocouple data for SDSs 2B and 4, including an elevation measurement and a plan view of the location of the thermocouples corresponding to each data series. NRC will provide additional specifications for its request shortly after the observation.
- 2012-02-7. DOE to provide revision 1 of SRNL-STI-2010-00668 when it becomes available.
- 2012-02-8. DOE to provide the FY13 Special Analysis modeling inputs change matrix to NRC shortly after the observation.

### 3.0 **FOLLOW-UP ACTIONS AND OVERALL CONCLUSIONS**

#### 3.1 Follow-up Actions from the Technical Discussion – Previous Observation Follow-up

- 2012-02-1. DOE to provide an estimate of the volume of water from environmental sources, if any, intruding into SDS 4 (Expected completion February 15, 2013).
- 2012-02-2. DOE to describe the expected surveillance and maintenance program for disposal structure penetrations after operations and prior to final site closure (Expected completion Fall 2013).
- 2012-02-3. DOE to describe the plans to maintain or close the drain water removal system after operations and prior to final closure (e.g., maintenance of instrumentation for liquid detection) (Expected completion Fall 2013).
- 2012-02-4. **(new)** As needed, NRC and DOE to discuss Salt Macro-batch 6 qualification sample report and any additional sampling reports related to Salt Batch 7 at the January public meeting.
- 2012-02-5. **(new)** NRC and DOE to add Salt Batch qualification sample reports to the routine document list in the revised NRC monitoring plan.

### 3.2 Follow-up Actions from the Technical Discussion – Salt Waste Processing

None

### 3.3 Follow-up Action from the Technical Discussion – Performance Assessment Maintenance Research Activities

- 2012-02-6. DOE to provide additional thermocouple data for SDS s 2B and 4, including an elevation measurement and a plan view of the location of the thermocouples corresponding to each data series. NRC will provide additional specifications for its request shortly after the observation.
- 2012-02-7. DOE to provide revision 1 of SRNL-STI-2010-00668 when it becomes available.
- 2012-02-8. DOE to provide the FY13 Special Analysis modeling inputs change matrix to NRC shortly after the observation.

### 3.4 Overall Conclusions

There are no new Open Issues resulting from Observation 2012-02. The previous Open Issues are now rolled into the concerns identified by NRC in the 2012 TER (NRC, 2012a). Those NRC concerns will be rolled into the monitoring factors in the revised monitoring plan that is being drafted by NRC. Based on the results of Observation 2012-02, there is no change to the NRC conclusions in that TER – NRC continues to conclude that it does not have reasonable assurance that salt waste disposal at the SDF meets the performance objectives in 10 CFR Part 61, specifically §61.41.

## 4.0 PARTICIPANTS

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## 5.0 REFERENCES

10 CFR 61, Federal Register, *Licensing Requirements for Land Disposal of Radioactive Waste*. Code of Federal Regulations, Office of the Federal Register. Washington, DC. January 2001.

DOE-WD-2005-001, Rev. 1, *U.S. Department of Energy Basis for Section 3116 Determination Salt Waste Disposal at the Savannah River Site*. DOE. Washington, DC. January 2006. ML102850319.

DOE-WD-2005-001 Rev. 0, *U.S. Department of Energy Draft Basis for Section 3116 Determination Salt Waste Disposal at the Savannah River Site*. DOE. Washington, DC. February 2005. ML051020072.

NDA, Congress, *Public Law 108-375, Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005, Section 3116, Defense Site Acceleration Completion*. U.S. Congress. Washington DC. October 2004.

PNNL-21723, *Equilibrium Solubility Model for Technetium Release from Saltstone Based on Anoxic Single-Pass Flow through Experiments*. PNNL and DOE. September 30, 2012. ML12345A267.

SIMCO, *Final Report, Comparison of Wasteform Mixtures*. SIMCO and WSRC. August 31, 2012. ML12345A264.

SRNL-L3100-2012-00062, *Results for the First Quarter 2012 Tank 50 WAC Slurry Sample: Tc-99*. SRS. Aiken, SC. May 2012. ML12284A333.

SRNL-STI-2010-00668, Rev. 0, *Long-term Technetium Interactions with Reducing Cementitious Materials*. Clemson and SRNL. March 15, 2011. ML111290356.

SRNL-STI-2010-00745, Rev. 0, *Impact of Curing Temperature on the Saturated Liquid Permeability of Saltstone*. SRNL. Aiken, SC. February 2011. ML13015A119.

SRNL-STI-2011-00706, Rev. 0, *Full-Scale Testing of the Formed-Core Sampler for Saltstone Facility Vaults*. SRS, Aiken, SC. December 2011. ML12171A283.

SRNL-STI-2012-00267, Rev. 0, *Transport through Cracked Concrete: Literature Review*. SRNL. April 30, 2012. ML12345A258.

SRNL-STI-2012-00435, Rev. 0, *Review of Concrete Biodeterioration in Relation to Buried Nuclear Waste*. SRNL. August 31, 2012. ML12345A162.

SRNL-STI-2012-00468, Rev. 0, *Method Evaluation, and Field Sample Measurements for the Rate of Movement of the Oxidation Front in Saltstone*. SRNL and Clemson. August 31, 2012. ML12345A156.

