CNWRA *A center of excellence in earth sciences and engineering™*

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March 26, 2008
Contract No. NRC–02–07–006
Account Nos. 20.14003.01.001–005
NMSS06n: PROJ0734/PROJ0735

U.S. Nuclear Regulatory Commission
ATTN: Mr. Michael Fuller
Division of Waste Management and Environmental Protection
Two White Flint North
11545 Rockville Pike
Mail Stop 7–J8
Washington, DC 20555

Subject: Intermediate Milestone (IM)—Summary of Technical Assistance in Evaluating Non-High-Level Waste Determinations for the U.S. Department of Energy Facilities in South Carolina and Idaho, Reactive Tasks 1–5 Activities for October–March of Fiscal Year 2008 (IM 14003.01.001.200, 14003.01.002.200, 14003.01.003.200, 14003.01.004.200, 14003.01.005.200)

Dear Mr. Fuller:

This letter transmits summary information documenting the completion of the subject deliverable. The fiscal year 2008 draft operations plan was revised to incorporate the U.S. Nuclear Regulatory Commission (NRC) staff comments. The task-specific activities conducted during the October to March of fiscal year 2008 period are summarized below for each of the five reactive tasks funded within this project.

Review Non-High-Level Waste Determinations for Savannah River Site (Task 1)

The non-high-level waste determinations for Tanks 18 and 19 at the Savannah River Site remained on hold pending final U.S. Department of Energy (DOE) decisions on schedules and scope for a newly developed tank cleaning methodology. The associated updated performance assessment and waste determination for the F-Tank Farm are also on hold. DOE has projected delivery of the F-Tank Farm performance assessment to NRC for consultation in the late summer of 2008.

Monitor Disposal Actions at Savannah River Site (Task 2)

Center for Nuclear Waste Regulatory Analyses (CNWRA) staff served as part of the onsite observation team and provided input to the Savannah River Site Saltstone Facility Onsite Observation Report written after conducting the site visit in October 2007. The site visits fulfill the NRC's monitoring role for assessing compliance with the performance objectives set out in 10 CFR Part 61, Subpart C. Specific activities included observing DOE waste disposal actions at the Savannah River Site Saltstone Production and Disposal Facility, interviewing key DOE personnel, and reviewing pertinent data. One CNWRA staff member participated as part of the onsite observation team for this 2-day monitoring visit. As discussed in the Operations Plan, to assist in the transparency and traceability of CNWRA assistance, the final Savannah River Site Saltstone Facility Onsite Observation report the NRC/CNWRA team produced is attached to this letter.

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12300 Twinbrook Parkway • Rockville, Maryland 20852-1606

Review Non-High-Level Waste Determinations for Idaho National Laboratory (Task 3)

DOE has provided no additional waste determinations for the Idaho National Laboratory, and all activity for this period has been conducted under Task 4 as monitoring of disposal actions.

Monitor Disposal Actions at Idaho National Laboratory (Task 4)

The CNWRA staff served as part of the onsite observation team and provided input to the Onsite Observation Report written after the site visit in August 2007. One CNWRA staff member participated as part of the onsite observation team for this 2-day monitoring visit. As discussed in Task 2, the finalized Idaho National Laboratory Onsite Observation report the NRC/CNWRA team produced is attached to this letter.

Support Generic Issues and Guidance on Implementing the NRC National Defense Authorization Act (NDAA) Responsibilities (Task 5)

Staff participated in follow-on meetings where NRC and CNWRA staffs addressed generic issues with DOE associated with the performance assessment for the Savannah River Site Area F-Tank Farm Facility.

Summary

While executing planned work for the reactive tasking associated with this project has been challenging, CNWRA has demonstrated flexibility in responding to the various NRC requests for support under those tasks. As documented in this letter report, CNWRA has provided high quality and efficient technical assistance to NRC during this reporting period.

Additional details on the activities discussed in this letter can be provided at your request. Please contact me at 210.522.2139 (dturner@swri.org) or Mr. Lane Howard, the principal investigator, at 210.522.4881 (lhoward@swri.org) if there are questions regarding the information discussed in this letter.

Sincerely,

David Turner
Assistant Director
Environmental Science and
Environmental Engineering

LH/DRT/ls-enclosures

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September 25, 2007

Keith Lockie
NE-ID/ID-S
FACILITY AND MATERIAL DISPOSITION
U.S. Department of Energy
Idaho Falls, ID 83401

SUBJECT: NUCLEAR REGULATORY COMMISSION ONSITE OBSERVATION REPORT FOR THE IDAHO NATIONAL LABORATORY IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER TANK FARM FACILITY

Dear Mr. Lockie:

The enclosed document describes the U.S. Nuclear Regulatory Commission=s (NRC) onsite observation activities on August 15, 2007, for monitoring disposal actions taken by the Department of Energy (DOE) at the Idaho National Laboratory (INL), Idaho Nuclear Technology and Engineering Center Tank Farm Facility (INTEC TFF). This onsite observation was conducted in accordance with the Ronald Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA), which requires NRC to monitor disposal actions taken by the Department of Energy for the purpose of assessing compliance with the performance objectives set out in Subpart C of Part 61 of Title 10 of the Code of Federal Regulations.

NRC's onsite observation at INL was primarily focused on performance objective, 10 CFR 61.41 by observing DOE=s tank grouting operations. Since the tank grouting operations will impact the long-term stability of the tank farm facility after its closure, this observation had also partially assessed the performance objective in 10 CFR 61.44. Additional visits will be conducted in the future to assess compliance with these and other performance objectives in 10 CFR Part 61, Subpart C.

If you have any questions or need additional information regarding this report, please call me at 301-415-6717, or call Xiaosong Yin, project manager on my staff, at 301-415-7640.

Sincerely,

/RA/

Scott Flanders, Deputy Director
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

Enclosure: NRC Observation Report

NE-ID/ID-S

September 25, 2007

FACILITY AND MATERIAL DISPOSITION
U.S. Department of Energy
Idaho Falls, ID 83401

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NRC=s onsite observation at INL was primarily focused on performance objective, 10 CFR 61.41, by observing DOE=s tank grouting operations. Since the tank grouting operations will impact the long-term stability of the tank farm facility after its closure, this observation had also partially assessed the performance objective in 10 CFR 61.44. Additional visits will be conducted in the future to assess compliance with these and other performance objectives in 10 CFR Part 61, Subpart C.

If you have any questions or need additional information regarding this report, please call me at 301-415-6717, or call Xiaosong Yin, project manager on my staff, at 301-415-7640.

Sincerely,

/RA/

Scott Flanders, Deputy Director
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

Enclosure: NRC Observation Report

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IDAHO NATIONAL LABORATORY IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER TANK FARM FACILITY NRC ONSITE OBSERVATION REPORT

1.0 BACKGROUND

The National Defense Authorization Act for Fiscal Year 2005 (NDAA) authorizes the DOE, in consultation with the 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 to assess compliance with the performance objectives in 10 CFR Part 61, Subpart C.

