September 5, 2012

Mr. Jim Folk, Deputy Assistant Manager
Waste Disposition Programs Division
U.S. Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, SC 29802

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION JUNE 12, 2012, ONSITE OBSERVATION REPORT FOR THE SAVANNAH RIVER SITE F-TANK FARM CLOSURE

Dear Mr. Folk:

The enclosed report describes the U.S. Nuclear Regulatory Commission's (NRC's) onsite observation activities on June 12, 2012, at the Savannah River Site (SRS) F-Tank Farm performed in coordination with the South Carolina Department of Health and Environmental Control. This onsite observation was conducted in accordance with Section 3116 of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (Section 3116), which requires NRC to monitor 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 site visit were consistent with those described in the NRC's observation guidance at SRS F-Tank Farm, dated June 4, 2012, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12135A666) and NRC's staff guidance for activities related to waste determinations (NUREG-1854, dated August 2007).

This onsite observation at SRS was focused on assessing compliance with the four performance objectives: (i) protection of the general population from releases of radioactivity (§61.41); (ii) protection of individuals from inadvertent intrusion (§61.42); (iii) protection of individuals during operations (§61.43); and (iv) stability of the disposal site after closure (§61.44). Meeting these performance objectives is predicated on the performance of the tanks and ancillary facilities as closed by DOE.

If you have any questions or need additional information regarding this report, please contact James Shaffner of my staff at James.Shaffner@nrc.gov, or at (301) 415-5496.

Sincerely,

/RA/

Andrew Persinko, 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

Enclosures:
NRC Observation Report
DOE Pre-briefing

cc w /enclosure:
WIR Service List

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DATE	8/2/12	8/6/12	8/6/12	8/28/12	9/5/12

OFFICIAL RECORD COPY

WIR SERVICE LIST

Glenn Carroll, Coordinator
Nuclear Watch South
P.O. Box 8574
Atlanta, GA 31106

Tom Clements, Member
Friends of the Earth
1112 Florence Street
Columbia, SC 29201

Jim Hardeman, Manager
Environmental Radiation Program
Environmental Protection Division
Georgia Department of Natural Resources
4220 International Parkway, Suite 100
Atlanta, GA 30354

Karen Patterson, Environmental Appointment
Governors' Nuclear Advisory Council and Tetra Tech NUS
900 Trail Road
Aiken, SC 29803-5297

Bobbie Paul, Executive Director
Georgia Womens Action for New Directions
250 Georgia Ave., SE
Suite 202
Atlanta, GA 30312

Robert H. Pope
Senior Remedial Project Manager
U.S. Environmental Protection Agency
Region 4, Superfund Division
Federal Facilities Branch, Waste Division
61 Forsyth Street
Atlanta, GA 30303

Jon Richards, Remedial Project Manager
U.S. Environmental Protection Agency
Region 4, Superfund Division
Federal Facilities Branch, Waste Division
61 Forsyth Street
Atlanta, GA 30303

Thomas Saporito, Executive Director
P.O. Box 8413
Jupiter, FL 33468

John J. Schnabel, Saltstone Project Inspector, Professional Engineer
Division of Mining and Solid Waste Management
Bureau of Land and Waste Management
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201-1208

Shelly. Wilson
Federal Facilities Liaison
Environmental Quality Control Administration
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201-1708

U.S. NUCLEAR REGULATORY COMMISSION JUNE 12, 2012, ONSITE OBSERVATION REPORT FOR THE SAVANNAH RIVER SITE F-TANK FARM CLOSURE

EXECUTIVE SUMMARY:

The U.S. Nuclear Regulatory Commission (NRC) staff conducted its first onsite observation visit to the F-Tank Farm at the Savannah River Site (SRS) on June 12, 2012. The purpose of this visit was to focus on Tank 18 and 19 grouting as it relates to compliance with performance objectives in 10 CFR Part 61, Subpart C: (i) protection of the general population from releases of radioactivity (§61.41); (ii) protection of individuals from inadvertent intrusion (§61.42), and (iii) protection of individuals during operations (§61.43). The NRC observed aspects of Tank 18 and 19 grouting operations and discussed NRC concerns related to potential cracking and shrinkage of the grout and other cementitious materials. Shrinkage or cracking of these materials could form fast pathways through the engineered barrier system and lead to early release of key radionuclides from the disposal system and are, therefore, important to the 10 CFR 61.41 and 61.42 performance objectives.

