BNF-003-98-0017

Hanford Tank Waste Ion Exchange Swelling Task Technical and Quality Assurance Plan

by
D. J. McCabe
Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

DOE Contract No. **DE-AC09-96SR18500**

DISCLAIMER

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

BNF-003-98-0017
Revision 0

Hanford Tank Waste Ion Exchange Swelling
Task Technical and Quality Assurance Plan (U)

October 19, 1998

Daniel J. McCabe, 773-42A

Authorized Derivative Classifier

Authorized Reviewing Official

DISCLAIMER NOTICE

Savannah River Technology Center
Westinghouse Savannah River Company
Aiken, SC 29808

1.0 Summary

The swelling and density properties of ion exchange resins intended for pretreatment of Hanford High Level Waste will be examined. The resins are known to swell in highly alkaline salt solutions, and this behavior must be fully understood to develop resin pretreatment protocols. This plan describes the experiments needed to determine the swelling and density properties of the resins. This plan also describes the Quality Assurance protocols which will be followed. This task does not impact any RW0333P requirements.[1]

2.0 Introduction

2.1 Definition

The conceptualized process for treatment of Hanford High Level Waste decontaminates radioactive solutions by ion exchange removal of Cs^{137} with SuperLig® 644 or 632 resins, Tc-99 removal with SuperLig® 639, and sulfate ion removal with SuperLig® 655. Other resins may also be used, as requested by BNFL, Inc.

The objective of this testing program is to define the resin pretreatment process for Hanford High Level Waste. This task will provide a basis for understanding resin swelling, which can lead to channeling and early breakthrough. The density of salt solution that leads to resin floating will also be determined to establish a limit for operation.

2.2 Requesting Organization

British Nuclear Fuels Inc. has requested this work through the Work For Others contract #RNFE099802.

2.3 Responsibilities

Waste Processing Technology (WPT) and Chemical and Hydrogen Technology (CHT) will plan and conduct the ion exchange tests.

CHT will procure the needed equipment and chemicals to perform the experiments.

2.4 Deliverables

The test results will be provided to BNFL, Inc. in the form of a summary document. BNFL, Inc. will review and approve the document prior to finalization.

3.0 Task Acceptance Criteria

The task activities will be reviewed and approved by BNFL, Inc. personnel. Results from the testing will be provided to BNFL, Inc. for input to the flow sheet design team.

4.0 Task Activities

4.1 Equipment Description

Simulant column
diameter: 2.5 cm
resin volume: 40-50 mL (swelled)
gravity flow through column

Column Apparatus

The columns will be prepared and tested in duplicate. The resin will be retained in the column by means of quartz wool, but will be unobstructed on the top of the resin bed. All solutions will be introduced at the top of the column and allowed to drain through by gravity at 3 Column Volumes per hour. If the top surface of resin is disturbed by introduction of liquid, it will be re-leveled by gentle stirring and tapped on the column exterior to promote re-settling. The liquid in the headspace will be minimized between solution cycles to reduce mixing. The columns will be equipped with graduations or a ruler to facilitate volume measurements.

The following resin characteristics will be recorded:

- Resin volume
- Buoyancy
- Effluent color
- Presence of fissures
- Presence of bubbles

If the concentration of species are not achievable for the planned solution compositions, the maximum concentration will be used and the remaining tests at higher concentration will be eliminated.

During overnight storage, the resin column will be covered with Parafilm® or similar material to reduce air absorption and evaporation.

The term "Column Volumes" (CV) will be defined as the resin volume measured after the first treatment with 0.25 M NaOH. This volume will be used for all subsequent tests, regardless of the measured column volume. All tests will be done at ambient temperature.

