

## LABELING AND MARKING SPECIFICATIONS

**INNER PACKAGES:** Each inner package must be marked or labeled with the following: department name and requisition number, form number (including revision date, if any), title, and quantity. Mark or label boxes and wrapped packages on one end (not top, bottom, or sides), banded packages on the band, and tied packages on the chipboard or newsboard. Shrink film packages must be labeled, not marked, on the top or the end; labels may be placed inside the wrap.

**SHIPPING CONTAINERS:** Each shipping container must have a shipping label applied to one end (not top, bottom, or side). The label must be reproduced (same size) from the facsimile below in black ink on white paper. The label must be filled in accurately and legibly, using bold characters at least 1/4" high, except the "From" box which may be smaller. The name and requisition number of the receiving department must be used in the "Dept." box and "Dept. Req. No." box of shipping container labels in lieu of the name and requisition number of the ordering department. Label entries must remain clear

and legible for a period of at least two years under normal warehouse conditions.

**SHIPPING BUNDLES:** The information required in the facsimile below must appear in a convenient location on each shipping bundle.

**MAILED SHIPMENTS:** The facsimile below shall be used as a mailing label applied to one end of the mailing container (not top, bottom, or side). Affix postage to parcels bearing this mailing label so that the stamps or meter strip overlap the upper right corner of the label.

**CAUTION:** Noncompliance with the labeling and marking specifications will be cause for the Government to relabel in accordance with the specifications and charge all costs thereof to the contractor. The Public Printer reserves the right to institute this action without prior notice to the contractor or to reject the order because of such noncompliance.

<b>FROM</b>		<b>FOR UPS DELIVERY APPLY POSTAGE</b>
DEPT.	DOE/LMSI W 501435	<b>USE THIS PROVIDED LABEL FOR THIS ORDER, ALONG WITH PROVIDED PINK STICKERS. DO NOT SUBSTITUTE WITH ANY OTHER GPO LABELS.</b>
DEPT. REQUISITION NO.	8-00003	
GPO JACKET NO.	689-096	<b>SUB. ID NO.</b>
GPO ORDER NO.	R1195	<b>TITLE</b> HNF-SP-1147
PROGRAM/PRINT ORDER NO.	1065-S/60035	<b>TO</b> DynCorp Tri-Cities Services, Inc Central Receiving 2355 Stevens Drive Richland, WA 99352
FORM OR PUBLICATION NO./DATE		<b>GOVERNMENT INTERNAL ADDRESS:</b> Kandy Jones 825 Jadwin/Room 385 700 Area
QUANTITY PER CONTAINER		
PACKAGES PER CONTAINER	PKGS. OF	

GPO Form 2511  
1891 P. 57870-3

## PRINT ORDER

You are hereby authorized to manufacture and ship the following described product in accordance with the purchase order and specifications indicated.

DEPARTMENT	REF. NO.	DATE	PURCHASE ORDER NO.	PRINT ORDER NO.	
CONTRACTOR	DOE/LMSI	8-00003	12/03/97	R1195	60035
DIGITAL IMAGE		JACKET NO.	ESTIMATED COST	SHIP/DSL DATE	
TITLE		689-096		12/08/97	
HNF-SP-1147		OBJECT CLASS	STATE CODE	PROGRAM NO.	
PROG	SETS	24 40	460	38585	
Galley				1065-S	
Page		COMPOSITION	CHARGEABLE	QUANTITY	
Blanks		Phototype	Cold Type	6450-81	
			Hot Metal	175 ea	
MATERIAL FURNISHED TO CONTRACTOR		APPROPRIATION		TRIM SIZE	
Manuscript	Blueprints	Line Illus.	Camera Cpy	IV	
			246	8.5 x 11	
TEXT STOCK		COVER STOCK	Negatives		
20# white bond		90# white index	Binders		
FOUR COLOR PROCESS PRINTG		NO. OF TEXT PAGES (including Blanks)		FOLD-IN STOCK	
Cover	1 2 3 4	Text	246		
1 ULC	Sew	COVER PRINTS		FOLD-INS/FORMS	
Side	Trim 4 Sides	3 2	2 3 2	Face Only	
Side	Shrink Film Wrap units of	X X		Face & Back	
Product	Perf. on Pdft	246		STRIP-INS	
	Other			NEGATIVES (If No. Required)	
Drill <input type="checkbox"/> round holes <input type="checkbox"/> in diameter or <input type="checkbox"/> side <input type="checkbox"/> in c. to c.					
Center of holes <input type="checkbox"/> inches from <input type="checkbox"/> edge of sheet					
Pad of <input type="checkbox"/> sheets/sets each. Pad on the <input type="checkbox"/> side. Chipboard required.					
Pack <input type="checkbox"/> in shipping container. <input type="checkbox"/> Pallets required.					

---

#### DISTRIBUTION

DynCorp Tri-Cities Services, Inc.  
Central Receiving  
2355 Stevens Drive  
Richland, WA 99352  
# 501435

Collate in blank back cover prior to tape binding documents

Pack originals in box with completed documents.

Department Authority (Signature and Title) <u>Linda J. Perkins</u>	Purchase Obligation	DATE SENT TO CONTRACTOR 12/03/97		
CONTRACTOR TO COMPLETE BOTTOM POSITION AND MAIL ENTIRE FORM TO: COMPTROLLER/FME, FINANCIAL MANAGEMENT SERVICE, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C. 20401				
Contractor Invoice No. _____	Date Prepared _____			
Date of Delivery/Shipment _____	Discount Terms _____			
ARTICLES OR SERVICES	QUANTITY	UNIT PRICE		AMOUNT
		COST	PER	
IF ADDITIONAL SPACE IS REQUIRED, USE STD. FORM 1034, 1035, OR ATTACH YOUR INVOICE.				TOTAL _____

IF ADDITIONAL SPACE IS REQUIRED, USE  
STD. FORM 1034, 1035, OR ATTACH YOUR INVOICE.

I CERTIFY THAT THE MATERIAL, GOODS, OR SERVICES HAVE BEEN DELIVERED/SHIPPED ON THE DATE INDICATED ABOVE AND THAT PAYMENT OR CREDIT HAS NOT BEEN RECEIVED.

I CERTIFY THAT THE MATERIAL, GOOGO, ENCODED IN...

## ASSEMBLY LIST

Page

1 01 2

Jacket Number

HNF-SP-1147, Rev. 2

## LEGEND

No. Text Pages \_\_\_\_\_

Indicates \_\_\_\_\_

Total No. Sheets \_\_\_\_\_

Indicates \_\_\_\_\_

No. Printed Sides \_\_\_\_\_

Indicates \_\_\_\_\_

Indicates \_\_\_\_\_

Foldins, total \_\_\_\_\_ units

Indicates \_\_\_\_\_

Indicates \_\_\_\_\_

SHEET NO.	FRONT	BACK	SHEET NO.	FRONT	BACK	SHEET NO.	FRONT	BACK	SHEET NO.	FRONT	BACK
1	cover	disc.	26	35	36	51	85	86	76	135	136
2	title	release	27	37	38	52	87	88	77	137	138
3	iii	iv	28	39	40	53	89	90	78	139	140
4	v	vi	29	41	42	54	91	92	79	141	142
5	vii	viii	30	43	44	55	93	94	80	143	144
6	ix	x	31	45	46	56	95	96	81	145	146
7	xi	xii	32	47	48	57	97	98	82	147	148
8	xiii	xiv	33	49	50	58	99	100	83	149	150
9	1	2	34	51	52	59	101	102	84	151	152
10	3	4	35	53	54	60	103	104	85	153	154
11	5	6	36	55	56	61	105	106	86	155	156
12	7	8	37	57	58	62	107	108	87	157	158
13	9	10	38	59	60	63	109	110	88	159	160
14	11	12	39	61	62	64	111	112	89	161	162
15	13	14	40	63	64	65	113	114	90	163	164
16	15	16	41	65	66	66	115	116	91	165	166
17	17	18	42	67	68	67	117	118	92	167	168
18	19	20	43	69	70	68	119	120	93	169	170
19	21	22	44	71	72	69	121	122	94	171	172
20	23	24	45	73	74	70	123	124	95	173	174
21	25	26	46	75	76	71	125	126	96	175	176
22	27	28	47	77	78	72	127	128	97	177	178
23	29	30	48	79	80	73	129	130	98	179	180
24	31	32	49	81	82	74	131	132	99	181	182
25	33	34	50	83	84	75	133	134	100	183	184

REMARKS \_\_\_\_\_

## ASSEMBLY LIST

Page

2 of 2

Jacket Number

HNF-SP-1147, Rev 1

## LEGEND

No. Text Pages \_\_\_\_\_

Indicates \_\_\_\_\_

Indicates \_\_\_\_\_

Total No. Sheets \_\_\_\_\_

Indicates \_\_\_\_\_

No. Printed Sides \_\_\_\_\_

Indicates \_\_\_\_\_

Indicates \_\_\_\_\_

Foldings, total \_\_\_\_\_ units

Indicates \_\_\_\_\_

SHEET NO.	FRONT	BACK	SHEET NO.	FRONT	BACK	SHEET NO.	FRONT	BACK	SHEET NO.	FRONT	BACK
1	185	186	26			51			76		
2	187	188	27			52			77		
3	189	190	28			53			78		
4	191	192	29			54			79		
5	193	194	30			55			80		
6	A-i	A-ii	31			56			81		
7	A-1	A-2	32			57			82		
8	B-i	B-ii	33			58			83		
9	B-1	B-2	34			59			84		
10	B-3	B-4	35			60			85		
11	C-i	C-ii	36			61			86		
12	C-1	C-2	37			62			87		
13	D-i	D-ii	38			63			88		
14	D-1	D-2	39			64			89		
15	E-i	E-ii	40			65			90		
16	E-1	E-2	41			66			91		
17	E-3	E-4	42			67			92		
18	F-i	F-ii	43			68			93		
19	F-1	F-2	44			69			94		
20	G-i	G-ii	45			70			95		
21	G-1	G-2	46			71			96		
22	Distr-1	Distr-2	47			72			97		
23	Distr-3	Distr-4	48			73			98		
24			49			74			99		
25			50			75			100		

REMARKS \_\_\_\_\_

# **PUREX/UO<sub>3</sub> Facilities Deactivation Lessons Learned History**

Prepared for the U.S. Department of Energy  
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the  
U.S. Department of Energy under Contract DE-AC06-96RL13200

Approved for public release; distribution is unlimited

**LEGAL DISCLAIMER**

---

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

---

This report has been reproduced from the best available copy.  
Available in paper copy and microfiche.

Available to the U.S. Department of Energy  
and its contractors from  
U.S. Department of Energy  
Office of Scientific and Technical Information (OSTI)  
P.O. Box 62  
Oak Ridge, TN 37831  
(615) 576-8401

Available to the public from the U.S. Department of Commerce  
National Technical Information Service (NTIS)  
5285 Port Royal Road  
Springfield, VA 22161  
(703) 487-4650

Printed in the United States of America

DISCLM-1.CHP (8-95)

# **PUREX/UO<sub>3</sub> Facilities Deactivation Lessons Learned History**

**R. W. Bailey**  
B&W Hanford Company

**M. S. Gerber**  
Fluor Daniel Hanford Company

Date Published  
October 1997

Prepared for the U.S. Department of Energy  
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the  
U.S. Department of Energy under Contract DE-AC06-96RL13200

Approved for public release; distribution is unlimited

## RELEASE AUTHORIZATION

Document Number: HNF-SP-1147, Rev. 2

Document Title: PUREX/U03 Facilities Deactivation Lessons Learned History

This document, reviewed in accordance with DOE Order 1430.1D, "Scientific and Technical Information Management," and DOE G 1430.1D-1, "Guide to the Management of Scientific and Technical Information," does not contain classified or sensitive unclassified information and is:

APPROVED FOR PUBLIC RELEASE

*V. L. Birkland*  
V. L. Birkland

*11/7/97*

Lockheed Martin Services, Inc.  
Document Control/Information Clearance

Reviewed for Applied Technology, Business Sensitive, Classified, Copyrighted, Export Controlled, Patent, Personal/Private, Proprietary, Protected CRADA, Trademark, Unclassified Controlled Nuclear Information.

LEGAL DISCLAIMER. This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof. This report has been reproduced from the best available copy. Printed in the United States of America. Available to the U.S. Department of Energy and its contractors from the U.S. Department of Energy Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; Telephone: 423/576-8401.

Available to the public from the U.S. Department of Commerce National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; Telephone: 703/487-4650.

## EXECUTIVE SUMMARY

In May 1997, a historic deactivation project at the PUREX (plutonium-uranium extraction) facility at the Hanford Site in south-central Washington State concluded its activities (Figure ES-1). The project work was finished at \$78 million under its original budget of \$222.5 million, and 16 months ahead of schedule. Closely watched throughout the U.S. Department of Energy (DOE) complex and by the U.S. Department of Defense for the value of its lessons learned, the PUREX Deactivation Project has become the national model for the safe transition of contaminated facilities to shut down status.

## A FAREWELL TO ARMS

"By deactivating the PUREX facility," explained James Mecca of DOE, the federal management agency that oversees the Hanford Site, "we're demonstrating America's commitment to live in peace, in real terms. PUREX was a leading facility in the Cold War, and now has proved its leadership in peace also." Between 1944 and 1990, the Hanford Site produced 53 metric tons of weapons-grade plutonium, approximately half the amount of such material ever produced for the United States defense stockpile. The PUREX plant processed about 80 percent of the Hanford Site's plutonium (Figure ES-2).

According to PUREX Plant Manager Bill Bailey, "the deactivation of PUREX is not a trivial event. PUREX was a workhorse in the buildup of the United States nuclear arsenal. Now with the major hazards removed and the mortgage reduced thirtyfold, it provides a path forward and momentum for cleanup of the rest of the weapons complex." The PUREX "mortgage" is the annual cost of surveillance and maintenance (S&M) for the facility. The annual mortgage was approximately \$35 million at the start of the PUREX Deactivation Project, but dropped to about \$1 million when the project was completed.

The PUREX/UO<sub>3</sub> Deactivation Project began in October 1993 with a 5-year schedule and a \$222.5-million budget.<sup>a,1</sup> As a result of innovations implemented during 1994 and 1995, the project schedule was shortened by over a year, with commensurate monetary savings. In 1994 the innovations included arranging to send contaminated nitric acid from the PUREX Plant to British Nuclear Fuels, Limited (BNFL) for reuse and sending metal solutions containing plutonium and uranium from PUREX to the Hanford Site tank farms. These two steps saved the project \$36.9 million.<sup>2</sup> In 1995, reductions in overhead rate, work scope, and budget, along with curtailed capital equipment expenditures, reduced the cost another \$25.6 million.<sup>3</sup> These savings were achieved by using activity-based cost estimating and applying technical schedule enhancements. In 1996, a series of changes brought about under the general concept of "reengineering" reduced the cost approximately another \$15 million, and brought the completion date forward to May 1997.<sup>4</sup>

---

<sup>a</sup> Note: Deactivation of the UO<sub>3</sub> Plant was completed in February 1995, and this facility was turned over to the DOE's decontamination and decommissioning (D&D) organization. After that time, the name of the PUREX/UO<sub>3</sub> Deactivation Project was shortened to the PUREX Deactivation Project.

Figure ES-1. PUREX Close-Out Ceremony,  
"Closing the Door on the Cold War," June 1997.

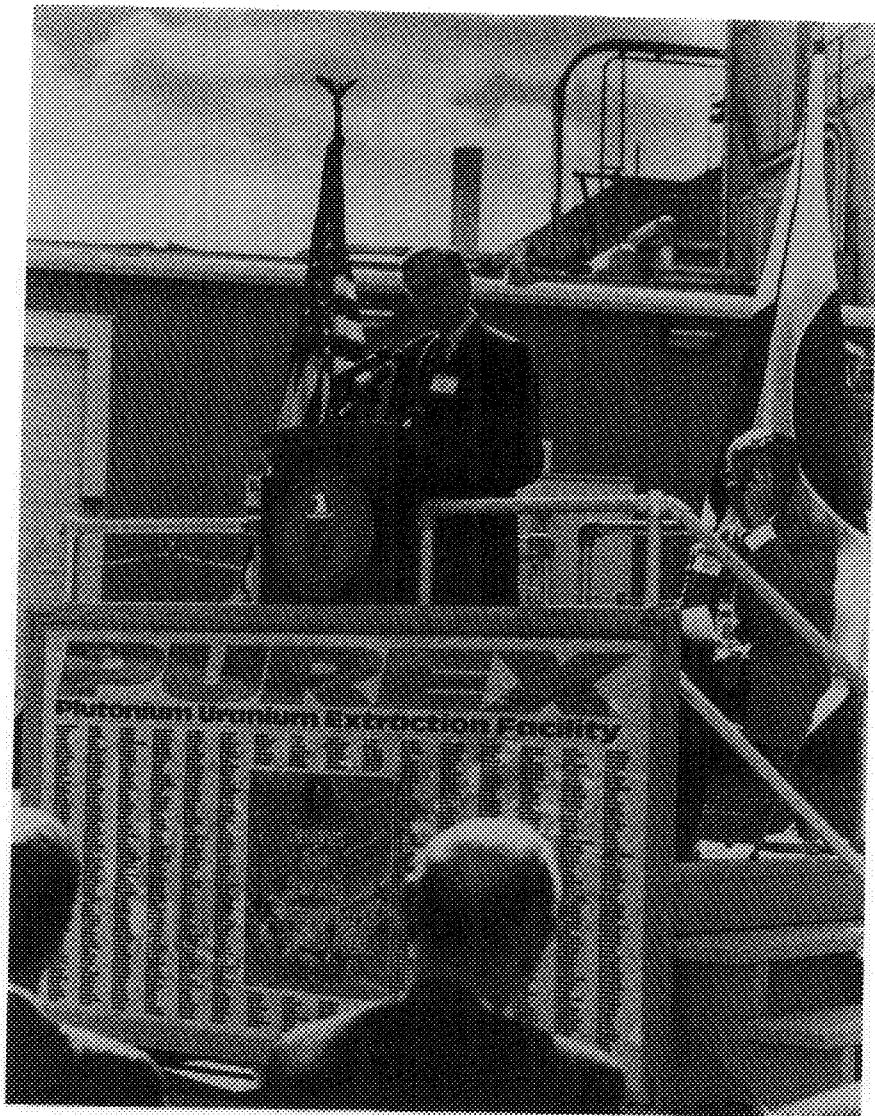
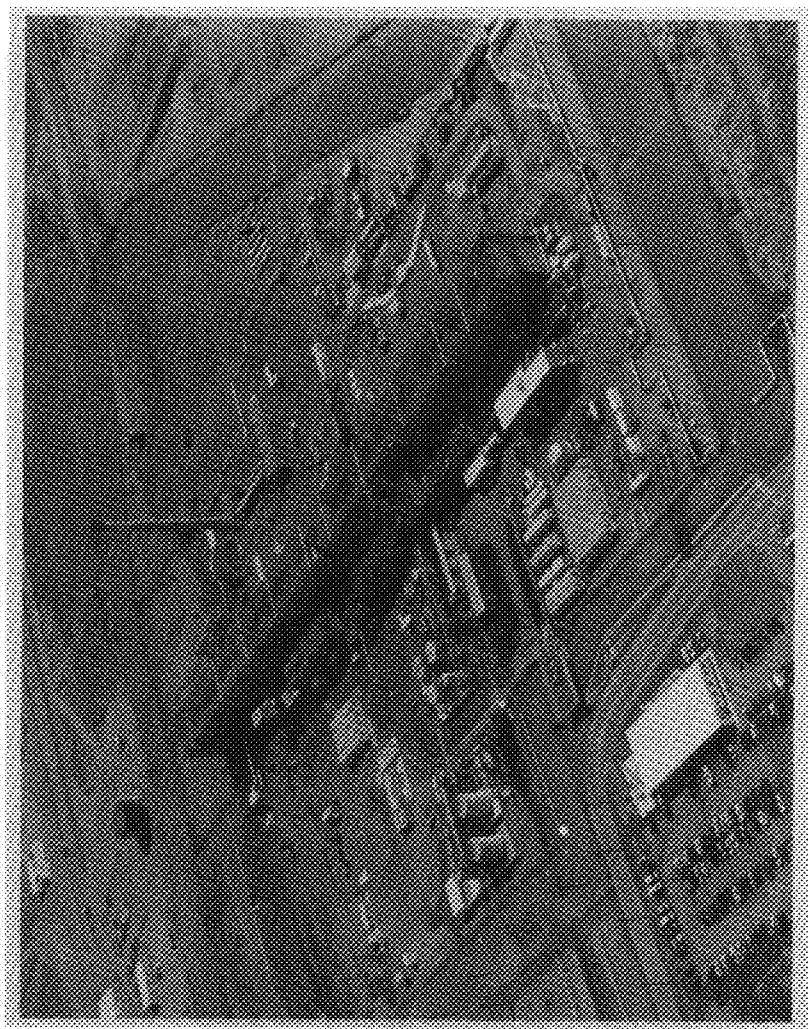


Figure ES-2. PUREX Plant and Ancillary Facilities, 1995.



Additional efficiencies in deactivation actions early in 1997, especially consolidating the heating, ventilation, and air conditioning systems, saved an additional \$3 million, bringing the total savings over the project life to \$78 million, or about 35 percent of the originally projected cost. Because these savings have immense potential value to other facilities within American and foreign weapons complexes, it is important to understand how the changes came about at PUREX, what decisions were made, and why they were made.

Many technical challenges were present in the PUREX facility at the start of the deactivation project. At each technical decision point, the DOE chose the option that involved the least physical manipulation of materials to shorten the time that facility systems had to operate. This basic principle helped to drive down the deactivation costs perhaps more than any other factor, allowing the "parked car" state to be achieved quickly and directly (Figure ES-3).

#### RIGHT-TO-LEFT PLANNING

Beyond meeting the technical challenges, the most important lesson learned in the PUREX Deactivation Project involves project planning. The benefits of right-to-left project planning are so great that the DOE would like to share them with the rest of the weapons complex. A deactivation project must start by identifying its end points, then base every task, budget, and organizational decision on reaching those end points.

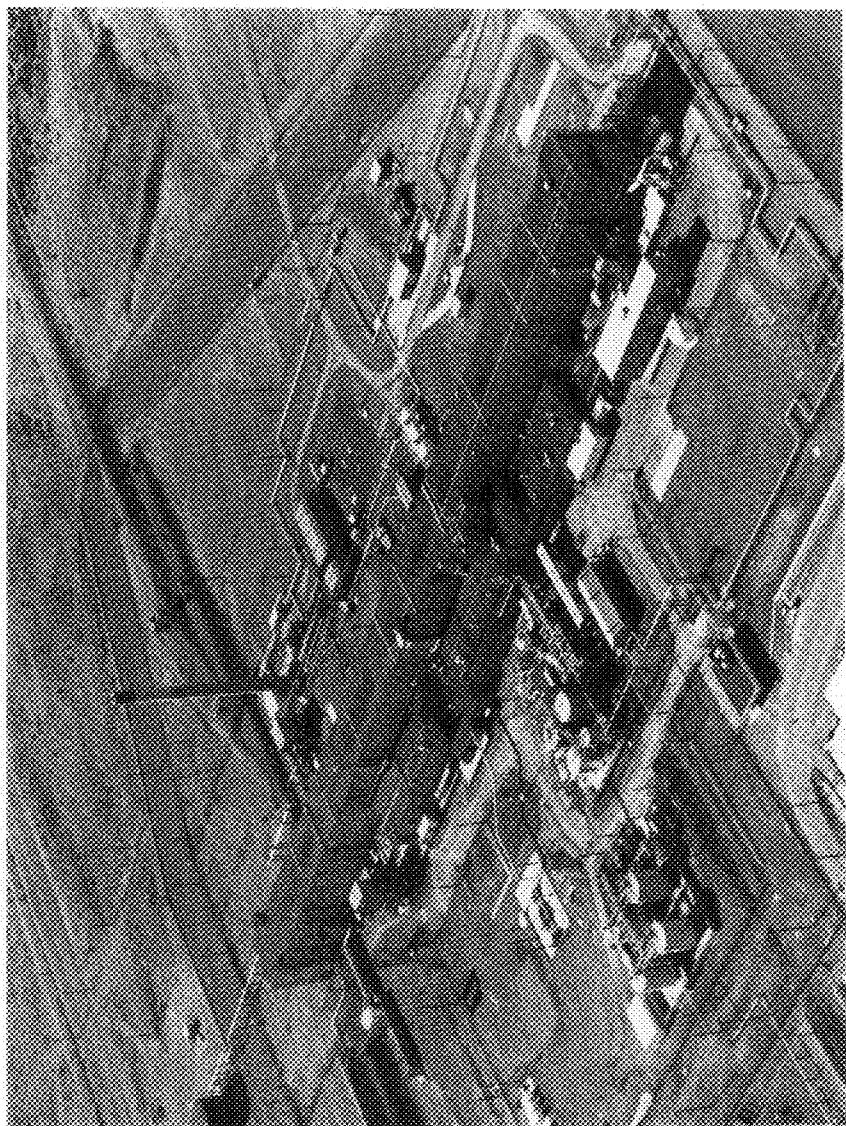
In addition, DOE learned that project planning and scheduling should be tied directly to costing and that project status should be checked often to reflect real-time work. According to DOE's Larry Romine, who worked closely with the PUREX facility during the deactivation effort, "people working on a successful project should never be guessing about its schedule or living with a paper schedule that does not represent the actual state of work."

The PUREX Deactivation Project led the way in many other areas where its experience can help other deactivating facilities. Early and frequent consultations with regulators allowed all parties to agree on streamlining regulatory documentation to levels that made sense to everyone. Likewise, safety analysts from DOE, contractors, consultants, and others worked together to write and revise safety documentation to levels that fit the needs of the plant as hazards decreased. Unique job hazards analyses tools also were developed for use by workers in the field, thus empowering those who actually performed the various shut-down tasks.

#### STAKEHOLDER INVOLVEMENT IMPORTANT

Stakeholder involvement played a key role in the PUREX shutdown effort. When the decision was made to ship the contaminated nitric acid to BNFL in England, 50 separate shipments had to travel nearly 6400 kilometers (4,000 miles) overland in the United States. PUREX personnel sent the draft environmental assessment of the shipments to more than 200 entities along the route, including state governments, Indian nations, and individuals. They held public meetings in the three eastern seaboard cities being considered as

Figure ES-3. PUREX Plant and Ancillary Facilities, 1997.



departure points. In this manner, they involved everyone who was interested. During the shipping period, the DOE Richland Operations Office held weekly conference calls with the emergency response and public health organizations in every corridor state to report progress and discuss questions or concerns.

Many other lessons were learned during the PUREX Deactivation Project. For example, leaving some decisions to the future is wise. Deactivation is an interim step in the life of a facility. The essential job of a deactivation project is to place a facility in a safe, stable, low-maintenance mode for an interim period. The team managing a deactivation project should make straightforward, cost-effective decisions based on the needs of the current situation, but should not try to foresee, force, or preclude decisions about decontamination and decommissioning that deserve to be made by citizens of the future. Keeping the limited objectives of the project in mind also can guide decisions that reduce risks and generate minimal waste.

Other salient lessons learned in the PUREX/UO<sub>3</sub> Deactivation Project involve sweeping changes that took place in the early 1990s in the culture at the Hanford Site. These changes included the following:

- Shifting employee relations and work structures
- Recognizing the value of independent review, teamwork, and reengineering concepts
- Discovering the essential nature of early and ongoing communication
- Drawing on the enormous value of resident knowledge acquired by people over years, sometimes decades, of working in old plants
- Recognizing when to bring in outside expertise for certain specialized tasks
- Using electronic technology to manage information
- Adopting new methods and bases for evaluating progress.

Because these changes helped save money and were accompanied by and an integral part of sweeping culture changes, the lessons learned during the PUREX Deactivation Project form an important chapter in DOE's and America's history.

#### LESSONS LEARNED HISTORY DOCUMENT

The *PUREX/UO<sub>3</sub> Facilities Deactivation Lessons Learned History* was first issued in January 1995. A revision was issued in September 1996 to incorporate several key changes that occurred in the project. This edition captures the ongoing and final lessons; some of the most unexpected and valuable lessons were learned in the final months of the project. In this edition, the significant lessons learned are captured at the end of each section then recounted in Chapter 11.0, "Lessons Consolidated." We hope and believe that the lessons learned from the PUREX Deactivation Project will help other facilities both inside and outside the DOE complex.<sup>5</sup>

## TABLE OF CONTENTS

1.0	HISTORY AND BACKGROUND AT THE PUREX AND UO <sub>3</sub> FACILITIES . . . . .	1
1.1	DEFENSE PRODUCTION HISTORY OF THE PUREX PLANT . . . . .	1
1.2	STABILIZATION CAMPAIGN CONDUCTED WHILE LEGAL ISSUES DEBATED . . . . .	1
1.3	PUREX STANDBY PERIOD AND FINAL SHUTDOWN ORDER . . . . .	5
1.4	STANDBY ACTIONS AND GOALS AT PUREX . . . . .	6
1.5	SALE OF PUREX FRESH CHEMICALS DEMONSTRATES EARLY CREATIVITY . . . . .	9
1.6	DEACTIVATION PLANNING BEGINS-NEW DEFINITIONS ARISE . . . . .	11
1.7	RED TEAM RECOMMENDS PROJECT APPROACH, STREAMLINED DOCUMENTATION . . . . .	12
1.8	UO <sub>3</sub> PLANT HISTORY AND BACKGROUND . . . . .	13
1.9	LESSONS LEARNED . . . . .	13
2.0	REENGINEERING THE HANFORD SITE . . . . .	15
2.1	THE REENGINEERING CONCEPT . . . . .	15
2.2	TIMING AND NEED DRIVE DECISION TO REENGINEER HANFORD SITE . . . . .	16
2.3	PUREX FACILITY FIRST CHOICE FOR HANFORD SITE REENGINEERING . . . . .	17
2.4	LESSONS LEARNED . . . . .	18
3.0	REENGINEERING THE PUREX PROJECT MANAGEMENT STRUCTURE . . . . .	19
3.1	THE CASE FOR ACTION . . . . .	19
3.2	REENGINEERING BRINGS DRAMATIC RESULTS AT PUREX . . . . .	19
3.3	REENGINEERING PROCESS BEGINS WITH ASSESSMENT OF ESSENTIAL PUREX TASKS . . . . .	20
3.4	TEAMS/SKILLS MIX IDENTIFIED . . . . .	23
3.5	JOB APPLICATION AND SELECTION PROCESS . . . . .	23
3.6	THE PUREX PEOPLE CENTER ADDRESSES CHANGE . . . . .	25
3.7	TRAINING PEOPLE FOR THE REENGINEERED WORK PLACE AT PUREX . . . . .	27
3.8	CLOSE-OUT OF THE PUREX TEAMS AND WORK FORCE REDEPLOYMENT . . . . .	30
3.9	RESULTS/ASSESSMENT OF PUREX WORK FORCE REENGINEERING . . . . .	31
3.10	LESSONS LEARNED . . . . .	33
4.0	PUREX WORK PLANNING/ENDPOINTS DEVELOPMENT AND DOCUMENTATION . . . . .	36
4.1	FIRST STEPS IN DEACTIVATION WORK PLANNING . . . . .	36
4.2	PROJECT MANAGEMENT PLAN . . . . .	37
4.3	END POINT CRITERIA WORKSHOP . . . . .	37
4.4	END POINTS ESTABLISHED USING MATRIX-BASED APPROACH . . . . .	38
4.5	END POINT PLANNING FIRST TESTED AT UO <sub>3</sub> PLANT . . . . .	40
4.6	PUREX PLANT END POINTS DEVELOPMENT REFINES UO <sub>3</sub> APPROACH . . . . .	42
4.7	FINAL END POINTS CLOSE-OUT . . . . .	43
4.8	FASTER TEAM FORMED . . . . .	45
4.9	LESSONS LEARNED . . . . .	45

## TABLE OF CONTENTS (cont)

5.0	SCHEDULING PROCESS AND PRODUCT . . . . .	47
5.1	EARLY SCHEDULING DECISIONS MADE . . . . .	47
5.2	OVERALL COORDINATION REQUIRED FOR DEACTIVATION PROJECT SCHEDULING . . . . .	48
5.3	1994 BASELINE REVISIONS MADE . . . . .	50
5.4	REBASELINING, REENGINEERING BRING SCHEDULE REVISIONS: LEAD TO TEAM OWNERSHIP . . . . .	50
5.5	FINAL SCHEDULE REVISIONS MADE . . . . .	51
5.6	LESSONS LEARNED . . . . .	52
6.0	REGULATORY ISSUES . . . . .	53
6.1	RESOURCE CONSERVATION AND RECOVERY ACT AND TRI-PARTY AGREEMENT ISSUES . . . . .	53
6.2	AIR PERMITTING ISSUES . . . . .	60
6.3	NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) ISSUES . . . . .	62
6.4	NATIONAL HISTORIC PRESERVATION ACT COMPLIANCE . . . . .	63
6.5	CLEAN WATER ACT COMPLIANCE . . . . .	64
6.6	UO <sub>3</sub> PLANT REGULATORY COMPLIANCE . . . . .	64
6.7	LESSONS LEARNED . . . . .	64
7.0	SAFETY DOCUMENTATION AND INNOVATIONS . . . . .	67
7.1	EXISTING OPERATIONAL AND STANDBY SAFETY DOCUMENTATION . . . . .	67
7.2	DEACTIVATION ORDER SPARKS "CROSSWALK" ACTIVITIES . . . . .	68
7.3	SAFETY BASES FOR EARLY DEACTIVATION ACTIVITIES . . . . .	68
7.4	GRADED HEALTH AND SAFETY PLAN DOCUMENT BECOMES CORNERSTONE . . . . .	70
7.5	PUREX S/RID COMPLETED . . . . .	72
7.6	REENGINEERING DEVELOPS EMPLOYEE JOB HAZARDS ANALYSIS . . . . .	72
7.7	CRITICALITY ALARM SILENCED . . . . .	74
7.8	SURVEILLANCE AND MAINTENANCE PLAN WRITTEN . . . . .	74
7.9	PUREX BASIS FOR INTERIM OPERATION DOCUMENT NEEDED . . . . .	76
7.10	LESSONS LEARNED . . . . .	77
8.0	TECHNICAL ISSUES . . . . .	79
8.1	N-CELL, PR ROOM, Q-CELL, AND SAMPLE GALLERY DEACTIVATION . . . . .	79
8.2	METAL SOLUTION DISPOSITION (D5/E6) . . . . .	86
8.3	SINGLE-PASS REACTOR FUEL AND N REACTOR FUEL DISPOSITION . . . . .	88
8.4	NITRIC ACID DISPOSITION . . . . .	92
8.5	ORGANIC DISPOSITION . . . . .	93
8.6	LABORATORY DEACTIVATION . . . . .	97
8.7	L-CELL CLEANOUT . . . . .	100
8.8	CANYON/VESSEL FLUSHING . . . . .	105
8.9	PUREX TUNNELS 1 AND 2 (218-E-14) (218-E-15) . . . . .	108
8.10	PUREX HVAC CONSOLIDATION . . . . .	114
8.11	PUREX ELECTRICAL/UTILITIES REVISIONS . . . . .	118
9.0	UO <sub>3</sub> DEACTIVATION . . . . .	121
10.0	STAKEHOLDER INVOLVEMENT . . . . .	128
11.0	LESSONS CONSOLIDATED . . . . .	133

TABLE OF CONTENTS (cont)

12.0 ENDNOTES . . . . .	147
13.0 BIBLIOGRAPHY . . . . .	157

APPENDICES

- A PUREX ORGANIZATIONAL CHARTS (BEFORE AND AFTER REENGINEERING)
- B INITIAL PUREX TEAMS CREATED IN DECEMBER 1996
- C TABLE OF PROCESS VESSELS AND CHEMICALS IN THE PUREX PLANT,  
COMPILED FOR REGULATORY STREAMLINING
- D PUREX M-80 TRI-PARTY AGREEMENT MILESTONES
- E JOB HAZARDS ANALYSIS FORM
- F FLUSH K-CELL CHART
- G PUREX HVAC SYSTEMS BEFORE AND AFTER CONSOLIDATION

## LIST OF ILLUSTRATIONS

1	Inside the 1,000-Foot-Long PUREX Canyon During Shutdown, 1982 . . . . .	2
2	Inside the PUREX Control Room During Operations, 1984 . . . . .	3
3	PUREX Workers Celebrate Completion of the Stabilization Run, March 1990 . . . . .	4
4	Cake Commemorating End of Successful November 1989 to March 1990 Stabilization Run . . . . .	4
5	The Radiation Zone Reduction Plan was one of the Earliest Steps Taken During the PUREX Standby Period . . . . .	7
6	Emissions from the PUREX White Room Fans and Exhaust Stacks were Reduced as Part of Standby-Period Work . . . . .	8
7	Hydrogen Peroxide Tanks Before They were Removed from the PUREX Facility for use in Another Project, 1993 . . . . .	10
8	PUREX Workers Gather to Hear About Reengineering Plans, 1995 . . . . .	22
9	Another Employee Meeting About Reengineering, 1995 . . . . .	22
10	A PUREX Team Moves into a Colocation Setting, Early 1996 . . . . .	26
11	Information Boards Established at PUREX to Keep Workers Informed . . . . .	28
12	Extensive Communication with Employees Helped Reengineering Succeed . . . . .	28
13	Early Deactivation Project Schedules Being Developed in the PUREX War Room, 1994 . . . . .	49
14	Washington State Police Inspect Truck that will Transport Contaminated Nitric Acid from the PUREX Facility . . . . .	55
15	A Washington Department of Health Inspector Verifies a Sampler Installation at PUREX, 1993 . . . . .	57
16	Permitted Waste Accumulation Area in the PUREX Facility, 1995 . . . . .	58
17	Monitoring PUREX Stack Emissions, 1994 . . . . .	61
18	Employee Awareness was an Important Part of the PUREX/UO <sub>3</sub> Deactivation Project Safety Program . . . . .	69
19	Good Housekeeping also Contributed to Safety During the PUREX/UO <sub>3</sub> Deactivation Project . . . . .	69
20	News Conference Announcing the Turnoff of the PUREX Criticality Alarm, June 1996 . . . . .	75
21	Nuclear Operator Removes Residual Plutonium Contamination from Equipment Inside N-Cell Glove Box, as Part of Deactivation, Early 1996 . . . . .	81
22	Waste is Packaged out of PUREX N-Cell, as Part of Deactivation, 1996 . . . . .	82
23	N-Cell Equipment is Sealed Shut After Cleanout, PUREX, 1996 . . . . .	83
24	Q-Cell Samplers Sealed Shut After Deactivation, PUREX Plant, 1994 . .	85
25	Transfer of Spent Fuel from PUREX to the 105-K West Basins, Hanford Site, 1995 . . . . .	90
26	Shipping Container Used to Transport Contaminated Nitric Acid from the PUREX Facility to England, 1995 . . . . .	94
27	Final Nitric Acid Shipment from PUREX is Readied, November 1995 . . .	95
28	Final Nitric Acid Shipment Leaves the PUREX Facility, November 1995 . . . . .	96
29	Inspection of Equipment Used to Transport Organic Solution from PUREX Facility to Diversified Scientific Services Incorporated in Tennessee, 1995 . . . . .	98

## LIST OF ILLUSTRATIONS (cont)

30	Operator Prepares Tank for Loading and Shipment of Organic Solution from PUREX Facility, 1995 . . . . .	99
31	Nuclear Operators Deactivate PUREX Laboratory Hoods, 1995 . . . . .	101
32	Foam is Spread Inside PUREX Laboratory Hood in Final Deactivation Step, 1996 . . . . .	102
33	PUREX L-Cell Equipment During Operations, 1971 . . . . .	103
34	PUREX Workers Prepare for L-Cell Characterization Entry, 1994 . . . . .	104
35	Cascade Flushing of K-Cell is Monitored in the PUREX Control Room, 1994 . . . . .	107
36	PUREX Storage Tunnel 1 Under Construction in 1954 . . . . .	109
37	324 Building Waste is Moved into PUREX Tunnel Number 2, 1996 . . . . .	112
38	Final Three Permitted Rail Cars of Waste (Closest to Plant) are Moved into PUREX Tunnel Number 2, Summer 1996 . . . . .	113
39	Main PUREX Stack (291-A), 1987. . . . .	115
40	T-Hoppers Holding Uranium Trioxide Powder, Outside the UO <sub>3</sub> Plant, 1984 . . . . .	122
41	Worker Cleaning Calciner as Part of UO <sub>3</sub> Plant Deactivation, 1994 . . . . .	125
42	Officials Gather to Transfer UO <sub>3</sub> Plant from the DOE's Deactivation Organization to the D&D Organization . . . . .	126
43	J. R. Wilkinson, Hanford Programs Manager for the Confederated Tribes of the Umatilla Indian Reservation, Speaks at PUREX All-Employee Meeting, 1994 . . . . .	130
44	Representatives of the Confederated Tribes of the Umatilla Indian Reservation Inspect Nitric Acid Transport Container at PUREX Facility, 1994 . . . . .	131

This page intentionally left blank.

## 1.0 HISTORY AND BACKGROUND AT THE PUREX AND UO<sub>3</sub> FACILITIES

### 1.1 DEFENSE PRODUCTION HISTORY OF THE PUREX PLANT

The Plutonium-Uranium Extraction (PUREX) facility (202-A Building) was constructed by the U.S. Atomic Energy Commission (AEC), a predecessor agency to the U.S. Department of Energy (DOE) from 1953 through 1955, and began full-scale processing of aluminum-clad, irradiated natural uranium (U) fuel elements in January 1956. It supported the national plutonium (Pu) production efforts until September 1972. The dissolver equipment was changed beginning in 1963 to accommodate the processing of larger, zirconium-clad fuel elements with higher U-235 content. Throughout its early operating years, the PUREX Plant was modified to allow production increases; the segregation of neptunium-237 into a separate, continuous stream; the processing of fuel from various special test reactors throughout the nation; and the performance of other missions. In November 1983, after 11 years of upgrades, the PUREX Facility reopened to resume processing irradiated fuel elements for defense production (Figures 1 and 2). The PUREX Facility closed briefly in 1988 to correct a minor violation of safety standards. On December 7, 1988, the plant was shut down for nearly a year when steam pressures fell below the levels needed to support backup safety equipment.

### 1.2 STABILIZATION CAMPAIGN CONDUCTED WHILE LEGAL ISSUES DEBATED

On January 12, 1989, the Natural Resources Defense Council, writing on behalf of two additional interest groups (the Hanford Education Action League [HEAL] and the Nuclear Safety Campaign), notified the DOE of their intention to sue if PUREX operations were resumed without preparing a supplement to the 1983 environmental impact statement (EIS).<sup>6</sup> Following several equipment repairs and improvements to waste-handling systems, the PUREX Facility conducted a "stabilization campaign" to reduce its inventory of special nuclear materials and to place various internal systems into a stable configuration. This activity lasted from November 1989 through March 1990 and processed 90.7 metric tons of irradiated uranium material that had been "stranded" in various forms and locations in the plant at the time of the abrupt shutdown on December 7, 1988. Conducting the stabilization campaign placed the facility in a much safer mode than would have existed if the irradiated material had been left in its then-current state. The material processed in the stabilization campaign included 54.7 metric tons of irradiated uranium material already declad and dissolved in 5 tanks, as well as material in the 3 dissolver cells. It also included 36 metric tons of uranium in solutions containing plutonium that needed rework (i.e., plutonium that did not meet the specifications from previous processing) (Figures 3 and 4).