Prior to the visit, The NRC and contractor staff reviewed a number of reports prepared by the U.S. Department of Energy (DOE) and its contractors related to grout specifications formulation, placement and anticipated performance. These reports are summarized in this report and will be evaluated in more detail in a separate technical review memoranda along with other technical reports previously provided to the NRC staff by DOE. In accordance with the onsite observation guidance (Agencywide Documents Access and Management System (ADAMS) Accession No. 12135A666), NRC staff had planned to accomplish the following objectives:

1. Observe grout truck arrival and check-in protocols.
2. Observe tests to ensure grout acceptability.
3. Observe external processes (i.e. point of origin) to introduce grout to delivery system.
4. Observe real time video of grout placement in tank(s).
5. Observe health physics practices to ensure worker protection.
6. Review and discuss specific measures to prevent in-tank grout shrinkage.
7. Review and discuss practices to ensure proper grouting of in-tank structures, and equipment.
8. Review and discuss practices to ensure proper grouting of tank vault features important to performance (e.g., basemat leak detection components).

The NRC was unable to accomplish onsite observation objectives 3, 6, and 8 listed above due to time and logistical constraints. These objectives will be addressed during a future visit.

It should be noted that this onsite observation was completed prior to the preparation of a formal monitoring plan. The monitoring plan is being prepared and will be used to inform onsite observations beginning in 2013.

NRC staff created no open issues associated with this onsite observation. However, NRC staff did provide several follow-up actions requesting information from DOE. In addition, NRC agreed to provide DOE with information related to research conducted by its contractors related to tank grout performance and information regarding alkali-silica-reaction that could be adverse to FTF tank grout performance.

A summary of the staff's observations and conclusions is provided below.

1.0 BACKGROUND:

Section 3116 of the National Defense Authorization Act for Fiscal Year 2005 (Section 3116) authorizes 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. Section 3116 also requires NRC to monitor DOE disposal actions to assess compliance with the performance objectives in 10 CFR Part 61, Subpart C.

On September 30, 2010, DOE submitted a "Draft Section 3116 Determination Closure of F-Tank Farm Savannah River Site" to demonstrate compliance with the Section 3116 criteria including demonstration of compliance with the performance objectives in 10 CFR Part 61, Subpart C (DOE, cite). In its consultation role, the NRC staff reviewed the draft waste determination and provided a number of recommendations that staff believed would be beneficial regarding DOE's demonstration of compliance with long-term performance objectives. The NRC documented the results of its review in a Technical Evaluation Report issued in October 2011 (NRC, 2011). DOE issued a final waste determination March 2012 taking into consideration the assumptions, conclusions, and recommendations in NRC's Technical Evaluation Report (DOE, 2012). DOE began grouting operations in April 2012.

To carry out its monitoring responsibility under Section 3116, NRC performs technical reviews and onsite observations related to DOE disposal activities, in coordination with the State of South Carolina site regulator, South Carolina Department of Health and Environmental Control (SC DHEC). Technical reviews generally focus on evaluation of information and data collected to provide support for key assumptions made in DOE's FTF Performance Assessment (PA) that are considered important to the compliance demonstration. Onsite observations generally are performed to: (i) observe the collection of information and data that are the subject of the technical reviews (e.g., observation of waste sampling used to generate radionuclide inventory data); or to (ii) observe key disposal (or closure) activities related to technical review areas or that are otherwise important to the compliance demonstration (e.g., slag and other material storage, grout formulation and preparation, and grout placement).