SRNL-STI-2012-00551, Rev. 0, *Formed Core Sampler Hydraulic Conductivity Testing*. SRNL. September 30, 2012. ML12345A150.

SRNL-STI-2012-00558, Rev. 0, *Process Formulations, and Curing Conditions that Affect Saltstone Properties*. SRNL. September 30, 2012. ML12345A146.

SRNL-STI-2012-00596, Rev. 0, *Technetium Sorption by Cementitious Materials under Reducing Conditions*. SRNL and Clemson. September 30, 2012. ML12345A134.

SRR-CWDA-2009-00017, *Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site*. SRR, Aiken, SC. October 2009. ML101590008.

SRR-CWDA-2012-00002, Rev. 0, *Revised Methodology for Determination of Inventories in SDF Vaults 1 and 4 through 9/30/2011*. SRR, Aiken, SC. January 2012. ML12171A395

SRR-CWDA-2012-00067, Rev. 0, *Determination of Inventory in SDF Vault 4 through 3/31/2012*. SRR, Aiken, SC. May 2012.

SRR-CWDA-2012-00095, Rev. 1, *Projected Technetium-99 Inventory in Saltstone Disposal Facility Units 2, 3, and 5*. SRR. Aiken, SC. July 2012. ML12198A307.

SRR-CWDA-2012-00108, *DOE Presentation During Observation: NRC Salt Waste Monitoring Updates*. SRR. Aiken, SC. August 2012. ML12235A359.

SRR-CWDA-2012-00112, *UWMQE on Revised Inventory with Margin*. SRR. Aiken, SC. 2012.

SRR-CWDA-2012-00165, *DOE Observation Presentation: NRC Salt Waste Monitoring Updates*. SRR. Aiken, SC. December 6, 2012. ML12345A120.

SRR-LWE-2012-00130, *Estimated Technetium-99 Concentration for Salt Batches 6 and 7*. SRR. Aiken, SC. July 2012. ML12284A345.

U.S. Department of Energy (DOE), *DOE Manual 435.1-1, Radioactive Waste Management Manual, Change 1*. DOE, Washington, D.C. June 2001a. ML110800193.

U.S. Department of Energy (DOE), *DOE Order 435.1, Radioactive Waste Management*. DOE. Washington, DC. August 2001b. ML101590125.

U.S. Department of Energy (DOE), *Response to Letter of Concern (Type IV) Regarding U.S. Department of Energy Disposal Activities at the Savannah River Site Saltstone Disposal Facility*. DOE. Washington, DC. July 2012a. ML12198A258.

U.S. Department of Energy (DOE), *Additional Response to Technical Evaluation Report for Revised Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site, South Carolina and the Letter of Concern*. DOE. Washington, DC. July 2012b. ML12215A081.

U.S. Nuclear Regulatory Commission (NRC), *Technical Evaluation Report for Draft Waste Determination for Salt Waste Disposal*. NRC. Washington, DC. December 2005. ML053010225.

U.S. Nuclear Regulatory Commission (NRC), *U.S. Nuclear Regulatory Commission Plan for Monitoring the U.S. Department of Energy Salt Waste Disposal at the Savannah River Site in Accordance with the National Defense Authorization Act for Fiscal Year 2005*. NRC. Washington, DC. May 2007a. ML070730363.

U.S. Nuclear Regulatory Commission (NRC), *NRC Staff Guidance for Activities Related to U.S. Department of Energy Waste Determinations – Draft Final Report for Interim Use*. NRC. Washington, DC. August, 2007b. ML072360184.

U.S. Nuclear Regulatory Commission (NRC), *Technical Evaluation Report for the Revised Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site, South Carolina*. NRC. Washington, DC. April 2012a. ML121020140.

U.S. Nuclear Regulatory Commission (NRC), *Letter of Concern (Type IV) Regarding U.S. Department of Energy Disposal Activities at the Savannah River Site Saltstone Disposal Facility*. NRC. Washington, DC. April 2012b. ML120650576.

U.S. Nuclear Regulatory Commission (NRC), *Letter to Terrel Spears of DOE, Acknowledging Receipt of July 12, 2012 Letter Regarding NRC's Letter of Concern (Type IV) Regarding Disposal at the Savannah River Site*. NRC. Washington, DC. August 29, 2012c. ML12213A447.

U.S. Nuclear Regulatory Commission (NRC), *Onsite Observation Documents – Response to NRC Follow-Up Action at CY2012-01 (August 2012) Onsite Observation Concerning Monitoring Factors Priority Table*. NRC. Washington, DC. August 31, 2012d. ML12349A041.

U.S. Nuclear Regulatory Commission (NRC), *U.S. Nuclear Regulatory Commission August 2012 Onsite Observation Report for the Savannah River Site Saltstone Facility*. NRC. Washington, DC. November 2012e. ML12286A191.

X-ESR-H-00377, Rev. 0, *Evaluation of ISDP Batch 5 Qualification Compliance to 512-S, DWPF, Tank Farm, and Saltstone Waste Acceptance Criteria*. SRS, Aiken, SC. April 2012. ML12284A386.