At the end of the stabilization campaign, the PUREX Plant still contained large quantities of radioactive and hazardous materials. Major portions of the inventory included the following:

- Approximately 9 kilograms of plutonium in oxide form in N-Cell (the oxide conversion cell) and the Product Removal (PR) room

Figure 1. Inside the 1,000-Foot-Long PUREX Canyon During Shutdown, 1982.

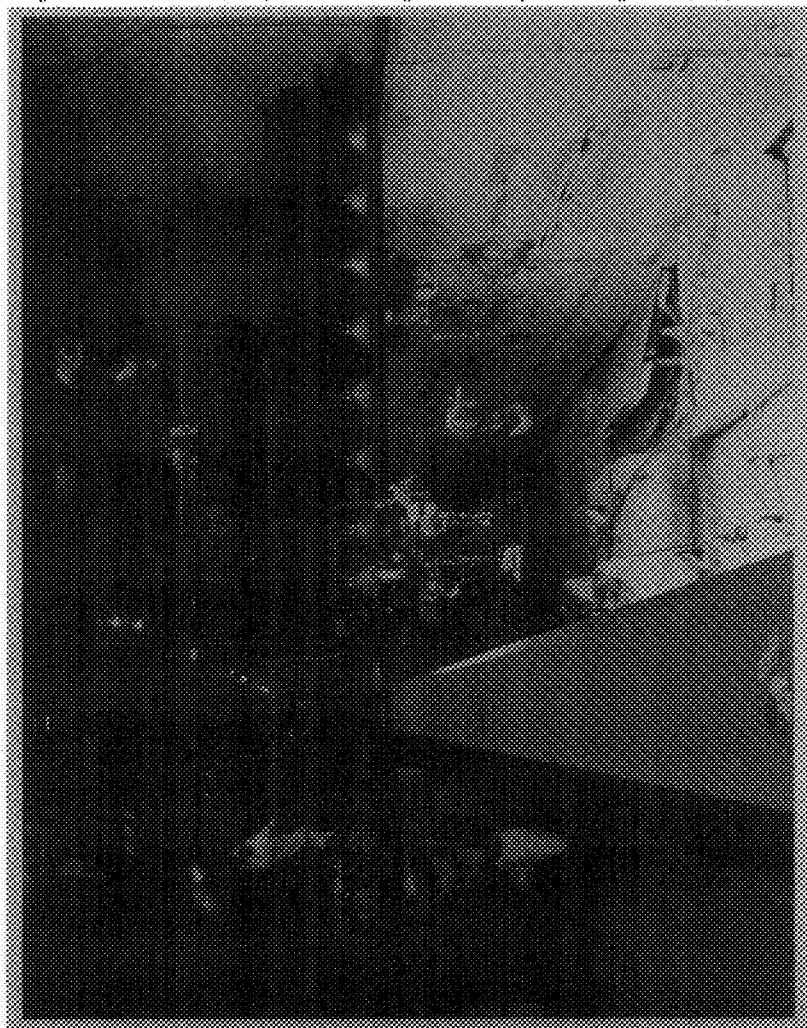


Figure 2. Inside the PUREX Control Room During Operations, 1984.



Figure 3. PUREX Workers Celebrate Completion of the Stabilization Run, March 1990.



Figure 4. Cake Commemorating End of Successful November 1989 to March 1990 Stabilization Run.



- Approximately 9 kilograms of plutonium and 5.3 metric tons of uranium in recycled uranium nitrate solution in tanks D5 and E6.
- Approximately 4,164 liters (1,100 gallon) of neptunium-bearing solution in tank J2
- Solids on the L-Cell floor containing an estimated 3.90 kilograms of plutonium
- Sludge on the E-Cell floor that covered approximately 1.1 to 1.4 cubic meters (40 to 48 cubic feet) that could contain up to 400 grams of plutonium
- 2.9 tons of aluminum-clad irradiated uranium fuel in the PUREX slug (fuel element) storage basin
- Between 681,372 and 757,080 liters (180,000 to 200,000 gallons) of contaminated nitric acid (recovered from both the PUREX process and subsequently from the UO<sub>3</sub> Plant)
- 79,493 liters (21,000 gallons) of organic solvent [tri-butyl phosphate (TBP), 23 percent in a normal paraffin hydrocarbon (NPH), 77 percent diluent-TBP/NPH] in G- and R-Cells
- Approximately 50 zirconium-clad, irradiated fuel elements on the floor of dissolver Cells A, B, and C
- Silver reactors containing active iodine-129 in A-, B-, and C-Cells.

Lead, mercury, and other hazardous substances were located in various parts of the facility, and 907,200 to 1,088,640 kilograms (1,000 to 1,200 tons) of bulk, fresh chemicals also were present.<sup>8</sup>

### 1.3 PUREX STANDBY PERIOD AND FINAL SHUTDOWN ORDER

On July 12, 1990, President George Bush approved the Nuclear Weapons Stockpile Memorandum, which demonstrated that plutonium recovered in the PUREX Facility was not needed to support nuclear weapons requirements. In effect, this memorandum invalidated the basis for the 1983 PUREX EIS, which was that PUREX operations were to be resumed to process plutonium necessary for national defense. In light of these developments, Secretary of Energy James Watkins announced in October 1990 that the PUREX Plant would be placed in standby mode and that an options study and an EIS would be prepared before restarting the facility. On December 22, 1992, DOE issued a final shutdown (closure) order for the PUREX Plant.<sup>9</sup>

Although the PUREX Plant was not officially ordered to standby status until October 1990, transition-to-standby activities began as soon as the stabilization campaign was finished in March 1990. Thus, the actual standby period extended from March 1990 through December 1992.

Expensive and frequent surveillance and maintenance (S&M) checks of safety and operating systems, mandated in safety documentation and necessary to keep the plant in standby-ready condition, consumed most of the facility's

time and budget. During 1990, tank integrity assessments, tank and vessel flushes, tank and other instrument calibrations, stack filter change-outs, and flushes and drains of headers in the pipe and operating (P&O) gallery were performed. Some instrument calibrations for non-critical systems and repairs to non-essential equipment were postponed because facility managers did not know when or if the instruments and equipment would be used again. The nitrogen oxide monitors on the main stack and the back-up facility were deactivated, as were exhausters in the P&O gallery. Efforts were made in a radiation zone reduction plan to move all regulated items into more central areas of the plant and surrounding area (Figure 5). This made more areas accessible without needing radiological postings and monitoring. The PUREX Plant was visited by DOE Tiger Teams (internal fact-finding teams) in May and June of 1990.<sup>10</sup>

#### 1.4 STANDBY ACTIONS AND GOALS AT PUREX

In early 1991, shortly after the standby order was officially issued, PUREX personnel began to define both overall and specific standby goals. General goals included minimizing utility and surveillance requirements and curtailing gaseous and liquid effluent releases to levels as low as reasonably achievable (ALARA) (at or below permitted levels) while laying up essential plant systems. Ventilation flows were to be reduced as far as possible to maintain confinement in radiation contamination zones and health and comfort in occupied areas (Figure 6). Program objectives were maintaining compliance with all applicable regulations and policies, maintaining effluent systems in a safe, minimum-flow condition, satisfying *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) milestones, minimizing chemical inventories in the plant and solid and liquid waste generation, limiting equipment deterioration so equipment would be available to support subsequent facility activities (either terminal cleanout or the resumption of fuel reprocessing), and conducting all activities cost-effectively.<sup>11</sup>

In January 1991, in response to a request from RL for a Standby Plan that would look ahead 3 to 8 years for final mission clarification, PUREX documented the actions that would be taken and the conditions that would be maintained during Standby. These actions included keeping the dissolver heels in A-, B-, and C-Cells and the single-pass fuel in the storage pool covered with water, locking out the dissolver off-gas electric and steam heaters, and disconnecting air supplies to air-driven pumps in N-Cell. The plant also pledged to not receive additional irradiated fuel shipments, to not introduce ammonia-bearing solutions into its systems, to maintain water coverings over the dissolver heels and the single-pass reactor fuel, to continue applicable operational safety requirements surveillances, and to maintain engineering and administrative controls designed to prevent criticalities.<sup>12</sup>

Because the ultimate mission of the PUREX Plant was not known in 1991, tasks were selected on a case-by-case basis to ensure future mission flexibility. Much of the day-to-day work of the facility continued to focus on conducting preventive maintenance to electrical and other essential systems, changing filters, sampling various effluents and in-plant materials, assessing and verifying tank and piping integrity, transferring and consolidating various solutions, and making necessary repairs. As in 1990, many optional equipment upgrades and instrument calibrations at PUREX were deferred until the plant's future could be better defined. However, an

Figure 5. The Radiation Zone Reduction Plan was one of the Earliest Steps Taken During the PUREX Standby Period.

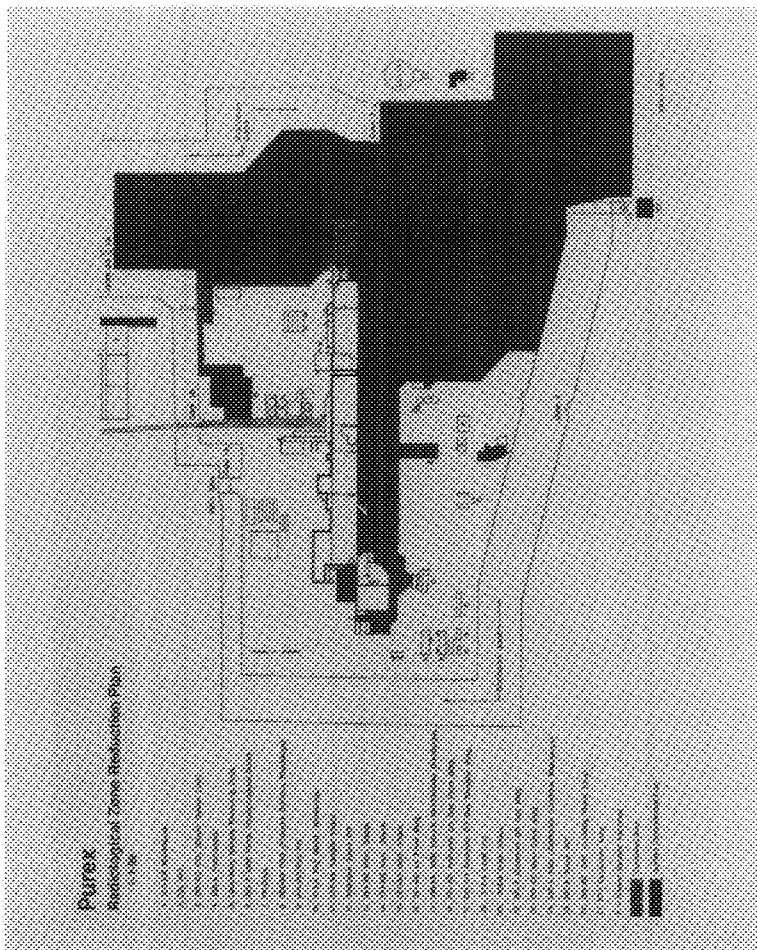
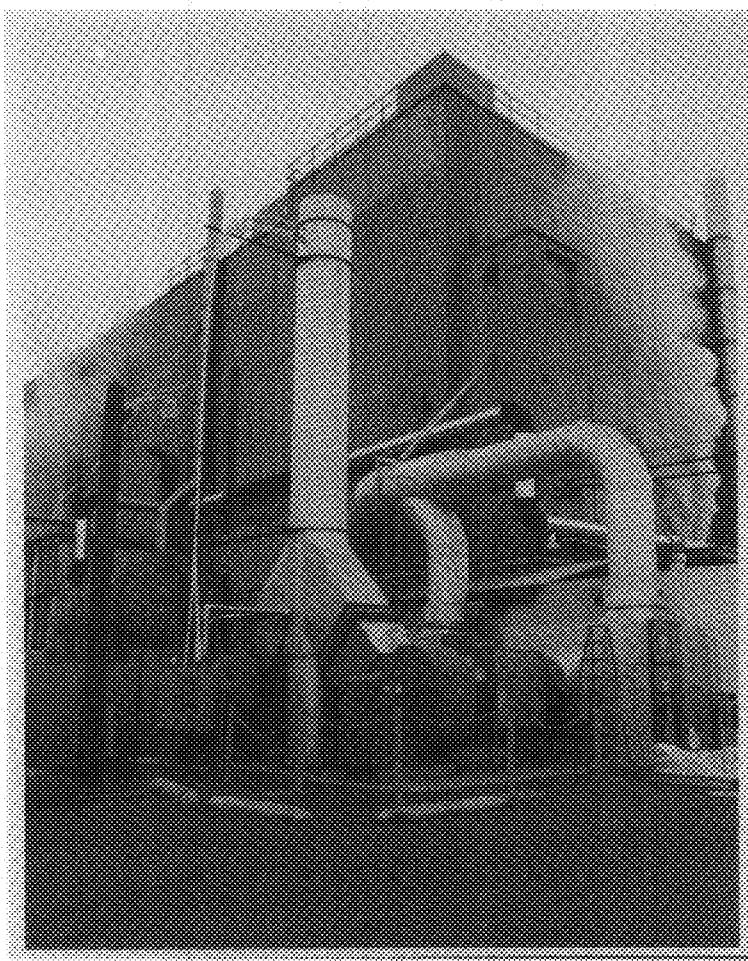


Figure 6. Emissions from the PUREX White Room Fans and Exhaust Stacks were Reduced as Part of Standby-Period Work.



in-cell closed-circuit television system was installed in the west canyon crane and new liquid beta-gamma monitors were installed for the PUREX chemical sewer.

Major cleanout work went forward in 1991 in N-Cell and the PR room. Plutonium oxide powder was removed from N-Cell glove boxes, dissolved in nitric acid, and transferred to tank E6. In March 1992, approximately 8,328 liters (2,200 gallon) of plutonium nitrate solution were transferred from tank E6 to tank D5 to make room for additional transfers into tank E6. (The plutonium nitrate solution that was accumulated in tanks D5 and E6 during this period would become the subject of major goals and regulatory attention during the PUREX Deactivation Project. See Sections 6.1 and 8.2.)

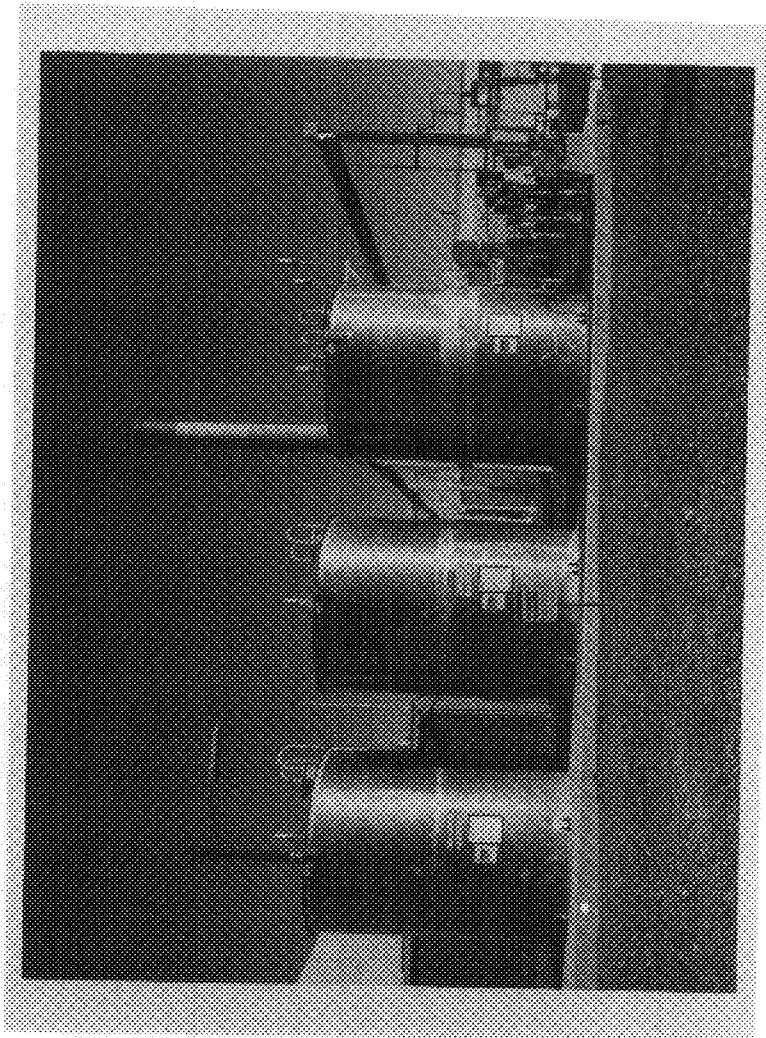
Other tasks accomplished in 1991 included terminating the PUREX steam condensate and cooling water heat exchange effluents, reducing the cold-side service effluents in the P&O gallery to minimize corrosion during standby, and shutting down the carbon-14/tritium sampler on the main stack.<sup>13</sup>

## 1.5 SALE OF PUREX FRESH CHEMICALS DEMONSTRATES EARLY CREATIVITY

A major activity undertaken at PUREX in 1991 to sell bulk fresh chemicals stored at the plant actually began some key deactivation work. In early 1991, PUREX had an inventory of 1,000 to 1,200 tons of fresh chemicals (about 80 percent in liquid form and 20 percent as dry solids) that had been shipped to the facility in anticipation of use in radiochemical processing. Plant personnel decided to try removing the chemicals in case the plant did not restart to avoid the safety implications and environmental concerns associated with long-term storage. They considered disposing of these chemicals as waste, a quick but expensive option. Because under Title 40 Code of Federal Regulations (CFR) Part 262, waste generators retain "cradle to grave responsibility" when generating waste, costs would have included not only the initial disposal fees estimated to be \$300,000 to \$400,000, but potential additional expenses if the landfill that accepted the chemicals ever leaked.

The General Services Administration procurement processes followed by the contractor that operated PUREX, Westinghouse Hanford Company (WHC), did not include a ready procedure to sell the chemicals back to the original vendors. Therefore, PUREX personnel decided to sell the chemicals as excess on the open market by placing notices in the *Commerce Business Daily*. Chemical brokers and distributors, local fertilizer companies, and another DOE site purchased or accepted most of the chemicals. The chemicals sold for only about 20 percent of their original cost, but all disposal and potential liability costs were avoided by not declaring the chemicals as waste. Under U.S. Department of Transportation (DOT) regulations (40 CFR), most of the chemicals had to be relabeled as hazardous materials, which caused some shipping delays. Still, shipments off the Hanford Site began in May 1992 and continued for about a year.<sup>14</sup> Following the same procedure of excessing useful materials and equipment no longer needed at PUREX, hydrogen peroxide and sodium hydroxide tanks and other items were transferred to other projects on Site in 1993 (Figure 7).

Figure 7. Hydrogen Peroxide Tanks Before They were Removed from the PUREX facility for use in Another Project, 1993.



During 1992, work was again performed cautiously at PUREX because the mission continued to be uncertain. Cleanout continued at N-Cell, where loose plutonium oxide powder was removed from crevices in the equipment, dried, and stored in the 2736-Z vaults at the Hanford Site's Plutonium Finishing Plant (PFP) for safe keeping. Also, about 4,164 liters (1,100 gallons) of neptunium-bearing solution were removed from tank J2 and discharged to the Hanford Site tank farms in January 1993 as high-level waste. The steam condensate stream overflow line was plugged, preventing any discharge to cribs 216-A-30 and 216-A-37-2 and allowing the shutdown of instrumentation that monitored the steam condensate stream. Other minor repairs were performed. Closed-loop chillers were installed on the main stack vacuum pumps to eliminate single-pass cooling water effluent. The main PUREX sanitary septic tile field failed and was taken out of service; the sewage flow was successfully rerouted to a backup tile field. One of three cooling-water liquid effluent streams was terminated. The backup foam fire system at the main stack was deactivated, along with the krypton and iodine monitoring systems. Other work included transferring liquids, flushing tanks, draining pipes and other lines, assessing tank and vessel integrity, and, of course, conducting the required S&M checks.<sup>15</sup>

## 1.6 DEACTIVATION PLANNING BEGINS—NEW DEFINITIONS ARISE

In the early spring of 1992, DOE and WHC PUREX management conceived and embarked on a new key activity that led directly into deactivation planning. Considering the end of the Cold War, the breakup of the Soviet Union into 15 independent republics, the reunification of Germany, and other obvious trends that further reduced the national need for special nuclear materials, starting to plan an overall strategy to close down the PUREX and UO<sub>3</sub> Plants in an orderly, comprehensive manner seemed prudent. At that time, no officially defined, intermediate position between standby/shutdown and D&D for nuclear facilities existed, except for a commercial power reactor condition termed "SAFSTOR" by the U.S. Nuclear Regulatory Commission. When PUREX managers examined the SAFSTOR requirements, they realized that few of them applied to the PUREX and UO<sub>3</sub> Facilities. A whole new concept was needed for planning and establishing requirements.

DOE Headquarters (DOE-HQ), RL, and PUREX WHC management decided that, because the entire concept of a "transition" or "deactivation" phase in a facility's life cycle was new, independent experts should be brought in to evaluate the planning process. If PUREX/UO<sub>3</sub> deactivation planning could be formulated into a system, the knowledge gained could serve as a model for other aging, terminated facilities across the DOE complex. An independent technical review team (known as the Red Team because it was to serve as a red flag or bold indicator of a new pathway) was chartered by the DOE EM-60 organization on May 19, 1992. This team was overseen by a technical oversight board of senior-level individuals with extensive experience in industry and the nuclear world. The Red Team's mission was to "perform a review of the planning, technical basis, and issues related to the transition of the PUREX Plant status from standby to safe deactivation, with minimum surveillance." The Red Team also would "provide recommendations, methods, activities, criteria, and potential changes to requirements that would apply at PUREX and other Department of Energy Facilities while personnel familiar with the plant operation are still available."<sup>16</sup>

## 1.7 RED TEAM RECOMMENDS PROJECT APPROACH, STREAMLINED DOCUMENTATION

In October 1992, the Red Team issued its report. It concluded that the PUREX Plant had no technical barriers to a timely transition to safe deactivation, defined as a "D&D ready state" that could be maintained "for a decade or more." It found that institutional management and regulatory barriers existed, but that they could be surmounted by "a change in methods of doing business." Treating the deactivation as a project rather than as another form of ongoing activity could save one-third the time, one-seventh the personnel effort, and one-sixth the integrated cost of a "more conventional approach." Achieving the goal of a "low mortgage end state," the report advised, would take close and active cooperation among many organizations, including DOE at all levels, Washington State and other regulators, WHC, and numerous stakeholders.<sup>17</sup>

In terms of specific recommendations, the Red Team report offered seven crucial end point criteria in order of importance:

1. Eliminate or stabilize environmental and safety risks
2. Leave in place equipment, systems, and materials for which an end state is not yet defined
3. Complete activities that depend on facility-specific process, operating, and facilities engineering expertise
4. Complete activities that depend on existing, functional facility-specific equipment that will be inoperable following a decade-long deactivation period
5. Configure the facility for and limit access to entry for a quarterly assessment
6. Establish and archive records and drawings
7. Leave the facility in an orderly condition.<sup>18</sup>

The report also proposed that all regulatory and planning documents except required environmental assessments (EAs) be combined into one transition project management plan, and that "overly conservative, zero-risk interpretations should be avoided...Not all regulations and orders apply to the transition to deactivation and not all activities are regulated." In terms of work planning, the report stated that "project tasks should be managed by work packages using a graded [commercial] approach to simplify the packages." The report observed, "planning is an inherent transition delay. To offset this, the project management team...must immediately define activities that can proceed in parallel with deactivation transition planning." Integrated, resource-loaded schedules with logic ties and a highlighted critical path were identified as the most sensible way to map, direct, and track the project.

The question of safety documentation was addressed clearly by the Red Team. "Preparation of a new SAR [Safety Analysis Report] for transitioning PUREX is not considered necessary...Use of the existing PUREX SAR, with appropriate supplements, is an effective method to define and manage the

safety envelope during transition to safe deactivation." The report also recommended close coordination between the management teams of WHC, RL, and DOE-HQ (the "troika" approach) to ensure the timely success of the project. It further attempted to address each major technical and physical challenge in the PUREX/UO<sub>3</sub> deactivation simply and directly with a brief statement of the scope of work to be accomplished. Such work included draining and flushing tanks and vessels, fixing surface contamination, mothballing equipment, disposing of fuel elements and contaminated solvents, and burying solid waste.<sup>19</sup>

## 1.8 UO<sub>3</sub> PLANT HISTORY AND BACKGROUND

The Uranium Trioxide (UO<sub>3</sub>) Facility was created in 1951 by modifying the World War II-vintage 224-U Facility. In 1952, it began full-scale operations to convert liquid uranyl nitrate hexahydrate (UNH) to UO<sub>3</sub> powder through a calcination process. During 1954 and 1955, an addition known as the 224-UA Building was constructed to hold six continuous-action calciners and improve powder- and waste-handling facilities. Together, the 224-U and 224-UA Buildings operated as the UO<sub>3</sub> Plant until the 1972 shutdown of the PUREX Plant. UO<sub>3</sub> operations closely followed the chronology of PUREX Facility operations because PUREX provided the sole feed material for UO<sub>3</sub> operations after 1967.

Calcination activities in the UO<sub>3</sub> Plant resumed in 1984 shortly after the 1983 restart of the PUREX Plant. Since then, the UO<sub>3</sub> Plant has conducted 17 operating campaigns because the small facility could calcine UNH much faster than the PUREX Facility could produce it while processing zirconium-clad fuel. The final UO<sub>3</sub> Facility closure order from the DOE came in December 1992 in tandem with the PUREX closure order. A last run was carried out at the UO<sub>3</sub> Plant from April through June 1993 to convert 757,080 liters (200,000 gallons) of remaining UNH to uranium trioxide powder. At the close of this campaign, as in past operations, the nitric acid recovered in the UO<sub>3</sub> calcination process was returned to the PUREX Plant.<sup>20</sup>

## 1.9 LESSONS LEARNED

**Lesson No. 1.** Finding an alternative use for a material is better than disposing of it as waste, even if the alternative use brings little or no monetary income. A designation as waste subjects a material to long-term regulatory control and the costs associated with disposal and regulatory surveillance and paperwork.

**Lesson No. 2.** Using creativity and forethought is possible even during periods when clear direction is lacking and mission flexibility needs to be preserved. Even during such times, some steps can be taken to temporarily deactivate portions of a large facility and bring down costs. Those who know the plant most intimately are best equipped to brainstorm the specific ways to implement cost-saving steps.

**Lesson No. 3.** Involving an independent technical review team early in the process to review a major deactivation operation and make overview recommendations provides healthy and useful input. It allows those with experience in the commercial world, those not directly tied to or constrained

by the day-to-day concerns of facility operations and management, to look at the operation. It also challenges the facility staff to think of the deactivation project differently. For conceiving broad concepts, the value of independent oversight is immeasurable.

**Lesson No. 4.** The advice of an independent review team such as the Red Team in attempting to scope and define specific work tasks and pathways within a large deactivation project is less helpful than the broad overview perspective brought by such a team. Washington State regulators, regional trustees, and stakeholders and the constraints imposed by the needs of other divisions on the Hanford Site actually shaped the PUREX Deactivation Project. As the project progressed, the ongoing advice of independent technical experts (ITE) that stayed with the work in a follow-on capacity helped define specific activities.

**Lesson No. 5.** Forewarning facilities as early as possible as a shutdown status approaches allows the facility engineers and work planners to begin preparing for deactivation work in a timely and efficient manner. The time that elapsed during the PUREX Plant's standby period actually created additional work for the deactivation project because some instruments and equipment deteriorated during that period. To prepare for the deactivation, significant work needed to be done to recalibrate and upgrade instruments and machinery.

## 2.0 REENGINEERING THE HANFORD SITE

### 2.1 THE REENGINEERING CONCEPT

The term "reengineering," was devised by business consultants James Champy and Michael Hammer in 1993. The process it represents was integrated into the PUREX Deactivation Project in late calendar 1995 and early 1996. Savings generated by the reengineering process are estimated at \$15 million over the remaining life of the project; the schedule acceleration is placed at 4 months. However, reengineering was not adopted at PUREX until just over 2 full years into the deactivation project. Because much greater savings and schedule accelerations probably could have been realized had the concept been implemented sooner, reengineering overhauls currently are being implemented early in the deactivation of other major Hanford Site facilities. The reengineering concept and its application at the PUREX facility are believed provide key lessons learned.<sup>21</sup>

According to Champy and Hammer, reengineering means "starting over" in terms of an overall assessment of the processes, methods, bases, assumptions, and organization of a facility or business. Reengineering cannot occur in small steps, but only dramatically: "It is an all-or-nothing proposition." It means reevaluating why facilities and businesses perform the steps and procedures they do. It cannot mean simply trying to introduce greater efficiency or productivity into existing processes. Industrial Revolution concepts of division of labor and breaking complex tasks down into small, specialized, repetitive steps to achieve efficiency are virtually reversed in reengineering. Multiple tasks are combined into processes because the variety inherent in process-oriented work can motivate employees bored by repetition and allow businesses or facilities to solve problems with flexibility, agility, and innovation. Similarly, the early Industrial Revolution concepts of creating a rule for every contingency and a hierarchical management structure are seen in reengineering as making businesses and facilities unresponsive to changes in customer needs and desired outcomes.<sup>22</sup>

Several characteristics are present in reengineered facilities and businesses. Chief among these is that several jobs are combined into one to foster greater worker responsibility, decision-making, and "ownership" of the outcome. Process steps are performed in natural order, following to the dictates of the process, not the rules of separate organizations. Processes have multiple versions, allowing flexibility and need to govern actions. Organizational boundaries are opened so work can be performed where and by whom it makes the most sense. Checks and controls are reduced, external contact points are minimized, and a "case manager" or "team leader" provides a single point of contact with other organizations and customers. "Hybrid" decentralized operations are prevalent and work units change from functional departments to process teams. People, once they are team members, feel empowered instead of controlled and they are motivated to "make a difference" and produce a good product or end state. Criteria for performance evaluation and advancement then can measure results, not just activity. Organizational structures are flat and cooperative instead of hierarchical and competitive. Managers become leaders, changing from a "command and control" to a mentoring

and participatory style. Throughout the new structures created in reengineering, information is exchanged and tracked electronically, accessible by and to all employee groups. Thus, information cannot be used as a source of power that furthers hierarchy.<sup>23</sup>

## 2.2 TIMING AND NEED DRIVE DECISION TO REENGINEER HANFORD SITE

At the Hanford Site, the time was right in 1995 for the Champy philosophy of reengineering to address crucial needs. Business in the record-high fiscal year (FY) 1995 Hanford Site budget of nearly \$2 billion had barely begun when the November 1994 election brought a dramatic shift toward a cost-conscious Congress. On December 19, 1994, President Bill Clinton's administration proposed stiff budget cuts, including cuts in DOE funds for nuclear waste management and cleanup.<sup>24</sup> The following March, researchers for the U.S. Senate Committee on Energy and Natural Resources produced *Train Wreck Along the River of Money*, a report criticizing DOE's cleanup programs as wasteful and unfocused.<sup>25</sup> The *Wall Street Journal* and other major print media ran equally critical articles denouncing "what happens if pork gets into play," specifically condemning the uses of DOE dollars in the Hanford Site cleanup.<sup>26</sup> When the Site's principal operating contractor, WHC, approached RL with the idea that reengineering could reduce costs and increase output, RL responded positively. Through the "change control" budgetary process, they allocated funds to WHC to proceed with reengineering.<sup>27</sup>

When WHC leaders looked at hard facts, they recognized the need for reengineering. In 1995, only 56.4 percent of the company's budget went to accomplish "core" objectives in the Hanford Site cleanup mission. Core work was defined as waste characterization, waste treatment and/or disposal, plant and facility maintenance, facility modification or building, and facility and waste surveillance. More money was being spent on the Site than when it produced half the nation's supply of defense plutonium and operated several research facilities. Increasing amounts of the budget were being spent on indirectly funded overhead organizations by "taxing" the programs directed to accomplish specific cleanup tasks. Such organizations included planning, administration, functions supporting regulatory compliance, personnel, communications, and other areas. Only 1 in 29 performance-based incentives (PBIs) that WHC had negotiated with DOE considered cost effectiveness as a specific performance criterion, although most PBIs focused on accelerating work in the belief that early completion would lead to cost savings. Another company incentive, the internal Challenge-170 Program, rewarded cost reduction, not cost effectiveness.<sup>28</sup>

Reengineering, WHC and RL leaders concurred, could help set priorities and streamline work in many areas, resulting in cost savings and a more motivated, involved, and efficient work force. The primary Site mission of "cleanup" was too vague to motivate many workers, and people were not personally involved in this concept. This sense of being disconnected existed even though many facilities had begun to organize as projects with clear deactivation missions and goals. Without a clear sense of participation and stake, many workers did not perform at optimal levels. Only 28 percent of projects active at the Hanford Site since 1987 had been completed by 1995, while 55 percent had been canceled or abandoned, which added to employee feelings of frustration. Paradoxically, in the safety and regulatory arenas, the level of control at the Hanford Site in 1995 was more strict for

deactivating facilities than it had been for facilities operating to produce special nuclear materials. In February 1995, DOE Assistant Secretary for Environmental Management Thomas Grumbly told Hanford Site managers to be bold in seeking changes. "Don't think we're just going to slide down the road to gradual change. Jump in, take the plunge...think out of the box."<sup>29</sup> Grumbly also called for savings through "productivity improvements."<sup>30</sup> The stage was set for reengineering.

Early in 1995, a Sitewide executive team of senior managers from DOE, WHC, and WHC's partner companies at the Hanford Site—Boeing Computer Services Richland (BCSR) and ICF Kaiser Hanford (ICF/KH)—was formed to define essential business practices and goals. At the center of a "business diamond" was "the work" of the Hanford Site. Surrounding that center were four focal areas: organizational structure, work culture, information technology, and management systems (including measurements and rewards). Based on opportunities for clear and dramatic improvement, the executive team identified three areas to target for change: facility operations, regulatory processes, and administration. Consequently, three teams were formed: the Plant Team, the Requirements Team, and the Administrative Team. The Plant Team concentrated on facility planning/scheduling, maintenance, safety, engineering, surveillance, and operations. The Requirements Team concentrated on challenging, streamlining, combining, reducing, and integrating various compliance, safety, and quality assurance functions. The Administrative Team focused on reducing overhead expenses such as those associated with procurement; communications; site services including road repairs, mail delivery, etc.; and program management. The Plant Team, tackling facility operations, looked for a candidate to become the Hanford Site's first reengineered facility.<sup>31</sup>

### 2.3 PUREX FACILITY FIRST CHOICE FOR HANFORD SITE REENGINEERING

In 1995, the Hanford Site's PUREX facility, long a leader in the United States's Cold War efforts, once again led a national effort. In this case, the effort was to conduct the deactivation of a major DOE plant as a project. Structured with goals, schedules, and budgets similar to those for a construction project, the huge deactivation of the PUREX Facility already had set many precedents for innovation approaches to safety and regulatory issues, stakeholder involvement, and technical achievements.<sup>32</sup> As a leading-edge undertaking, the PUREX Deactivation Project was selected as a reengineering laboratory at the beginning of FY 1996. One primary reason for its selection was the enthusiasm and willingness to risk change displayed by the WHC PUREX Plant Director. A second key reason was the demonstrable success of the PUREX Deactivation Project. Site decision-makers reasoned that the premier demonstration facility was the right choice to start reengineering. Management believed that reengineering could enhance PUREX's existing strong performance (although many plant workers questioned why they should be "reengineered" when they already were doing a good job).<sup>33</sup>

The core principle guiding the reengineering of PUREX was to implement a holistic approach to the entire business system. The PUREX management structure and work force organization were completely overhauled, work scope was reorganized, and responsibilities and training were developed to support the emergent order and culture. While efforts had been made earlier to

develop project end points, the end points now became the central driving guide for all project work (see Sections 4.3, 4.4, and 4.6).

Information technology was thoroughly integrated into the new approach so that information could infuse streamlining, leveling, and empowerment throughout the new system. Likewise, the ways that safety planning and assessment, regulatory compliance, scheduling, and technical work were accomplished were adjusted. All work responsibilities were integrated into a team-based organization. The result was that the reengineered PUREX facility, in the final 2 years of its deactivation project, pioneered more change than was envisioned even as the first set of lessons learned was being written in late 1994.<sup>34</sup>

## 2.4 LESSONS LEARNED

**Lesson No. 6.** The complete reengineering concept, with all of its non-traditional business practices, can successfully reduce costs and streamline work at deactivating facilities. Generally, even though such facilities may have already reorganized from their operating configuration into a deactivation project, they can benefit from thorough reengineering. Reengineering focuses people to specific, personal, achievable goals, thus tapping their maximum energies.

**Lesson No. 7.** The timing for reengineering is nearly perfect. While Congress calls for budget cuts in DOE facilities that have no known future missions, environmental and other laws and imperatives require safe shutdown. Reengineering can make closing old facilities cost effective. It also can help empower and better prepare the frightened workers at many older DOE facilities, thus improving prospects for continued employment for these loyal employees.

**Lesson No. 8.** While reengineering can help virtually all large organizations, if possible, it should be first introduced at facilities that are already doing well and are staffed by enthusiastic, positive leaders and employees.

**Lesson No. 9.** When reengineering is undertaken, an organization, a facility, and/or a DOE Site must plunge into it holistically, and with support for change at all levels.

### 3.0 REENGINEERING THE PUREX PROJECT MANAGEMENT STRUCTURE

#### 3.1 THE CASE FOR ACTION

At the PUREX facility, reengineering began by completely renovating the management and work force structures. The shortfalls of the old structure included jobs that were narrowly defined, requiring many "handoffs" to accomplish even simple tasks. Also, the divisions of responsibility meant that the organizations writing procedures and work packages were not the ones responsible for the work results. Organizations could stop or slow work to meet their own internal requirements and priorities without being accountable for the effect of their actions on the entire deactivation project. Steps toward "projectization," or organizing resources into functional project units, began during 1994-95, and gave facility managers more control than they had when large centralized support organizations existed. However, by late 1995, it was clear that "stovepipe" organizations, self-contained units within projects, still existed to block the development of true, overall process ownership. Also, in deactivation, where the real business is going out of business, motivating workers to accomplish this quickly and efficiently was difficult. The executive team felt that reengineering could break down the mental barriers as well as the internal organizational barriers and motivate workers based on ownership. Employees would know that their own performance on a team would be recognized and could serve as the basis for an excellent recommendation for the next available jobs.<sup>35</sup>

#### 3.2 REENGINEERING BRINGS DRAMATIC RESULTS AT PUREX

In terms of sheer numbers, the results of reengineering the management and work force structure at PUREX were dramatic. In September 1995, the PUREX facility was organized by functional departments, and employed 26 managers, 6 team leaders, and 268 workers. Major departments were Surveillance, Deactivation, Maintenance, Radiation Control, Administration, and Technical Training, where individual managers oversaw their own "pieces of the pie." Smaller departments were laboratory and special analyses, safety, and quality assurance. By February 1996, reengineering at PUREX had reduced the number of managers to 6, increased the number of team leaders to 10, and reduced the number of employees to 225. Seventeen of the staff reductions were attributed to the deactivation process and 26 (about 10 percent of the total staff) were attributed to reengineering. The management span increased from 11 to 1 before reengineering to 37.5 to 1 after reengineering.

The number of people signing each work package fell from an average of 14 before reengineering to only 5 within 6 weeks after reengineering. (Strict comparisons are not possible in this area because the Job Control System [JCS] was used in nearly all cases before reengineering and an innovation known as the Job Hazards Analysis [JHA] was substituted in many cases as part of reengineering. Section 7.6 describes the JHA.) With reengineering, the amount of work at PUREX that required full work packages dropped from 70 to

5 percent,<sup>b</sup> the average number of hours that workers spent performing or planning work each day rose dramatically; the need for corrective maintenance operations fell, and the ratio of review time to work time also dropped.

### 3.3 REENGINEERING PROCESS BEGINS WITH ASSESSMENT OF ESSENTIAL PUREX TASKS

PUREX reengineering began with an assessment to identify its culture, bottlenecks, and power structure, "taking the facility's temperature," according to a Sitewide reengineering leader.<sup>36</sup> In October 1995, a "culture" survey was conducted to establish PUREX Plant workers' baseline perceptions of problems and strengths in the work environment before reengineering. Results of the survey identified seven areas where significant improvement could be made.

- Regulation and rigor in risk management were applied almost to the point of seeking "zero risk"
- Employees did not always perceive paths forward for themselves
- Paperwork was burdensome
- Systems sometimes fostered conflict between organizations even when individuals cooperated
- Management was not seen as a primary enabler for removing barriers in the field
- Employees felt that they could not tap resources when and where they needed to
- Employees had to face losing their friends, identity, and the sense of "family" when shutdown occurred.

These problems were seen to be fed by management systems, values, and rules both modeled and expressed. The PUREX management committed to adopting a new set of values, rules, and expectations that would point toward the following new future states to replace the problem areas identified.

- Regulation would be streamlined, managed risk would be at the center of all work, and no rigorous efforts would be made to drive risk to zero
- Employees would understand their own paths forward
- Only paperwork that supported essential work needs would be processed
- Cooperation in and among multidiscipline teams would be standard operating procedure

---

<sup>b</sup> Part of the reductions in the size and number of work packages also can be attributed to a concurrent WHC effort to streamline Standards and Requirements Identification Documents (S/RIDS). See Section 7.5.

- Management would be forward thinking and would empower front-line workers to make decisions
- Resources would be deployed for maximum effect and clearly defined goals and objectives would drive the work
- All employees would take personal accountability for performance and would be recognized appropriately. Also, poor performance would have logical consequences.<sup>37</sup>

While the culture survey was being done, a reengineering laboratory team known as the Lab Team was created to assess and restructure PUREX job roles and the personnel system. Any PUREX employee or member of the WHC management structure that oversaw PUREX or the unions whose members worked at PUREX could nominate members to the Lab Team. Any PUREX employee could submit his or her own name as a volunteer. Nominations were studied and members were appointed to the Lab Team by representatives of CSC Index, Inc., James Champy's consulting firm, and two Hanford Sitewide leaders of the reengineering effort. Final approval for Lab Team selections came from the PUREX Deactivation Project Director. The Lab Team, as it was constituted in the Autumn of 1995, had 11 members. The chairman was a safety engineer who had been involved in the Sitewide Plant Team. Other members included a DOE representative, a CSC Index, Inc. representative, a PUREX engineer, a shift manager and an operations engineer, a scheduler, a nuclear operator, a pipefitter, a radiological control technician, and an electrician. Serving on the Lab Team was deemed a full-time job, and members' other work assignments were suspended. The Lab Team's work took from September through November 1995 (Figures 8 and 9).