4.2 Acid Cycling (SuperLig® 632, 644, 639, 655)

1. Wet resin with deionized water for 24 hours in a poly bottle
2. Load the resin into the column and tap the column exterior to promote settling
3. Measure the wetted resin volume and observations
4. Pretreat the resin with 0.25 M NaOH; allow solution to gravity drain at 150 mL per hour. Record resin volume and observations after every 150 mL are collected.
5. Continue pretreatment until two consecutive volume measurements are identical
6. Remove excess liquid from column headspace
7. Displace the NaOH solution with d.i. water until 3 CV are collected
8. Record resin volume and observations after every 3 CV
9. Continue washing until two consecutive volume measurements are identical
10. Elute the resin with 0.5 M HNO_3
11. Record resin volume and observations after collecting every 3 CV
12. Continue eluting until two consecutive volume measurements are identical
13. Remove excess liquid from column headspace
14. Displace HNO_3 solution with 3 CV of deionized water
15. Record resin volume and observations after 3 CV have been collected
16. Pretreat the resin with 0.25 M NaOH
17. Record resin volume and observations after every 3 CV have been collected
18. Continue pretreatment until two consecutive volume measurements are identical
19. Remove excess liquid from column headspace

4.3 pH Dependence (SuperLig® 632, 644)

1. Use the resin samples previously pretreated with 0.25 M NaOH
2. Treat the resin with 0.5 M NaOH
3. Record resin volume and observations after collecting every 3 CV
4. Continue treating with this solution until two consecutive volume measurements are identical
5. Treat the resin with 3 CV of 1.0 M NaOH
6. Record resin volume and observations after collecting 1.5 and 3 CV
7. Repeat steps 5-6 for 3.0, 5.0, 7.0, and 8.0 M NaOH. Stop testing if the resin floats. Continue to higher NaOH concentrations if the resin does not float (1 M increments).
8. Remove excess liquid from column headspace
9. Displace NaOH solution with deionized water for 3 CV
10. Record the resin volume and observations after 3 CV
11. Elute the resin with 0.5 M HNO_3
12. Record resin volume and observations after every 1.5 CV have been collected
13. Continue eluting until two consecutive volume measurements are identical
14. Remove excess liquid from column headspace
15. Displace HNO_3 solution with deionized water for 3 CV
16. Record the resin volume and observations after 3 CV

17. Pretreat the resin with 0.25 M NaOH for 3 CV
18. Record resin volume and observations after every 1.5 CV have been collected
19. Continue pretreatment until two consecutive volume measurements are identical
20. Remove excess liquid from column headspace

4.4. Ionic Strength Dependence (SuperLig® 632, 644)

1. Use the resin samples previously used in Section 4.3
2. Treat the resin with a solution containing 0.25 M NaOH and 0.25 M $NaNO_3$ until 3 CV have been collected
3. Record resin volume and observations after 3 CV have been collected
4. Continue pretreatment until two consecutive volume measurements are identical
5. Pretreat the resin with a solution containing 0.25 M NaOH and 0.75 M $NaNO_3$ until 3 CV have been collected
6. Record resin volume and observations after 1.5 and 3 CV have been collected
7. Repeat steps 5-6 for solutions containing:

NaOH (M)	NaNO3 (M)
0.25	2.75
0.25	4.75
0.25	6.75
0.25	7.75

Terminate testing if the resin floats. Continue to higher $NaNO_3$ concentrations if the resin does not float.

8. Displace the solution with 0.25 M NaOH until 3 CV have been collected
9. Record the resin volume and observations.
10. Repeat steps 5-6 for solutions containing:

NaOH (M)	Na2SO4 (M)
0.25	0.375
0.25	2.375

11. Displace the solution with deionized water until 3 CV have been collected
12. Record the resin volume and observations after 1.5 and 3 CV have been collected
13. Elute the resin with 0.5 M HNO_3
14. Record resin volume and observations after every 1.5 and 3 CV have been collected
15. Continue eluting until two consecutive volume measurements are identical
16. Remove excess liquid from column headspace
17. Displace HNO_3 solution with deionized water for 3 CV
18. Pretreat the resin with 0.25 M NaOH for 3 CV
19. Record resin volume and observations after every 1.5 and 3 CV have been collected

20. Continue pretreatment until two consecutive volume measurements are identical
21. Remove excess liquid from column headspace

