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NUCLEAR REGULATORY COMMISSION
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September 26, 2023

MEMORANDUM TO: Stephen Koenick
Low-Level Waste and Projects Branch
Division of Decommissioning, Uranium Recovery, and Waste Programs
Office of Nuclear Material Safety and Safeguards

THROUGH: Christepher McKenney, Chief
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FROM: Cynthia Barr, Senior Risk Analyst
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Signed by Barr, Cynthia on 09/26/23

SUBJECT: REVISION 1 TECHNICAL REVIEW: U.S. DEPARTMENT OF ENERGY DOCUMENTATION RELATED TO TANK 12H GROUTING OPERATIONS AT THE H-TANK FARM FACILITY, SAVANNAH RIVER SITE, AIKEN, SC, WITH EMPHASES ON SPECIFICATIONS, TESTING, RECOMMENDATIONS AND PLACEMENT PROCEDURES (PROJECT NO. PRO0734)

The U.S. Nuclear Regulatory Commission (NRC) performed a technical review of several documents prepared by the U.S. Department of Energy (DOE) that provided information on grouting and closure of Tank 12H in 2016. The focus of NRC's technical review was on grout formulations and specifications, testing, recommendations, and placement procedures. Since the original technical review report was issued in 2020 (see ADAMS Accession No. ML20296A550), additional information and documents were provided by DOE related to Tank 12H and other tank grouting. This report is an update to ML20296A550.

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ML20296A550 supplemented information from a previous technical review report focused on grouting of both Tanks 12H and 16H (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16231A444). Because grouting of Tank 12H had just begun during development of ML16231A444, NRC staff were only able to reach preliminary findings about Tank 12H. NRC also revisits findings from previous technical review reports related to Tanks 18F and 19F grouted in 2012; and Tanks 5F and 6F grouted in 2013 (ADAMS Accession Nos. ML13269A365 and ML14342A784).

Proper tank grouting is important to several factors for effective long-term performance of the closed tank farms, including chemical conditioning of the water infiltrating into the tanks before contact with the waste layers, stability of the vessels (including filling of void space) and reducing the probability of inadvertent intrusion (e.g., the thick concrete and grout could alert an inadvertent intruder to stop drilling before reaching the waste layer).

This technical review can be tied to several monitoring factors listed in NRC's combined F-Area and H-Area Tank Farm monitoring plan entitled "U.S. Nuclear Regulatory Commission Plan for Monitoring Disposal Actions Taken by the U.S. Department of Energy at the Savannah River Site F-Area and H-Area Tank Farm Facilities in Accordance with the National Defense Authorization Act for Fiscal Year 2005" (available using ADAMS Accession No. ML15238A761) issued in October 2015 (hereafter, Monitoring Plan). The Monitoring Plan discusses NRC's approach to fulfilling its responsibilities under the National Defense Authorization Act for Fiscal Year 2005 to monitor DOE disposal actions to assess compliance with the Performance Objectives in Title 10 *Code of the Federal Regulations* (10 CFR) Part 61, Subpart C, for DOE wastes (and associated disposal facilities) found to be incidental to reprocessing.
NRC's Monitoring Plan lists the technical areas, which are the focus of NRC's monitoring activities. This technical review generally supports NRC's Monitoring Area 3, "Cementitious Material Performance", and particularly Monitoring Factors 3.2 "Groundwater Conditioning via Reducing Grout," 3.3, "Shrinkage and Cracking," and 3.4, "Grout Performance" listed in the NRC's Monitoring Plan.

The NRC staff concludes that performance requirements for the tank grout formulation recommended and tested for Tank 12H closure are generally consistent with initial bulk chemical and hydraulic properties assumed in DOE's H-Area Tank Farm Facility Performance Assessment (PA) (SRR-CWDA-2010-00128). However, DOE has not provided sufficient information and testing to support its exclusion of shrinkage gaps, cracks, and other preferential flow pathways through the grout monolith from the reference case in DOE's PA.
These conclusions were also true for performance assessment analyses conducted for Tanks 18F, 19F, 5F, 6F, and 16H, including DOE's F-Area and H-Area Tank Farm Facility PAs.

The NRC staff expects DOE to provide additional information related to the extent and performance impact of tank grout shrinkage to support a reasonable assurance decision that the performance objectives specified in 10 CFR Part 61, Subpart C are met. As stated above, DOE assumes in the PAs for F- and H-Area that the grout does not shrink or crack in the base or reference case. Rather, the grout is assumed to degrade slowly with a subsequent increase in saturated hydraulic conductivity of the grout matrix over time. This slow-degradation assumption is risk-significant because conceptually DOE thereby assumes that the entire grout matrix is available to slowly condition infiltrating groundwater to relatively low E_h and high pH, which may be necessary to maintain the low solubility of key radionuclides. For the tank grout to condition infiltrating water to relatively low E_h and high pH, water must flow through and interact with the grout. In contrast, if flow is concentrated along fast pathways (e.g., through annular apertures between the tank wall or internal cooling coils/structural columns and tank grout, shrinkage gaps at grout flow lobe seams and grout lift interfaces, or cracks in the tank grout), flow rates through the grout may be significantly faster and the extent of interaction between infiltrating groundwater and tank grout may be significantly less than assumed in DOE's PAs, thereby hastening the time to transition to risk-significant solubility and dose for certain key radionuclides. Furthermore, tank grout shrinkage and the existence of preferential pathways may enhance flow through the engineered system and consequently lead to greater release rates independent of the chemical buffering effect of reducing tank grout. NRC staff will continue to evaluate the potential for shrinkage- and cracking-induced[1] preferential flow through the tank grout under MF 3.3, "Shrinkage and Cracking" (ADAMS Accession No. ML15238A761), as well as DOE's assumptions regarding flow through the tank grout that influences the extent of groundwater conditioning in MF 3.2 "Groundwater Conditioning via Reducing Grout".

