Task Technical and Quality Assurance Plan for Testing Methods to Reduce 235 Uranium Enrichment in Tank 43H Supernatant Liquid

by

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1.0 Introduction[1]

In July of 1997, the 2H-Evaporator was shutdown due to the inability to lift material from the vessel. Inspections of the gravity drain line (GDL) showed a scale deposit coating the inside of the line. A sample of the material was obtained and analyses confirmed the deposit was a sodium aluminosilicate scale of the form $Na_8Al_6Si_6O_{24}(NO_3)_2$. The analyses also showed ~3 wt% uranium in the form of sodium diuranate ($Na_2U_2O_7$) at less than 1 wt% enriched in ^{235}U.

Visual inspection of the evaporator pot showed no evidence of scale deposition or degradation. The GDL was successfully cleaned with an 8000 psi water stream at this time. The GDL was again cleaned with a pressure washer in June 1998. An inspection of the evaporator pot at this time showed minimal deposits on the walls and internal lines. For the rest of 1998 and the first part of 1999, operations continued to experience poor lift performance. Finally in October 1999, the 2H-Evaporator was shut down due to the inability to lift solution from the evaporator.

Visual internal inspection of the evaporator pot showed a significant buildup of solids on all of the exposed surfaces of the evaporator pot. A sample of the material in the bottom of the evaporator cone was taken at this time. The sample confirmed that the material was the same sodium aluminosilicate scale mixed with sodium diuranate that was found in the gravity drain line, however this material had ~7.4 wt % uranium and was ~3 wt% ^{235}U. Due to the high amount of uranium and the higher enrichment, the 2H evaporator PISA (Potential Inadequacy in the Safety Analysis) was declared in January 2000. This PISA addresses the unexpected buildup of fissile material in the evaporator pot, resulting in a criticality concern that was not addressed in the current Authorization Basis (AB).

Plans are to chemically clean the evaporator pot by dissolving the solids in a 1.5M nitric acid solution containing depleted uranium. After cleanout of the evaporator pot, evaporation of liquid wastes will resume using material from Tank 43H. Recent analyses of surface and variable depth samples from Tank 43H indicate an average total uranium concentration of 15.0 ± 2.9 mg/L and average ^{235}U enrichment of 3.12 ± 0.63 wt %. Thus, as previously observed sodium diuranate solids containing enriched uranium could deposit in the evaporator vessel. Criticality safety during evaporator operation would be enhanced if the enrichment could be reduced to or less than that of natural abundance. HLWE requested that SRTC conduct tests to identify a method to reduce the ^{235}U enrichment in the supernatant liquid presently stored in Tank 43H.[2]

2.0 Task Description

Task activities include scoping tests to determine the extent and rate of isotopic dilution of ^{235}U upon the addition of depleted uranium solution to an alkaline solution that simulates supernatant liquid waste currently stored in Tank 43H. The composition of the Tank 43H simulant will feature most recently reported values obtained from dip samples taken from the tank (see Table I).

Mechanical mixing is limited in Tank 43H to air/steam sparging. Scoping tests will bound mixing conditions by conducting tests under well-mixed and unmixed conditions. The unmixed tests will be manually shaken just prior to sampling to ensure one obtains and analyzes a representative sample from the test bottle.

Scoping tests will also include tests that feature a prestrike with freshly precipitated ferric hydroxide or manganese oxide to remove soluble uranium. Prestriking with either of these materials should reduce the liquid phase uranium concentration enabling isotopic dilution of the uranium to proceed at a faster rate. The quantity of sorbent will be selected by the researcher with concurrence with the CST Engineering contact.