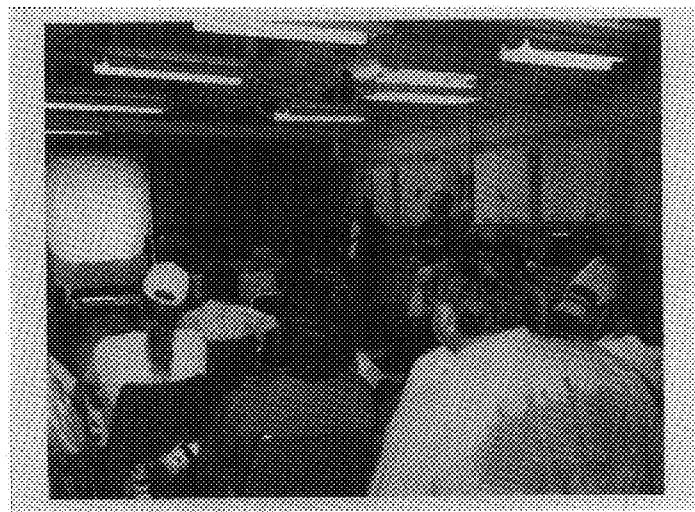
The Lab Team's first task was to validate the PUREX core processes (surveillance, maintenance, and facility modifications). The existing organization was considered a barrier between workers and accomplishing work.<sup>38</sup> Therefore, the next task was to dismantle the existing departments and job roles at the facility. To complete this step, the Lab Team had to define the PUREX work necessary to achieve deactivation. As soon as they began to deliberate, the Lab Team realized that speaking in general terms about essential work was easy, but defining how the facility should and could operate was difficult. Involving the people who had worked at PUREX longest and knew the facility intimately became most important. The end points defined and published at PUREX by August 1995 (see Section 4.6) again served as the real drivers and focal points to map essential work.

After deliberating, the Lab Team decided that the PUREX work processes were surveillance, turnover/end point management, and five specific field activities still to be accomplished. The field activities were HVAC consolidation, glove box stabilization, utilities consolidation, canyon/galleries closeout, and ancillary structures/outside areas deactivation. A team was designated for each work activity. Three other teams were designated to support the seven core teams: a facility support team, a project support team, and a technical support team. Also, a project management team consisting of six managers and several activity leads (lead scheduler, regulatory compliance officer, safety compliance officer, project analyst, and other) was designated to lead the entire deactivation project. The Project Director position, as the lead for the entire deactivation project, was retained.<sup>39</sup>

Figure 8. PUREX Workers Gather to Hear About Reengineering Plans, 1995.



Figure 9. Another Employee Meeting About Reengineering, 1995.



Early in its work, the Lab Team was confronted with an in-house rebellion. Later said to have occurred on "Black Monday," the rebellion occurred when a Lab Team member from the PUREX facility stood up and stated that the team was trying to "sell" or "shove" programs at the plant. Soon complaints to Lab Team members and Employee Concerns (a grievance process) representatives increased. The emotional aspects of change, especially fear, had been underestimated. Communication with and participation by employees was increased. The Lab Team invited employees to attend their work sessions. However, even though they wanted more information, most employees could not bring themselves to go to the sessions. So, Lab Team members began posting times when they would visit various PUREX lunch rooms to have "brown-bag" sessions with workers. In familiar settings, and not feeling outnumbered, workers felt more free to question Lab Team members. Gradually, converted through casual conversations, PUREX employees accepted many of the ideas that Lab Team members had tried to implement.<sup>c, 40</sup>

### 3.4 TEAMS/SKILLS MIX IDENTIFIED

Once the PUREX teams were designated as entities, the next task was identifying what skills mix each process team needed to be successful. At this point, the discussions turned to the heart of reengineering concepts and focused on empowerment and driving decision-making to the lowest levels. Knowing the PUREX facility and tasks as well as they did, and having a few members from outside PUREX to add perspective, the Lab Team had to become very realistic about what would and would not work in actual practice in a reengineered facility. It was most important that each team comprise the resources it would need to perform work processes from beginning to end. If any critical resources were missing, the teams and the entire reengineering experiment could fail. Some areas of specialized expertise, such as regulatory and safety compliance, were assigned to individuals who would serve the entire PUREX Plant. These individuals were placed on the project management team where the other teams could call on them.<sup>41</sup> After much discussion, the initial teams were assembled. (See Appendices A and B.)

### 3.5 JOB APPLICATION AND SELECTION PROCESS

Once the job positions needed for each team were identified, the employees already working at the PUREX facility had to apply for the new positions. The old jobs would be abolished under the reengineered system. The WHC Human Resources (HR) Department, involved from the start, now added new attributes to traditional, technical job descriptions. Initiative, judgment, teamwork skills, leadership, decision-making ability, and customer focus were added to job descriptions for positions where employees were not represented by unions. Even for bargaining unit positions where job descriptions stayed the same, people were told that their work scope would broaden to include helping prepare work packages instead of simply executing them. Four additional job positions were created. Three of these were for coaches, "champions for change" who would meet with teams to resolve issues that developed in the novel work situations. The coach positions were

---

<sup>c</sup> Other efforts in communication, and also special training programs, also facilitated the change process at PUREX. See Sections 3.5 and 3.6.

expected to be temporary, but they functioned through the end of the deactivation project. The fourth position was a Configuration Control Specialist; a person to coordinate and map interactions so that the work of the teams did not conflict, and to ensure control of essential plant systems.

WHC's HR involvement in reengineering the PUREX work force focused on four areas: selection, compensation, performance measurements, and redeployment of excess workers. An employee selection process was devised allowing employees an opportunity to look at a variety of jobs. Selections were made by committee rather than by a single assessor, and selection was based on job-specific criteria developed by the Lab Team and selection committees. With the need for employees to be able to move between jobs (including moving to jobs that have lower grade levels under the existing system), salary administration was changed to pilot a "broad banding" system for the new positions. Employees were slotted into broad salary ranges, so that in no cases would individual salaries immediately change. Bands were listed simply as management, professional, and salaried non-exempt. Broad banding supported reengineering by allowing flexibility in determining compensation based on individual skills and experience. It fit with the change to less hierarchical organizations and supported horizontal skills development and lateral job mobility. No changes were made to the labor agreement and/or bargaining unit salary programs.

While performance evaluations were left with managers in the PUREX reengineering effort, a computer-based program was made available for piloting. The program provided an option for peer assessment of team members, as well as significant input by team leaders in rating the performance of team members against specific objectives. With the potential for employees to be made surplus by reengineering and by faster completion of work scope, a more formal worker redeployment process also was initiated.

In December 1995, the new job positions were posted at the PUREX facility in a "People Center" newsletter established in the Spring of 1995 at PUREX and some ancillary locations. (For an explanation and discussion of the PUREX People Center, see Section 3.6.) Only then-current PUREX employees could apply for the new positions. Applicants had 2 weeks to respond and were asked to list their first, second, and third choices for placement on teams. Two more choices were allowed initially, but the number was cut to three for workability. Employees were encouraged to list not just jobs closely fitting their current job, but also jobs that might use skills not previously recognized or used.

While the jobs were posted, three selection committees were brought together to review the applications and to pick people. A high-level selection committee chose people for the six management positions, a second committee chose the team leaders and coaches, and a third committee chose the team members. The interviewing and selection process took approximately 2 weeks. During the posting, application, and selection process, work slowed dramatically at PUREX. WHC now estimates that the PUREX facility spent 9,000 hours, and approximately \$649,000 in specific costs on this process. (Additional costs associated with temporary lost productivity are difficult to measure.)<sup>42</sup>

In December 1995, 71 percent of the exempt (management and professional) applicants at PUREX received their first choice job, 12 percent received their

second choice, four percent received their third choice, and six percent received their fourth choice. Seven percent of exempt persons were placed in jobs outside their choices. Fifteen percent of the salaried non-exempt applicants at PUREX received their first choice, 24 percent received their second choice, 7 percent received their third choice, and 15 percent received their fourth choice. Thirty-nine percent of salaried non-exempt persons were placed in positions outside their requested choices. The WHC HR Department presented job placement opportunities for the 26 people not placed in any of the new PUREX positions, and all persons were placed (Figure 10).

### 3.6 THE PUREX PEOPLE CENTER ADDRESSES CHANGE

In January 1995, well before the PUREX work force reengineering effort began, a People Center was established at the facility to address the massive changes that were anticipated and in some ways feared by the PUREX employees. PUREX employees already were facing two huge transitions that prompted the formation of the People Center. They knew, as employees of a deactivating facility, that they were "working themselves out of a job." The PUREX Plant was scheduled to close completely and stand empty in 1997, subject only to periodic visits by monitoring personnel. Every PUREX employee would have to find another job. In 1995 RL announced that it would recompete the work using an entirely new format, instead of renewing WHC's contract. The Project Hanford Management Contract (PHMC) would be awarded to a management and integration (M&I) contractor to interface between RL and a consortium of smaller companies hired to complete specific projects. Many (perhaps most) WHC employees would be hired by the smaller companies to perform specific and specialized functions. (As far as WHC employees knew in 1995, they might not be hired at all by the new companies or they might be hired under conditions and with expectations so different that retaining their new jobs over the long term could not be assured.<sup>d</sup><sup>43</sup>)

Management realized that, with the magnitude and overlapping effects of the changes PUREX employees faced, they could decide to leave their jobs early unless some positive steps were taken to reassure them. This early flight of experienced workers would jeopardize the success of the Deactivation Project. Early in the project, knowing that jobs would diminish and end because of the nature of deactivation work, the PUREX organization began some team-building, people-focused activities.

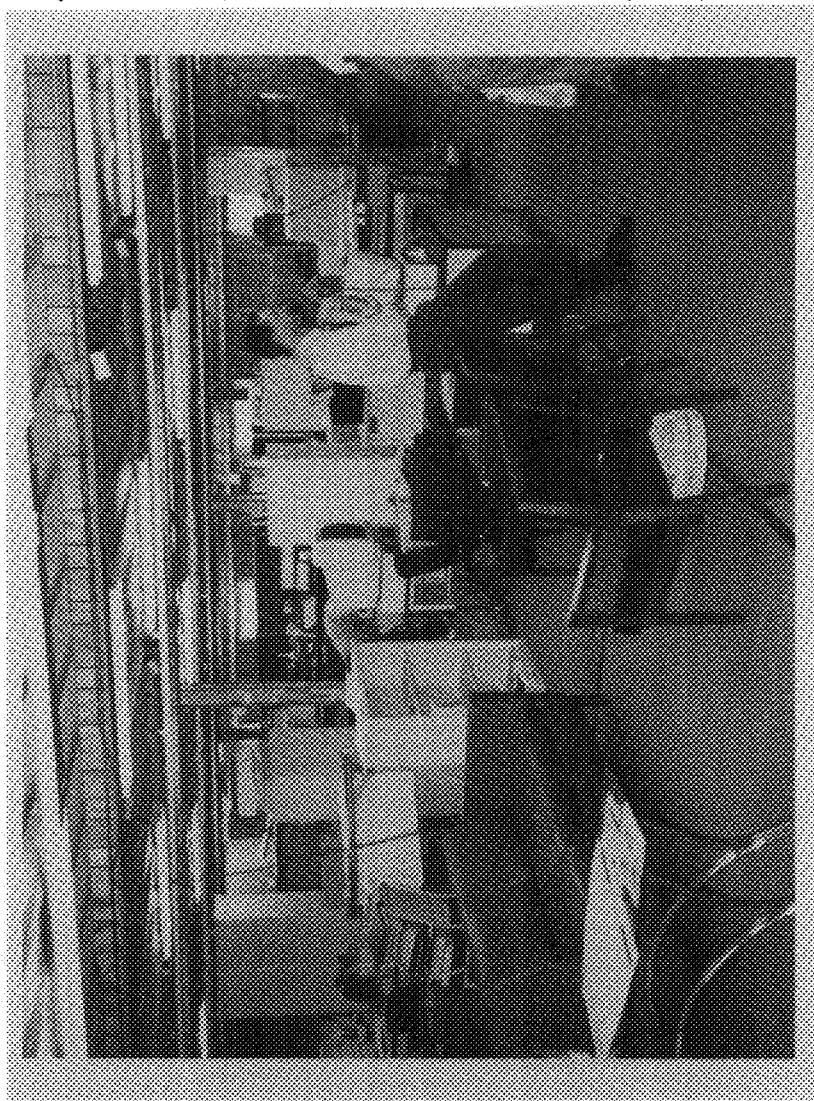
In late 1994, PUREX management formed a task team to discuss the formation of a People Center, possibly modeled on a center at Motorola Corporation. The task team consisted of an organizational development specialist, a communications specialist, and representatives of many PUREX job categories (management, exempt, salaried non-exempt, and bargaining unit).

The group quickly honed in on the Center's key missions of communicating information and providing job placement assistance. The crucial difference between the People Center and traditional HR services would be that the Center

---

<sup>d</sup> On June 19, 1996, RL announced that, "with the exception of management personnel as defined in the RFP (request for proposals), all other incumbent staff will be offered jobs somewhere in the new structure" at least until December 31, 1996. However, this was not known in 1995.

Figure 10. A PURCX Team Moves into a Colocation Setting, Early 1996.



would be available well before people were officially issued termination notices. In its charter, the PUREX People Center stated its purpose as being "to provide job retention at the project by providing direct access to all Human Resources services; timely information about the project, site and external information; and by giving PUREX employees opportunities to help prepare themselves for employment at the completion of the project." Efforts to place people whose jobs were ending at the PUREX facility spread outward in a widening circle first on the Hanford Site, then in the Tri-Cities area, and then throughout the Pacific Northwest.

For the PUREX People Center to function optimally, the task team decided that it would have to be located at the PUREX facility, and would have to be staffed full time on a rotational basis so that employees could have access to it whenever they felt most anxious. The benefits of the People Center to the PUREX Deactivation Project were defined as enhancing project stability; giving employees access to accurate information about the Hanford Site, the Transition Projects Division of WHC (in which the PUREX facility was located organizationally), and PUREX forecasts; providing employees access to career pathing tools; sharing information to enable employees to make intelligent career decisions; giving employees a place to talk and a person to talk to; providing confidential counseling; and quashing unfounded rumors. The Center offered HR job placement services (Internet connections and other computer links, voicemail services, points-of-contact lists from local agencies, forms, WHC procedures, union contacts and contracts, union seniority lists); PUREX staffing forecasts; assistance in writing resumes; books, audio tapes, and video tapes on the interview process; bibliographies of resources from the local college and university; and contact with coordinators and specialists in Employee Concerns (a grievance program), organizational development, and communications.<sup>44</sup>

A People Center newsletter was started immediately, and was published intermittently, but at least every 3 weeks. The newsletter was distributed to PUREX employees, WHC and DOE senior management, HR, the WHC Employee Concerns office, and WHC Communications. Copies also were left in a prominent place in the PUREX badge house. The newsletter featured articles on Deactivation Project milestones, stress management, teaming, team members, change, reengineering principles and news, and to enhance the fun/partnership aspect, a slip for a prize drawing. The newsletter always included an illustration or a graph in recognition of the fact that some people retain graphic information more easily than printed words. Also to accommodate people's different learning styles, employee meetings were held monthly at PUREX so that people could hear the project news and ask questions (Figures 11 and 12).

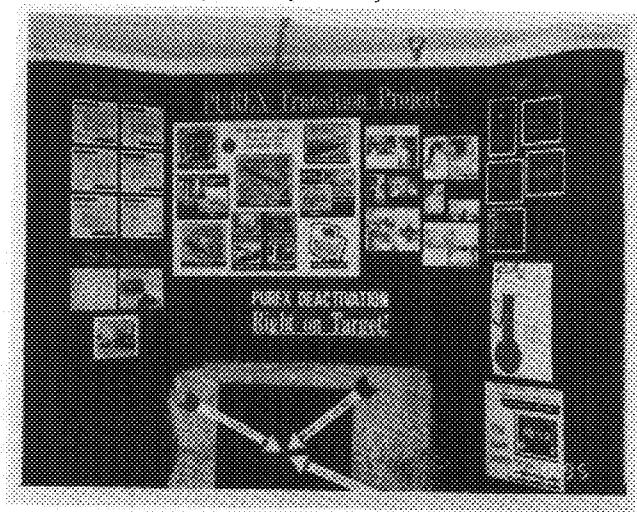
### 3.7 TRAINING PEOPLE FOR THE REENGINEERED WORK PLACE AT PUREX

As reengineering implementation approached at the PUREX Plant, the team recognized that the effort would bog down and perhaps fail if people were not given ongoing training in how to function in new modes. An organizational development specialist was hired full time in the Autumn of 1995. Training was developed in teaming and communication skills, leadership, and problem solving based on vendor-supplied commercial modules. As soon as the PUREX work teams were formed in December 1995, each team began a 4-day training session. The training was of the simplistic and mechanical "how to" variety, rather than the "wide-angle" variety. The module concept and length of

Figure 11. Information Boards Established at PUREX to Keep Workers Informed.



Figure 12. Extensive Communication with Employees Helped Reengineering Succeed.



training caused complaints from PUREX workers. They chafed at the length of the training when they felt they needed to be at work accomplishing deactivation goals. They also perceived the training as "motherhood" training on topics such as how to get along. The reengineering team soon realized that PUREX team members would not need this training until they were further along in the process of having to struggle with their first tasks as teams.

Soon, new training tools were substituted that focused on the basic roles and responsibilities of whole teams. A "Team Start-up Kit" module was used to force teams to look at their essential reasons for being. Questions asked in the module compelled teams to examine their basic purposes and ground rules, define their customers, identify what they actually did, and ask why the overall organization could not exist without them. This module helped address many problems that can slow down new teams. It helped them understand the team concept, establish operating guidelines, and conduct effective team meetings and training. Most importantly, it helped them understand and write a charter for themselves.

At PUREX, charter-writing was delayed several months into the reengineering cycle. Plant leaders now realize that developing the charter earlier could have imprinted the teaming concept sooner. They also learned that basic training should have come first, with training in operating as a team following in short, intermittent sessions, especially when asked for by the teams.

Organizationally, the PUREX teams followed typical developmental curves through five distinct stages: start-up, confusion, leader-centered (dependent on the team leader for direction, motivation), tightly formed (integrated and loyal, though perhaps still sub-functional), and finally self-directed (able to carry out multiple tasks in a cooperative, coordinated manner). After the charter-writing stage, ongoing training using a Team Development Kit helped the teams work through these stages toward maturity. It helped them identify areas for development, measure effectiveness, and improve performance.<sup>45</sup>

Perhaps the most difficult aspect of training in the PUREX work force reengineering endeavor is addressing a "sea of change in attitudes and values" about the definition of loyalty and the reorientation of workers from dependence to self-reliance. A 1994 article in the *Harvard Business Review* stated that the changes of the late 20th century and emerging 21st century could only be weathered if American businesses entered a "new covenant" where employers and employees shared the responsibility for maintaining and enhancing employability inside and outside of existing organizations and companies. According to the article, employees could no longer entrust major career decisions to a paternal organization. Doing so made them dependent and static. Also, employers could no longer regard employees as disloyal if they developed new skills and moved easily across functional boundaries.<sup>46</sup>

At the PUREX facility, a long history of secrecy and conservatism in following governmental directives made such new ideas difficult to internalize. Early in the deactivation project, PUREX leaders began to explore ways to encourage openness, boldness, and attitudes that bespoke personal independence in employees. However, the PUREX work force reengineering truly brought home to workers the DOE imperative to achieve culture change. Many of the reengineering training sessions needed to focus

on career-resilient attitudes to replace the paternalistic patterns practiced over decades at the isolated Hanford Site.<sup>47</sup>

### 3.8 CLOSE-OUT OF THE PUREX TEAMS AND WORK FORCE REDEPLOYMENT

As the PUREX Deactivation Project completed some major milestones in August 1996, two of the work teams were dissolved. The Glove Box Team and the Canyon/Gallery Team finished their work and the team members found other jobs either at PUREX or elsewhere on the Hanford Site. On October 1, 1996, an early retirement incentive program offered at the end of FY 1996 to the entire Hanford Site work force brought the number of PUREX workers down to 190 from the 225 who had made up the first reengineered teams in January and February of 1996. The declining numbers led to the teams being reorganized and a Waste Team being added.

As the deactivation project neared completion in January 1997, the remaining eight teams were reconfigured as the following four teams.

- The Field Team (dubbed "F Troop" by PUREX employees), which focused on physical work
- The Administration Team, which focused on records and property disposition
- The Turnover Team, which focused on end points close-out
- The Technical Team, which focused on finishing safety documentation, revising the radiation control documents, and writing the last engineering and regulatory documents and correspondence.

With broadly defined work scopes, these teams were ideal for the final phases of the PUREX Deactivation Project when flexibility was essential to close-out success. Also in January 1997, a schedule was implemented that released several employees every other Monday from the PUREX work force. This practice continued through late March, when the facility started releasing people each week. On April 1, all employees were combined onto the PUREX Turnover Team. By late April, PUREX Plant had just eight employees assigned to deactivation work. By then, it had been decided that this small contingent would continue with the facility through the end of FY 1997 to supervise a roofing job that would be performed by subcontractors and to perform the initial, real-time trials of the S&M program.

Early in FY 1997, the PUREX Deactivation Project assigned one manager and one non-manager to spend most of their time on redeployment activities. On October 1, approximately half of the 190-member work force 1996, were union (bargaining unit) members. The unions representing these bargaining unit people handled their redeployment using the seniority system. A Sitewide "bumping system" was used, where crafts people with more seniority were moved from PUREX to other Hanford Site positions, replacing those with less seniority. The end of the PUREX Deactivation project resulted in about 20 bargaining unit persons being laid off, although nearly all PUREX bargaining unit people were bumped to other onsite positions.

With the unions placing the bargaining unit employees, the two redeployment "officers" appointed in the PUREX staff focused on placing the approximately 80 non-union people into new jobs. The redeployment officers relied heavily on the support of B&W Hanford Company (BWHC), which replaced WHC in managing transition facilities for DOE on October 1, 1996. BWHC was strongly committed to work force redeployment. BWHC management was concerned for the workers, and realized that if PUREX workers lost their jobs at the end of the deactivation project, BWHC would have difficulty keeping talented employees working on the other Hanford Site deactivation projects. BWHC management also knew that anxiety about their careers would prevent the PUREX people from focusing their best efforts on finishing the current deactivation project with excellence. Knowing that redeployment officers were at work on their behalf and that the company supported these efforts, the PUREX employees could give their full attention to performing fast, money-saving work through the end of the project.

The PUREX redeployment officers established a "circle" of potential employers for displaced PUREX workers, given priority levels based on their desirability. The highest priority, or the smallest ring of the circle, was BWHC itself. The company was staffing a new project to deactivate two large, aging laboratories in the Hanford Site's 300 Area. This new effort, the 324/327 Buildings Deactivation Project, hired the largest number of ex-PUREX employees. In fact, many PUREX workers spent the last few months of their PUREX tenure in a job-sharing arrangement with the 324/327 Buildings project. PUREX workers were considered ideal for the new deactivation project because of their experience and their proven abilities to save money, work safely, and exceed schedule commitments. The next priority for redeployment was other companies on the Hanford Site that fell under the "Project Hanford" umbrella, an association of 13 companies. Several PUREX workers were hired to work on Site waste clean-up projects managed by Rust Federal Services Hanford (now Waste Management Federal Services of Hanford, Inc.), Lockheed Martin Hanford Company, and others.

The next level pursued by the PUREX redeployment officers for workers leaving PUREX was jobs off the Hanford Site, but in the Tri-Cities area. The PUREX redeployment officers went to the economic development office of Project Hanford's lead contractor, Fluor Daniel Hanford Company, for leads on new or expanding businesses in the local area. PUREX workers were attractive to these employers because, through their roles on reengineered teams, many of them discovered or honed skills that complemented their basic job skills. The fourth priority was jobs at other DOE sites or other locations operated by the parent companies of the Project Hanford companies. Workers willing to leave south-central Washington State received surprising new opportunities through the market networks of these major companies. By the end of the PUREX Deactivation Project, all but four exempt workers had new jobs. Notices of pending termination were issued to these four people on May 1, 1997.

### 3.9 RESULTS/ASSESSMENT OF PUREX WORK FORCE REENGINEERING

The results of reengineering on the PUREX workers and their performance were positive, qualitatively as well as quantitatively (see Section 3.2). Increased efficiency in performing field work was obvious as work teams were empowered to resolve problems encountered in the field and change work documents as appropriate. Reengineering "legitimized" some processes that

already existed unofficially at PUREX—ways around the system became the system. Work teams followed assignments from beginning to end, feeling and being responsible for a task until it was accomplished. The teams scheduled work internally to support the overall project schedule. Teams approved their own procedures and work packages, and were responsible for all aspects of performance and budgeting. Radioactivity control technicians (RCT) wrote the radiation work permits for their teams. However, teams also could draw on experts, such as estimators and safety officers, to augment existing in-plant capabilities. Teams were responsible for their own productivity and outcomes and for evaluating their progress. Teams also were colocated, adding to a sense of involvement, job satisfaction, and ownership that were among the most notable differences among employees.

The issue of job security, always a worker concern in deactivation projects, was addressed by ensuring that personal and team excellence would be highly visible in a reengineered organization and could result in better future job prospects. Reengineering, according to HR personnel involved with the PUREX work force reengineering effort, actually allowed a nonproductive person fewer chances to hide that lack of productivity. The new system brought many issues, especially performance, to light. Under the old system, personal commitment to the outcome of a job could be obscured. In the new work teams, an individual who was not performing or was making excuses instead of acting to accomplish work was visible to other team members. Likewise, extreme egotism, which demands glory and subverts cooperation, became more visible, even in workers who had seemed dedicated for many years. Corrective actions could be taken sooner and more directly.<sup>48</sup>

Managers and team leaders at PUREX also experienced many positive changes. Managers in the old PUREX organization who became team leaders or individual contributors under reengineering were initially frustrated. However, as non-managers, they found that only a few of their functions (notably the right to allocate expenditures above certain levels and to take personnel actions) had been diminished. Managers and team leaders all functioned more as mentors and "barrier busters" than as traditional supervisors in the reengineered PUREX organization. Managers had to shed much of their accustomed decision-making role because most work decisions were made by the teams. The sense of participation in a joint, mutually rewarding endeavor increased among PUREX workers, team leaders, and managers.

One problem caused by reengineering the PUREX work force was that employees who formerly devoted much of their time to "walk-in work," such as responding to investigative teams, writing special documents, leading facility tours, etc., could no longer perform these extraneous but still important duties without diluting efforts toward core work. Therefore, the organization had to depend on and educate specialists from outside the PUREX facility when special needs arose. At the same time, budget cuts in "overhead" support organizations made specialists less available to support facility needs.

Not every organizational problem at PUREX was solved by reengineering. As in all human endeavors, issues arose and were resolved over time and some issues were never resolved.<sup>49</sup>

### 3.10 LESSONS LEARNED

**Lesson No. 10.** Reengineering breaks internal organizational barriers and motivates workers based on ownership and the knowledge that their own performance on teams will be recognized. The knowledge that the best performing teams may be the first to be hired or recommended for new positions offers a powerful incentive for people to work themselves out of their jobs.

**Lesson No. 11.** Organizational culture, fed by management systems, values, and rules both modeled and expressed, is often deeply entrenched and very conservative at older DOE Sites. (The same may be true of many older industries and Department of Defense sites.) This culture, which valued secrecy, loyalty, and a zero-risk mentality, must be recognized and the commitment to change underscored boldly at all levels of management if reengineering is to succeed. Moves toward a self-directed work force must be encouraged by management, and must never be viewed as disloyal.

**Lesson No. 12.** Involving people who have worked at a facility or in an organization for a long time is essential if the true nature of the work and needs of the facility are to be understood. When less intimately involved persons try to define essential work needs in a facility, they usually can formulate only general statements. For the detailed work analysis necessary to structure teams that can succeed, long-time workers must be involved.

**Lesson No. 13.** When external teams arrive at a facility to begin reengineering, they must be careful not to "shove" ideas at the facility workers, and they must communicate and make themselves regularly accessible. Opportunities for workers to talk with external teams must be structured so that the workers are not intimidated. Team members should go individually to facility lunchrooms and other gathering spots, both by making scheduled appearance and dropping in, to allow workers to ask questions. Announcing that the team has an open-door policy may not make employees comfortable enough to approach the team.

**Lesson No. 14.** If teams lack critical resources, they will not succeed. At the same time, specialists such as safety and regulatory experts should serve all teams equally and not be assigned permanently to an individual team.

**Lesson No. 15.** Team leaders need skills in judgment, initiative, leadership, team building, decision making, and customer focus, in addition to their technical skills. Also, individual workers can use the job reapplication process to display personal skills that may have been unrecognized before.

**Lesson No. 16.** A reengineered team environment offers fewer absolute opportunities to climb an organizational ladder. Therefore, salaries must be placed in "broad bands" to allow individuals to proceed at their own pace up a merit-based continuum.

**Lesson No. 17.** A facility like the PUREX People Center benefits a deactivation project greatly by opening up communication, quelling rumors, and helping dispel discontent and fear by giving workers early and ongoing access to HR expertise. The emotional reaction of fear of change is powerful. A People Center, located in the facility and staffed full-time on a rotational basis, allows people to talk and seek resources and information when they feel the need.

**Lesson No. 18.** People working themselves out of a job should be given access to information about future jobs long before their current jobs end. Otherwise, fear of unemployment may drive them away from the deactivating facility before they can complete the deactivation work.

**Lesson No. 19.** Different people respond best to different forms of communication. Facilities should use all avenues of communication, including written, graphic, and verbal.

**Lesson No. 20.** A charter stating its basic purpose and identity should be written by each team soon after its formation. A charter sets the tone for the "new world" of the reengineered facility.

**Lesson No. 21.** Ongoing training after a team begins to struggle with actual work problems is important. Training in specific skills such as problem-solving, communication, etc. should not begin immediately after team formation. If such training is mandated too soon, much of what is offered will not be appreciated and may even be resisted by team members.

**Lesson No. 22.** Teams have five distinct stages of development: start-up, confusion, leader-centered, tightly formed, and self-directed. These stages must be recognized by management and organizational development personnel who facilitate the reengineering process. If these stages are not recognized as normal, facility leadership may think that reengineering has failed.

**Lesson No. 23.** Once a team is formed, it must be given cradle-to-grave responsibility for its work products. If control is taken away from the team, members may stop feeling responsible for the work and the reengineering experiment may fail.

**Lesson No. 24.** Teams must be physically colocated to bond and to feel jointly responsible for work.

**Lesson No. 25.** Reengineering brings nonproductivity and egotism to light. Hiding such patterns is impossible in a reengineered structure. Surprises may await managers and coworkers when some employees reveal these attributes that make them less than cooperative.

**Lesson No. 26.** Reengineering is not a one-time activity; it is a way of thinking. Some problems will never be solved in a facility, and some may take long, slow, patient action to uncover and remedy. After reengineering, management and workers still need to vigilantly seek ways to smooth and improve. Reengineering is a never-ending process.

**Lesson No. 27.** Teams should not be too large. A team of more than 20 people will have trouble focusing its discussions and reaching closure on decisions.

**Lesson No. 28.** Not every job function or set of workers should be brought together in a team. Teams must have common goals to function. Workers in administrative, facility, and technical support functions, by the nature of their tasks, will not share the same goals. These workers should continue to be managed as groups.

**Lesson No. 29.** All key reengineering decisions in a deactivation project must be driven by the project's end points. If the end points are not in place, teams may be organized in ways that are less than optimal, budgeting and scheduling will not be efficient, and the project will flounder.

**Lesson No. 30.** One or two redeployment officers should be appointed in a deactivation project several months before the project ends. As workscope begins to diminish visibly, people will become anxious about their futures and may not perform optimally. However, the presence of dedicated redeployment officers working in their behalf relieves much of this anxiety and allows employees to focus on their work. Management and corporate support for redeployment efforts is essential.

## 4.0 PUREX WORK PLANNING/ENDPOINTS DEVELOPMENT AND DOCUMENTATION

### 4.1 FIRST STEPS IN DEACTIVATION WORK PLANNING

When the PUREX facility shutdown order was received in December 1992, plant managers began detailed planning for the actual physical steps that would be needed to bring the huge facility to a safe, low-cost, low-maintenance deactivation status. It must be recalled that facility deactivation work, pursued as a project, was a new field at the time, and DOE guidance manuals that are available today had not yet been written.<sup>50</sup> After receiving a generic set of D&D acceptance criteria in March 1993, PUREX personnel held a large workshop to discuss and define the major technical tasks. They divided the technical work into 20 major tasks:

- Chemical disposition
- Single-pass reactor fuel disposition
- Slug storage basin deactivation
- N-Reactor fuel disposition
- Zirconium heel stabilization
- Uranium/plutonium solution disposition (D5/E6)
- Canyon flushing
- In-plant waste concentration
- Contaminated solvent disposal (organic—TBP/NPH)
- Contaminated nitric acid disposition
- PR room cleanout
- N-Cell cleanout
- Q-Cell cleanout
- Sample gallery deactivation
- Laboratory deactivation
- P&O gallery and white room deactivation
- Utilities and service systems (water, steam, electrical, and fire suppression)
- Support and ancillary systems deactivation (293-A, 203-A, 211-A, 206-A, 205-A, 212-A, 294-A and other ancillary buildings)

- HVAC consolidation
- UO<sub>3</sub> Plant deactivation.

Some technical tasks and subtasks were reorganized many times, but by July 1993, the list was finalized and held through the end of the first official year of the PUREX/UO<sub>3</sub> Deactivation Project (FY 1994).<sup>51</sup>

Once the major technical tasks were defined, a lead engineer and a support engineering team were assigned to each task. For 2 months beginning in August 1993, personnel from the engineering, operations, maintenance, and program and project control organizations met nearly continually in the PUREX war room (a central conference room). They first defined the logic and sequence of each main task, along with the resources to continue routine and required S&M checks. In the summer of 1993, schedulers from the PUREX project control organization began producing draft schedules primarily based on the input and decisions made during the meetings held in the war room. (See Chapter 5 for more detailed information on scheduling.)<sup>52</sup>

#### 4.2 PROJECT MANAGEMENT PLAN

Early in FY 1993, work began on a *PUREX/UO<sub>3</sub> Deactivation Management Plan* (PMP). Prepared under the guidance of DOE Order 4700.1, *Project Management*, the PUREX plan was large and comprehensive. It attempted to encompass regulatory planning, safety strategy, scheduling and budgets, numerous technical plans, management and organizational structure, information and reporting requirements, safeguards and security plans, records management, a plan for managing critical skills and work force redeployment, stakeholder involvement, an S&M plan, waste management, and provisions for quality assurance. When issued as a draft in September 1993, the document filled over 220 pages. After stakeholder and DOE review, it was even longer.

The plan was issued in final form in August 1994. It was useful as a comprehensive record, but was unwieldy to review and revise, so it lost much of its flexibility and usefulness to the project. The plan also had other shortcomings. The work breakdown structure was not well defined or structured for a true project. Because end point criteria, specific project end points, and S&M plans had not yet been developed, the plan could not be a true map of the project. It did not contain the same level of detail for S&M and deactivation activities. Where deactivation activities were specified in detail, they sometimes changed over the life of the project. The plan also provided only limited detail for the technical baseline and for integration with other Site management systems. By the last year of the project, the plan had little value as a reference document.<sup>53</sup>

#### 4.3 END POINT CRITERIA WORKSHOP

The process of developing end points in the PUREX/UO<sub>3</sub> Deactivation Process is described in detail because of the overriding value that end points have provided to the project. During late 1993 and early 1994, as the PUREX/UO<sub>3</sub> PMP was being drafted, DOE and the ITEs assigned to aid the project questioned work planning at its most basic level. The ITEs pointed out that without predetermined end point criteria, the deactivation project truly

lacked a compass. How could planners decide whether or not a particular job was necessary and valid if they had not defined the desired or required end products of all the jobs? How could specific meaning be added to vague end point terms such as "safe," "ready for D&D," and "clean." These comments led PUREX management to decide to perform an End Point Criteria Value Engineering Study<sup>e</sup> in February 1994.<sup>54</sup>

The End Point Criteria Value Engineering Study was conducted jointly by representatives of the contractor and RL D&D organizations, the RL deactivation organization, ITEs, and many components of the PUREX/UO<sub>3</sub> organization. The study's purpose was to define D&D acceptance criteria for this particular project in a cooperative manner. The study emphasized that maximum safety improvements must be extracted from every deactivation dollar spent. The product of the study was not the expected set of joint D&D acceptance criteria. Instead, the key conclusion was that, with a long lag time between deactivation and eventual D&D, planners of the deactivation project could not know or anticipate the methods, needs, and capabilities of future D&D endeavors. Factors ranging from technology to public desires could change the character of 21st century D&D efforts into forms not even imaginable by today's planners. Therefore, the study concentrated on developing a methodology for making deactivation decisions. The process itself was the product. Its highest value was that it could be applied flexibly to resolve the ITEs' concerns, as well as other concerns and issues that might develop along the way.

#### 4.4 END POINTS ESTABLISHED USING MATRIX-BASED APPROACH

A matrix-based approach to establishing deactivation end points became the product of the study. A two-dimensional matrix was devised to be applied across systems and spaces in the PUREX and UO<sub>3</sub> Facilities. At the top of each page of the matrix, one structure or space (or a collection of similar structures and spaces) within the plants was identified. One axis of the matrix listed the top six goals to be considered in deciding which deactivation tasks to complete. These six goals were:

- Protect the deactivation and eventual D&D workers
- Protect the public and the environment
- Prepare the facilities to need only quarterly S&M checks
- Comply with applicable regulations
- Consider D&D needs as far as possible in a general sense
- Keep commitments made to stakeholders.

The other axis listed issues and hazards associated with each structure or space. Examples of such issues and hazards included the presence of the following:

---

<sup>e</sup> Value Engineering is the name of a workshop with a specific format, used many times at WHC and other companies.

- Fixed radioactive contamination
- Non-fixed radioactive contamination
- Mixed waste
- Low-level waste
- Transuranic waste
- Transuranic mixed waste
- Non-regulated waste
- Hazardous materials
- Fissile materials
- Industrial Occupational Safety and Health Administration (OSHA) Washington Industrial Safety and Health Administration (WISHA) hazards
- Residual liquids
- Dose rates in the area
- Confined spaces
- Exterior penetrations that could allow access by animals or the effects of weather changes
- Fire hazards
- Active utilities
- Spare parts
- Whether or not the areas or structures in question were posted as radiation and/or asbestos zones
- The structural integrity of the facility
- The status of equipment in the facility.

Working across the matrix, each condition or hazard within the plants could be addressed in light of which actions could or should be taken to mitigate the hazard. The study report stated that the matrices identified in terms of concept and initial design during the Value Engineering Study needed to be refined and extended to more sophisticated levels.<sup>55</sup>

Once the End Point Criteria Value Engineering Study was completed, PUREX personnel convened in the war room to reexamine each planned deactivation action. Next, the PUREX engineering organization began examining the existing facility work plans and procedures and writing new ones where needed for deactivation actions. Where possible, existing work plans were used as a

cost-savings measure. Revisions also began on the PUREX/UO<sub>3</sub> Deactivation Project Management Plan. At the same time, so many valuable concepts had emerged from the PUREX End Point Value Engineering Study that DOE Headquarters contracted to have the *Facility Deactivation End Points Handbook* written to serve as a guide for facilities across the nation.<sup>56</sup>

Even as deactivation work planning consumed much of the time and attention of PUREX personnel throughout 1993 and 1994, and as required S&M checks expended much of the remaining plant resources, some actual deactivation tasks moved ahead. Meeting together, engineers, supervisors, and nuclear process operators defined several deactivation tasks to be done as "best management practices" before specific end point criteria plans were finalized. The effort to define end points became more urgent as planners realized how crucial these criteria were to work and resource decisions.

#### 4.5 END POINT PLANNING FIRST TESTED AT UO<sub>3</sub> PLANT

The first real test and application of end point planning came at the UO<sub>3</sub> Plant, where a series of precedent-setting steps were taken in 1994 that extended the concepts initially defined in the PUREX Deactivation End Point Value Engineering Study of February 1994. The seven key, generic objectives for facility deactivation projects remained the same. However, the following seven logic-based guiding principles were defined for the UO<sub>3</sub> deactivation.

- Every end point decision should be driven by and clearly linked to major program objectives and goals (those defined by PUREX in the Value Engineering Study).
- The end point condition of the deactivated facility should employ "defense-in-depth" as a fundamental safety approach. As applied at UO<sub>3</sub>, there would be three layers of protection: elimination of hazards, effective facility containment, and facility monitoring and control.
- End point decisions should be linked integrally to decisions and constraints on resources and methods. Cost effectiveness was important.
- Successful end point development would require ownership (buy-in) by all affected organizations.
- Clear, measurable completion criteria would need to be established for work teams in the field.
- Because ultimate D&D methods, time frames, and end states could not be known,<sup>f</sup> end point decisions should not be driven by D&D presumptions.<sup>f</sup>

---

<sup>f</sup> Note: End point criteria are those that apply to the finish points of a deactivation process. End state criteria are those that apply to the finish points of a D&D process.

- End point development should be an iterative process. While end points should be established early, they also should retain some flexibility because they might have to be revised during the deactivation process.<sup>57</sup>

In the UO<sub>3</sub> Plant End Point Criteria document that was created in 1994, the primary deactivation tasks were defined as follows:

- Eliminate or reduce hazards (chemical and physical)
- Deal with radiation fields (eliminate, shield or isolate)
- Reduce contamination and prevent its spread
- Remove waste
- Isolate and contain residual, potentially hazardous materials or conditions
- Provide the capability to monitor and control the facility
- Refurbish or install any facility modifications necessary to support future work (S&M or D&D)
- Document and label legacy equipment and systems.

An internal classification system for spaces and systems within the facility then was applied. The following six cases or criteria were used; three concerned spaces and three concerned systems:

- Case 1 was internal spaces for which routine access was expected during the S&M period (post-deactivation, but pre-D&D)
- Case 2 was internal spaces for which routine access was not expected
- Case 3 was external spaces, including building envelopes
- Case 4 was systems and/or equipment to be kept operational (such as surveillance lights)
- Case 5 was systems and/or equipment to be mothballed for possible future use by D&D (such as freight elevators)
- Case 6 was systems and/or equipment to be abandoned in place.

Every place, system, and piece of equipment in the facility was to be assigned to one of these cases.<sup>58</sup>

The UO<sub>3</sub> deactivation project objectives, fundamental tasks, and the six cases were integrated in the first prototypical example of the extended end point matrix. Three levels of evaluation were performed:

- Level I activities applied to all the facility

- Level II activities applied to just one case (but to all spaces, systems or equipment within that case)
- Level III activities applied to just one object in the plant.

A matrix was created for each level. End points were determined for each level, based on what specific tasks would be necessary to achieve deactivation objectives. Each task was evaluated as it related to each objective and assigned to one of four general categories.

- Category One tasks, because of the objectives they supported, needed to be given primary consideration or rank in setting the end points.
- Category Two tasks, because of the objectives they supported, could be given secondary consideration. They were important but would not be the controlling factors in setting end points.
- Category Three tasks were applicable to particular regulations, requirements, or stakeholder commitments.
- Category Four tasks were not applicable to the direct support of any end point objective.

Every activity that could be done in deactivation was scored in at least one matrix (and sometimes in a matrix for each level), graded, and negotiated among representatives of the deactivation and D&D organizations. In this manner, agreement was reached about which activities would be performed in the UO<sub>3</sub> Plant deactivation. The matrices and their agreed-on results were compiled into the UO<sub>3</sub> End Point Criteria Tracking Document, a signature book that actually recorded completion of all 1,740 end points (signature by deactivation contractor personnel) and verification (signature by D&D contractor personnel).<sup>59</sup>

#### 4.6 PUREX PLANT END POINTS DEVELOPMENT REFINES UO<sub>3</sub> APPROACH

As soon as the UO<sub>3</sub> Plant end points were fully written (although not all completed and signed off) in the Autumn of 1994, full-time work began developing the PUREX end points. The same guiding principles and basic objectives applied at both facilities. Developing PUREX end points required the same primary tasks as had been performed for the UO<sub>3</sub> end points: following the sequence through classification of spaces and systems, applying the functional matrix, and establishing detailed end points for each space and system. However, difficulties emerged in applying these methods at the huge PUREX facility. At the same time, lessons were being learned in implementing the end points at the UO<sub>3</sub> Plant. These events combined to bring about some key changes that improved the PUREX end points.<sup>60</sup>

One salient difficulty at PUREX was the facility's sheer size. At UO<sub>3</sub>, all the criteria assigned to each case had been applied to each applicable space and system, and became the end points for that space or system. When this process was applied at the PUREX Plant, and when specific named end points were added (such as the removal of plutonium residues from a given laboratory hood), the result was nearly 10,000 end points!<sup>61</sup> Also, as the

1,740 UO<sub>3</sub> end points were being signed off at that plant, the team discovered that many of them were not applicable, and that simply using criteria as end points resulted in end points that were vague and subject to interpretation and argument. End points such as "remove fixed contamination from...(a certain space) using best management practices" had no real measurements attached to them, and the deactivation and D&D organizations sometimes could not agree on when they were completed. Also, every system and space did not need action for each criterion, so that some UO<sub>3</sub> end points had to be closed by writing "N/A" (not applicable).