The U.S. Nuclear Regulatory Commission (NRC) conducted its first onsite observation at the Idaho National Laboratory Idaho Nuclear Technology and Engineering Center Tank Farm Facility (INTEC TFF) on April 24–25, 2007. NRC activities during this visit focused primarily on two performance objectives, 10 CFR 61.41, protection of the general population from releases of radioactivity, and 10 CFR 61.43, protection of individuals during operations. NRC also partially assessed the performance objective in 10 CFR 61.44, stability of the disposal site after closure. A report that provided the results of the NRC onsite observation was transmitted to DOE on June 1, 2007 (Flanders, 2007).

NRC had intended during the April visit to observe ongoing tank operations at the INTEC TFF. However, several days prior to the scheduled NRC trip, operational problems were encountered by the U.S. Department of Energy (DOE) contractor, CH2M-HILL and Washington Group, Idaho (CWI), during grouting of tank WM-182 and grouting operations were suspended in order to fix the problem. NRC was unable to observe any tank grouting operations in progress and its activities during the April visit were limited to a tour of the grout batch plant, review of records, and interviews with CWI staff. Thus, NRC conducted a second onsite observation at the INTEC TFF on August 15, 2007, to observe ongoing tank grouting operations and to followup on issues remaining from its first visit.

2.0 NRC ONSITE OBSERVATION ACTIVITIES

2.1 Grout Formulation and Performance

2.1.1. Observation Scope

The observation of DOE tank grouting operations is related to Key Monitoring Area (KMA) 2, "Grout Formulation and Performance" identified in the NRC monitoring plan for the INTEC TFF (NRC, 2007). An objective of NRC monitoring activities related to KMA 2 is to ensure that the final grout formulation used to stabilize the INTEC TFF waste is consistent with design specifications assumed in the final waste determination (DOE-ID, 2006), or that significant deviations from design specifications will not negatively impact the expected performance of the grout.

2.1.2 Observation Results

NRC observed ongoing tank grouting operations at the INTEC TFF. NRC visited the batch plant and observed the preparation of controlled low-strength material (CLSM) grout components and placement into cement mixer trucks. Preparation of grout mixtures at the batch plant is computer controlled and for each batch (or truckload) of grout, a ticket is prepared documenting

the mix description, volume of material in the mix, percent moisture of the sand, and water to cement ratio, using State-certified calibrated equipment. At the INTEC TFF, NRC observed the transfer of the grout mixture from the mixer truck to the boom pump truck and subsequently to the waste tank's surrounding vault. NRC observed that procedures are being implemented to ensure radiation protection of workers at the INTEC TFF during the tank grouting activity. In the control trailer, NRC viewed the placement of the CLSM grout into tank WM-181 through a video camera located inside the tank. The tank video camera is able to pan and zoom on different areas inside the tank. NRC also observed through in-tank video cameras the condition of the grout that had been placed inside the large tanks WM-180 through WM-186. While residual flush water, which was used to rinse off the grout mast, was observed to be present in some tanks, no surface cracking of the hardened grout in any of the tanks was visible. Addition of the residual rinse water to the CLSM will not increase the water to cement ratio appreciably as the water was very small compared to the large volume of CLSM in the tank.

NRC also watched videos of the engineered grout placement in tank WM-185. Two purposes of the segmented engineering grouting pours was to (1) attempt to remove additional liquid waste by directing it toward the pump and (2) to promote mixing of the engineering grout with the remaining waste that could not be extracted. By observing the video, the segmented pours provided opportunity to remove additional liquid waste as flow of water toward the pump could be seen. The star patterned segmented pours fold in the waste as they are placed. Layering of the grout pours was evident on the video.

CWI staff indicated that sampling and testing of the CLSM grout is done twice a day—once in the morning (typically the first batch) and another in the afternoon. NRC observed the sampling of grout from the first grout batch of the day and the measurements of temperature, air content, unit weight, and puddle size, which were conducted in accordance with the "Compliance and Monitoring Plan for Performing Grouting at the INTEC Tank Farm Facility Closure Project" (CWI, 2007). NRC noted that cylinder samples of the grout were set aside by CWI staff for later 7-, 28- and 56-day strength tests.

NRC also reviewed CWI records, including the "Grout Supervisor Tracking Form," "Truck Supervisor Tracking Form," and "Tank Farm Inspection Planning Package" and verified that the required information have been filled in. The "Grout Supervisor Tracking Form" recorded the required and actual volume of each grout pour, the start and stop times of grout placement, and the tank riser number through which the grout was placed. The "Truck Supervisor Tracking Form" recorded the required slump range and the actual slump measured. Information in these forms is monitored by the Grout Supervisor and Truck Supervisor as they are entered into the forms for any possible variance that could impact assumptions made in the final waste determination. Additional documents included with the "Tank Farm Inspection Planning Package" include the INEEL Construction Concrete Control Report, which provides results of laboratory material testing (e.g., 7–, 28–, and 56–day strength test) and of field tests (e.g., slump or puddle size, air content, grout temperature). The values recorded in the reviewed documents were determined to be within DOE specifications.

DOE and CWI staff also indicated that grouting procedures have been revised to take into account the lessons learned from grouting tank WM 182. Prior to the previous observation trip, during tank WM-182's engineered grout placement, both arms became lodged into an engineering grout pour. The lower section of one arm was left in place. Even with the one arm left in place in the grout, CWI was able to finish the star pattern, consistent with the planned approach for all the tanks. No appreciable effect on the degree of mixing is expected, however, a smaller amount of excess liquid was able to be extracted from the tank. This excess is

expected to be a very small fraction of the total activity remaining in the tank, and therefore, will have negligible impacts on performance. In addition to changing the procedures, the cameras in the tanks were upgraded to assist in avoiding similar problems in the future, as positional awareness of the end of the arms was identified as a contributor to the incident.

2.1.2 Review of DOE Response to Request for Additional Information

As a result of its first onsite observation visit in April 2007, NRC requested additional information from DOE regarding (i) the qualifications required of vendors to be on the approved vendor list and (ii) the minimum cure time between grout pours. NRC also requested documentation regarding the risk significance of the higher water to cement ratios, compared to that assumed in the performance assessment supporting the waste determination, of grout used to fill tanks WM-104, WM-105, and WM-106. In response, the DOE transmitted additional information to NRC on August 6, 2007 (van Camp, 2007). NRC staff reviewed the information after returning from its August 2007 onsite observation visit.

Qualifications of Vendors on the Approved Vendor List

DOE indicated in its response that the subcontract with Valley Ready Mix, the grout component supplier, was developed and approved consistent with the CWI Management Control Procedure (MCP)–540, "Assigning Quality Levels" and MCP-1186, "Service Acquisitions," which do not require Valley Ready Mix to be on an approved vendor list. However, DOE indicated that CWI evaluated Valley Ready Mix, including its Quality Assurance Plan, and determined that the company has the ability to comply with the contractual requirements of the tank farm grouting subcontract. NRC reviewed the Quality Assurance Plan of Valley Ready Mix and determined that Valley Ready Mix has procedures in place to ensure the grout materials it supplies CWI meet DOE specifications, in terms of constituent formulation and standard grout characteristics.