Table I. Composition of Tank 43H Supernatant Liquid

Component	Value	Unit	Reference
Nitrate	1.23	molar	3
Free Hydroxide	2.50	molar	3
Nitrite	0.81	molar	3
Carbonate	0.05	molar	3
Aluminate	0.20	molar	3
Sulfate	0.018	molar	3
Oxalate	0.0069	molar	3
Phosphate	0.0064	molar	3
Total Uranium	15.0 ± 2.9	mg/L	4
^{235}U	3.12 ± 0.63	wt %	4

All scoping tests are planned for 25 °C, which is at the lower range of temperatures (24 – 38 °C) recorded for the supernatant liquid in Tank 43H over the last 21 months.[5] Temperature and mixing will be controlled using a shaking waterbath. Unmixed tests may be conducted in a controlled temperature oven if available. An alkaline depleted uranium (DU) solution will be used to isotopically dilute the ^{235}U enrichment in the simulant Tank 43H waste solution. Plans are dissolve the DU in nitric acid to a concentration of between 5 and 30 g/L. Sodium carbonate will then be added until the solution is alkaline. An alternate test will add the DU as acidic solution (pH = 1).

Another alternate test will utilize a reverse strike approach where the supernatant liquid is added to the uranium carbonate solution. The density of the DU solution will be adjusted to be similar to that of the Tank 43H supernate. Having both solutions at or close to the same density will minimize segregation of the two solutions and, thus, promote mixing.

Sufficient DU will be added to reduce the ^{235}U enrichment to less than 1 wt %. Uranium isotopics will be measured using inductively coupled plasma – mass spectrometry (ICP-MS).[6] Samples will be taken periodically over a two-week period to measure for ^{235}U enrichment. Sampling frequency and the testing period may adjusted as necessary as scoping test results become available.

Upon completion of testing with simulated waste solutions, WPTS researchers will conduct a confirmatory test with Tank 43H waste. This test will be conducted in the SRTC Shielded Cells facility. Test conditions for the radioactive waste test will be established based on results from the scoping tests with simulated waste solutions.

Based on the results of the initial scoping tests, WPTS will make recommendations to CST Engineering concerning a process to dilute the ^{235}U enrichment in Tank 43H

supernatant liquid. The recommendations will include what, if any, additional tests are needed. The recommendations and a summary of testing results will be issued by WPTS to CST Engineering in a technical report.

3.0 Risk Review

Table II highlights the elements identified as programmatic risks. Where available, the table lists mitigating factors or actions. Equipment, analytical services, personnel, facilities, emergent activities, and results contribute to the programmatic risks. The most likely risk in this development involves delays in obtaining the necessary equipment and delays associated with bringing the new experimental equipment on-line.

Table II: Programmatic risk and Mitigation

Risk Factor	Event	Mitigation
Equipment		
Any equipment needed to complete this task	Breaks	Replace and shift to alternative equipment.
Personnel		
D. T. Hobbs	Unavailable	Shift in technical personnel.
L. N. Oji	Unavailable	Shift in technical personnel.
M. S. Blume	Unavailable	Shift in technical personnel
H. L. Thacker	Unavailable	Shift in technical personnel
Analytical		
ICP-MS	Unavailable	Delays program.

4.0 Schedule

October 6, 2000	Complete scoping tests
October 13, 2000	Make recommendations based on scoping test results
October 27, 2000	Complete draft report
November 17, 2000	Complete confirmatory scoping test with archived radioactive waste

5.0 Safety

The task leader reviewed the safety aspects of the experiments described in this task plan to determine their impact on the safety of the facilities. The review included evaluation of the checklist from the Conduct of Research and Development Manual, WSRC-IM-97-00024, Rev 2. The work introduces no new chemicals. No new experimental hazards (such as new electrical, significant quantities of combustible, explosive, or corrosive materials, pressure or mechanical equipment) arise from the planned experiments.

5.1 Test Controls

Samples submitted to the Analytical Development Section for determination of uranium concentration and enrichment will feature blind standards and blanks. The temperature will be controlled and recorded during each test using calibrated testing equipment. The remainder of this section of the document details the controls necessary to ensure the quality of the results obtained in the above detailed tasks performed by WPTS.