With respect to submerged tanks (i.e., partially or fully in the saturated zone), such as Tank 12H, DOE assumes mixing between aquifer water primarily flowing horizontally through the tank grout and infiltrating groundwater primarily flowing vertically through the tank grout. Therefore, the initial chemistry of the water in contact with the waste zone is assumed to be less conditioned (i.e., higher E_h and lower pH) via its interactions with reducing tank grout compared to what is assumed for non-submerged tanks where groundwater primarily flows vertically through the overlying, reducing tank grout. After the reduction capacity of the tank grout is depleted, the chemistry of the waste zone transitions to a higher E_h, reflective of oxidized conditions. The impact of the more moderate chemical conditions for submerged tanks, such as Tank 12H, is potentially higher solubility of key radionuclides such as plutonium and technetium. NRC staff will continue to monitor the impact of submerged groundwater conditions on waste release from H-Tank Farm tanks, such as Tank 12H.

The key radionuclide contributing to dose in DOE's PA for Tank 12H is I-129. The PA assumes no solubility control for I-129. Although DOE does not take credit for solubility control to limit I-129 dose in its PAs, DOE does take credit for sorption of I-129 in cementitious materials. If DOE chooses to take advantage of solubility control for I-129 in the future, a better understanding of the expected evolution of the geochemical conditions in the waste zone would be needed. NRC staff will continue to monitor the impact of groundwater chemistry on I-129 attenuation and dose, including the impact of aquifer chemistry on I-129 waste release from submerged tanks, such as Tank 12H. Additionally, due to significant variability in Tank 12H and Tank 18F waste release results, NRC staff will continue to monitor the extent of groundwater conditioning via reducing tank grout in submerged and unsubmerged tanks, as well as the impact of waste geochemistry on key radionuclide release from other F-Area and H-Area tank farm tanks.

Other conclusions unique to Tank 12H grouting include:

- Regarding the change in slag from Grade 100 to Grade 120 during Tank 12H grouting, DOE should address the performance impact of using two different slag cements in Tank 12H reducing tank grout: Holcim Grade 100 grout [163 cubic meters (213 cubic yards)] was placed in the bottom of the first lift in the primary and Lehigh Grade 120 grout [2,840 cubic meters (3,714 cubic yards)] was placed above. DOE should evaluate differences in chemical reactivity, saturated hydraulic conductivity, and compressive strength between the Grade 100 and Grade 120 slag tank grouts and any resulting

[1] While cracking may enhance flow through the reducing tank grout in the bulk monolith, which could be beneficial to performance, the impacts of crack formation are not well understood. Additional information in this area would be beneficial to assess the impact of crack formation on tank grout performance.

performance impact. NRC staff will continue to monitor the impact of slag grade on chemical reactivity, saturated hydraulic conductivity, and compressive strength of reducing tank grout.

- DOE has not provided sufficient information about the potential impact of excess water present in submerged, grouted tanks, such as Tank 12H, on the quality of grout placed into the tank, and therefore on anticipated performance of tank grout in a submerged or partially submerged tank. DOE should undertake analyses to better understand the impact on grout performance and grout quality of the significant amount of liquid present in submerged tanks that interacts heterogeneously with tank grout, both during early days post-placement and longer term. DOE should provide information about the potential impact on grout performance of standing water in Tank 12H during grouting and of heterogeneous water-to-cement ratios in tank grout when grouting submerged tanks. The NRC staff will monitor potential impacts of high levels of saturation in partially submerged to submerged tanks. The NRC staff will monitor how DOE contractors grouted around pools of water that remained on the floor of Tank 12H immediately before grouting commenced, and any potential impacts that may have been associated with grouting around pools of standing water. The NRC staff will continue to monitor the potential for grout bleed-water segregation and potential impacts on future water flow through the grout monolith and waste release.

Other key findings from previous reviews are summarized in the conclusions section of the main report. In this report, there is no significant change to the NRC staff overall conclusions from the F- and H-Tank Farm TERs regarding compliance of DOE disposal actions with the 10 CFR Part 61 performance objectives. Likewise, there is no significant change to the status of Monitoring Factors 3.2 “Groundwater Conditioning via Reducing Grout,” 3.3, “Shrinkage and Cracking,” and 3.4, “Grout Performance” listed in the NRC staff’s Monitoring Plan for the tank farm facilities (ADAMS Accession No. ML15238A761).

Enclosure:
Technical Review of Documents Related
to Tank 12H Grout Formulations,
Testing, Procedures, and Operations at the
H-Area Tank Farm at the Savannah River Site

Cc:
WIR Service List

Technical Review of Grout Documentation for Tank 12H at SRS H-Tank Farm Facility (Revision) DATE September 26, 2023

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