4.5 Buoyancy vs. Simulant Composition (SuperLig® 632, 644, 639, 655)

1. Use the resin from Section 4.4
2. Prepare the following solution: Non-hazardous Envelope A (tk 241-AN-105) at 4.5 – 5.0 M total [Na^+]
3. Add NaNO3 and NaOH to achieve the following concentrations:

[Na^+] (M)	Free [OH^-] (M)	Free [OH^-] (M)	Free [OH^-] (M)	Free [OH^-] (M)
5	0.75	1.0	1.5	2.0
6	0.75	1.0	1.5	2.0
7	0.75	1.0	1.5	2.0
9	0.75	1.0	1.5	2.0

4. Prepare the solutions at 0.75 M and 2.0 M free hydroxide, and perform steps 5-6. If a change in resin properties is observed, continue testing with the 1.0 and 1.5 M free hydroxide solutions. If not, discontinue testing and proceed to step 7.
5. Pass each of these solutions through the resin columns until 3 CV have been collected.
6. Record the resin volume and observations after collecting 1.5 and 3 CV of each solution
7. Displace simulant solution with deionized water until 3 CV have been collected
8. Record the resin volume and observations
9. Elute the resin with 0.5 M HNO_3
10. Record resin volume and observations after every 3 CV have been collected
11. Continue eluting until two consecutive volume measurements are identical
12. Remove excess liquid from column headspace
13. Displace HNO_3 solution with deionized water for 3 CV
14. Pretreat the resin with 0.25 M NaOH for 3 CV
15. Record resin volume and observations after every 3 CV have been collected
16. Continue pretreatment until two consecutive volume measurements are identical
17. Displace the NaOH solution with 3 CV of deionized water
18. Cover the column with Parafilm® to minimize air absorption or liquid evaporation during storage.

4.8 Data Recording

Sequential steps will be itemized in written instructions and recorded in a laboratory notebook. All activities will be conducted with approved procedures or written instructions, and all results will be recorded on data sheets entered in a laboratory notebook. Where applicable, analyses will be conducted by ADS and are governed by

the ADS Quality Assurance program. All measurements will be conducted as routine analyses.

The following documents will become Quality Assurance Records:

- Technical Task and Quality Assurance Plan
- Results of any independent technical review
- Laboratory notebooks
- Supporting documentation as determined by the task leader.
- Procedure list and procedures required to provide supporting documentation

Quality Assurance Records shall be indexed and sent to BNFL, Inc. at project completion or placed in WSRC box storage if the customer does not request the records within 60 days of contract completion.

5.0 Task Schedule

Refer to "BNFL Part B schedule", S.T. Wach.

6.0 Approvals

6.1 Design Check

M.C. Thompson 10/20/98
M.C. Thompson Date
Chemical and Hydrogen Technology

6.2 Approval

H.F. Sturm 10/21/98
H.F. Sturm Date
Waste Management and Environmental Technology

Michael E. Johnson 10/22/98
M.E. Johnson Date
BNFL, Inc.

10/21/98

P.E. Lowe Date
SRTC-QA, Cognizant Quality Function

7.0 References

1. BNF-003-98-0008, Rev. 0, Savannah River Technology Center Quality Assurance Program Plan for British Nuclear Fuels Limited Work for Others Agreement (WFO98-003)(U), P.E. Lowe, L.M. Nelson, to be published.

8.0 Attachments

Attachment 1 - Task QA Plan Checklist

Distribution:
S.T. Wach, 773-42A
M.E. Johnson, BNFL, Inc.
N.M. Hassan, 773-A
W.D. King, 773-42A
L.M. Nelson, 773-43A
BNFL Part B Document File, B. Skwarek, 773-41A

TASK QA PLAN FOR THE TWRS PRIVATIZATION PROJECT

Document No.BNFL-003-98-0017
Revision No. 0

Listed below are the sections of the WSRC Quality Assurance Manual 1Q. The contents of the 1Q Manual are responsive to the requirements of DOE Order 6700.6C, 10CFR830.120 and to the WSRC Quality Assurance Management Plan (WSRC-RP-92-225). WSRC 1Q sections applicable to the work being performed for the TWRS Privatization Project should be indicated (mark Yes, No, or "AR"-as required). Also indicate procedures SRTC implements to control the work (including L1, 8.21, Supplemental QA Requirements for RW-0333P). This checklist identifies only procedures used to control work activities performed by SRTC for the TWRS Privatization Project. All identified procedures may not be applicable to each activity involved in the project.

