2

⑤ Sta. 4

SEP 01 1994

ENGINEERING DATA TRANSMITTAL

Page 1 of 8

1. EDT 608054

2. To: (Receiving Organization) Information Resource Management	3. From: (Originating Organization) Waste Treatment Systems Engineering	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: 7CF40	6. Cog. Engr.: E. Q. Le	7. Purchase Order No.: N/A
8. Originator Remarks: This EDT implements the Process Control Plan to provide a general description of activities which will take place during 242-A Evaporator Campaign 94-2. The Process Control Plan addresses compliance with the 242-A Waste Analysis Plan, the Tank Farm Waste Compatibility Program, the Criticality Prevention Specifications, the Evaporator and LERF Radiological Source Terms during campaign 94-2.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: 242-A Evaporator
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.:
		14. Required Response Date:

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-PCP-009		0	Process Control Plan for 242-A Evaporator Campaign 94-2	ESQ	1	1	

16. KEY

Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment	4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
1	1	Cog.Eng. E. Q. Le		8/31/94	R1-43						
1	1	Cog. Mgr. R. J. Nicklas		9/1/94							
1	1	QA H. K. Ananda	Don Board for	9-1-94							
1	1	Safety S. U. Zaman		9-1-94							
1	1	Env. M. W. Bowman	M W Bowman	9-1-94							
1	1	Operations. J. E. Geary		9-1-94							

18. 8/31/94 Signature of EDT Originator DATE	19. 9/1/94 Authorized Rep. for Receiving Organization Date	20. 9/1/94 Cog. Manager Date	21. DOE APPROVAL (if required) Ctrl. No.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

INSTRUCTIONS FOR COMPLETION OF THE ENGINEERING DATA TRANSMITTAL

(USE BLACK INK OR TYPE)

BLOCK	TITLE	
(1)*	EDT	● Pre-assigned EDT number.
(2)	To: (Receiving Organization)	● Enter the individual's name, title of the organization, or entity (e.g., Distribution) that the EDT is being transmitted to.
(3)	From: (Originating Organization)	● Enter the title of the organization originating and transmitting the EDT.
(4)	Related EDT No.	● Enter EDT numbers which relate to the data being transmitted.
(5)*	Proj./Prog./Dept./Div.	● Enter the Project/Program/Department/Division title or Project/Program acronym or Project Number, Work Order Number or Organization Code.
(6)*	Cognizant Engineer	● Enter the name of the individual identified as being responsible for coordinating disposition of the EDT.
(7)	Purchase Order No.	● Enter related Purchase Order (P.O.) Number, if available.
(8)*	Originator Remarks	● Enter special or additional comments concerning transmittal, or "Key" retrieval words may be entered.
(9)	Equipment/Component No.	● Enter equipment/component number of affected item, if appropriate.
(10)	System/Bldg./Facility	● Enter appropriate system, building or facility number, if appropriate.
(11)	Receiver Remarks	● Enter special or additional comments concerning transmittal.
(12)	Major Assm. Dwg. No.	● Enter applicable drawing number of major assembly, if appropriate.
(13)	Permit/Permit Application No.	● Enter applicable permit or permit application number, if appropriate.
(14)	Required Response Date	● Enter the date a response is required from individuals identified in Block 17 (Signature/Distribution).
(15)*	Data Transmitted	
	(A)* Item Number	● Enter sequential number, beginning with 1, of the information listed on EDT.
	(B)* Document/Drawing No.	● Enter the unique identification number assigned to the document or drawing being transmitted.
	(C)* Sheet No.	● Enter the sheet number of the information being transmitted. If no sheet number, leave blank.
	(D)* Rev. No.	● Enter the revision number of the information being transmitted. If no revision number, leave blank.
	(E) Title or Description of Data Transmitted	● Enter the title of the document or drawing or a brief description of the subject if no title is identified.
	(F)* Impact Level	● Enter the appropriate Impact Level (Block 15). Also, indicate the appropriate approvals for each item listed, i.e., SQ, ESQ, etc. Use NA for non-engineering documents.
	(G) Reason for Transmittal	● Enter the appropriate code to identify the purpose of the data transmittal (see Block 16).
	(H) Originator Disposition	● Enter the appropriate disposition code (see Block 16).
	(I) Receiver Disposition	● Enter the appropriate disposition code (see Block 16).
(16)	Key	● Number codes used in completion of Blocks 15 (G), (H), and (I), and 17 (G), (H) (Signature/Distribution).
(17)	Signature/Distribution	
	(G) Reason	● Enter the code of the reason for transmittal (Block 16).
	(H) Disposition	● Enter the code for the disposition (Block 16).
	(J) Name	● Enter the signature of the individual completing the Disposition 17 (H) and the Transmittal.
	(K)* Signature	● Obtain appropriate signature(s).
	(L)* Date	● Enter date signature is obtained.
	(M)* MSIN	● Enter MSIN. Note: If Distribution Sheet is used, show entire distribution (including that indicated on Page 1 of the EDT) on the Distribution Sheet.
(18)	Signature of EDT Originator	● Enter the signature and date of the individual originating the EDT (entered prior to transmittal to Receiving Organization). If the EDT originator is the cognizant engineer, sign both Blocks 17 and 18.
(19)	Authorized Representative for Receiving Organization	● Enter the signature and date of the individual identified by the Receiving Organization as authorized to approve disposition of the EDT and acceptance of the data transmitted, as applicable.
(20)*	Cognizant Manager	● Enter the signature and date of the cognizant manager. (This signature is authorization for release.)
(21)*	DOE Approval	● Enter DOE approval (if required) by letter number and indicate DOE action.

---

*Asterisk denote the required minimum items check by Configuration Documentation prior to release; these are the minimum release requirements.

~~ECN~~ EDT-608054
Page 2 of 8

Figure B-3. Unreviewed Safety Question-Evaluation Form

USQ Tracking Number:

AREA: (Circle Those That Apply) [✓ EAST] WEST

FACILITY: (Circle Those That Apply) [✓ 242-A] DST SST [✓ LERF] AGING WASTE

EQUIPMENT DESCRIPTION:

REFERENCE DOCUMENT: (Circle Those That Apply)

ECN No._________ PCA No._________ WORK PKG No._________ OTHER (Specify EDT 608054)

TITLE: PROCESS CONTROL PLAN FOR 242-A EVAPORATOR 94-2, WHC-SD-WM-PCP-009, Rev. 0

1. Does the PROPOSED CHANGE or DISCOVERY increase the probability of occurrence of an accident previously evaluated in the AUTHORIZATION BASIS documentation?
No XX Yes/Maybe___

Basis: EDT 608054 does not increase the probability of any accident evaluated in the WHC-SD-WM-SAR-023, "242-A Evaporator/Crystallizer Safety Analysis Report", Rev. 1-B, Chapter 9 or WHC-SD-W105-SAR-001, Final Safety Analysis Report 242-A Evaporator Liquid Effluent Retention Facility", Rev. 0-C. The EDT implements the Process Control Plan to provide a general description of activities which will take place during 242-A Evaporator Campaign 94-2. The process control plan is written to address compliance with the 242-A Waste Analysis Plan, the Tank Farm Waste Compatibility Program, the Criticality Prevention Specifications, the Evaporator and LERF Radiological Source Terms during campaign 94-2. The activities have no effect on the accidents described in Table 9-1, "Summary of Radiological Consequences".

The attached pages identify incorrect statements which need to be updated in the SAR involving process control at the 242-A Evaporator. The discoveries listed on the attached pages have no effect on the probability of the accidents described in Table 9-1, "Summary of Radiological Consequences".

EDT-608054
Page 3 of 8

2. Does the PROPOSED CHANGE or DISCOVERY increase the consequences of an accident previously evaluated in the AUTHORIZATION BASIS documentation?
   No_XX_ Yes/Maybe___

Basis:EDT 608054 does not increase the consequences of any accident evaluated in the WHC-SD-WM-SAR-023, "242-A Evaporator/Crytallizer Safety Analysis Report", Rev. 1-B, Chapter 9 or WHC-SD-W105-SAR-001, Final Safety Analysis Report 242-A Evaporator Liquid Effluent Retention Facility", Rev. 0-C. The EDT implements the Process Control Plan to provide a general description of activities which will take place during 242-A Evaporator Campaign 94-2. The process control plan is written to address compliance with the 242-A Waste Analysis Plan, the Tank Farm Waste Compatibility Program, the Criticality Prevention Specifications, the Evaporator and LERF Radiological Source Terms during campaign 94-2. The consequences of an radiological source term accident previously evaluated in the 242-A SAR and LERF SAR do not increase since the evaluation in the Process Control Plan has set the Waste Volume Reduction Factor such that the radiological source term cannot exceed the 242-A Evaporator and LERF Radiological Source Terms. Activities as described in the Process Control Plan have no effect on the accidents described in Table 9-1, "Summary of Radiological Consequences".

The attached pages identify incorrect statements which need to be updated in the SAR involving process control at the 242-A Evaporator. The discoveries listed on the attached pages have no effect on maintaining the DBA feed composition. The consequences of the accidents described in Table 9-1, "Summary of Radiological Consequences" are not impacted by these discoveries.

3. Does the PROPOSED CHANGE or DISCOVERY increase the probability of occurrence of a malfunction of EQUIPMENT previously evaluated in the AUTHORIZATION BASIS documentation?
   No_XX_ Yes/Maybe___

Basis:EDT 608054 has no effect on the probability of a malfunction of ITS EQUIPMENT as described in the WHC-SD-WM-SAR-023, "242-A Evaporator/Crytallizer Safety Analysis Report", Rev. 1-B, Chapter 9 or WHC-SD-W105-SAR-001, Final Safety Analysis Report 242-A Evaporator Liquid Effluent Retention Facility", Rev. 0-C. The EDT implements the Process Control Plan to provide a general description of activities which will take place during 242-A Evaporator Campaign 94-2. The process control plan is written to address compliance with the 242-A Waste Analysis Plan, the Tank Farm Waste Compatibility Program, the Criticality Prevention Specifications, the Evaporator and LERF Radiological Source Terms during campaign 94-2. The activities do not effect ITS EQUIPMENT at the 242-A Evaporator or at the Liquid Effluent Retention Facility.

The attached pages identify incorrect statements which need to be updated in the SAR involving process control at the 242-A Evaporator. The discoveries are specific to process control, and have no effect on ITS EQUIPMENT at the 242-A Evaporator.

EDT-608054
Page 4 of 8

4. Does the PROPOSED CHANGE or DISCOVERY increase the consequences of a malfunction of ITS EQUIPMENT previously evaluated in the AUTHORIZATION BASIS documentation?
   No_XX_ Yes/Maybe___

Basis:EDT 608054 has no effect on the consequences of a malfunction of ITS EQUIPMENT as described in the WHC-SD-WM-SAR-023, "242-A Evaporator/Crytallizer Safety Analysis Report", Rev. 1-B, Chapter 9 or WHC-SD-W105-SAR-001, Final Safety Analysis Report 242-A Evaporator Liquid Effluent Retention Facility", Rev. 0-C. The EDT implements the Process Control Plan to provide a general description of activities which will take place during 242-A Evaporator Campaign 94-2. The process control plan is written to address compliance with the 242-A Waste Analysis Plan, the Tank Farm Waste Compatibility Program, Criticality Prevention Specifications, the 242-A Operating Specification Document, the Evaporator and LERF Radiological Source Terms during campaign 94-2. The activities have no effect on ITS EQUIPMENT at the 242-A Evaporator or at the Liquid Effluent Retention Facility.

The attached pages identify incorrect statements which need to be updated in the SAR involving process control at the 242-A Evaporator. The discoveries are specific to process control, and have no effect on ITS EQUIPMENT at the 242-A Evaporator.

5. Does the PROPOSED CHANGE or DISCOVERY create the possibility of an accident of a different type than any previously evaluated in the AUTHORIZATION BASIS documentation? No_XX_ Yes/Maybe___

Basis:EDT 608054 does not create the possibility of an accident of a different type than previously evaluated in the WHC-SD-WM-SAR-023, "242-A Evaporator/Crytallizer Safety Analysis Report", Rev. 1-B, Chapter 9 or WHC-SD-W105-SAR-001, Final Safety Analysis Report 242-A Evaporator Liquid Effluent Retention Facility", Rev. 0-C. The EDT implements the Process Control Plan to provide a general description of activities which will take place during 242-A Evaporator Campaign 94-2. The process control plan is written to address compliance with the 242-A Waste Analysis Plan, the Tank Farm Waste Compatibility Program, Criticality Prevention Specifications, the 242-A Operating Specification Document, the Evaporator and LERF Radiological Source Terms during campaign 94-2. The activities do not effect accidents at the 242-A Evaporator or the Liquid Effluent Retention Facility.

The attached pages identify incorrect statements which need to be updated in the SAR involving process control at the 242-A Evaporator. The discoveries listed on the attached pages will not effect accidents at the 242-A Evaporator.

EDT-608054
Page 5 of 8

6. Does the PROPOSED CHANGE or DISCOVERY create the possibility of a malfunction of EQUIPMENT of a different type than any previously evaluated in the AUTHORIZATION BASIS documentation?
   No_XX_ Yes/Maybe___

Basis:EDT 608054 does not create the possibility of a malfunction of ITS EQUIPMENT of a different type than previously evaluated in the WHC-SD-WM-SAR-023, "242-A Evaporator/Crytallizer Safety Analysis Report", Rev. 1-B, Chapter 9 or WHC-SD-W105-SAR-001, Final Safety Analysis Report 242-A Evaporator Liquid Effluent Retention Facility", Rev. 0-C. The EDT implements the Process Control Plan to provide a general description of activities which will take place during 242-A Evaporator Campaign 94-2. The process control plan is written to address compliance with the 242-A Waste Analysis Plan, the Tank Farm Waste Compatibility Program, Criticality Prevention Specifications, the 242-A Operating Specification Document, the Evaporator and LERF Radiological Source Terms during campaign 94-2. The activities do not effect on ITS EQUIPMENTS at the 242-A Evaporator or the Liquid Effluent Retention Facility.

The attached pages identify incorrect statements which need to be updated in the SAR involving process control at the 242-A Evaporator. The discoveries are specific to process control, and have no effect on ITS EQUIPMENT at the 242-A Evaporator.

7. Does the PROPOSED CHANGE or DISCOVERY reduce the margin of safety as defined in the basis for any Technical Specification/Operational Safety Requirement?
   No_XX_ Yes/Maybe___

Basis:EDT 608054 does not reduce the margin of safety as defined in the WHC-SD-WM-SAR-023, "242-A Evaporator/Crytallizer Safety Analysis Report", Rev. 1-B, Chapter 9 or WHC-SD-W105-SAR-001, Final Safety Analysis Report 242-A Evaporator Liquid Effluent Retention Facility", Rev. 0-C. The EDT implements the Process Control Plan to provide a general description of activities which will take place during 242-A Evaporator Campaign 94-2. The process control plan is written to address compliance with the 242-A Waste Analysis Plan, the Tank Farm Waste Compatibility Program, Criticality Prevention Specifications, the 242-A Operating Specification Document, the Evaporator and LERF Radiological Source Terms during campaign 94-2. The activities do not effect on the margin of safety as described in Table 9-1, "Summary of Radiological Consequences"

The attached pages identify incorrect statements which need to be updated in the SAR involving process control at the 242-A Evaporator. The discoveries are specific to process control, and have no effect on the margin of safety as described in Table 9-1, "Summary of Radiological Consequences". No OSR, SL, or LCO are modified.

EOT-608054
Page 6 of 8

8. Does the PROPOSED CHANGE or DISCOVERY require a new or revised Technical Safety Requirement/ Operational Safety Requirement or a compensatory measure required by a Compliance Implementation Plan?
No_XX_ Yes/Maybe____

Basis:EDT 608054 does not require a new or revised WHC-SD-WM-SAR-023, "242-A Evaporator/Crytallizer Safety Analysis Report", Rev. 1-B, Chapter 9 or WHC-SD-W105-SAR-001, Final Safety Analysis Report 242-A Evaporator Liquid Effluent Retention Facility", Rev. 0-C. The EDT implements the Process Control Plan to provide a general description of activities which will take place during 242-A Evaporator Campaign 94-2. The process control plan is written to address compliance with the 242-A Waste Analysis Plan, the Tank Farm Waste Compatibility Program, Criticality Prevention Specifications, the 242-A Operating Specification Document, the Evaporator and LERF Radiological Source Terms during campaign 94-2. The activities do not required a new or revised Operational Safety Requirement and has no effect on bounding accidents specified in the SAR, Chapter 9.

The attached pages identify incorrect statements which need to be updated in the SAR involving process control at the 242-A Evaporator. The discoveries are specific to process control, and have no effect on the accidents described in Table 9-1, "Summary of Radiological Consequences". No OSR, SL, or LCO are modified.
(Use additional space if necessary to explain Basis.)

USQE #1 Brian Von Bargen
Print Name
Brian Von Bargen 8/19/94
Signature Date

USQE #2 MD Guthrie
Print Name
Mike Guthrie 8/19/94
Signature Date

PRC REVIEW (If Required)
Meeting #: ________ Date ________

PRC Chairman Concurrence: ____________________ ________
Signature Date

EDT-608054
Page 7 of 8

SUPPLEMENTAL INFORMATION

Purpose of Unreviewed Safety Question (USQ) Evaluation

The USQ addresses the proposed changes to the SAR resulting from EDT 608054 to the Process Control Plan for 242-A Evaporator Campaign 94-1. In preparing this USQ, numerous incorrect statements were discovered in the SAR relating to process control at the 242-A Evaporator. This USQ addresses both the proposed changes and discoveries.

242-A Evaporator SAR Process Control References

Section 4.1.1.2

Table 4-7 in the SAR references Table 3-20 of the 242-A Evaporator Dangerous Waste Permit Application which includes an exotherm limit of 450 °F, a nitrate/nitrite limit of 40 weight percent, and a TOC limit of 10 g/l. Presently, the Process Control Plan, WHC-SD-WM-PCP-009, Rev. 0, specifies only an exotherm limit of 335 °F (Godfrey 1993). Table 4-7 in the SAR should be corrected to reflect the limits presented in the Process Control Plan.

Table 4-8 in the SAR references Tables 3-13 through 3-17 of the 242-A Evaporator Dangerous Waste Permit Application. The Process Control Plan, WHC-SD-WM-PCP-009, Rev. 0, removed the feed limits for the slurry product to meet the Land Disposal Restrictions (Basra 1994). Table 4-8 of the SAR should be deleted.

Table 4-9 in the SAR references Table 3-22 of the 242-A Evaporator Dangerous Waste Permit Application. Table 3-22 lists three constituents which should not be limits. This error has been corrected in the Process Control Plan, WHC-SD-WM-PCP-009, Rev. 0 (Basra 1994). Table 4-9 should be revised to include the correct limits listed in the Process Control Plan.

Table 4-10 in the SAR references Table 3-23 of the 242-A Evaporator Dangerous Waste Permit Application. Table 3-23 contains several constituents which were removed as limits from the Process Control Plan, WHC-SD-WM-PCP-009, Rev. 0 (Basra 1994). Table 4-10 should be revised to include the correct limits listed in the Process Control Plan.

Section 4.1.3.1

Table 4-13 in the SAR references Table 3-12 of the 242-A Evaporator Dangerous Waste Permit Application. The Process Control Plan, WHC-SD-WM-PCP-009, Rev. 0 removed the Land Disposal Restrictions limits for slurry product (Basra 1994). Table 4-13 of the SAR should be deleted.

EDT-608054
Page 8 of 8

Table 4-14 in the SAR reference Table 3-18 of the 242-A Evaporator Dangerous Waste Permit Application. The pH and ammonia limit in the Table 3-18 listed in the Process Control Plan, WHC-SD-WM-PCP-009, Rev. 0, has been modified to 2.0 < pH < 12.5 and ammonia < 10,000 ppm (Basra 1994). Table 4-14 should be revised to reflect the current limit.

Section 6.1.1.1

The SAR states "Complexed Wastes are not pumped into TK-AW-102." The Tank Farm Waste Compatibility Program defines waste as complex when the total organic carbon concentration exceeds 10 g/L when evaporated to the double shell slurry feed product composition. The compatibility program requires segregation of complex waste but does not preclude processing complex waste by the 242-A Evaporator (Carothers 1991). The contents of 107-AP, 108-AP, 102-AW and 106-AW presently meet this definition of complex waste. Post-campaign sampling and analysis will be used to determine whether complexants are present in the material. This SAR should be revised to meet the current definition of complex waste.

REFERENCES

Aguirren, H., 1994, Final Safety Analysis Report 242-A Evaporator Liquid Effluent Retention Facility, WHC-SD-W105-001, Rev. 0-C, Westinghouse Hanford Company, Richland, Washington.

Basra, T. S., 1994, 242-A Evaporator Waste Analysis Plan, WHC-SD-WM-EV-060, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

Carothers, K. G., 1991, Tank Farm Waste Comptibility Program, WHC-SD-WM-OCD-015, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE/RL, 1991, 242-A Evaporator Dangerous Waste Permit Application, DOE/RL-90-42, Rev. 0, U.S. Department of Energy-Richland Operations Office, Richland, Washington.

Godfrey, S. D., 1993, Operating Specifications for The 242-A Evaporator-Crystallizer, OSD-T-151-00012, Rev D-0, Westinghouse Hanford Company, Richland, Washington.

Lavender, 1994, 242-A Evaporator/Crystallizer Safety Analysis Report, WHC-SD-WM-SAR-023, Rev. 1-B, Westinghouse Hanford Company, Richland, Washington.

RELEASE AUTHORIZATION

Document Number: WHC-SD-WM-PCP-009, REV 0

Document Title: PROCESS CONTROL PLAN FOR 242-A EVAPORATOR CAMPAIGN 94-2

Release Date: 9/1/94

* * * * * * * * * * * * * *

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

* * * * * * * * * * * * * *

WHC Information Release Administration Specialist:

Kara J Broz

Kara Broz
(Signature)

9/1/94
(Date)

SUPPORTING DOCUMENT

1. Total Pages ~~133~~ 144 9/1/94

2. Title
Process Control Plan for 242-A Evaporator Campaign 94-2

3. Number
WHC-SD-WM-PCP-009

4. Rev No.
0

5. Key Words
242-A Evaporator, Process Control Plan, Run Plan, Campaign 94-2, Radiological Source Term, Compatibility

APPROVED FOR PUBLIC RELEASE

KMB 9/1/94

6. Author
Name: E. Q. Le

Signature

Organization/Charge Code 7CF40/N117G

7. Abstract

242-A Evaporator Campaign 94-2 will process approximately 3.42 million gallons of dilute waste from tanks 101-AP, 107-AP, 108AP, 102-AW, and 106-AW. The process control plan describes activities which will occur during Campaign 94-2. This document also addresses compliance with the tank farm waste compatibility program, the 242-A radiological source term, the criticality prevention specifications, and effluent discharge limits.

8. ~~PURPOSE AND USE OF DOCUMENT - This document was prepared for use within the U.S. Department of Energy and its contractors. It is to be used only to perform, direct, or integrate work under U.S. Department of Energy contracts. This document is not approved for public release until reviewed.~~

~~PATENT STATUS - This document copy, since it is transmitted in advance of patent clearance, is made available in confidence solely for use in performance of work under contracts with the U.S. Department of Energy. This document is not to be published nor its contents otherwise disseminated or used for purposes other than specified above before patent approval for such release or use has been secured, upon request, from the Patent Counsel, U.S. Department of Energy Field Office, Richland, WA.~~

9. Impact Level ESQ

10. RELEASE STAMP

OFFICIAL RELEASE ⑤
BY WHC
DATE SEP 01 1994
Sta. 4

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED JTD

CONTENTS

Page

1.0 INTRODUCTION 1

2.0 CAMPAIGN OBJECTIVE 2

3.0 FEED CHARACTERIZATION 3

3.1 Waste Compatibility 3
3.1.1 Watch List Tanks 4
3.1.2 New Waste Streams 4
3.1.3 Organic Complexants 4
3.1.4 Transuranic Waste Segregation 5
3.1.5 High Phosphate Waste 6
3.1.6 Energetics 6
3.1.7 Corrosivity 6
3.1.8 Heat Generation 7
3.1.9 Criticality 7
3.1.10 Flammable Gas 8
3.1.11 Transfer Line Plugging 8
3.1.12 Mixing and Compatibility 8

3.2 Radiological Limits 9
3.2.1 Evaporator Radiological Source Term 9
3.2.2 LERF Radiological Limits 9
3.2.3 Gaseous Radiological Limits 10

3.3 Organic Limits 10
3.3.1 LERF Organic Limits 10
3.3.2 Vessel Vent Discharge Limits 11

3.4 Other Considerations 11
3.4.1 Ammonium Concentrations 11
3.4.2 Separable Organic Layers 12

4.0 CAMPAIGN DESCRIPTION 12

4.1 Feed Activities 12
4.1.1 Feed Inventories 12
4.1.2 Feed Activities 13

4.2 Processing Activity Description 13

4.3 Sampling and Monitoring Requirements 14
4.3.1 Compliance Samples 14
4.3.2 Process Control Samples 15
4.3.3 Gaseous Effluent Monitoring 16
4.3.4 Liquid Effluent Monitoring 17

4.4 Product/Waste Disposition 17

5.0 REFERENCES 18

APPENDICES

A. INDEX OF TECHNICAL OPERATING CONTROLS A-1

B. 242-A EVAPORATOR LIMITS B-1

C. FEED CHARACTERIZATION ANALYSES C-1

D. COMPARISON OF CAMPAIGN 94-2 TO 242-A EVAPORATOR LIMITS D-1

E. CALCULATIONS E-1

F. PREDICTS RUNS F-1

G. REFERENCE LETTERS G-1

TABLES

1. Miscellaneous 242-A Evaporator Feed Limits B-3
2. Evaporator Feed Limits for LERF Acceptance B-4
3. Evaporator Feed Limits Based on Volatile Emissions B-5
4. Process Condensate Chemical Limits B-6
5. Process Condensate DCGs B-7
6. 242-A Evaporator Radiological Source Term B-9
7. Double-Shell Tank Waste Corrosion Specifications B-10
8. Steam Condensate and Cooling Water Radionuclide Limits B-11
9. Vessel Vent Radionuclide Limits B-12
10. Organic Analyses for Tank 101-AP C-3
11. Organic Analyses for Tank 107-AP C-4
12. Organic Analyses for Tank 108-AP C-5
13. Radionuclide Analyses C-6
14. Estimated Radionuclide Analyses C-7
15. Candidate Feed Tanks Inorganic Analyses C-8
16. Estimated Inorganic Feed Composition C-9
17. Comparison of Miscellaneous 242-A Evaporator Feed Limits to Campaign 94-2 Feed D-3
18. Comparison of Campaign 94-2 Feed Composition to Evaporator Feed Limits for Organic LERF Acceptance D-4
19. Comparison of Campaign 94-2 Feed Composition to Evaporator Feed Limits Based on Volatile Emissions D-5
20. Comparison of Feed Concentrations to Radiological Source Term . . . D-6
21. Comparison of Projected Slurry Concentration to Radiological Source Term D-7
22. Comparison of Projected Process Condensate Concentrations to LERF Radiological Limits D-8
23. Comparison of Feed Composition and Projected Slurry to Double-Shell Tank Waste Corrosion Specifications D-10

23. Comparison of Projected Vessel Vent Discharge to Vessel Vent Radionuclide Limits D-11

LIST OF TERMS

ACW	242-A cooling water
ALC	airlift circulator
APC	242-A process condensate
ASC	242-A steam condensate
CAM	continuous air monitor
DCG	derived concentration guide
DSC	differential scanning calorimetry
DDSSF	dilute double-shell slurry feed
DST	Double Shell Tank
EDMC	Environmental Data Management Center
EPA	Environmental Protection Agency
ETF	Effluent Treatment Facility
FD-A	242-A feed
ICP	inductively coupled plasma
LERF	Liquid Effluent Retention Facility
LIMS	Laboratory Information Management System
MCS	monitor and control system
NCRW	neutralized cladding removal waste
ND	not detectable
PM	preventive maintenance
PPM	part per million
SAR	safety analysis report
semi-VOA	semivolatile organic analysis
SLY-A	242-A slurry
SPG	specific gravity
TIC	total inorganic carbon
TOC	total organic carbon
TRU	transuranic
VOA	volatile organic analysis
WVRF	waste volume reduction factor

This page intentionally left blank

PROCESS CONTROL PLAN FOR 242-A CAMPAIGN 94-2

1.0 INTRODUCTION

This process control plan (PCP) provides a general description of activities which will take place during 242-A Evaporator Campaign 94-2 in the fall of 1994. This campaign is referred as Campaign 94-2. The PCP addresses compliance with the Tank Farm Waste Compatibility Program, the criticality prevention specifications, the evaporator radiological source term, and effluent discharge limits during Campaign 94-2. The requirements and authority for preparing, reviewing, and releasing this document are covered in Section 8.12 of WHC-IP-0842, *Process Control Plans* (WHC 1993).