2.0 NRC ONSITE OBSERVATION ACTIVITIES:

2.1 Technical Focus:

Staff focused on long-term concerns related to grout shrinkage and cracking and its impact on the ability to meet 10 CFR 61.41 and 61.42. Observation of tank grouting and protection of workers and members of the public in compliance with 10 CFR 61.43.

2.2 Observation Scope:

In accordance with the onsite observation guidance (ADAMS Accession No. 12135A666), NRC staff had planned to accomplish the following objectives during the June 12, 2012 site visit:

1. Observe grout truck arrival and check-in protocols.
2. Observe tests to ensure grout acceptability.

3. Observe external processes (i.e. point-of-origin) to introduce grout to delivery system.
4. Observe real time video of grout placement in tank(s).
5. Observe health physics practices to ensure worker protection.
6. Review and discuss specific measures to prevent in-tank grout shrinkage.
7. Review and discuss practices to ensure proper grouting of in-tank structures and equipment.
8. Review and discuss practices to ensure proper grouting of tank vault features important to performance (e.g., basemat leak detection components).

The NRC was unable to accomplish onsite observation objectives 3, 6, and 8 due to timing or other constraints. These objectives, and others that will be documented in the subsequent onsite observation guidance, will be addressed during a future visit, as is possible.

2.1.2 On-Site Observation- DOE Grouting Activities for Tank 18:

The DOE began the onsite observation with an in-briefing that included an overview of the grout placement process, radiation protection, and contamination control, and quality control, as well as industrial and radiological safety considerations for site visitors. During the in-briefing participants were also able to observe “real time” video stream of grout placement including placement of grout in Tank 18. The presentations were followed by a tour of grouting operations, as discussed in more detail below:

1. In re. Item 1 (Section 2.1.1, above), the NRC staff observed ongoing grouting operations (above ground) from several perspectives. The staff was able to observe the arrival and verification of grout trucks, the delivery of grout to above ground hoppers, and the pumping of grout into a slick line.

2. In re. Item 2, NRC staff also observed an example of periodic testing of grout acceptability. Samples for testing are taken from the first grout batch of the day and at least one truck after the first 100 cubic yards of grout. Testing includes measurement of grout slump flow (to determine grout flowability and ability to self-level), temperature, unit weight/yield, bleed, and air content. Nine grout cylindrical samples also are prepared and archived for testing of compressive strength at 7, 28, and 91 days. These cylinders are stored under controlled temperature–humidity conditions prior to testing.

3. In re. Item 3 (partial), during the site tour, some NRC staff was provided a brief overview of Quality Assurance (QA) oversight of the grout supplier. The vendor has an approved QA program and is subject to inspections and surveillances by DOE and SRR.

4. In re. Item 4, the DOE contractor staff presented an overview of grouting operations for the tank, supplemented by real-time video of grouting operations. A camera and light array is used to monitor grout placement and the video is time stamped and archived onto DVDs. The use of a pneumatically launched “pig” was mentioned as the method to clean the grout slick line and tremie at the end of each shift. This method eliminates the need to wash the system with water, which could create local areas in the tank grout with higher water-to-cement ratio and higher permeability.

5. In re. Item 5, the DOE provided information on radiological controls and its radiation worker protection program. DOE indicated that a project-specific radiation work permit was created to track worker doses associated with Tanks 18 and 19 grout placement.

6. In re. Item 7, the DOE contractor staff also described the grouting of the internals of in-situ equipment, such as slurry pumps and transfer jets, and the procedure to be used for grouting tank risers

7. The DOE contractor staff indicated that, as of June 7, 2012, Tank 18 is approximately 67 percent full and has received a total of 699 truckloads of grout. Tank 19 is approximately 83 percent full and has received a total of 866 truckloads of grout. No risers in either tank have been capped

2.1.3 Observation Results:

Technical Discussion – Long term concerns related to grout shrinkage and cracking and its impact on the ability to meet PO 61.41[1]

The on-site observation focused on the ongoing grouting of Tank 18 in light of NRC staff concerns related to the potential for future cracking and/or shrinkage of emplaced grout material. Such shrinkage and cracking have the potential to create preferential fast-flow pathways for water through the bulk grout to the residual waste. Further, fast flow through localized paths in the grout could decrease the chemical reducing capability of the grout:

1. In re. Items 1 and 2, DOE staff explained that for each batch (or truckload) of grout, a ticket is prepared documenting the mix description, amount of each component in the mix, and water to cement ratio. NRC staff examined representative batch tickets of grout that was accepted for placement into the tank, and verified that the measured weights of the engineered grout pour components (Portland cement, fly ash, slag, sand, granite aggregate, water, and admixtures) reported in the tickets are within 1 percent of the grout mix design specifications listed in C-DCF-F-01524 (Revise Tanks 18F and 19F Closure Grout Specification). The water to cement ratio recorded in the batch tickets was found to be consistent with the specification in C-DCF-F-01524. NRC staff also examined representative batch tickets of grout that was rejected for placement, and verified that the rejected grout batches did not meet the slump flow requirement (24 to 28 inches) listed in C-DCF-F-01524.

[1] Preceding the out-brief with DOE, NRC staff internally met to discuss technical issues related to grout shrinkage, cracking, and other features that may lead to preferential or by-passing pathways through the grouted tanks. SC DHEC representatives supporting the observation were also in attendance and participated in the discussion.

2. In re. Item 4, the NRC staff noted mounding of grout in the center of Tank 18 due to placement of the grout through the center riser and what appeared to be an inability of the tank grout to completely self-level. NRC staff was concerned that filling the tank vaults may be difficult because DOE may be unable to deliver grout to the periphery of the tank due to premature filling of the grout access point in the center of the vault. DOE indicated that the domed roofs of the Type IV tank vaults will make it easier to fill all void space above the spring line of the tanks. However, DOE indicated that, if necessary, it would create additional access points in peripheral risers to ensure void space within the tank is minimized.

3. In re. Item 4, the NRC staff also noted the appearance of "lobes"[2], which is accentuated by the: (i) limited ability of the tank grout to self-level and (ii) incomplete lateral delivery of grout from the center riser to the tank periphery near the walls. NRC staff indicated its concerns with this grout feature because the results of an NRC contractor field experiment using a previously proposed FTF grout formulation showed that the lobe interfaces, as well as interfaces between successive lifts, are subject to shrinkage and could form higher conductivity zones that are more conductive to water through the monolith (Dinwiddie, et al., 2012).

4. In re. Item 4, the NRC staff also inquired about the potential for lower quality grout to form near the tank walls due to the use of process water to lubricate the tremies prior to the start of grouting each day. This water collects at the edge of the tank and could lead to locally higher water-to-cement ratios in the grout at the edges of the tank.

5. In re. Item 4, the NRC requested DOE to provide a video record of tank filling that would be beneficial to NRC staff understanding of: (i) the evolution of grout mounding and lobe formation over time; and (ii) the potential for lower quality grout to form near the tank walls due to the use of process water (and resultant higher water-to-cement ratios of grout in contact with collected water at the tank walls) at the start of each day of grouting. SC DHEC officials noted that they are monitoring grouting operations on an on-going basis and will be glad to share resulting information with NRC.

6. In re. Item 6, the NRC staff communicated its concerns with the potential formation of preferential fast-flow pathways along sidewalls, at the interfaces of residual equipment, and between grout lobes due to shrinkage. Although NRC staff intended to review and discuss with DOE measures to prevent in-tank grout shrinkage, DOE staff did not address grout shrinkage during its presentation, nor did it provide additional information during the out-brief when the issue was raised by NRC staff. NRC staff noted that DOE report SRNL-STI-2011-00551 recommended development and testing of a shrinkage compensating all-in-one grout mix design and described special test forms that were designed and instrumented to evaluate dimensional changes (shrinkage and expansion) as a function of time, temperature, and humidity. This topic will be evaluated in more detail in a separate technical review memorandum.

[2] A grout flow lobe is a fan-shaped mass of grout that forms on a slope by the changing direction of flow.