The reducing capacity of the tank grout is important in mitigating the release of Tc-99, whereas the short-term performance of the grouted vault is important in mitigating the release from the contaminated sand pads of short-lived radionuclides, such as Sr-90, that could potentially dominate the predicted doses from the INTEC TFF within the first few hundred years. This is accomplished at INTEC TFF by adding blast furnace slag to the concrete. The amount of sulfide in the slag is important because it imposes on the grout a reducing condition that helps mitigate the release of Tc-99. The measured sulfide sulfur content of the slag listed in representative chemical test reports was found to be greater than the specified 0.7 weight percent minimum, during our April monitoring visit. However, these reports were from Valley Ready Mix's supplier and not apparently independently verified. While Valley Ready Mix had procedures in place to ensure that it supplied grout materials consistent with DOE specifications for normal characteristics, it does not appear that any additional testing for sulfide content was performed by Valley Ready Mix of the slag they received from their supplier or that Valley Ready Mix verified, by independent testing, that their supplier had a proper quality assurance plan for the DOE application. In the future, DOE should consider whether specific additional requirements added to their contractor quality assurance program should be included to address non-standard grout characteristics that are relied on in the safety assessment. Additional quality assurance would strengthen their safety case. The NRC considers this issue closed.

Minimum Cure Time Between Grout Pours

DOE provided a copy of a CWI engineering study documented in Engineering Design File (EDF)-8059, "Grout Temperature Increase for the INTEC Tank Farm Closure" (CWI, 2007),

which calculated the maximum temperature of the grout that would result from heat generation during cure of the CLSM. Two mathematical models were evaluated–an adiabatic model and a kinetic model–and conservative assumptions were used with respect to the placement temperature and the volume of each of the three grout lifts emplaced in the tank. Based on the results of the kinetic model, DOE indicated that the maximum temperature within the CLSM was 142 °F, which is significantly below the acceptance criterion of 170 °F, and that no additional thermal-related controls need to be implemented by CWI. The 170 °F acceptance criterion was reported to have been conservatively selected from the literature for materials of higher strength than required of CLSM.

NRC conducted independent calculations of the maximum temperature within the CLSM during cure using the method discussed in Bamforth (2007) and verified that the maximum temperature would be significantly below 170 °F. NRC noted that the analysis presented in EDF-8059 did not consider the temperature gradients in the grout monolith that could occur during cure. Temperature gradients lead to stresses that could result in formation of surface and interior cracks in the monolith (Bamforth, 2007). In a followup conference call, the DOE stated that the formation of early age cracks is bounded by the conservative assumptions regarding grout degradation used in the performance assessment supporting the waste determination. NRC concurs that the effect of early age cracking on radionuclide release is likely bounded by the conservative assumptions used in the performance assessment calculations and considers this issue closed. Nevertheless, engineering calculations may be useful prior to tank grouting at other DOE sites such that steps could be taken to limit temperature gradients and the potential for crack formation. The NRC considers this issue closed.

Risk Significance of High Water to Cement Ratio Used for Grouting the 113.6-cubic meter (30,000-gallon) Tanks WM-104, WM-105, and WM-106

DOE stated in its response that no specific release model was developed for the 113.6 m3 (30,000 gal) tanks for the performance assessment calculations supporting the 3116 waste determination. Therefore, no specific water-to-cement ratio for the 113.6 m3 (30,000 gal) tanks was assumed in the performance assessment supporting DOE's waste determination. The reason for not including a release model for the 113.6 m3 (30,000 gal) tanks is the small radionuclide inventory in those tanks compared to the inventory in the 1,136 m3 (300,000 gal) tanks, and it was concluded that, for performance assessment purposes, the inventory for the large 1,136 m3 (300,000 gal) tanks bound any additional contamination that may be released from the 113.6 m3 (30,000 gal) tanks. Based on the small radionuclide inventory in the 113.6 m3 (30,000 gal) tanks, the high water to cement ratio of the grout used in three of the four 30,000-gallon tanks poses a low risk of significantly increasing the dose to the general population. The NRC considers this issue closed.

2.1.3 Conclusions

The NRC observation team observed ongoing tank grout operations and reviewed records at the INTEC TFF. NRC determined that the DOE and CWI quality assurance program pertaining to tank grouting, grout formulation, and placement is being implemented effectively.

NRC has reviewed the documents DOE provided in response to an NRC request made during its April 2007 onsite observation visit. NRC is closing the issues from the April 2007 observation report as it has determined that satisfactory information has been received.

For the issue on the qualification for vendors on the approved vendor list, DOE supplied

information on the quality assurance program of its vendor, Valley Ready Mix, which ensure the grout materials it supplies to CWI meet DOE specifications, in terms of constituent formulation and standard grout characteristics. NRC is recommending that if specific characteristics of the grout material, which are not part of the standard grout characteristics, such as the sulfide level of the slag, are being relied on for performance, specific requirements for testing should be added to the quality assurance programs.

DOE provided adequate information for NRC to close the issue on the minimum cure time for the grout lifts. NRC is recommending that DOE remain cognizant of the potential for crack formation, which may be more of an issue at other sites which have not used very conservative assumptions for concrete degradation.

The third issue addressed the water to cement ratio used in three of the small tanks, as compared to the water to cement ratio assumed in the waste determination. NRC determined that, based on the small radionuclide inventory in the 113.6 m3 (30,000 gal) tanks, the high water to cement ratio of the grout used in three of the four 113.6 m3 (30,000 gal) tanks poses a low risk of significantly increasing the dose to the general population

3.0 PARTICIPANTS

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Idaho Department of Environmental Quality
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Partial List of DOE Representatives
Keith Lockie, DOE-ID
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4.0 REFERENCES

Bamforth, P.B. Early-age Thermal Crack Control in Concrete. London, U.K.: CIRIA. 2007.

CWI. "Compliance and Monitoring Plan for Performing Grouting at the INTEC Tank Farm Facility Closure Project." PLN-2309, Revision 2. Idaho Falls, Idaho: CH2M-WG, LLC (CWI). March 2007.

DOE-ID. DOE/ID–11226, "Basis for Section 3116 Determination for the Idaho Nuclear Technology and Engineering Center Tank Farm Facility." Rev. 0. Idaho Falls, Idaho. DOE Idaho. November 2006.

Flanders, S. "Nuclear Regulatory Commission Onsite Observation Report for the Idaho National Laboratory Idaho Nuclear Technology and Engineering Center Tank Farm Facility." Letter (June 1, 2007) to K. Lockie, DOE. Washington, DC: NRC.

NRC. "U.S. Nuclear Regulatory Commission Plan for Monitoring Disposal Actions Taken by the U.S. Department of Energy at the Idaho National Laboratory Idaho Nuclear Technology and Engineering Center Tank Farm Facility in Accordance with the National Defense Authorization Act for Fiscal Year 2005." Washington, D.C.: U.S. Nuclear Regulatory Commission. May 2007.

Van Camp, S.G. "Contract No. DE-AC07-05ID14516—Response to Nuclear Regulatory Commission Onsite Observation Report of Tank Farm Closure Activities." Letter (August 6, 2007) to S. Flanders, NRC. Washington, DC: DOE.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 31, 2008

Lawrence T. Ling, Director
Waste Disposition Programs Division
U.S. Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, SC 29802

SUBJECT: NUCLEAR REGULATORY COMMISSION ONSITE OBSERVATION REPORT FOR THE SAVANNAH RIVER SITE SALTSTONE PRODUCTION AND DISPOSAL FACILITIES

Dear Mr. Ling:

The enclosed document describes the U.S. Nuclear Regulatory Commission's (NRC's) onsite observation activities on October 29-30, 2007, at the Savannah River Site (SRS), Saltstone Production Facility (SPF) and Saltstone Disposal Facility (SDF). This onsite observation was conducted in accordance with the Ronald Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA), which requires NRC to monitor disposal actions taken by the 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 site visit were consistent with those described in the NRC's monitoring plan for salt waste disposal at SRS (dated May 3, 2007) and NRC's staff guidance for activities related to waste determinations (NUREG-1854, dated August, 2007).