Campaign 94-2 is a subsequent operating run of the 242-A Evaporator following the successful and safely completed first campaign in 1994 (campaign 94-1). The 242-A Evaporator Campaign 94-1 was started on April 15, 1994 after the evaporator had undergone five years of extensive upgrades. Campaign 94-1 was completed on June 13, 1994 following which the plant was shutdown for a scheduled outage.

The Liquid Effluent Retention Facility (LERF) Basin 43 will continue to be used for interim storage of process condensate from the evaporator campaign 94-2. The LERF consists of three double-lined basins, each with a capacity of 6.5 million gallons, located about one mile north of the 242-A Evaporator. LERF basin 42 will be used for additional storage of campaign 94-2 process condensate if necessary. LERF basin 44 will be maintained as emergency/contingency space. The LERF basins will store the process condensate until the Effluent Treatment Facility (ETF) becomes operational.

The Index of Technical Operating Controls in Appendix A identifies safety and environmental related documents relevant to this campaign. Appendix B contains safety and environmental limits which will be implemented during Campaign 94-2.

Appendix C contains the analytical data used in the preparation of this process control plan. The data packages for the feed tanks 101-AP and 107-AP characterization may be obtained from the Environmental Data Management Center (EDMC). Analyses for the samples from tanks 102-AW and 106-AW may be obtained from the Laboratory Information Management System (LIMS). The data package for the feed tank 108-AP characterization at the time of this revision has not been officially released. A total of ten supernatant samples were taken from each of the three tanks, 101-AP, 107-AP, and 108-AP to provide sufficient volume for the feed characterization. The samples were taken from three risers on each tank at differing depths. In addition, surface samples were taken from these tanks to check for the presence of separable phase organic. Due to the PNL 325 lab shutdown, tank 108-AP separable phase organic analysis was incomplete.

Tables 10-12 in Appendix C contain the organic constituents identified in the volatile and semi-volatile organic analyses for tanks 101-AP, 107-AP, and 108-AP. The list has been restricted to those compounds which were specified as limits in tables 1-9 of Appendix B. Arithmetic means were used to average sample data when analyses were performed on individual samples.

The radionuclide and inorganic analyses were composite based upon proportional volumes to the waste volumes in three tanks. The composite analyses listed in Tables 13 and 15 of Appendix C were calculated using 32% for 101-AP (385 inches), 34% for 107-AP (403 inches), and 34% for 108-AP (411 inches). After campaign 94-1 was completed, approximately 29.8 and 10 inches of partially processed waste and flush water from the campaign 94-1 still remain in tanks 102-AW and 106-AW respectively. To allow a more accurate determination of WVRF and radionuclide concentrations, the radionuclide and inorganic compositions listed in Tables 14 and 16 of Appendix C were estimated to include the effects of the Campaign 94-1 remaining processed waste to this Campaign 94-2. The estimated composite analyses in Table 16 were calculated using 31% for 101-AP (385 inches), 33% for 107-AP (403 inches), 33% for 108-AP (411 inches), 2% for 102-AW (29.8 inches) and 1% for 106-AW (10 inches).

Appendix D contains assessments of the feed composition and projected 242-A process streams concentrations. These assessments were evaluated by comparison of concentrations against their safety and environmental limits listed in tables 1-9 of Appendix B. Appendix E contains the calculations used to prepare this document and Appendix F contains printouts from the PREDICT computer model for the campaign 94-2.

Appendix G contains the results from the mixing/compatibility studies. The mixing/compatibility study consisted of a visual determination of chemical reactions, thermal analysis, specific gravity analyses on a composite of tanks 101-AP, 107-AP, and 108-AP. The boildown study was used to develop temperature vs. WVRF curves at three pressures. Also contained in Appendix G are the internal letters which were referenced in this document.

2.0 CAMPAIGN OBJECTIVE

Campaign 94-2 is envisioned to process approximately 3.42 million gallons of waste from tanks 101-AP, 107-AP, 108-AP and from 102-AW and 106-AW tank heels with a projected overall WVRF of 87.5%. The WVRF is limited to 87.5% due to a rapid increase in specific gravity (SpG) at 90% WVRF indicated by Laboratory boildown studies. The basis for using SpG as an indicator for the formation of a flammable gas accumulation is that typical double-shell tank high salt wastes do not yield significant amounts of solids unless SpG is greater than 1.35 (Carothers 1994). The flammable gas is formed from radiolysis if the radionuclides and chemical concentrations are too high.

Another objective of ending the campaign at 87.5% WVRF is to hinder formation of a gel-like solution due to supersaturation when solids precipitate by terminating this campaign prior to the saturation level of nitrate/nitrate salt. At this WVRF, it is predicted that waste will be concentrated two evaporator passes before reaching nitrite precipitation boundary without exceeding receiver tank composition limits. The slurry product from this campaign will be dilute double-shell slurry feed (DDSSF) waste.

Due to the PNL 325 lab shutdown, tank 108-AP preliminary characterization data was used to write this process control plan. The officially released data package for tank 108-AP will likely contain data with nearly the same values used in this revision. Since the total organic carbon analysis for 108-AP tank surface sample was not completed, the 102-AW feed tank liquid level must be controlled and set above 100 inches during Campaign 94-2 (WHC 1989). Before the final evaporator pass, liquid and surface samples from tank 102-AW will be collected and analyzed for separable phase organic to determine whether waste can be further processed. If no presence of separable organic indicated by the laboratory, then the level in tank 102-AW will be reset to minimum at 6 inches for the final evaporator pass of the campaign (WHC 1989).

The boildown studies for this campaign by laboratory indicated that severe foaming was observed at WVRF of 70%. To prevent potential process fluid carry over into TK-C-100 and potential evaporator shutdowns caused by high deentrainment pad differential pressure, addition of anti-foam chemicals will be performed during this evaporator run.

Throughput for this campaign is estimated to be approximately 6.2 million gallons. The processing time for the campaign is forecasted to be 58 days with scheduled maintenance downtime of seven days. The slurry product from Campaign 94-2 will be transferred to tank 106-AW. Slurry product at the completion of the campaign is estimated to be approximately 4.4 x 10^5 gallons of DDSSF. Approximately 3.5 million gallons of process condensate is anticipated to be transferred to LERF. The calculations and assumptions used to arrive at the campaign WVRF, throughput, duration, and process condensate output are contained in Appendix E.

Evaporator campaign 94-2 will run with the ion exchange column off-line. The campaign process condensate radionuclide concentrations predicted by the Flowsheet Computer Model indicated that radionuclide concentrations are far below the safety limits. LERF Basin 43 is currently about half-full and continues to be used for storage of Campaign 94-2 process condensate. LERF basin 42 will be used for additional storage of campaign 94-2 process condensate if necessary.

3.0 FEED CHARACTERIZATION

3.1 WASTE COMPATIBILITY

The Tank Farm Waste Compatibility Program (Carothers 1991 & Carothers 1994) specifies the process document waste compatibilities, identifies concerns and resolves potential incompatibilities. The program requires a formally documented assessment of waste compatibility prior to transfer or mixing of different waste types. Prior to operations, laboratory boildown studies were performed on a composite sampling of the campaign feed tanks to substantiate no change in chemical or physical forms of the waste to ensure the waste compatibility. In addition, the boildown studies provided reasonable assurance that campaign waste will be processed safely in the 242-A Evaporator facility. The compatibility assessment for tanks 101-AP, 107-AP, 108-AP, 102-AW, and 106-AW is addressed in this section. These tanks hereafter are referred as campaign feed tanks. The projected Evaporator slurry product composition was also evaluated against the compatibility criteria in order to guarantee no additional waste categories or tank safety concerns will be created as a result of transferring slurry product to tank 106-AW.

3.1.1 Watch List Tanks

Waste contained in a Watch List Tank in the Double-Shell Tank (DST) systems shall be isolated to prevent inadvertent commingling with other wastes. The Watch List Tanks have an Unreviewed Safety Question (USQ) because of the potential consequences of radiological release resulting from uncontrolled increases in temperature and pressure. The *Tank Farm Surveillance and Waste Status Summary Report for November 1993*, WHC-EP-182-68 (Hanlon 1994), specifies that campaign feed tanks are not watch list tanks.

3.1.2 New Waste Streams

New waste streams sent to the tank farms from new or significantly modified chemical processes implemented at a facility shall be accepted only after issuing an approved tank farm flowsheet. No new waste types are generated within the 241-AP and 241-AW Double-Shell Tank (DST) systems or by the 242-A Evaporator facility. Slurry waste stream from the 242-A Evaporator is not new waste source. The approved *Vacuum Evaporator-Crystallizer Flowsheet for Waste Liquors*, ARH-F-101 (Vandercook 1976), provides the overall basis for safe and efficient waste handing, storage, and processing wastes through the 242-A Evaporator.

3.1.3 Organic Complexants

Waste streams that contain organic complexants are segregated in tank farms as complex waste. Because no analytical procedure is currently in place to routinely measure the complexants used on site, waste is classified as complex if the total organic carbon (TOC) concentration exceeds 10 g/L if evaporated to the composition where sodium aluminate in solution reaches saturation without exceeding receiver tank composition limits. The 10 g/L TOC concentration limit is to reduce the potential for hydrogen or flammable gas accumulation and prevent slurry-growth problems in receiver tanks if waste is concentrated exceeding its nitrate/nitrite saturation level.

The PREDICT computer program was used to extrapolate the TOC for campaign feed tanks and campaign composite to the sodium aluminate solubility boundary (Allison 1984). The PREDICT computer model was developed primarily to simulate the effect the evaporation process has on the solubilities of aluminate, carbonate, nitrate, nitrite, phosphate, and sulphate. PREDICT uses the conservative assumption that all organic constituents remain in the slurry product during the evaporation process. The concentrations in Tables 15 and 16 were used in the PREDICT program.

The waste in tanks 102-AW, 106-AW, 107-AP, 108-AP and campaign composite exceeded the 10 g/L definition of a complex waste. Only the waste in tank 101-AP composite meet the criteria for a non-complex waste. The TOCs at sodium aluminate boundary for tank 101-AP is predicted to have value of 1.5 g/L. The extrapolated TOC at sodium aluminate boundary from the PREDICT program printouts can be found in Appendix F.

Tanks that contain waste greater than three weight percent TOC on a dry basis are also classified as complex. These tanks have organic chemicals which are potentially flammable and mixtures of organic materials mixed with nitrate and nitrate salts can deflagrate. There is no credible organic safety concern for these tanks if they contain mostly liquid. The safety concern is with tanks that primarily contain solids because they could dry out and heat up, and high organic concentrations in the tanks could support an exothermic reaction at high elevated temperatures.

The waste in campaign feed tanks and campaign composite did not meet the 3 wt% TOC definition of complex waste. The concentrations in Tables 15 and 16 were are estimated to have TOC values on a dry basis ranging from 0.10% to 1.0%. The weight percent TOC calculations can be found in Appendix E.

Tanks 107-AP and 108-AP received water and dilute miscellaneous waste streams including Plutonium-Uranium Extraction Plant ammonium scrubber feed, B-Plant steam condensate, and dilute 222-S laboratory waste. The heel waste in tanks 102-AW and 106-AW came primarily from the partially concentrated product from 242-A Evaporator Campaign 89-2 and 94-1, which processed neutralized cladding removal waste and miscellaneous dilute wastes. These tanks do not contain organic complexants.

Segregation of complex and non-complex waste was implemented to maximize use of tank space. Complex and non-complex waste were not segregated to prevent chemical reactions between the different waste types. Complex waste is concentrated only to the saturation level of the nitrate/nitrite in order to avoid formation of a gel-like solution due to its supersaturation when solids precipitate.

The nitrite precipitation for this campaign was predicted to occur at WVRF of 96.9%. Laboratory boildown studies evidenced that a rapid increase in specific gravity (SpG) at 90% WVRF. Waste stored at a high SpG will yield significant amount of solids which has the potential for flammable gas accumulation. Therefore, the specific gravity limit will control the WVRF for the campaign 94-2. This campaign will be terminated at 87.5% WVRF which is well before the nitrite saturation level. The purpose of segregation of complex and non-complex waste will not be defeated, since there is no penalty on waste volume reduction when processing non-complex waste in tank 101-AP and complex waste in tanks 107-AP, 108-AP, 102-AW and 106-AW.

To avoid unnecessarily and infeasibly segregating waste as complex and non-complex, the content of tank 101-AP will be processed with that of tanks 102-AW, 106-AW, 107-AP and 108-AP. The combined waste from campaign feed tanks was evaluated in regards to complex waste designation. The PREDICT computer model speculated that the campaign 94-2 slurry product will be complexed with a TOC content of 12.6 g/L when extrapolated to Eight Molar caustic limit. A sample will be taken near the end of the campaign to further evaluate whether the slurry product should be designated a complex waste.

3.1.4 Transuranic (TRU) Waste Segregation

Waste containing a TRU concentration of equal or greater than 100 nCi/g is considered as TRU waste and should be segregated from non-TRU waste. Dissolving precipitated TRU constituents increases the mobility of the TRU and, therefore, increases the risks of interim storage. In addition, disposal cost of the TRU waste is much more expensive than non-complex waste due to the requirement of additional waste pretreatment steps needed to prepare the wastes for final disposal processes. The predominate radionuclide activity of TRU wastes are from Plutonium-239 and Americium-241. The campaign feed tanks and slurry product at 87% WVRF were estimated to have TRU values ranging 0.54 to 11.7 nCi/g. The TRU calculations can be found in Appendix F. The campaign feed tanks and slurry product are categorized as non-TRU waste since they do not meet the definition of TRU waste.

3.1.5 High Phosphate Waste

Waste containing high phosphate concentrations (i.e., $[PO_4^{-3}] > 0.1$ M) should not be mixed with waste with a high salt content (i.e., $[Na^+] > 8$ M). Studies on sodium phosphate (Na_3PO_4) solutions have demonstrated the formation of needle-shaped crystals of $Na_3PO_4 \bullet 12H_2O$ which increase the viscosity of the waste and can cause the formation of a gel-like matrix (Carothers 1991). The phosphate and sodium concentrations for slurry product is predicted to be 5.46×10^{-3} M and 1.32 M, respectively. The phosphate and sodium concentrations can be found in Tables 15 and 16 for campaign feed tanks. The phosphate and sodium concentrations for campaign slurry product were predicted by Computer Process Flowsheet to have values of 5.46×10^{-3} M and 1.32 M which are well below 0.1 M and 8 M limits, respectively.

3.1.6 Energetics

Wastes that exhibit exothermic reactions at less than 335 °F shall be segregated and/or mixed with waste that exhibit the same reactivity. An exotherm exists when a material stores a large quantity of energy in the form of chemical energy or physical strain which is released when the material is heated. Wastes that exhibit exotherms indicate the potential for self-heating and could enter into a propagating chemical reaction. The differential scanning calorimetry (DSC) analysis performed on wastes in campaign feed tanks and campaign composite detected no exotherms below the limit of 335 °F.

Wastes that exhibit energy releases from exotherms in excess of the energy absorption from endotherms shall be segregated from all other wastes. The net energy available for heating the waste from an exothermic chemical reaction is greatly diminished by endotherms. If the endotherms are greater, then a propagating reaction would be inhibited. Base on laboratory thermal analysis on campaign feed tanks and campaign composite sample conducted up to 932 °F, it is indicated that only the endotherm associated with water evaporation/boiling is seen. From DSC plots generated by Laboratory, it is evident that absolute value of the exotherm/endotherm ratio is well below the ratio limit of 1. The thermal analysis results for campaign feed tanks can be obtained from the Environmental Data Management Center and Laboratory Information Management System. The results from thermal analysis for campaign feed tanks can be obtained from EDCM/LIMS and for campaign composite can be found in Appendix G.

3.1.7 Corrosivity

Waste that do not meet tank corrosivity limits should not be transferred to tank farms. The nitrate, nitrite and hydroxide concentrations are limited in order to inhibit uniform corrosion rates and stress corrosion cracking in the

DST. As shown in tables 15 and 16, the nitrate, nitrite and hydroxide concentrations for campaign feed tanks are within in the tank corrosion boundary limits. The slurry product composite values in Table 31 were compared against double shell tank waste corrosion specifications listed Table 7. The nitrate molar concentration for the slurry product is predicted to be approximately 0.352M. This concentration places condition 1 (table 31) into effect. Under condition 1, the boundary condition for hydroxide concentrations (0.73 M) is within limits because it is greater than the lower limit of 0.01M and less than the upper limit of 5.0 M . Similarly, boundary condition for nitrite concentrations (4.7 M) is within limits because it was greater than the lower limit of 0.011M and less than the upper limit of 5.5M. Comparison of feed composition and projected slurry to DST waste corrosion specifications can be found in Table 23.

The PREDICT program was also used to extrapolate the hydroxide, nitrate, and nitrite levels for the feed composite throughout the campaign. The nitrate, nitrite, and hydroxide levels will not violate the tank corrosion specifications at any point during the campaign. The printouts from the PREDICT program can be found in Appendix F.

3.1.8 Heat Generation

Receiver tanks 102-AW and 106-AW shall not receive transfers of waste capable of generating heat at a rate greater than 70,000 Btu/hr. Heat generation rate of waste transferred is limited to avoid causing an excess heat generation rate of waste in receiver tanks (102-AW & 106-AW). The heat content less than 70,000 Btu/hr will prevent a release of contamination due to internal boiling. The predominant heat load is from Cesium-137 (half life of 30 yrs) and Strontium-90 (half life of 28.1 years). The combined heat generation for all campaign feed tanks was estimated to be 686 Btu/hr which is well below heat load limit of 70,000 Btu/hr. The heat load calculations can be found in Appendix E.

3.1.9 Criticality

The criticality prevention specification is cited in CPS-T-149-00010. The criticality prevention program limits the concentration of fissile material to 0.05 g/gal for all transfers to and within the DST systems. More restrictive requirement limits the concentration of fissile material in the feed to the evaporator to be less than 0.01 g/gal.

Fissile isotopes of primary concern are ^{239}Pu, ^{233}U and ^{235}U. Of these, ^{239}Pu is by far the most significant contributor to the criticality potential of tank waste. When calculating fissile material concentrations, a ^{235}U enrichment of less than one weight percent can be excluded in concentration and total mass calculations (RHO 1988). ^{239}Pu and ^{233}U are included in the fissile material concentration regardless of their enrichment. A copy of the internal letter addressing the predicted fissile uranium concentrations in tank waste can be found in Appendix G.

The quantity of ^{233}U in the campaign feed tanks was negligible when compared to the fissile limit. Fissile concentrations for campaign feed tanks, composite, and slurry product were estimated to have values ranging from 9.95 x 10^{-6} g/gal to 1.96 x 10^{-4} g/gal which are well below the Evaporator feed and

DST systems limits of 0.01 g/gal and 0.05 g/gal, respectively. Additional calculations indicated that a WVRF of greater than 99.7% would be required to exceed the Evaporator feed fissile material concentration limit of 0.01 g/gal for this campaign. The campaign will be terminated well before that point with a projected WVRF of 87.5%. Fissile concentration calculations can be found in Appendix E.

3.1.10 Flammable Gas

Waste having a weighted mean specific gravity (Sp.G) greater than 1.41 should be segregated. Waste stored at a high SpG can yield significant amounts of solids which creates the potential for flammable gas accumulation. The SpG analysis performed on wastes in each campaign feed tank estimated that the highest SpG value of these tanks would be 1.19. In addition, the boildown studies from the Laboratory indicated that the final campaign product SpG at 87.5% WVRF will be less than 1.12 which is well below the SpG limit of 1.41. The results from specific gravity analysis for campaign feed tanks can be found in Tables 14 & 15 and campaign slurry product can be found in Appendix G.

3.1.11 Transfer Line Plugging

Waste having a Reynolds number of less than 20,000 and greater than 30 percent volume solids should not be transferred without a technical evaluation. The Reynolds numbers for campaign feed tanks and slurry product were estimated to be several times the minimum Reynolds number limit. The Reynolds number calculations can be found in Appendix E.

The waste in campaign feed tanks and slurry campaign composite did not exceed the 30 percent volume solid limit. The concentrations for tanks 101-AP, 107-AP and 108-AP in Table 15 were estimated to have percent volume solid values ranging from 0.83% to 2.85%. The heel waste concentrations of tanks 102-AW and 106-AW in Table 16 were estimated to have values of 12.2% and 24.4%, respectively which are lower than the percent solid limit of 30. High percent solids in heel tanks 102-AW and 106-AW are expected since waste in these tanks are processed waste from campaign 94-1. The Predict Runs from appendix F indicated that the campaign will be terminated well before the 30 percent volume solid with a projected WVRF of 87.5%. The percent solid calculations can be found in Appendix E.

3.1.12 Mixing and Compatibility Study

In addition to addressing the individual criteria, a mixing and compatibility study was performed on a composite of the feed for this campaign to ensure the waste compatibility and provide data to establish processing controls. The samples were mixed with no apparent changes in color, temperature, clarity, or any visually determinable characteristic (Beck 1992). The letter containing the results from the mixing and compatibility study can be found in Appendix G.

3.2 RADIOLOGICAL LIMITS

3.2.1 Evaporator Radiological Source Term

The *242-A Evaporator OSR Compliance Strategy for Radiological Source Strengths*, WHC-SD-WM-OCD-016, governs the operation of the 242-A Evaporator within its radiological source term. Prior to an evaporator campaign, WHC-SD-WM-OCD-016 requires a comparison of the composite waste concentrations to the radiological source term limits for each constituent. The most restrictive radionuclide is then evaluated against the campaign WVRF (Tranbarger 1992).

The campaign feed composite and projected slurry product values were compared against each of the constituents in the radiological source term in Table 6. Using the assumption that all constituents concentrate at the same ratio, ^{129}I was found to be the most restrictive radionuclide with a concentration of 15 percent of the radiological source term. The comparisons of feed and slurry product radionuclide level to source term limit are contained in Tables 20 and 21.

Isotopic plutonium analysis for ^{241}Pu cannot be performed at the 222-S Analytical Laboratories. WHC-SD-WM-OCD-016 contains formulas for ^{241}Pu which allow its calculation based upon the $^{239/240}$Pu concentration. When the formulas are applied, ^{241}Pu was found to be less than one percent of the radiological source term (Tranbarger 1992).

For some constituents, the analytical method does not provide an accurate concentration because detection limits are altered due to interference from other radionuclides (Tranbarger 1992). In these cases, the analytical result is reported with a "less than" sign. The "less than" result for ^{226}Ra and ^{238}Pu were found to be factors of 3.4 and 62 greater than the radiological source term values, respectively. WHC-SD-WM-OCD-016 contains formulas for ^{226}Ra and ^{238}Pu which provide more realistic concentrations. When the formulas were applied, the ^{226}Ra and ^{238}Pu values were reduced to less than 0.5 percent of the radiological source term.

3.2.2 LERF Radiological Limits

The LERF radiological limits are based upon maintaining the sum of the ratio of concentration to Derived Concentration Guide (DCG) value for twenty-two radionuclides at less than 5,000 (Lavender 1993a). Values for each of the constituents in the LERF radiological limit were entered into the process flowsheet for the 242-A Evaporator (Lavender 1993b). The process flowsheet was developed to model the partition of constituents during the evaporation process. The process condensate concentrations at 87.5% WVRF from the flowsheet were compared against the DCG for each of the twenty-two radionuclides in Table 5.

Table 21 lists the projected process condensate concentration to DCG ratios for each of the radionuclides in the LERF radiological limit. The sum of the concentration to DCG ratios were found to be less than an order of magnitude below the 5,000 limit.

Isotopic plutonium analysis for ^{241}Pu cannot be performed at the 222-S Analytical Laboratories. WHC-SD-WM-OCD-016 contains formulas for ^{241}Pu which allow its calculation based upon the $^{239/240}$Pu concentration. The calculated ^{241}Pu concentration was entered into the process flowsheet and the concentration to DCG ratio was found to be less than one.

For some constituents, the analytical method does not provide an accurate concentration because detection limits are altered due to interference from other radionuclides. In these cases, the analytical result is reported with a "less than" sign (Tranbarger 1992). WHC-SD-WM-OCD-016 contains a formula for ^{226}Ra and ^{238}Pu which provides a more realistic concentration. The calculated ^{226}Ra and ^{238}Pu to DCG ratios were found to be less than one.

3.2.2 Gaseous Radiological Limits

Gaseous effluent from 242-A Evaporator vessel ventilation system is expected to be radiologically contaminated. Continuous monitoring of exhaust air will be performed during the campaign to provide notification of excessive concentrations of radionuclides. Specification limits for radioactive gaseous releases are set to meet the requirements of WHC-CM-7-5 Environmental Compliance program.

The predominant total alpha and total beta activities are from Pu-239 and Sr-90, respectively. Pu-239 and Sr-90 values in the campaign feed were entered into the process flowsheet for the 242-A Evaporator (Lavender 1993b). The process flowsheet was developed to model the partition of constituents during the evaporation process. The Pu-238 and Sr-90 gaseous concentrations at 87.5% WVRF from the flowsheet were compared against the vessel vent radionuclide limits in Table 9. The projected radionuclide levels for Pu-239 and Sr-90 in the gaseous effluent were negligible when compared to the vessel vent radionuclide limits. Comparison of projected vessel vent discharge to vessel vent radionuclide limits is contained in Table 24.

3.3 ORGANIC LIMITS

3.3.1 LERF Organic Limits

Table 4 contains the organic limits for process condensate in the LERF. Table 2 contains the feed limits for process condensate to meet the LERF composition limits. The upper 90% confidence interval of the sample analyses in Tables 10-12 were compared against the organic feed limits for LERF acceptance contained in Table 2. The concentration for each constituent was found to be considerably smaller than each of the limits in Table 2. The comparison of campaign composition to evaporator feed limits for organic LERF acceptance can be found in Table 18. The feed to product ratio (R) was assumed to be 2 for this comparison.

Acetone, 2-butanone and tetrahydrofuran are constituents in the LERF organic limits to be detected by either the VOA or the semi-VOA. Acetone was only detected in tank 108-AP samples. The average concentration for acetone is three order of magnitude below the limit specified in Table 2. 2-butanone and tetrahydrofuran are detected in tanks 101-AP and 108-AP samples.

The average concentration for 2-butanone and tetrahydrofuran in these tanks are less than two percent of the organic LERF limit.

The heel waste in tanks 102-AW and 106-AW are the processed waste from campaign 94-1. Most of volatile organic compounds were boiled off during that campaign. The logical assumption was made to neglect volatile organic compounds in tanks 102-AW and 106-AW from the comparison with the organic LERF limits.

3.3.2 Vessel Vent Discharge Limits

The individual constituent limits in Table 3 were chosen to prevent the vessel vent from exceeding the volatile emission limit of 3 lb/hr (Basra 1994). The volatile emission limits are applied using a sum of fractions technique. The upper 90% confidence interval for the sample analyses in Tables 10-12 were compared against the volatile emissions limits in Table 3 for each constituent. The comparison of campaign feed composite to evaporator feed limits based on volatile emissions is contained in Table 19. The sum of fractions was less than one. The feed to product ratio (R) was assumed to be 2 for this comparison.