In February 1995, the same month that the UO<sub>3</sub> Plant transitioned to the D&D organization and the first set of nearly 10,000 PUREX end points was published, work began on revising the PUREX end points. The deactivation and D&D organizations both carefully evaluated each area, space, and system in the PUREX Plant. If a given criterion did not apply, the end point was deleted at this nexus. Also, where criteria did apply and became end points, the end points themselves were tightened into quantifiable, measurable language. For example, "remove fixed contamination from...[a certain space]..." became "remove fixed contamination from...[a certain space] such that contamination readings are no higher than [a specific number]." In this way, the PUREX end points, as finally determined by August 1995, stood at 2,525 and reflected more exactly what needed to be done. Work plans then could be written to provide the specific "hows" of reaching each end point. Schedule rebaselining to fit the end points followed in the Autumn of 1995 (see Section 5.4). Unfortunately, at PUREX, post-deactivation S&M planning was not well developed when the end points were being written, so that the clarification that a clear S&M plan might have provided was not available.<sup>62</sup>

As a last step in the end point planning process, an independent contractor performed a hazards analysis to certify that the actual state of the PUREX facility, once all the end points were completed as agreed on by the deactivation and D&D organizations, would leave the facility in a safe, stable configuration. The hazards analysis used a graded approach in recognition of the complexity of and the inventory at risk in the PUREX facility, and assessed the likelihood and consequences of potential releases. When this study was completed in February 1996, it validated the PUREX end point plans, and the process of signing off all of the end point items moved forward.<sup>63</sup>

#### 4.7 FINAL END POINTS CLOSE-OUT

As the PUREX Deactivation project entered its final 6 months, project managers and staff recognized gaps and gray areas in the end points. While engineering and technical issues closed succinctly in the end points, PUREX personnel found many loose ends when they tried to achieve specific closure in other areas. The greatest single area of concern became the administrative end points, those directed at emptying the PUREX building and support buildings of property and records. With the Ancillary Buildings Team disbanded, and personnel leaving PUREX on a regular basis, the Administration Team was overwhelmed in the last 6 months of the project. In the Winter of 1997, this team met with all remaining project personnel and generated a list of 100 topics that needed attention. The list included subjects such as the disposition of furniture, letterbooks, trailers and mobile offices charged as property to the PUREX organization, telephones, computers, office supplies, manuals, files and records, and vehicles; how and when to stop mail services

and vending machine supplies; how to track and return items borrowed from other facilities; and how to arrange for essential services such as access to radiological protective clothing and masks after caretaker staff had departed. It became clear that the everyday details of shutting down a facility complex as large as PUREX and its ancillary structures were much more complicated than anyone realized. Focused as the deactivation project had been on engineering excellence, it had allowed daunting levels of "administrivia" to wait until too many people were gone.

In the broad category of administration, several other problems became evident as PUREX tried to close end points during the last months of the project. Plant and company manuals all had been written for operations; none gave instructions on how to completely stop a process or go to a surveillance and maintenance-only mode. Also, some end points referred to manuals and procedures that no longer existed. Also, even when both deactivation and D&D personnel agreed on variances for certain end points, no mechanism existed to approve or verify the changes. Bimonthly partnering meetings between deactivation and D&D personnel helped to identify loose ends but could not place resolutions into an accountable system.

Solutions developed at PUREX included writing many desk instructions, letters of instruction, and a "punch list" of items that simply could not close until after the project finished. Also, many signs and a tour of the facility on video were developed to physically guide S&M and D&D workers of the future. Desk instructions, basically brief and specific substitutes for manuals in cases where policies needed to outlive the project, were written in the areas of health and safety, radiation control, access control, maintenance support, configuration control, and documentation. Letters of instruction were written for obtaining keys, maps, protective clothing, and radiation survey services once PUREX facilities were completely unoccupied. The punch list included a PUREX canyon roof repair, final approval of safety documentation for the S&M phase, and other items that could have held up project close-out for months. Finally, it was decided that while the PUREX Deactivation Project would close in May, actual turnover to the D&D organization would wait until after October 1, 1997, to coincide with the funding authorization. A skeleton staff of eight deactivation personnel would stay on at PUREX over the interim period to begin the S&M phase and close out the final items.

The other need that became most apparent at PUREX when the time came to close out the final end points was the lack of adequate documentation on why and how certain end points had been chosen. Although lengthy debate had been held among deactivation and D&D personnel in hammering out end point agreements, these debates had not been documented. Therefore, when independent oversight entities such as the Defense Nuclear Facilities Safety Board (DNFSB) questioned why certain end points had been chosen, ready access to the details was missing. In some cases, end points had been selected because technical barriers prevented other solutions; in others, cost, safety, and other factors had governed the choices. However, when questioned, PUREX personnel sometimes had to expend time and effort writing up justifications for the end point choices. These justifications should have been documented as they occurred and made a part of the permanent project records.

#### 4.8 FASTER TEAM FORMED

As a result of the many lessons learned throughout the work planning and end point development and implementation efforts of the PUREX Deactivation Project, 10 project leaders formed the Facility Stabilization and Environmental Restoration (FASTER) Team at the close of the project. The team will provide expert assistance to help other facilities conduct competent, efficient deactivation projects. Among the services offered by the FASTER team are project start-up consultation, design review, project planning, end point specifications, process and organizational improvement, procedures and work planning, and safety strategy development. The team believes that the lessons learned at PUREX, especially in the realm of "right-to-left" (end to beginning) work planning, can help other deactivating facilities save time and money, and minimize waste. They also have developed end point specification software and other products based on their experiences in progressing from the first PUREX Deactivation Project Management Plan through the final end points closure.

#### 4.9 LESSONS LEARNED

**Lesson No. 31.** A short, high-level project plan prepared as a policy document would be a better tool for setting overall deactivation strategy than a deactivation project management plan. Subplans dealing with issues such as regulatory compliance, safety strategy, stakeholder involvement, etc., then could be issued as supporting or ancillary documents. Then, each document could be revised and implemented quickly without waiting for total consensus on all sectors of the project.

**Lesson No. 32.** A deactivation project management plan should focus primarily on the baseline, baseline control, reporting, management, and summary sections. The project control system is crucial and should be consistent with project management methods rather than with operating methods.

**Lesson No. 33.** End point criteria *must* be developed at the start of a deactivation project so that they can be available as tools to set the work priorities throughout the project. Much money, time, and effort will be saved if right-to-left thinking is practiced. End point criteria should have been in place before PUREX schedules were developed and before other work planning went forward. End point criteria and end points must be set as a *first* priority in a deactivation project. They guide every aspect of the work, the budgeting, and the facility's organization.

**Lesson No. 34.** Because many years often pass, or can be expected to pass, between deactivation and ultimate D&D of major DOE facilities, the exact needs, methods, and end states of D&D in the 21st century cannot be anticipated. Therefore, developing a functional matrix-based approach to deciding which deactivation tasks add value to a project is better than establishing vague end point criteria. Such an approach must have joint participation and concurrence between the deactivation and D&D organizations.

**Lesson No. 35.** The sophisticated and interwoven objectives, fundamental tasks, levels, cases, and matrices developed in the PUREX and UO<sub>3</sub> Deactivation end point criteria compel all parties to take a justifiable, accountable look at why each task is done. Each task must have value to pass this test and to

be approved and executed. This approach results in cost savings and enhanced safety for deactivation workers, because it eliminates some unnecessary tasks. Another advantage of this methodology is its inherent ability to build consensus between deactivation and D&D programs, and to avoid costly disagreements at the time of facility turnover and beyond.

**Lesson No. 36.** End point specifications should state in specific terms what work must be done, but not how it should be done. The "how" aspect should be written into work plans that follow closely on the end points.

**Lesson No. 37.** End points should be specifically written such that visual verification is possible and can be agreed on easily by the deactivation and D&D organizations. If end points are not specific, agree ahead of time on the verification methods and standards. For example, visually verifying an end point that states "Resolve Serious Threats" or "Seal" is difficult. The criteria that constitute sufficient compliance need to be quantifiable and agreed on ahead of time.

**Lesson No. 38.** "Not applicable" can never close an end point. If an action is truly not applicable, it should not be an end point.

**Lesson No. 39.** Plans for post-deactivation S&M should be written before or along with end points, so that S&M activities can be factored into end point development.

**Lesson No. 40.** Negotiated agreements and/or special requirements resulting from regulatory drivers or stakeholder interests need to be known and factored into end point planning. If specific commitments have been made for the facility or for or by the deactivation or D&D organizations, these need to be identified ahead of time.

**Lesson No. 41.** While engineering and technical end points can be closed with precision by facility personnel, administrative end points can be surprisingly burdensome. Administrative close-out requires foresight and planning, and should not be left until most of the personnel have left a facility. The details of closing out a large complex of buildings and leaving an understandable set of procedures and instructions for future personnel constitute a huge endeavor.

**Lesson No. 42.** The reasons driving the selection of each end point should be written up at the time the agreements are reached, and should be made a part of the permanent deactivation project records.

## 5.0 SCHEDULING PROCESS AND PRODUCT

### 5.1 EARLY SCHEDULING DECISIONS MADE

In early 1993, DOE made clear to the PUREX management that the project schedules should be a key component of the planning. The benefits of logical, integrated schedules were expected to more than surpass the cost and effort of producing them. By integrating tasks in a logical sequence, timed and resource-loaded to accurate completion dates, the huge deactivation project could proceed without repetitious effort, time lags, or gaps, saving money. At PUREX, an early scheduling decision concerned whether the in-house Project Control organization or a specialized outside firm should perform the scheduling work. The first decision kept the work in house, but provided for additional training for the PUREX schedulers because they had never before performed tasks of the complexity and magnitude required by the Deactivation Project. It was reasoned that the dedication and commitment of the in-house staff to the old facility would outweigh the expertise of a specialized firm.

The Quik-Net<sup>64</sup> software scheduling program was chosen primarily because Quik-Net equipment (software and compatible computers) already was in use at PUREX and many schedulers and engineers who would have input to the schedules were familiar with it. It was thought that several scheduling programs could function to establish the PUREX/UO<sub>3</sub> schedules, but that the procurement, training, and start-up times would cause unacceptable project delays. Because the PUREX/UO<sub>3</sub> deactivation would require a huge number of extremely complex schedules, the Quik-Net vendors conducted two types of special, project-specific training. They spent 90 days in full-time residence at the Hanford Site, working with the expanding PUREX Project Control scheduling staff. They also believed that one key to producing good schedules was to upgrade the level of understanding of scheduling needs among all the personnel who would provide input to the schedules. To implement this belief and to allow all PUREX personnel to speak the same language as the schedulers, the Quik-Net vendors conducted 2-day training sessions for all personnel associated with the deactivation project.<sup>65</sup>

In early 1993, PUREX Project Control issued a call letter to all plant personnel responsible for Standby schedules. The letter asked that open items on the old schedules be evaluated to determine if they were necessary to the deactivation project. Unnecessary items were removed via a formal schedule change request; useful items were retained but sometimes renamed or regrouped with other activities. At the same time, the Quik-Net vendors conducted a schedule review to identify crucial concepts that would allow the most useful deactivation schedules to be created. The primary recommendations from this review included the need to develop a high-level ("master") project framework and planning process, strengthen the resource management process, build flexibility for changes into the scheduling process, monitor progress in specific, identifiable ways, and transfer real leadership authority for schedules to the PUREX Project Control organization.<sup>65</sup>

---

<sup>64</sup> "Quik-Net" is a trademark product of Project Software and Development Inc., of Cambridge, Massachusetts.

Scheduling for the PUREX/UO<sub>3</sub> deactivation tasks began in the spring of 1993 with four main project areas (then known as Level I Schedules) identified: criteria and plans, facility deactivation, UO<sub>3</sub> transition, and project management. A lead manager was assigned to each Level I area and asked to gather a team of engineers to name the Level II tasks in each area. (At that time, Level II schedules represented one more increment of detail beyond the large umbrella tasks identified in the Level I schedules.) Creating the Level II schedules resulted in 2 major tasks in criteria and plans, 15 activities in facility deactivation, 8 activities in UO<sub>3</sub> transition, and 6 activities in project management being identified. Each Level II activity then was assigned a champion, who in turn assembled a larger team composed of engineers, craft supervisors, and nuclear process operators.

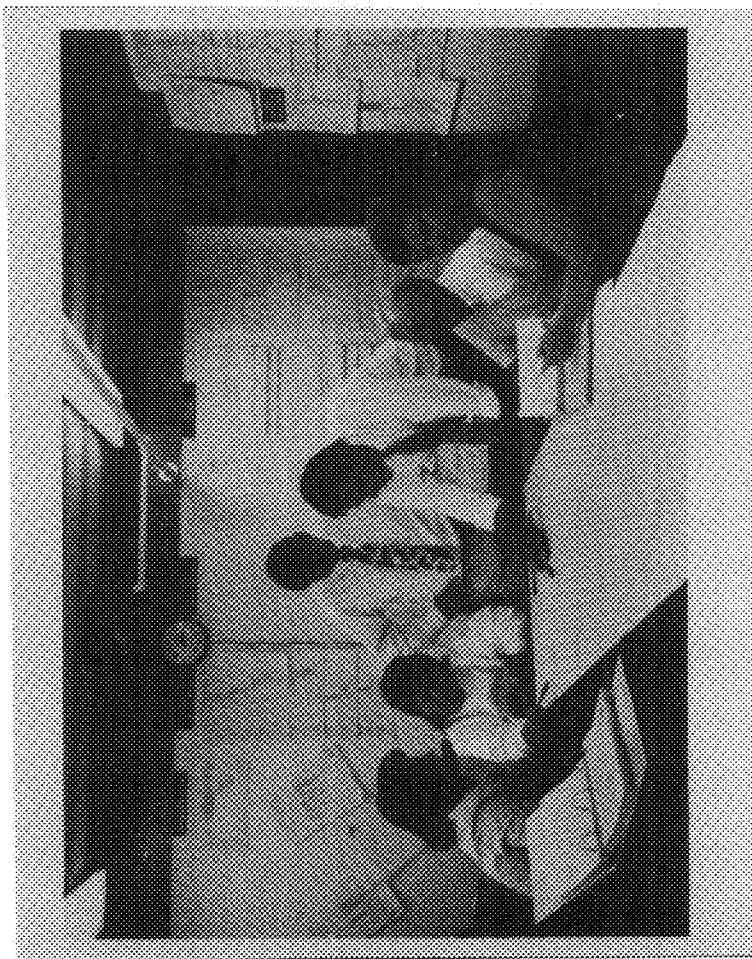
It was at that time that the marathon meetings in the PUREX war room began (see Section 4.1). The specific tasks necessary to accomplish each Level II task were written on small pieces of paper and discussed in detail by the persons who actually would write the work plans and perform the work. Then the specific tasks were rearranged in various sequences along the walls until consensus was achieved on the best pathway to accomplish each task. Thus, Level III, IV, and V schedules representing greater increments of detail were drafted (Figure 13).

## 5.2 OVERALL COORDINATION REQUIRED FOR DEACTIVATION PROJECT SCHEDULING

For the deactivation tasks, the next scheduling step was to identify the proper sequence for conducting various activities. PUREX personnel soon learned that in defining the sequencing step they encountered the real differences between facility operations work and project work. In routine operations, many jobs occur simultaneously, so work groups do not have to coordinate closely with one another. Also, operations personnel generally work in just one area or task. However, in a project environment, work must be performed in a logical sequence or the performance of one task will result in delays in another task. Also, work already performed in one task may have to be redone, if, for example, the work on another task recontaminates or reactivates an area already cleaned or closed in the first task. Also, in a project environment, personnel shift among various jobs so their time needs to be carefully and logically allocated.

Once the logic ties were identified, critical path jobs (high-priority jobs with long duration or first need in the project) were highlighted. Then all the jobs were resource-loaded. Engineers and the people actually responsible for performing the tasks met to decide how many person-hours or days were needed to accomplish each task. For some tasks that depended on specialized, aged equipment (such as the PUREX cranes), a 40-percent contingency factor was added to the time allotments to allow for outages and equipment breakdowns. At this point, the PUREX Project Control schedulers placed all the crucial information developed in the war room into their programs and produced draft schedules to be examined for overlaps, duplication, and other flaws.

Figure 13. Early Deactivation Project Schedules Being Developed  
in the PUREX War Room, 1994.



As part of the examination and checking process, the engineers responsible for each Level II task wrote a work breakdown structure (WBS) dictionary that named and described each task and listed the subtasks needed to accomplish it and any unknown factors that could affect the task. The WBS is a management technique for dividing a total program into manageable units of work. The WBS should provide the basic map for developing estimates, schedules, cost collection, and program reporting because it states what needs to be done. The WBS also should be the basis for developing a responsibility matrix to identify which organizations and subcontractors have prime and support responsibilities for each WBS element. At PUREX, although all the steps necessary to developing a WBS and a WBS dictionary were accomplished, they sometimes occurred in overlapping rather than sequential fashion. More outside scheduling and project control expertise could have helped streamline these steps. However, by the end of FY 1993, a set of 108 Level V schedules, fully integrated and resource-loaded, was issued as the baseline schedule for the PUREX/UO<sub>3</sub> deactivation project.<sup>66</sup>

### 5.3 1994 BASELINE REVISIONS

During FY 1994, the 1993 baseline schedules were revised in response to technical and work changes imposed by regulatory requirements, stakeholder input, and new information received from preliminary characterizations of plant areas. Other factors contributing to the revision included steam outages and other equipment and system breakdowns. Throughout the year, the PUREX war room often was filled with discussions of how best to accomplish specific tasks in light of new developments. Two major innovative ideas in disposition options for the plutonium/uranium solution and the contaminated nitric acid remaining in the plant resulted in a schedule compression of 10 months (see Sections 8.2 and 8.4). In addition to reducing S&M costs, these new approaches saved \$36.9 million for the overall deactivation project. At the end of FY 1994, the PUREX/UO<sub>3</sub> deactivation project still was guided by 108 Level V schedules, albeit revised from the schedules used in FY 1993.<sup>67</sup>

### 5.4 REBASELINING, REENGINEERING BRING SCHEDULE REVISIONS: LEAD TO TEAM OWNERSHIP

As an early milestone of FY 1995, the PUREX/UO<sub>3</sub> schedules converted from the Quik-Net program to a software product known as PX<sup>h</sup>, because PX had become the Hanford Site standard and could integrate the financial data system (FDS) with schedules. When schedules delineated activities, the PX software could link these tasks integrally with their associated costs. Such a capability is a distinct advantage during rebaselining efforts, because it makes automatic the transfer of budgets with work tasks. In the PUREX Deactivation Project conversion to PX, difficulties were encountered because the PX software handled some data differently from the way Quik-Net had, especially in the area of sequencing. Because Quik-Net was not as sophisticated, it ignored some logic ties in the schedules. PX searched for each logic tie. When it could not find some key ties that were understood by everyone in the PUREX organization, but were not specifically programmed into

---

<sup>h</sup> PX is a trademark product of Project Software and Development Inc., of Cambridge, Massachusetts.

the schedule, it showed the project schedule as having drastic variances and gaps. These problems were resolved during the spring of 1995, and were folded into a periodic schedule rebaselining effort.<sup>68</sup>

In early autumn 1995, reengineering began at the PUREX facility and resulted in the creation of work teams (see Sections 3.3, 3.4, and 3.5). Each team was assigned the existing schedules for its tasks, and became responsible for completing them. (The schedules had been assigned to cognizant engineers under the old system.) An early effort for each team was to validate its schedules to make sure they reflected only those activities necessary to reach the PUREX end points (see Section 4.6). Only by such validation could the project define its remaining budget needs and determine whether resources were properly applied. The resource-loading in some schedules fit the new teams better in some cases than in others. All the field teams rewrote their schedules in the spring and summer of 1996, buying ownership and participatory commitment to meeting those schedules. To help formulate new schedules, the Utilities team wrote a detailed, eight-step process that its members followed in doing any generic task. Each step had several substeps to guide the team scheduler in allocating time. The eight steps were: scope the work, prepare the required paperwork, schedule resources, procure and fabricate materials, prepare the job site, perform the work, stage waste for disposal and material excess, and close out. By using such internally devised tools, team commitment was strengthened and end points were realistically set and met.<sup>69</sup>

## 5.5 FINAL SCHEDULE REVISIONS MADE

In the final year of the PUREX Deactivation Project, significant schedule revisions occurred at two points. In January 1997, when the remaining members of original teams were regrouped into four new teams, the schedules of all the teams responsible for physical deactivation work were combined into one master "field work" schedule. This revised schedule reflected the acceleration of work achieved in several of the field work activities, especially in deactivation of the PUREX HVAC systems (see Section 8.10). It also reflected the realization that some work could not physically be completed during Winter months so that, while resources were ready, work still had to wait. At the same time, schedules were determined for the remaining technical documentation and for administrative work. The administrative schedule focused on the disposition of records and property charged to the PUREX organization.

In April 1997, PUREX Deactivation Project personnel constructed a master logic diagram to capture all remaining items on all schedules and map a path for the final close-out of each item. They grouped all tasks under two final headings, which became the two final PUREX schedules. Under one heading, field work, end points close-out, technical documentation and administrative items were collected into the punch list schedule of items that could be worked on by a skeleton crew after the official end of the project. The other major schedule guided the "interim S&M" phase that occurred from the close of the project until actual turnover of the PUREX facilities to the D&D organization. Preventive maintenance on the canyon exhaust fan, the 202-A Building roof repairs, and other tasks performed in the summer of 1997 were placed on this schedule. A list of instructions, almost a small project management plan, also was written to guide activities during this interim phase.

## 5.6 LESSONS LEARNED

**Lesson No. 43.** While the practice of generating fully developed, integrated, resource-loaded schedules is time consuming, it saves money in the long run for a large project. The cost and effort of producing the schedules are vastly surpassed by the savings that result from focusing the work and avoiding the delays and duplication that would occur without such schedules.

**Lesson No. 44.** Organizations within old facilities and DOE sites often have strong emotional ties and commitments to these facilities. Also, the intimate familiarity these persons have with the facilities is invaluable in producing realistic estimates of how work must and will occur, given facility configurations and physical quirks. While they often need additional training in areas such as scheduling, they are willing to learn new skills to stay with the facilities throughout deactivation. Their loyalty produces a strong work ethic and is valuable to the project. Keeping the operating employees with the deactivation project also provides them with enhanced skills that can lead to better career opportunities after the facility closes.

**Lesson No. 45.** The specialized expertise of state-of-the-art firms using complex software definitely is needed in scheduling huge deactivation projects. Using schedules that are current, tied to costs, and readily adaptable to scope and budget changes and rebaselining efforts is so crucial to project success that it must be directed by experts.

**Lesson No. 46.** Because S&M tasks consume much of a facility's budget during the early years of a deactivation project, detailed scheduling attention should be given to these tasks as well as to deactivation tasks. As requirements for S&M tasks decrease over the life of a deactivation project, the reduction must be reflected in the schedule.

**Lesson No. 47.** Schedules for large and complex deactivation projects need to be easy to change. They need to be "living" schedules because no person or team, however knowledgeable, can anticipate all the changes that will occur over the life of the project. Also, the schedule needs to recognize and incorporate the impacts of special tasks, such as responding to audits and providing special tours, that pull people away from their regular jobs.

**Lesson No. 48.** The software package chosen for a large deactivation project should be evaluated carefully before it is adopted. The sheer size and complexity of integrated, resource-loaded schedules that guide thousands of tasks demands software of huge capacity and flexibility. A change in software during a project can be very disruptive, even if the new software has technical advantages. Such changes should be made only if the technical advantages are overwhelming.

**Lesson No. 49.** Winter weather must be considered when schedules are created. Some field work tasks cannot close during winter months, final punch list schedules can be used to capture tasks that spill over.

## 6.0 REGULATORY ISSUES

6.1 RESOURCE CONSERVATION AND RECOVERY ACT AND  
TRI-PARTY AGREEMENT ISSUES:

The *Resource Conservation and Recovery Act of 1976* (RCRA) requires that a permitted treatment, storage, or disposal facility be closed within a specified number of days after receiving the last waste shipment. However, RCRA does not address the deactivation phase of a facility. Likewise, the *Washington Administrative Code* (WAC) was not written specifically with lengthy deactivation projects in mind. Therefore, a process to address and allow facility deactivation without going directly to closure was developed and documented in the Tri-Party Agreement for public review and acceptance. In the case of a facility as large as the PUREX Plant whose deactivation project lasted nearly 4 years, many interim agreements had to be negotiated with its regulators. The negotiations and their subsequent implementation depended on open and frequent communications, trust, and the willingness to enter into agreements that made sense based on what was both possible and safe.

As soon as the PUREX/UO<sub>3</sub> shutdown order came in December 1992, the regulatory status of certain materials in the plants changed. As WHC pointed out in January 1993, during the facility operations period "materials containing special nuclear materials...[were] classified...as feed material to an ongoing production process. Therefore, the materials were not considered subject to regulation as a dangerous waste, as defined by WAC 173-303. Since some of these materials are now intended for discard, the in-process materials are solid waste, and to the extent that nonradioactive components exhibit dangerous waste characteristics, those nonradioactive components are dangerous wastes...The units these materials are stored in are not covered in the PUREX interim status Part A Permit Application."

In light of this new situation, RL requested an early meeting to review the PUREX situation with the Washington State Department of Ecology (Ecology), the agency that administers RCRA as well as its own dangerous waste statutes.

The RCRA issues centered on only 8 of the more than 300 vessels in the PUREX Plant being identified as systems in the PUREX treatment, storage, and/or disposal (TSD) unit in the Part A Permit Application for the plant at the time the shutdown order was issued. However, many more vessels contained in-process materials that could be reclassified as solid waste regulated under RCRA because of this order. According to the *Federal Register*, process materials were not designated as waste for the first 90 days after facility operations ceased. However, the PUREX Plant still had only 180 days to develop a regulatory plan for the process materials and other solid materials.

Beginning in March 1993, WHC and RL met with Ecology and EPA and solicited their help in effecting a proper shutdown of the PUREX and UO<sub>3</sub> facilities. Waste minimization, cost-control, and compliance all were important goals. The contractor and RL explained the situation of the soon-to-be unpermitted tanks in the PUREX Plant, and asked for time and help in charting a path through the new, large, and complex regulatory situation.

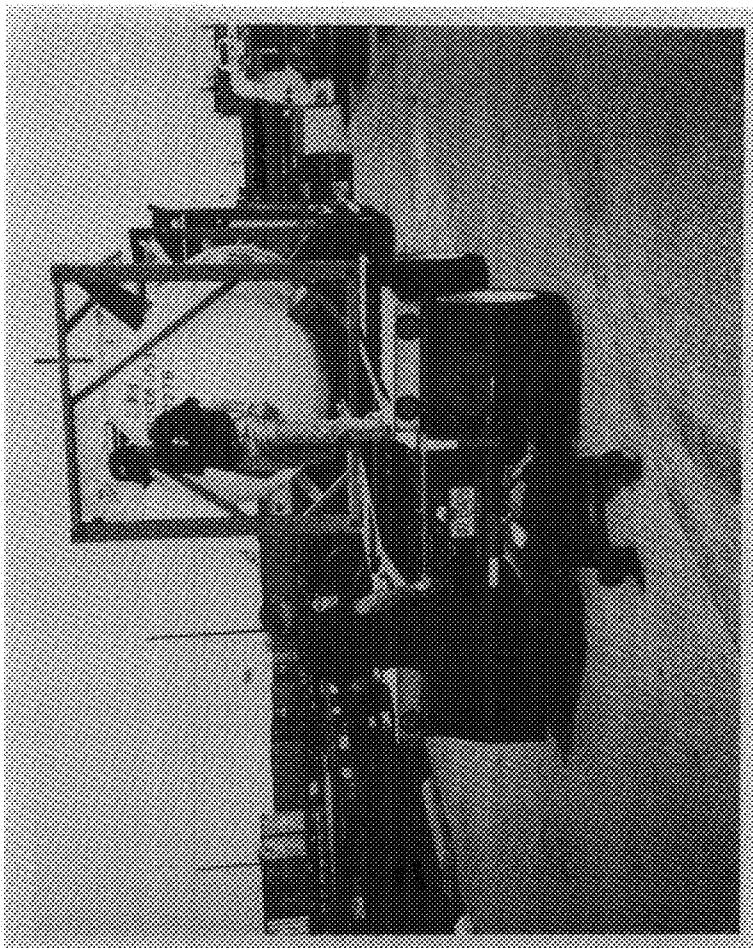
In April 1993, RL, DOE Headquarters, WHC, and Ecology held a week-long workshop to work through the PUREX regulatory dilemmas imposed by the shutdown order. A day-long workshop also was held with PUREX work planners and engineers and WHC regulatory support personnel to help each group understand what types of information and help each would need from the other to resolve the complex PUREX regulatory situation. In July 1993, regular monthly video conferences to discuss these issues were initiated among RL, WHC, Ecology, EPA, and the Washington State Department of Health (WDOH). In the summer of 1994, a series of face-to-face meetings was held at PUREX between WHC, DOE, and the regulators. The cumulative outcome of these meetings was to build trust and ownership and to obtain the assent of all the parties to work together to find solutions, rather than imposing penalties or engaging in other confrontational actions (Figure 14). Among the specific outcomes was the development of a Data Quality Objectives (DQO) document that set forth the requirements for flushing process vessels. (Regular meetings and video conferences continued between regulators and DOE every 4 to 6 weeks, to the end of the deactivation project. The value of these meetings never diminished.)<sup>71</sup>

Meanwhile, a list of the in-process chemicals remaining in the PUREX process tanks was compiled (see Appendix 14.3). The location and capacity of each vessel and tank were identified, along with the part of the process in which they were used, the current status and contents, the flush methods, the sampling requirements, and when or if they had been emptied. For example, in January 1993, PUREX tank J2, holding hazardous waste solutions bearing residues from previous neptunium-237 separations were sent to Hanford Site underground waste storage tank 241-AZ-102, via PUREX transfer tank F18. In 1994, WHC and RL adopted the position that all but 41 PUREX tanks could be dispositioned without being permitted under RCRA. The materials in these tanks could be consolidated and disposed of offsite or flushed through underground piping to the Hanford Site's tank farms. Because the existing permit application included 8 of the 41 tanks, DOE proposed including the other 33 in a revision of the RCRA Dangerous Waste Part A Permit Application. The regulators agreed to this course and the tanks were permitted.<sup>72</sup>

However, during the deactivation project in 1995, four more tanks in the PUREX Plant were discovered to contain dangerous waste that had not been noted and permitted. Traditionally, a Notice of Intent (NOI) to amend the Part A permit and add the four tanks would have been required of DOE and would have needed approval by Ecology. However, by the time the tanks were discovered, Ecology, DOE, and EPA were in the midst of discussions to revise the Tri-Party Agreement. They agreed to add language stating that for facilities "that have received a shut-down notice (facilities being transitioned)...system components (e.g., tanks and ancillary equipment) may be added to the Hanford Facility RCRA Dangerous Waste Part A permit without providing notification [to Ecology, local communities, and the public]...provided that these components have no further waste management mission prior to RCRA closure or deactivation." The four PUREX tanks were added to the Part A permit following the streamlined process.<sup>73</sup>

Another issue typically faced by transitioning facilities also was solved through cooperation between DOE and its regulators. DOE proposed carefully drawn, noncontiguous boundaries for the PUREX Building TSD unit for the revised Part A RCRA permit application. The boundaries included only the areas where dangerous waste actually was located, both in vessels and in areas

Figure 14. Washington State Police inspect Truck that will Transport Contaminated Nitric Acid from the PUREX Facility.



and containers on the PUREX canyon deck where solid radioactive and mixed waste in the form of concrete debris, equipment pieces, and other materials were stored and staged. When Ecology approved these boundaries, it meant that waste storage boxes and other containers and areas on the PUREX deck could hold debris resulting from deactivation work and could stage solid waste from other Hanford Site facilities awaiting final disposition. Areas in and near the PUREX facility that were included in the revised Part A Permit included Cells D through N, Q-Cell, U-Cell, Tanks P-4 and TK-40 outside, the crane area, hot pipe trench, slug storage basin, hot shop, west crane maintenance platform, and a shielding wall between the crane area and the canyon lobby (Figures 15 and 16).<sup>74</sup>

In January 1994, the Tri-Party Agreement was modified "to include the stabilization of facilities and 'transition' activities (those activities between the shutdown decision and the start of formal decontamination and decommissioning)." That year, many of the key issues pending under RCRA and other laws and regulations affecting the PUREX and UO<sub>3</sub> Plants were swept into Tri-Party Agreement milestone negotiations.<sup>75</sup>

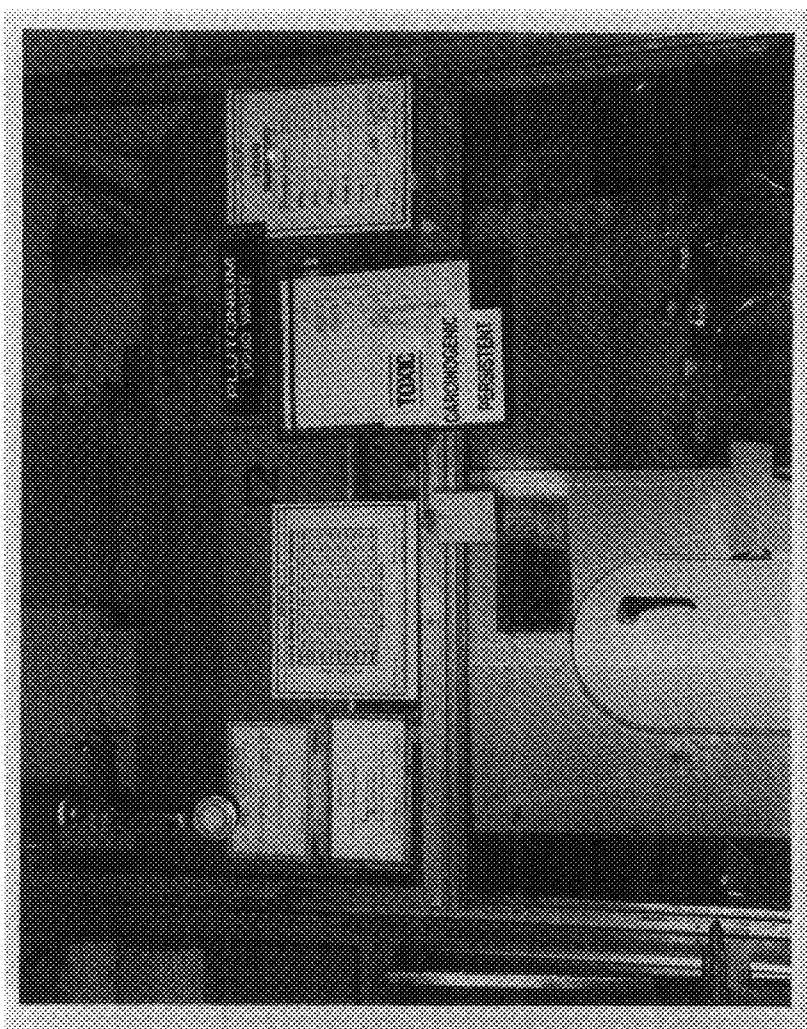
In one case DOE contended that the approximately 187,000 gallons of contaminated nitric acid at PUREX was not a waste because an alternative use had been found for the material in England (see Section 8.4). This position was accepted by Ecology and EPA, and the PUREX nitric acid was shipped to the BNFL facility at Sellafield, England in 50 shipments that were completed in early November 1995.<sup>76</sup> Another issue that was negotiated concerned listed waste in the PUREX Plant. In past practice, the PUREX laboratory had removed small liquid samples from the process and analyzed them using solvent extraction operations. The leftover materials were returned to the process solutions. Solvents from the analyses could have been considered listed waste. However, DOE proposed to Ecology in 1994 that "de minimus additions of PUREX laboratory solvents to the PUREX process do not necessarily make the PUREX system a hazardous waste management system." As part of the Tri-Party Agreement decisions, settlements were reached about the hazardous materials in the PUREX Plant, and the laboratory solutions were not specifically permitted as dangerous waste.<sup>77</sup>

An additional key issue negotiated for the PUREX Deactivation Project as part of the Tri-Party Agreement was whether a RCRA Part B Permit Application or facility closure plan would constitute the final documentation for the hazardous and dangerous components of the PUREX Plant. As a result of the negotiations, the PUREX storage tunnels (two enclosures, one 500 feet long and one 1,500 feet long, accessed by rail track and holding contaminated equipment and other solid waste forms) were deemed to need different documentation. The PUREX tunnels, as waste storage units, required a Part B (final) Permit to continue functioning as an operating storage facility. As such, the tunnels can receive and store waste from other Hanford Site facilities. The tunnels may continue to receive waste until they undergo final closure and their waste is dispositioned. In late July 1996, Revision 3 of this Part B Permit was sent to the regulators, as required in Tri-Party Agreement Milestone M-80-02, in conjunction with a preclosure work plan for the PUREX Plant. The preclosure work plan was a compromise agreed to by DOE and its regulators to address facility status and safety in the period between deactivation and D&D. The final Part B Permit for the PUREX Tunnels will be incorporated into the modified Hanford Facilities RCRA Permit.<sup>78</sup>

Figure 15. A Washington Department of Health Inspector Verifies a Sampler Installation at PUREX, 1993.



Figure 16. Permitted Waste Accumulation Area  
in the PUREX Facility, 1995.



The PUREX facility itself was placed in a special "transitioning TSD" category created in revisions to Chapter 8 of the Tri-Party Agreement. Under the Chapter 8 provisions, the plant would continue to store some waste that would not be cleaned out of inaccessible areas during deactivation, but PUREX would not "operate" as a TSD. Three phases of documentation to achieve RCRA closure were called for in Chapter 8 because of the expected long lag time between deactivation and final D&D. In the Transition Phase, a project management plan, an end point criteria document, and a preclosure work plan were required. In the S&M Phase, a S&M plan was required (see Section 7.8). In the Disposition Phase, a final D&D phase that could occur decades after Transition, another project management plan would be required, along with a facility disposition end state criteria document and a RCRA closure plan for the TSD units within the facility. In compliance with Milestones M-80-02 and M-80-02-T02, the PUREX Deactivation End Point Criteria document was written in 1995 and the PUREX S&M Plan was completed in 1997. All Tri-Party Agreement signatories were involved in approving these documents.<sup>79</sup>

Other specific transition activities in the PUREX Deactivation Project also became Tri-Party Agreement milestones in revisions finalized during 1995 and 1996. Once these activities were incorporated into the Tri-Party Agreement, Ecology was designated as the "lead regulator" to track compliance and EPA became less involved in monitoring the PUREX Deactivation Project. Removal of spent fuel rods from the PUREX Plant (see Section 8.3) became Milestone M-80-00-T05 and was completed when the spent fuel was transferred to the 105-K West Basins at the Hanford Site on October 12, 1995. Deactivation of the PUREX R-Cell became Milestone M-80-01, completed in early 1995. Removal of process waste solution from PUREX tanks D5 and E6 became Milestone M-80-03 and was completed in 1995 (see Section 8.2). Deactivation of the PUREX Sample Gallery, including but not limited to flushing headers and high radiation samplers, decontaminating or stabilizing hoods containing significant quantities of SNM, and decontaminating, stabilizing, and/or removing hood ductwork, became Milestone M-80-00-T07. It was completed in July 1996.<sup>80</sup>

Deactivation of the U-Cell fractionator, including but not limited to removing recovered nitric acid, flushing vessels, and sealing U-Cell cover blocks, became Milestone M-80-04, completed in April 1997. Deactivation of the 211-A aqueous make-up area, including but not limited to removing the chemical inventory and flushing or emptying tanks and supply headers to the PUREX canyon, became Milestone M-80-05. It was completed in July 1996. Deactivation of the 203-A Uranium Storage and Pumping Station, including but not limited to emptying and flushing tank systems and decontaminating and stabilizing contaminated surfaces as necessary, became Milestone M-80-07, which was completed early in September 1996. Completion of canyon and vessel flushing and isolation and blanking of canyon piping became Milestone M-80-06, completed in July 1996. Lastly, the designation and documentation of all hazardous and dangerous substances in the PUREX Plant at the conclusion of the transition phase became Milestone M-80-08, due for completion in July 1998.<sup>81</sup> Other milestones were achieved in 1997.

## 6.2 AIR PERMITTING ISSUES

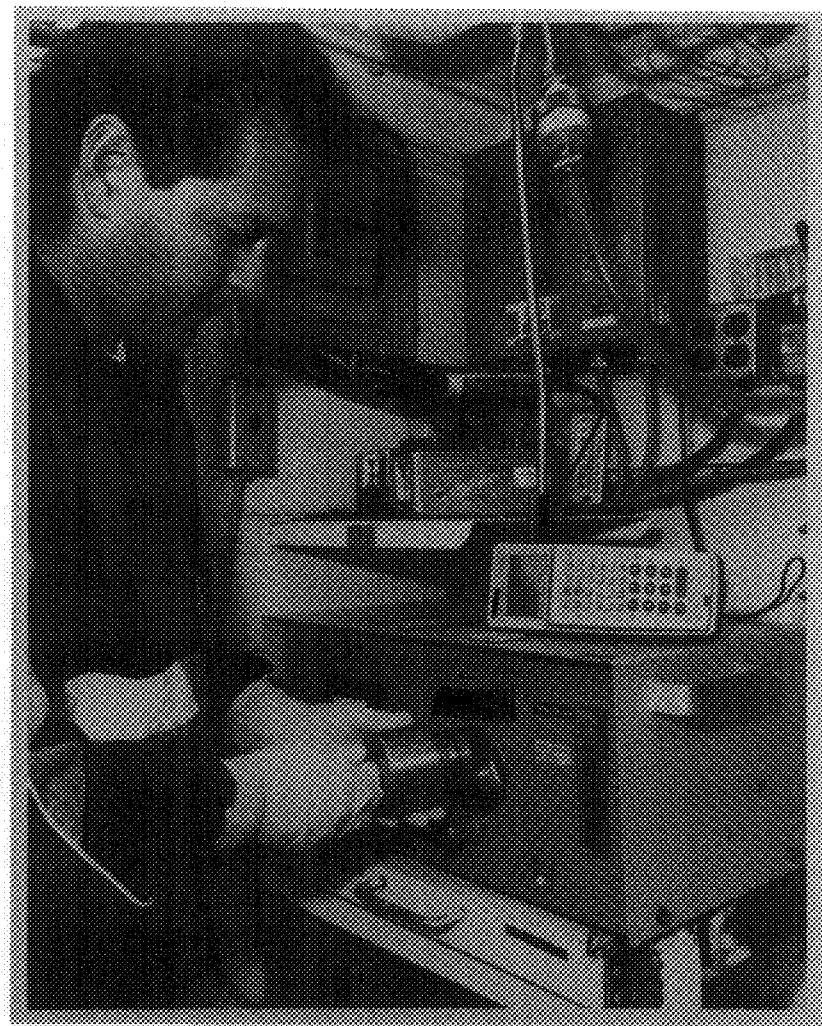
In the area of air permitting for the PUREX/UO<sub>3</sub> deactivation project, the approval of DOH, Ecology, and EPA was needed to conduct deactivation activities. DOH had the authority to regulate radioactive air emissions; Ecology was responsible for regulating nonradioactive air emissions (nitrogen oxides-nitrogen oxide and toxic air pollutants). EPA had the authority to regulate both radioactive and nitrogen oxide emissions, but not toxic air pollutants. WHC and RL believed that deactivation activities would generate emissions at a much lower level than emissions during the years of normal operations, as represented by the last 2 full years of normal PUREX and UO<sub>3</sub> operations. They proposed to demonstrate the lower emissions to the regulators with clear figures, hoping that full new permit applications would not be needed. This strategy would save time and money. WHC and RL submitted several "emissions comparison documents" to the state regulators in early 1994; the regulators accepted them in the spring and summer (Figure 17).<sup>82</sup>

DOH and EPA did require permit applications for radioactive air emissions generated for certain "non-routine" activities. These activities required air permitting because they were outside the normal activities performed at PUREX. Three permits for activities that would potentially generate radioactive air emissions were written in 1995 and 1996. The first permit application was for transferring the spent fuel from the PUREX Plant to the 105-K West Basin. The return of spent fuel to the fuel storage basins was not considered routine. The permit application was approved by WDOH on July 11, 1995, and EPA on August 14, 1995.