Yes	No	AR	
			1.1 ORGANIZATION
x			1Q, QAP 1-1, Organization
x			L1, 1.02, SRTC Organization
			1-2 STOP WORK
x			1Q, QAP 1-2, Stop Work
			2-1 QUALITY ASSURANCE PROGRAM
x			1Q, QAP 2-1, Quality Assurance Program
x			L1, 8.01, SRTC QA Program Implementation
x			L1, 8.02, SRTC QA Program Clarifications, Attachment 8.2-1
			2-2 PERSONNEL TRAINING & QUALIFICATION
x			1Q, QAP 2-2, Personnel Training & Qualification
x			L1, 5.01, SRTC Training, Orientation & Employee Development
x			L1, 1.32, Read & Sign
x			L1, 1.33, Employee & Facility Access Orientation
			2-3 CONTROL OF RESEARCH & DEVELOPMENT ACTIVITIES
x			1Q, QAP 2-3, Control of Research & Development Activities
x			L1, 8.02, SRTC QA Program Clarifications, Attachment 8.2-3
x			L1, 7.10, Control of Technical Work
			2-4 AUDITOR/LEAD AUDITOR QUALIFICATION & CERTIFICATION
	x		1Q, QAP 2-4, Auditor/Lead Auditor Qualification & Certification
			2-5 QUALIFICATION & CERTIFICATION OF INDEPENDENT INSPECTION PERSONNEL
	x		1Q, QAP 2-5, Qualification & Certification of Independent Inspection Personnel
			2-6 QA MANUAL REVISION
x			1Q, QAP 2-6, QA Manual Revisions
			2-7 QA PROGRAM REQUIREMENTS FOR ANALYTICAL MEASUREMENT SYSTEMS
	x		1Q, QAP 2-7, QA Program Requirements for Analytical Measurement Systems
			2-10 INDEPENDENT INSPECTION PERSONNEL ON-THE-JOB TRAINING
	x		1Q, QAP 2-10, Independent Inspection Personnel – OTJ Training

Yes	No	AR	
			3.1 DESIGN CONTROL
	x		1Q, QAP 3-1, Design Control
	x		L1, 7.10, Control of Technical Work
			4-1 PROCUREMENT DOCUMENT CONTROL
x			1Q, QAP 4-1, Procurement Document Control
			5-1 INSTRUCTIONS, PROCEDURES & DRAWINGS
x			1Q, QAP 5-1, Instructions, Procedures & Drawings
	x		E7, 2.30, Drawings
x			L1, 1.01, SRTC Procedure Administration
x			L1, 1.01.1, SRTC Work Instructions
			6-1 DOCUMENT CONTROL
x			1Q, QAP 6-1, Document Control
x			L1, 1.30, SRTC Document Control
			7-2 CONTROL OF PURCHASED ITEMS & SERVICES
x			1Q, QAP 7-2, Control of Purchased Items & Services
			7-3 COMMERCIAL GRADE ITEM DEDICATION AND MATERIAL UPGRADE
	x		1Q, QAP 7-3, Commercial Grade Item Dedication & Material Upgrade
	x		E7, 3.46, Replacement Item Evaluation/Commercial Grade Item Dedication
			8-1 IDENTIFICATION & CONTROL OF ITEMS
x			1Q, QAP 8-1, Identification & Control of Items
x			L1, 8.02, SRTC QA Program Clarifications, Attachment 8.8-1
			9-1 CONTROL OF PROCESSES
	x		1Q, QAP 9-1, Control of Processes
			9-2 CONTROL OF NONDESTRUCTIVE EXAMINATION
	x		1Q, QAP 9-2, Control of NDE
			9-3 CONTROL OF WELDING & OTHER JOINING PROCESSES
	x		1Q, QAP 9-3, Control of Welding
			9-4 WORK CONTROL
	x		1Q, QAP 9-4, Work Control
			10-1 INSPECTION & VERIFICATION
	x		1Q, QAP 10-1, Inspection & Verification
	x		L1, 8.10, Inspection
	x		L1, 8.10.1, Independent Inspection Releases
			11-1 TEST CONTROL
	x		1Q, QAP 11-1, Test Control
			12-1 CONTROL OF MEASURING & TEST EQUIPMENT
x			1Q, QAP 12-1, Control of Measuring & Test Equipment