In general, the upper 90% confidence interval of the concentrations for acetone, benzyl alcohol, 2-butoxyethanol, 2-hexanone, tetradydronfuran and tributylphosphate listed are several orders of magnitude below the volatile emission limits. The 1-butanol concentration in tank 107-AP was the closest of any of the constituents to the Table 3 limits. The upper 90% confidence interval of 1-butanol concentration in tank 107-AP was 13 percent of the volatile emission limit. When compared to the volatile emission limits, all of the other organic constituents were negligible.

The heel waste in tanks 102-AW and 106-AW is the processed waste from campaign 94-1. Most of volatile organic compounds were boiled off during the campaign. The logical assumption was made to neglect volatile organic compounds from the comparison with the vessel vent discharge limits.

3.4 OTHER CONSIDERATIONS

3.4.1 Ammonium Concentrations

Gaseous ammonia discharges from the vessel vent exhaust stack are required to be maintained below 100 pounds in any 24 hour period (WHC 1988). Ammonium concentrations in the process condensate at the LERF must be maintained below 10,000 mg/L (Basra 1994).

The ammonium concentrations for campaign feed tanks are listed in Tables 15 and 16. Few assumptions were made to predict largest ammonium concentrations which would be discharged during campaign 94-2 when compared with discharge limits. One assumption was made to neglect ammonium concentration in 102-AW and 106-AW tank heels since ammonia in these tanks was boiled off from campaign 94-1. The largest ammonium concentration from the feed tanks was used and ammonia was assumed to be boiled off in the first evaporator process pass for this comparison. The ammonium concentration in the tank 101-AP was found to be largest of all and was entered into the process flowsheet (Lavender 1993b). The quantity of ammonia in the vessel vent exhaust stack calculated by the process flowsheet was approximately eight percent of 100 lb/day limit. The ammonium level calculated for the process condensate was 35% of the LERF composition limit.

3.4.2 Separable Organic Layers

Organic vapors can accumulate in the condensate collection tank C-100 during evaporator operations if separable organic in the feed tanks is processed. Organic liquid fire or vapor explosion could potentially result from the accumulations if the temperature is above 165 degree F and there is an ignition (spark ect...). During evaporator operations, the possibility exists for an immiscible organic layer to develop in the condensate collection tank C-100. In addition, the presence of an immiscible organic layer in the process condensate would cause operational difficulties at the ETF.

Based on the evaluation of PCP for campaign 94-1, it indicated that no organic layer existed in tanks 102-AW and 106-AW. Surface samples were taken from tanks 101-AP, 107-AP and 108-AP for TOC analyses. The TOC analyses for 101-AP and 107-AP were 0.013 g/L and 0.010 g/L, respectively. The results are very similar to those in Table 15 which indicates a separable organic layer was not present in tanks 101-AP and 107-AP.

The surface organic analysis for tank 108-AP was not completed due to 325 PNL Laboratory shutdown. Lacking data for tank 108-AP organic layer analysis, the 102-AW feed tank liquid level must be controlled and set above 100 inches during Campaign 94-2. Before the final evaporator pass startup, liquid and surface samples from tank 102-AW will be collected and analyzed for separable phase organic to determine whether waste can be further processed. If no presence of separable organic is indicated by the laboratory, then the level in tank 102-AW will be reset to minimum at 6 inches for the final evaporator process pass of the campaign.

A copy of the internal letter addressing the TK-C-100 operating strategy to prevent separable phase organic from being transferred to LERF is contained in Appendix G.

4.0 CAMPAIGN DESCRIPTION

4.1 FEED ACTIVITIES

4.1.1 Feed Inventories

<u>241-AW</u>

Tank 102-AW will continue to be used as the evaporator feed tank. Waste can be transferred to Tank 102-AW from any one of the tanks within the system. The feed tank is agitated with air lift circulators to mix the contents prior to being pumped to the evaporator. Prior to TK-101-AP to TK-102-AW transfer on August 12, 1994, the 102-AW liquid level has been 29.8 inches. The current liquid level in tank 102-AW at the time of this revision was 301.9 inches.

Tank 106-AW will be used as the slurry receiver tank for this campaign. At the time of this revision, the 106-AW surface level was 260.5 inches. At the start of the campaign, approximately 10 inches of supernate will be in tank 106-AW after TK-106-AW to TK-106-AN transfer.

Waste in tanks 102-AW and 106-AW came primarily from the partially concentrated product from 242-A Evaporator Campaign 94-1, which processed the supernate from NCRW and miscellaneous dilute wastes.

241-AP

Tanks 101-AP, 107-AP, and 108-AP received water and dilute miscellaneous waste streams including Plutonium-Uranium Extraction Plant ammonium scrubber feed, B-Plant steam condensate, and dilute 222-S laboratory waste. Prior to TK-101-AP to TK-102-AW transfer on August 12, 1994, the 101-AP liquid level has been 385.4 inches. At the time of this revision, the current levels in tanks 101-AP, 107-AP and 108-AP were 115.0 inches, 403.4 inches, and 411.1 inches, respectively.

4.1.2 Feed Activities

Two airlift circulators (ALCs) are installed in tank 102-AW. One ALC is 16 inches in diameter and the other is 24 inches in diameter. The ALCs are used to blend the supernatant liquid in tank 102-AW to provide a uniform feed for the evaporator. The ALC operating procedure states that the 16 inch ALC is to be used when the liquid level in tank 102-AW is between 190 and 240 inches. The 24 inch ALC is to be used when the liquid level is greater than 240 inches.

The 24 inch ALC will be started two days prior to the campaign to facilitate mixing of the supernatant liquid in the tank. The ALCs will continue to be operated within their procedural limits throughout the campaign. Both ALCs will be shut down at the completion of the campaign.

4.2 PROCESSING ACTIVITY DESCRIPTION

Processing time for Campaign 94-2 is anticipated to be 58 days. One week outage is expected during which preventive maintenance and instrument calibrations will be performed.

Throughout the campaign, feed rates are expected to be 80-130 gpm and boiloff rates are expected to be 40-65 gpm to maintain a WVRF per pass of roughly 50%. The Monitoring Control Systems may be employed for automatic control of several aspects of the evaporator process including the following, however manual operation is possible:

- Evaporator Feed Flow Rate
- Evaporator Vessel Level
- Slurry Flow Rate
- Evaporator Vessel Pressure
- Tank C-100 Level
- Cooling Water Backpressure

At the time of this revision, the liquid levels for tanks 102-AW and 101-AP were 301.9 inches and 115.0 inches, respectively. Waste in tank 101-AP is expected to be transferred to the liquid in tank 102-AW to a level of 360 inches prior to campaign 94-2 start. Prior to the 242-A campaign 94-2 startup, the air-lift circulators will be started in 102-AW to provide a uniform feed for the evaporator and the ammonia monitor should be operating.

The 242-A Evaporator facility startup will be commenced per TO-600-020 and TO-600-030. To prevent potential excessive radioactivity overflows into TK-C-100 and potential recurring evaporator shutdowns caused by foaming from the boildown studies, feed will be pumped initially to the evaporator with the simultaneous addition of anti-foam chemicals per TO-660-141 is performed. To minimize the use of antifoam chemicals, a stepwise reduction of the addition of antifoam chemicals into the 242-A Evaporator will be implemented when the evaporator process reaches steady state condition.

After the waste volume in tank 102-AW has been reduced by approximately half by processing waste through the 242-A Evaporator facility, batch transfers of waste from 106-AW to 102-AW will be employed throughout the campaign. The discrete passes will allow a greater time for potential solids in the slurry product to settle out in tank 106-AW prior to supernatant liquid being pumped to tank 102-AW.

The slurry discharge flowrate will be controlled to attain approximately 50% WVR per pass. Waste in tanks 101-AP, 107-AP, and 108-AP will be transferred to tank 102-AW until the liquid levels in these tanks are at 10 inches. The maximum surface level for tank 106-AW will be set at 416 inches.

At the completion of the campaign, waste inventories in 101-AP, 107-AP, 108-AP, and 102-AW are expected to be minimal. Tank 106-AW is expected to contain approximately 160 inches of supernatant liquid with a slight increase in amount of solids. A sludge level measurement shall be performed on tank 106-AW at the completion of the campaign to check for the amount of solids.

4.3 SAMPLING AND MONITORING REQUIREMENTS

4.3.1 Compliance Samples

Five process condensate, two steam condensate and two cooling water compliance samples will be taken during campaign 94-2 on the evaporator effluent streams to demonstrate compliance with environmental regulations. Compliance samples comply with Environmental Protection Agency (EPA) sampling methods and laboratory protocol to as great a degree as possible. Compliance Sampling of slurry products will not be conducted since the Land Disposal Restriction treatment standards are not applicable. No compliance vessel vent samples will be collected since RCRA requirements for the 242-A Evaporator Vessel Vent (VV) stream are not applicable.

Compliance sampling requirements for cooling water are discussed in WHC-SD-WM-EV-078, *242-A Evaporator Cooling Water Sampling and Analysis Plan* (Loll 1992a). Compliance sampling requirements for steam condensate are discussed in WHC-SD-WM-EV-079, *242-A Evaporator Steam Condensate Sampling and Analysis Plan* (Loll 1992b). Compliance sampling requirements for the process condensate are included in the *242-A Evaporator Waste Analysis Plan* (Basra 1994).

4.3.2 Process Control Samples

In addition to the compliance samples, process control samples will be taken on the various evaporator streams throughout Campaign 94-2. Analyses to be performed on process control samples are included in the *242-A Evaporator Sample Schedule* (Le 1994).

242-A Cooling Water (ACW) Samples

A portion of the cooling water stream is collected on a daily basis in the RC-2 carboy during evaporator operations. Two 1 liter cooling water sample bottles will be taken daily per TO-630-060 for annual discharge reporting requirements. One liter bottle will be taken per the Sample Schedule for process control and one additional 1 liter bottle shall be taken for composite analysis.

ACW samples will be analyzed for total alpha, total beta, and pH. The sample analyses will be used to ensure compliance with limits listed in Table 8 for discharge to 216-B-3 Pond. The used raw water stream has no diversion capabilities, thus, excessive radiation levels detected in this stream require an immediate evaporator shut down.

242-A Process Condensate (APC) Samples

APC samples will be taken throughout the campaign to ensure compliance with the LERF composition limits listed in Tables 4 and 5. APC samples will be analyzed for total alpha, ^{129}I, ^{144}Ce and U_{gross} as a verification of the radionuclide concentration in the process condensate. These radionuclide concentrations were found to have the largest DCG ratios in the process condensate. They constitute approximately 82 percent of the entire LERF radiological DCG ratios. These APC samples will also be analyzed for TOC and ammonia to verify the organic and ammonium concentrations in the process condensate. The APC samples will be taken weekly from the RC-3 proportional sampler and analyzed for the constituents in the LERF radiological limits to provide verification.

The limits in Tables 4 and 5 apply only to the composition of process condensate in the LERF at any given time. APC samples which exceed the Table 4 or 5 values would require an evaluation be made of whether continued transfer of process condensate would cause a violation of the LERF composition limits.

242-A Steam Condensate (ASC) Samples

A representative portion of the steam condensate stream is collected in the RC-1 carboy during the transfer of condensate to a retention basin. ASC samples will be taken per TO-630-040 each time a steam condensate basin is filled. One liter will be taken per the Sample Schedule and two additional liters will be taken for composite analysis. ASC samples are analyzed for total alpha, total beta, and pH. The sample analyses will be used to ensure compliance with discharge limits listed in Table 8. If sample results are found to have exceeded the discharge limits, a confirmatory ASC sample can be taken from the 207-A Pump Pit. The appropriate sample shall be analyzed and found to be within discharge limits listed in Table 8 prior to discharge of a retention basin to 216-B-3 Pond. In the event that the discharge limits are exceeded, the retention basin shall be transferred to tank 102-AW.

<u>242-A Feed (FD-A) Samples</u>

Feed samples will be taken each time a new feed is introduced into the 242-A Evaporator from the feed sampler SAMP-F-1. FD-A samples are analyzed for TOC, selected inorganics, and major radionuclides. The sample analyses will be used to verify the major inorganic and radiological constituents concentrations as expected during the campaign. An additional feed sample will be taken near the end of campaign for evaluation of final evaporator process pass WVRF. Individual sampling times will be specified by process memo.

<u>242-A Slurry (SLY-A) Samples</u>

Slurry samples will be taken each time a new feed is introduced into the 242-A Evaporator from the slurry sampler SAMP-F-2. The SLY-A samples are analyzed for TOC, selected inorganics, and major radionuclides. The sample analyses will primarily be used to verify that the major inorganic and radiological constituents concentrate as expected during the campaign.

Additionally, one slurry sample will be taken on the final pass through the evaporator to provide necessary data for campaign 95-1 and verify compliance with the radiological source term listed in Table 6. The evaporator process shall be shut down if any of the constituents in Table 6 were found to have exceeded the radiological source term. Individual sampling times will be specified by process memo.

<u>102-AW Tank Samples</u>

One supernate sample and one surface sample will be taken near the end of campaign from tank 102-AW. The samples are analyzed for TOCs to determine whether a separable phase organic exists in tank 102-AW. If no presence of separable organic, then the level in tank 102-AW will be reset to minimum at 6 inches.

4.3.3 Gaseous Effluent Monitoring

The 242-A building ventilation exhaust stack (296-A-21) contains a generic stack monitoring system. One portion of the exhaust is diverted to a record sampler where radioactive particulates are collected on filter paper. The record sampler filter paper is collected weekly and analyzed. The filter paper is then maintained for monthly composite samples. The remaining portion of this stream is split between an alpha continuous air monitor (CAM) and a beta-gamma CAM. The K1-5-3 and K1-5-2 exhaust fans are interlocked to shut down on high beta-gamma radiation.

The vessel vent exhaust stack (296-A-22) has a monitoring system similar in design to that of 296-A-21 except for the inclusion of a silver zeolite filter sampler. The silver zeolite filter is routinely collected and analyzed for gaseous radioisotopes of iodine, antimony, tin, and ruthenium (Lavender 1993b). The limits are 100 DCGs for iodine & ruthenium and 10 DCGs for antimony and ruthenium. The evaporator process is interlocked to shut down on high beta-gamma radiation.

The infrared gas analyzer continues to be used to continuously monitor ammonia levels in the vessel vent effluent stream. The ammonia monitor alarm is set at 650 ppm which is roughly half the level that would exceed the 100 lbs per 24 hours limit if maintained for 24 hours. Gaseous ammonia releases exceeding 100 pounds in a 24 hour period shall immediately be reported to Environmental Compliance per WHC-CM-7-5 (WHC 1988).

4.3.4 Liquid Effluent Monitoring

A portion of used raw water stream is diverted through the RC-2 radiation monitoring cell. This stream has no diversion capabilities, thus, excessive radiation levels in this stream require an immediate evaporator shut down.

The steam condensate stream flows past an in-line radiation monitor RIAS-EA1-1 on the inlet to the C-103 weir. A portion of the steam condensate in the C-103 weir is diverted through the RC-1 radiation monitoring cell. On detection of high radiation in the steam condensate from either of the radiation monitors, an interlock will shut down steam to the evaporator process and divert the steam condensate stream to tank 102-AW.

The process condensate stream flows past an in-line radiation monitor RIAS-CA1-1 on the inlet to the C-100 tank. After passing through, a portion of the process condensate stream is diverted through the RC-3 radiation monitoring cell. On detection of high radiation from the in-line radiation monitor, an interlock will shut off feed to the evaporator process, shut down steam to the evaporator process, and terminate process condensate flow to LERF. On detection of high radiation from the RC-3 radiation monitor, an interlock will terminate process condensate flow to LERF.

4.3.5 Quality Assurance

During campaign, surveillances may be performed by Quality Assurance for compliance to this process control plan.

4.4 PRODUCT/WASTE DISPOSITION

The slurry product from Campaign 94-2 will be transferred to tank 106-AW. Tank 106-AW is expected to contain approximately 4.4×10^5 gallons of DDSSF product at the completion of the campaign.

All process condensate from the campaign shall be transferred to LERF for active storage. Approximately 3.5 million gallons of process condensate is anticipated to be transferred to LERF during the campaign. Approximately 0.5 million gallons of this condensate is projected to be the result of water additions due to pad sprays, seal water, and steam jets.

Under normal conditions, steam condensate generated during the campaign will be discharged from the 207-A retention basins to 216-B-3 Pond. Steam condensate would be transferred to tank 102-AW in the unlikely event that radioactive contamination is detected in the steam condensate stream. All cooling water used during the campaign will be discharged to 216-B-3 Pond.

5.0 REFERENCES

Allison, J. M., 1984, *Computer Prediction of Evaporator Operations*, SD-WM-ADP-004, Rockwell Hanford Operations, Richland, Washington.

Basra, T. S., 1994, *Interim Changes In 242-A Evaporator Waste Analysis Plan*, ECN 613527, Westinghouse Hanford Company, Richland, Washington.

Beck, M. A., 1994, "Evaporator Boildown Results", internal memo, Westinghouse Hanford Company, Richland, Washington.

Carothers, K. G., 1991, *Tank Farm Waste Compatibility Program*, WHC-SD-WM-OCD-015, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Carothers, K. G., 1994, *Data Quality Objectives for The Waste Compatibility Program*, WHC-SD-WM-DQO-001, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Crummel, G. M., and R. D. Gustavson, 1993, *242-A Effluent Monitoring Plan*, WHC-EP-0466, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

DOE/RL, 1991, *242-A Evaporator Dangerous Waste Permit Application*, DOE/RL-90-42, Rev. 0, U.S. Department of Energy-Richland Operations Office, Richland, Washington.

Hanlon, B. M., 1994, *Tank Farm Surveillance and Waste Status Summary Report for March 1994*, WHC-EP-0182-72, Westinghouse Hanford Company, Richland, Washington.

Harris, J. P., 1992, *Operating Specifications for the 241-AN, AP, AW, AY, AZ, & SY Tank Farms*, OSD-T-151-00007, Rev./Mod. H-5, Westinghouse Hanford Company, Richland, Washington.

Johnson, P. G., 1993, *Operating Specifications for the Liquid Effluent Retention Facility*, OSD-T-151-00029, Rev./Mod. A-2, Westinghouse Hanford Company, Richland, Washington.

Jonas, A. L., 1989, *242-A Evaporator/Crystallizer Fiscal Year 1989 Campaign Run 89-2 Post Run Document*, WHC-SD-WM-PE-038, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Lavender, 1993a, *Final Safety Analysis Report, Project W-105, Liquid Effluent Retention Facility*, WHC-SD-W105-SAR-001, Rev. 0-C, Westinghouse Hanford Company, Richland, Washington.

Lavender, 1993b, *242-A Evaporator/Crystallizer Safety Analysis Report*, WHC-SD-WM-SAR-023, Rev. 1-B, Westinghouse Hanford Company, Richland, Washington.

Le, E. Q., 1993, "Part B Evaporator Feed Concentration Limits Change Request", internal memo, Westinghouse Hanford Company, Richland, Washington.

Le, E. Q, 1994 *242-A Evaporator Sample Schedule*, FSS-T-630-00001, Rev./Mod. B-4, Westinghouse Hanford Company, Richland, Washington.

Loll, C. M., 1992a, *242-A Evaporator Cooling Water Sampling and Analysis Plan*, WHC-SD-WM-EV-078, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Loll, C. M., 1992b, *242-A Evaporator Steam Condensate Sampling and Analysis Plan*, WHC-SD-WM-EV-079, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

O'Rourke, J. F., 1992, "Tank C-100 Operating Level", internal memo, Westinghouse Hanford Company, Richland, Washington.

Pitkoff, C. C., 1992, "Isotopic Uranium Analysis Composition", internal memo, Westinghouse Hanford Company, Richland, Washington.

Reynolds, D. A., 1988, "Viscosity of Evaporator Slurries" internal memo, Westinghouse Hanford Company, Richland, Washington.

RHO, 1988, *Criticality Prevention Specification for Waste Storage Tanks and Associated Equipment*, CPS-T-149-00010, Rev./Mod. D-0, Rockwell Hanford Operations, Richland, Washington.

Tranbarger, R. K., 1992, WHC-SD-WM-OCD-016, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Wahlquist, R. A., 1993, *Operating Specifications for the 242-A Evaporator-Crystallizer*, OSD-T-151-00012, Rev./Mod. D-1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988, *Environmental Compliance*, WHC-CM-7-5, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1989, *Waste Storage Tank Status and Leak Detection Criteria*, WHC-SD-WM-TI-357, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993, *Waste Tank Administration*, WHC-IP-0842, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Vandercook, R. E., 1976, *Vacuum Evaporator-Crystallizer Flowsheet for Waste Liquors*, ARH-F-101, Westinghouse Hanford Company, Richland, Washington.

This page intentionally left blank

APPENDIX A

INDEX OF TECHNICAL OPERATING CONTROLS

This page intentionally left blank.

APPENDIX A

INDEX OF TECHNICAL OPERATING CONTROLS

DOE/RL-90-42, Rev. 0, *242-A Evaporator Dangerous Waste Permit Application.*

FSS-T-630-00001, Rev. B-4, *242-A Evaporator Sample Schedule.*

OSD-T-151-00007, Rev./Mod. H-5, *Operating Specifications for the 241-AN, AP, AW, AY, AZ, & SY Tank Farms.*

OSD-T-151-00012, Rev./Mod. D-1, *Operating Specifications for the 242-A Evaporator-Crystallizer.*

OSD-T-151-00029, Rev./Mod. A-1, *Operating Specifications for the Liquid Effluent Retention Facility.*

WHC-EP-0466, Rev. 1, *242-A Effluent Monitoring Plan.*

WHC-SD-WM-EV-060, Rev. 3, *242-A Evaporator Waste Analysis Plan.*

WHC-SD-WM-EV-078, Rev. 2, *242-A Evaporator Cooling Water Sampling and Analysis Plan.*

WHC-SD-WM-EV-079, Rev. 2, *242-A Evaporator Steam Condensate Sampling and Analysis Plan.*

WHC-SD-WM-SAR-023, Rev. 1, *242-A Evaporator/Crystallizer Safety Analysis Report.*

WHC-SD-WM-TI-357, Rev. 1, *Waste Storage Tank Status and Leak Detection Criteria.*

This page intentionally left blank.

APPENDIX B

242-A EVAPORATOR LIMITS

This page intentionally left blank.

Table 1. Miscellaneous 242-A Evaporator Feed Limits

Constituent	Limit
Differential Scanning Calorimetry[1]	No exotherm at a temperature below 335°F
Complexed Waste[2]	Do not concentrate exceeding the $NaNO_3/NaNO_2$ precipitation boundary
Fissile Material Concentration[3]	<0.01 gPu/gal

[1] From *Operating Specifications for the 242-A Evaporator-Crystallizer* (Wahlquist 1993).

[2] From internal memo "Part B Evaporator Feed Concentration Limits Change Request" (Le 1993).

[3] From *Criticality Prevention Specifications for Waste Storage Tanks and Associated Equipment* (RHO 1988).

Table 2. Evaporator Feed Limits for LERF Acceptance[1]

Constituent	Limit (mg/L)
Ammonia	10,000 × (R - 1)/R
Acetone	600 × (R - 1)/R
Methyl Ethyl Ketone	20 × (R - 1)/R
Methyl Isobutyl Ketone	10 × (R - 1)/R
2-Propanol	10 × (R - 1)/R
Tetrahydrofuran	20 × (R - 1)/R

where R = feed rate divided by the product rate

[1] From ECN 613527, *242-A Evaporator Waste Analysis Plan* (Basra, 1994).

Table 3. Evaporator Feed Limits Based on Volatile Emissions[1]

Constituent	Limit (mg/L)[2]
Acetone	$87.2 \times (R - 1)/R$
Benzyl Alcohol	$182 \times (R - 1)/R$
1-Butanol	$226 \times (R - 1)/R$
2-Butanone	$58.0 \times (R - 1)/R$
2-Butoxyethanol	$95.2 \times (R - 1)/R$
2-Hexanone	$41.6 \times (R - 1)/R$
2-Propanol	$247 \times (R - 1)/R$
Tetradecane	$1.43 \times 10^6 \times (R - 1)/R$
Tetrahydrofuran	$14.4 \times (R - 1)/R$
Tributyl Phosphate	$1.015 \times 10^4 \times (R - 1)/R$
Tridecane	$5.836 \times 10^5 \times (R - 1)/R$

where R = feed rate divided by the product rate

[1] From ECN 613527, *242-A Evaporator Waste Analysis Plan* (Basra 1994).

[2] Individual constituent limits were chosen to prevent the vessel vent effluent from exceeding the volatile emission limit of 3 lb/hr or 3.1 tons/yr. Limits are applied using a sum of fractions technique (Barsa 1994).

The sum-of-the fractions technique is applied to constituents as follows:

$$\sum_{n=1}^{i}\left(\frac{Conc_n}{LIMIT_n}\right) \le 1$$

Where i is the number of organic constituents detected in analysis of the waste feed tank.

PROCESS CONDENSATE DISCHARGE LIMITS

Table 4. Process Condensate Chemical Limits[1]

Constituent	Limit (mg/L)
pH (unitless)	>2.0 and <12.5
Ammonia	10,000
Acetone	600
Methyl Ethyl Ketone	20
Methyl Isobutyl Ketone	10
2-Propanol	10
Tetrahydrofuran	20

[1] From in ECN 613527, *242-A Evaporator Waste Analysis Plan* (Basra 1994).

Table 5. Process Condensate DCGs[1]

Radionuclide	DCG (water) (μCi/mL)[2]
^{3}H	2.0×10^{-3}
^{14}C	7.0×10^{-5}
^{60}Co	5.0×10^{-6}
^{79}Se	2.0×10^{-5}
^{90}Sr	1.0×10^{-6}
^{94}Nb	3.0×10^{-5}
^{99}Tc	1.0×10^{-4}
^{106}Ru	6.0×10^{-6}
^{129}I	5.0×10^{-7}
^{134}Cs	2.0×10^{-6}
^{137}Cs	3.0×10^{-6}
^{144}Ce	7.0×10^{-6}
^{154}Eu	2.0×10^{-5}
^{155}Eu	1.0×10^{-4}
^{226}Ra	1.0×10^{-7}
^{237}Np	3.0×10^{-8}
^{238}Pu	4.0×10^{-8}
$^{239/240}$Pu	3.0×10^{-8}
^{241}Pu	2.0×10^{-6}
^{241}Am	3.0×10^{-8}
^{244}Cm	6.0×10^{-8}
U_{Gross}[3]	5.0×10^{-7}

[1] From *Final Safety Analysis Report, Project W-105, Liquid Effluent Retention Facility* (Lavender 1993).

[2] The DCGs are applied using the Unity Rule, modified as follows:

$$\sum_{n=1}^{N}\left(\frac{Conc_n}{DCG_n}\right) \leq 5000$$

[3] The DCG for ^{234}U was used for that of U_{Gross} for conservatism.

SLURRY DISCHARGE LIMITS

Table 6. 242-A Evaporator Radiological Source Term[1]

Radionuclide	Limit (μCi/mL)
^{14}C	0.26
^{60}Co	1.2
^{79}Se	7.8×10^{-2}
^{90}Sr	220
^{94}Nb	9.8×10^{-2}
^{99}Tc	2.0
^{106}Ru	53
^{129}I	2.6×10^{-3}
^{134}Cs	15
^{137}Cs	1,500
^{154}Eu	5.0
^{155}Eu	7.0
^{226}Ra	3.3×10^{-2}
^{238}Pu	1.3×10^{-3}
$^{239/240}Pu$	0.16
^{241}Pu	15
^{241}Am	1.0
^{244}Cm	1.3×10^{-2}

[1] From *242-A Evaporator/Crystallizer Safety Analysis Report* (Lavender 1992).