The second permit application allowed transfer of up to 2 million curies of radioactive waste from the Hanford Site's 324 Chemical Engineering Building into PUREX Storage Tunnel 2. The 324 Building waste was the first non-PUREX-generated waste to be considered for storage in the PUREX tunnels. Several negotiating sessions with EPA and DOH were required because the PUREX Storage Tunnel 2 stack was a minor stack and the addition of the 324 Building Waste had the potential to require reclassifying it as a major stack. Finally, both agencies agreed to allow RL to prove that the stack should remain a minor stack and the permit application was approved with conditions by DOH on December 4, 1995, and EPA on December 6, 1995. Continuous operation of the tunnel exhauster and stack sampler started on December 13, 1995. Both DOH and EPA insisted that stack sample analyses include total alpha and beta analysis, and quarterly composites of alpha spectrometry, strontium-90, and a high-resolution gamma scan. Further, DOH insisted that nondestructive analysis (NDA) of the high-efficiency particulate air (HEPA) filter on the tunnel exhauster be performed twice in 1996. These NDAs indicated that the detection limit was low enough to detect changes on the filter loading that would indicate a need to upgrade the stack later if required.

In March 1996 PUREX placed two railcars of waste material (contaminated PUREX equipment) into PUREX Storage Tunnel 2. When EPA and DOH approved the permit application for the 324 Building waste, they were not aware that additional PUREX waste material would be placed in Tunnel 2. When DOE and EPA met to discuss the situation, they agreed that DOE would submit a request for determination of modification for the permit. RL prepared correspondence to EPA and WDOH requesting such a determination. On March 27, 1996, EPA replied that adding the two railcars did not constitute a modification. On

Figure 17. Monitoring PUREX Stack Emissions, 1994.



March 29, 1996, WDOH responded that adding two railcars did not significantly affect the potential for the tunnel to emit air pollutants.

Finally, in the spring of 1996, a third permit application for DOH and EPA was prepared for four rail cars used to transport liquid waste. For concurrence purposes, waste from the 325 Radiochemistry Building was described as a sealed source in the third permit application. DOE requested that DOH and EPA approve the permit application under the same conditions as for the 324 Building waste permit. EPA and WDOH approved the permit application on May 28 and June 7, 1996, respectively. However, WDOH notified DOE that any additional materials placed into PUREX Tunnel 2 would require that stack 216-A-10 be upgraded to a "major" stack for compliance with "National Emission Standards for Hazardous Air Pollutants" (NESHAPS). Earlier in 1995, changes were written into the WAC, requiring that notices of construction (NOC) be filed for DOH approval as soon as decommissioning or transitioning begins at state facilities generating radioactive air emissions.<sup>83</sup>

Ecology did not approve of the levels of nitrogen oxide that were estimated in an initial PUREX proposal to conduct in-plant sugar denitration (destruction) of approximately 700,000 liters (187,000 gallons) of contaminated nitric acid as part of the PUREX Deactivation Project. However, the issue was dropped when PUREX technical personnel developed an alternative strategy for dispositioning this nitric acid (see Section 8.4). Another PUREX initiative in 1994 challenged the sampling frequency of the facility's nine minor exhaust stacks. After discussions with regulators and technical evaluations, the frequency of monitoring of the minor stacks under NESHAPS (40 CFR 61) regulations was reduced, reducing costs.<sup>84</sup>

### 6.3 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) ISSUES

Jointly, WHC and RL worked to achieve compliance with the requirements of the *National Environmental Policy Act of 1969* (NEPA) in as cost-effective and efficient a manner as possible. A creative solution was needed that encompassed both compliance and time- and cost-saving measures. The PUREX and UO<sub>3</sub> facilities had an EIS for operations, and management realized that the preparation of a new EIS for deactivation could be a lengthy activity and consume a sizeable share of the project's budget.<sup>85</sup>

Together with WHC regulatory support personnel, PUREX management proposed the formation of a NEPA screening panel that would compare deactivation activities with activities already documented and analyzed in the existing EIS for plant operations. The screening was performed in autumn 1993 by a panel composed of personnel from PUREX, WHC regulatory support, and RL. The panel initially indicated that all proposed deactivation activities except two could be performed under existing Hanford Sitewide categorical exclusions (CXs), a simple form of NEPA documentation, or under three new CXs that would need to be written for the deactivation. The three new CXs were expected to be needed to document consolidating the PUREX HVAC systems, shipping the contaminated nitric acid offsite, and shipping the PUREX TBP as a waste to an offsite incinerator.

The NEPA screening panel also initially indicated that, in addition to the three new CXs, the PUREX deactivation project would need to prepare EAs, a medium level of documentation, for two activities: Phase III cleanout

(i.e., glove box removal) of the N-Cell, and shipment of irradiated fuel to wet storage in the Hanford Site's 105-K West Basin.<sup>86</sup> During 1994-96, the original NEPA strategy changed. PUREX facility management changed its plans for N-Cell deactivation, making the cleanout less extensive (see Section 8.1). With this decision, the screening panel determined that an EA would not be required. In September 1994, DOE Headquarters decided that preparing a CX for shipping the contaminated nitric acid offsite would be insufficient, and provided direction to prepare an EA for this action. The EA was finalized in February 1995. Meanwhile, the CXs for shipping the TBP/NPH organic mixture, and the consolidation modifications to the PUREX HVAC systems were finalized in late 1994. The EA for transferring the PUREX spent fuel to the 105-K West Basins was finalized in July 1995.<sup>87</sup>

In late 1995, DOE and WHC decided to prepare another CX that would provide NEPA documentation for several transition activities that would be undertaken both by the PUREX Plant and by other deactivating Hanford Site facilities. This CX, finalized in early 1996, provided for the "deactivation, deenergization, or isolation of unneeded plant systems and stabilization in Hanford facilities, all areas, Hanford Site." Undertaken as part of WHC's Regulatory Integration and Process Improvement PBI, this CX provided NEPA "coverage" for a wide range of activities that included decontaminating areas (wash downs, wipings, flushings, and vacuum blasting of surfaces); stabilizing surfaces via painting, sealing, or applying fixatives; emptying vessels and piping; flushing vessels and piping; plugging, capping, or blanking ductwork, piping, and vessel nozzles; stabilizing, consolidating, or removing outside contaminated areas adjacent to facilities; decontaminating, stabilizing, or removing glove boxes and fume hoods; removing, reusing, or recycling nonhazardous and hazardous materials; removing and transporting hazardous and radioactive waste to appropriate storage locations or burial grounds; removing fencing and paved parking lots adjacent to facilities; sealing facility penetrations and repairing roofing; excavating to isolate piping to and from facilities; testing, sampling, and monitoring in and around deactivated facilities; preparing equipment and facilities to withstand winter freezing temperatures; minimizing or eliminating plant operating systems (such as electrical and utility equipment); and installing electrical, monitoring, and utility services to facilities to maintain, if appropriate, essential system operations.<sup>88</sup>

#### 6.4 NATIONAL HISTORIC PRESERVATION ACT COMPLIANCE

Early in the PUREX Deactivation Project, a cultural resources review was conducted as required under the *National Historic Preservation Act (NHPA) of 1966* (NHPA). It was determined that none of the actions planned in the PUREX/UO<sub>3</sub> deactivation were invasive or intrusive enough to activate the need to prepare facility documentation under NHPA. Later, in 1996, plans to document briefly the history of the PUREX canyon building (202-A), the PUREX dissolver off-gas building (293-A), the PUREX exhaust air filter building (294-A), and the PUREX badge house (2701-AB-a replacement badge house built in the 1980s) were formulated in an agreement between RL, the Washington State Historic Preservation Office (SHPO) and the National Advisory Council on Historic Preservation (Advisory Council). In the same agreement, plans were made to document the history of the 241-AW PUREX tank farm.<sup>89</sup>

## 6.5 CLEAN WATER ACT COMPLIANCE

Compliance with clean water regulations was not difficult or complicated for the PUREX Deactivation Project because no discharges to the Columbia River occurred. Discharges to groundwater beneath the Hanford Site already were addressed in early Sitewide Tri-Party Agreement negotiations. In accordance with Tri-Party Agreement Milestone M-17-00, 19 major untreated Site discharges to the ground ended by June 1995 and 14 other major untreated discharges ended by October 1997. Therefore, in June 1995 when the Hanford Site 200 Areas Treated Effluent Disposal Facility (TEDF) was completed, the PUREX Facility connected its low-level waste water discharges to it. The PUREX chemical sewer continued to feed into the TEDF until complete plant shutdown occurred in May 1997. After that time, no effluents drained from the PUREX Plant.<sup>90</sup>

## 6.6 UO<sub>3</sub> PLANT REGULATORY COMPLIANCE

The regulatory compliance situation for the UO<sub>3</sub> Plant deactivation was considerably simpler than for the larger and more complex PUREX Facility. No RCRA permits were required at the UO<sub>3</sub> Plant because no waste was treated or stored there for over 90 days. The facility did have some less-than-90-day storage pads and satellite accumulation areas for which RCRA permits were not needed. RL determined that all NEPA documentation requirements for the UO<sub>3</sub> Plant deactivation were fulfilled under existing Hanford Sitewide CXs. Under 1995 amendments to the Tri-Party Agreement, DOE's state and federal (EPA) regulators did have approval authority over the UO<sub>3</sub> Plant end point criteria document and the UO<sub>3</sub> Plant S&M plan (Milestones M-80-00-T01 and M-80-00-T02). Contaminated discharges to the ground and groundwater were eliminated in decontamination actions taken as part of the UO<sub>3</sub> deactivation (see Section 9.0).<sup>91</sup>

## 6.7 LESSONS LEARNED

**Lesson No. 50.** DOE and its contractors need to understand the regulatory ramifications of shutdown orders on facilities and work to minimize the impacts of unexpected changes in direction. Planning and communications between DOE and its contractors should occur so that facility preparations for the consolidation and disposition of hazardous materials can begin before formal closure orders arrive. The PUREX Facility contained a number of substances for which no RCRA permits were in place after the operational and standby status of the facility changed. Likewise, NEPA documentation possibly could have been prepared as part of and supporting the deactivation decision.

**Lesson No. 51.** Involving and informing regulators early in any regulatory process or negotiation is essential. This establishes a cooperative spirit so joint efforts can be directed at solutions rather than confrontational or penalty-based actions. The regulatory dilemmas encountered in during PUREX deactivation were the first of their kind. Early and open communication with regulators was crucial to finding acceptable solutions to these dilemmas. Such communication should occur through every stage of the deactivation project.

**Lesson No. 52.** Regulatory issues and needs must be communicated by contractor and DOE experts to all of the managers, engineers, and work planners at a facility. Just as understanding the methods and needs of the scheduling professionals by the plant operating personnel contributed to better schedules, understanding regulatory requirements by facility operators will (and did at PUREX) help ensure that regulatory mistakes and violations are avoided.

**Lesson No. 53.** For facilities in states that have negotiated special agreements with state and federal regulators (such as the Hanford Site's Tri-Party Agreement), such agreements can break regulatory impasses that might be encountered under RCRA and other statutes. Because the Tri-Party Agreement has legal precedence over some other environmental laws, it can be a useful tool in negotiating creative solutions to unique situations. One example of such a prototypical solution might be the provision written into the Tri-Party Agreement that transitioning facilities do not need to prepare NOIs before modifying their RCRA Part A permits when additional hazardous waste units are discovered during deactivation.

**Lesson No. 54.** Emissions comparison documents, while initially useful, will not replace full new permit applications for deactivation actions that generate radioactive air emissions. Radioactive air emissions are a subject of such intense public concern that, at least in Washington State, the WAC has been tightened to require full NOCs for deactivation activities that generate such emissions.

**Lesson No. 55.** The NEPA screening approach taken in the PUREX and UO<sub>3</sub> facility deactivations is an extremely helpful and precedent-setting activity. Because an operational EIS existed, it was possible to comply with NEPA requirements without preparing a new EIS for deactivation. This action saved enormous amounts of time and money and should be particularly highlighted and used at other facilities with existing EIS documentation that are undergoing deactivation. In cases where deactivating facilities do not have operational EISs, other existing documentation at the facilities (such as Accelerated Hazards Reduction program documentation, etc.) should be examined to see if it can serve a similar function.

**Lesson No. 56.** The idea of designing a noncontiguous boundary for those portions of deactivating facilities that are RCRA TSDs then writing the Part A permit specifically to those boundaries is creative and cost effective. It forces monitoring and oversight only for the truly affected portions of large facilities. Carefully distinguishing between facilities that will function as long-term TSDs, such as the PUREX tunnels, and those that will serve as interim TSDs, such as the PUREX Building, and permitting each type of TSD differently is important.

**Lesson No. 57.** Categorizing process substances that have alternative uses or possible alternative definitions as materials other than waste is beneficial and cost effective. At PUREX, examples such as the disposition of the slightly contaminated nitric acid, organic TBP/NPH solution, and laboratory sample solutions, demonstrate clearly the life-cycle savings that can be realized from not having to permit and monitor excess substances as waste.

**Lesson No. 58.** The evolution of three types of documentation to serve various times in the life cycle of transitioning TSDs is beneficial because it leaves room for modifying long-term plans whenever D&D occurs. It would not be useful for today's decision makers to try to write the final closure plan for the PUREX facility not knowing the technology or the public preferences and values of the future.

**Lesson No. 59.** As in the case of the PUREX stacks, deactivating facilities must scrutinize their diminishing emissions, effluents, etc. to identify when they may fall below regulatory criteria and allow lesser levels of monitoring and documentation. The result is cost and time savings.

**Lesson No. 60.** The CX that was prepared for "deactivation, de-energization, or isolation of unneeded plant systems and stabilization in Hanford facilities" is an example of a very valuable concept. That concept is writing broad and inclusive Sitewide or complex-wide regulatory documentation whenever possible to avoid creating documentation for every small or repetitive action. Cost and time savings again result.

## 7.0 SAFETY DOCUMENTATION AND INNOVATIONS

### 7.1 EXISTING OPERATIONAL AND STANDBY SAFETY DOCUMENTATION

When the shutdown order came for the PUREX and UO<sub>3</sub> facilities in December 1992, each facility had an existing final safety analysis report (FSAR). The PUREX Plant's operations safety requirements (OSR), the safety boundaries, safety conditions, and other control features, were contained in Chapter 11 of the facility FSAR. PUREX also possessed a long list of preexisting hazards control documents and criticality prevention specifications, along with a process control manual (PCM) with addendum, that mandated which routine S&M checks were required at the facility. During the standby period, a revised version of the PUREX FSAR and an operating specifications document were written to cover expected activities that had not been documented and analyzed from a safety perspective during operations. However, this revision had not yet been approved by DOE Headquarters. A separate document, known as the "Split Report," also was created at PUREX as the result of a screening process in which each OSR was examined for its applicability to the operating mode and/or standby conditions. The Split Report represented an effort to reduce the number of OSRs, but maintain an adequate safety boundary for ongoing actions. This report examined each OSR's applicability to installed instrumentation, key process variables, and any structure, system, or component that functioned to actuate or mitigate accidents or transients. All OSRs that were found to apply to any of these situations or this equipment were retained as being applicable during Standby.<sup>92</sup>

The analysis contained in the Split Report, as well as other safety analyses carried out by PUREX personnel, defined 10 limiting conditions of operation that would apply to limit the PUREX Plant's operations during Standby. As long as the activities described in the following limiting conditions of operation were observed, the plant could safely carry out certain standby activities not fully anticipated or described in existing safety documentation.

- Fuel receipt and handling were prohibited.
- The dissolver off-gas system would be deactivated.
- Charging operations were prohibited.
- The ammonium fluoride/ammonium nitrate (AFAN) line to the dissolvers would be isolated to prevent accidental additions. (AFAN is a unique mix of chemicals used to dissolve N Reactor fuel through what was known as the "Zirflex" process.)
- The organic streams from G- and R-Cells to the solvent extraction vessels would be isolated.
- The pumps and agitators servicing the TK-G5 and TK-R7 tanks would be deactivated and the coil inlets isolated.

- The sugar header would be isolated to prevent the addition of sugar to any canyon vessel (to prevent sugar denitration activities).
- The inlets to canyon tank coils that discharged to the cooling water low-level effluent stream and the chemical sewer low-level effluent stream would be isolated.

Also, a preliminary hazards analysis for standby was performed at PUREX, and standby operating specifications were approved for issue.<sup>93</sup> At that point, in December 1992, the final closure order was issued.

## 7.2 DEACTIVATION ORDER SPARKS "CROSSWALK" ACTIVITIES

In early 1993, a series of small workshops was held with personnel from WHC, RL, and a consulting firm with expertise in safety. These workshops were held to discuss how to address safety concerns about deactivation activities, while remaining true to the Independent Technical Review Team's 1992 advice not to write an entirely new FSAR for deactivation. In April and June of 1993, larger workshops were held that also included stakeholders and regulators. At these workshops an idea known as the "crosswalk" was presented and amplified by PUREX personnel. The crosswalk concept consisted of a series of comparison activities (somewhat similar to the NEPA screening concept described in Section 6.3). All the activities expected during the PUREX deactivation project would be compared with existing safety documentation and screened using guidance and forms found in DOE Order 5480.23. The existing PUREX safety documents to be used were the last approved revision of the FSAR (Rev. 5), the latest revision of PCM Addendum 1, the Split Report, and another applicability document created during the standby period. The existing unreviewed safety question (USQ) process explained in DOE Order 5480.21 would be used to prepare a screening form and examine each deactivation task. Tasks identified as non-USQ (those falling within existing safety envelopes) would be closed. A safety evaluation would be prepared for every task falling outside previously analyzed safety criteria.<sup>94</sup>

In the crosswalk strategy, any deactivation actions that were not covered in existing documentation would be addressed by revising the PCM to add "mode applicability statements," compiling an interim safety basis document for shutdown activities, and writing a preliminary hazards classification document for deactivation. However, DOE Headquarters expressed strong concerns that in the defined crosswalk strategy worker safety and health issues were not receiving as much attention as they would under OSHA standards. It was suggested that PUREX conduct a scoping review of WHC occupational safety and health manuals, evaluate the applicability of existing manuals and safety and health programs to the PUREX/U<sub>3</sub> deactivation project, develop and modify existing programs as necessary to cover all deactivation tasks, and then implement these programs (Figures 18 and 19).<sup>95</sup>

## 7.3 SAFETY BASES FOR EARLY DEACTIVATION ACTIVITIES

Through the remainder of 1993 and into early 1994, discussions went forward between PUREX WHC and DOE personnel regarding various proposals for developing adequate safety documentation for the huge deactivation project

Figure 18. Employee Awareness was an Important Part of the PUREX/UO<sub>3</sub> Deactivation Project Safety Program.

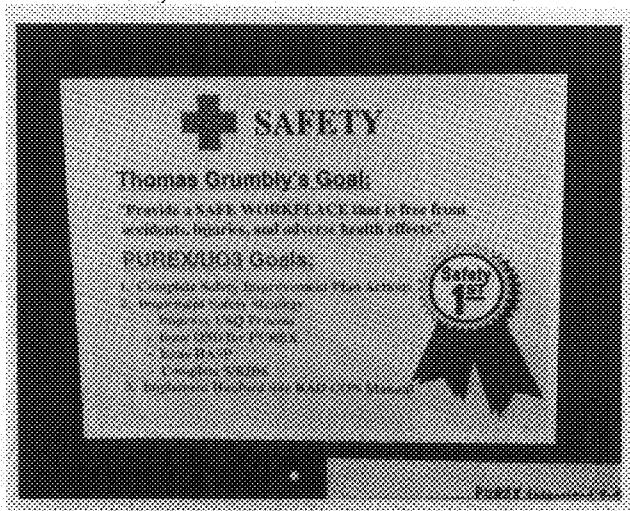
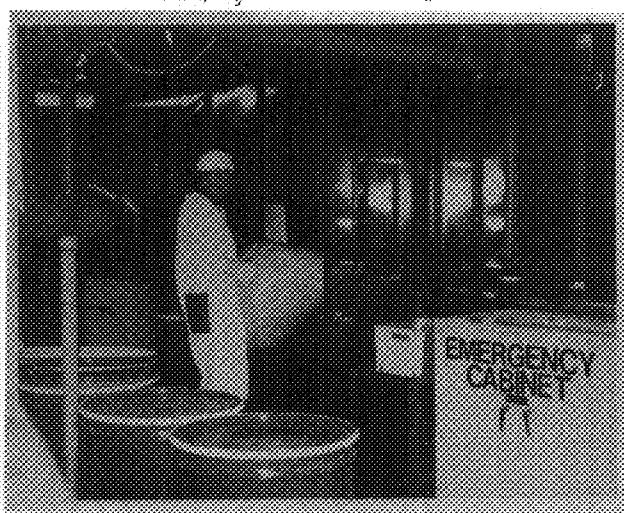


Figure 19. Good Housekeeping also Contributed to Safety During the PUREX/UO<sub>3</sub> Deactivation Project.



without writing an entirely new FSAR. In January 1994, PUREX issued a technical information document that allowed some early deactivation actions to go forward. In March, RL issued a letter authorizing deactivation activities to go forward at PUREX using the safety analyses and requirements in the following documentation:

- The existing version of Chapter 11 of the PUREX FSAR
- All associated and existing safety bases documentation
- The non-radiological risk acceptance guidelines contained in the (revised) WHC Safety Analysis Manual
- The (revised) PUREX/UO<sub>3</sub> Plant administration manual (for the identification and resolution of unreviewed safety questions).

Because the RL letter did not include the operations-based PCM, it paved the way for eliminating that document.<sup>96</sup> Both DOE and the contractor realized that the PUREX S/RID that would soon be produced in response to recommendation 90-2 of the DNFSB also would have to be incorporated into the safety authorization basis for deactivation activities. (If the S/RID was not so linked, a path to waive it would have to be defined with DOE concurrence.) An upgraded worker safety and health program plan also would need to be developed.<sup>97</sup>

#### 7.4 GRADED HEALTH AND SAFETY PLAN DOCUMENT BECOMES CORNERSTONE

As a "best management practice" in early 1994, PUREX decided to create a health and safety plan even though the CFR did not require one because PUREX was not (and still is not) defined as an uncontrolled hazardous waste site. To begin, PUREX commissioned a subcontractor to write a hazards baseline document for the facility. A hazards training class was developed for deactivation workers. These activities were supported by the development of a unique preliminary hazards screening/assessment (PHSA) form/process. The process used a two-part screening form to evaluate the relative hazards for each task and to determine the appropriate level of analysis to assess the task. The matrix-based form was based partially on a checklist found in a 1992 hazards evaluation procedures study conducted by the American Institute of Chemical Engineers. The PHSA form was initiated to achieve the following:

- Increase attention to worker safety issues during the PUREX deactivation project
- To serve as a graded formal approach to determine activities that could affect the safety authorization basis and analyze them
- To involve the workers in the worker safety development and evaluation processes
- To communicate potential hazards to deactivation workers
- To integrate the S/RID into the work authorization process in a graded manner.

The form was to be used to screen each work plan for all levels of potential safety issues as it was written.<sup>98</sup>

The safety requirements and analyses written into the PUREX deactivation PHSA process were more strict than those in general use at DOE non-reactor facilities. This conservative approach was endorsed by DOE Headquarters, "in view of the absence of approved...DOE guidelines over the credible spectrum of potential accidents." The PUREX PHSA form analyzed each job on the basis of the following five initial criteria:

- Its complexity and size
- The type of process (physical, electronic, mechanical, computer, biological, or human)
- The type of operation (fixed facility, transportation, permanent, temporary, continuous, semi-batch, or batch)
- The nature of the hazard (toxicity, reactivity, flammability, radioactivity, explosivity, criticality, or other)
- The event or scenario of concern (loss-of-function event, single failure, multiple failure, procedure, process upset, software, hardware, human, or simple loss of containment).

The form then probed the perceived risks and experiences of workers who would be involved with the job. Finally, it asked a series of questions about the nature of the job, the physical hazards, what could go wrong, how much damage would be done in worst case scenarios, and whether or not further analysis should be done.<sup>99</sup>

Under the PUREX PHSA process, a team of experienced safety analysts and the preparer of each work plan participated in each job screening. A graded approach was applied.

- If a job was deemed to be so simple that it did not require any formal analysis (Case III), it could be performed under existing WHC procedures.
- If a job was deemed to be of medium complexity with more than minimal accident potential (Case II), a team performed a job safety analysis (JSA) to identify hazards and the controls necessary to prevent or mitigate those hazards.
- If a job was deemed so hazardous as to require a formal analysis (Case I), a team would perform a hazards and operability analysis or use other, more detailed analysis techniques, recommend and incorporate job controls into the work plan, and conduct a USQ determination.

Additional actions taken included modifying the PUREX procedures in regard to USQs to strengthen the PHSA form for use with existing safety documentation. PUREX also issued a revised version of its deactivation operating specifications, which replaced the PCM Addendum 1.<sup>100</sup>

In late FY 1994, the PUREX safety documentation strategy, a creative blend of existing safety documentation with new consideration of deactivation tasks, achieved DOE Headquarters concurrence. Especially in the areas of worker safety, health, and participation, areas about which DOE is increasingly concerned, the PUREX Health and Safety Plan's graded approach was so successful that its designer became instrumental in developing a new EM/EH handbook for the safety documentation and integration of all DOE facilities.<sup>101</sup>

## 7.5 PUREX S/RID COMPLETED

In early 1996 the PUREX S/RID was completed. It incorporated all previous standards and requirements into the following 17 functional areas.

- Management Systems
- Configuration Management
- Emergency Management
- Engineering Program
- Maintenance
- Fire Protection
- Waste Management
- Occupational Safety & Health
- Decontamination & Decommissioning.
- Quality Assurance
- Training and Qualification
- Safeguards & Security
- Operations
- Radiation Protection
- Packaging & Transportation
- Nuclear Safety
- Environmental Protection

The new PUREX S/RID also consolidated requirements that were mentioned in several documents into one statement of each requirement, which reduced the overall number of requirements by approximately 200.<sup>102</sup>

## 7.6 REENGINEERING DEVELOPS EMPLOYEE JOB HAZARDS ANALYSIS

Even as the S/RID activity was approaching its conclusion, the WHC Reengineering Plant Team identified the need for more streamlining. The safety basis for facility operations at the Hanford Site, the Plant Team found, was "outdated and conservative, causing over-interpretation." No integrated risk management strategy was implemented Sitewide and, most importantly, workers were not integrally involved in making decisions about their own safety.<sup>103</sup>

Specifically in response to the reengineering mandates to place serious responsibility with work teams and to use information technology in a way that is accessible and user friendly for everyday application, the Qualitative Job Hazards Analysis was developed at the PUREX facility. In practice, the majority of the PHSA (Part 1) was converted into a computerized Job Hazards Analysis (JHA). This on-line job assessment tool was implemented during January 1996, just after the PUREX work teams were formed. It was converted to a "numerical scoring system" during the spring of 1996 and it now is used by every PUREX team to screen and score jobs. The JHA does not replace the JCS system, but it allows many jobs to proceed with minimal, team-based approvals. Determinations of when additional analysis and/or approvals are needed for work to proceed are based on the Conduct of Work section of WHC-CM-3-5, *Document Control and Records Management Manual*. Only jobs hazardous enough to be rated "Case I" under the older PHSA need the involvement of safety professionals from outside the PUREX team. The PUREX

S/RID is linked as a list of references to the JHA, and soon the S/RID will become part of the PUREX safety basis authorization by becoming a reference in the PUREX FSAR. This will create a complete tie-in of safety basis authorizations for deactivation activities.<sup>104</sup>

Graded in every aspect, the PUREX JHA first instructs workers to complete the appropriate sections of the form if any of the following conditions apply.

- The planned activity is not covered under an existing RWP (Radiation Work Permit)
- Hazards and hazard controls have not been previously identified in standard operating procedures (SOP) or existing JHA
- The planned activity will change existing equipment
- "Lock and tag" other than personal locking devices will be required
- The work is on safety or safety-significant systems
- Detailed work instructions are required to complete the activity
- Permits are required to complete the activity
- Special waste-handling instructions will be required to complete the activity.

These criteria immediately eliminate some jobs that are extremely simple and innocuous and jobs that have existing safety analysis and documentation. Such jobs are freed of unnecessary or redundant documentation.

Next, the JHA follows the same path as the PHSA (formerly completed by technical safety support personnel) in asking about the complexity of the job, the type of process, the type of operation, events of concern, length of worker experience, relevance of experience, accident exposure, perceived risks, and severity of consequences. Then, a series of follow-on questions is asked about the exact requirements of the job. The presence of any of the following exposure factors raises the hazards score of a job.

- Radiological work
- Welding/cutting/burning/hot work
- Hazardous waste operation
- Lead handling or abatement
- Confined space entry
- Noise area or noise producing
- Dust producing
- Chemical use involvement
- Temperature extreme
- Tank/line/vessel opening or breaching
- Surface removal (sand or abrasive blasting, grinding)
- Painting
- Asbestos abatement/handling
- Special metals or carcinogenic materials

- Contaminated soil excavation/disruption
- Other exposure hazards.

Worker safety concerns are then incorporated. The presence of any of the following exposure factors raises the hazards score of a job.

- |  |                      |
|--|----------------------|
| • Fall hazards of over 2 meters (6 feet) | • Energy sources     |
| • Temporary electrical arrangements      | • Electrical hazards |
| • Deenergization of equipment            | • Fire/explosion     |
| • Walking/working surfaces               | • Excavation         |
| • Demolition                             | • Roof work          |
| • Pinch points                           | • Remote work        |
| • Mechanized equipment                   | • Hand tools         |
| • Hoisting and rigging.                  | • Power tools        |

Environmental and nuclear safety concerns are then incorporated, and the JHA actually ranks each job. A numerical score at or above 13 points of a possible 28 means that the job requires further safety analysis. This graded approach ensures that jobs with more significant safety hazards receive serious professional attention, while simpler jobs can proceed without time-consuming and expensive layers of unnecessary analysis.

## 7.7 CRITICALITY ALARM SILENCED

In June 1996, so much fissionable material in the PUREX Plant had been removed or stabilized that the criticality alarm was disconnected forever in a benchmark event (Figure 20). Safety analysts concluded that criticality was no longer a credible event at PUREX, and the nuclear facility Hazard Category was reduced from 2 to 3. Except for being disconnected temporarily and upgraded during a plant shutdown that ran from 1972 to 1983, the alarm had monitored the PUREX Facility ever since the plant began practice runs with radioactive materials in December 1955. A DOE spokesman summarized the situation this way: "To turn off the criticality alarm means an era really has come to an end."<sup>105</sup>

## 7.8 SURVEILLANCE AND MAINTENANCE PLAN WRITTEN

Chapter 8 of the Tri-Party Agreement required that an S&M Plan be written to govern PUREX Plant surveillance and monitoring activities between the end of the deactivation project and the start of D&D (see Section 6.1). As end points closed in early 1997 and the physical removal of hazards allowed the PUREX facility to move from nuclear facility Hazard Category 2 to Hazard Category 3, plant personnel wrote the S&M Plan. Essentially, the S&M Plan was a required part of the safety documentation that governed facility activities and safety checks after deactivation. The plan first described the PUREX facility, its systems, and its necessary maintenance activities. Chief among these activities were the quarterly and routine surveillances of air flows, air temperatures, liquid levels in filters and exhaust plenums, humidity and dewpoint of air in the filters, stack alpha and beta activity measurements, and reliability checks on the switch gear and motor control centers governing the HVAC systems. During the PUREX Deactivation Project, a Surveillance, Monitoring and Control System (SAMCONS) was installed in a shelter just south

Figure 20. News Conference Announcing the Turnoff of  
the PUREX Criticality Alarm, June 1996.



of the 202-A Building. It served as the main data acquisition center for S&M data, and it fed into a Central Data Acquisition and Control (CEDAC) station located in active Hanford Site building maintained by the D&D organization about 6 miles away.

The PUREX S&M Plan also addressed the training and qualification of S&M personnel; types of maintenance; maintenance procedures; planning, scheduling, and coordination of maintenance; post-maintenance testing; control and calibration of maintenance equipment; and maintenance reporting. In addition to regular S&M checks, the PUREX facility needed facility condition inspections to identify structural or equipment degradation and seasonal facility preservation actions to ensure against cold weather damage. The plan provided a route or map of the locations requiring checks in and around the facility and described the radiological controls and procedures necessary for entering and checking these areas.<sup>106</sup>

Writing the PUREX S&M Plan required close coordination with the D&D organization, because most of the steps in the plan references that organization's procedures. In retrospect, it might have been better if DOE had assigned the plan as a joint task to deactivation and D&D personnel. The plan's timing and approval cycle also required close coordination among a number of entities. The plan could not be written until necessary information about facility condition and other topics became available. Yet, writing it during the last 4 months of the deactivation project meant that approvals would not be in place when the deactivation project closed. The compromise solution was that two S&M Plans eventually were written. One plan, issued just before the deactivation project ended, was a product of the deactivation organization and was approved by DOE. Called a "post-deactivation surveillance plan," this document served the interim period between May 1997 and the time when a document for longer term service could be written to incorporate all of the D&D organization's comments to gain regulator approval.

Another consideration in the PUREX S&M Plan had to be level of detail. Because the plan referenced so many existing safety documents, Hanford Site manuals, and D&D procedures, it nearly became just a compendium of statements committing the shutdown PUREX facility to abide by various other documents. Some PUREX personnel thought the document could have taken the form of a simple listing of such other documents, with a general statement that these documents would govern the PUREX facility. Thus, the PUREX S&M Plan, as the first such plan written under the Tri-Party Agreement, was a valuable learning tool.

## 7.9 PUREX BASIS FOR INTERIM OPERATION DOCUMENT NEEDED

Once the PUREX Facility was downgraded from a Hazard Category 2 to a Hazard Category 3 nuclear facility, many of the hazards had been removed from the plant, and other hazards had been sealed, the FSAR no longer fit the facility. The plant condition and configuration described in the FSAR was no longer accurate, and the process description for operations did not apply at all. It therefore became necessary under DOE orders to prepare new safety documentation for the deactivated PUREX facility. During 1996, PUREX personnel prepared two interim safety basis (ISB) documents, one for the PUREX facility itself and one for the PUREX tunnels. However, even these documents and other documents that they referenced did not adequately reflect the actual

end state conditions of the facility at the close of the deactivation project. Also, questions arose about the level of scrutiny and approval that would or should be applied to the documents referenced in and supporting the ISBs. It soon became clear that, once again, the PUREX facility was "breaking trail" on the new pathway of deactivation. While deactivation project objectives had focused on the physical removal of hazards to reduce the facility's mortgage and risk, questions about the safety basis for turnover had been left until near the end.<sup>107</sup>

After considering these issues, DOE requested that new documentation be prepared for the PUREX facility and tunnels. The new documentation would need to be complete and descriptive enough to stand alone. The new documents, known as basis for interim operations (BIO) documents, will serve as the functional safety analysis documents for the PUREX facility in its deactivated state. These BIOs, written in 1997, must be approved for turnover to DOE's EM-40 organization.<sup>108</sup>

## 7.10 LESSONS LEARNED

**Lesson No. 61.** Existing safety documentation from facility operational periods should be used creatively and carefully to begin deactivation project safety documentation. Revisions, comparisons, "crosswalks," and other types of screening procedures can be used to determine which deactivation actions may be covered in existing documentation and which actions need supplementary coverage. Having those who know the facility well make such comparisons is more cost effective and time efficient than preparing all new safety documentation for facility shutdowns.

**Lesson No. 62.** Workshops and other joint working efforts that bring together the principals interested in safety documentation (DOE, the operating contractor, and ITEs and other consultants) are important early in a deactivation project for brainstorming and establishing the major cornerstones of consensus about the safety documentation.

**Lesson No. 63.** Worker health and safety, always a DOE and contractor concern, has been elevated in recent years to even more important status. Often, worker safety and health aspects will prove to be the area where older facility safety documentation does not meet modern standards. Incorporating worker safety and health considerations that are comparable to or exceed the levels demanded by OSHA into newer revisions or supplements of safety documentation is extremely important.

**Lesson No. 64.** Worker involvement (including the use of job screening devices that are operated by worker teams at their own personal computer work stations) and using a graded approach to the levels of safety analysis required for various deactivation tasks are the two most important keys to making the safety analysis process useful, efficient, and satisfactory to all concerned. The graded approach is cost effective in that it does not demand a high level of analysis for simple jobs already covered in established procedures. Worker involvement is also cost effective in that it provides a higher level of assurance that workers are participating willingly and without hesitation in the jobs that are required for facility deactivation.

**Lesson No. 65.** The S&M Plan to govern facility safety checks in the period between deactivation and D&D should be written either by the D&D organization or by a joint team of deactivation/D&D personnel. The deactivation personnel are not familiar enough with the procedures and requirements of the D&D organization to write this plan alone. Also, level of detail in the plan should be carefully assessed. Some plans could be as simple as a compilation of other orders, requirements, and procedures.

**Lesson No. 66.** BIO documents can serve as a useful alternative to writing lengthy safety analysis reports for deactivated facilities. However, to realize the most savings and efficiency, the BIOs should be written near the end of the deactivation project with the understanding that their final approval will not occur until after the project ends.

## 8.0 TECHNICAL ISSUES

This chapter covers only the major technical activities of the PUREX deactivation project that are believed to yield lessons of great or precedent-setting importance. Technical activities not discussed include the deactivation of the instruments, fire protection system, liquid effluents system, utilities, and P&O gallery and white room; surveillance and monitoring planning; in-plant waste concentration (E-F11); and dissolver heels and 211-A stabilization. These issues are discussed in the *PUREX/UO<sub>3</sub> Deactivation Project Management Plan*.<sup>109</sup> The following technical activities are discussed because they have followed unique pathways.

### 8.1 N-CELL, PR ROOM, Q-CELL, AND SAMPLE GALLERY DEACTIVATION

N-Cell processing equipment was added to the PUREX Plant in 1978 to provide the capability to convert plutonium nitrate solution (the original PUREX product) to plutonium oxide powder. Although oxide conversion traditionally had been done at the PFP, it was believed that transporting plutonium from PUREX (in the Hanford Site's 200 East Area) to the plutonium storage vaults (in the 200 West Area, PFP Complex) would be safer with the plutonium in oxide form. The cell contains 6 full-size glove boxes [typically 3.7 meters (12 feet) tall and 2.7 to 4 meters (9 to 13 feet) long], 2 extra-large glove boxes built together as a free-standing unit [7.6 meters (25 feet) tall and 11 meters (36 feet) long], as well as 4 small glove boxes for powder loadout, canning, bagging, and maintenance.

During operations, each extra-large glove box contained a calciner, a first stage titanium calciner, and a second stage stainless steel calciner that operated in series. The second stage calciner discharged plutonium oxide powder into a vibrating screen assembly known as a scalper. The powder loadout glove box contained a small muffle furnace.<sup>110</sup>

Once the decision was made to close the PUREX Facility in 1992, removing as much plutonium and plutonium-contaminated equipment as possible from N-Cell became important. A boundary estimate of the plutonium inventory conducted in 1993 found between 900 and 13,000 grams of plutonium in the cell; the best estimate was about 3,000 grams. Such amounts helped to place the PUREX Plant in a "high-hazard classification" as defined in the preliminary hazards analysis. Reducing the amount of plutonium was necessary to attain many other deactivation goals: shutting off the criticality alarm in N-Cell, lowering the probability of a contamination spread after the building ventilation was reduced (in later deactivation steps), and keeping the radiation exposure to workers ALARA. It was known that the experienced crew of PUREX nuclear operators available to the deactivation project could perform N-Cell cleanout more efficiently than future D&D workers who would not be familiar with the plant, and that the decay of plutonium-241 to americium-241 in the intervening years actually would increase future radiation exposures.<sup>111</sup>

An early draft plan called for removing the 12 N-Cell glove boxes. This would ensure that N-Cell was left in a state in which S&M personnel could work safely without the spread of alpha contamination. However, PUREX personnel decided by mid-1993 that such equipment removal was D&D work and could not be justified as part of deactivation work. Also, an EA would likely have been

needed for the activity. The cost of the work itself, as well as the cost of preparing the EA (with concomitant time additions to the project), led to the decision to stabilize the glove boxes in place. It was decided to reduce plutonium contamination within the glove boxes to a level that would ensure that D&D personnel could later remove the glove boxes without the risk of criticality and with minimal risk of significant contamination spread.

The next plan for N-Cell cleanout included three phases. Phase I, which began in the Spring of 1993, consisted of removing small equipment from the glove boxes. ("Small" was defined as anything that could fit through a bagout port, including tubing, valves, and pumps.) Phase I also included installing new gloves on many glove ports that had been sealed temporarily during Standby, and refurbishing the cell's Segmented Gamma Scanning Assay System (SGSAS). The SGSAS monitoring instrumentation assayed the material being removed from the glove boxes to document the amount of plutonium being placed in each transuranic waste drum.<sup>112</sup> Phase I of the N-Cell deactivation was completed by March 1996.

Phase II was to consist of cutting up and removing some large equipment (such as the calciners) from the glove boxes. Little of the large equipment actually was cut up and removed.

Phase III included wiping down and painting the interior of the glove boxes with an acrylic latex contamination fixant (Figures 21 and 22). Next, metallic "pie pans" were placed over the glove ports, then the glove ports were wrapped with a polyolefin "shrink-wrap" material, and finally that material was heated to activate a tar-like adhesive it contained (Figure 23). Also, miscellaneous storage cabinets were removed from the N-Cell loadout room. These activities were completed ahead of schedule in June 1996.