NRC's onsite observation at SRS was primarily focused on two performance objectives, 10 CFR 61.41, protection of the general population from releases of radioactivity, and 10 CFR 61.43, protection of individuals during operations, by observing DOE's saltstone wasteform production and disposal operations, and verifying DOE's radiation protection measures associated with those operations. Since saltstone wasteform production operations could impact the long-term stability of the disposal facility after its closure, this observation also partially assessed the performance objective in 10 CFR 61.44, stability of the disposal site after closure. Additional visits will be conducted in the future to assess compliance with these and other performance objectives in 10 CFR Part 61, Subpart C.

The enclosed report indicates that, during our visit, we were unable to obtain some information needed to fully assess whether current operations are consistent with assumptions made in the waste determination (DOE 2006) with respect to vault integrity and the characterization of the final saltstone wasteform. As such, we plan to conduct another onsite monitoring visit during the first quarter of 2008 to follow up on our observations regarding: 1) final product (wasteform) characterization; 2) impacts of the differences in observed conditions of Vault 4 with the waste determination; and 3) impacts on the final product properties of the intra-batch variations from flush water additions and additives used to ensure processability. The fact that NRC staff is requesting more information regarding these areas does not mean that the NRC has concluded that DOE disposal activities are not in compliance with 10 CFR 61, Subpart C, but rather that more information is needed to support DOE's assumptions and approaches. We recognize that, consistent with NRC's monitoring plan for the salt waste disposal facility, monitoring can be iterative and several onsite observation visits may be necessary in order to obtain all the

information needed to close an issue. During a conference call on January 28, 2008, between NRC and DOE, DOE indicated that some of the information requested by the NRC may be available and will be made accessible to the NRC at the next observation visit to SRS. If DOE would like to provide this information in advance of the next onsite observation visit, you may send it to us, and we will evaluate it.

On October 30, 2007, at the conclusion of the onsite observation activities, members of my staff discussed the topics addressed in this report with you and members of your staff. If you have any questions or need additional information regarding this report, please contact Michael Fuller, Project Manager on my staff, at 301-415-0520.

Sincerely,

Scott Flanders, Deputy Director
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

Enclosure:
NRC Observation Report

cc w encl:
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SAVANNAH RIVER SITE SALTSTONE PRODUCTION AND DISPOSAL FACILITIES
NRC ONSITE OBSERVATION REPORT

EXECUTIVE SUMMARY

NRC staff conducted its first onsite observation visit of the Saltstone Production Facility (SPF) and Saltstone Disposal Facility (SDF) at the Savannah River Site (SRS) on October 29-20, 2007. This visit was intended to focus on two of the four performance objectives—10 CFR 61.41, *protection of the general population from releases of radioactivity*, and 10 CFR 61.43, *protection of individuals during operations*—by observing DOE saltstone wasteform production operations and verifying DOE's radiation protection measures for relevant operations. Because the saltstone wasteform production operations could impact the long-term stability of the disposal facility after its closure, this observation also was intended to partially assess compliance with the performance objective in 10 CFR 61.44, *stability of the disposal site after closure*. This report provides a description of NRC onsite observation activities and identifies NRC observations from the visit.

NRC staff evaluated the implementation of the grout quality assurance program, the construction of the vault, the waste sampling program, the radiation protection program, and also reviewed pertinent records. NRC staff observed operation of the SPF and toured the SDF (Vault 4), and interviewed key SRS and contractor personnel. NRC staff observed activities and reviewed data collected to assess consistency with assumptions made in the waste determination (DOE, 2006).

Grout Formulation and Placement

- The observation determined that the quality assurance program of DOE and its contractor is effective. NRC staff also determined DOE has a program for verifying that the grout components conform to applicable American Society for Testing and Materials (ASTM) standards. NRC recommended that DOE consider performing independent verification of vendor material characterization.

- Additional information beyond that supplied with the performance assessment and supporting documentation provided with the waste determination was not available during the monitoring visit to support the physical characteristics of the saltstone wasteform. Current characterization processes, as described to NRC by DOE during the monitoring visit, does not allow for a verification of physical properties assigned in the final waste determination. Final product characterization is an open issue because inadequate quality of saltstone could result in the disposal of saltstone being non-compliant with the 61.41 performance objective.

- Additional information is needed on the impact on the properties of the final product from potential intra-batch variability in bulk components, flush water additions, and additives used to ensure processability. Inadequate quality of saltstone could result in the disposal of saltstone being non-compliant with the 61.41 performance objective; therefore this is an open issue that NRC will follow up on during future monitoring activities.

Vault Construction

- The observation determined that DOE has taken action in an attempt to mitigate the impact of previously identified vault construction defects (e.g., cracking) on facility performance. However these efforts have not been fully effective as contaminated seeps were noted while observing the current cell of Vault 4 being filled. The observation determined that DOE appropriately characterizes and manages the contamination. The level of contamination measured on the outside of the vault does not pose an immediate health and safety concern to workers or the public. The area is maintained as a radiologically controlled area but workers or authorized visitors can safely walk next to the vaults.

- NRC was unable to determine that DOE has assessed the risk significance of the impact of differences in observed conditions of the vaults to conditions assumed in its final waste determination and performance assessment (PA). If the quality of the saltstone wasteform proves to be inadequate, failures of the SDF vaults to adequately contain the waste, could result in the disposal of saltstone being non-compliant with the 61.41 performance objective. Therefore, this is an open issue that NRC will follow up on during future site monitoring activities.

Waste Sampling

- The observation determined that DOE's procedures used to characterize the waste in Tank 50, the feed tank to the SPF, appeared to be adequate to determine the inventory of radionuclides that are sent to the SPF, and ultimately to the SDF. However, NRC staff plans to examine sampling activities and results in more depth, during future monitoring visits. Therefore, this is an open issue that NRC will follow up on during future monitoring activities.

- NRC recommends that DOE either confirm that the build up of solids be readily identified during processing or take actions to mitigate such build up. Therefore, this is an open issue that NRC will follow up on during future monitoring activities.

Radiation Protection Program

- The observation determined that DOE has an adequate program for protecting its personnel and the public from radiation exposures during operations at the SPF and SDF. Although the review resulted in no open issues, NRC will continue monitoring activities related to radiation protection during future onsite observation visits to SRS.

1.0 BACKGROUND

The National Defense Authorization Act for Fiscal Year 2005 (NDAA) authorizes the DOE, in consultation with the 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 to assess compliance with the performance objectives in 10 CFR Part 61, Subpart C.

On March 31, 2005, DOE submitted a "Draft Section 3116 Determination, Salt Waste Disposal Savannah River Site" 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, the NRC staff reviewed the draft waste determination and concluded that there was reasonable assurance that the applicable criteria of the NDAA could be met, provided certain assumptions made in DOE's analyses are verified via monitoring. NRC documented the results of its review in a technical evaluation report (TER) issued in December 2005. DOE issued a final waste determination in January 2006 taking into consideration the assumptions, conclusions, and recommendations documented in NRC's TER.