Table 7. Double-Shell Tank Waste Corrosion Specifications[1]

Constituent	Limit (M)
$[NO_3] \leq 1.0$ M	
Hydroxide	$0.01 \leq [OH] \leq 5.0$
Nitrite	$0.011 \leq [NO_2] \leq 5.5$
$1.0\ M \leq [NO_3] \leq 3.0$ M	
Hydroxide	$0.1 \times [NO_3] \leq [OH] \leq 10$
Nitrite	$[OH] + [NO_2] \geq 0.4 \times [NO_3]$
$3.0\ M \leq [NO_3] \leq 5.0$ M	
Hydroxide	$0.3 \leq [OH] \leq 10$
Nitrite	$[OH] + [NO_2] \geq 1.2$

[1] From *Operating Specifications for the 241-AN, AP, AW, AY, AZ, & SY Tank Farms* (Harris 1992).

Table 8. Steam Condensate and Cooling Water Radionuclide Limits[1]

Radionuclide	Limit (μCi/mL)
Annual Average Concentration (any consecutive 12 month period)	
^{239}Pu (Total Alpha)	6.0×10^{-8}
^{137}Cs	3.0×10^{-5}
^{90}Sr (Total Beta)	2.0×10^{-5}
U^{Gross}	2.0×10^{-8}
Monthly Average Concentration	
^{239}Pu (Total Alpha)	1.2×10^{-7}
^{137}Cs	6.0×10^{-5}
^{90}Sr (Total Beta)	4.0×10^{-5}
U^{Gross}	4.0×10^{-8}

[1] From *Operating Specifications for the 242-A Evaporator-Crystallizer* (Wahlquist 1993).

VESSEL VENT EMISSION LIMITS

Table 9. Vessel Vent Radionuclide Limits[1]

Radionuclide	Limit (μCi/mL)
Annual Average Concentration (any consecutive 12 month period)	
^{239}Pu (Total Alpha)	2.0×10^{-14}
^{90}Sr (Total Beta)	9.0×10^{-12}
Weekly Average Concentration (any consecutive 7 day period)	
^{239}Pu (Total Alpha)	2.0×10^{-13}
^{90}Sr (Total Beta)	9.0×10^{-11}
Maximum Instantaneous Concentration (average over a 4 hour period)	
^{239}Pu (Total Alpha)	1.0×10^{-10}
^{90}Sr (Total Beta)	4.5×10^{-8}

[1] From *Operating Specifications from the 242-A Evaporator-Crystallizer* (Wahlquist 1993).

APPENDIX C

FEED CHARACTERIZATION ANALYSES

This page intentionally left blank.

Table 10. Organic Analyses for Tank 101-AP

SAMPLE NUMBER	2-BUTANONE (μg/L)	TETRAHYDROFURAN (μg/L)	BENZYL ALCOHOL (μg/L)	1-BUTANOL (μg/L)	2-BUTOXYETHANOL (μg/L)
R3607	≤ 500	≤ 500	≤ 2000	≤ 2000	≤ 2000
R3609	≤ 500	≤ 500	≤ 2000	≤ 2000	≤ 2000
R3611	≤ 500	≤ 500	≤ 2000	≤ 2000	≤ 2000
R3613	≤ 500	≤ 500	≤ 2000	≤ 2000	≤ 2000
R3615	≤ 500	≤ 500	≤ 2000	≤ 2000	≤ 2000
MEAN	500	500	2000	2000	2000
STANDARD DEVIATION	NA	NA	NA	NA	NA
UPPER 90% CONFIDENCE INTERVAL	NA	NA	NA	NA	NA

Table 11. Organic Analyses for Tank 107-AP

SAMPLE NUMBER	TRIBUTUL PHOSPHATE (μg/L)	BENZYL ALCOHOL (μg/L)	1-BUTANOL (μg/L)	2-BUTOXYETHANOL (μg/L)
R3620	3200	≤ 2000	14000	≤ 2000
R3622	2200	≤ 2000	14000	≤ 2000
R3624	2300	≤ 2000	15000	≤ 2000
R3626	4700	≤ 2000	7800	≤ 2000
R3628	2600	≤ 2000	6400	≤ 2000
MEAN	3000	2000	11440	2000
STANDARD DEVIATION	1027	NA	4013	NA
UPPER 90% CONFIDENCE INTERVAL	3755	NA	14392	NA

Table 12. Organic Analyses for Tank 108-AP

SAMPLE NUMBER	ACETONE (μg/L)	2-BUTANONE (μg/L)	TETRAHYDROFURAN (μg/L)	2-BUTOXYETHANOL (μg/L)	2-HEXANONE	TRIBUTYL PHOSPHATE
R3644	ND	ND	ND	730	ND	3300
R3637	ND	ND	ND	890	ND	3900
R3639	ND	ND	ND	270	ND	1600
R3641	ND	ND	ND	340	ND	1700
R3643	NA	NA	NA	ND	NA	ND
R3633A	340	≤ 36	16	1800	3	NA
R3635A	530	62	ND	600	5	NA
MEAN	435	49	16	502	4	2625
STANDARD DEVIATION	NA	NA	NA	629	NA	1153
UPPER 90% CONFIDENCE INTERVAL	NA	NA	NA	924	NA	3573

Table 13. Radionuclide Analyses

RADIONUCLIDE	101-AP	107-AP	108-AP	COMPOSITE
^{3}H (μCi/mL)	2.10×10^{-3}	3.44×10^{-2}	1.12×10^{-2}	1.62×10^{-2}
^{14}C (μCi/mL)	$<2.30 \times 10^{-6}$	$\leq 2.68 \times 10^{-6}$	$<2.19 \times 10^{-6}$	$<3.29 \times 10^{-6}$
^{60}Co (μCi/mL)	$<2.73 \times 10^{-4}$	$\leq 5.70 \times 10^{-5}$	$<2.02 \times 10^{-4}$	$<1.75 \times 10^{-4}$
^{79}Se (μCi/mL)	$<6.15 \times 10^{-6}$	$<5.38 \times 10^{-6}$	1.21×10^{-5}	$<7.91 \times 10^{-6}$
^{90}Sr (μCi/mL)	5.63×10^{-4}	1.18×10^{-4}	7.72×10^{-2}	2.65×10^{-2}
^{94}Nb (μCi/mL)	$<2.49 \times 10^{-4}$	$\leq 4.60 \times 10^{-5}$	$<4.81 \times 10^{-4}$	$<2.59 \times 10^{-4}$
^{99}Tc (μCi/mL)	$<2.54 \times 10^{-5}$	$<2.05 \times 10^{-5}$	3.08×10^{-4}	$<1.20 \times 10^{-4}$
^{106}Ru (μCi/mL)	$<4.73 \times 10^{-3}$	$\leq 8.35 \times 10^{-4}$	$<2.72 \times 10^{-2}$	$<1.10 \times 10^{-2}$
^{129}I (μCi/mL)	$<4.08 \times 10^{-5}$	$\leq 3.96 \times 10^{-5}$	$<6.30 \times 10^{-5}$	$<4.79 \times 10^{-5}$
^{134}Cs (μCi/mL)	$<2.88 \times 10^{-4}$	$<5.00 \times 10^{-5}$	$<1.49 \times 10^{-3}$	$<6.16 \times 10^{-4}$
^{137}Cs (μCi/mL)	$<3.26 \times 10^{-3}$	$\leq 8.50 \times 10^{-5}$	$4.29 \times 10^{+0}$	$<1.46 \times 10^{+0}$
^{144}Ce (μCi/mL)	$<2.12 \times 10^{-2}$	$<4.00 \times 10^{-4}$	$<9.04 \times 10^{-3}$	$<9.99 \times 10^{-3}$
^{154}Eu (μCi/mL)	$<9.68 \times 10^{-4}$	$\leq 1.55 \times 10^{-4}$	$<9.01 \times 10^{-4}$	$<6.69 \times 10^{-4}$
^{155}Eu (μCi/mL)	$<6.53 \times 10^{-4}$	$\leq 1.20 \times 10^{-4}$	$<4.87 \times 10^{-3}$	$<1.91 \times 10^{-3}$
^{226}Ra (μCi/mL)	$<4.65 \times 10^{-3}$	$\leq 9.68 \times 10^{-4}$	$<3.74 \times 10^{-2}$	$<1.45 \times 10^{-2}$
^{237}Np (μCi/mL)	$<4.70 \times 10^{-5}$	1.40×10^{-5}	$<1.64 \times 10^{-4}$	$<7.56 \times 10^{-5}$
^{238}Pu (μCi/mL)	$<3.02 \times 10^{-4}$	$\leq 6.24 \times 10^{-4}$	$<6.33 \times 10^{-4}$	$<1.01 \times 10^{-4}$
$^{239/240}$Pu (μCi/mL)	$<2.13 \times 10^{-4}$	$\leq 4.79 \times 10^{-4}$	$<5.10 \times 10^{-4}$	$<4.04 \times 10^{-4}$
^{241}Am (μCi/mL)	$<3.18 \times 10^{-4}$	$<6.37 \times 10^{-5}$	$<5.58 \times 10^{-3}$	$<2.02 \times 10^{-3}$
^{244}Cm (μCi/mL)	$<3.18 \times 10^{-4}$	$<6.37 \times 10^{-5}$	$<5.51 \times 10^{-4}$	$<3.04 \times 10^{-4}$
U_{Gross} (g/L)	3.56×10^{-4}	2.34×10^{-5}	1.35×10^{-2}	4.71×10^{-3}

Table 14. Estimated Radionuclide Composite

RADIONUCLIDE	102-AW (μCi/mL)	106-AW (μCi/mL)	COMPOSITE (μCi/mL)	ESTIMATED COMPOSITE (μCi/mL)
^{3}H	2.53×10^{-2}	4.89×10^{-3}	1.62×10^{-2}	1.63×10^{-2}
^{14}C	6.15×10^{-5}	1.57×10^{-4}	$<3.29 \times 10^{-6}$	$<5.12 \times 10^{-6}$
^{60}Co	3.00×10^{-2}	$<2.48 \times 10^{-2}$	$<1.75 \times 10^{-4}$	$<1.02 \times 10^{-3}$
^{79}Se	5.23×10^{-5}	1.05×10^{-4}	$<7.91 \times 10^{-6}$	9.77×10^{-6}
^{90}Sr	3.49×10^{-1}	4.38×10^{-2}	2.65×10^{-2}	3.31×10^{-2}
^{94}Nb	2.78×10^{-2}	5.56×10^{-2}	$<2.59 \times 10^{-4}$	$<1.36 \times 10^{-3}$
^{99}Tc	1.19×10^{-2}	2.81×10^{-2}	$<1.20 \times 10^{-4}$	$<6.35 \times 10^{-4}$
^{106}Ru	$<1.24 \times 10^{+0}$	$<1.34 \times 10^{+0}$	$<1.10 \times 10^{-2}$	$<4.89 \times 10^{-2}$
^{129}I	$<6.00 \times 10^{-5}$	$<3.39 \times 10^{-5}$	$<4.79 \times 10^{-5}$	$<4.80 \times 10^{-5}$
^{134}Cs	1.29×10^{-2}	2.90×10^{-1}	$<6.16 \times 10^{-4}$	$<3.76 \times 10^{-3}$
^{137}Cs	$4.35 \times 10^{+1}$	$9.85 \times 10^{+1}$	$<1.46 \times 10^{+0}$	$<3.27 \times 10^{+0}$
^{144}Ce	5.72×10^{-1}	$1.14 \times 10^{+0}$	$<9.99 \times 10^{-3}$	3.26×10^{-2}
^{154}Eu	$<8.20 \times 10^{-2}$	6.20×10^{-2}	$<6.69 \times 10^{-4}$	$<2.91 \times 10^{-3}$
^{155}Eu	$<2.26 \times 10^{-1}$	1.84×10^{-1}	$<1.91 \times 10^{-3}$	$<8.21 \times 10^{-3}$
^{226}Ra	3.49×10^{-5}	4.38×10^{-6}	$<1.45 \times 10^{-2}$	$<1.41 \times 10^{-2}$
^{237}Np	2.52×10^{-4}	5.04×10^{-4}	$<7.56 \times 10^{-5}$	$<8.34 \times 10^{-5}$
^{238}Pu	4.08×10^{-5}	1.39×10^{-4}	$<1.01 \times 10^{-4}$	$<9.79 \times 10^{-3}$
$^{239/240}$Pu	1.63×10^{-4}	5.57×10^{-4}	$<4.04 \times 10^{-4}$	$<4.01 \times 10^{-4}$
^{241}Am	6.61×10^{-4}	1.48×10^{-3}	$<2.02 \times 10^{-3}$	$<1.99 \times 10^{-3}$
^{244}Cm	4.00×10^{-6}	8.00×10^{-6}	$<3.04 \times 10^{-4}$	$<2.95 \times 10^{-4}$
U_{Gross} (g/L)	1.32×10^{-2}	2.64×10^{-2}	4.71×10^{-3}	5.11×10^{-3}

Table 15. Candidate Feed Tanks Inorganic Analyses

CONSTITUENT	101-AP ANALYTICAL RESULT	107-AP ANALYTICAL RESULT	108-AP ANALYTICAL RESULT	COMPOSITE
Al (M)	2.59×10^{-5}	4.01×10^{-5}	1.54×10^{-3}	5.46×10^{-4}
F (M)	3.61×10^{-3}	5.32×10^{-3}	1.84×10^{-3}	3.54×10^{-3}
Na (M)	5.57×10^{-2}	9.87×10^{-2}	1.20×10^{-1}	9.22×10^{-2}
NH_4 (ppm)	$1.96 \times 10^{+3}$	$4.00 \times 10^{+1}$	$8.00 \times 10^{+2}$	$9.13 \times 10^{+2}$
NO_2 (M)	2.92×10^{-1}	5.10×10^{-1}	2.30×10^{-2}	2.75×10^{-1}
NO_3 (M)	2.52×10^{-2}	1.64×10^{-2}	2.52×10^{-2}	2.22×10^{-2}
OH (M)	1.07×10^{-1}	1.47×10^{-2}	1.03×10^{-2}	4.27×10^{-2}
PO_4 (M)	1.05×10^{-4}	1.05×10^{-4}	9.76×10^{-4}	4.01×10^{-4}
SO_4 (M)	8.96×10^{-4}	5.06×10^{-4}	2.10×10^{-3}	1.17×10^{-3}
SPG	0.986	0.989	0.988	0.988
TIC (M)	3.17×10^{-3}	4.50×10^{-3}	8.05×10^{-3}	5.28×10^{-3}
TOC (g/L)	0.0206	0.0700	0.0748	0.0558

Table 16. Estimated Inorganic Feed Composition

CONSTITUENT	102-AW CONCENTRATION	106-AW CONCENTRATION	FEED COMPOSITE	ESTIMATE COMPOSITE
Al (M)	5.89×10^{-2}	1.18×10^{-1}	5.46×10^{-4}	2.89×10^{-3}
F (M)	4.74×10^{-2}	2.74×10^{-1}	3.54×10^{-3}	7.12×10^{-3}
Na (M)	$1.88 \times 10^{+0}$	$3.76 \times 10^{+0}$	9.22×10^{-2}	1.65×10^{-1}
NH_4 (ppm)	1.05×10^{-1}	$<8.00 \times 10^{+3}$	$9.13 \times 10^{+2}$	$9.65 \times 10^{+2}$
NO_2 (M)	1.87×10^{-1}	4.78×10^{-1}	2.75×10^{-1}	2.75×10^{-1}
NO_3 (M)	6.56×10^{-1}	$1.31 \times 10^{+0}$	2.22×10^{-2}	4.78×10^{-2}
OH (M)	4.36×10^{-1}	$1.14 \times 10^{+0}$	4.27×10^{-2}	6.15×10^{-2}
PO_4 (M)	9.20×10^{-4}	2.75×10^{-2}	4.01×10^{-4}	6.83×10^{-4}
SO_4 (M)	2.81×10^{-2}	6.82×10^{-2}	1.17×10^{-3}	2.38×10^{-3}
SPG	1.09	1.19	0.988	0.992
TIC (M)	2.38×10^{-1}	1.00×10^{-1}	5.28×10^{-3}	1.09×10^{-2}
TOC (g/L)	1.07	2.14	0.0558	0.0970

This page intentionally left blank

APPENDIX D

COMPARISON OF CAMPAIGN 94-2 TO 242-A EVAPORATOR LIMITS

This page intentionally left blank.

Table 17. Comparison of Miscellaneous 242-A Evaporator Feed Limits to Campaign 94-2 Feed

CONSTITUENT	**FEED**	**LIMIT**	**COMMENT**
Differential Scanning Calorimetry[1]	No exotherm was detected	No exotherm at a temperature below 335°F	IN COMPLIANCE
Complexed Waste[2]	Stop concentrating at two passes before reach nitrite precipitation	Do not concentrate exceeding the $NaNO_3/NaNO_2$ precipitation boundary	IN COMPLIANCE
Fissile Material Concentration[3]	2.5×10^{-5} gPu/gal	<0.01 gPu/gal	IN COMPLIANCE

[1] From *Operating Specifications for the 242-A Evaporator-Crystallizer* (Wahlquist 1993).

[2] From internal memo "Part B Evaporator Feed Concentration Limits Change Request" (Le 1993).

[3] From *Criticality Prevention Specifications for Waste Storage Tanks and Associated Equipment* (RHO 1988).

Table 18. Comparision of Campaign 94-2 Feed Composition to Evaporator Feed Limits for Organic LERF Acceptance[1]

CONSTITUENT	FEED	LIMIT	FEED/LIMIT	COMMENT
Ammonia (mg/L)	912	5,000	1.8×10^{-1}	IN COMPLIANCE
Acetone (mg/L)	0.148	300	4.9×10^{-4}	IN COMPLIANCE
2-Butanone (mg/L)	0.177	10	1.8×10^{-2}	IN COMPLIANCE
Hexone (mg/L)	ND	5.0	< 0.0	IN COMPLIANCE
2-Propanol (mg/L)	ND	5.0	< 0.0	IN COMPLIANCE
Tetrahydrofuran (mg/L)	0.165	10	1.7×10^{-2}	IN COMPLIANCE

where R = feed rate divided by the product rate

[1] From *ECN 613527, 242-A Evaporator Waste Analysis Plan* (Basra 1994)

Table 19. Comparision of Campaign 94-2 Feed Composition to Evaporator Feed Limits Based on Volatile Emissions[1]

CONSTITUENT	FEED	LIMIT [2]	FEED/LIMIT	COMMENT
Acetone (mg/L)	1.48×10^{-1}	$4.36 \times 10^{+1}$	3.39×10^{-3}	IN COMPLIANCE
Benzyl Alcohol (mg/L)	$1.32 \times 10^{+0}$	$9.10 \times 10^{+1}$	1.45×10^{-2}	IN COMPLIANCE
1-Butanol (mg/L)	$4.52 \times 10^{+0}$	$1.13 \times 10^{+2}$	4.00×10^{-2}	IN COMPLIANCE
2-Butanone (mg/L)	1.80×10^{-1}	$2.90 \times 10^{+1}$	6.21×10^{-3}	IN COMPLIANCE
2-Butoxyethanol (mg/L)	$1.49 \times 10^{+0}$	$4.76 \times 10^{+1}$	3.13×10^{-2}	IN COMPLIANCE
2-Hexanone (mg/L)	1.36×10^{-3}	$2.08 \times 10^{+1}$	6.54×10^{-5}	IN COMPLIANCE
2-Propanol (mg/L)	ND	$1.24 \times 10^{+2}$	< 0.0	IN COMPLIANCE
Tetradecane (mg/L)	ND	$7.15 \times 10^{+5}$	< 0.0	IN COMPLIANCE
Tetrahydrofuran (mg/L)	1.60×10^{-3}	$7.20 \times 10^{+0}$	2.22×10^{-4}	IN COMPLIANCE
Tributyl Phosphate (mg/L)	$1.91 \times 10^{+0}$	$5.08 \times 10^{+3}$	3.76×10^{-4}	IN COMPLIANCE
Tridecane (mg/L)	ND	$2.92 \times 10^{+5}$	< 0.0	IN COMPLIANCE

where R = feed rate divided by the product rate

[1] From *242-A Evaporator Waste Analysis Plan* (Basra 1994).

[2] Individual constituent limits were chosen to prevent the vessel vent effluent from exceeding the volatile emission limit of 3 lb/hr or 3.1 tons/yr. Limits are applied using a sum of fractions technique (Basra 1994).

Table 20. Comparision of Feed Concentrations to Radiological Source Term[1]

RADIONUCLIDE	FEED (μCi/mL)	LIMIT (μCi/mL)	FEED/LIMIT	COMMENT
^{14}C	5.1×10^{-6}	0.26	2.0×10^{-5}	IN COMPLIANCE
^{60}Co	1.0×10^{-3}	1.2	8.5×10^{-4}	IN COMPLIANCE
^{79}Se	9.8×10^{-6}	7.8×10^{-2}	1.3×10^{-4}	IN COMPLIANCE
^{90}Sr	3.3×10^{-2}	220	1.5×10^{-4}	IN COMPLIANCE
^{94}Nb	1.4×10^{-3}	9.8×10^{-2}	1.4×10^{-2}	IN COMPLIANCE
^{99}Tc	6.4×10^{-4}	2.0	3.2×10^{-4}	IN COMPLIANCE
^{106}Ru	4.9×10^{-2}	53	9.2×10^{-4}	IN COMPLIANCE
^{129}I	4.8×10^{-5}	2.6×10^{-3}	1.9×10^{-2}	IN COMPLIANCE
^{134}Cs	3.8×10^{-3}	15	2.5×10^{-4}	IN COMPLIANCE
^{137}Cs	$3.3 \times 10^{+0}$	1,500	2.2×10^{-3}	IN COMPLIANCE
^{154}Eu	2.9×10^{-3}	5.0	5.8×10^{-4}	IN COMPLIANCE
^{155}Eu	8.2×10^{-3}	7.0	1.2×10^{-3}	IN COMPLIANCE
^{226}Ra[2]	3.3×10^{-6}	3.3×10^{-2}	1.0×10^{-4}	IN COMPLIANCE
^{238}Pu[3]	1.0×10^{-4}	1.3×10^{-3}	6.3×10^{-4}	IN COMPLIANCE
$^{239/240}$Pu	4.0×10^{-4}	0.16	2.5×10^{-3}	IN COMPLIANCE
^{241}Pu[4]	1.6×10^{-2}	15	1.1×10^{-3}	IN COMPLIANCE
^{241}Am	1.5×10^{-2}	1.0	1.5×10^{-2}	IN COMPLIANCE
^{244}Cm	3.0×10^{-4}	1.3×10^{-2}	2.3×10^{-2}	IN COMPLIANCE

[1] From *242-A Evaporator/Crystallizer Safety Analysis Report* (Lavender 1992).

[2] Due to its relatively high detection limit, the ^{226}Ra concentration was calculated using the formula, ^{90}Sr x (1.0×10^{-4}), taken from WHC-SD-WM-OCD-016 (Tranbarger 1992).

[3] Due to the difficulties associated with its analysis, the ^{238}Pu concentration was calculated using the formula, $^{239/240}$Pu x 0.25, taken from WHC-SD-WM-OCD-016 (Tranbarger 1992).

[4] Due to the difficulties associated with its analysis, the ^{241}Pu concentration was calculated using the formula, $^{239/240}$Pu x 41, taken from WHC-SD-WM-OCD-016 (Tranbarger 1992).

Table 21. Comparision of Projected Slurry Concentrations to Radiological Source Term[1]

RADIONUCLIDE	SLURRY[2] (μCi/mL)	LIMIT (μCi/mL)	SLURRY/LIMIT	COMMENT
^{14}C	4.1×10^{-5}	0.26	1.6×10^{-4}	IN COMPLIANCE
^{60}Co	8.2×10^{-3}	1.2	6.8×10^{-3}	IN COMPLIANCE
^{79}Se	7.8×10^{-5}	7.8×10^{-2}	1.0×10^{-3}	IN COMPLIANCE
^{90}Sr	2.6×10^{-1}	220	1.2×10^{-3}	IN COMPLIANCE
^{94}Nb	1.1×10^{-2}	9.8×10^{-2}	1.1×10^{-1}	IN COMPLIANCE
^{99}Tc	5.1×10^{-3}	2.0	2.5×10^{-3}	IN COMPLIANCE
^{106}Ru	3.9×10^{-1}	53	7.4×10^{-3}	IN COMPLIANCE
^{129}I	3.8×10^{-4}	2.6×10^{-3}	1.5×10^{-1}	IN COMPLIANCE
^{134}Cs	3.0×10^{-2}	15	2.0×10^{-3}	IN COMPLIANCE
^{137}Cs	$2.6 \times 10^{+1}$	1,500	1.7×10^{-2}	IN COMPLIANCE
^{154}Eu	2.3×10^{-2}	5.0	4.7×10^{-3}	IN COMPLIANCE
^{155}Eu	6.6×10^{-2}	7.0	9.4×10^{-3}	IN COMPLIANCE
^{226}Ra[3]	2.7×10^{-5}	3.3×10^{-2}	8.0×10^{-4}	IN COMPLIANCE
^{238}Pu[4]	8.0×10^{-4}	1.3×10^{-3}	5.0×10^{-3}	IN COMPLIANCE
$^{239/240}$Pu	3.2×10^{-3}	0.16	2.0×10^{-2}	IN COMPLIANCE
^{241}Pu[5]	1.3×10^{-1}	15	8.8×10^{-3}	IN COMPLIANCE
^{241}Am	1.2×10^{-1}	1.0	1.2×10^{-1}	IN COMPLIANCE
^{244}Cm	2.4×10^{-3}	1.3×10^{-2}	1.8×10^{-1}	IN COMPLIANCE

[1] From *242-A Evaporator/Crystallizer Safety Analysis Report* (Lavender 1992).

[2] The slurry values were obtained by entering the feed value into the process flowsheet for the 242-A Evaporator.

[3] Due to its relatively high detection limit, the ^{226}Ra concentration was calculated using the formula, ^{90}Sr x (1.0×10^{-4}), taken from WHC-SD-WM-OCD-016 (Tranbarger 1992).

[4] Due to the difficulties associated with its analysis, the ^{238}Pu concentration was calculated using the formula, $^{239/240}$Pu x 0.25, taken from WHC-SD-WM-OCD-016 (Tranbarger 1992).

[5] Due to the difficulties associated with its analysis, the ^{241}Pu concentration was calculated using the formula, $^{239/240}$Pu x 41, taken from WHC-SD-WM-OCD-016 (Tranbarger 1992).

Table 22. Comparison of Projected Process Condensate Concentrations to LERF Radiological Limits

RADIONUCLIDE	PROCESS CONDENSATE[1] (μCi/mL)	DCG (μCi/mL)	PC CONC./DCG
^{3}H	1.7×10^{-2}	2.0×10^{-3}	8.5
^{14}C	7.2×10^{-8}	7.0×10^{-5}	<1.0
^{60}Co	1.4×10^{-5}	5.0×10^{-6}	2.8
^{79}Se	1.4×10^{-7}	2.0×10^{-5}	<1.0
^{90}Sr	2.0×10^{-6}	1.0×10^{-6}	2.0
^{94}Nb	1.9×10^{-5}	3.0×10^{-5}	<1.0
^{99}Tc	8.9×10^{-6}	1.0×10^{-4}	<1.0
^{106}Ru	8.9×10^{-7}	6.0×10^{-6}	<1.0
^{129}I	4.3×10^{-5}	5.0×10^{-7}	86
^{134}Cs	1.5×10^{-5}	2.0×10^{-6}	7.5
^{137}Cs	5.0×10^{-7}	3.0×10^{-6}	<1.0
^{144}Ce	4.5×10^{-4}	7.0×10^{-6}	64.3
^{154}Eu	4.1×10^{-5}	2.0×10^{-5}	2.1
^{155}Eu	1.1×10^{-4}	1.0×10^{-4}	1.1
^{226}Ra[2]	4.6×10^{-8}	1.0×10^{-7}	<1.0
^{237}Np	1.2×10^{-6}	3.0×10^{-8}	40
^{238}Pu[3]	3.8×10^{-10}	4.0×10^{-8}	<1.0
$^{239/240}$Pu	1.5×10^{-9}	3.0×10^{-8}	<1.0
^{241}Pu[4]	6.3×10^{-8}	2.0×10^{-6}	<1.0
^{241}Am	2.0×10^{-8}	3.0×10^{-8}	<1.0
^{244}Cm	4.1×10^{-6}	6.0×10^{-8}	68.3
U_{Gross}[5]	9.9×10^{-6}	5.0×10^{-7}	19.8
TOTAL	1.8×10^{-2}	5,000 DCG LIMIT	313 DCG IN COMPLIANCE

[1] The process condensate values were obtained by entering the feed values into the process flowsheet for the 242-A Evaporator.