A milestone project is under way that will consolidate the entire ventilation system that served N-Cell, Q-Cell, and the PR room. In this project, many of the filters will be removed, and the glove boxes will be vented to the canyon. These activities are part of the larger PUREX HVAC consolidation project (see Section 8.10).<sup>113</sup>

The PR room at the PUREX Plant was used during operations to sample plutonium nitrate solution from the process, then transfer it to either M-Cell storage tanks for processing in N-Cell or into product cans for shipment to the PFP. The PR room also functioned to receive rework solution from N-Cell and L-Cell for transfer back into the PUREX process. Major upgrades in 1981 included replacing glove box panels with noncombustible materials and redesigning the L9 agitator shaft seal. The PR room contains four glove boxes, which held receiver tanks, vacuum jets and condensers, a scale hoist, liquid seal pot, piping, pumps, valves, and other hardware. During the Standby period, PR room tanks and glove boxes were flushed with nitric acid to reduce the plutonium inventory. The flush solution was stored in tank E6, and the nitric acid transfer lines to the PR room were blanked in the P&O gallery.<sup>114</sup>

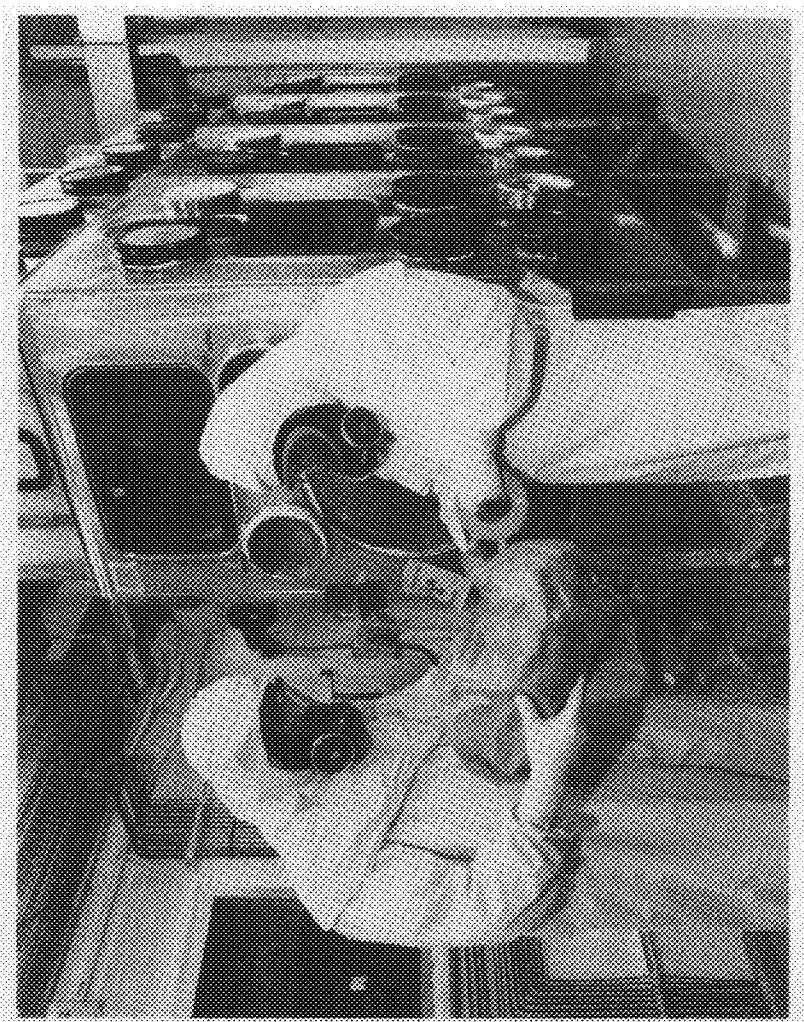
Figure 21. Nuclear Operator Removes Residual Plutonium Contamination from Equipment Inside N-Cell Glove Box, as Part of Deactivation, Early 1996.



Figure 22. Waste is Packaged out of PUREX N-Cell, as Part of Deactivation, 1996.



Figure 23. N-Cell Equipment is Sealed Shut After Cleanout, PUREX, 1996.



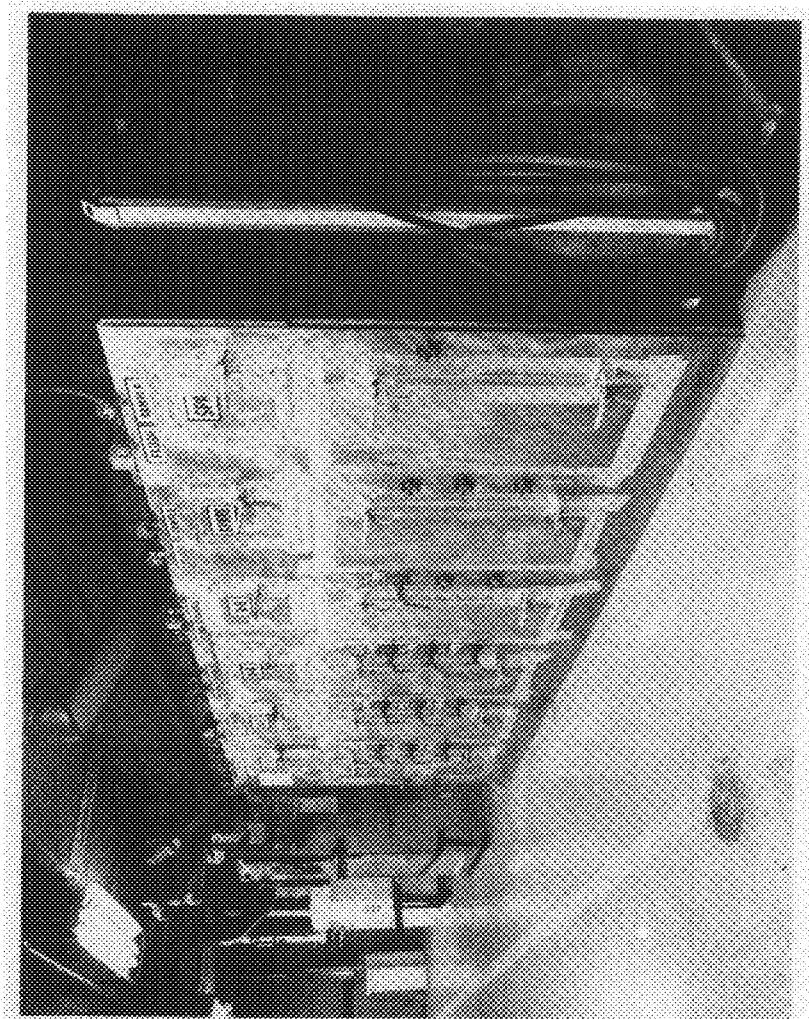
The deactivation plan for the PR room basically followed the same sequence as that for N-Cell, and took place after most of the N-Cell deactivation was completed. Residual solution heels were removed from the PR room tanks, small equipment was removed from the glove boxes, then the glove box interiors were wiped and sprayed with fixant. Lastly, glove box exterior penetrations and miscellaneous equipment used during the deactivation work was removed and the ports were sealed. The removal and sealing work was completed in June 1996 ahead of schedule. The ventilation system was consolidated and the glove box ventilation was rerouted as part of the PUREX HVAC consolidation milestone.<sup>115</sup>

Q-Cell in the PUREX Plant was used from 1958 through 1972 to perform the final steps in purifying neptunium-237 from the process stream. Neptunium was separated and concentrated in the J-Cell package, then transferred to Q-Cell for concentration and purification, and finally loaded into bottles as neptunium nitrate for shipment to other facilities. After the decision was made in the early 1980s not to restart Q-Cell, the transfer line from the J-Cell package was blanked, the vessels and glove boxes were flushed, and the steam and water headers to Q-Cell were disconnected during the Standby period. At that time, the amount of fissile materials in Q-Cell was inventoried and placed at less than 450 grams. This amount allowed the Q-Cell criticality alarm to be disconnected. The equipment remaining in Q-Cell included the concentrator, an ion-exchange column, feed tanks, a sump tank located inside a hot cell, and valves, pumps, and other small equipment pieces located inside the maintenance glove box.<sup>116</sup>

The deactivation plan for Q-Cell followed the pattern for N-Cell and the PR room. Residual solution heels in Q-Cell tanks were sampled. It was necessary to remove contaminated residual solutions from the Q-Cell aqueous make-up tanks and the hot cell tanks. Some glove box equipment was removed, the interiors of the glove boxes were wiped and sprayed with contamination fixant, and the outer penetrations and ports on the maintenance, loadout, and hot cell vault glove boxes were sealed by June 1996, also ahead of schedule (Figure 24). Ventilation ducts were blanked and the filters removed and the glove box ventilation was rerouted as part of the PUREX HVAC consolidation milestone.<sup>117</sup>

The Sample Gallery in the PUREX Plant is a long corridor that runs parallel to the main canyon on the second floor of the 202-A (PUREX) building. During operations, it provided access to the canyon tanks for sampling purposes. Three types of sample stations were built with varying amounts of shielding to accommodate sample solutions containing different levels of radioactivity. Air jets were used to circulate solutions from process vessels, through sample cups enclosed in housings in sample stations, and then back to the point of removal from the process. Other miscellaneous activities and equipment that were housed in the sample gallery included a manipulator maintenance shop, a low-level waste compactor, cold chemical make-up tanks for N-Cell, two neutralization systems, and a shielded pipe chase containing chemical headers. Sampler hoods were exhausted through two stacks (296-A-6 on the east end and 296-A-7 on the west end) via a sampler exhaust duct that runs the length of the sample gallery. Recurring leaks of contaminated condensate over the years indicate a buildup of radioactivity in the hoods and duct.<sup>118</sup>

Figure 24. Q-Cell Samplers Sealed Shut After Deactivation,  
PUREX Plant, 1994.



Deactivation of the sample gallery consisted of removing debris from samplers, then sealing the sampler hoods and valve pits. Silicon rubber sealants were used on the cracks around the hood doors; larger openings were covered with rigid plastic sheets. Polyurethane foam sealants were used to seal valve pit cover blocks and valve extension handles. Sample gallery deactivation was completed in July 1996, as part of the PUREX Residence Out milestone, a large campaign to empty the 202-A building of personnel, furniture, supplies, and other fixtures necessary to support everyday occupancy.<sup>119</sup>

## LESSONS LEARNED

**Lesson No. 67.** New techniques in contamination fixation and sealing can be used to reduce the possibility of contamination migration so that full removal and burial of contaminated equipment and duct work is not necessary during deactivation. NDA results and facility conditions should be carefully weighed. In some cases, physical glove box and duct removal may be the best and safest choice.

### 8.2 METAL SOLUTION DISPOSITION (D5/E6)

Because the PUREX Facility was in "Standby pending restart" until late 1992, approximately 8,101 liters (2,140 gallons) of recycled product UNH solution were routed into tank E6. This substance was needed to meet criticality specifications for receipt of plutonium-bearing solutions generated during stabilization and cleanout activities conducted at the plant. From 1990 to 1993, the plutonium oxide powder from N-Cell was dissolved in nitric acid and transferred as plutonium nitrate solution into head-end tank E6 (via temporary storage tank L-11). Tank E6 also received plutonium-bearing solutions generated from flushing solvent extraction vessels during Standby. In March 1992, about 8,328 liters (2,200 gallons) of the solution blend in tank E6, containing an estimated 3,760 grams of plutonium, was transferred into tank D5 to make room in tank E6 for additional transfers from tank L-11. By early 1994, the solutions in both tanks E6 and D5 contained approximately 9 kilograms of plutonium and 5 metric tons of uranium.<sup>120</sup>

With the December 1992 shutdown order, the PUREX Plant was prohibited from conducting any processing activities. Furthermore, solvent extraction vessels already had been partially flushed of residual actinides; canyon process streams had been partially isolated from input and output streams; aqueous make-up tanks were flushed, drained, and disconnected; and many instruments and procedures associated with canyon activities had been deactivated or allowed to lapse. In many cases, operator training to support in-canyon activities associated with the plutonium/uranium solutions had expired. Therefore, a crucial question became how best to dispose of the plutonium/uranium solution material in tanks D5 and E6. Several options were considered, including multibatch separation of the uranium and plutonium, using various partitioning flowsheets and mechanisms. However, the integrity of several PUREX tanks and vessels would have to be verified if these options were adopted. N-Cell would have to be kept operational for converting the recovered plutonium portion to plutonium oxide, and some of the required activities were outside the bounds of the existing PUREX FSAR.<sup>121</sup>

Another disposal option involved co-precipitation of the solids from the supernate portion of the solutions. The liquid portions [about 26,498 liters (7,000 gallons)] would be transferred to the Hanford Site's tank farms; the solids would be added with absorbent material (vermiculite) into 208 liter (55-gallons) drums for storage as transuranic waste. It was estimated that 150 to 300 such drums would be generated. For a time in 1993, the co-precipitation option was preferred. However, further analysis showed that, for this option, risk levels were in the "medium" range in the areas of worker and environmental protection and regulatory concerns were associated with the vessels needed for the co-precipitation operation, waste minimization, and life-cycle cost. Also, this option presented serious implementation time and schedule impacts, because new equipment would need to be designed, procured, built, installed, tested, and reviewed.

In late 1993, another option, direct transfers of the neutralized D5/E6 materials to the Hanford Site's tank farms, was selected. The transfer option was found to involve "low" risks in many of the same areas where the co-precipitation option had involved "medium" risks. An added main benefit of this decision concerned the overall cost reduction associated with early completion of the PUREX deactivation project. Early in the transfer planning, it was thought that this material would be diluted with flush solutions that resulted from other canyon deactivation activities and had been concentrated in the PUREX F-11 concentrator. Approximately 50 batch transfers, totalling 757,080 liters (200,000 gallons), were thought to be needed. Criticality limits the D5/E6 material and the waste tanks were studied carefully. Because the PUREX material contained uranium and cadmium (both of which enhance criticality safety), a criticality safety analysis in early 1995 allowed the amount of fissile material per batch from PUREX to be increased to 500 grams per batch. At that point, the D5/E6 material was mixed with limited amounts of canyon flush material and transferred to the tank farms in only 30 transfers totalling 80,000 gallons. The transfers were completed in April 1995.<sup>j22</sup>

## LESSONS LEARNED

**Lesson No. 68.** Any unnecessary manipulations, separations, conversions, or handling of plutonium- and uranium-bearing solutions should be avoided. The age of the process vessels in the PUREX Plant and many other DOE facilities triggers renewed regulatory involvement if any further or different uses are made of this equipment. Also, worker and environmental risk increases every time additional processes are performed on plutonium and uranium materials.

**Lesson No. 69.** The cost savings associated with timely deactivation of large facilities such as the PUREX plant are so overwhelming and important that optional activities that involve keeping plant systems active must be declined. The PUREX facility is so complex and its internal systems so intertwined that the need to perform any activities associated with plutonium/uranium solutions meant that nearly all of the plant's systems would have to remain active. This would have slowed the overall deactivation project, and DOE's imperative need and desire to proceed with deactivation would not have been met.

**Lesson No. 70.** The use of well-established, simple technologies that could be readily implemented contributed to the successful disposition of the D5/E6 material. Existing procedures and specifications also were used so that only minor piping changes within the PUREX facility were required. As a result of keeping it simple, significant cost savings were achieved and the activity was completed safely and ahead of schedule.

### 8.3 SINGLE-PASS REACTOR FUEL AND N REACTOR FUEL DISPOSITION

At the time of the PUREX shutdown order, the plant contained 2.9 metric tons of aluminum-clad, single-pass reactor fuel stored underwater in the facility slug storage basin. This fuel had been in storage in the basin since 1972 and consisted of 779 pieces packaged in four baskets. The PUREX dissolver cells also contained approximately 40 N Reactor fuel elements (0.5 metric tons), that had been inadvertently dropped on the floor during charging operations 12 or more years ago. Remote inspections of the fuel and samples of the water from the storage basin showed that the single-pass reactor fuel was somewhat corroded, and that the N Reactor fuel had deteriorated significantly.

Several alternatives existed for disposing of the fuel. One option, leaving the fuel inside the PUREX canyon, had to be ruled out immediately because the D&D organization absolutely would not accept the building for turnover if it contained spent fuel. Another option, processing the fuel through PUREX, was prohibited specifically by the DOE shutdown order. The alternative of transferring the PUREX spent fuel to an offsite storage facility was deemed to be nearly impossible because of stakeholder and regulatory concerns about the shipment of unprocessed nuclear fuel. One potentially viable option was to transfer the single-pass fuel to other storage facilities on the Hanford Site. However, the Fuels and Materials Examination Facility and the Washington Public Power Supply System reactor would have needed extensive, expensive, and time-consuming modifications. The only other available facility was the T Plant pool cell. However, T Plant officials were trying to get rid of their spent fuel inventory to reduce the hazard classification of that structure. Another possible choice was installing a fuel conversion process in the PUREX Plant and converting the fuel to a form acceptable for dry storage. However, selecting, permitting, and installing a stabilization process would have taken several years. By 1993, the preferred option for WHC and DOE officials was to transfer the PUREX spent fuel to wet storage in the 105-K West Basins on site. These basins already held 2,200 metric tons of other spent nuclear fuel, and were funded on a path forward to stabilize and move this fuel to a new storage facility to be built and permitted on Site.<sup>123</sup>

The fuel transfer activities were reviewed to determine what documentation would be required. An environmental assessment was prepared to determine the impacts of the fuel loading, transfer, and unloading on the environment. The environmental assessment was issued and a Finding of No Significant Impact was approved by the DOE in July 1995. At the same time, an air permit was prepared for the 105-K West Basins to support the fuel unloading activities. This permit was approved by DOE, Ecology, and WDOH in late summer 1995. The development of both of these documents required a cooperative effort by the Hanford Site Spent Nuclear Fuel Project, and the PUREX and Regulatory Support groups. Late in the process it was decided that

because fuel transfers had not taken place in some time, readiness reviews would be required at both PUREX and the 105-K West Basins. These reviews were accomplished and all necessary concerns were addressed.<sup>124</sup>

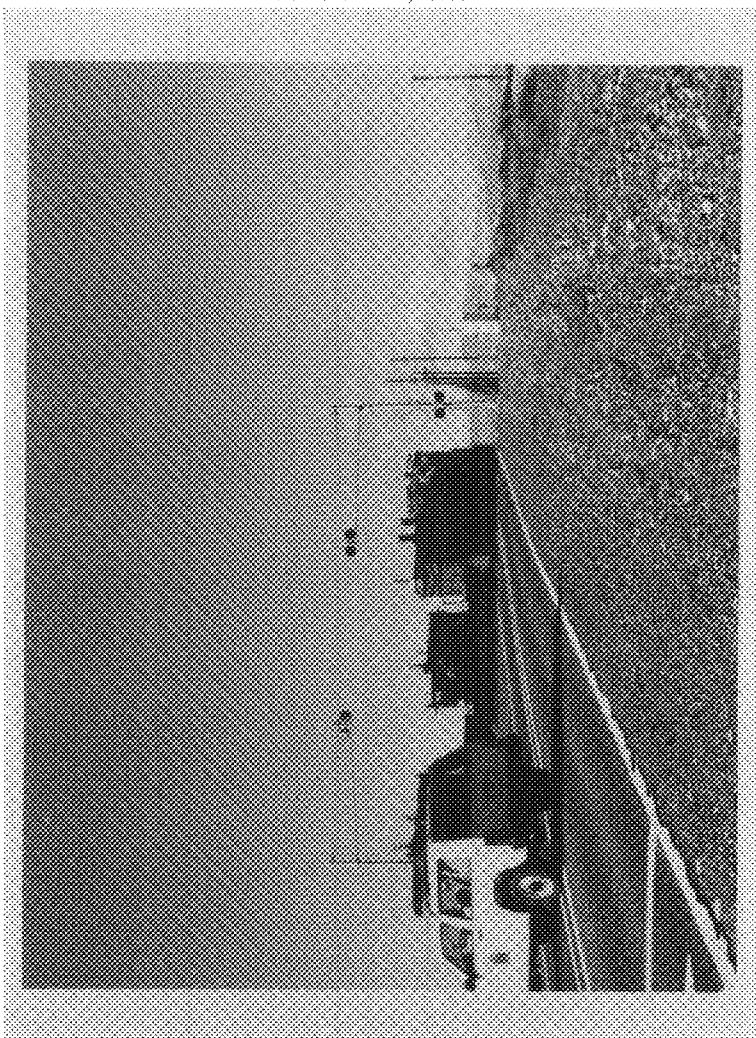
The recovery of the fuel dropped on the PUREX dissolver cell floors presented a unique challenge. This fuel had been dropped many years ago and needed to be recovered and packaged into canisters for shipment to the 105-K West Basins. This process had never been attempted in the PUREX facility and all new tools and equipment were required. The engineering and operations groups teamed to develop the new tools to recover and package the fuel. First, computer mock-ups were created to test the equipment designs in simulated PUREX settings. State-of-the-art designs, which might have allowed more intricate maneuverability of equipment and more compact packing of the fuel, were rejected in favor of sturdy, simple equipment. Because the equipment would be used only once, it was designed and built using procedures that allowed a great deal of hands-on testing and evaluation. Also, every part of the PUREX dissolver cells and all pertinent work locations were videotaped and studied to help in the equipment design and work planning. The equipment was tested and later modified using "dummy" (non-radioactive) materials before it was placed into the PUREX process canyon.<sup>125</sup>

The recovery of the fuel started with removal of the dissolver equipment to expose the fuel elements. The fuel recovery equipment then was used to grasp each element, wash it, and load it into a canister. Each day's work was videotaped and studied to improve the procedure for the next day's work. The loaded canisters were stored in a rack on the canyon deck. Preparing the aluminum-clad fuel required that an overpack bucket be removed and the fuel baskets placed into new lifting buckets.

One basket of fuel in the PUREX basin already was in an overpack bucket. This bucket was designed for charging the dissolvers and would not fit into the shipping container. The overpack bucket was removed by lifting it to the water's surface then using an impact wrench to remove the retaining bolts. The overpack was then lowered and the basket was removed and placed into a new overpack bucket as were the other three baskets. The new overpack bucket was used both as a precaution to ensure that the fuel remained covered with water and to provide a new lifting container. Before the fuel transfer, the buckets were moved onto the canyon deck and flushed with water to remove as much corrosion material as possible.<sup>126</sup>

The K Basins personnel prepared an area for unloading the canistered fuel. The equipment needed to seal the canisters after receipt was constructed and installed in the basins. Additional tools needed to unload the aluminum-clad fuel also were fabricated and installed. Both the aluminum-clad fuel and recovered dissolver fuel canisters were loaded into irradiated fuel cask cars. These cask cars had been prepared for this shipment by replacing the shielding water. The lids to the cars were closed and sealed with tape (an added precaution required by the regulatory agencies to prevent water from sloshing out of the cars). The cars were surveyed and shipped to the 105-K West Basins where they were opened and the fuel loaded into one segment of the basin. These operations were completed in October 1995 (Figure 25).

Figure 25. Transfer of Spent Fuel from PUREX to the 105-K West Basins,  
Hanford Site, 1995.



Although communication was excellent between the Spent Nuclear Fuel Project and PUREX, the procedures had not been cross-reviewed. This omission led to confusion about the security sealing of the cars and caused some delay. However, the basketed fuel was removed and loaded into canisters at the 105-K West Basins. A problem arose when the very fine corrosion material remaining on the fuel rose from the baskets and obscured the camera. This was overcome by experienced operators who worked without the video to collect the elements and load the canisters.<sup>127</sup>

## LESSONS LEARNED

**Lesson No. 71.** Videotaping the PUREX dissolver cells where the fuel was laying and videotaping all pertinent locations helped in planning the fuel recovery and transfer activities. Taping also helped to assign recovered fuel Nuclear Material values, document canister loading, account for all fuel elements, and provide an ongoing method to review and learn from previous days' activities. All work with sensitive materials such as spent fuel elements (and other items with accountability requirements) should be taped without editing and at the highest tape speeds, to provide the best opportunities for learning and improving the procedures.

**Lesson No. 72.** Planning and surveying every step of the way when dealing with an activity involving radiological contamination outside of plant radiation zones leads to time savings in the end. Such activities have high visibility, and involve many regulations and stipulations. Making sure all the surveys and preparations are done before starting the main activity will prevent any expensive work stoppages during the activity. At PUREX, the identification of allowable contamination levels on the cask cars almost stopped the fuel transfer at the last minute.

**Lesson No. 73.** The EA process can be very time consuming. To expedite matters, processes that already are covered in existing documents should be identified and the existing documentation included in the beginning. Early contact should be made with the EA review team to discuss and agree on what will be included. Also, the review team itself should be carefully chosen to include the people directly involved with the activity. They have expert knowledge and this knowledge should be tapped. The review team should not be expanded to include anyone other than those who are essential or the process may become unwieldy.

**Lesson No. 74.** Alternatives for the disposition of spent fuel are severely limited by considerations of the time and money needed to satisfy regulatory requirements, safety considerations, and stakeholder concerns. The requirements to permit the movement of even small amounts of spent fuel away from the DOE site of origin are significant and perhaps even prohibitive in today's climate. Therefore, spent fuel remaining at the end of processing activities should be dealt with on site and should be grouped with other existing spent fuel if it exists.

**Lesson No. 75.** Operating personnel should be kept involved with every step of the design to improve the ease of use with new equipment. Also, problems with the design can be identified early by experienced plant personnel. Such problems may not necessarily be recognized even by a knowledgeable engineering staff. For example, by allowing the crane operator at PUREX to design his tools with minimal support by engineering, the tools were constructed quickly and accurately for use in the specific task.

**Lesson No. 76.** Design of equipment should be kept simple and rugged to ensure consistent operation and avoid potential equipment failures. Such equipment may not be state of the art and may not be able to perform intricate maneuvers, but the performance tradeoff between durability and cost effectiveness is worthwhile. Also, keeping the design classification for new equipment to as low a level as possible allows for timely inspections and drawing development.

**Lesson No. 77.** Provision should always be made for cross-review of procedures when more than one organization is involved in an activity.

**Lesson No. 78.** When an activity such as fuel transfer is a high priority for one project but not another, understandings and agreements need to be reached at high management levels to determine which priority level will apply.

**Lesson No. 79.** Computer simulation of equipment is very helpful to engineers and operators in both evaluating use inside remote areas (such as the PUREX canyon) and visualizing and planning activities.

**Lesson No. 80.** To the extent possible, the time between planning, documenting, and carrying out an activity should be kept as short as possible. When time elapses, documentation changes may be required, personnel assigned to the activity may change, and readiness reviews may become more extensive. Such changes add time to the overall activity schedule. At PUREX, some of the personnel familiar with fuel transfers were lost during the initial years after the Standby runs. When the time came for the final fuel transfers in 1995, some of the personnel in key positions had never done this activity before so more extensive readiness reviews were needed.

#### 8.4 NITRIC ACID DISPOSITION

Once the PUREX/UO<sub>3</sub> Facilities received their final closure orders and the UO<sub>3</sub> stabilization run (Section 9.0) was complete, the plants had approximately 681,372 liters to 757,080 liters (180,000 to 200,000 gallons) of slightly contaminated (low specific activity) nitric acid. The plan in 1993 was to dispose of this material via sugar denitration in the PUREX Plant. Sugar denitration had been a standard practice at the facility since 1963, but it produced a strong nitrogen oxide off-gas that would have posed a serious regulatory hurdle. Also, the amounts present at PUREX would have taken over 1 year to process, thereby prolonging the overall deactivation project. In early FY 1994, an alternative disposition plan was developed to sell the nitric acid as a process chemical to a fuel reprocessing facility owned by BNFL at Sellafield, England.<sup>128</sup>

Because the transfer of a process chemical to a foreign reprocessing facility would involve non-proliferation concerns, DOE stipulated that the UO<sub>3</sub>

product that would be generated by BNFL would not be placed on the commercial uranium market. The next concern was the safe transportation of the material and the development of adequate NEPA documentation (with attendant public involvement) to ensure such safety. A memorandum of understanding was written between WHC and DOE, and a transportation plan was developed to ensure the implementation of all required safety procedures. In the summer of 1994, DOE sought an export license for the shipment from the U.S. Nuclear Regulatory Commission and DOE and BNFL were negotiating a final contract. In August however, strong concerns about non-proliferation and the costs and procedures of the transfer were expressed by the environmental group Greenpeace and some DOE Headquarters staff members.<sup>129</sup>

In September, Secretary of Energy Hazel O'Leary authorized the shipment to proceed pending preparation of an EA (with attendant public involvement), receipt of an export license, and approval of a transportation plan. At nearly the same time, Washington State regulators concurred that the nitric acid was not a waste because it would be used as a process chemical and not abandoned or stored. The export license was granted in November 1994, and the EA was completed in February 1995. A Finding of No Significant Impact was approved in May 1995. Shipments began almost immediately,<sup>130</sup> and were completed 25 weeks later, in November 1995 (Figures 26, 27, and 28).

## LESSONS LEARNED

**Lesson No. 81.** Finding an alternative use for a slightly contaminated process chemical with an interested buyer or consumer is better than having the material declared a waste. The same lesson was learned, and for the same reasons, in connection with uncontaminated fresh chemicals that were sold from the PUREX Plant during the Standby period.

**Lesson No. 82.** Public involvement conducted as an honest and open attempt to communicate and find mutually satisfying solutions can be the key to resolving seemingly intransigent issues. Also, public involvement uncovers true public sentiments, and prevents a vocal minority from inaccurately representing the public (see Section 10.0).

## 8.5 ORGANIC DISPOSITION

When the shutdown order came for the PUREX plant, the facility was left with approximately 79,493 liters (21,000 gallons) of slightly contaminated organic solvent, a mixture of TBP and normal paraffin hydrocarbon (NPH). The solvent was located in tanks G5 and R7 in the PUREX canyon, but was moved outside the plant into tank 40 in 1993 so that certain in-plant fire system components could be deactivated. Among several potential disposal methods, two were identified as the most viable from the perspectives of safety, waste minimization, and environmental hazard control. Thermal destruction in a licensed commercial incinerator was one preferred option, but this choice would have cost approximately \$1.5 million because so few incinerators are able to accommodate mixed waste.

The alternative pursued most avidly by WHC and RL was to transfer the solvent to the New Waste Calcining Facility at the Idaho National Engineering Laboratory for use as a fuel. Discussions to effect this transfer were

Figure 26. Shipping Container Used to Transport Contaminated Nitric Acid from the PUREX Facility to England, 1995.

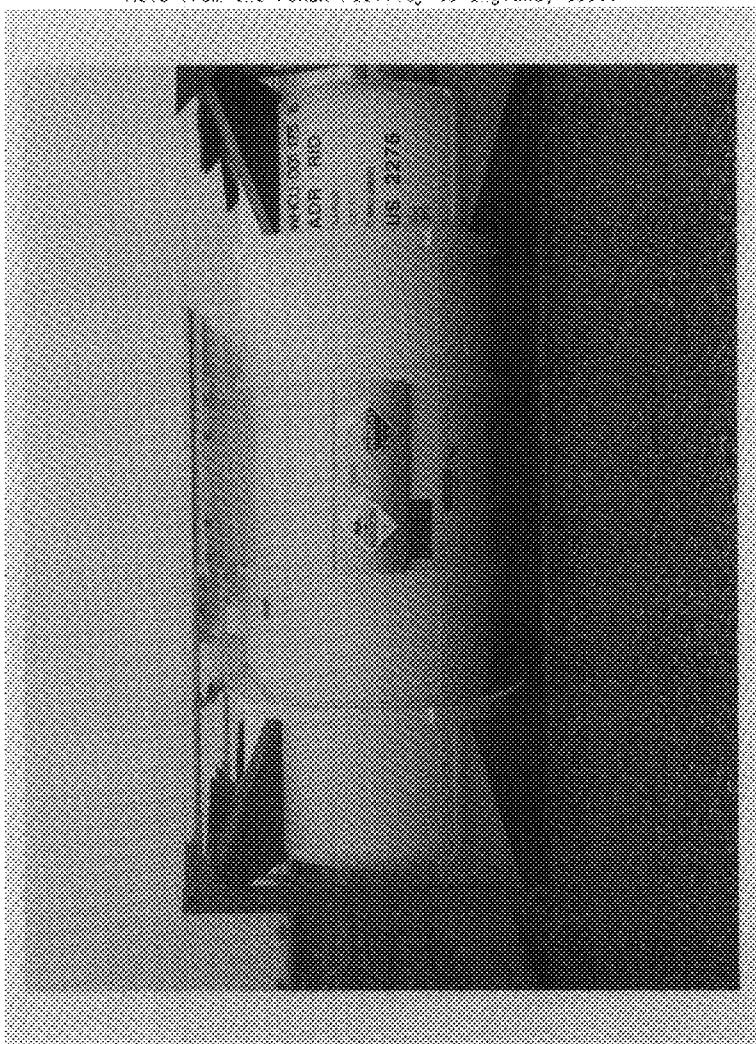


Figure 27. Final Nitric Acid Shipment from PUREX is Readied,  
November 1995.

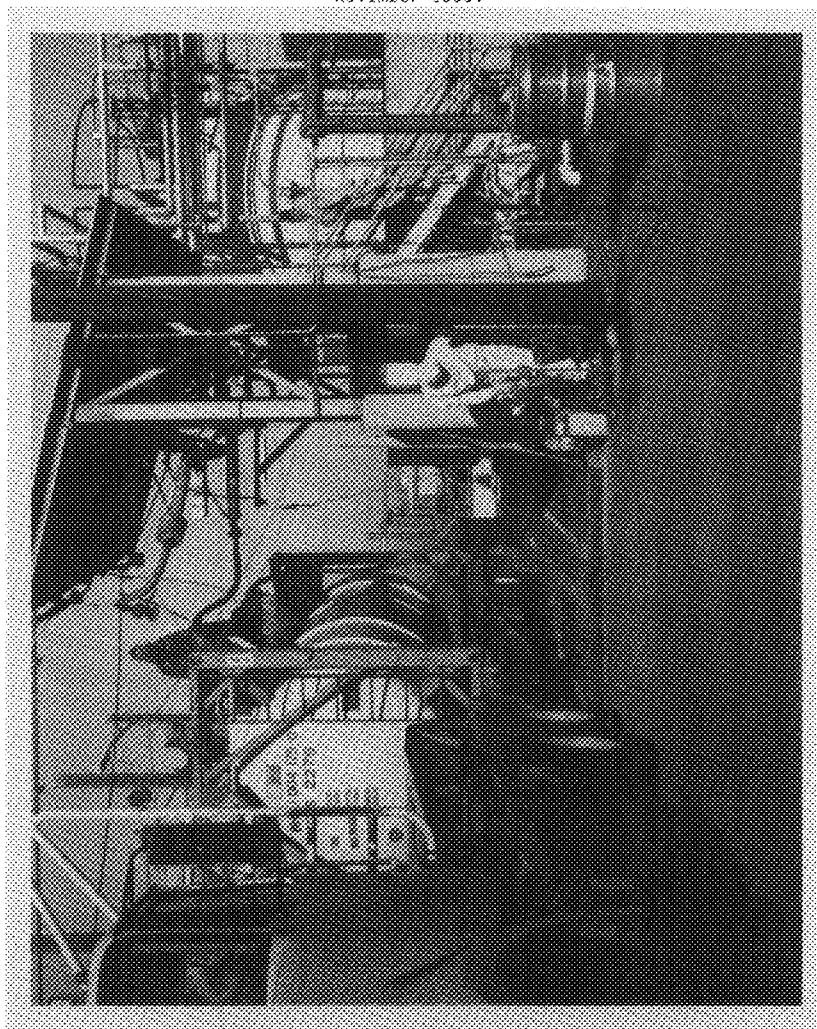
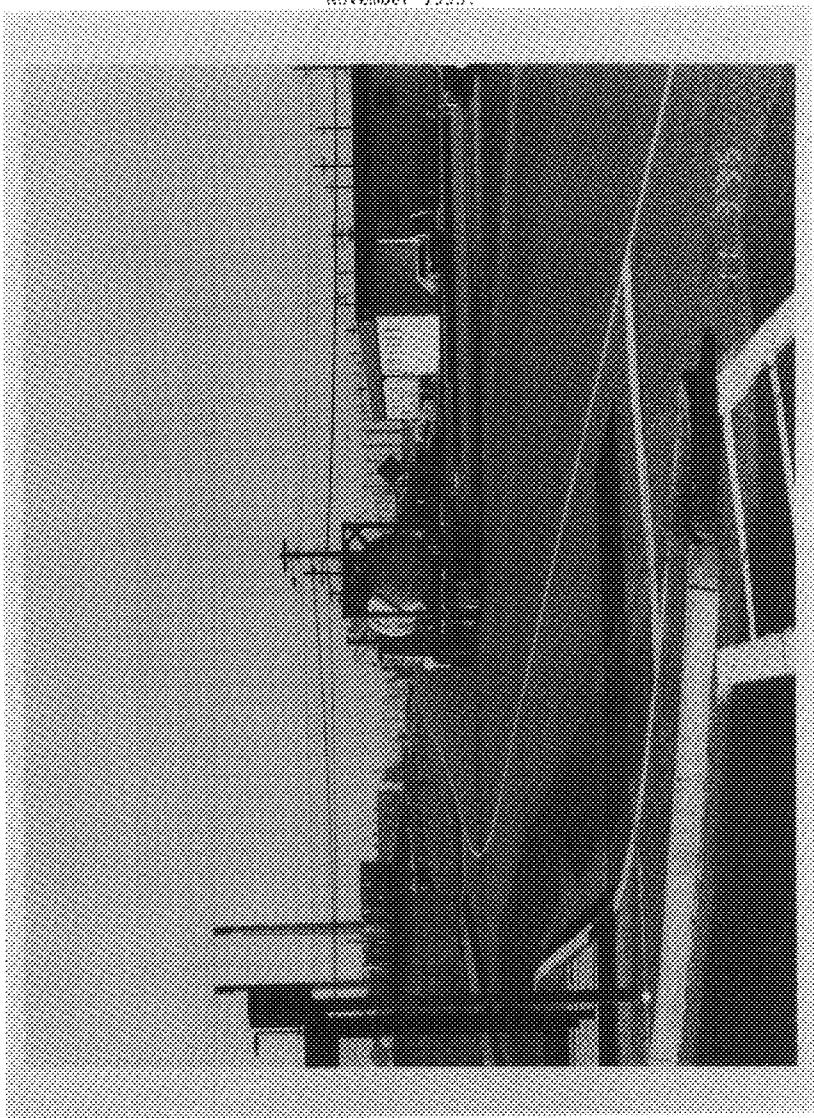


Figure 28. Final Nitric Acid Shipment Leaves the PUREX Facility,  
November 1995.



initiated in the Spring of 1993 among all the interested parties: RL, DOE/ID, WHC, Westinghouse Idaho Nuclear Company, Inc., and state officials and regulators in both Washington and Idaho. The material was to be shipped as a hazardous waste. Approvals were obtained from nearly all parties; a shipping date was set in September 1993. However, Idaho State officials, having strongly opposed receiving nuclear waste from other states and having had to compromise and accept unwanted spent nuclear fuel from decommissioned naval vessels earlier in 1993, decided that they could not accept the PUREX solvent as a waste.<sup>131</sup>

A series of negotiations followed in 1994, during which DOE officials attempted to demonstrate that the PUREX organic solvent was not a waste because of its intended beneficial use as a product in the New Waste Calcining Facility. Furthermore, the 1993 CX prepared on the shipment of the solvent had identified it as a low-specific-activity material, one of the least restrictive transport categories. However, Idaho officials were unconvinced, and the issue became entangled in a larger dispute between Idaho's Governor Cecil Andrus and the U.S. Navy over shipments of naval nuclear waste to Idaho. An alternative destination for the PUREX organic solution was found at Diversified Scientific Services Incorporated (DSSI) in Tennessee. DSSI planned to burn the material in a co-generation facility to create electricity. The solution was shipped to DSSI as waste in six shipments between September 27, 1995, and June 12, 1996 (Figures 29 and 30).<sup>132</sup>

## LESSONS LEARNED

**Lesson No. 83.** Some obstacles to moving nuclear process materials and other types of deactivation alternatives cannot be controlled or overcome by plant and DOE personnel. The historical/political climate toward nuclear materials is such that even the most preferred alternatives (from the technical perspective) sometimes cannot be implemented in every locality.

**Lesson No. 84.** Persistence and patience can find a destination and a cooperative customer when one is pursued over time. Many avenues should be explored.

### 8.6 LABORATORY DEACTIVATION

The PUREX laboratory is an integral part of the facility in that it was constructed to be completely contained within the facility. When PUREX was built, this connection was seen as an advantage because it offered better radiological protection than could be achieved when transferring sample solutions outside the plant. However, such a connection appeared in a different light when it came time for the PUREX Plant to shut down. For a time in 1993, consideration was given to keeping the PUREX laboratory open to perform waste characterization and other work valuable to the Hanford Site. However, even though DOE was concerned about laboratory shortages, the continuing function of the PUREX laboratory after plant deactivation could not be justified. Whole new support systems (i.e., electrical, water, HVAC, etc.) would have had to have been constructed or overall plant utilities would have had to have been maintained. The overall goal of driving S&M costs to the absolute minimum also could not be reached. Therefore, the decision was made to close the PUREX laboratory toward the end of the deactivation project after

Figure 29. Inspection of Equipment Used to Transport Organic Solution from PUREX Facility to Diversified Scientific Services Incorporated in Tennessee, 1995.