To carry out its monitoring responsibility under the NDAA, NRC plans to perform three types of activities focusing on key assumptions, called "factors" identified in its monitoring plan for saltwaste disposal at SRS (NRC, 2007): (i) technical reviews, (ii) onsite observations, and (iii) data reviews. Technical reviews generally will focus on obtaining additional model support for assumptions DOE made in its PA that are considered important to DOE's compliance demonstration. Onsite observations generally will be performed to (i) observe and review data collected to assess consistency with assumption made in the waste determination (e.g., observation of waste sampling used to generate data on radionuclide inventories) or (ii) observe key disposal (or closure) activities related to technical review areas (e.g., slag and other material storage, grout formulation and preparation, and grout placements). Data reviews will supplement technical reviews focusing on real-time monitoring data that may also indicate future system performance or review of records or reports that can be used to directly assess compliance with performance objectives.

NRC's October 2007 onsite observation at SRS was focused primarily on two performance objectives, 10 CFR 61.41, *protection of the general population from releases of radioactivity*, and 10 CFR 61.43, *protection of individuals during operations*, by observing DOE's operations at the SPF and SDF, and verifying DOE's radiation protection measures there. Because the saltstone wasteform production operations could impact the long-term stability of the disposal facility after its closure, this observation also was intended to partially assess compliance with the performance objective in 10 CFR 61.44, *stability of the disposal site after closure*. Additional visits will be conducted in the future to assess the performance objective in 10 CFR 61.42, *protection of individuals against inadvertent intrusion*, and to continue assessing DOE compliance with the other performance objectives.

2.0 NRC ONSITE OBSERVATION ACTIVITIES

2.1 Grout Formulation and Placement

2.1.1. Observation Scope

The observation of DOE saltstone production and disposal operations is related to Factor 1 - "Oxidation of Saltstone", and Factor 2 - "Hydraulic Isolation of Saltstone" identified in the NRC monitoring plan for the SRS SPF and SDF (NRC, 2007). The general objectives of NRC monitoring activities related to Factor 1 and Factor 2 are to ensure that the saltstone that is produced is of sufficient quality such that there is reasonable assurance that the performance objectives of 10 CFR Part 61 will be achieved. As discussed in the NRC TER for review of salt waste disposal at the SRS, the hydraulic and chemical properties of the wasteform are important for isolating the radioactivity contained in the waste from the environment (NRC, 2005). A

specific objective of the monitoring visit was to ensure that the saltstone formulation produced in the SPF and emplaced in the SDF is consistent with the design specifications assumed in the final waste determination [DOE Savannah River Site (DOE-SRS, 2006)], or that significant deviations from design specifications will not negatively impact the expected performance of the wasteform. Staff also attempted to obtain information that DOE has collected to further evaluate uncertainties (discussed in the NRC TER).

2.1.2 Observation Results

NRC staff observed ongoing saltstone facility operations at SRS. NRC visited the SPF and observed the preparation of saltstone grout components and placement into the vault. Preparation of saltstone at the SPF is remotely controlled by a group of operators in the control room using a digital control system (DCS). NRC observed the mixing of the saltstone wasteform and transfer of the grout mixture from the SPF to the SDF via video cameras located in the plant and vault and displayed in the control room. DOE staff indicated that the plant is able to fill a vault cell at the rate of approximately 4 cm per hour for an approximately 0.3 m per daily shift lift in a vault cell.

NRC staff observed the bins used to store the dry slag and cementitious materials prior to mixing with dissolved salt waste. The bins appeared adequate for preventing precipitation from contacting the grout materials to minimize the degradation in the quality and chemical reactivity of the slag and Portland cement. The grout materials include blast furnace slag, fly ash, and Portland cement which are delivered by truck to the saltstone bins and are mixed in a 45-wt% slag, 45-wt% fly ash, and 10-wt% Portland cement formulation. NRC staff reviewed sample quality assurance records and verified that the received grout materials had certified chemical and physical test reports that are based on ASTM standards (e.g., ASTM C 989 for blast furnace slag, ASTM C 618-03 for fly ash, and ASTM C 150 for Portland cement). A review of representative test reports indicated the received materials conformed to the standards.

NRC staff also verified that the measured sulfide sulfur content of the blast furnace slag supplied by the vendor is consistent with the quality assurance receipt inspection procedures supplied by DOE staff during the observation visit. The amount of sulfide in the slag is important because it imposes a reducing condition on the grout that helps mitigate the release of Tc-99. The measured sulfide sulfur content should be greater than 0.6 wt% by inspection procedure but less than 2.5 wt% in accordance with ASTM C 989 requirements. Representative test reports were provided to verify that blast furnace slag content is within this range. However, it should be noted that all test reports were from the material vendor and other than the receipt inspection procedures conducted for each truckload of material, no confirmatory chemical analyses are conducted by DOE. Independent verification of the material characteristics would provide additional assurance of the product quality.

Bulk material (slag, fly ash, cement) proportions are controlled by weighing the components. Target masses for each batch are 2700 lb fly ash, 2700 lb slag, and 600 lb cement. An alarm is activated if the component masses are +/- 300 lb from the targets. NRC staff observed a number of alarm notifications for masses deviating from the targets. These alarm notifications were verbally acknowledged between operators in the control room and were part of normal operations. The alarms are a warning to the operators to check the masses of the dry bulk materials being input to the process to ensure product composition specifications could be met and do not represent a failure of the process. The dry bulk materials were blended prior to

transfer to a hopper for mixing with salt waste in the SPF. DOE stated that the dry bulk materials have different particle size distributions and different flowability characteristics. DOE does not have a system to evaluate the relative proportion of the saltstone components within a batch once mixed with salt waste, although as stated above they do have a system to verify the total quantity of dry bulk materials input to a batch. However, product quality was evaluated when the facility was initially placed into operation (e.g., cold "non-radioactive" samples were produced using surrogate waste streams and were characterized for bulk properties such as strength). Toxicity Characteristics Leaching Procedure (TCLP) tests were previously completed over a range of compositions; however, as previously noted in the TER, DOE has not generated hydraulic and chemical properties of saltstone over a similar range of compositions (NRC, 2005). No additional data on the hydraulic and chemical properties of saltstone was available at the time of the monitoring visit. Additional data on the hydraulic and chemical properties of saltstone will greatly reduce the uncertainty in estimating future performance of the SDF.

Salt waste is sent from Tank 50 to a feed tank at the SPF. The feed tank has a mixer that can be operated only when the pump used to transfer salt waste to the blending system is not in operation. Waste that has been processed to date has not had a significant amount of solids. However there may be the potential for buildup of solids in the feed tank with current mixing and mobilization systems. If solids build up were to occur, it could impact wasteform composition. Solids buildup could result in additional radiological exposure to workers if new systems need to be used to mobilize the solids. NRC recommends that DOE either ensure that solids build up can be clearly identified during processing or take actions to mitigate the potential for solids build up.