[2] Due to the difficulties associated with its analysis, the ^{241}Pu concentration was calculated using the formula, $^{239/240}Pu \times 41$, taken from WHC-SD-WM-OCD-016 (Tranbarger 1992).

[3] The uranium concentration from Table 14 was converted to µCi/mL by using the specific activity of one percent enriched uranium.

Table 23: Comparison of Feed Composition and Projected Slurry to Double-Shell Tank Waste Corrosion Specifications[1]

PARAMETER	FEED	SLURRY[2]	LIMIT	COMMENT
Condition 1 Hydroxide Nitrite	$[NO3] = 0.048M$ $[OH] = 0.062M$ $[NO2] = 0.28M$	$[NO3] = 0.18M$ $[OH] = 0.50M$ $[NO2] = 2.3M$	When $[NO3] \leq 1.0M$ $0.01M \leq [OH] \leq 5.0M$ $0.011M \leq [NO2] \leq 5.5M$	IN COMPLIANCE
Condition 2 Hydroxide Nitrite	NA	NA	When $1.0M < [NO3] \leq 3.0M$ $0.1 \times [NO3] \leq [OH] \leq 10M$ $[OH] + [NO2] \geq 0.4 \times [NO3]$	NA
Condition 3 Hydroxide Nitrite	NA	NA	When $3.0M < [NO3] \leq 5.5M$ $0.3 \leq [OH] < 10M$ $[OH] + [NO2] \geq 1.2$	NA

[1] From *Operating Specifications for the 241-AN, AP, AW, AY, AZ, & SY Tank Farms* (Harris 1992).

[2] The slurry values were otained by entering the feed value into the process flowsheet for the 242-A Evaporator.

Table 24. Comparision of Projected Vessel Vent Discharge To Vessel Vent Radionuclide Limits[1]

RADIONUCLIDE	VESSEL VENT[2]	LIMIT	VENT/LIMIT	COMMENT
Annual Average Concentration (any consecutive 12 month period)				
^{239}Pu (μCi/mL) (Total Alpha)	NA	2.0×10^{-14}	NA	NA
^{90}Sr (μCi/mL) (Total Beta)	NA	9.0×10^{-12}	NA	NA
Weekly Average Concentration (any consecutive 7 day period)				
^{239}Pu (μCi/mL) (Total Alpha)	2.8×10^{-21}	2.0×10^{-13}	1.4×10^{-8}	IN COMPLIANCE
^{90}Sr (μCi/mL) (Total Beta)	1.3×10^{-18}	9.0×10^{-11}	1.4×10^{-8}	IN COMPLIANCE
Maximum Instantaneous Concentration (average over a 4 hour period)				
^{239}Pu (μCi/mL) (Total Alpha)	2.8×10^{-21}	1.0×10^{-10}	2.8×10^{-11}	IN COMPLIANCE
^{90}Sr (μCi/mL) (Total Beta)	1.3×10^{-18}	4.5×10^{-8}	2.9×10^{-11}	IN COMPLIANCE

[1] From *Operating Specifications from the 242-A Evaporator-Crystallizer* (Wahlquist 1993).

[2] The vessel vent values were obtained by entering the feed value into the process flowsheet for the 242-A Evaporator.

This page intentionally left blank.

APPENDIX E

CALCULATIONS

This page intentionally left blank.

THROUGHPUT

$$THROUGHPUT = \sum_{n=1}^{p} \frac{x}{\left(\frac{1}{1-WVRF}\right)^{n-1}} + (w)(t)$$

where t = processing time = throughput/feed rate (min)
x = amount of waste to be processed (gal)
p = number of evaporator passes
w = water addition rate from seal water and pad sprays (gpm)
WVRF = waste volume reduction factor per evaporator pass

assume p = 3 passes
x = 3.42×10^6 gal
w = 2 gpm (pad sprays) + 2 gpm (seal water) = 4 gpm
feed rate = 100 gpm
WVRF per pass = 0.5

Throughput = 6.2×10^6 gal

CAMPAIGN DURATION

Campaign Duration = throughput/feed rate/total operating efficiency

assume feed rate = 100 gpm
total operating efficiency = 0.75

Campaign Duration = 58 days

LERF ACCUMULATION

Process Condensate = WVRF x Amount of Feed + (w)(t)

where w = water addition rate from seal water, pad sprays, & steam jets (gpm)
t = processing time = throughput/feed rate (min)

assume WVRF = 0.875
feed volume = 3.42×10^6 gal
w = 2 gpm (pad sprays) + 2 gpm (seal water) + 4 gpm (steam jets)
w = 8 gpm

Process Condensate = 3.49×10^6 gal

CRITICALITY CALCULATION

Limit < 0.01 g/gal (in feed)
Limit < 0.05 g/gal (in tank)

$$\text{Pu(g/gal)} = \frac{\text{Pu}(\mu\text{Ci/mL}) \times 10^{3}\ (\text{mL/L}) \times 3.785\ (\text{L/gal})}{6.2 \times 10^{-2}(\text{Ci/g}) \times 10^{6}\ (\mu\text{Ci/Ci})}$$

Parameter	Pu (μCi/mL)	Pu (g/gal)
101-AP	2.13E-4	1.30E-5
107-AP	4.79E-4	2.92E-5
108-AP	5.10E-4	3.11E-5
102-AW	1.63E-4	9.95E-6
106-AW	5.57E-4	3.40E-5
Composite	4.01E-4	2.45E-5
Slurry	3.21E-3	1.96E-4

WVRF AT FISSILE LIMIT CALCULATIONS

Fissile material concentration

U_{Gross} = 5.11×10^{-3} g/gal

^{233}U = $(1.077 \times 10^{-10}) \times (5.11 \times 10^{-3})$ = 5.50×10^{-13} g/gal

$^{239/240}Pu^1$ = 2.45×10^{-5} g/gal

Total = $^{233}U + {}^{239/240}Pu$ = 2.45×10^{-5} g/gal

WVRF to reach 0.01 g/gal limit (1.0 - Concentration/Limit) x 100
= $(1.0 - 2.45 \times 10^{-5}/0.01) \times 100$
= 99.7%

[1] The $^{239/240}Pu$ concentration from the composite column in Table 14 was converted to g/gal by utilizing the specific activity of ^{239}Pu.

TRU CALCULATION

Limit $< 100\ \mu Ci/g$

$$\text{TRU } (\mu Ci/g) = \frac{[Pu^{239}\ (\mu Ci/mL) + Am^{241}\ (\mu Ci/mL)] \times 10^3\ (nCi/\mu Ci)}{SpG\ (g/mL)}$$

Parameter	Pu^{239} (μCi/mL)	Am^{241} (μCi/ml)	SpG (g/mL)	TRU (μCi/g)
101-AP	2.13E-4	3.18E-4	0.986	0.538
107-AP	4.79E-4	6.37E-5	0.989	0.548
108-AP	5.10E-4	5.58E-3	0.988	6.16
102-AW	1.63E-4	6.61E-4	1.09	0.756
106-AW	4.04E-4	2.02E-3	1.19	2.04
Slurry	3.20E-3	1.20E-2	1.30	11.7

HEAT GENERATION CALCULATION

Limit < 70.00 BTu/hr

Heat(BTu/hr) = [Cs^{137} (μCi/mL) x 1.6×10^{-2} (BTu/hr.Ci) + Cs^{90} (μCi/ml) x 2.3×10^{-2} (BTu/hr.Ci)] x Tank volume(gal) x 3.785 (L/gal) x x 10^{-6} (Ci/μCi) x 10^{3} (mL/L)

Parameter	Cs^{137} (μCi/mL)	Sr^{90} (μCi/mL)	Heat (BTu/hr)
101-AP	3.26E-3	5.63E-4	0.260
107-AP	8.50E-5	1.18E-4	0.017
108-AP	4.29E 0	7.72E-2	302.0
102-AW	43.5E 0	3.49E-1	219.0
106-AW	98.5E 0	4.38E-2	165.0

REYNOLDS CALCULATION

Limit $\geq 20,000$

$$Re = \frac{dvD}{n}$$

where d = pipe diameter (ft)
v = velocity (ft/s)
D = density (lb/ft^3)
n = viscosity (lb/ft-s)

Parameter	d (ft)	v (ft/s)	D (lb/ft^3)	n (lb/ft-s)[1]	Re
101-AP	0.25	4.54	61.76	6.70E-4	1.05E5
107-AP	0.25	4.54	61.95	6.70E-4	1.05E5
108-AP	0.25	4.54	61.89	6.70E-4	1.05E5
102-AW	0.25	4.54	68.28	1.99E-3	3.97E4
106-AW	0.25	4.54	70.16	2.82E-3	2.80E4
Slurry	0.17	5.11	70.16	2.85E-3	2.10E4

[1] Due to the unavaible data of its analysis, viscosity value was calculated using the formula, 42.65*SPG - 0.3850*T -35.82 from IM-13314-88-105 (Reynolds 1988)

% TOC ON A DRY BASIS AND % SOLID CALCULATION

Limit < 3% (for non-complex)

$$\% \text{ TOC} = \frac{\text{TOC (g/L)}}{\text{Total (g/L)}} \times 100\%$$

$$\% \text{ Solids} = \frac{\text{Total (g/L)}}{\text{1000 (g/L)}} \times 100\%$$

Constituents	101-AP (g/L)	107-AP (g/L)	108-AP (g/L)	102-AW (g/L)	106-AW (g/L)	Composite (g/L)
Al	6.99E-04	1.08E-03	4.15E-02	1.59E+00	3.18E+00	7.78E-02
F	6.86E-02	1.01E-01	3.23E-02	9.01E-01	5.21E+00	1.35E-01
Na	1.28E+00	2.27E+00	2.76E+00	4.32E+01	8.64E+01	3.79E+00
NH4	1.96E+00	4.00E-02	8.00E-01	1.05E-04	8.00E+00	9.65E-01
NO2	1.34E+01	2.35E+01	1.06E+00	8.60E+00	2.20E+01	1.26E+01
NO3	1.56E+00	1.02E+00	1.56E+00	4.07E+01	8.12E+01	2.96E+00
OH	1.82E+00	2.50E-01	1.75E-01	7.42E+00	1.94E+01	1.05E+00
PO4	9.97E-03	9.97E-03	9.27E-02	8.74E-02	2.61E+00	6.48E-02
SO4	8.61E-02	4.86E-02	2.02E-01	2.70E+00	6.55E+00	2.29E-01
SpG	9.86E-01	9.89E-01	9.88E-01	1.09E+00	1.19E+00	9.92E-01
TIC	1.90E-01	2.70E-01	4.83E-01	1.43E+01	6.00E+00	6.53E-01
TOC	2.06E-02	7.00E-02	7.48E-02	1.07E+00	2.14E+00	9.70E-02
%TOC	0.10	0.25	0.90	0.88	0.88	0.41
%SOLID	2.14	2.85	0.83	12.16	24.39	2.37

APPENDIX F

PREDICT RUNS

This page intentionally left blank.

101-AP PREDICT RUN

```
PASS    ONE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     44.1 C  111.4 F    PRESSURE   60.0 Torr
PASS WVR        50.0               TOTAL WVR          50.0
                                     EVAPORATOR             TANK CONDITIONS
                                     CONDITIONS                 20.0 C
                 FEED      SLURRY    SUPERNATE SOLIDS*      SUPERNATE SOLIDS
VOLUME, gal    .106E+07  .531E+06  .531E+06  .000          .531E+06  13.9
HYDROXIDE,M        .107      .214      .214      .000          .214      .000
ALUMINATE,M        .000      .000      .000      .000          .000      .000
NITRATE,M          .025      .050      .050      .000          .050      .000
NITRITE,M          .292      .584      .584      .000          .584      .000
CARBONATE,M        .003      .006      .006      .000          .006      .000
PHOSPHATE,M        .000      .000      .000      .000          .000      .000
SULFATE,M          .001      .002      .002      .000          .002      .000
FLUORIDE,M         .004      .007      .007      .000          .007      .000
ORGANIC,G/L        .021      .041      .041      .000          .041      .000


PASS    TWO    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     44.4 C  111.9 F    PRESSURE   60.0 Torr
PASS WVR        50.0               TOTAL WVR          75.0
                                     EVAPORATOR             TANK CONDITIONS
                                     CONDITIONS                 20.0 C
                 FEED      SLURRY    SUPERNATE SOLIDS*      SUPERNATE SOLIDS
VOLUME, gal    .531E+06  .265E+06  .265E+06  .000          .265E+06  .000
HYDROXIDE,M        .214      .428      .428      .000          .428      .000
ALUMINATE,M        .000      .000      .000      .000          .000      .000
NITRATE,M          .050      .101      .101      .000          .101      .000
NITRITE,M          .584     1.168     1.168      .000         1.168      .000
CARBONATE,M        .006      .013      .013      .000          .013      .000
PHOSPHATE,M        .000      .000      .000      .000          .000      .000
SULFATE,M          .002      .004      .004      .000          .004      .000
FLUORIDE,M         .007      .014      .014      .000          .014      .000
ORGANIC,G/L        .041      .082      .082      .000          .082      .000
```

101-AP PREDICT RUN (CONT.)

```
PASS THREE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     45.4 C  113.7 F     PRESSURE   60.0 Torr
PASS WVR        50.0                TOTAL WVR           87.5
                                       EVAPORATOR              TANK CONDITIONS
                                       CONDITIONS                  20.0 C
                   FEED      SLURRY    SUPERNATE  SOLIDS*      SUPERNATE  SOLIDS
VOLUME, gal     .265E+06   .133E+06   .133E+06   .000         .133E+06   .000
HYDROXIDE,M         .428       .856       .856       .000         .856       .000
ALUMINATE,M         .000       .000       .000       .000         .000       .000
NITRATE,M           .101       .202       .202       .000         .202       .000
NITRITE,M          1.168      2.336      2.336       .000        2.336       .000
CARBONATE,M         .013       .025       .025       .000         .025       .000
PHOSPHATE,M         .000       .000       .000       .000         .000       .000
SULFATE,M           .004       .007       .007       .000         .007       .000
FLUORIDE,M          .014       .029       .029       .000         .029       .000
ORGANIC,G/L         .082       .165       .165       .000         .165       .000


PASS  FOUR    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     49.4 C  120.9 F     PRESSURE   60.0 Torr
PASS WVR        50.0                TOTAL WVR           93.7
                                       EVAPORATOR              TANK CONDITIONS
                                       CONDITIONS                  20.0 C
                   FEED      SLURRY    SUPERNATE  SOLIDS*      SUPERNATE  SOLIDS
VOLUME, gal     .133E+06   .663E+05   .663E+05   .000         .663E+05   .000
HYDROXIDE,M         .856      1.712      1.712       .000        1.712       .000
ALUMINATE,M         .000       .000       .000       .000         .000       .000
NITRATE,M           .202       .403       .403       .000         .403       .000
NITRITE,M          2.336      4.672      4.672       .000        4.672       .000
CARBONATE,M         .025       .051       .051       .000         .051       .000
PHOSPHATE,M         .000       .000       .000       .000         .000       .000
SULFATE,M           .007       .014       .014       .000         .014       .000
FLUORIDE,M          .029       .058       .058       .000         .058       .000
ORGANIC,G/L         .165       .330       .330       .000         .330       .000
```

101-AP PREDICT RUN (CONT.)

```
PASS  FIVE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     62.3 C  144.1 F     PRESSURE   60.0 Torr
PASS WVR        50.0                TOTAL WVR            96.9
                                      EVAPORATOR               TANK CONDITIONS
                                      CONDITIONS                   20.0 C
                  FEED      SLURRY    SUPERNATE SOLIDS*       SUPERNATE SOLIDS
VOLUME, gal     .663E+05  .359E+05  .332E+05  .276E+04      .332E+05  .533E+04
HYDROXIDE,M        1.712     3.161     3.424      .000         3.424      .000
ALUMINATE,M         .000      .001      .001      .000          .001      .000
NITRATE,M           .403      .744      .806      .000          .806      .000
NITRITE,M          4.672     8.626     6.843     1.250         4.450     2.447
CARBONATE,M         .051      .094      .072      .015          .058      .022
PHOSPHATE,M         .000      .000      .000      .000          .000      .000
SULFATE,M           .014      .026      .029      .000          .029      .000
FLUORIDE,M          .058      .107      .029      .043          .029      .043
ORGANIC,G/L         .330      .609      .659      .000          .659      .000
```

```
PASS   SIX    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     71.8 C  161.3 F     PRESSURE   60.0 Torr
PASS WVR        50.0                TOTAL WVR            98.2
                                      EVAPORATOR               TANK CONDITIONS
                                      CONDITIONS                   20.0 C
                  FEED      SLURRY    SUPERNATE SOLIDS*       SUPERNATE SOLIDS
VOLUME, gal     .278E+05  .154E+05  .139E+05  .144E+04      .139E+05  .289E+04
HYDROXIDE,M        3.424     6.207     6.848      .000         6.848      .000
ALUMINATE,M         .001      .002      .002      .000          .002      .000
NITRATE,M           .806     1.462     1.613      .000         1.482      .066
NITRITE,M          4.450     8.066     5.828     1.535         2.818     3.040
CARBONATE,M         .058      .105      .055      .030          .009      .053
PHOSPHATE,M         .000      .000      .000      .000          .000      .000
SULFATE,M           .029      .052      .057      .000          .057      .000
FLUORIDE,M          .029      .053      .014      .022          .014      .022
ORGANIC,G/L         .659     1.195     1.318      .000         1.318      .000
```

101-AP PREDICT RUN (CONT.)

```
PASS SEVEN   DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 8 MOLAR CAUSTIC LIMI
TEMPERATURE    63.2 C  145.7 F    PRESSURE   60.0 Torr
PASS WVR       14.4               TOTAL WVR           98.3
                                     EVAPORATOR           TANK CONDITIONS
                                     CONDITIONS                20.0 C
                 FEED      SLURRY    SUPERNATE SOLIDS*    SUPERNATE SOLIDS
VOLUME, gal      .110E+05  .944E+04  .944E+04  .000       .944E+04  414.
HYDROXIDE,M          6.848     8.000     8.000      .000      8.000      .000
ALUMINATE,M           .002      .002      .002      .000       .002      .000
NITRATE,M            1.482     1.731     1.731      .000      1.313      .358
NITRITE,M            2.818     3.292     3.292      .000      2.413      .753
CARBONATE,M           .009      .010      .010      .000       .009      .001
PHOSPHATE,M           .000      .000      .000      .000       .000      .000
SULFATE,M             .057      .067      .067      .000       .067      .000
FLUORIDE,M            .014      .016      .016      .000       .016      .000
ORGANIC,G/L          1.318     1.540     1.540      .000      1.540      .000
```

107-AP PREDICT RUN

```
PASS    ONE     DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE      44.2 C   111.5 F     PRESSURE    60.0 Torr
PASS WVR         50.0                 TOTAL WVR            50.0
                                         EVAPORATOR             TANK CONDITIONS
                                         CONDITIONS                  20.0 C
                     FEED      SLURRY    SUPERNATE SOLIDS*      SUPERNATE SOLIDS
VOLUME, gal         .111E+07  .555E+06  .555E+06  .000         .555E+06  14.6
HYDROXIDE,M             .015      .029      .029       .000        .029       .000
ALUMINATE,M             .000      .000      .000       .000        .000       .000
NITRATE,M               .016      .033      .033       .000        .033       .000
NITRITE,M               .510     1.020     1.020       .000       1.020       .000
CARBONATE,M             .004      .009      .009       .000        .009       .000
PHOSPHATE,M             .000      .000      .000       .000        .000       .000
SULFATE,M               .001      .001      .001       .000        .001       .000
FLUORIDE,M              .005      .011      .011       .000        .011       .000
ORGANIC,G/L             .070      .140      .140       .000        .140       .000


PASS    TWO     DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE      44.6 C   112.3 F     PRESSURE    60.0 Torr
PASS WVR         50.0                 TOTAL WVR            75.0
                                         EVAPORATOR             TANK CONDITIONS
                                         CONDITIONS                  20.0 C
                     FEED      SLURRY    SUPERNATE SOLIDS*      SUPERNATE SOLIDS
VOLUME, gal         .555E+06  .278E+06  .278E+06  .000         .278E+06  .000
HYDROXIDE,M             .029      .059      .059       .000        .059       .000
ALUMINATE,M             .000      .000      .000       .000        .000       .000
NITRATE,M               .033      .066      .066       .000        .066       .000
NITRITE,M              1.020     2.040     2.040       .000       2.040       .000
CARBONATE,M             .009      .018      .018       .000        .018       .000
PHOSPHATE,M             .000      .000      .000       .000        .000       .000
SULFATE,M               .001      .002      .002       .000        .002       .000
FLUORIDE,M              .011      .021      .021       .000        .021       .000
ORGANIC,G/L             .140      .280      .280       .000        .280       .000
```

107-AP PREDICT RUN (CONT.)

```
PASS THREE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE      46.2 C  115.2 F     PRESSURE   60.0 Torr
PASS WVR         50.0                TOTAL WVR            87.5
                                        EVAPORATOR            TANK CONDITIONS
                                        CONDITIONS               20.0 C
                    FEED      SLURRY    SUPERNATE SOLIDS*     SUPERNATE SOLIDS
VOLUME, gal      .278E+06  .139E+06  .139E+06  .000        .139E+06  .000
HYDROXIDE,M          .059      .118      .118       .000        .118       .000
ALUMINATE,M          .000      .000      .000       .000        .000       .000
NITRATE,M            .066      .131      .131       .000        .131       .000
NITRITE,M           2.040     4.080     4.080       .000       4.080       .000
CARBONATE,M          .018      .036      .036       .000        .036       .000
PHOSPHATE,M          .000      .000      .000       .000        .000       .000
SULFATE,M            .002      .004      .004       .000        .004       .000
FLUORIDE,M           .021      .043      .043       .000        .043       .000
ORGANIC,G/L          .280      .560      .560       .000        .560       .000


PASS  FOUR    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE      52.8 C  127.0 F     PRESSURE   60.0 Torr
PASS WVR         50.0                TOTAL WVR            93.7
                                        EVAPORATOR            TANK CONDITIONS
                                        CONDITIONS               20.0 C
                    FEED      SLURRY    SUPERNATE SOLIDS*     SUPERNATE SOLIDS
VOLUME, gal      .139E+06  .695E+05  .694E+05  21.1        .694E+05  .400E+04
HYDROXIDE,M          .118      .235      .235       .000        .235       .000
ALUMINATE,M          .000      .001      .001       .000        .001       .000
NITRATE,M            .131      .262      .262       .000        .262       .000
NITRITE,M           4.080     8.158     8.160       .000       6.357       .901
CARBONATE,M          .036      .072      .072       .000        .072       .000
PHOSPHATE,M          .000      .000      .000       .000        .000       .000
SULFATE,M            .004      .008      .008       .000        .008       .000
FLUORIDE,M           .043      .085      .065       .010        .065       .010
ORGANIC,G/L          .560     1.120     1.120       .000       1.120       .000
```

107-AP PREDICT RUN (CONT.)

```
PASS   FIVE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     58.1 C  136.5 F    PRESSURE   60.0 Torr
PASS WVR        50.0               TOTAL WVR             96.7
                                      EVAPORATOR               TANK CONDITIONS
                                      CONDITIONS                  20.0 C
                    FEED      SLURRY    SUPERNATE SOLIDS*      SUPERNATE SOLIDS
VOLUME, gal      .654E+05  .374E+05  .327E+05  .466E+04    .327E+05  .688E+04
HYDROXIDE,M          .235      .412      .470      .000        .470      .000
ALUMINATE,M          .001      .001      .001      .000        .001      .000
NITRATE,M            .262      .459      .525      .000        .525      .000
NITRITE,M           6.357    11.130     8.285     2.215       6.152     3.281
CARBONATE,M          .072      .126      .144      .000        .144      .000
PHOSPHATE,M          .000      .000      .000      .000        .000      .000
SULFATE,M            .008      .014      .016      .000        .016      .000
FLUORIDE,M           .065      .114      .040      .045        .040      .045
ORGANIC,G/L         1.120     1.961     2.240      .000       2.240      .000


PASS    SIX    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     60.6 C  141.1 F    PRESSURE   60.0 Torr
PASS WVR        50.0               TOTAL WVR             97.9
                                      EVAPORATOR               TANK CONDITIONS
                                      CONDITIONS                  20.0 C
                    FEED      SLURRY    SUPERNATE SOLIDS*      SUPERNATE SOLIDS
VOLUME, gal      .258E+05  .148E+05  .129E+05  .188E+04    .129E+05  .283E+04
HYDROXIDE,M          .470      .821      .941      .000        .941      .000
ALUMINATE,M          .001      .002      .003      .000        .003      .000
NITRATE,M            .525      .916     1.050      .000       1.050      .000
NITRITE,M           6.152    10.738     8.037     2.133       5.748     3.278
CARBONATE,M          .144      .251      .171      .058        .171      .058
PHOSPHATE,M          .000      .000      .000      .000        .000      .000
SULFATE,M            .016      .028      .032      .000        .032      .000
FLUORIDE,M           .040      .070      .033      .024        .033      .024
ORGANIC,G/L         2.240     3.910     4.480      .000       4.480      .000
```

107-AP PREDICT RUN (CONT.)

```
PASS SEVEN    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     64.3 C  147.8 F    PRESSURE   60.0 Torr
PASS WVR        50.0               TOTAL WVR           98.3
                                      EVAPORATOR              TANK CONDITIONS
                                      CONDITIONS                 20.0 C
                 FEED      SLURRY     SUPERNATE SOLIDS*       SUPERNATE SOLIDS
VOLUME, gal     .101E+05  .579E+04   .505E+04  745.           .505E+04  .115E+04
HYDROXIDE,M         .941     1.639      1.882      .000          1.882      .000
ALUMINATE,M         .003      .004       .005      .000           .005      .000
NITRATE,M          1.050     1.829      2.099      .000          2.099      .000
NITRITE,M          5.748    10.017      7.491     2.003          4.967     3.265
CARBONATE,M         .171      .298       .097      .123           .088      .127
PHOSPHATE,M         .000      .000       .000      .000           .000      .000
SULFATE,M           .032      .056       .065      .000           .065      .000
FLUORIDE,M          .033      .057       .025      .021           .025      .021
ORGANIC,G/L        4.480     7.807      8.960      .000          8.960      .000


PASS EIGHT    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     74.1 C  165.4 F    PRESSURE   60.0 Torr
PASS WVR        50.0               TOTAL WVR           98.5
                                      EVAPORATOR              TANK CONDITIONS
                                      CONDITIONS                 20.0 C
                 FEED      SLURRY     SUPERNATE SOLIDS*       SUPERNATE SOLIDS
VOLUME, gal     .389E+04  .217E+04   .195E+04  223.           .195E+04  567.
HYDROXIDE,M        1.882     3.377      3.763      .000          3.763      .000
ALUMINATE,M         .005      .009       .010      .000           .010      .000
NITRATE,M          2.099     3.767      4.198      .000          2.253      .973
NITRITE,M          4.967     8.914      6.673     1.631          3.512     3.211
CARBONATE,M         .088      .158       .051      .063           .014      .081
PHOSPHATE,M         .000      .000       .000      .000           .000      .000
SULFATE,M           .065      .116       .130      .000           .130      .000
FLUORIDE,M          .025      .045       .011      .019           .011      .019
ORGANIC,G/L        8.960    16.080     17.920      .000         17.920      .000
```

107-AP PREDICT RUN (CONT.)

```
PASS  NINE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE    85.6 C  186.0 F     PRESSURE   60.0 Torr
PASS WVR       50.0                TOTAL WVR           98.5
                                      EVAPORATOR              TANK CONDITIONS
                                      CONDITIONS                   20.0 C
                FEED      SLURRY      SUPERNATE SOLIDS*       SUPERNATE SOLIDS
VOLUME, gal     .138E+04  718.        690.      28.2          690.      196.
HYDROXIDE,M        3.763     7.231       7.526      .000         7.526       .000
ALUMINATE,M         .010      .020        .021      .000          .021       .000
NITRATE,M          2.253     4.330       4.414      .046         1.329      1.589
NITRITE,M          3.512     6.749       5.861      .582         1.939      2.543
CARBONATE,M         .014      .027        .028      .000          .000       .014
PHOSPHATE,M         .000      .000        .000      .000          .000       .000
SULFATE,M           .130      .249        .259      .000          .259       .000
FLUORIDE,M          .011      .021        .002      .010          .002       .010
ORGANIC,G/L       17.920    34.434      35.840      .000        35.840       .000
```

```
PASS   TEN    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 8 MOLAR CAUSTIC LIMI
TEMPERATURE     60.0 C  140.1 F     PRESSURE   60.0 Torr
PASS WVR         6.0                TOTAL WVR           98.6
                                      EVAPORATOR              TANK CONDITIONS
                                      CONDITIONS                   20.0 C
                FEED      SLURRY      SUPERNATE SOLIDS*       SUPERNATE SOLIDS
VOLUME, gal     494.      464.        464.      .000          464.      1.38
HYDROXIDE,M        7.526     8.007       8.007      .000         8.007       .000
ALUMINATE,M         .021      .022        .022      .000          .022       .000
NITRATE,M          1.329     1.414       1.414      .000         1.335       .074
NITRITE,M          1.939     2.063       2.063      .000         2.063       .000
CARBONATE,M         .000      .000        .000      .000          .000       .000
PHOSPHATE,M         .000      .000        .000      .000          .000       .000
SULFATE,M           .259      .276        .276      .000          .276       .000
FLUORIDE,M          .002      .002        .002      .000          .002       .000
ORGANIC,G/L       35.840    38.128      38.128      .000        38.128       .000
```

This page intentionally left blank.