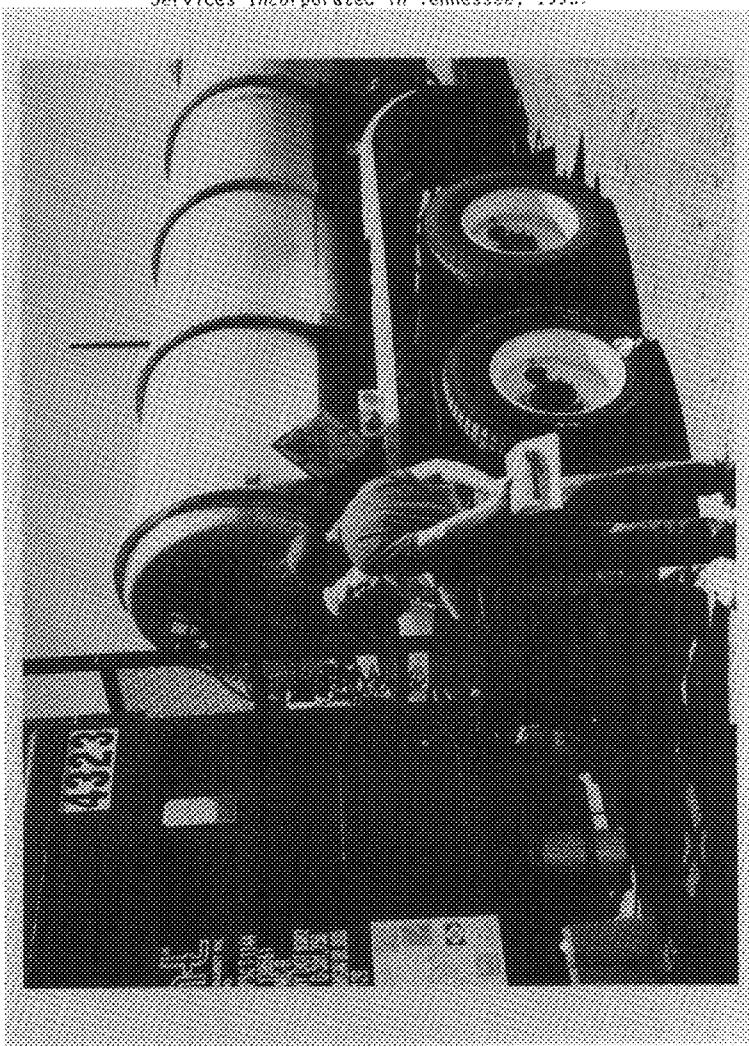
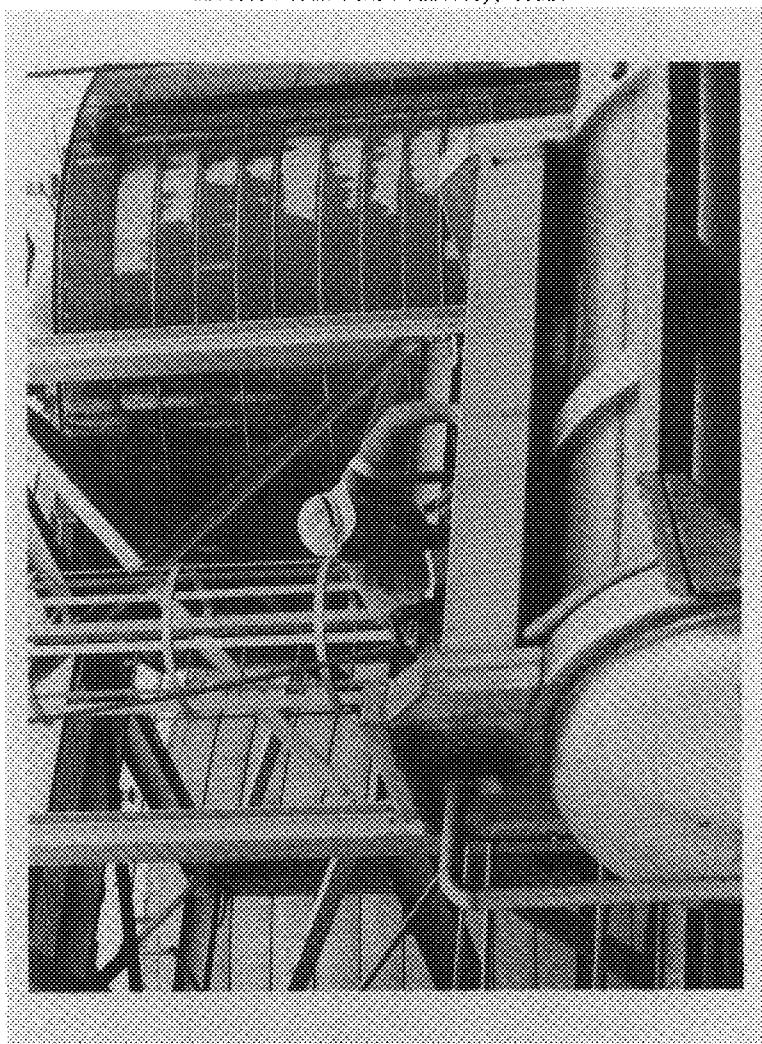


Figure 30. Operator Prepares Tank for Loading and Shipment of Organic Solution from PUREX Facility, 1995.



to close the PUREX laboratory toward the end of the deactivation project after maintaining it to sample canyon flush materials and other substances generated by the project itself.<sup>133</sup>

The actual steps in the deactivation of the PUREX analytical laboratory closely followed the pattern established in the cleanout of N-Cell, the PR room, Q-Cell, and the Sample Gallery. Small equipment within glove boxes and open-faced hoods was removed, but the structures themselves remain. Contamination fixants were sprayed and painted inside and around the glove boxes and hoods (Figures 31 and 32). As part of the overall PUREX HVAC consolidation project, the exhaust plenum at the rear of each laboratory hood, the exhaust lateral between hoods and the overhead exhaust header, and the exhaust lateral itself will be filled with polyurethane foam to prevent contamination migration. The vacuum header lateral lines have been injected with epoxy resin, utilities have been disconnected, piping and drains have been blanked, and filters have been removed. Sink drains have been filled with grout. All laboratory deactivation work except for the HVAC portions was completed in mid-1996. The HVAC tasks were completed in 1997.<sup>134</sup>

## LESSONS LEARNED

**Lesson No. 85.** The lessons learned in the deactivation of the PUREX analytical laboratory closely follow those learned in connection with N-Cell, the PR room, Q-Cell, and the Sample Gallery. Individual systems within large facilities cannot be kept open without the undue expense of maintaining at least portions of larger systems. There is an optimum time to deactivate a support facility and move the needed services to other facilities. Also, using modern contamination fixant techniques, glove boxes and other large equipment pieces can be left inside facilities, while contamination is controlled.

### 8.7 L-CELL CLEANOUT

L-Cell at the PUREX Facility housed the third (final) plutonium concentration step (Figure 33). As such, it became highly contaminated over the years. During the standby and early deactivation periods, remote television cameras operated by the PUREX crane detected solids and sludge material on the floor of L-Cell. Learning about the nature, extent, and source of this contaminated material was essential to characterization efforts. In the Spring of 1994, a team of PUREX personnel comprising health physics technicians, engineers, managers, safety experts, and nuclear process operators began meeting to plan a human entry into L-Cell to obtain better characterization information. The team carefully mapped a route through the cell that would be followed by the entering personnel who would take video footage and obtain samples of the floor residue. Then they made the crucial decision that, to best follow the ALARA radiation exposure guidelines, the entry would be made by just one person. Next, "dry run" dress and undress procedures were rehearsed and a practice run was made following a duplicate of the route through an uncontaminated area. When the L-Cell entry was made on May 4, 1994, it went smoothly and 2 hours of valuable video footage, as well as many important samples, were obtained (Figure 34).<sup>135</sup>

Figure 31. Nuclear Operators Deactivate Pluthermal Laboratory Hoods, 1995.

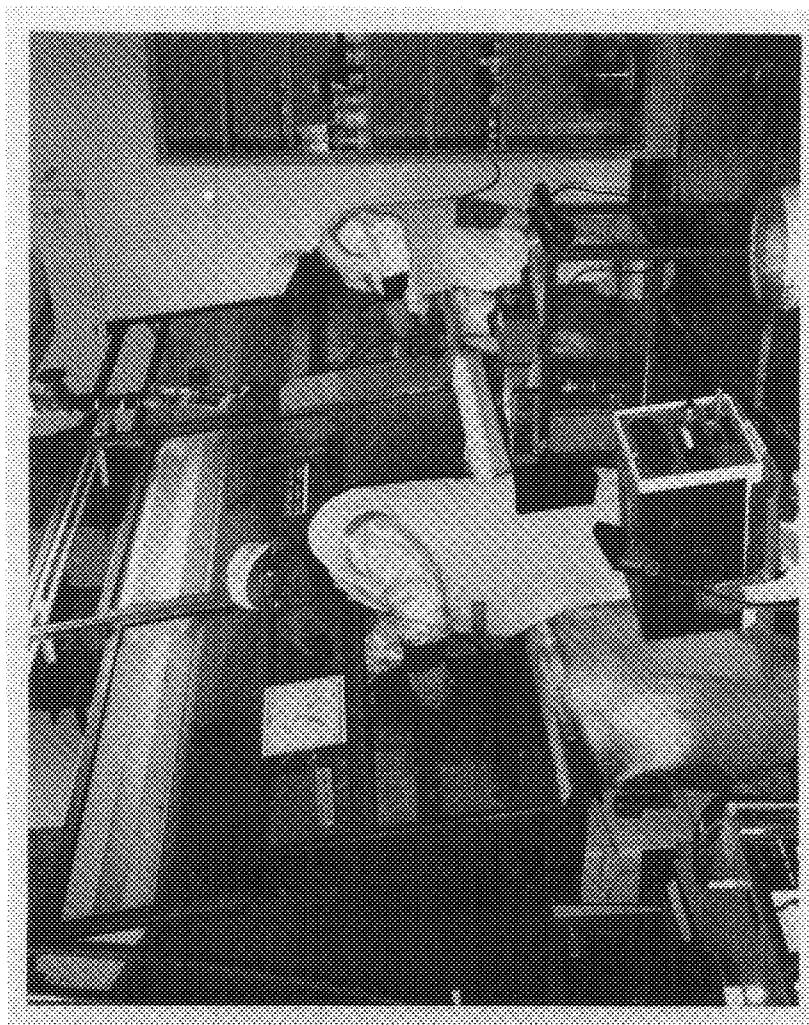


Figure 32. foam is Spread Inside PUREX Laboratory Hood in Final Deactivation Step, 1996.

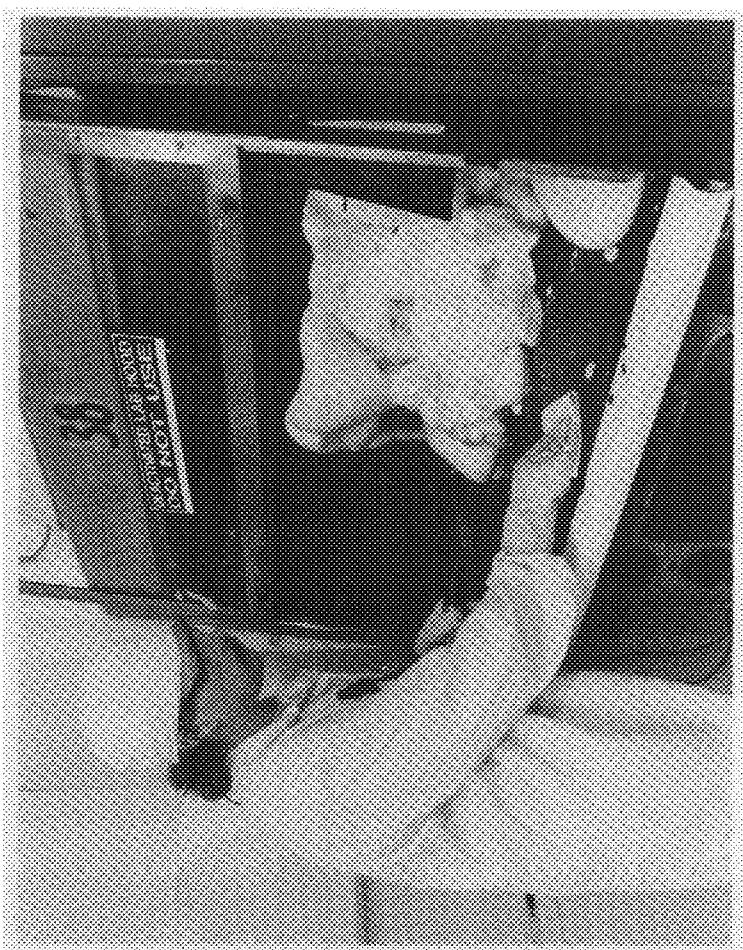


Figure 33. PUREX I-Cell Equipment During Operations, 1971.

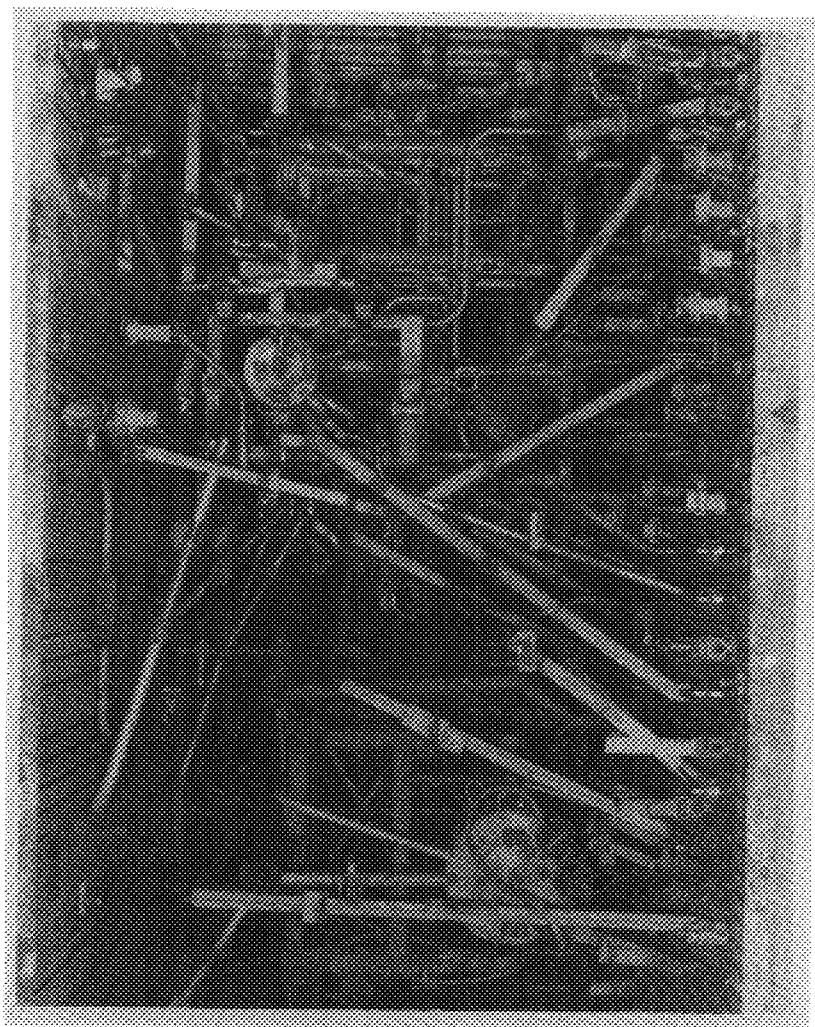
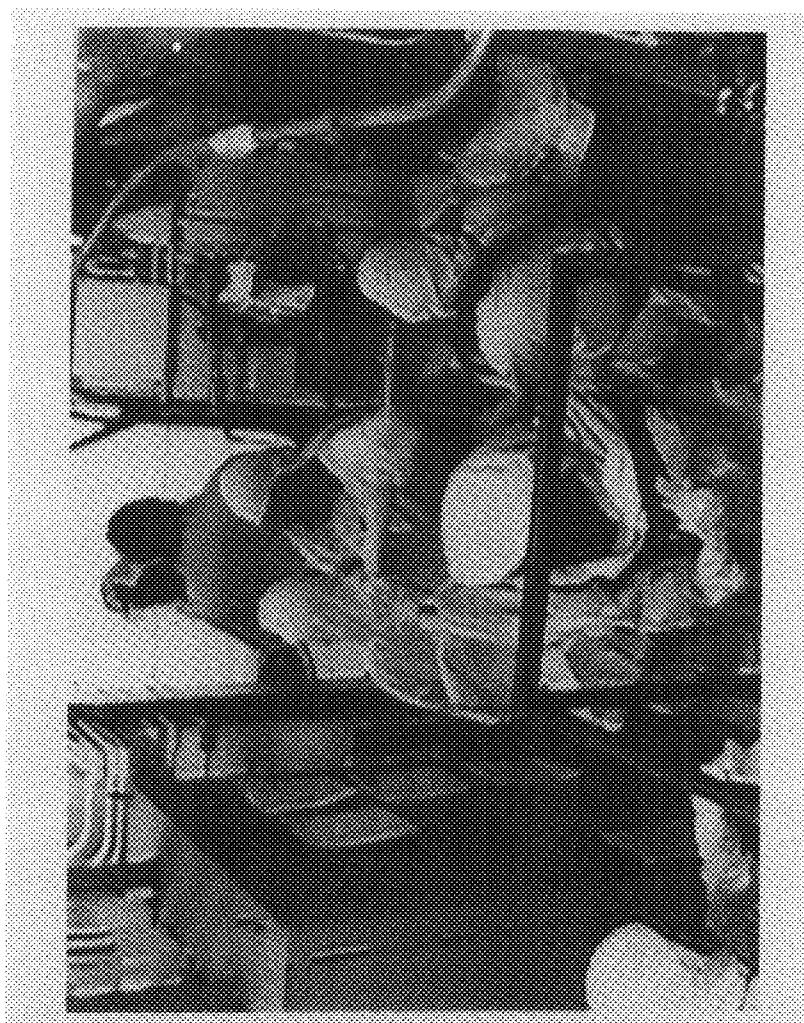


Figure 34. PUREX Workers Prepare for L-Cell Characterization Entry, 1994.



Two solid matrix accumulations were found under tanks L2 and L8; subsequent assay determined an overall cell floor accumulation of between 3,718 to 6,168 grams of plutonium. Criticality analyses of the form, amount, and configuration of the plutonium in L-Cell showed that the material was not conducive to a criticality event. Therefore, it was decided in the deactivation project to leave the cell in its current condition. Removing the plutonium, it was believed, would not appreciably reduce the risk to the public, the environment, onsite workers, or future D&D workers. Furthermore, it was estimated that such removal would extend the deactivation schedule by 6 months and increase project costs by approximately \$15 million.<sup>136</sup>

## LESSONS LEARNED

**Lesson No. 86.** Careful planning with input from many knowledgeable plant people, as well as practice dry runs, are key elements in achieving smooth, efficient, and low-exposure results when work must be done in high-radiation areas.

### 8.8 CANYON/VESSEL FLUSHING

Following the completion of the PUREX stabilization campaign in 1990, the operating process was shut down in accordance with routine procedures. These procedures involved conducting vessel integrity tests where process vessels were filled with water and then emptied. Essentially a flushing activity, these actions removed much of the SNM and fission product waste from the process piping and equipment. During subsequent activities performed in preparation for potential restart of the plant, including tank calibration and tank integrity assessments, most of the equipment underwent additional water flushes. Therefore, it was decided in the PUREX Deactivation Project to limit further internal flushing of the canyon equipment to that required to ensure that any residual heels did not exhibit dangerous waste characteristics (pH of between 2 and 12.5), and to remove any suspected high-potential "pockets" of SNM or fission products. The decision to flush only to these levels and criteria was based on waste minimization considerations and on the belief that future D&D decisions should and would determine the necessary levels of "cleanliness" for the process vessels.

At the start of deactivation planning, several alternatives for flushing the canyon equipment were considered. The first was to transfer all solutions in the canyon vessels to the Hanford Site's tank farms and to document the holdup of SNM or hazardous constituents within each vessel. Regulations governing the Hanford Site require that all hazardous material from vessels in a TSD unit or system be removed before the unit is turned over to D&D. This eliminated the option of leaving holdup material. The second alternative was to conduct chemical and water flushes of the process equipment to remove SNM and hazardous material. Because of the large volume of waste water that would be produced, this alternative also was eliminated.

The method selected to flush the canyon equipment was to transfer all remaining solutions in the PUREX canyon vessels to the tank farms, then conduct a cascading heel flush of the process equipment using raw water. This method of flushing not only eliminated hazardous constituents remaining in the tank heels, but minimized waste water volume transferred to tank farms

(Figure 35). In addition to minimizing the use of raw water, excess water from the PUREX slug storage basin and steam condensate were used to flush specific canyon vessels.

Seventy-four PUREX canyon vessels were flushed, including vessels named as part of the TSD system. These vessels and associated systems were flushed (cascaded) to ensure that dangerous waste constituents were removed from the corresponding piping and tanks. Significant waste volume minimization was achieved using this approach. To support the cascading of flush solution through the individual systems of canyon vessels, canyon routes were installed or reconfigured.

Flush solutions were cascaded from one vessel in a system to the next with samples obtained at a predetermined point (See Appendix E for an example chart from K-Cell). Each system was flushed until the sample of the rinsate in the vessel heel no longer exhibited dangerous waste characteristics. Once the process sample exhibited no dangerous waste characteristics, a RCRA protocol sample was collected. This sample was the final item needed to designate the solution as non-dangerous waste.

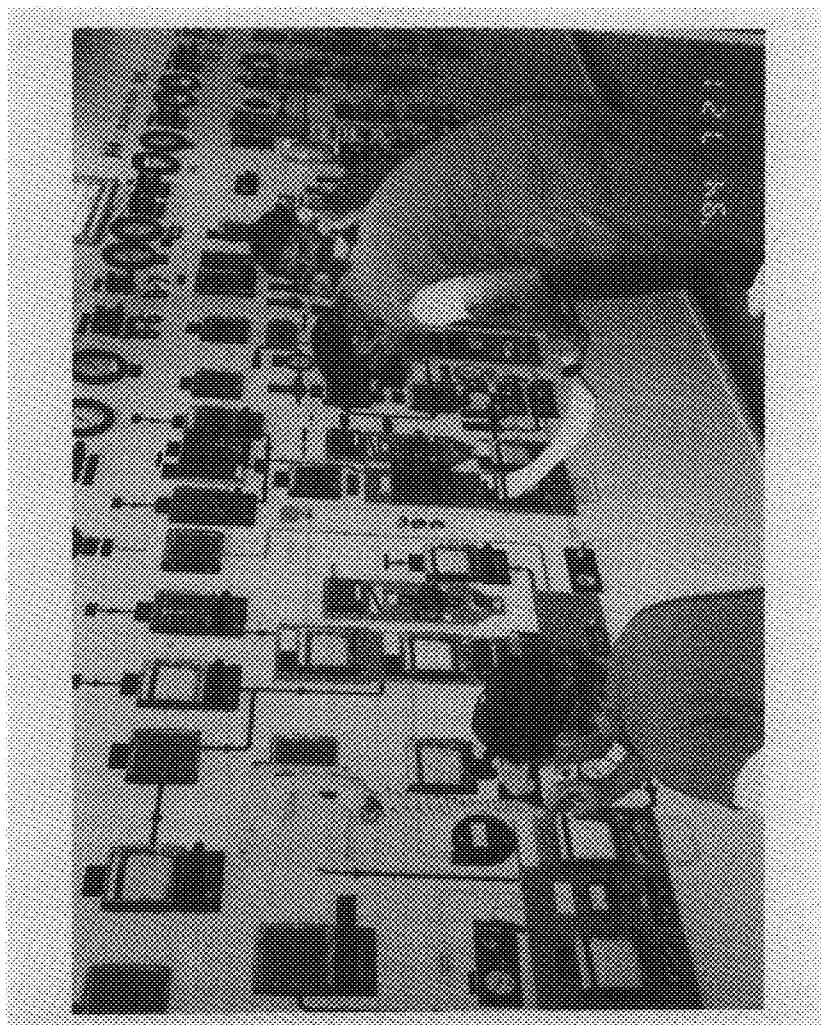
Strict compliance with federal regulation required analysis for every constituent listed by the EPA in 40 CFR 261. In lieu of sampling and analyzing for each constituent, the DQO process was used to determine an appropriate degree of analysis. The DQO process involved discussions among personnel from DOE, WHC, and Ecology, and yielded an agreement to sample for only 20 analytes. The basis for the agreement consisted of past RCRA sample results from PUREX waste and past process knowledge. Although the review of past sample analyses indicated that corrosivity (pH), cadmium, and chromium were the only constituents of concern, it was agreed that the additional analyses would be performed to ensure that no dangerous waste characteristics remain in the canyon vessels.<sup>137</sup>

Approximately 500,000 gallons of waste water were transferred to the Hanford Site's tank farms on completion of canyon vessel flushing in April of 1996. A total waste volume of 1.5 million gallons was projected and allotted for PUREX deactivation activities before the canyon vessel flushing project began. Recycling waste water from other sources as flush water for the canyon vessels contributed to successfully minimizing the waste. In addition, the cascading method of flushing vessels allowed significant waste minimization by adding water to one vessel and cascading it through the system of vessels. The cascaded approach resulted in significant cost savings and waste volume reductions.<sup>138</sup>

## LESSONS LEARNED

**Lesson No. 87.** Establishing effective, early, and ongoing communication between facility and regulatory personnel is essential. Regulatory support and communication were essential in determining the extent of flushing needed at PUREX, the sample analysis required, and the methods of flushing. Although interaction with regulators often costs time, ultimately it results in completing the project safely and ahead of schedule.

Figure 35. Cascadia Flushing of K-Cell is Monitored in the PUREX Control Room, 1994.



**Lesson No. 88.** Looking for ways to combine activities is important, especially when attempting to minimize waste production. The combination of recycling waste water from other sources and using the cascaded flushes method to clean the canyon vessels at PUREX reduced the anticipated waste volume by 50 percent. It also resulted in significant cost savings by completing the canyon vessel flushing project ahead of schedule.

### 8.9 PUREX TUNNELS 1 AND 2 (218-E-14) (218-E-15)

Two solid waste storage tunnels are associated with the PUREX facility. The tunnels extend south from the main railroad tunnel that serves the PUREX plant on the east end. Tunnel Number 1 was built when the PUREX facility was constructed and Tunnel Number 2 was built in 1964 to store high-dose-rate mixed waste from the PUREX plant and other sources on the Hanford Site (Figure 36). Each storage tunnel is isolated from the main plant railroad tunnel by a water-fillable shielding door. No electrical utilities, water lines, drains, fire detection or suppression systems, radiation monitoring, or communication systems are provided inside the PUREX Storage Tunnels.

Tunnel Number 1, completed in 1956, consists of three areas: the water-fillable door, the storage area, and the vent shaft. The water-fillable door is located at the north end of Tunnel Number 1 and separates the storage tunnel from the main PUREX railroad tunnel. The door is 7.5 meters high, 6.6 meters wide, and 2.1 meters thick, and is constructed of 1.3 centimeter thick steel plate. The door is hollow so that it can be filled with water to act as a radiation shield when in the down (closed) position. The Tunnel Number 1 water-fillable door will be drained as part of PUREX Deactivation Project.

The storage area of the tunnel extends southward from the water-fillable door. The inside dimensions of Tunnel Number 1 are 109.1 meters long, 6.7 meters high, and 5.9 meters wide. Ceiling and walls are 35.6 centimeters thick and are constructed of 30.5 centimeter by 35.6 centimeter, creosote pressure treated, Douglas fir timbers arranged side by side. The first 30.5 meters of the east wall are constructed of 0.9 meter-thick reinforced concrete. A 40.8 kilogram mineral surface roofing material was used to cover the exterior surface of the timbers before 2.4 meters of earth fill were placed on top. The earth cover serves as protection from the elements and radiation shielding. The timbers that form the wall rest on reinforced concrete footings 0.9 meter wide by 0.3 meter thick. The floor consists of a railroad track laid on a gravel bed. The space between the ties is filled to the top of the tie with gravel ballast. The tracks are on a 1.0-percent downward slope to the south to ensure that the rail cars remain in their storage position. A rail car bumper is located 2.4 meters from the south end of the track to act as a stop. The capacity of the storage area is eight, 12.8 meter-long rail cars.

Between 1962 and 1980, nine pipe risers were installed through the roof of Tunnel Number 1. Seven of the risers were used for wood sampling of the tunnel ceiling timbers. The other two were used to obtain air samples and temperature data about the internal environment of the tunnel. Currently, all risers are capped. A vent shaft is located at the south end of Tunnel Number 1. The shaft is approximately 1.5 meters in cross section and is constructed of reinforced concrete. The vent stack extends approximately

Figure 36. PUREX Storage Tunnel 1 Under Construction in 1954.



0.3 meter above grade and was capped with a single-stage HEPA filter, a 283 cubic meter-per-minute exhaust fan, and a 6.1 meter-tall exhaust stack.

Over the years, material selected for storage in the tunnels was loaded onto rail cars modified to serve as both transport and storage platforms. A remote-controlled battery-powered locomotive or a locomotive and a string of spacer cars was used to position the rail car in the storage tunnel. The cars were placed in storage positions numbered sequentially, commencing with Position 1 that abuts the rail stop bumper at the south end of each tunnel. Position 2 is the location of the rail car that abuts the rail car in Position 1 and the sequence continues.

In June 1960, the first two rail cars were loaded with a single, approximately 12.5 meter-long failed separation column and placed in Tunnel Number 1. Between June 1960 and January 1965, six more rail cars were placed in Tunnel Number 1, filling the tunnel. After the last car was placed in the northernmost storage position (Position 8), the water-fillable door was closed, filled with water, and deactivated electrically. After Tunnel Number 1 was filled to capacity, it was sealed. Sealing activities included deenergizing the ventilation system and blanking the ventilation system upstream of the air filters to prevent interaction of the tunnel air with external air.

Tunnel Number 2 was constructed in 1964. Like Tunnel Number 1, Tunnel Number 2 consists of three functional areas: the water-fillable door, the storage area, and the vent shaft. Construction of Storage Tunnel Number 2 differs as follows.

- A combination of steel and reinforced concrete was used instead of wood timbers to construct the storage area.
- Tunnel Number 2 is longer, with five times the storage capacity of Tunnel Number 1.
- The floor of Tunnel Number 2, outboard of the railroad ties, slopes upward to a height of approximately 1.8 meters above the railroad bed. The floor in Tunnel Number 1 remains flat all the way out to the side walls.
- The railroad tunnel approach to Tunnel Number 2 angles eastward then southward to parallel Tunnel Number 1. The approach to Tunnel Number 1 is a straight extension southward from the PUREX plant. Centerline to centerline is approximately 18.3 meters.

The vent shaft, located at the south end of Tunnel Number 2, is approximately 1.5 meters by 1.5 meters in cross-section and is constructed of reinforced concrete. The vent shaft extends approximately 0.3 meter above grade and is capped with an exhaust system consisting of a single-stage HEPA filter, a 153 cubic meter-per-minute exhaust fan, and a 6.1 meter-tall exhaust stack. The ventilation system is currently active; however, the exhaust fan has been dampened down to provide only about 100 cubic meters per minute of exhaust flow.

The first rail car was placed in storage in Tunnel Number 2 in December 1967. As of June 19, 1996, 28 rail cars had been placed in Storage Tunnel 2.<sup>139</sup>

In the PUREX Deactivation Project, Hanford Site officials and regulators decided to separate the tunnels administratively from the PUREX facility. The rail cars and stored waste material will remain in the storage tunnels until retrieval is required. Separate permitting requirements and agreements now apply to the tunnels. (See Sections 6.1 and 6.2.)

During the PUREX Deactivation Project, some plant waste and some waste from other onsite sources was added to Tunnel Number 2. Rail cars in positions 24 and 25 contain waste that originated in B-Cell in the 324 building. The waste was packaged in stainless steel canisters and shipped to PUREX in a steel shipping cask mounted on a railroad flat car (Figure 37). The first nine shipments were completed April 1, 1996, and staged in G-Cell in the PUREX canyon. Eight more shipments were completed June 8, 1996. The waste canisters were loaded into reinforced concrete burial boxes in two separate operations. The first box was placed in Tunnel Number 2 on April 26, 1996; the second was placed in Tunnel Number 2 on June 12, 1996. The two boxes sit on separate railroad flat cars. Also, during the PUREX Deactivation Project, 3 empty 75,800 liter (20,000-gallon) stainless steel rail tank cars with high dose rates resulting from internal contamination were placed in positions 26, 27, and 28 of Tunnel Number 2 (Figure 38). These rail cars were purchased in 1966 and were used for contaminated liquid waste transfers between N Reactor, the 340 facility, FFTF, T Plant, and the tank farms. Rail cars in positions 1 through 23 contain failed equipment from the PUREX Facility.

When significant decay of the radioactive fission products contaminating the equipment has occurred, the equipment may be retrieved for final disposal. While each rail car is retrievable, the rail cars can be removed only in reverse order (i.e., last in, first out) because they are stored on a single, dead-end line of railroad tracks. The most recent waste with some of the highest activity must decay before older waste can be retrieved. Therefore, final disposition of the PUREX tunnels will be treated entirely differently from the PUREX Deactivation Project. Meanwhile, the Deactivation Project has committed to 56 end points for the tunnels, including surveying and posting of radiological conditions, documenting the location of remaining dangerous waste, installing physical barriers to prevent unauthorized entry, isolating and removing the tunnel effluent release points (296-A-9 and 296-A-10), and draining water from the tunnel doors.<sup>140</sup>

## LESSONS LEARNED

**Lesson No. 89.** When ancillary facilities such as the PUREX Tunnels clearly have different missions and vastly different anticipated operating life spans, they should be separated administratively and treated differently in terms of regulatory and physical planning.

Figure 37. 324 Building Waste is Moved into PUREX Tunnel Number 2, 1996.

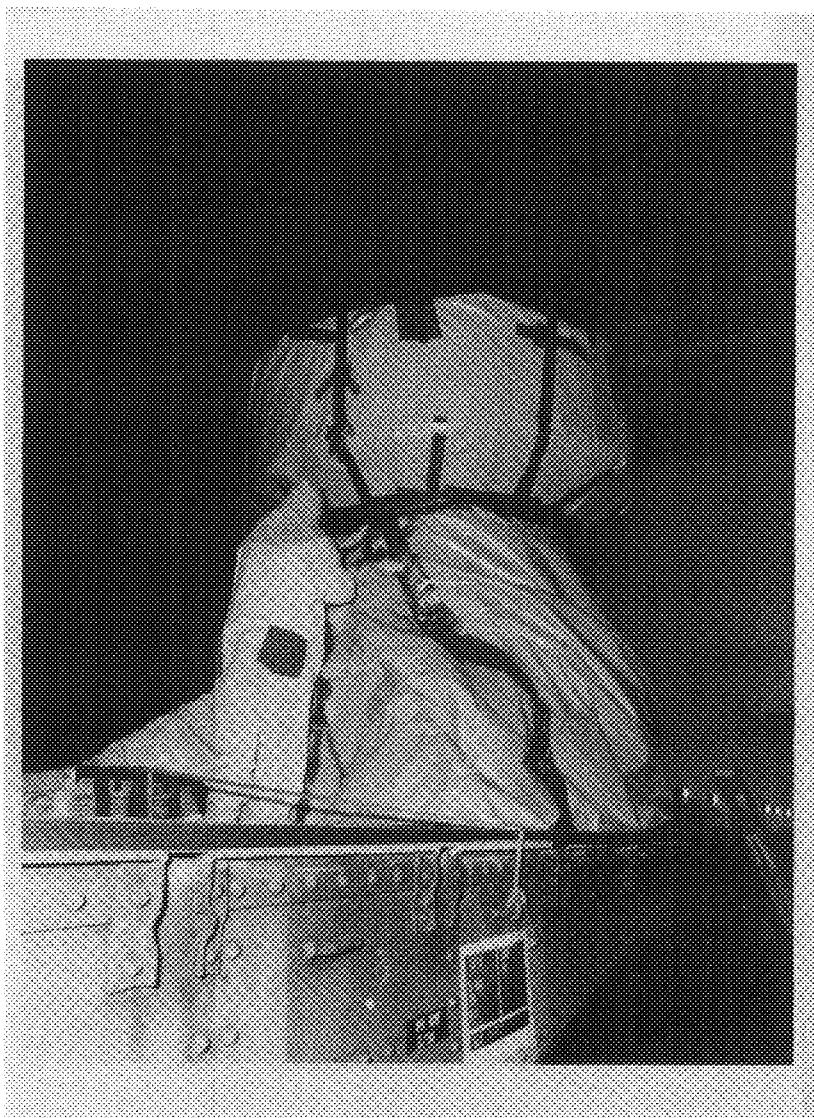
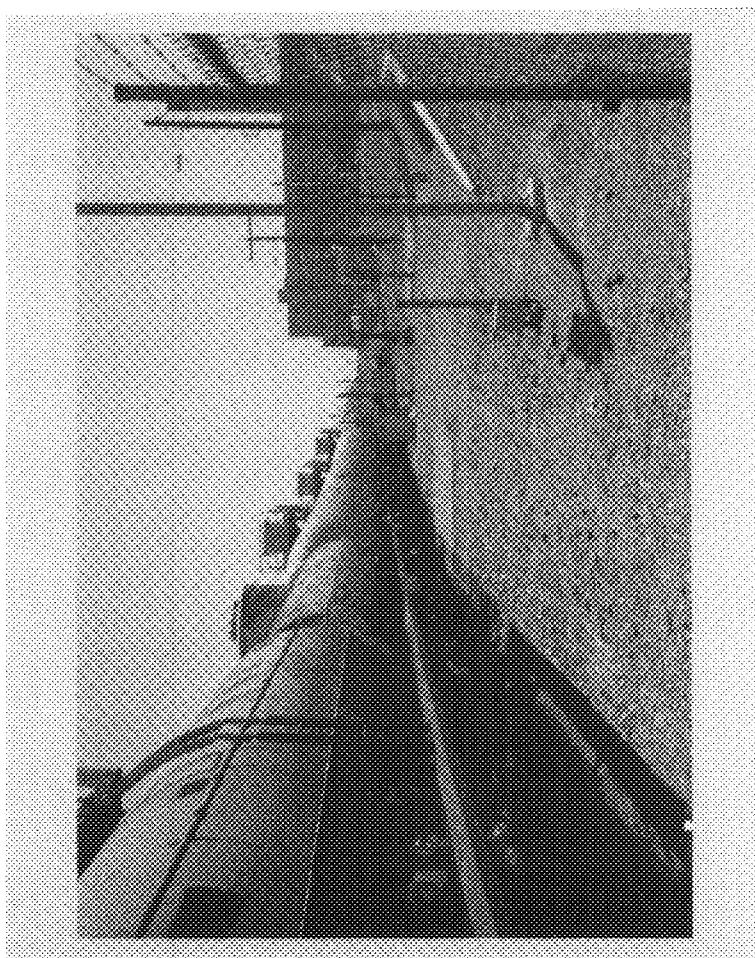


Figure 38. Final Three Permitted Rail Cars of Waste (Closest to Plant) are Moved into PUREX Tunnel Number 2, Summer 1986.



## 8.10 PUREX HVAC CONSOLIDATION

During normal operations and throughout most of the deactivation years, the 202-A Building was served by four separate ventilation systems designed to keep normal work areas free of airborne radioactive contamination. The systems operated by maintaining differential pressure to ensure that air flowed from zones containing no contamination into zones with progressively greater potential for radioactive contamination. Air was taken from the environment, passed through roughing filters and spray washers, heated if required, and supplied to the zone to be ventilated. Air was removed from the area at a constant rate, passed through HEPA filters, and exhausted to the atmosphere. The supply was modulated to maintain the correct differential pressure within the zone.

Ventilation System 1 served the canyon and process cells, the area with the greatest potential for radioactive contamination. Ventilation air supplied to the main canyon area was drawn into the cells from the top. From the cells, air was drawn through small ports into the air tunnel, then through deep bed glass fiber filters 1 and 2 and the 291-A stack filters, and was exhausted through the stack by electric fans. The exhaust was monitored and sampled for radionuclides.

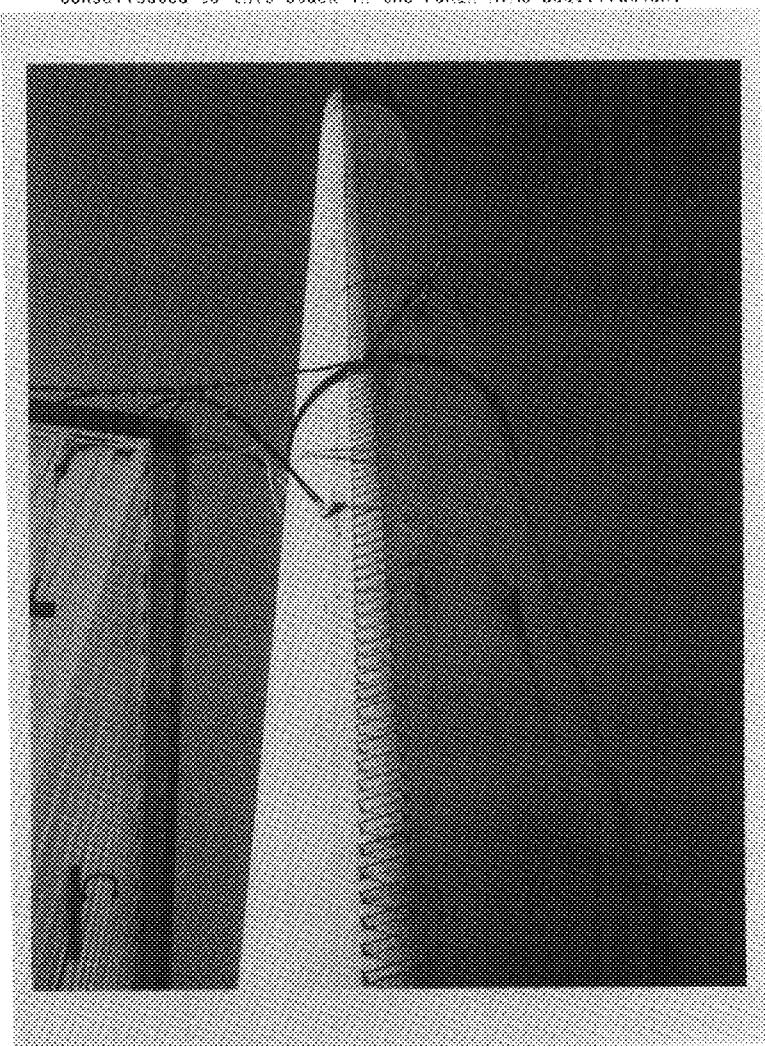
Deep bed filters 1 and 2 were designed to remove 99 percent of the radioactive particles from the exhaust ventilation air; tests in the 1990s showed them to be more than 99.93 percent efficient. The filters were 26 meters (85 feet) long by 16 meters (52 feet) wide and 4 meters (13 feet) deep. The air flowed sequentially through two glass filters. In filter 1, the first unit or prefilter consisted of a 2 meter (7-foot)-deep bed of "free packed" 115 K glass fiber; in filter 2 the first unit was 5 separate layers packed with different densities of glass fiber. The second unit, known as the cleanup filter, consisted of 132 American Air Filter<sup>i</sup>, deep bed filter units, each packed with 1.3 centimeters (0.5 inch) of AA fiberglass [19.2 kilograms per cubic meter (1.2 pounds per cubic foot) density] and 1.3 centimeters (0.5 inch) of B fiberglass [22.4 kilograms per cubic meter (1.4 pounds per cubic foot) density], each with a total area of 15 meters square (50 feet square). The design pressure drop was 5.1 centimeter (2.0 inches) water gauge at superficial velocities of 15 meters (50 feet) per minute through the prefilters and 6 meters (20 feet) per minute through the cleanup filters. The ventilation system included a bypass channel and provisions for the air duct to direct the air through either or both filter units. The air flowed downward through the prefilter bed in filter 1 and upward in the prefilter of filter 2. Air flowed upward through the cleanup filters in both filter units.

The 291-A stack filters, or Number 4 filter building, was designed to remove 99.95 percent of the radioactive particles from the exhaust ventilation air (Figure 39). The unit consisted of a filter building containing 10 filter assemblies arranged in parallel. The filter building is 35 meters (114 feet) long by 13 meters (42 feet) wide by 5 meters (17 feet) high. An inlet and outlet plenum were installed underground to provide air routing to the facility. The filter assemblies were installed across the two plenums. The

---

<sup>i</sup> American Air Filters are a trademark product of the SnyderGeneral Corp. of Dallas, TX.

Figure 39. Main PUREX Stack (291-A), 1987. All Air Emissions will be Consolidated to this Stack in the PUREX HVAC Deactivation.



filter assemblies consist of two banks (stages) of 12 HEPA filters arranged in a 3-filter wide by 4-filter high configuration. Each filter assembly was rated for 340 cubic meters (12,000 cubic feet) per minute air flow at 2.5 centimeters (1 inch) water gauge differential pressure drop. Each filter assembly could be valved out at the inlet and at the outlet. Each filter assembly had instrumentation to monitor the filter bank differential pressure, the first stage front face radiation level. The filter assembly flow rate was displayed on an instrument panel located in the facility supply blower room. Additional instrumentation indicated plenum differential pressure and air lock-to-filter room differential pressure. The facility was equipped with a supply fan that was exhausted through a single-stage HEPA filter assembly to the outlet plenum.

Air from the 202-A building had to pass through deep bed filters 1 and 2 in parallel. All air then passed through the 291-A stack or four filters before being released to the environment through the main stack.