The specification for the water (salt solution) to cement (dry components) ratio is 0.6. Set retardant (0.3 gpm) and anti-foam agents (0.1 gpm) are added to the dry components and salt waste to facilitate processing. After blending of salt waste and the dry components in the SPF, saltstone is transferred to the SDF where it is emplaced in the vaults through fill pipes. Temperatures within the vault and saltstone are measured with thermocouples. Temperatures are limited to 85 C and the maximum observed temperature has been approximately 50 C. Relative humidity is not monitored within the disposal cells, which is noted as a limitation of the system but is not otherwise expected to impact final product quality. During cold weather, a significant quantity of condensation has been observed within the cells. Visual inspection of the final wasteform is completed to a limited degree; however condensation limits the ability to conduct remote visual inspections. NRC staff inquired, but no still or video images were available for staff review. At the end of a production run (typically at the end of a work day), the system is flushed with approximately 1200 gallons of water. The flush water is sent directly to the saltstone vault in use for the production run. The ultimate disposition and impact of the flush water on the final product was not known by DOE. If the flush water blends with the saltstone that has not yet set in the SDF, the water cement ratio of this portion of the product would be much higher than that assumed in the waste determination. Very high water to cement ratios *could result in the affected fraction of the saltstone wasteform having inferior hydraulic* properties. Based on processing rates and current system operation, it is estimated the fraction of saltstone that may be impacted by high water to cement ratio is less than 5 volume percent.

During the monitoring visit, no additional information was provided to characterize the hydraulic and chemical properties of the final product emplaced within the SDF (e.g., core or other samples). As discussed in Section 2.2.2, the hydraulic properties of the vaults are not likely to be consistent with the assumptions in the waste determination. Because the vaults were

envisioned to provide secondary containment, a less robust secondary containment places more burden on the primary containment (i.e. saltstone) to provide the degree of isolation assumed in the waste determination. In addition, the implied deviation of the observed properties of the vaults highlights the difficulty of achieving in the field the properties observed in laboratory samples or in analogous facilities. No information to verify the properties of saltstone emplaced in the SDF was available for the NRC staff to review. DOE staff interviewed were not aware of any plans to characterize the emplaced saltstone. Information is needed from DOE to demonstrate that the hydraulic and chemical properties of the final product are consistent with the assumptions in the waste determination, or demonstrate that any deviations are not significant with respect to demonstrating compliance with the performance objectives.

2.1.3 Conclusions and Followup Actions

The NRC staff determined that the DOE quality assurance program pertaining to the specification of dry bulk materials is being effectively implemented. However, considering the importance of reducing capacity of saltstone to achieving the 61.41 performance objective, DOE should consider performing independent characterization of the slag upon receipt of the material rather than relying upon the vendor's documentation.

Records indicate the saltstone components conform to ASTM standards and the wasteform formulations are consistent with the assumed composition in the waste determination, with one exception. As discussed in Section 2.1.2, system flushing at the end of a production run likely results in a portion of the saltstone having a much higher water to cement ratio than assumed in the waste determination. NRC staff will follow up on this issue during future monitoring visits.

Current DOE effort has been focused on process implementation and control. Although physical properties of saltstone (hydraulic conductivity and diffusivity) were identified as the most sensitive parameters in the analysis supporting the waste determination, DOE has not completed final product characterization nor were any plans to complete characterization of the final product provided during the observation. Intra-batch variability in product composition is not characterized. As discussed in Section 2.2.3, the observed quality of the secondary containment (the SDF vaults) is not as effective as previously assumed. Verifying the quality of the saltstone wasteform is important to ensuring that the 61.41 performance objective will be satisfied. Final product characterization is identified as an open issue that will be evaluated during future site visits. NRC staff intends to return to SRS, in the first quarter of 2008, to observe future saltstone production, characterization, and disposal operations, and follow up on the issues identified above.

2.2 Vault Construction

2.2.1. Observation Scope

The observation of DOE saltstone disposal operations is related to Factor 1 -"Oxidation of Saltstone", and Factor 2 - "Hydraulic Isolation of Saltstone" identified in the NRC monitoring plan for the SRS SPF and SDF (NRC, 2007). The reinforced concrete vaults of the SDF were assumed in the DOE waste determination to provide secondary containment for the radioactivity contained in saltstone and to limit the exposure of the saltstone wasteform to aggressive environmental conditions. A specific objective of the monitoring visit was to observe the saltstone disposal vaults to ensure that the assumptions regarding vault performance in the

waste determination were valid. Because the vault currently in operation was previously constructed, construction of the vault was not observed by NRC staff.

2.2.2 Observation Results

A number of problems were observed with vault performance during early operations by DOE. Cell A of Vault 4 had bulging, primarily at the bottom of the vaults, and weep sites where contamination was observed on the exterior surfaces of the vaults. These problems were discussed in detail in a variety of DOE reports and other forms of communication with State regulators [for example, an October 19, 2006 Letter from DOE to John McCain (DHEC)]. The primary mitigating action was to add a geotextile fabric membrane with an impervious backing to the vault walls.

Although the currently used cells have the geotextile fabric and impervious backing on the interior walls, the vaults continue to have contaminated seeps that appear on the exterior surface of the vaults as they are filled with saltstone. NRC staff observed seeps on one wall of the vault currently being filled. The seeps appeared to be less than a meter in length. DOE stated that the seeps dry relatively quickly as the vaults are filled and the saltstone sets, sealing the fractures that are the source of the seeps. Information to indicate that the seeps are no longer active was not available at the time of the onsite observation visit. Because the seeps, if active, could influence the rate of release of radionuclides from the vaults, it is recommended that DOE quantify or provide information as to the degree of sealing of the fractures. One approach to evaluating whether the existing fractures are active would be to introduce water into inactive disposal cells and observe the resulting response of the vaults. Nondestructive techniques could also be used to quantify the status of the fractures.

The area adjacent to the vaults is maintained as a radiologically controlled area. Contamination samples are taken of the seeps to characterize the amount of removable radioactive contamination. The area is roped off with appropriate signs and markers.

NRC noted during the monitoring visit that DOE observed Cs-137 in the ditch adjacent to Vault 4, Cell G [October 19, 2006 letter from DOE to John McCain (DHEC)], and that remedial action had been taken (e.g., contaminated soil was removed from the ditch).

The vaults are intended to provide secondary containment for the radioactivity contained in saltstone and limit the exposure of the saltstone wasteform to aggressive environmental conditions. However, the current containment is not complete as assumed in the base case analysis supporting the waste determination [DOE, 2006]. The waste determination and supporting performance objective demonstration document assumed the hydraulic conductivity of the vault would be less than or equal to 1E-12 cm/s for 100 years after facility closure. The hydraulic conductivity of the saltstone was assumed to be 1E-11 cm/s over this time. The *analysis increased the hydraulic conductivity in a stepwise manner over the 10,000 year* performance period. The observation of seeps suggest that the vaults are of insufficient quality to achieve 1E-12 cm/s (which is representative of a very high quality concrete). DOE stated that the cracks (which result in the seeps) were attributed to the way the vaults were poured and cured. NRC previously documented the importance and relevance of the physical properties of the vaults and saltstone in the NRC TER documenting the review of the waste determination [NRC, 2005]. The hydraulic conductivity potentially affects the rate of release of waste from the facility as well as the degradation of the materials over time. During the onsite observation, DOE

stated they had not completed an evaluation to assess the impact of the observed condition of the vault on the waste determination (i.e., the difference between observed and assumed conditions). DOE plans to update the performance assessment supporting the saltstone waste determination in fiscal year 2009. Currently, DOE is envisioning a new vault design based on commercial water storage tank technology.