108-AP PREDICT RUN

```
PASS    ONE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE      44.0 C   111.3 F     PRESSURE    60.0 Torr
PASS WVR         50.0                 TOTAL WVR             50.0
                                         EVAPORATOR               TANK CONDITIONS
                                         CONDITIONS                  20.0 C
                      FEED      SLURRY   SUPERNATE  SOLIDS*       SUPERNATE  SOLIDS
VOLUME, gal       .113E+07  .566E+06   .566E+06   .000          .566E+06   138.
HYDROXIDE,M           .010       .021       .021       .000         .021        .000
ALUMINATE,M           .002       .003       .003       .000         .003        .000
NITRATE,M             .025       .050       .050       .000         .050        .000
NITRITE,M             .023       .046       .046       .000         .046        .000
CARBONATE,M           .008       .016       .016       .000         .016        .000
PHOSPHATE,M           .001       .002       .002       .000         .000        .001
SULFATE,M             .002       .004       .004       .000         .004        .000
FLUORIDE,M            .002       .004       .004       .000         .004        .000
ORGANIC,G/L           .075       .150       .150       .000         .150        .000


PASS    TWO    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE      44.1 C   111.3 F     PRESSURE    60.0 Torr
PASS WVR         50.0                 TOTAL WVR             75.0
                                         EVAPORATOR               TANK CONDITIONS
                                         CONDITIONS                  20.0 C
                      FEED      SLURRY   SUPERNATE  SOLIDS*       SUPERNATE  SOLIDS
VOLUME, gal       .566E+06  .283E+06   .283E+06   .000          .283E+06   .000
HYDROXIDE,M           .021       .041       .041       .000         .041        .000
ALUMINATE,M           .003       .006       .006       .000         .006        .000
NITRATE,M             .050       .101       .101       .000         .101        .000
NITRITE,M             .046       .092       .092       .000         .092        .000
CARBONATE,M           .016       .032       .032       .000         .032        .000
PHOSPHATE,M           .000       .000       .000       .000         .000        .000
SULFATE,M             .004       .008       .008       .000         .008        .000
FLUORIDE,M            .004       .007       .007       .000         .007        .000
ORGANIC,G/L           .150       .299       .299       .000         .299        .000
```

108-AP PREDICT RUN (CONT.)

```
PASS THREE    DOUBLE SHELL SLURRY RUN
PASS STOPPED  AT 50% WVR LIMIT.
TEMPERATURE     44.1 C   111.4 F     PRESSURE   60.0 Torr
PASS WVR        50.0                 TOTAL WVR             87.5
                                        EVAPORATOR               TANK CONDITIONS
                                        CONDITIONS                   20.0 C
                    FEED      SLURRY    SUPERNATE  SOLIDS*       SUPERNATE  SOLIDS
VOLUME, gal      .283E+06   .141E+06   .141E+06   .000          .141E+06   .000
HYDROXIDE,M          .041       .082       .082       .000          .082       .000
ALUMINATE,M          .006       .012       .012       .000          .012       .000
NITRATE,M            .101       .202       .202       .000          .202       .000
NITRITE,M            .092       .184       .184       .000          .184       .000
CARBONATE,M          .032       .064       .064       .000          .064       .000
PHOSPHATE,M          .000       .000       .000       .000          .000       .000
SULFATE,M            .008       .017       .017       .000          .017       .000
FLUORIDE,M           .007       .015       .015       .000          .015       .000
ORGANIC,G/L          .299       .598       .598       .000          .598       .000
```

```
PASS  FOUR    DOUBLE SHELL SLURRY RUN
PASS STOPPED  AT 50% WVR LIMIT.
TEMPERATURE     44.2 C   111.6 F     PRESSURE   60.0 Torr
PASS WVR        50.0                 TOTAL WVR             93.7
                                        EVAPORATOR               TANK CONDITIONS
                                        CONDITIONS                   20.0 C
                    FEED      SLURRY    SUPERNATE  SOLIDS*       SUPERNATE  SOLIDS
VOLUME, gal      .141E+06   .707E+05   .707E+05   .000          .707E+05   .000
HYDROXIDE,M          .082       .165       .165       .000          .165       .000
ALUMINATE,M          .012       .025       .025       .000          .025       .000
NITRATE,M            .202       .403       .403       .000          .403       .000
NITRITE,M            .184       .368       .368       .000          .368       .000
CARBONATE,M          .064       .129       .129       .000          .129       .000
PHOSPHATE,M          .000       .000       .000       .000          .000       .000
SULFATE,M            .017       .034       .034       .000          .034       .000
FLUORIDE,M           .015       .029       .029       .000          .029       .000
ORGANIC,G/L          .598      1.197      1.197       .000         1.197       .000
```

108-AP PREDICT RUN (CONT.)

```
PASS   FIVE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     44.8 C   112.6 F     PRESSURE   60.0 Torr
PASS WVR        50.0                 TOTAL WVR           96.9
                                        EVAPORATOR                TANK CONDITIONS
                                        CONDITIONS                    20.0 C
                  FEED       SLURRY     SUPERNATE  SOLIDS*        SUPERNATE  SOLIDS
VOLUME, gal     .707E+05   .354E+05    .354E+05   .000            .354E+05   .000
HYDROXIDE,M         .165       .330        .330       .000            .330      .000
ALUMINATE,M         .025       .049        .049       .000            .049      .000
NITRATE,M           .403       .806        .806       .000            .806      .000
NITRITE,M           .368       .736        .736       .000            .736      .000
CARBONATE,M         .129       .258        .258       .000            .258      .000
PHOSPHATE,M         .000       .000        .000       .000            .000      .000
SULFATE,M           .034       .067        .067       .000            .067      .000
FLUORIDE,M          .029       .059        .059       .000            .059      .000
ORGANIC,G/L        1.197      2.394       2.394       .000           2.394      .000


PASS   SIX     DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     47.1 C   116.8 F     PRESSURE   60.0 Torr
PASS WVR        50.0                 TOTAL WVR           98.4
                                        EVAPORATOR                TANK CONDITIONS
                                        CONDITIONS                    20.0 C
                  FEED       SLURRY     SUPERNATE  SOLIDS*        SUPERNATE  SOLIDS
VOLUME, gal     .354E+05   .177E+05    .177E+05   .000            .177E+05   .000
HYDROXIDE,M         .330       .659        .659       .000            .659      .000
ALUMINATE,M         .049       .099        .099       .000            .099      .000
NITRATE,M           .806      1.613       1.613       .000           1.613      .000
NITRITE,M           .736      1.472       1.472       .000           1.472      .000
CARBONATE,M         .258       .515        .515       .000            .515      .000
PHOSPHATE,M         .000       .000        .000       .000            .000      .000
SULFATE,M           .067       .134        .134       .000            .134      .000
FLUORIDE,M          .059       .118        .118       .000            .118      .000
ORGANIC,G/L        2.394      4.787       4.787       .000           4.787      .000
```

108-AP PREDICT RUN (CONT.)

```
PASS SEVEN    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     54.0 C  129.2 F     PRESSURE   60.0 Torr
PASS WVR        50.0                TOTAL WVR             99.2
                                       EVAPORATOR             TANK CONDITIONS
                                       CONDITIONS                 20.0 C
                  FEED       SLURRY    SUPERNATE  SOLIDS*     SUPERNATE  SOLIDS
VOLUME, gal     .177E+05   .934E+04   .884E+04   501.         .884E+04   573.
HYDROXIDE,M         .659      1.248      1.318       .000        1.318       .000
ALUMINATE,M         .099       .187       .197       .000         .197       .000
NITRATE,M          1.613      3.053      3.226       .000        3.106       .060
NITRITE,M          1.472      2.786      2.944       .000        2.944       .000
CARBONATE,M         .515       .975       .355       .338         .311       .360
PHOSPHATE,M         .000       .000       .000       .000         .000       .000
SULFATE,M           .134       .254       .269       .000         .269       .000
FLUORIDE,M          .118       .223       .057       .089         .057       .089
ORGANIC,G/L        4.787      9.061      9.574       .000        9.574       .000


PASS EIGHT    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     69.8 C  157.6 F     PRESSURE   60.0 Torr
PASS WVR        50.0                TOTAL WVR             99.6
                                       EVAPORATOR             TANK CONDITIONS
                                       CONDITIONS                 20.0 C
                  FEED       SLURRY    SUPERNATE  SOLIDS*     SUPERNATE  SOLIDS
VOLUME, gal     .827E+04   .462E+04   .414E+04   482.         .414E+04   .122E+04
HYDROXIDE,M        1.318      2.362      2.637       .000        2.637       .000
ALUMINATE,M         .197       .353       .394       .000         .394       .000
NITRATE,M          3.106      5.564      5.088       .562        2.362      1.925
NITRITE,M          2.944      5.274      5.888       .000        3.581      1.153
CARBONATE,M         .311       .556       .057       .282         .027       .297
PHOSPHATE,M         .000       .000       .000       .000         .000       .000
SULFATE,M           .269       .482       .019       .259         .019       .259
FLUORIDE,M          .057       .103       .016       .049         .016       .049
ORGANIC,G/L        9.574     17.151     19.149       .000       19.149       .000
```

108-AP PREDICT RUN (CONT.)

```
PASS   NINE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     78.8 C  173.9 F    PRESSURE   60.0 Torr
PASS WVR        50.0               TOTAL WVR           99.7
                                      EVAPORATOR             TANK CONDITIONS
                                      CONDITIONS                 20.0 C
                 FEED      SLURRY     SUPERNATE SOLIDS*      SUPERNATE SOLIDS
VOLUME, gal     .292E+04  .157E+04   .146E+04  108.          .146E+04  420.
HYDROXIDE,M        2.637     4.910      5.274       .000        5.274       .000
ALUMINATE,M         .394      .734       .788       .000         .788       .000
NITRATE,M          2.362     4.398      4.151       .286        1.340      1.692
NITRITE,M          3.581     6.669      5.527       .818        2.236      2.463
CARBONATE,M         .027      .051       .054       .000         .009       .023
PHOSPHATE,M         .000      .000       .000       .000         .000       .000
SULFATE,M           .019      .036       .039       .000         .039       .000
FLUORIDE,M          .016      .030       .007       .013         .007       .013
ORGANIC,G/L       19.149    35.659     38.298       .000       38.298       .000
```

```
PASS   TEN     DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 8 MOLAR CAUSTIC LIMI
TEMPERATURE     68.1 C  154.5 F    PRESSURE   60.0 Torr
PASS WVR        34.1               TOTAL WVR           99.7
                                      EVAPORATOR             TANK CONDITIONS
                                      CONDITIONS                 20.0 C
                 FEED      SLURRY     SUPERNATE SOLIDS*      SUPERNATE SOLIDS
VOLUME, gal     .104E+04  684.       684.       .000         684.      81.5
HYDROXIDE,M        5.274     8.002      8.002       .000        8.002       .000
ALUMINATE,M         .788     1.196      1.196       .000         .625       .377
NITRATE,M          1.340     2.033      2.033       .000         .824       .797
NITRITE,M          2.236     3.393      3.393       .000        1.572      1.200
CARBONATE,M         .009      .014       .014       .000         .007       .004
PHOSPHATE,M         .000      .000       .000       .000         .000       .000
SULFATE,M           .039      .059       .059       .000         .059       .000
FLUORIDE,M          .007      .010       .010       .000         .010       .000
ORGANIC,G/L       38.298    58.115     58.115       .000       58.115       .000
```

This page intentionally left blank.

102-AW PREDICT RUN

```
PASS    ONE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     45.7 C   114.2 F     PRESSURE   60.0 Torr
PASS WVR        50.0                 TOTAL WVR             50.0
                                        EVAPORATOR                TANK CONDITIONS
                                        CONDITIONS                    20.0 C
                   FEED        SLURRY   SUPERNATE  SOLIDS*        SUPERNATE  SOLIDS
VOLUME, gal      .821E+05   .411E+05   .411E+05   .000            .411E+05   9.43
HYDROXIDE,M          .436       .872       .872       .000          .872        .000
ALUMINATE,M          .059       .118       .118       .000          .118        .000
NITRATE,M            .656      1.312      1.312       .000         1.312        .000
NITRITE,M            .187       .374       .374       .000          .374        .000
CARBONATE,M          .238       .476       .476       .000          .476        .000
PHOSPHATE,M          .001       .002       .002       .000          .000        .001
SULFATE,M            .028       .056       .056       .000          .056        .000
FLUORIDE,M           .047       .095       .095       .000          .095        .000
ORGANIC,G/L         1.070      2.140      2.140       .000         2.140        .000


PASS    TWO    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     50.3 C   122.5 F     PRESSURE   60.0 Torr
PASS WVR        50.0                 TOTAL WVR             75.0
                                        EVAPORATOR                TANK CONDITIONS
                                        CONDITIONS                    20.0 C
                   FEED        SLURRY   SUPERNATE  SOLIDS*        SUPERNATE  SOLIDS
VOLUME, gal      .411E+05   .212E+05   .205E+05   669.            .205E+05   708.
HYDROXIDE,M          .872      1.689      1.744       .000         1.744        .000
ALUMINATE,M          .118       .228       .236       .000          .236        .000
NITRATE,M           1.312      2.541      2.624       .000         2.624        .000
NITRITE,M            .374       .724       .748       .000          .748        .000
CARBONATE,M          .476       .922       .564       .194          .540        .206
PHOSPHATE,M          .000       .000       .000       .000          .000        .000
SULFATE,M            .056       .109       .112       .000          .112        .000
FLUORIDE,M           .095       .184       .086       .052          .086        .052
ORGANIC,G/L         2.140      4.145      4.280       .000         4.280        .000
```

102-AW PREDICT RUN (CONT.)

```
PASS THREE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     59.0 C  138.2 F    PRESSURE    60.0 Torr
PASS WVR        50.0               TOTAL WVR            87.1
                                     EVAPORATOR             TANK CONDITIONS
                                     CONDITIONS                 20.0 C
                 FEED      SLURRY    SUPERNATE SOLIDS*      SUPERNATE SOLIDS
VOLUME, gal     .198E+05  .109E+05  .991E+04  .101E+04     .991E+04  .189E+04
HYDROXIDE,M        1.744     3.165     3.488      .000        3.488      .000
ALUMINATE,M         .236      .428      .471      .000         .471      .000
NITRATE,M          2.624     4.762     4.666      .291        2.380     1.434
NITRITE,M           .748     1.357     1.496      .000        1.496      .000
CARBONATE,M         .540      .981      .104      .489         .073      .504
PHOSPHATE,M         .000      .000      .000      .000         .000      .000
SULFATE,M           .112      .204      .225      .000         .225      .000
FLUORIDE,M          .086      .157      .037      .068         .037      .068
ORGANIC,G/L        4.280     7.767     8.560      .000        8.560      .000


PASS  FOUR    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     74.7 C  166.5 F    PRESSURE    60.0 Torr
PASS WVR        50.0               TOTAL WVR            91.9
                                     EVAPORATOR             TANK CONDITIONS
                                     CONDITIONS                 20.0 C
                 FEED      SLURRY    SUPERNATE SOLIDS*      SUPERNATE SOLIDS
VOLUME, gal     .802E+04  .415E+04  .401E+04  141.         .401E+04  789.
HYDROXIDE,M        3.488     6.739     6.976      .000        6.976      .000
ALUMINATE,M         .471      .910      .942      .000         .942      .000
NITRATE,M          2.380     4.598     4.052      .354        1.182     1.789
NITRITE,M          1.496     2.890     2.992      .000        1.421      .785
CARBONATE,M         .073      .142      .053      .047         .008      .070
PHOSPHATE,M         .000      .000      .000      .000         .000      .000
SULFATE,M           .225      .434      .450      .000         .450      .000
FLUORIDE,M          .037      .072      .011      .032         .011      .032
ORGANIC,G/L        8.560    16.539    17.120      .000       17.120      .000
```

102-AW PREDICT RUN (CONT.)

```
PASS  FIVE   DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 8 MOLAR CAUSTIC LIMI
TEMPERATURE     63.0 C  145.4 F    PRESSURE   60.0 Torr
PASS WVR        12.8               TOTAL WVR           92.4
                                      EVAPORATOR                 TANK CONDITIONS
                                      CONDITIONS                     20.0 C
                 FEED      SLURRY     SUPERNATE SOLIDS*          SUPERNATE SOLIDS
VOLUME, gal     .322E+04  .281E+04   .281E+04  .000             .281E+04  50.9
HYDROXIDE,M        6.976     8.000      8.000       .000          8.000      .000
ALUMINATE,M         .942     1.081      1.081       .000           .704      .328
NITRATE,M          1.182     1.356      1.356       .000          1.140      .188
NITRITE,M          1.421     1.630      1.630       .000          1.630      .000
CARBONATE,M         .008      .009       .009       .000           .009      .000
PHOSPHATE,M         .000      .000       .000       .000           .000      .000
SULFATE,M           .450      .516       .516       .000           .516      .000
FLUORIDE,M          .011      .012       .012       .000           .012      .000
ORGANIC,G/L       17.120    19.633     19.633       .000         19.633      .000
```

This page intentionally left blank.

106-AW PREDICT RUN

```
PASS   ONE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     49.6 C  121.2 F     PRESSURE   60.0 Torr
PASS WVR        50.0                TOTAL WVR            50.0
                                       EVAPORATOR              TANK CONDITIONS
                                       CONDITIONS                  20.0 C
                 FEED      SLURRY      SUPERNATE SOLIDS*       SUPERNATE SOLIDS
VOLUME, gal     .276E+05  .139E+05    .138E+05  94.0           .138E+05  189.
HYDROXIDE,M       1.140     2.265       2.280       .000        2.280        .000
ALUMINATE,M        .118      .234        .236       .000         .236        .000
NITRATE,M         1.310     2.602       2.620       .000        2.620        .000
NITRITE,M          .478      .950        .956       .000         .956        .000
CARBONATE,M        .100      .199        .200       .000         .200        .000
PHOSPHATE,M        .027      .055        .055       .000         .000        .027
SULFATE,M          .068      .135        .136       .000         .136        .000
FLUORIDE,M         .274      .544        .095       .226         .095        .226
ORGANIC,G/L       2.140     4.251       4.280       .000        4.280        .000


PASS   TWO    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     62.7 C  144.9 F     PRESSURE   60.0 Torr
PASS WVR        50.0                TOTAL WVR            74.7
                                       EVAPORATOR              TANK CONDITIONS
                                       CONDITIONS                  20.0 C
                 FEED      SLURRY      SUPERNATE SOLIDS*       SUPERNATE SOLIDS
VOLUME, gal     .136E+05  .720E+04    .680E+04  404.           .680E+04  .104E+04
HYDROXIDE,M       2.280     4.304       4.560       .000        4.560        .000
ALUMINATE,M        .236      .446        .472       .000         .472        .000
NITRATE,M         2.620     4.946       4.456       .392        2.029       1.605
NITRITE,M          .956     1.805       1.912       .000        1.912        .000
CARBONATE,M        .200      .378        .056       .172         .030        .185
PHOSPHATE,M        .000      .000        .000       .000         .000        .000
SULFATE,M          .136      .257        .273       .000         .273        .000
FLUORIDE,M         .095      .179        .028       .081         .028        .081
ORGANIC,G/L       4.280     8.080       8.560       .000        8.560        .000
```

106-AW PREDICT RUN (CONT.)

```
PASS THREE   DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 8 MOLAR CAUSTIC LIMI
TEMPERATURE    75.1 C  167.2 F    PRESSURE   60.0 Torr
PASS WVR       43.0               TOTAL WVR           83.6
                                     EVAPORATOR          TANK CONDITIONS
                                     CONDITIONS               20.0 C
                 FEED      SLURRY    SUPERNATE SOLIDS*    SUPERNATE SOLIDS
VOLUME, gal      .576E+04  .328E+04  .328E+04  1.93       .328E+04  570.
HYDROXIDE,M         4.560     7.995     8.000      .000      8.000      .000
ALUMINATE,M          .472      .828      .828      .000       .569      .148
NITRATE,M           2.029     3.558     3.560      .000       .979     1.471
NITRITE,M           1.912     3.352     3.354      .000      1.306     1.167
CARBONATE,M          .030      .053      .053      .000       .003      .028
PHOSPHATE,M          .000      .000      .000      .000       .000      .000
SULFATE,M            .273      .478      .479      .000       .479      .000
FLUORIDE,M           .028      .049      .010      .022       .010      .022
ORGANIC,G/L         8.560    15.009    15.018      .000     15.018      .000
```

COMPOSITE RUN

```
PASS   ONE   DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE    44.1 C  111.4 F    PRESSURE   60.0 Torr
PASS WVR       50.0               TOTAL WVR           50.0
                                     EVAPORATOR           TANK CONDITIONS
                                     CONDITIONS                20.0 C
                 FEED      SLURRY    SUPERNATE SOLIDS*    SUPERNATE SOLIDS
VOLUME, gal      .342E+07  .171E+07  .171E+07  .000       .171E+07  291.
HYDROXIDE,M          .062      .123      .123      .000       .123      .000
ALUMINATE,M          .003      .006      .006      .000       .006      .000
NITRATE,M            .048      .096      .096      .000       .096      .000
NITRITE,M            .275      .550      .550      .000       .550      .000
CARBONATE,M          .011      .022      .022      .000       .022      .000
PHOSPHATE,M          .001      .001      .001      .000       .000      .001
SULFATE,M            .002      .005      .005      .000       .005      .000
FLUORIDE,M           .007      .014      .014      .000       .014      .000
ORGANIC,G/L          .097      .194      .194      .000       .194      .000
```

```
PASS   TWO   DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE    44.4 C  111.8 F    PRESSURE   60.0 Torr
PASS WVR       50.0               TOTAL WVR           75.0
                                     EVAPORATOR           TANK CONDITIONS
                                     CONDITIONS                20.0 C
                 FEED      SLURRY    SUPERNATE SOLIDS*    SUPERNATE SOLIDS
VOLUME, gal      .171E+07  .854E+06  .854E+06  .000       .854E+06  .000
HYDROXIDE,M          .123      .246      .246      .000       .246      .000
ALUMINATE,M          .006      .012      .012      .000       .012      .000
NITRATE,M            .096      .191      .191      .000       .191      .000
NITRITE,M            .550     1.100     1.100      .000      1.100      .000
CARBONATE,M          .022      .044      .044      .000       .044      .000
PHOSPHATE,M          .000      .000      .000      .000       .000      .000
SULFATE,M            .005      .010      .010      .000       .010      .000
FLUORIDE,M           .014      .028      .028      .000       .028      .000
ORGANIC,G/L          .194      .388      .388      .000       .388      .000
```

COMPOSITE RUN (CONT.)

```
PASS THREE    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     45.3 C  113.5 F    PRESSURE   60.0 Torr
PASS WVR        50.0               TOTAL WVR          87.5
                                      EVAPORATOR            TANK CONDITIONS
                                      CONDITIONS               20.0 C
                 FEED       SLURRY    SUPERNATE SOLIDS*     SUPERNATE SOLIDS
VOLUME, gal     .854E+06   .427E+06   .427E+06   .000       .427E+06   .000
HYDROXIDE,M         .246       .492       .492       .000       .492       .000
ALUMINATE,M         .012       .023       .023       .000       .023       .000
NITRATE,M           .191       .382       .382       .000       .382       .000
NITRITE,M          1.100      2.200      2.200       .000      2.200       .000
CARBONATE,M         .044       .087       .087       .000       .087       .000
PHOSPHATE,M         .000       .000       .000       .000       .000       .000
SULFATE,M           .010       .019       .019       .000       .019       .000
FLUORIDE,M          .028       .057       .057       .000       .057       .000
ORGANIC,G/L         .388       .776       .776       .000       .776       .000
```

```
PASS  FOUR    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     49.0 C  120.3 F    PRESSURE   60.0 Torr
PASS WVR        50.0               TOTAL WVR          93.7
                                      EVAPORATOR            TANK CONDITIONS
                                      CONDITIONS               20.0 C
                 FEED       SLURRY    SUPERNATE SOLIDS*     SUPERNATE SOLIDS
VOLUME, gal     .427E+06   .214E+06   .214E+06   36.5       .214E+06   36.5
HYDROXIDE,M         .492       .984       .984       .000       .984       .000
ALUMINATE,M         .023       .046       .046       .000       .046       .000
NITRATE,M           .382       .765       .765       .000       .765       .000
NITRITE,M          2.200      4.399      4.400       .000      4.400       .000
CARBONATE,M         .087       .174       .174       .000       .174       .000
PHOSPHATE,M         .000       .000       .000       .000       .000       .000
SULFATE,M           .019       .038       .038       .000       .038       .000
FLUORIDE,M          .057       .114       .103       .006       .103       .006
ORGANIC,G/L         .776      1.552      1.552       .000      1.552       .000
```

COMPOSITE RUN (CONT.)

```
PASS   FIVE   DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     62.8 C  145.0 F     PRESSURE   60.0 Torr
PASS WVR        50.0                TOTAL WVR            96.9
                                       EVAPORATOR             TANK CONDITIONS
                                       CONDITIONS                20.0 C
                  FEED      SLURRY     SUPERNATE  SOLIDS*     SUPERNATE  SOLIDS
VOLUME, gal     .213E+06   .114E+06   .107E+06   .691E+04    .107E+06   .153E+05
HYDROXIDE,M         .984      1.848      1.968       .000       1.968       .000
ALUMINATE,M         .046       .087       .092       .000        .092       .000
NITRATE,M           .765      1.437      1.530       .000       1.530       .000
NITRITE,M          4.400      8.265      7.448       .676       5.023      1.889
CARBONATE,M         .174       .328       .111       .119        .098       .125
PHOSPHATE,M         .000       .000       .000       .000        .000       .000
SULFATE,M           .038       .072       .076       .000        .076       .000
FLUORIDE,M          .103       .193       .028       .089        .028       .089
ORGANIC,G/L        1.552      2.915      3.104       .000       3.104       .000


PASS    SIX   DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     71.3 C  160.3 F     PRESSURE   60.0 Torr
PASS WVR        50.0                TOTAL WVR            98.2
                                       EVAPORATOR             TANK CONDITIONS
                                       CONDITIONS                20.0 C
                  FEED      SLURRY     SUPERNATE  SOLIDS*     SUPERNATE  SOLIDS
VOLUME, gal     .915E+05   .514E+05   .457E+05   .565E+04    .457E+05   .118E+05
HYDROXIDE,M        1.968      3.503      3.936       .000       3.936       .000
ALUMINATE,M         .092       .165       .185       .000        .185       .000
NITRATE,M          1.530      2.723      3.059       .000       2.067       .496
NITRITE,M          5.023      8.941      6.560      1.743       3.587      3.229
CARBONATE,M         .098       .175       .048       .074        .017       .090
PHOSPHATE,M         .000       .000       .000       .000        .000       .000
SULFATE,M           .076       .136       .152       .000        .152       .000
FLUORIDE,M          .028       .050       .014       .021        .014       .021
ORGANIC,G/L        3.104      5.526      6.208       .000       6.208       .000
```

COMPOSITE RUN (CONT.)

```
PASS SEVEN    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 50% WVR LIMIT.
TEMPERATURE     86.7 C  188.0 F     PRESSURE   60.0 Torr
PASS WVR        50.0                TOTAL WVR          98.7
                                      EVAPORATOR            TANK CONDITIONS
                                      CONDITIONS                20.0 C
                  FEED       SLURRY   SUPERNATE SOLIDS*     SUPERNATE SOLIDS
VOLUME, gal     .339E+05   .178E+05   .170E+05  873.        .170E+05  .505E+04
HYDROXIDE,M        3.936      7.487      7.872      .000       7.872      .000
ALUMINATE,M         .185       .352       .370      .000        .370      .000
NITRATE,M          2.067      3.931      4.111      .011       1.036     1.549
NITRITE,M          3.587      6.823      5.598      .788       1.583     2.796
CARBONATE,M         .017       .033       .035      .000        .000      .017
PHOSPHATE,M         .000       .000       .000      .000        .000      .000
SULFATE,M           .152       .290       .305      .000        .305      .000
FLUORIDE,M          .014       .027       .001      .014        .001      .014
ORGANIC,G/L        6.208     11.809     12.416      .000      12.416      .000
```

```
PASS EIGHT    DOUBLE SHELL SLURRY RUN
PASS STOPPED AT 8 MOLAR CAUSTIC LIMI
TEMPERATURE     59.0 C  138.2 F     PRESSURE   60.0 Torr
PASS WVR         1.6                TOTAL WVR          98.7
                                      EVAPORATOR            TANK CONDITIONS
                                      CONDITIONS                20.0 C
                  FEED       SLURRY   SUPERNATE SOLIDS*     SUPERNATE SOLIDS
VOLUME, gal     .119E+05   .117E+05   .117E+05  .000        .117E+05  .000
HYDROXIDE,M        7.872      8.000      8.000      .000       8.000      .000
ALUMINATE,M         .370       .376       .376      .000        .376      .000
NITRATE,M          1.036      1.053      1.053      .000       1.053      .000
NITRITE,M          1.583      1.608      1.608      .000       1.608      .000
CARBONATE,M         .000       .000       .000      .000        .000      .000
PHOSPHATE,M         .000       .000       .000      .000        .000      .000
SULFATE,M           .305       .310       .310      .000        .310      .000
FLUORIDE,M          .001       .001       .001      .000        .001      .000
ORGANIC,G/L       12.416     12.618     12.618      .000      12.618      .000
```

APPENDIX G

REFERENCE LETTERS

This page intentionally left blank.