5.2 Task Quality Assurance (QA) Plan Checklist

See Attachment 1.

5.3 Additional Comments

Additional tests not explicitly detailed in this Task and QA plan may be conducted under this task plan without revision provided that in the opinion of the researchers, that the additional tests do not change the hazard assessment for this activity or require new or additional quality assurance controls.

Manual L1 Procedure 3.07 will govern obtaining chemical analyses by the ADS. The ADS uses Manual 1Q Procedure 2-7 for M&TE. The QA level performed will vary by analysis.

6.0 Approvals

D.T. Hobbs, Author — Date 9/22/00

L. N. Oji, Author — Date 9/22/00

M. S. Blume, Author — Date 9/22/00

H. L. Thacker, Author — Date 9/22/00

J. J. Connelly, SRTC Quality Assurance Department — Date 22 SEP 00

W. B. Van Pelt, Manager, SRTC WPTS — Date 9-25-00

B.L. Lewis, Manager, CST Engineering — Date 9-25-00

7.0 REFERENCES

[1] C. S. Boley, M. C. Thompson, W. R. Wilmarth, "Technical Basis for the 242-16H Evaporator Cleaning Flowsheet (U)," SRS Report WSRC-TR-2000-00211, Rev. 0, July 12, 2000.

[2] B. Lewis, "Development of Process to Reduce the Uranium Enrichment in Tank 43," Technical Task Request HLE-TTR-2000-063, Rev. 0, August 17, 2000.

[3] Sample Taken from Tank 43H on 7/30/00 and Reported in High-Level Waste Tank Corrosion Chemistry Database maintained CST Engineering and recorded in MS Excel file 'Ntank43.xls'.

[4] W. R.Wilmarth and R. A. Peterson, "Analyses of Surface and Variable Depth Samples from Tank 43H," WSRC-TR-2000-00208, Rev. 0, September 2000.

[5] Tank farm morning reports [get reference].

[6] "Inductively Coupled Plasma – Mass Spectrometry Elemental and Isotopic Analysis for Aqueous Liquid Samples," Manual 16.1, Analytical Development Section Analytical Operating Procedure ADS-1543, Rev. 1, April 1, 1998.

WPT TASK QUALITY ASSURANCE PLAN CHECKLIST

Task Technical Plan No: WSRC-RP-2000-00797 Task Title: Reduction of Tank 43H Uranium Enrichment
Listed below are the sections of WSRC 1Q. Check WSRC 1Q sections applicable to the task. Also check procedures WPT implements to control the task. This checklist identifies only procedures used to control task activities performed by WPT.
(Form Revised 2/2000)

WSRC 1Q Section	Applies To Task	QA Procedures Implemented by WPT	Procedure Used
Organization	x	1Q, QAP 1-1, Organization L1, 1.02, SRTC Organization	x x
		1Q, QAP 1-2, Stop Work	x
QA Program	x	1Q, QAP 2-1, Quality Assurance Program L1, 8.01, SRTC QA Program Implementation L1, 8.02, SRTC QA Program Clarifications	x x x
	x	1Q, QAP 2-2, Personnel Training & Qual. L1, 5.01, SRTC Training, Orient. & Employee Dev. L1, 1.32, Read and Sign L1, 1.33, Facility Access Training/Employee Orient.	x x x x
	x	1Q, QAP 2-3, Control of R&D Activities L1, 8.02, SRTC QA Program Clarifications L1, 7.10, Control of Technical Work	x x x
		1Q, QAP 2-4, Auditor/Lead Auditor Qual. & Cert.	NA for WPT
		1Q, QAP 2-5, Qual. & Cert. of Independent Insp. Personnel	NA for WPT
		1Q, QAP 2-6, QA Manual Revisions	
		1Q, QAP 2-7 QA Program Req. for Analytical Measurement Systems	NA for WPT
		1Q, QAP 2-10, Independent Inspection Personnel On-The-Job Trn.	NA for WPT
	x	L1, 4.19, Laboratory Notebooks and Logbooks	x
Design Control		1Q, QAP 3-1, Design Control L1, 7.10, Control of Technical Work	
Procurement Document Control	x	1Q, QAP 4-1, Procurement Document Control 7B & 3E (for reference only)	x
Instructions, Procedures and Drawings	x	1Q, QAP 5-1, Instructions, Procedures, & Drawings E7, 2.30, Drawings L1, 1.01, SRTC Procedure Administration L1, 1.01.1, Work Instruction Administration	x x x
Document Control	x	1Q, QAP 6-1, Document Control L1, 1.30, Document Control	x x
Control of Purchased Items and Services	x	1Q, QAP 7-2, Control of Purchased Items & Services 7B & 3E (for reference only)	x