The risk implications of the vault quality being less than assumed in the waste determination should be quantified by DOE with further analysis. However a summary of previous calculations can provide valuable risk context. DOE assumed that the complete saltstone inventory was in one vault for purposes of estimating the radiological impacts in the performance assessment supporting the final waste determination, even though it would actually be placed in up to fourteen vaults [DOE, 2006]. In addition, the peak whole body dose was estimated to be approximately 2.3 mrem/yr (compared to a 25 mrem/yr performance objective for 61.41). Therefore, there is margin for deviation from the assumptions in the final waste determination without DOE's disposal actions being non-compliance with the performance objectives. However, lack of robust secondary containment places more importance on: 1) verifying the physical properties of the saltstone wasteform, and 2) ensuring that the saltstone is likely to be sufficiently resistant to degradation under anticipated future exposure conditions. In addition, the observation of the seeps suggests that the vaults should possibly be represented as sources of contamination in future performance assessment calculations rather than barriers to contamination.

2.2.3 Conclusions and Followup Actions

The NRC staff determined that the vaults provide adequate containment from a waste processing standpoint. That is, the vaults isolate the vast majority of the radioactivity in saltstone from the environment while the saltstone sets. However, quality issues previously identified by DOE continue to persist irrespective of mitigating actions. Seeps result in contamination reaching the exterior surfaces of the vaults. Based upon NRC staff observations, DOE appears to have appropriately characterized and managed the contamination such that it does not pose an immediate health and safety concern to workers or the public.

The impact of the seeps on the long-term performance of saltstone will need to be quantified by DOE and reviewed by NRC. This is identified as an open issue that will be evaluated during future site visits.

2.3 Waste Sampling

2.3.1 Observation Scope

The objective of monitoring waste sampling is to evaluate the methodology used to quantify the inventory of radionuclides that is sent to the SDF. This review is being performed as part of the evaluation of Factor 6, Feed Tank Sampling, which was identified in the NRC monitoring plan (NRC, 2007). As stated in the monitoring plan, the total inventory of radionuclides disposed of in the SDF is an important part of meeting performance objectives of 10 CFR 61.41. Tank 50 in H-Tank Farm serves as the feed tank for transfers from the tank farms to the SPF and is the point of compliance for demonstrating that the waste meets the Saltstone Waste Acceptance Criteria (WAC) (Culbertson, 2007). As no sampling was ongoing at the time of the observation, the NRC

staff's activities focused on reviewing DOE's methodology for waste sampling and analysis. This was achieved by conducting interviews with site personnel and reviewing relevant documents.

2.3.2 Observation Results

As stated above, Tank 50 is the point of compliance for waste that is being transferred to the SPF and any waste transferred from this tank must meet the Saltstone WAC (Culbertson, 2007). The Saltstone WAC ensures that waste entering the SPF is within the Documented Safety Analysis, Performance Assessment, and Operating Permitted values. The Tank 50 contents must remain in compliance with the Saltstone WAC when transfers to the SPF are occurring, though the WAC limits may be met either prior to the waste being transferred to Tank 50 or by blending of the waste with a lower concentration waste stream within Tank 50.

The sampling plan for Tank 50 is documented in the "Sampling Strategy for Tank 50 Point of Compliance Transfers to Saltstone" (Ketusky, 2005). Samples are taken quarterly for chemical constituents and semi-annually for radionuclides.

In addition, a sample is taken for both chemical and radiological contents for each salt batch. NRC staff discussed the methodology used to obtain samples from Tank 50 with site personnel. The site personnel stated that samples from Tank 50 are taken from near the surface of the waste. Agitation pumps are run for several hours before the tank is sampled in order to ensure a representative sample and to ensure that particles in Tank 50 are adequately characterized. During sample collection, the pump nearest the location where the sample is being taken is shut down, but the other pumps continue to run. After the samples are collected, they are sent to a lab for quantification. A data integrity review is performed on the results of the analytical measurements prior to the acceptance of the data. In addition, samples are periodically sent to two different labs for quantification to evaluate the precision of the measurements.

A materials balance is maintained for the radionuclides in Tank 50 in order to track the inventory in the tank in between when samples are taken. In this materials balance, all inputs to and outputs from the tank are tracked and this information is used to calculate the current conditions in the tank. After new sampling results are obtained, the materials balance is re-baselined to the values measured in the samples.

In addition to transfers from other tanks in the tank farm, Tank 50 also receives waste streams from the general purpose evaporator and from Effluent Treatment Process (ETP) concentrate. Site personnel stated that these waste streams are required to meet the WAC for Saltstone before being transferred to Tank 50. Compliance with the WAC is demonstrated through periodic sampling of the waste streams and process knowledge. Waste streams were characterized initially through sampling, and periodic samples are taken to ensure that the assumptions regarding the system waste characterization have not changed. Site personnel *stated that there was not a lot of variability observed in these waste streams over time.*

The tank farm waste currently in Tank 50 is from Tanks 23 and 49. The waste in these tanks has been characterized through sampling. Tank 49 contains salt waste resulting from the use of the Deliquification, Dissolution, and Adjustment (DDA) process on Tank 41 salt waste. In this process, salt cake in Tank 41 was dissolved and sent to Tank 49, and during this process it is possible for any sludge particles that are entrained in the salt in Tank 41 to be carried over to Tank 49. Tank 49 serves as a settling tank for these particles prior to the transfer of the Tank 41

salt waste to Tank 50. In order to ensure that radionuclide removal efficiencies were as expected during the DDA process, samples were taken at various depths in Tank 49 to verify that settling occurs and that the amount of particles transferred to Tank 50 is limited. Currently, the waste in Tank 50 is not being slurried during transfers to the SPF, so only supernate is being transferred. However, in the future, the agitation pumps will be run and the tank will be slurried during transfers to the SPF and any settled particles in Tank 50 will be transferred along with the supernate.

2.3.3 Conclusions and Followup Actions

NRC staff determined that the procedures used to assess the inventory of radionuclides in the feed tank that are sent to the SDF appeared to be adequate. No issues were observed with the methodology used to obtain samples from Tank 50 or from other inputs to Tank 50. In addition, the approach of only taking samples from Tank 50 twice a year and using a material balance to calculate the inventory in the tank may prove to be acceptable because DOE's procedures call for characterization of the inputs to Tank 50. It is important for the inventory of radionuclides that is sent to the SPF to be based on sampling results instead of process knowledge when possible.