Westinghouse Hanford Company **Internal Memo**

From: Processing and Chemistry Laboratories 8E110-PCL94-058
Phone: 373-2182 T6-09
Date: July 28, 1994
Subject: EVAPORATOR BOILDOWN RESULTS

To:	E. Q. Le	R1-43
cc:	B. H. Von Bargen	R1-43
	R. J. Nicklas	R1-43
	J. R. Jewett	T6-50
	G. L. Miller	T6-06
	Process Aids	T6-50
	MAB File/LB	

References:

(1) Internal Memo, E. Q. Le to M. A. Beck, et al., "242-A Evaporator Campaign 2 Studies," dated July 7, 1994.

(2) R. C. Smith, "242-A Evaporator Project Analytical Services Statement of Work," WHC-SOW-93-0006, Revision 1, May 1993.

(3) M. A. Beck, "Determination of Boiling Pressures and Temperatures as a Function of % WVR (Boildown), "LT-519-183, Revision A-0, June 1994.

(4) Beck, M. A., 1990, "222-S Laboratory Support," Controlled Laboratory Notebook WHC-N-421-1,pp. 129-142.

(5) R. C. Weast, Ph.D., Handbook of Chemistry and Physics, 58th ed., CRC Press, Cleveland, 1977-1978, p. D-180.

INTRODUCTION

The Process Chemistry Laboratories were requested to support the 242-A Evaporator restart as part of the overall 222-S laboratory effort (References 1 and 2). The boildown was conducted by following procedure LT-519-183 Rev A-0 (Reference 3), and was recorded in a controlled laboratory notebook (Reference 4).

The net purpose of these studies is to determine the characteristics of double-shell tank materials as they are processed in the evaporator.

The results for the boildown study (which includes pressure and temperature versus %WVR and density of final boildown residue) supporting the 242-A Evaporator restart are reported below.

MIXING AND COMPATIBILITY STUDY

Aliquots from the following tanks were composited: 241-102-AP, 241-107-AP and 241-108-AP. The percentage of 241-101-AP in the aliquot is 36%, that of 241-107-AP is 35% and that of 241-108-AP is 29%. The samples were mixed together with no apparent changes in color, temperature, clarity, or any other visually determinable characteristic. The Differential Scanning Calorimetry (DSC) results indicate that only the endotherm associated with water evaporation/ boiling is seen. No exotherms of any kind are evident in the DSC plots.

BOILDOWN PRESSURE, TEMPERATURE STUDY

The boildown was performed in a vacuum distillation apparatus with an adjustable vacuum-limiting manometer and an isolatable collection graduated cylinder. The boildown was conducted over a seven hour period. The evaporation was done at 80 torr (to avoid excessive foaming and bumping of solution). Percent Waste Volume Reduction (%WVR) was measured by observing the amount of condensate collected in a graduated cylinder. As the graduated cylinder became full, it was isolated from the rest of the system and the condensate was removed. Temperature in the boiling liquid was measured using a J-type thermocouple. The indicated values of temperature were converted to actual temperature. The thermocouple was calibrated in reference to a National Institute of Standards and Technology (NIST) traceable thermometer. The temperature readings of both the thermocouple and the standard thermometer were taken every 5 °C between 20 ° C and 70 °C. Readings were also taken at 80, 90 and 99 °C (since the pressure in the lab is too low to allow for boiling at 100 °C). Pressure was set using an electronic manometer with a low pressure limiter set at the desired level. The pressure measurement was calibrated by observing the pressure versus temperature response of pure water, and comparing the values thus obtained to the corresponding literature (Reference 5) values for pure water. The blank run that was done showed no temperature change as %WVR increased, despite the fact the thermocouple was not in the solution for high values of %WVR.

DENSITY MEASUREMENT

The density was measured at approximately 25 °C at atmospheric pressure. The liquid was transferred from the boildown flask to a pre-weighed volumetric flask. The liquid was stirred, and every attempt made to ensure that suspended solids were included in the sample. The measurement of the liquid at several different temperatures and pressures, as specified in Reference 1, was not possible since the equipment, and the sample size did not permit such measurement.

RESULTS

The attachment shows the tabulated data (next page) in graphical form. The data graphed as straight lines labeled "42, 60, 79 torr" are published values of pure water at those pressures (from Reference 5) that are independent of percent boildown.

%WVR	Volume Collected (mL)	Indicated Pressure (torr)	Corrected Pressure (torr)	Indicated Temperature (°C)	Corrected Temp (°C)	Visual Observations and Remarks
0	-	745	713	20.2	20.6	Ambient Air prior to hot plate startup
0	0	75	79	47.0	47.2	
0	0	55	60	41.6	41.8	Prone to bumping as pressure is reduced
0	0	35	41	34.4	34.8	This low pressure value is highly variable. Temperature varies ±0.2 °C
10	12	75	79	47.2	47.4	
10	12	55	60	42.2	42.4	
10	12	36	42	36.0	36.4	
20	24	75	79	47.4	47.6	
20	24	55	60	42.0	42.2	Temp measured after a big bump
20	24	36	42	35.4	35.8	
30	36	75	79	47.0	47.2	
30	36	55	60	42.2	42.4	Condenser temperature about 7 °C during test
30	36	36	42	35.2	35.6	
40	48	75	79	47.2	47.4	
40	48	55	60	42.2	42.4	
40	48	35	41	35.4	35.8	
50	60	75	79	46.8	47	
50	60	55	60	44.7	44.9	Temp value possibly incorrectly read or recorded
50	60	35	41	34.8	35.2	
60	72	75	79	47.0	47.2	No unusual foaming, no cloudiness at all
60	72	55	60	41.4	41.6	
60	72	35	41	35.8	36.2	
70	84	75	79	47.4	47.6	@ 92 mL liquid collected, large bubble (1-2 cm diameter) foam
70	84	55	60	41.6	41.8	foam volume up to 6 times the volume of liquid (150 mL vs 25 mL)
70	84	35	41	35.2	35.6	no cloudiness.
80	96	75	79	47.0	47.2	1st cloudiness at 80 torr and 46.8 °C, light floc type solids
80	96	55	60	41.4	41.6	
80	96	35	41	34.6	35	Specific gravity 1.03 g/mL
90	108	75	79	48.2	48.4	granular specks on flask wall above bubble burst line
90	108	55	60	42.4	42.6	dilute Tang(TM) texture, (yellow green color)
90	108	35	41	35.4	35.8	Specific Gravity 1.12 g/mL
	~109					Specific gravity 1.3 g/mL Note that only 1.5 *ml* liquid remained in the flask

The density measurement yielded a densities of 1.03 g/mL at 80 %WVR, 1.12 at 90 % WVR and 1.3 g/mL at slightly above 90 % WVR.

The %WVR values should be considered approximations with low bias. The amount of liquid in the boiling flask is somewhat less than the condensate collected, as a few milliliters often are caught in the condenser or other parts of the boildown apparatus. This would cause an underestimation if the %WVR and a high bias to the density. Some water is also lost to the vacuum system and is not collected in the receiving flask which would also lead to a "lower" apparent %WVR than is actually the case.

CONCLUSIONS

The composite material is largely water, and has no unusual characteristics. The foaming seen was of very light-walled bubbles, and should not present a problem.

The customer should realize that the values of % WVR are biased low (the actual values of %WVR are higher than those reported). This bias is especially prominent at high values of %WVR.

The amount of solids in solution is quite low compared to the usual amount of solids in Hanford waste tanks.

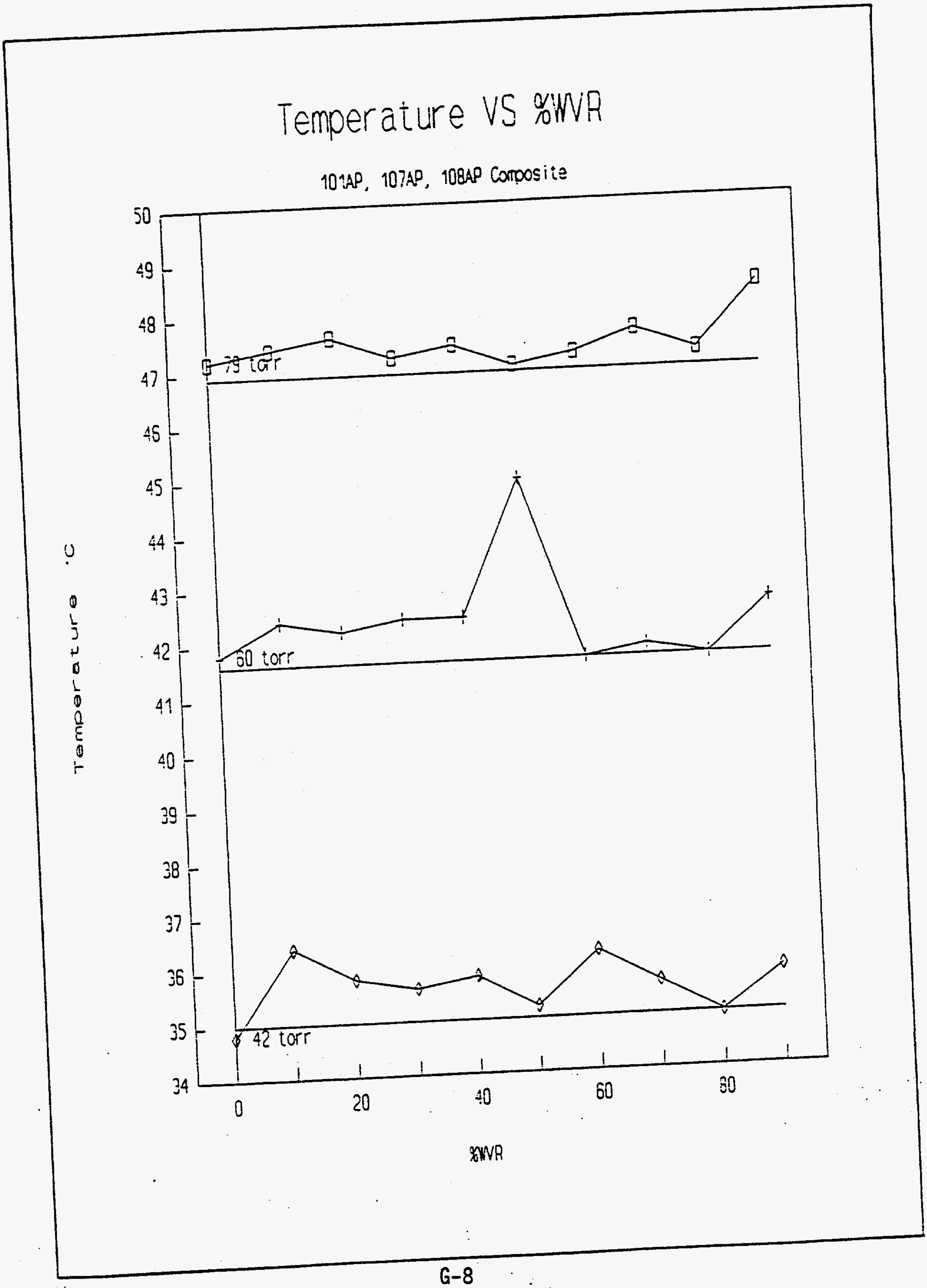
This completes the current efforts of the Process Chemistry Laboratories on behalf of the second Evaporator campaign. If you have any questions, please feel free to call me at 373-2182.

Mark A Beck

Mark A. Beck, Advanced Scientist
Process Chemistry Laboratories

adm

Attachment to 8E110-PCL94-058
Evaporator Boildown Results
Page 1 OF 1


Temperature VS %WVR
101AP, 107AP, 108AP Composite
Temperature °C
50
49
48
47
46
45
44
43
42
41
40
39
38
37
36
35
34
79 torr
60 torr
42 torr
0
20
40
60
80
%WVR

Westinghouse
Hanford Company

Internal
Memo

From: Single-Shell Tanks
Phone: 3-3531 R1-49
Date: August 6, 1992
Subject: ISOTOPIC URANIUM ANALYSIS COMPOSITION

7C242-92-019

To: S. D. Godfrey R1-51

cc: K. G. Carothers R1-51 KGC
J. E. Geary R1-43
R. J. Nicklas R1-43
T. S. Vail R1-49
CCP:DRH File/LB

When performing an isotopic uranium analysis from total uranium concentration, it has been calculated that the following break-down can be used to determine U-233, U-235 and U-238 concentrations when dealing with spent N Reactor fuel.

U-233	1.077E-8	%
U-235	0.933	%
U-238	99.012	%

The included calculations were based on data contained in SD-CP-TI-105 <u>ORIGEN2 Predictions of N Reactor Fuel Actinide Composition</u> for 6% plutonium enrichment.

C. C. Pitkoff, Engineer
Single-Shell Tanks

lmt

Attachment

This page intentionally left blank.

6% ENRICHMENT FUEL MIXTURES AND URANIUM ISOTOPE PERCENTAGES

A. Pure MK IV Fuel

Inner Cell: 913 MWD Burn Up
Outer Cell: 1188 MWD Burn Up

U Isotope	Mass	Wt. Fraction	Wt. %
233	1.049E-4 g	1.0512E-10	1.0512E-8 %
234	6.800E1 g	6.8143E-5	
235	8.354E3 g	8.3716E-3	8.3716E-1 %
236	5.911E2 g	5.9234E-4	
237	1.569E-7 g	1.5723E-13	
238	9.889E5 g	0.99098	99.098 %
	0.000 g		
	9.979E5 g		

B. Pure MK IA Fuel

Inner Cell: 946 MWD Burn Up
Outer Cell: 1537 MWD Burn Up

U Isotope	Mass	Wt. Fraction	Wt. %
233	1.095E-4 g	1.0976E-10	1.0976E-8 %
234	8.098E1 g	8.1175E-5	
235	1.010E4 g	1.0124E-2	1.0124 %
236	4.695E2 g	4.7063E-4	
237	1.544E-7 g	1.5477E-13	
238	9.870E5 g	0.9894	98.94 %
239	0.000 g		
	9.976E5 g		

C. Inner and Outer Cell Fuel Mixture #1

Inner Cell: 1101 MWD Burn Up of MK IV Fuel
Outer Cell: 3300 MWD Burn Up of MK IA Fuel

U Isotope	Mass	Wt. Fraction	Wt. %
233	1.059E-4 g	1.06E-10	1.06E-8 %
234	7.056E1 g	7.070E-5	
235	8.710E3 g	8.729E-3	8.729E-1 %
236	5.681E2 g	5.693E-4	
237	1.566E-7 g	1.569E-13	
238	9.885E5 g	0.9906	99.06 %
239	0.000 g	0.000	
	9.978E5		

6% ENRICHMENT FUEL MIXTURES AND URANIUM ISOTOPE PERCENTAGES (cont.)

D. Inner and Outer Cell Fuel Mixture #2

Inner Cell: 1101 MWD Burn Up of MK IV Fuel
Outer Cell: 3300 MWD Burn Up of 20% MK 1A and 80% MK IV Fuels

U Isotope	Mass		Wt. Fraction	Wt. %	
233	2.191E-5	g	1.0982E-10	1.0982E-8	%
234	1.620E1	g	8.1203E-5		
235	2.019E3	g	0.0101	1.01	%
236	9.389E1	g	4.7062E-4		
237	3.088E-8	g	1.5479E-13		
238	1.974E5	g	0.9895	98.95	%
239	0.000	g			
	1.995E5	g			

E. Average U Isotope Concentration for the 4 Given Fuel Types

U 233	U 235	U 238
1.0512E-8 %	8.3716E-1 %	99.098 %
1.0976E-8 %	1.0124 %	98.94 %
1.0982E-8 %	1.01 %	98.95 %
1.06E-8 %	0.8729 %	99.06 %
4.3070E-8 %	3.732 %	396.048 %
/ 4	/ 4	/ 4
1.077E-8 %	0.933 %	99.012 %

Avg. U 233 = 1.077E-8 %
Avg. U 235 = 0.933 %
Avg. U 238 = 99.012 %

Westinghouse
Hanford Company

Internal
Memo

7C241-92-038

From: J. F. O'Rourke
Phone: 3-2977 R1-43
Date: July 20, 1992
Subject: TANK C-100 OPERATING LEVEL

To:	R. J. Nicklas	R1-43
cc:	J. E. Geary	R1-43
	M. D. Guthrie	R1-43
	A. P. Larrick	R1-43
	F. N. McDonald	R3-45
	W. R. Owen	R1-48
	J. M. Petty	S5-14
	M. C. Teats	R1-43
	R. B. Wurz	S5-14
	JFO File/LB	

References:

(1) WHC-SD-WM-TI-357, Revision 1, September 12, 1989, R. K. Welty and N. J. Vermeulen, *Waste Storage Tank Status and Leak Detection Criteria*.

(2) WHC-SD-WM-PE-036, *242-A Evaporator/Crystallizer Fiscal Year Campaign Run 88-1 Post Run Document*, to be issued.

(3) Off-Normal Condition/Event Report, Tank Farm Surveillance & Operations, "*Organics in Ion Exchange Column Eluate*", dated September 25, 1986.

(4) Internal Memo, E. G. Gratny to R. B. Gelman, "*Tank Farm & Evaporator Process Control's Evaluation of the C-100 Tank Interfacial Recorders*", dated August 8, 1983.

(5) Internal Memo, R. B. Bendixsen to J. F. Albaugh, "*Separable Organic in Waste Tanks*", dated April 28, 1983.

(6) SD-WM-TI-076, April 22, 1983, N. W. Kirch, *PUREX Organic Waste*.

The concern has been expressed recently that process condensate with separable phase organics could be transferred to the Liquid Effluent Retention Facility (LERF) and ultimately to the proposed Effluent Treatment Facility (ETF). Significant quantities of separable organics introduced into the process condensate would adversely effect treatment systems at the ETF. This letter outlines the administrative controls to be employed to prevent a separable phase organics transfer from the 242-A Evaporator to the LERF.

During past operations, the PUREX facility transferred wastes containing tributyl phosphate (TBP) and normal paraffin hydrocarbons (NPH) to tank farms. Both TBP and NPH form insoluble layers when mixed with aqueous liquids. Data gathered at the PUREX facility indicates TBP is roughly 100 times more soluble in water than NPH (Reference 5). TBP and NPH are materials of relatively low volatilities, with vapor pressures lower than that of water at corresponding temperatures (Reference 6). The specific gravities of NPH and TBP are 0.85 and 0.95, respectively (Reference 4).

Separable phase organics have been discovered in the process condensate twice during the operating history of the 242-A Evaporator. The first occurrence was on September 11, 1986, when a sample taken during routine regeneration of the ion exchange media contained approximately 50% of an insoluble organic material by volume (Reference 3). The immiscible material was later analyzed and found to be NPH (Reference 3). The other occurrence was on May 2, 1988, when an organic layer was discovered on the process condensate in retention basin #2 (Reference 2).

An arrangement of dip tubes (Attachment 1) is used to detect the presence of an organic layer floating on the process condensate in the C-100 tank. Dip tubes A and C are used to measure the specific gravity in the lower 40 inches of the tank. Dip tubes C and D measure the specific gravity in the 46.5 inches immediately above the lower dip tubes. An organic layer between either pair of dip tubes would be detected by the decrease in specific gravity.

The Monitor and Control System (MCS) has a low alarm for the bottom pair of dip tubes which activates at a specific gravity of 0.98. In past evaporator operations, the nominal operating temperature in tank C-100 was 100 °F. The specific gravity of water at this temperature is approximately 0.99. The MCS low alarm is set low enough to detect separable organics without causing spurious alarms.

In the past, the operating level in tank C-100 was maintained at 37% (67 inches) which is located between dip tubes C and D. Due to its greater specific gravity, TBP would result in the lowest organic-aqueous interface. Actually, NPH is far more likely to accumulate in the C-100 tank than TBP due to its lesser solubility in water. For greater conservatism, the process condensate was assumed to be at ambient temperature and the specific gravity equal to 1.00. Approximately 4,000 gallons of TBP would have to accumulate prior to activation of the MCS alarm. Upon activation of the alarm, the organic-aqueous interface would be located 8 inches below the pump suction nozzle. Clearly, this is not an effective method to prevent separable organics from being transferred to the LERF or the ETF.

Waste Treatment Systems Engineering (WTSE) recommends the operating level in tank C-100 be raised to 50% (90 inches) which corresponds to 3.5 inches above dip tube D. An increase in the operating level would decrease the quantity of TBP needed to activate a low specific gravity alarm of 0.98 to 2,000 gallons. Of greater importance, raising the operating level would increase the distance between a potential organic-aqueous interface and the pump suction nozzle to 36 inches.

Raising the operating level from 37% to 50% would reduce the surge volume available in the C-100 tank to receive process condensate when the discharge to LERF has been interrupted. The available volume in the C-100 tank would be reduced by approximately 2,100 gallons. The decrease in surge volume is not expected to significantly hinder evaporator operations.

The implementation of a new operating level in tank C-100 will necessitate the following actions:

- Adding a low alarm for specific gravity on the upper dip tube interface in tank C-100.
- Modifying plant operating procedures TO-600-030 and TO-640-020.
- Activating and modifying plant operating procedure TO-600-190.
- Modifying alarm response procedure ARP-T-601-00013.

In addition to increasing the operating level, other administrative controls are necessary. The minimum level in the evaporator feed tank 102-AW is restricted to 100 inches unless a surface sample has been taken and a separable organic phase is not present (Reference 1). The minimum level in tank 102-AW is 5 inches whenever a surface sample has been taken and no separable organic phase is present (Reference 1). Before each campaign, a surface sample should be taken from each tank to be processed and analyzed for total organic carbon (TOC).

The minimum level in tank 102-AW should be restricted to 100 inches whenever a tank with a separable phase organics is transferred to the evaporator feed tank. Tank 102-AW can be pumped down below 100 inches after a surface sample has been taken with no indication of separable organics. Despite the relatively low volatilities of NPH and TBP, passive evaporation will cause the removal of the separable organics through the primary ventilation system of the tank (Reference 6).

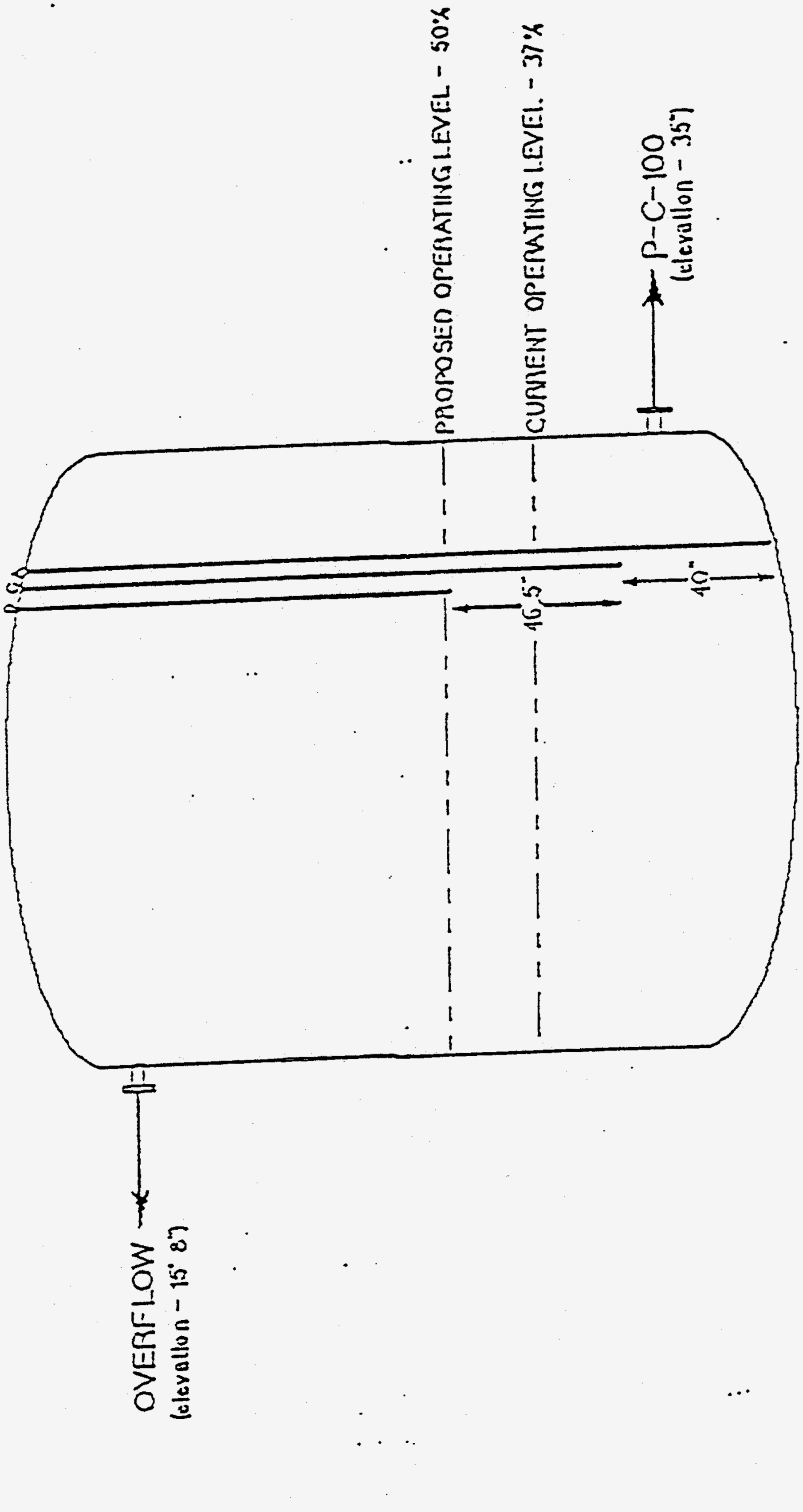
Whenever a MCS alarm for specific gravity in tank C-100 is activated, the tank should be overflowed to the evaporator feed tank and a sample be taken of the process condensate. The level in the feed tank should be kept above 100 inches until a surface sample is taken with no indication of separable phase organics.