Yes	No	AR	
			12-2 CONTROL OF INSTALLED PROCESS INSTRUMENTATION
	x		1Q, QAP 12-2, Control of Installed Process Instrumentation
			12-3 CONTROL & CALIBRATION OF RADIATION MONITORING EQUIPMENT
	x		1Q, QAP 12-3, Control of Radiation Monitoring Equipment
			13-1 PACKAGING, HANDLING, SHIPPING & STORAGE
x			1Q, QAP 13-1, Packaging, Handling, Shipping & Storage
x			L1, 8.02, SRTC QA Program Clarifications, Attachment 8.13-1
			14-1 INSPECTION, TEST & OPERATING STATUS
	x		1Q, QAP 14-1, Inspection, Test & Operating Status
	x		L1, 8.02, SRTC QA Program Clarifications, Attachment 8.14-1
x			**15-1 CONTROL OF NONCONFORMING ITEMS**
x			1Q, QAP 15-1, Control of Nonconforming Items
			L1, 8.02, SRTC QA Program Clarifications, Attachment 8.15-1
			15-2 CONTROL OF NONCONFORMING ACTIVITIES
x			1Q, QAP 15-2, Control of Nonconforming Activities
x			L1, 8.02, SRTC QA Program Clarifications, Attachment 8.15-2
			16-1 CORRECTIVE ACTION SYSTEM
x			1Q, QAP 16-1, Corrective Action System
			16-2 QUALITY ALERT
x			1Q, QAP 16-2, Quality Alert
			17-1 QA RECORDS MANAGEMENT
x			1Q, QAP 17-1, QA Records Management
x			L1, 8.02, SRTC QA Program Clarifications, Attachment 8.17-1
			18-2 QUALITY ASSURANCE SURVEILLANCE
x			1Q, QAP 18-2, Quality Assurance Surveillance
x			L1, 8.18.1, Surveillance
			18-3 QUALITY ASSURANCE EXTERNAL AUDITS
	x		1Q, QAP 18-3, Quality Assurance External Audits
	x		L1, 8.18, SRTC Quality Assurance Audit Program
			18-4 MANAGEMENT ASSESSMENTS
x			1Q, QAP 18-4, Management Assessments
			18-6 Quality Assurance Internal Audits
	x		1Q, QAP 18-6
	x		L1, 8.18, SRTC Quality Assurance Audit Program
			19-2 QUALITY IMPROVEMENT
	x		1Q, QAP 19-2, Quality Improvement
	x		L1, 8.02, SRTC QA Program Clarifications, Attachment 8.19-2

Yes	No	AR	
			20-1 SOFTWARE QUALITY ASSURANCE
	x		1Q, QAP 20-1, Software Quality Assurance
	x		L1, 8.20, Software Management & Quality Assurance
			21-1 ENVIRONMENTAL QUALITY ASSURANCE
	x		1Q, QAP 21-1, QA Requirements for the Collection & Evaluation of Environ. Data
			In addition to procedures noted above, if RW-0333P requirements are invoked, the following procedures may apply:
			Control of R&D:
	x		L1, 8.21, Supplemental QA Requirements for RW-0333P
			Sample Control:
	x		L1, 3.07, Obtaining Analytical Services
	x		L1, 2.21, Radioactive Sample Receiving, Labeling, & Tracking
			Scientific Investigation:
	x		L1, 4.19, Laboratory Notebook Use

R&D Hazards Screening Checklist

Listed below are characteristics of an experiment/project that may present hazards above normal risks to SRTC. Circle YES or NO for each item listed. For each "yes" answer you will be directed to a secondary hazard review or reviews that will direct completion of specific actions need to manage/mitigate the identified hazard.