Site personnel stated that waste transferred to Tank 50 from other tanks in the tank farms did not have to meet the WAC for Saltstone and that some credit could be taken for mixing with other waste streams. NRC staff believes that this approach is acceptable, but it is important for Tank 50 to be well mixed and for the waste that is sent to the SPF to meet the WAC prior to transfer. Problems could arise if transfers from Tank 50 to the SPF were to be made while Tank 50 is receiving a significant transfer because mixing of the waste streams may not occur in the tank before the waste is removed. In addition, when the agitation pumps are turned on during transfer of waste from Tank 50 to the SPF, it is important to monitor the amount of solids in the waste to ensure that plugs of abnormally large concentrations of solids are not sent to the SPF. For example, if agitation pumps do not adequately suspend all particles, then there is the potential for higher concentrations of solids in the waste when the level of liquid in the tank is low. The potential for solids to build up in the Salt Feed Tank in the SPF also should be considered. During future monitoring visits, NRC staff plans to examine records relating to sampling activities as well as to examine sampling results in more depth. In particular, NRC staff plans to compare the analytical results from the samples to the inventories of radionuclides calculated in the materials balance to verify the accuracy of the materials balance calculations used to predict the concentration of radionuclides in Tank 50. NRC staff also plans to review the QA plans related to obtaining and analyzing samples in more detail. In addition, NRC staff plans to observe waste sampling activities during a future monitoring visit. More information on the site's waste characterization methods, waste sampling quality assurance program, and confirmation that the measured radionuclide concentrations are as predicted is needed for closure of this monitoring activity.

2.4 Radiation Protection Program

2.4.1 Groundwater and Air Effluent Monitoring

2.4.1.1 Observation Scope

NRC staff interviewed DOE's contractor environmental monitoring personnel and reviewed records of the environmental monitoring (EM) program pertaining to SDF Vault 4 (designated

"451-Z" in EM records) and the SPF stack (designated "210-Z building" in EM records). The staff focused specifically on the 2007 groundwater monitoring program results for three groundwater monitoring wells installed downgradient of Vault 4, and the 2007 air effluent monitoring program for the SPF stack and Vault 4. Staff toured the SPF and the vicinity of Vault 4 to develop an understanding of the facility layout. The staff's reviews were guided by Sections 3.2.6 and 5.2.2 of the May 3, 2007, "U.S. NRC Plan for Monitoring the U.S. DOE Salt Waste Disposal at the Savannah River Site in Accordance with the National Defense Authorization Act for Fiscal Year 2005." (NRC, 2007)

2.4.1.2 Observation Results

With regard to groundwater monitoring, NRC staff and DOE contractor personnel discussed the location of downgradient wells, sample collection methods, frequencies of sample collection, sample analysis, and recent sample results. NRC staff requested copies of and reviewed: (1) three procedures relating to groundwater monitoring well installation, sampling methods, and sample packaging (WSRC, 2006a, 2007a, 2007b); and (2) Revision 4 of the Groundwater Monitoring Plan for the Z-Area Saltstone Disposal Facility (WSRC, 2006b). The staff also reviewed preliminary sample results for calendar year 2007.

NRC staff found no indication in the sampling results that potential monitored contaminants from Vault 4 have entered nearby groundwater. Of particular interest to NRC staff was the results for nitrate analysis, a major soluble component of the grouted wastes in Vault 4. The nitrate concentration in downgradient wells was similar to the nitrate concentration in the upgradient well.

With regard to air effluent monitoring, NRC staff and DOE contractor personnel discussed the SRS program for demonstrating compliance with the requirements of 40 CFR Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities" at the SPF and the SDF (Vault 4). The DOE program for compliance with 40 CFR Part 61, Subpart H, an EPA rule, addresses the 10 mrem constraint on total effective dose equivalent (TEDE) to an individual member of the public cited in 10 CFR 20.1101(d), which, in turn, is among the applicable portions of 10 CFR Part 20 that must be met for NRC to have reasonable assurance that the 10 CFR 61.43 performance objectives will be met during facility operation. DOE contractor personnel explained that processing of low curie salt (LCS) solution containing up to 0.2 curies per gallon is not expected to result in radionuclide emissions from the SPF due to the configuration of the blender and the screw-type mixer. Therefore, air effluent monitoring is only performed on air exhausted from Vault 4 during loading of LCS grout. NRC staff reviewed the basis for the type and frequency of air effluent monitoring at Vault 4 (SRS, 2005). Since the maximum effective dose equivalent (MEDE) and potential effective dose equivalent (PEDE) is less than 0.1 mrem/year, no control devices are used on the Vault 4 air effluent, and periodic quarterly sampling with offline analysis is performed during *facility operations.*

NRC staff reviewed the preliminary 2007 air effluent monitoring data for gross alpha- and beta-emitting radionuclides and specific radionuclides (cobalt-60, strontium-89/90, cesium-137, uranium-235/238, plutonium-238/239, americium-241, and curium-244). All monitoring results indicate that the public total effective dose equivalent remains below the 0.0816 millirem per year MEDE and PEDE calculated by contractor personnel, and well below the 10 CFR Part 20.1101(d) constraint of 10 mrem TEDE per year.

2.4.1.3 Conclusions and Followup Actions

During this observation visit, NRC staff reviewed sampling results for both the groundwater and air effluent monitoring programs at the SPF. NRC staff found that there is no indication of groundwater contamination in the vicinity of Vault 4 resulting from salt waste disposal operations. NRC staff also found that the air effluent sampling results for Vault 4 during filling operations indicate that doses to nearby workers and members of the public from air effluents remain well below applicable limits of 10 CFR Part 20 (i.e., the 10 mrem per year constraint on TEDE to the public). NRC staff plans to continue monitoring DOE environmental monitoring and surveillance programs at the SPF and SDF, for the foreseeable future, as an open activity under the NRC monitoring plan.

2.4.2 Worker Dose Monitoring

2.4.2.1 Observation Scope

To verify that DOE's radiation protection program is in place for operations at the SPF and the SDF to assess compliance with 10 CFR Part 61.43, *protection of individuals during operations*, the onsite observation included (i) interviews with DOE, and contractor radiation protection personnel; (ii) reviews of radiological control documents associated with saltstone operations, e.g., the SRS Radiation Control, and (iii) reviews of associated worker dose records. NRC staff toured the SPF and the SDF to verify the adequacy of access controls.

2.4.2.2 Observation Results

Through interviews with the F Tank Farm Manager and former Facility Manager for Saltstone, as well as other key site radiation protection personnel, and through reviews of pertinent personnel dosimetry records, NRC staff determined that SRS has an adequate radiation protection program. The NRC staff determined that the SPF and the SDF operations are controlled by 10 CFR 835 and the SRS Radiation Control Manual (WSRC Manual 5Q, *Radiological Control*). There is no saltstone-specific radiation protection program.

NRC staff reviewed personnel dosimetry reports for the 2nd and 3rd quarters of 2007. For approximately 150 individuals, the total quarterly person-rem were 40 mrem and 22 mrem, respectively, and quarterly radiation doses to individuals were predominately in the 0-3 mrem range. These doses are well within the dose limits in 10 CFR Part 835. It was during this timeframe that limited operations were ongoing at the SPF and the SDF similar to the operations observed during this visit.

NRC staff also determined that there were no incidents involving personal contamination or loss of control of radioactive material during saltstone operations, year to date in 2007.

Through interviews with key facility and radiation protection personnel, it was determined that there are adequate training and emergency response programs in place at SRS.

2.4.2.3 Conclusions and Followup Actions

Through a review of the radiation protection program implemented by DOE at the SPF and the SDF, interviews with radiation protection personnel, and a tour of the facility, NRC staff determined that DOE has an adequate radiation protection program in place for SPF and SDF operations. No specific items were identified for followup, and there are currently no associated open items. NRC will continue monitoring activities related to radiation protection during future onsite observation visits to SRS.

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