In summary, WTSE recommends raising the operating level in tank C-100 from 37% to 50%. This change would necessitate the addition of a MCS alarm for the upper interface in tank C-100 and the modification of plant operating procedures and alarm response procedures. WTSE also recommends pre-campaign surface samples of the feed tank and feed source tanks to detect immiscible organic layers and restricting the minimum level in tank 102-AW to 100 inches upon detection of separable organic layers.

If you have any questions regarding this letter, feel free to contact me at 3-2977.

J. F. O'Rourke, Advanced Engineer
Waste Treatment Systems Engineering

Attachments (1)


PROPOSED OPERATING LEVEL - 50%
CURRENT OPERATING LEVEL - 37%
P-C-100
(elevation - 35')
16.5"
40"
OVERFLOW
(elevation - 15' 8")

This page intentionally left blank.

Westinghouse
Hanford Company

Internal
Memo

7C241-93-023

From: Waste Treatment
Phone: 3-4214 R1-43
Date: June 25, 1993
Subject: PART B EVAPORATOR FEED CONCENTRATION LIMITS CHANGE REQUEST

To: R. D. Gustavson R1-51

cc: M. D. Guthrie R1-43 MDG
A. P. Larrick R1-43
E. Q. Le R1-43
R. J. Nicklas R1-43
J. E. O'Rouke R1-43
RJN File/LB

Reference:
1. Memo # 7C241-93-016, E. Q. Le to R. D. Gustavson, same subject, dated April 28, 1993.
2. Operating Specifications For The 242-A Evaporator-Crystallizer, OSD-T-151-0012, Revision D-0, June 02, 1993.

In a previous memo (Ref.1) I addressed that the evaporator feed concentration limits listed in the table 3-20 in the 242-A Evaporator Dangerous Waste Permit Application are incorrect and need to be revised. In that memo it stated that administrative limit for differential scanning calorimeter was 450°F. Further study indicates that materials capable of releasing large amount of energy at temperatures below 335°F are not permitted in the evaporator feed (Ref.2). This temperature limit was determined from evaluating the steam system in the 242-A Evaporator facility and determining a conservative steam pressure which may be fed into the systems reboiler.

A table below lists the constituent, limit and basis for evaporator feed concentration limits regarding the operational safety considerations. The table can be used to replace the Table 3-20 in the 242-A Evaporator Dangerous Waste Permit Application.

R. O. Gustavson
Page 2
June 25, 1993

Constituent	Limit	Basis
Differential scanning calorimetry	No exotherm at a temperature below 335°F	The presence of an exotherm at a temperature below 335°F indicates the presence of a thermally unstable material that is unsuitable for exposure to the temperatures encountered in the evaporator process.
Complex Waste	Do not concentrate exceeding the NaNO3/NaNO2 precipitation boundary.	The precipitation of NaNO3/NaNO2 solids will increase the viscosity of the solution rapidly and can cause the formation of a gel-like solution that may be too viscous to transfer to DSTs.

Your revision to the Table 3-20 and limit of no exotherm at a temperature below 335°F in all applicable sections in the 242-A Evaporator Dangerous Waste Permit Application is further requested. We plan to use the limit in the table above for the 1993 Evaporator Restart Campaign. If you have any questions or comments, please feel free to contact me at 3-4214.

E. Q. Le, Engineer
Waste Treatment

jrt

Westinghouse
Hanford Company

Internal
Memo

From: Tank Farm Process Technology Section
Phone: 3-3115 2750E/A215/200E R2-11
Date: June 30, 1988
Subject: VISCOSITY OF EVAPORATOR SLURRIES

13314-88-105

To:	M. C. Teats	R1-51
cc:	D. R. Bratzel	T6-50
	G. L. Borsheim	R2-18
	G. Goff	R1-51
	B. M. Maus	R1-51
	L. A. Mihalik	R2-11
	R. J. Nicklas	R1-51
	J. P. Sederberg	R1-51
	DAR File/LB	

Viscosities of evaporator slurries have been taken for a number of years. The data available was gathered up and a brief analysis of the data was performed.

The data came from the post run documents of the past evaporator campaigns. The viscosities reported are both boildown data and evaporator slurry samples. While there may be a difference in viscosity of a slurry from a batch boildown and the continuous evaporator crystallizer, the difference is probably smaller than the measuring error.

The viscosity was judged to be a function of the temperature, concentration and solids in the supernate. The viscosity cooling curves gave extensive temperature data. There were two concentration indicators used in this analysis. The first was specific gravity. The sodium concentration was used as the other indicator of concentration. Both of these indicators were measured at 25 °C. Specific gravity and sodium concentration were taken from the total slurry when that data was available. If not, then supernate data was used. There could be appreciable difference between supernate and slurry concentrations if many solids are present. Both specific gravity and sodium concentrations were not available on all samples.

The viscosity was commonly measured under several shear rates to allow for an estimation of Newtonian behavior. Only the highest shear rate was used for this analysis. Usually there was less than ten percent difference between the highest and the lowest shear rate.

The data is listed in the attachment and is available on computer disk for those who may be interested.

VISCOMETER COMPARISONS

Two different brands of viscometers, working on different principles, were used during this time frame. While no process solutions were measured by both viscometers, some estimate of the difference between the viscometers can be seen in Figure 1. The data was sorted by viscometers and then similar specific gravities were plotted for each viscometer. Only solutions with solids were used.

Figure 1 seems to indicate that the Brookfield measured somewhat lower than the Haake. On a percentage basis, the Brookfield measured about 50% of the Haake.

For the remainder of the analysis, only the Haake Viscometer data was used. The Haake is the viscometer that will be used in the future. At a later time, these correlations may be compared with current data. Using only the Haake data would assure a better match between past and future correlations.

NO SOLIDS IN SLURRY

There was quite a clean break in the data on solids in the evaporator slurry stream. A specific gravity of 1.35 seemed to be the point that solids formed. Below that concentration, no solids were reported in any of the samples.
Figure 2 shows the way viscosity varied with temperature and specific gravity. The dips and raises were artificial characteristics of the gridding program. There is an essentially smooth plane that reflects what was expected. Higher temperature and lower concentrations gave lower viscosities. Lower temperatures and higher concentrations were higher viscosities.

For this data, the sodium concentrations and the specific gravity were well correlated. But temperature was the largest influence on viscosity. A correlation for this data set is:

1) $\text{Viscosity} = -35.82 - .3850*T + 42.65*SPG$

The correlation coefficient is .904. The temperature is in ^{0}C and the viscosity is given in centipoise.

SOLIDS IN SLURRY

Above a specific gravity of 1.35, solids were usually present. Figure 3 indicates how the solids may affect the viscosity. The high peak is one campaign, 84-5, that had high viscosities. A simple correlation for the solids is not possible.

2) Viscosity = -138.7 - 1.164*T + 145.2*SPG

gives a correlation coefficient of .494 which is clearly not very good. The high viscosity run appears to be the main reason for the poor fit.

Figure 4 is only those runs that had sodium concentrations. The surface is smoother with fewer peaks. Temperature had the greatest contribution with the concentration terms adding smaller corrections. Using just the sodium concentration as a measure of concentration gives:

3) Viscosity = 51.37 - 1.386*T + 2.791*NA

The correlation coefficient is 0.66. The sodium concentration, NA, is moles per liter.

Using both sodium concentration and specific gravity gives:

4) Viscosity = -33.65 - 1.381*T + 62.68*SPG + 2.206*NA

with a correlation coefficient of .69.

OTHER WORK POSSIBLE

The viscosity of slurries is not well understood. The analysis given here is not meant to be an in depth study of the viscosity. Other things that should be looked at include:

Amount of solids present
Type of solids present
Organics
Batch versus continuous evaporation

However, no additional studies are planned at this time.

D. A. Reynolds
Tank Farm Process Technology Section

kjr

This page intentionally left blank.

ATTACHMENT

SOLID
1=NO SOLID
2 = SOLIDS

VISCOMETER
1=BROCKFIELD
2=HAAKE

TEMP	Cp	SPG	Na	SOLID	VISC	RUN	DOCUMENT
50	3.7	1.329		1	1	82-1	SD-WM-PE-002
40	4.8	1.329		1	1	82-1	SD-WM-PE-002
31	7.4	1.329		2	1	82-1	SD-WM-PE-002
20	10.3	1.329		2	1	82-1	SD-WM-PE-002
15	13.2	1.329		2	1	82-1	SD-WM-PE-002
11	16.4	1.329		2	1	82-1	SD-WM-PE-002
51	3.5	1.324		1	1	82-1	SD-WM-PE-002
41	5.1	1.324		1	1	82-1	SD-WM-PE-002
31	7	1.324		1	1	82-1	SD-WM-PE-002
20	12.1	1.324		1	1	82-1	SD-WM-PE-002
15.5	17.2	1.324		2	1	82-1	SD-WM-PE-002
50	1.3	1.131		1	1	82-1	SD-WM-PE-002
40	1.4	1.131		1	1	82-1	SD-WM-PE-002
30	1.7	1.131		1	1	82-1	SD-WM-PE-002
25	2.3	1.131		1	1	82-1	SD-WM-PE-002
20	3	1.131		1	1	82-1	SD-WM-PE-002
15	2.9	1.131		1	1	82-1	SD-WM-PE-002
5	4.9	1.131		1	1	82-1	SD-WM-PE-002
50	0.8	1.148		1	1	82-1	SD-WM-PE-002
40	0.9	1.148		1	1	82-1	SD-WM-PE-002
30	1.3	1.148		1	1	82-1	SD-WM-PE-002
20	2	1.148		1	1	82-1	SD-WM-PE-002
10	2.9	1.148		1	1	82-1	SD-WM-PE-002
0	5.8	1.148		1	1	82-1	SD-WM-PE-002
26	5	1.015		1	1	84-1	SD-WM-PE-015
35	3	1.015		1	1	84-1	SD-WM-PE-015
47	2	1.015		1	1	84-1	SD-WM-PE-015
1	51	1.332	8.87	1	1	84-4	SD-WM-PE-017
10	26	1.332	8.87	1	1	84-4	SD-WM-PE-017
20	16	1.332	8.87	1	1	84-4	SD-WM-PE-017
30	10	1.332	8.87	1	1	84-4	SD-WM-PE-017
40	8	1.332	8.87	1	1	84-4	SD-WM-PE-017
48	6	1.332	8.87	1	1	84-4	SD-WM-PE-017
48	9	1.422	8.32	2	1	84-4	SD-WM-PE-017
40	13	1.422	8.32	2	1	84-4	SD-WM-PE-017
30	17	1.422	8.32	2	1	84-4	SD-WM-PE-017
20	27	1.422	8.32	2	1	84-4	SD-WM-PE-017
10	42	1.422	8.32	2	1	84-4	SD-WM-PE-017
10	49	1.482		2	1	84-4	SD-WM-PE-017
20	25	1.482		2	1	84-4	SD-WM-PE-017
30.5	16	1.482		2	1	84-4	SD-WM-PE-017
40	12	1.482		2	1	84-4	SD-WM-PE-017

SOLID
1=NO SOLID
2 = SOLIDS

VISCOMETER
1=BROCKFIELD
2=HAAKE

TEMP	Cp	SPG	Na	SOLID	VISC	RUN	DOCUMENT
7	33	1.462		2	1	84-4	SD-WM-PE-017
10	25	1.462		2	1	84-4	SD-WM-PE-017
16	37	1.462		2	1	84-4	SD-WM-PE-017
20	14	1.462		2	1	84-4	SD-WM-PE-017
23	23	1.462		2	1	84-4	SD-WM-PE-017
28	19	1.462		2	1	84-4	SD-WM-PE-017
30	8	1.462		2	1	84-4	SD-WM-PE-017
50	6	1.462		2	1	84-4	SD-WM-PE-017
50	1	1.085		1	1	84-4	SD-WM-PE-017
40	3	1.085		1	1	84-4	SD-WM-PE-017
30	3	1.085		1	1	84-4	SD-WM-PE-017
20	4	1.085		1	1	84-4	SD-WM-PE-017
10	4	1.085		1	1	84-4	SD-WM-PE-017
0	8	1.085		1	1	84-4	SD-WM-PE-017
47.5	17	1.53	13.33	2	2	85-2	SD-WM-PE-020
40	24	1.53	13.33	2	2	85-2	SD-WM-PE-020
35	30	1.53	13.33	2	2	85-2	SD-WM-PE-020
30	38	1.53	13.33	2	2	85-2	SD-WM-PE-020
25	50	1.53	13.33	2	2	85-2	SD-WM-PE-020
50	16.5	1.49	11.78	2	2	85-2	SD-WM-PE-020
45	22	1.49	11.78	2	2	85-2	SD-WM-PE-020
40	27	1.49	11.78	2	2	85-2	SD-WM-PE-020
35	36.5	1.49	11.78	2	2	85-2	SD-WM-PE-020
30	52	1.49	11.78	2	2	85-2	SD-WM-PE-020
20	75	1.49	11.78	2	2	85-2	SD-WM-PE-020
50	15	1.35	11.63	2	2	85-2	SD-WM-PE-020
45	20	1.35	11.63	2	2	85-2	SD-WM-PE-020
40	26	1.35	11.63	2	2	85-2	SD-WM-PE-020
35	33.5	1.35	11.63	2	2	85-2	SD-WM-PE-020
30	44	1.35	11.63	2	2	85-2	SD-WM-PE-020
25	56.5	1.35	11.63	2	2	85-2	SD-WM-PE-020
50.5	18	1.52	12.65	2	2	85-1	SD-WM-PE-019
45	25	1.52	12.65	2	2	85-1	SD-WM-PE-019
40	33	1.52	12.65	2	2	85-1	SD-WM-PE-019
35	43	1.52	12.65	2	2	85-1	SD-WM-PE-019
30	56	1.52	12.65	2	2	85-1	SD-WM-PE-019
25	77	1.52	12.65	2	2	85-1	SD-WM-PE-019
50	12	1.43	9.47	2	2	85-1	SD-WM-PE-019
45	17	1.43	9.47	2	2	85-1	SD-WM-PE-019
40	18	1.43	9.47	2	2	85-1	SD-WM-PE-019
35	20	1.43	9.47	2	2	85-1	SD-WM-PE-019
30	26	1.43	9.47	2	2	85-1	SD-WM-PE-019
25	35	1.43	9.47	2	2	85-1	SD-WM-PE-019
50	12	1.41	9.21	2	2	85-1	SD-WM-PE-019
45	16	1.41	9.21	2	2	85-1	SD-WM-PE-019
40	14	1.41	9.21	2	2	85-1	SD-WM-PE-019

SOLID
1=NO SOLID
2 = SOLIDS

VISCOMETER
1=BROCKFIELD
2=HAAKE

TEMP	Cp	SPG	Na	SOLID	VISC	RUN	DOCUMENT
35	17	1.41	9.21	2	2	85-1	SD-WM-PE-019
30	21	1.41	9.21	2	2	85-1	SD-WM-PE-019
25	26	1.41	9.21	2	2	85-1	SD-WM-PE-019
50	1	1.45	10.11	2	2	85-1	SD-WM-PE-019
45	3	1.45	10.11	2	2	85-1	SD-WM-PE-019
40	35	1.45	10.11	2	2	85-1	SD-WM-PE-019

Figure 1

VISCOSITY

Viscometer Effect

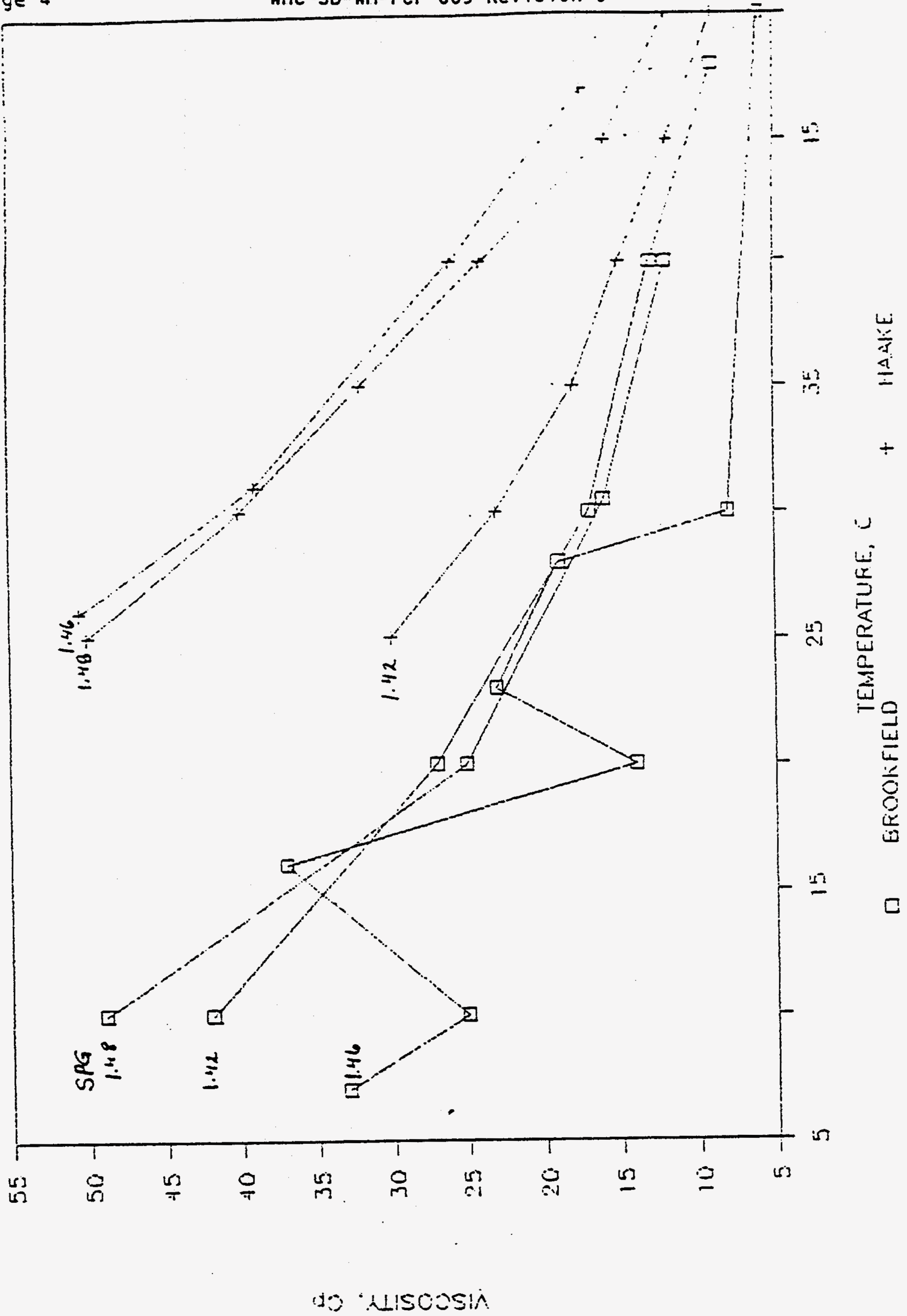


Figure 2
VISCOSITY VERSUS TEMPERATURE AND DENSITY (No Solids Present)

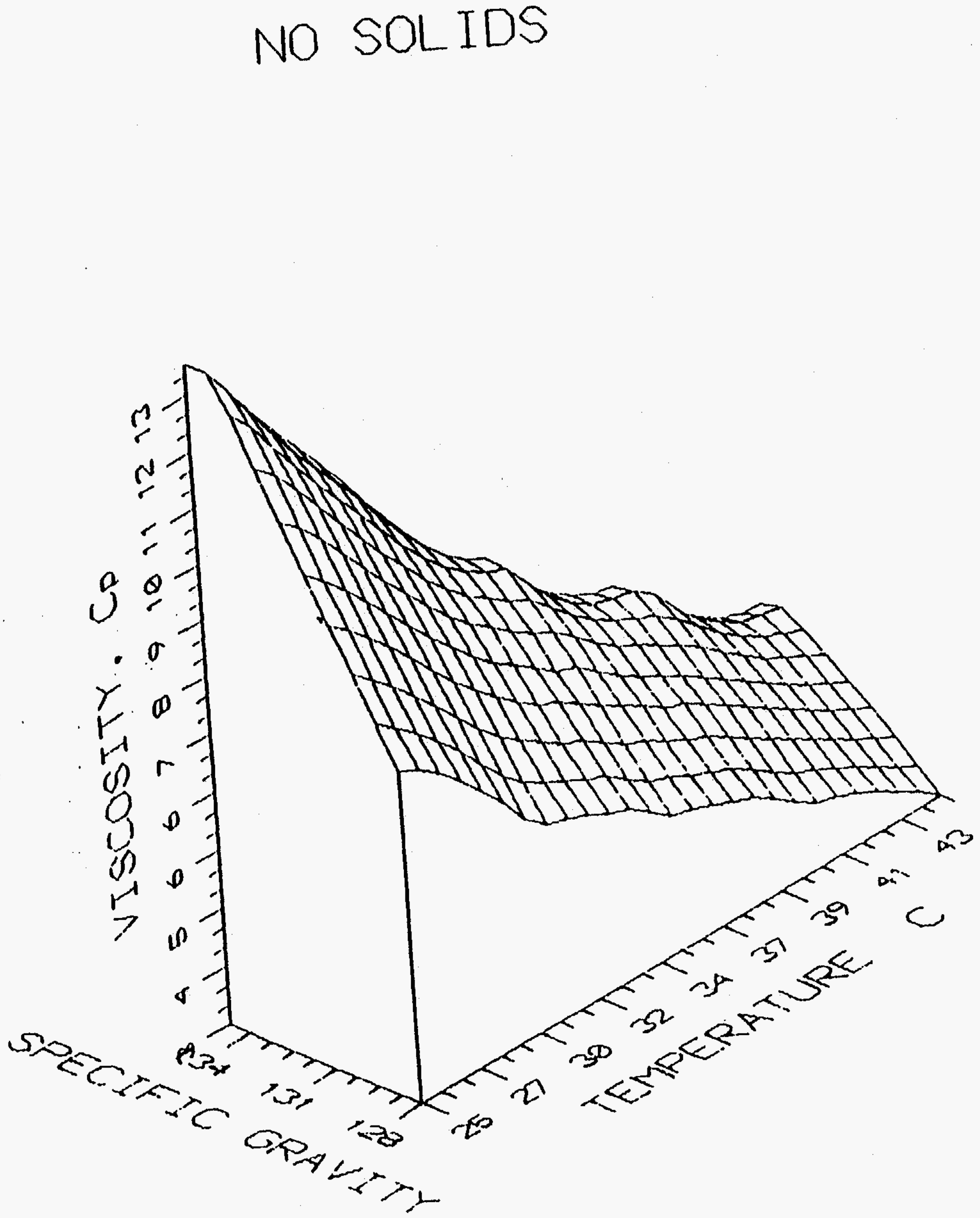


Figure 3
VISCOSITY VERSUS TEMPERATURE AND DENSITY (Solids Present)

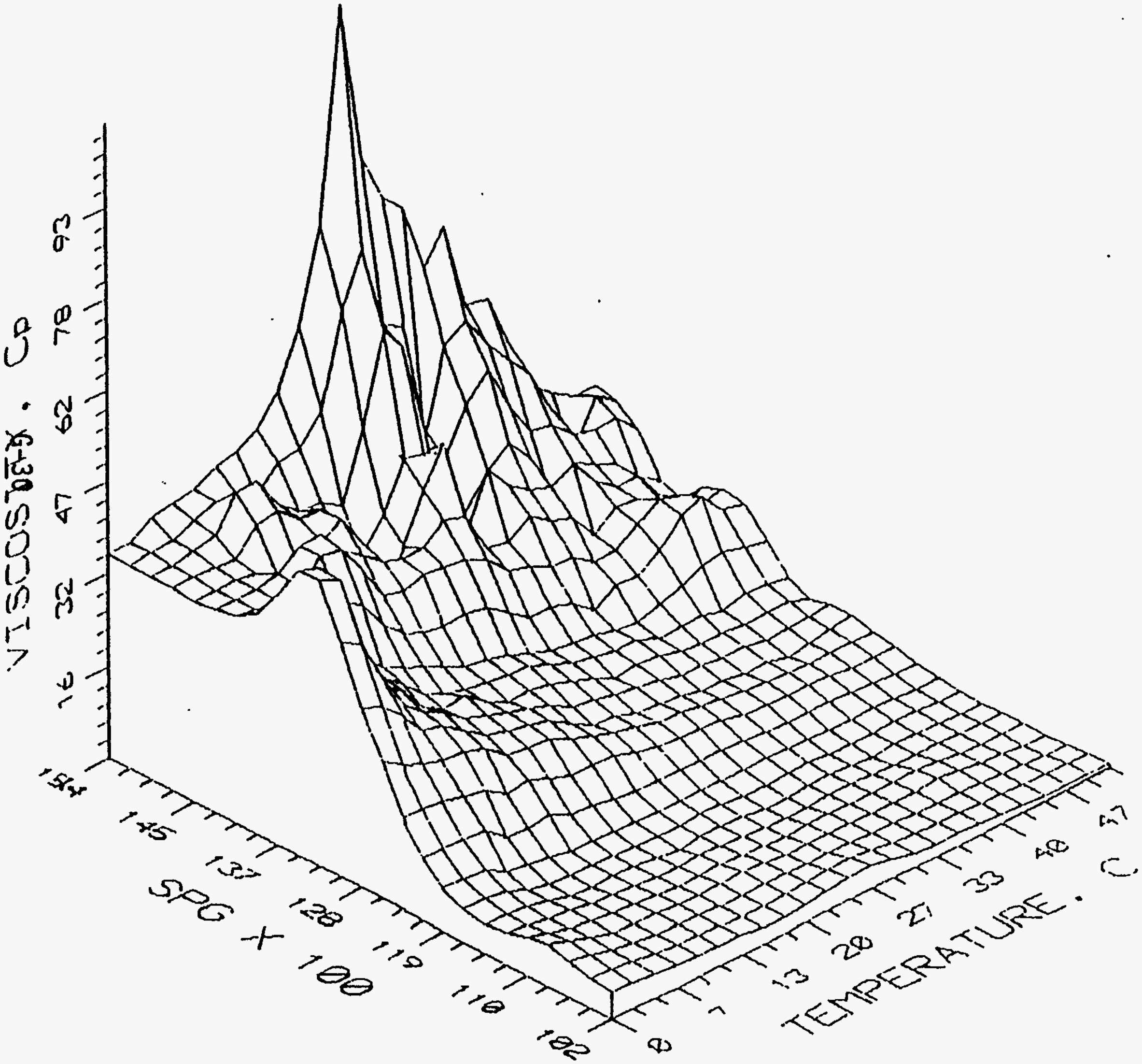


Figure 4

VISCOSITY VERSUS TEMPERATURE AND SODIUM CONCENTRATION