Project/Task: Hanford Tank Waste Ion Exchange Swelling Task Technical and Quality Assurance Plan (U)
Date 10/20/98
Reviewer: _____

	YES	NO
ENERGIES		
A. Electricity (exposed energized parts > 50V). See Figures 4 & 11.		x
B. Fissionable materials. Specify _____ See Figures 4, 5, 6, 7, 9, & 11.		x
C. High noise levels (>85dBA). See Figures 4, 8, & 11.		x
D. Microwave/radiofrequencies (30 KHz- 300 GHz), electric or magnetic fields. See Figures 4, 8, & 11.		x
E. Lasers (other than class 1). See Figures 4, 8, & 11.		x
F. Moving equipment (exposed belts, chains, gears, pinch rollers, pulleys, rotating shafts/blades, wheels, etc.) See Figures 4 & 11.		x
G. Radioactive materials. Specify: Radionuclides_____ Amount_____ Physical Form_____ See Figures 4, 5, 6, 7, 9, & 11.		x
H. Static magnetic fields > 600 Gauss. See Figures 4, 8, & 11.		x
I. Sub-radiofrequency (<30 KHz) electric and magnetic fields. See Figures 4, 8, & 11.		x
J. Temperatures (<32°F or >150°F). Consider furnaces, ovens, dryers, boilers, steam systems, heaters, dewars, chillers, and release of compressed gases. See Figures 4, 8, 10, & 11.		x
K. Vacuum (external pressure > 15PSI). See Figures 4, 8, & 11.		x
L. Pressure (compressible materials > 30PSI; or non-compressible materials > 150PSI). See Figures 4, 8, & 11.		x
M. Pressure vessels (> 15PSI and >6" ID; and/or contain toxic, corrosive, or nuclear materials). See Figures 4, 8 & 11.		x
WORKSITE ENVIRONMENTAL CONDITIONS		
A. Boating or work over water. See Figure 4, 8, & 11.		x
B. Cold or heat stress conditions. See Figure 4, 8, & 11.		x
C. Confined spaces/trenches/or evacuations. See Figures 4, 8, & 11.		x
D. Flammable atmospheres (> 10% LEL). See Figures 4, 8, 10, & 11.		x
E. Oxygen deficient atmospheres (<19.5% O_2). See Figures 4, 8, & 11.		x
F. Toxic atmosphere (airborne contaminant concentrations expected to exceed 50% of the Threshold Limit Value).		x

See Figures 4, 5, 8, & 11.

	YES	NO
G. Activity performed in a nuclear facility. See Figure 6.	x	
H. Work with radioactive or contaminated material or entry into controlled area. See Figures 6 & 7.		x

HAZARDOUS MATERIALS

A. Biological Agents. See Figures 4, 5, 8, 9, & 11.		x
B. Carcinogens, mutagens, teratogens. Specify:_____ See Figures 4, 5, 8, 9, & 11.		x
C. Corrosives. See Figures 4, 5, 8, 9, & 11.	x	
D. Cryogenic gases/liquids. See Figures 4, 8, & 11.		x
E. Flammable/combustible gases, liquids, solids. Specify: Amount:_____ See Figures 4, 5, 8, 9, 10, & 11.		x
F. Toxic Chemicals. Specify: Amount: <500 g See Figures 4, 5, 8, 9, & 11.	x	
G. Oxidizers. Specify: Amount: <500 g See Figures 4, 5, 8, 9, 10, & 11.	x	
H. Hydrocarbons (>55 gallons). See Figures 4, 5, 8, 9, & 11.		x
I. Any hazardous substance. Specify:_____ See Figures 4, 5, 8, 9, & 11.		x

ENVIRONMENTAL COMPLIANCE

A. Release of regulated gas or particulate to the environment. See Figure 9.		x
B. Release of regulated materials to a waste disposal system. See Figure 9.		x
C. Waste disposal problems (including equipment). See Figure 9.		x
D. Creation of radioactive waste. See Figure 9.		x