		1Q, QAP 7-3, Com. Grade Item Dedication & Material Upgrade E7, 3.46, Replacement Item Evaluation/Commercial Grade Item Dedication	
Identification and Control of Items	x	1Q, QAP 8-1, ID and Control of Items L1, 8.02, SRTC QA Program Clarifications	x x
Control of Processes		1Q, QAP 9-1, Control of Processes	NA for WPT
		1Q, QAP 9-2, Control of Nondestructive Examination	NA for WPT
		1Q, QAP 9-3, Control of Welding & Joining Processes Y12	NA for WPT
		1Q, QAP 9-4, Work Control 1Y, 8.01, Work Control Procedure L1, 8.02, SRTC QA Program Clarifications	
Inspection		1Q, QAP 10-1, Inspection & Verification L1, 8.10, Inspection L1, 8.10.1, Independent Inspection Releases	NA for WPT NA for WPT
Test Control		1Q, QAP 11-1, Test Control (applies to WPT only for acceptance testing)	
Control of Measuring & Test Equipment	x	1Q, QAP 12-1, Control of Measuring &Test Equipment	x
		1Q, QAP 12-2, Control of Installed Process Instrumentation	
		1Q, QAP 12-3, Control & Calibration of Radiation Monitoring Equipment	
Packaging, Handling, Shipping & Storage	x	1Q, QAP 13-1, Pkg., Handling, Ship. & Storage L1, 8.02, SRTC QA Program Clarifications	x
Inspection, Test, and Operating Status		1Q, QAP 14-1, Inspection, Test, & Operating Status L1, 8.02, SRTC QA Program Clarifications	
Control of Nonconforming Items & Action	x	1Q, QAP 15-1, Control of Nonconforming Items L1, 8.02, SRTC QA Program Clarifications	x
		1Q, QAP 15-2, Control of Nonconforming Activities L1, 8.02, SRTC QA Program Clarifications	
Corrective Action System	x	1Q, QAP 16-1, Corrective Action System	x
	x	1Q, QAP 16-2, Quality Alert	x
Quality Assurance Records	x	1Q, QAP 17-1, Quality Assurance Records Management L1, 8.02, SRTC QA Program Clarifications	x x

Audits	x	1Q, QAP 18-2, QA Surveillance L1, 8.18.1, Surveillance	x x
		1Q, QAP 18-3, QA External Audits L1, 8.18, SRTC QA Audit Program	
		1Q, QAP 18-4, Management Assessments 12Q, Assessment Manual	
		1Q, QAP 18-6, Quality Assurance Internal Audits	
Quality Improvement	x	1Q, QAP 19-2, Quality Improvement L1, 8.02, SRTC QA Program Clarifications	x x
Software Quality Assurance		1Q, QAP 20-1, Software QA L1, 8.20, Software Management & Quality Assurance	
Environmental Quality Assurance		1Q, QAP 21-1, Quality Assurance Requirements for the Collection and Evaluation of Environmental Data	NA for WPT

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