7. In re. Item 6, the NRC staff communicated its concern with the potential formation of cracks in the tank grout due to Alkali–Silica Reaction (ASR). ASR is a process whereby reactive aggregates breakdown under exposure to the highly alkaline pore solution in concrete, which can result in significant expansion and, in some cases, cause cracking of concrete. This concern arose because the grout being used to fill Tanks 18 and 19 include 3/8-inch granite "pea gravel" as aggregates, instead of using only sand aggregate as described in the DOE PA document (SRS-REG-2007-00002), and because of recent observations of concrete cracking at the Seabrook nuclear power plant in Seabrook, New Hampshire. In that facility, granite aggregates also were used in the concrete mix. ASR is a slow process and its occurrence at Seabrook became evident only decades after the plant was constructed. The Tank 18 and 19 grout fill mix contain less Portland cement than the concrete mix used at Seabrook and likely would be less susceptible to ASR.

   Nevertheless, NRC staff is concerned that DOE's criterion for acceptance of vendor supplied granite aggregate relies on short-term alkali reactivity tests (ASTM C1260), which is unlikely to predict the occurrence of ASR over the very long period of performance for compliance with PO 61.41. This topic will be evaluated in more detail in a separate technical review memorandum

- In re. Item 2, the NRC staff noted that DOE report SRNL-TI-2011-00551 indicated that currently available Portland cements contain up to 5 wt% limestone. NRC staff communicated its concern that a reduction in the amount of Portland cement in the grout mix would lower the pH buffering capacity of the grout and could affect the timing of release of key radionuclides. This topic will be evaluated in more detail in a separate technical review memorandum.

Technical Discussion – Ability to meet PO 61.43:

- In re. Item 5, DOE gave an overview of its radiation protection protocols specific to the grouting project during the in-briefing. However, NRC staff did not have an opportunity to analyze the program in any detail. It was agreed that a detailed discussion regarding specific aspects of DOE's radiation protection program would be conducted during a future onsite observation when subject matter experts are included as members of the observation team.

3.0 FOLLOW-UP ACTIONS AND CONCLUSION:

The NRC requested selected sample videos of Tank 18 grout pours to include at least 4 hours of continuous video for one operating day per week. Sample should include different calendar days (e.g. Monday one week; Friday; Wednesday etc.). NRC requests two examples of "end-of day-beginning-of-next-day video" and two examples of "end-of-week–beginning-of-next-week" video.

The NRC requested a copy of an in-tank daily inspection video from grout pouring operations.

SCDHEC indicated that it will continue to monitor grouting activities as part of its own inspection process and would be willing to share resulting information with NRC.

NRC requested grout batch tickets from four accepted loads and four rejected loads. (completed)

NRC will provide DOE with latest reports on grout and saltstone conducted by the CNWRA. (completed)

NRC will provide DOE documentation on ASR in concrete of the Seabrook Station. (completed)

There were no conclusions resulting from this on-site observation.

4.0 PARTICIPANTS:

In Brief and Tour of Grouting Operations (am) and Out-brief (pm)

U.S. NRC:
George Alexander
Cynthia Barr
Leah Parks
Christepher McKenney
Janelle Jessie
James Shaffner
Roberto Pabalan (CNWRA/SWRI)

U.S. DOE-SRS:
Sherri Ross

SRR:
Ginger Dickert (pm)
Steve Thomas
Stuart MacVean (pm)
Larry Romanowski
Kent Rosenberger
James Herbert (am)
Victor Franklin (pm)
Kim Hauer
Bruce Dragon(pm)
Ron Campbell
Dan Wood
Andy Tisler

SOUTH CAROLINA DHEC
Barry Mullinax
Byron Amick
Scott Simons

U.S. DOE HQ
Linda Suttora

5.0 REFERENCES:

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Work Order No. 01087938–15: Placement of Grout Tank 19 Center Riser. 2012.

Work Order No. 01087939–17: Placement of Grout Tank 18 Various Equipment Locations. 2012.

Work Order No. 01087938–16: Placement of Grout Tank 19 Various Equipment Locations. 2012.