Ventilation System 2 serviced the areas of the building that had a potential for contamination and were routinely occupied or entered by workers. Air was supplied to the Sample Gallery, the regulated shop, N-Cell, Q-Cell, R-Cell, U-Cell, the PR room, and the canyon lobby. These areas had six exhaust fans. Eleven distinct HEPA filter units refined the effluent air before release. Exhaust was continuously sampled and monitored for radionuclide content.

Ventilation System 3 serviced the areas with the lowest potential for contamination: the P&O Gallery, storage gallery, aqueous make-up areas, and the shop and office areas. A portion of the P&O gallery was ventilated through the East Crane Maintenance Platform (ECMP) and into the main canyon. The west end of the P&O Gallery was known as the White Room and had a potential for contamination from suck-back and line rupture. A separate ventilation system filtered the air from this area. This exhaust was continuously sampled and monitored for radionuclide content.

Ventilation System 4 serviced the PUREX Plant laboratory and was largely independent of the systems in the rest of the 202-A Building. This regulated area included the decontamination room, laboratory rooms, and the sample storage room. Exhaust air was discharged from the laboratory hoods and rooms through two local stacks. Two exhaust fans were provided. Exhaust air was monitored and sampled before discharge.<sup>141</sup>

After the decision to close the PUREX facility was announced, the most important HVAC deactivation issue was whether to attempt a static containment of the plant's contamination or to provide a low-level ventilation system. After numerous discussions it was determined that a low-flow-rate ventilation system would provide the greatest margin of safety. The 202-A Building was not designed as a containment structure, but relied on differential pressure zones to control the radionuclide content. The building contains numerous openings, pass-throughs, pipe chases, and expansion joints. To provide more than a temporary seal would represent a significant investment of manpower and resources. Early in predeactivation planning, the Red Team recommended a low-flow ventilation system.<sup>142</sup>

The chief HVAC deactivation task then became simplifying the existing ventilation system. It was determined that the work could be done by opening

ducts at key locations in the plant and allowing the air to flow from "clean" areas to areas with more potential for contamination. By using the rooms, hallways, and stairways in place of ducting, the friction losses of the system would be greatly reduced, allowing the amount of operating equipment to be reduced. The air in areas with no potential or extremely small potential of contamination could simply remain stagnant.

Plans were formulated to reduce the four separate ventilation systems to one cascaded flow system. The 11 effluent points of the PUREX plant would be reduced to 1 main exhaust stack. The number of miscellaneous artificial air movers would be greatly reduced. Of the 177 fans at PUREX, only the 3 main exhaust fans would continue to function. Of the 89 air filters, only 2 main exhaust filters would remain in service. The total air flow through the plant would be reduced from about 25,900 cubic meters (85,000 cubic feet) per minute to about 9100 cubic meters (30,000 cubic feet) minute. Engineering studies were performed to estimate the system's feasibility and performance.<sup>143</sup>

Engineering documentation was prepared for these modifications and a series of reviews was performed to validate the design. A value engineering review explored different options for the cascaded system. WHC nuclear safety groups approved the engineering documentation, and also performed a hazardous operations review and a safety analysis, checking potential failure modes and estimating theoretical releases. A study was performed to determine if the supply air to the plant after shutdown should be heated. Options for ventilating the PUREX railroad tunnel also were explored and reviewed by DOE. A private engineering firm evaluated the potential for air to leak into the building air under normal and high-wind conditions, with and without ventilation. Because the 202-A Building is so large and the HVAC issues so crucial, other consultants performed additional reviews as an overview of the whole PUREX utilities system (HVAC, electrical, and controls). Finally, the crafts workers performed facility walk-downs and job-scoping exercises for each task to ensure that the deactivation HVAC modifications were constructable and that they used workers efficiently.<sup>144</sup>

After identifying the required modifications to the systems, the tasks were divided into three groups: preswitchover, switchover, and shutdown. All the HVAC modification activities were scheduled to take place toward the end of the deactivation project, after the completion of other key activities had cleared the 202-A Building of nearly all other workers. Preswitchover activities included tasks that could be performed without having a major impact on the existing plant ventilation. These tasks included opening ducts at key locations, closing off the ventilation to U-Cell and R-Cell, and staging and preparing for major tasks to be performed later in the project. Preswitchover activities were completed in September 1996.

The Switchover activities modified and reconfigured the overall PUREX ventilation system to a cascade-flow system. Some flow paths were diverted or created; others were blanked. Each level inside the building had the flows rerouted, balanced, and stabilized to match the new flow scheme. Tasks in this effort included modifying air handlers, blanking N-Cell exhaust, and removing ducting elbows in the Hot Shop. Switchover activities were completed in February 1997.

Shutdown tasks adjusted the final configuration of the system. Flows within the building were reduced, the final main HEPA filters were configured, stacks were capped, and documentation was completed by April 1997.<sup>145</sup>

## LESSONS LEARNED

**Lesson No. 90.** Existing ventilation systems can be modified in many ways and many devices are available to help regulate them. At PUREX, as with the fuel removal equipment and procedures, the simplest methods were chosen because they were felt to be the most dependable. Systems requiring the least maintenance are best for long-term use in large facilities.

**Lesson No. 91.** In planning large deactivation activities, determine which outside resources have the necessary expertise and experience to validate the designs, then obtain their help in reviewing plans. Make sure that the most expert reviews are conducted as early in the process as possible.

## 8.11 PUREX ELECTRICAL/UTILITIES REVISIONS

During its operating years, the PUREX facility received electrical power from the Northwest Power Pool at a substation northwest of the plant. This substation was supplied by two 230 kilovolt overhead lines equipped with static wire protection. The 230 kilovolt load was reduced to 13.8 kilovolt by two transformers, with either transformer capable of carrying the entire load for limited periods. Two 13.8 kilovolt overhead lines supplied a PUREX Plant switching station. If one line was inoperative, the load was switched in the PUREX Plant by 2,400 volt switch gear. Other 13.8 kilovolt lines in the Hanford Site's 200 East Area could be switched to carry the PUREX load if needed. Also, 2,400 volt standby power was available.

Electrical power was distributed to PUREX from the switching station via two 13.8 kilovolt underground lines to two 3.75 million volt amperes, 13.8/2.4 kilovolt transformers at the northeast end of the 202-A PUREX canyon building. Each transformer could carry the total load for PUREX. Each transformer supplied power at 2,400 volts to one of the main buses. The two systems were interlocked so that a failure of one power supply activated circuit breakers connecting the two systems. The number 2 bus normally was tied to a standby (emergency) bus, and provided power through it to a few key loads. The standby bus was energized by diesel generators if the normal power supply was lost. Some equipment, such as the exhaust fans for the main ventilation system, were powered directly from the 2.4 kilovolt buses. Generally, lower power loads in the west (tail) half of the building were served through the west switch gear room. Power loads in the east half of the 202-A Building were served through the east switch gear room. Each 2.4 kilovolt bus supplied power to a 2,400/480 volt transformer at each switch gear room. Each transformer, in turn, energized a 480 volt bus. Each switch gear room had two 480 volt buses, energized by separate transformers, that could be interconnected if the power supply to one failed. Power was distributed to electrical components from the 480 volt system through motor control centers located throughout the building as close to the loads as possible.

Three 375 kilowatt diesel generators provided backup power to the PUREX Plant. About 20 percent of building lighting, all perimeter lighting, and the facility instrument power panels were connected to the backup power system. Other motors in ventilation and agitation service, totaling a connected load of 435 horsepower, also were supplied from the backup electrical system.

Personnel planning for the deactivation of the PUREX Plant realized early that it would not make sense to maintain the equipment to supply large power loads to the facility in its shutdown state. Minimal power would be needed for surveillance lighting, HVAC system fans, stack sampler systems, liquid level monitors, and the SAMS CON unit. Cost estimates and safety reviews were prepared for two basic scenarios. The first involved reconfiguring the old PUREX equipment and replacing parts that no longer met codes. The other involved installing a new (or mostly new) system. The second alternative was chosen for cost, safety, and schedule reasons.

It was decided to construct a new substation just south of the PUREX Plant. Locating the new substation close to the 202-A Building was especially important in saving money. The close proximity of the power source to the loads in the deactivation period reduced the necessary sizes of electrical cable and the length (amount) of cable required. (Much of the older cable would have had to be replaced anyway because it was worn and did not meet national electrical codes. Also, the old cable was routed through the PUREX building. This routing had to be changed to prevent impact to the fire hazards analysis of the building in its deactivated state.) Savings in cable costs alone were estimated at \$1.2 million by constructing the new substation.

Other advantages to constructing the new substation included the following:

- The time between maintenance periods for the new equipment also was considerably longer than for the older equipment.
- Working in a new electrical environment that had not yet been energized allowed construction and cable workers to work without the extra safety personnel and barriers that would have been required to refit the active system.
- Electrical work could be scheduled in parallel with other deactivation work instead of interrupting other work to lock and tag out older equipment during refits.

The new PUREX substation was modular, skid-mounted, and built by a subcontractor. It used solid state electrical equipment and 5 kilovolt vacuum breakers, and was equipped with its own fire detection and suppression system and HVAC system. Two 13.8 kilovolt/2,400 volt transformers were located adjacent to the 13.8 kilovolt overhead feeders, and new 2,400 volt lines were installed to the substation, including 2,400 volt switch gear, 2,400 volt/480 volt transformers, and 480 volt motor control centers. Also, new surveillance lighting, lighting panels, and transformers were installed throughout the PUREX facility. Power was turned on in the new PUREX substation in late February 1997.<sup>146</sup>

## LESSONS LEARNED

**Lesson No. 92.** Modifying obsolete equipment that must be reconfigured in deactivation projects often is not cost effective. Newer, modular equipment can offer savings in terms of greater reliability, longer times between maintenance periods, ease of access, and adherence to modern codes. Also, installing new equipment keeps construction workers out of the way of deactivation workers, preventing costly schedule interruptions.

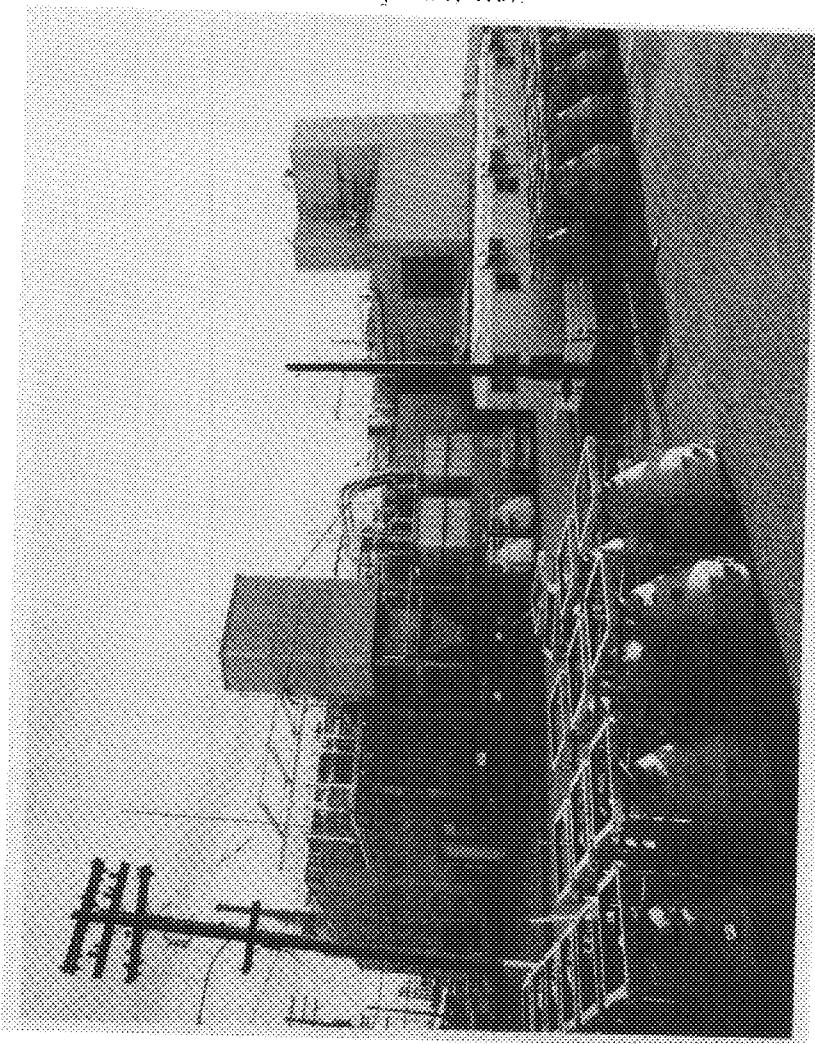
9.0  $\text{UO}_3$  DEACTIVATION

From April to June 1993, a stabilization run was conducted at the  $\text{UO}_3$  Plant to convert 757,080 liters (200,000 gallons) of UNH liquid to  $\text{UO}_3$  powder. At the same time deactivation planning was under way. The initial deactivation plan, completed in July 1993, enunciated the following objectives for the  $\text{UO}_3$  project: reduce the level of support needed to maintain and monitor the plant in a safe shutdown condition, define and meet D&D acceptance criteria, terminate effluents, shut off electrical power at the main transformer, remove PCB-contaminated transformer oil, connect to a new power source, disconnect steam and water lines outside the building, and shut down all active ventilation so that personnel would enter the facility only quarterly for maintenance.<sup>147</sup>

The initial deactivation plan proposed a three-phase project. Phase I was to include removing residual process materials; cleanout, flushing, and deactivating most process instrumentation and equipment (including the calciners themselves); stabilizing and pumping out plant liquid systems; isolating unnecessary steam and water lines; and removing most spare parts, furniture, tools, and other equipment and supplies. Phase II was to include decontaminating and/or covering outside surface contamination areas so that storm water processing no longer would be needed. This would eliminate the continual generation of liquid effluents that might need treatment and the need for most S&M checks at the facility. Then, the remaining equipment that processed storm water was to be deactivated. Phase III was to address "all remaining activities that must be completed before the facility is turned over to the Surplus Facilities Program, now the Environmental Restoration Contractor (ERC). The work of Phase III was to encompass deactivating and isolating all remaining utilities, deactivating the HVAC and fire protection systems, sealing building penetrations, dealing with a contaminated roof, stabilizing the 211-U chemical storage tanks associated with the  $\text{UO}_3$  Plant, cleaning out the 272-U Shop Building, shipping stored  $\text{UO}_3$  powder to the Oak Ridge Site (Figure 40), and removing any remaining flammable or hazardous materials and miscellaneous items.<sup>148</sup>

As the  $\text{UO}_3$  deactivation project went forward, however, opportunities arose for consolidating work. Some work was performed out of the planned sequence and Phases II and III of the deactivation project were combined. Shortly after the stabilization run was completed, 4 tons of depleted  $\text{UO}_3$  powder stored in drums were shipped to the Oak Ridge Site. At the same time, transfers of recovered nitric acid to PUREX began. Approximately 378,540 liters (100,000 gallons) were sent to PUREX in 33 tank truck shipments. While the nitric acid was being transferred,  $\text{UO}_3$  Plant liquid systems were flushed. The goal was to flush until the pH of the flush solution was between the regulatory threshold limits of 2.0 and 12.5. The plant liquid systems included the UNH receiving and concentration systems (tanks C-1, X-1, X-2, X-30, concentrators ED-2, ED-6, and ED-7, along with all associated pumps and piping), the nitric acid and wet scrubber system (the TA-3 acid tower, tank C-6 acid cooler, storage tanks C-3 and C-4, the wet scrubbers, and all associated pumps and piping), and miscellaneous tanks and equipment (tanks X-38, X-19, X-20, and associated pumps and piping, the plant's two UNH trucks, and three nitric acid tank cars). The 211-U chemical storage tanks that were associated with the  $\text{UO}_3$  Plant also were flushed and stabilized.

Figure 40. T-Hoppers Holding Uranium Trioxide Powder, Outside the  $UO_3$  Plant, 1984.



As soon as the flushings were complete, about 37,854 liters (10,000 gallons) of flush solutions measuring more than 1 molar nitric acid were shipped to PUREX, along with small amounts of UNH concentrated from tank flushes. The UNH tank truck heels then were removed at PUREX, and the nitric acid tank car heels were sent to PUREX for removal in late 1994. Additional steps taken in Phase I of the  $UO_3$  Plant cleanout included removing the tops of the calciners and vacuuming out the  $UO_3$  powder. Also, powder was removed from the powder handling system and bag filters, the U-2 exhaust system was disconnected, and the  $UO_3$  Facility instruments were deactivated. Phase I of the deactivation project was completed in early March 1994, two weeks ahead of the RL milestone date of March 16.<sup>149</sup>

One of the crucial  $UO_3$  Deactivation Phase II projects was to discontinue discharges of low-level contaminated effluents to the 216-U-17 crib and the 216-U-14 ditch. Almost all such effluents resulted from the runoff of storm water over contaminated roofs, piping, and other outdoor surfaces at the facility. In the system that had been used since the mid-1980s, such storm water was collected in sumps and tank enclosures at the back of the 224-U Building (sumps 203-U and 203-UX), and in sumps located in a concrete pad between the 224-U, 224-UA, and 272-U Buildings. The sumps drained to collection tank C-7, then were sent to tank C-2 for concentration. Condensate from the off-gases was collected and stored in tank X-37 until ready for disposal. The tank C-2 condensate was neutralized with potassium hydroxide and a small amount of phosphoric acid to stabilize the pH in tank C-5, then sent to the 216-U-17 crib. Some uncontaminated storm water, along with the discharged cooling water resulting from Tank C-2 operations, drained to the 216-U-14 ditch via the 207-U basins. From the 207-U basins, this material was sent to the 216-U-14 ditch for ground percolation.

When the  $UO_3$  deactivation project began,  $UO_3$  Plant work planners did not know whether they would place protective coverings over the contaminated outdoor surfaces, reroof the facility, or decontaminate the surfaces. To evaluate the decontamination option, they had to negotiate acceptable levels of contamination reduction with the Hanford Site's regulators. A new approach was devised in meetings between the contractor and DOE representatives and regulatory agencies. They agreed that if outside surfaces could be decontaminated to the point that not more than 5 to 50 grams of uranium per year would enter the 207-U basins via runoff from the  $UO_3$  Plant, reroofing and protective outside coverings would not be needed. The 207-U basins had been lined with high-density polyethylene in December 1992 and could be used to evaporate relatively clean runoff. Independent DOH sampling of ambient air 100 yards from these basins would verify compliance with the requirements. To implement the agreement, decontamination was undertaken at  $UO_3$  with water, scrub brushes, and a mobile pressure sprayer attached to a HEPA filter. No chemical decontaminating agents were used. Then, the sump collection system at the facility was diverted to the 207-U basins (not tanks C-7, C-2, and C-5), and the lines between the 207-U basins and the 216-U-14 ditch were blanked. The tie-ins were completed on September 22, 1994, beating an RL milestone date.<sup>150</sup>

Further work done in the  $UO_3$  Plant deactivation project in FY 1994 included stabilizing the asbestos in rooms housing old calciner pots and the old powder handling tower, cleaning out both the "hot" (radioactive) and cold portions of the 272-U shop, applying a new roof coating to the 272-U shop and the 224-U facility, disconnecting remaining utilities and power sources to the

$\text{UO}_3$  Plant buildings, and installing an independent power source for the new surveillance lights for 224-UA (Figure 41). A great deal of time also was spent removing small objects, furniture, contaminated tools, and other miscellaneous materials from the facility and documenting the plant's legacy equipment for turnover to the D&D program.<sup>151</sup>

In defining its end point criteria, the  $\text{UO}_3$  Plant took a series of precedent-setting steps that extended the concepts initially defined in the PUREX Deactivation End Point Value Engineering Study of February 1994 (see Section 4.2). The  $\text{UO}_3$  Plant deactivation end point planning became the Hanford Site's first real test and application of the new methodology (see Section 4.4). Once the deactivation and D&D organizations agreed on which activities would be performed in the  $\text{UO}_3$  Plant deactivation, the matrices and their agreed results were compiled into the  $\text{UO}_3$  End Point Criteria Document, a signature book. The 1,740 end points (signed by deactivation contractor personnel) and verification (signed by D&D contractor personnel) were completed in January 1995. Only one issue remained-disposing of some very old depleted  $\text{UO}_3$  powder (about 0.2 percent uranium-235) and some enriched (about 0.9 percent uranium-235) powder from the 1993  $\text{UO}_3$  stabilization campaign. The depleted material was stored in steel drums and the enriched material was stored in containers called T-hoppers in the 2714-U Building in the  $\text{UO}_3$  Plant complex. The depleted powder was buried in its containers as low-level waste in early 1996; the enriched powder (along with 14 more drums from BNFL) will later be moved to another storage location. Meanwhile, in a special ceremony in February 1995, the  $\text{UO}_3$  facility was turned over to the D&D organization (Figure 42).<sup>152</sup>

After facility turnover, one additional  $\text{UO}_3$  issue emerged to provide a lesson for the PUREX Plant. During the winter of 1995-96, the Hanford Site experienced severe freezing weather that caused some freeze damage in piping at the  $\text{UO}_3$  Plant. When the weather warmed, puddles of water from the damaged pipes melted into the plant. The damaged pipes could not be drained via gravity, or in some cases, could not be reached at all without dismantling other large sections of pipe. When the DNFSB (an inspector agency of Congress) was informed of the leaks, its concern was not for the  $\text{UO}_3$  Plant, where contamination levels are low, but for similar situations that might happen in the future at the more highly contaminated PUREX Plant. As a result, PUREX pipes were inspected for locations that might not be subject to gravity drain. A commercial vendor "hot tap" product (used to connect into pipes while they are pressurized) was used to drain certain PUREX pipes without dismantling them. This solution was very cost effective because it was used in 11 places to drain small amounts of liquid without having to dismantle large pipes. The resultant savings amounted to approximately two work days per tap.

## LESSONS LEARNED

**Lesson No. 93.** At  $\text{UO}_3$ , the final flushes of the process vessels were included as part of the stabilization run activities. Because these flushes were considered part of operations, no RCRA permits were needed for the flush material and the RCRA 90-day clock for the  $\text{UO}_3$  Facility did not start ticking until the final flushes were completed. By that time, almost all hazardous materials that might have been considered waste under a different timing

Figure 41. Worker Cleaning Calciner as Part of UO<sub>3</sub> Plant Deactivation, 1994.

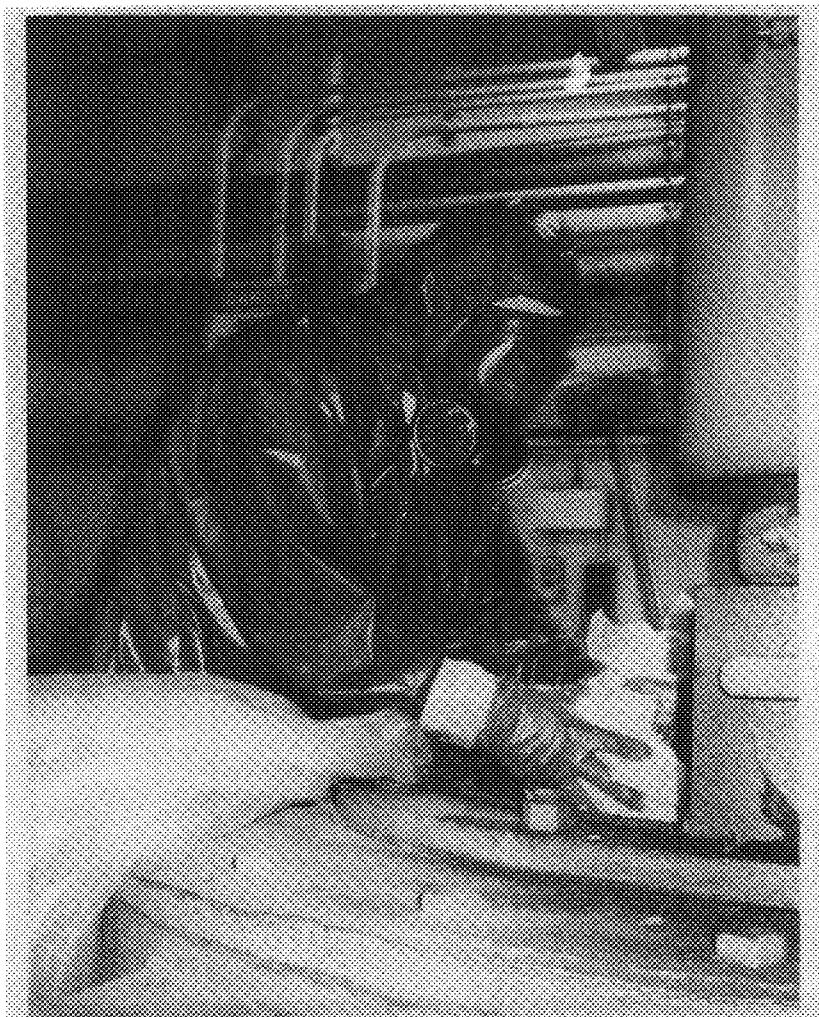
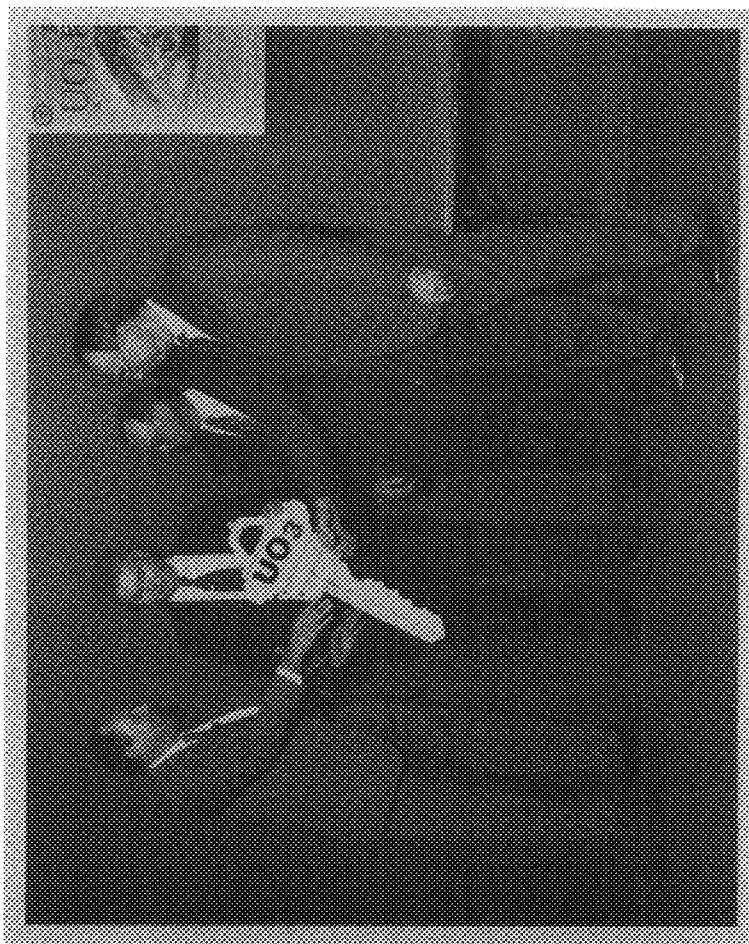


Figure 42. Officials Gather to Transfer UD<sub>2</sub> Plant from the DOE's Deactivation Organization to the D&D Organization  
(Thomas Grumbly holds key).



structure had been removed from the plant. Other facilities should consider writing vessel and equipment flushes and other ancillary activities into their stabilization run plans.

**Lesson No. 94.** Issues such as which groups will perform deactivation work tasks must be worked out globally at the start of a project. For example, the issue of which tasks constitute plant "modifications" can have legal (Davis-Bacon Act) and labor ramifications, and can slow or stop a deactivation project.

**Lesson No. 95.** The disposition of small equipment, tools, furniture, and other miscellaneous supplies and items might be viewed as a private business opportunity as facilities deactivate across the DOE complex. Facility management considered the amount of time spent on such disposition disproportionately large and these activities had to compete with other deactivation tasks for the time of facility personnel. If such activities were privatized, more productive uses might be found for some of the equipment and waste burials might be minimized.

**Lesson No. 96.** When a facility is in the final stages of deactivation, high priorities are assigned to final close-out items. However, other organizations and facilities are not in the rush mode, and may not assign as high a priority to their interfaces and correspondence, sign-offs, etc. as the deactivating facility facing final deadlines. Leaving time for other organizations to work at their usual pace or on their usual cycles is important.

**Lesson No. 97.** Many final deactivation end points mandate posting signs at various places around facilities. Make a "signs map" ahead of time, make sure that all signs are physically prepared and accounted for on the map well before the deadlines.

**Lesson No. 98.** The hot-tap method of sealing pipes that are inaccessible or configured so that they cannot be drained by gravity is a cost-effective way to ensure that contamination will not migrate from the pipes over time in deactivated facilities. Deactivating facilities should be inspected for such piping situations and hot-tap drained before deactivation is complete.

## 10.0 STAKEHOLDER INVOLVEMENT

The PUREX/UO<sub>3</sub> deactivation project recognized very early that stakeholder involvement would be crucial to its success. Following DOE guidelines, the public involvement strategy was to involve DOE and contractor personnel (with employees viewed as key stakeholders), legislated authority structures such as state and federal regulators, the DNFSB, public advocates, advisory groups, Indian nations, and the general public. Any group affected by or able to affect the PUREX/UO<sub>3</sub> deactivation project was considered a stakeholder. A key goal of the stakeholder involvement plan was to include stakeholders from early in the concept stage through the implementation phases.

Stakeholder involvement activities first established a common information base from which interested parties could learn about the PUREX and UO<sub>3</sub> plants, including their history and past missions, current status, condition, and needs. Project management recognized that stakeholders needed to be informed about key decision points and alternatives, including constraints, costs, and timetables. They also needed to be given a chance to define their values and provide feedback about how the project and its alternatives would affect those values. The facilitation of information transfer between stakeholders and project managers was deemed to be essential.<sup>153</sup> Also, providing progress reports was considered important.

To begin their own public involvement learning process, PUREX/UO<sub>3</sub> deactivation managers and work planners attended a workshop in April 1993. At the same time, a historical report on the facilities was begun. For this document, more than 300 formerly classified documents on plant operations were declassified and incorporated. A smaller brochure on the facilities and their major deactivation issues also was written and distributed through the public mailing lists associated with the Tri-Party Agreement. In the winter of 1993-1994, a 4-page fact sheet on the project was prepared and distributed to more than 1,000 stakeholders. At the same time, the original draft Project Management Plan was mailed to a shorter list of interest groups involved with the Hanford Advisory Board (HAB), a regional consortium organized by RL to provide input on key Hanford Site decisions. This mailing was followed up by phone calls by PUREX/UO<sub>3</sub> managers to HAB members to solicit comments; the comments that were received were incorporated into the final PMP issued in August 1994.

In December 1993, Ecology took the initiative to host a meeting with PUREX personnel and other interested parties to discuss deactivation issues. A series of PUREX facility tours was conducted for members of the new HAB in January and February of 1994. After the HAB began its regular monthly meetings, PUREX managers worked through the designated HAB staff personnel to maintain open communication and to supply any documentation or presentations that the HAB requested. In May 1994, PUREX/UO<sub>3</sub> managers traveled to Seattle to present information and answer questions about the deactivation project at a premeeting of the HAB. PUREX managers also participated in similar meeting held in Richland in October 1994.

Beginning in March 1994, other face-to-face meetings took place between PUREX/UO<sub>3</sub> personnel and interested stakeholders when managers traveled to the offices of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR).

CTUIR representatives visited the PUREX Plant in July and September. In July, they met with a small group of PUREX personnel to explain their stake in the Hanford Site and how their values could be affected by deactivation activities. They also inspected the shipping containers that would be used to transport contaminated nitric acid to BNFL. On the September visit, the CTUIR Hanford Site Projects manager was the featured speaker at a PUREX/UO<sub>3</sub> all-employee meeting and praised facility tribal involvement as "a model for the rest of the Hanford Site...They have bent over backwards to incorporate our concerns into their transportation plans" (Figures 43 and 44). In July, PUREX personnel traveled to Pendleton, Oregon to meet with the Transport Committee of the Oregon Hanford Waste Board. Several subsequent meetings were held with this group, as well as myriad other groups during the remainder of the deactivation project. Among these groups were audiences at annual Waste Management, Environmental Remediation, Spectrum, and other conferences and the Hanford Natural Resources Trustee Council.<sup>154</sup>

Near the end of FY 1994, PUREX personnel began their most extensive public involvement activity, planning a far-flung series of public mailings and meetings with interested groups in states and Indian reservations across the nation, along the route that the contaminated nitric acid would follow on its way to England. Secretary of Energy O'Leary decreed in September that she would authorize the shipments, totalling approximately 726,000 liters (205,000 gallons), if certain conditions were met to satisfy expressed public concerns. (See Section 8.4.) The EA on the shipment was the primary vehicle for public comment, but PUREX officials went further and drew up a map of the entire route. They contacted every state and local government along that route, as well as the Umatilla Indian reservation, offering to present facts on the shipment plans. Because the 50 separate shipments would travel nearly 4,000 overland miles in the United States and pass through 12 states, obtaining the cooperation and buy-in of everyone along the way was considered essential. PUREX personnel held public meetings in the three cities being considered as ports of departure (Baltimore, Maryland; Newark, New Jersey; and Portsmouth, Virginia). The draft EA was sent to more than 200 states, Indian nations, and individuals, and more than 50 requests for more information were received. Approval of the EA and transportation plan allowed the shipments to take place from May through November 1995. During the shipping period, weekly conference calls were held between DOE and emergency response and public health organizations in every corridor state to report progress and discuss any questions or concerns.<sup>155</sup>

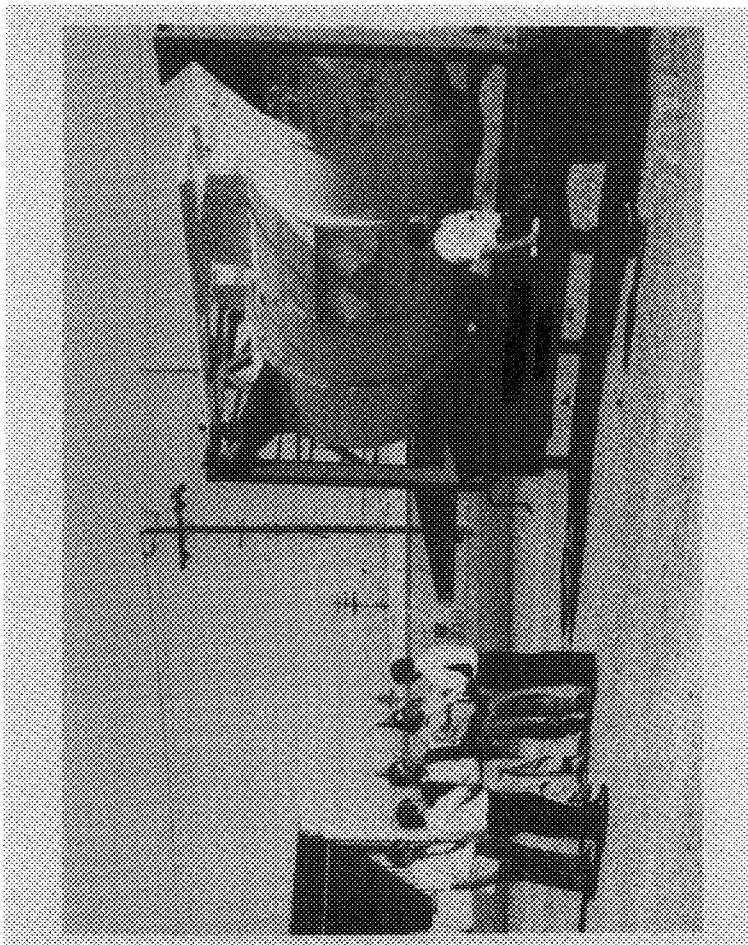
## LESSONS LEARNED

**Lesson No. 99.** Public and tribal involvement is essential to the success of major deactivation projects. Such involvement should be started early, and should include initial efforts to assemble and distribute documents that allow nontechnical people to understand the history, operations, and condition of large, complex facilities. Providing such documents can save plant personnel considerable time that might otherwise be spent answering repetitive questions. Communication also can prevent a domino effect of misunderstandings about the deactivation, based on basic misunderstandings of plant functions, layout, history, chemical and radiological inventory, and many other topics. Plant tours are important to help stakeholders understand the scope of the physical plant, the deactivation project, and the work being performed.

Figure 43. J. R. Wilkinson, Hanford Programs Manager for the  
Confederated Tribes of the Umatilla Indian Reservation,  
speaks at PUREX All-Employee Meeting, 1994.



Figure 44. Representatives of the Confederated Tribes of the Umatilla Indian Reservation Inspect Nitric Acid Transport Container at PUREX Facility, 1994.



**Lesson No. 100.** Once the common information base is established (the first phase of public involvement), the process should become a dialogue. Two-way, iterative communication is essential. Plant personnel must truly listen to the values, motivations, and concerns of stakeholders, and must be willing to change their ideas based on the input of others. The era of unilateral federal decisions clearly is over and leadership in the new era means flexibility and trust. Compromises can be reached and obtaining the buy-in of regional stakeholders can ensure the long-term success of deactivation projects and other DOE missions.

**Lesson No. 101.** Communication with facility employees (a key stakeholder group) is essential, especially considering that employees of a successful deactivation project literally work themselves out of their jobs. They must be kept apprised of project goals and their roles in achieving these goals, and they must be given guidance on how and where their skills can be applied after deactivation.

**Lesson No. 102.** Stakeholder involvement includes many external review groups that have an interest in various aspects of a complex, prototypical facility such as the PUREX Plant. During 1993 and 1994, the PUREX Facility was subject to a spent fuel vulnerability assessment, a chemical vulnerability assessment, and a plutonium vulnerability assessment and reviews by the NNSB, the General Accounting Office, and DOE Headquarters special safety teams. It also experienced a vast increase in requests for tours and media information associated with its being a deactivation project model. Supporting all these requests for information must be factored into deactivation project costs and personnel needs. One innovative cost-saving method adopted at PUREX and available to other plants is preparing video tours and information packages that can be duplicated and used many times.

**Lesson No. 103.** Communication and dialogue take many forms. Some groups, such as some Native Americans, prefer verbal to written communication. Flexibility and variety of format must be used to reach all stakeholders.

**Lesson No. 104.** The biggest potential physical hazards in a deactivation project may not attract the most public comment and interest. At PUREX, the shipment of irradiated fuel rods to the 105-K West Basins generated much less public interest than the nitric acid shipment to England, yet the radionuclide inventory and hazardous nature of the spent fuel was much greater. The public will tell the facility managers what its interests are and managers must listen and heed the public's perceptions.

## 11.0 LESSONS CONSOLIDATED

**Lesson No. 1.** Finding an alternate use for a material is better than disposing of it as waste, even if the alternative use brings little or no income. Designating a material as waste means long-term regulatory control and generates costs associated with disposal, regulatory surveillance, and paperwork.

**Lesson No. 2.** Creativity and forethought can be employed even during periods when clear direction is lacking and mission flexibility needs to be preserved. During such times, some steps can be taken to temporarily deactivate portions of a large facility and bring down costs. Those who know the plant most intimately can best brainstorm the specific ways to implement cost-saving steps.

**Lesson No. 3.** The early involvement of an independent technical team to review a major deactivation operation and make overview recommendations allows the operation to be viewed by those with commercial experience and by those not directly tied to or constrained by the day-to-day concerns of facility operations and management. It also provides a challenge to the facility staff to think of the deactivation project in different terms. In developing broad concepts, the value of independent oversight is immeasurable.

**Lesson No. 4.** The advice of an independent review team such as the Red Team in attempting to scope and define specific work tasks and pathways within a large deactivation project is less helpful than the broad overview perspective brought by such a team. Washington State regulators, regional trustees, and stakeholders, and the constraints imposed by the needs and requirements of other divisions on the Hanford Site actually shaped the PUREX Deactivation Project. As the project progressed, the ongoing advice of ITEs that stayed with the work in a follow-on capacity helped define specific activities.

**Lesson No. 5.** The time that elapsed during the PUREX Plant's Standby period created additional work because some instruments and equipment deteriorated. To prepare for the deactivation, significant work was needed to recalibrate and upgrade instruments and machinery. As much forewarning as possible should be given to facilities as shutdown approaches. Such warning allow the facility engineers and work planners to begin preparing for deactivation work in a timely and efficient manner.

**Lesson No. 6.** The reengineering concept, with all of its non-traditional business practices, can be a valuable tool in bringing down costs and streamlining work at deactivating facilities. Generally, even though such facilities may have already reorganized from their operating configuration into a deactivation project, they can benefit from a thorough reengineering overhaul. Reengineering focuses people to specific, personal, achievable goals, thus tapping their maximum energies.

**Lesson No. 7.** The timing for reengineering is nearly perfect. While Congress calls for budget cuts in DOE facilities with no known future missions, environmental and other laws and imperatives require safe shutdown. Reengineering can bring cost-effective closeout to old facilities. It also can help empower and better prepare the frightened work force at many older DOE facilities, thus improving reemployability of these loyal employees.

**Lesson No. 8.** While reengineering can help virtually all large organizations, it should be introduced first at facilities that are already doing well and that are staffed by enthusiastic, positive leaders and employees.

**Lesson No. 9.** When reengineering is undertaken, an organization, a facility, or a DOE Site must plunge into it completely and support change at all levels.

**Lesson No. 10.** Reengineering breaks internal organizational barriers and motivates workers based on ownership and the knowledge that their own performance on teams will be recognized. The knowledge that the best performing teams may be the first to be hired or recommended for new positions offers a powerful incentive to people to work themselves out of their jobs.

**Lesson No. 11.** Organizational culture, fed by management systems, values, and rules both modeled and expressed, is often deeply entrenched and conservative at older DOE Sites. (The same may be true of many older industries and Department of Defense sites.) This culture, which valued secrecy, loyalty, and a zero-risk mentality, must be recognized and the commitment to change underscored boldly at all levels of management, if reengineering is to succeed. Moves toward a self-directed work force must be encouraged by management, and must never be viewed as disloyal.

**Lesson No. 12.** Involving people who have worked at a facility or in an organization for a long time is essential if the true nature of the work and needs of the facility are to be understood. When newer, less intimately involved persons try to define essential work needs in a facility, they usually can develop only general statements. For the detailed work analysis necessary to structure teams to succeed, long-time workers must be involved.

**Lesson No. 13.** When external teams arrive at a facility to begin reengineering, they must be careful not to shove ideas at the facility workers, and they must communicate and make themselves regularly accessible to the facility workers. Opportunities for workers to talk with external teams must be structured so that the workers are not intimidated. Team members should go individually to facility lunchrooms and other gathering spots, both formally and dropping in, and allow workers to ask questions. Announcing that the team has an open-door policy may not make employees comfortable enough to approach the team.

**Lesson No. 14.** If teams lack critical resources, they will not succeed. At the same time, it makes sense for specialists such as safety and regulatory experts to serve all teams equally, and not be assigned permanently to an individual team.

**Lesson No. 15.** Team leaders need skills in judgment, initiative, leadership, team-building, decision-making, and customer-focus in addition to their technical skills. Also, individual workers can use the job reapplication process to display personal skills that may have been unrecognized before.

**Lesson No. 16.** A reengineered, team environment offers fewer absolute opportunities to climb an organizational ladder. Therefore, salaries must be placed in "broad bands" to allow individuals to proceed at their own paces up a merit-based continuum.

**Lesson No. 17.** A facility such as the PUREX People Center benefits a deactivation project greatly because it opens up communication, quells rumors, and helps dispel discontent and fear by giving workers early and ongoing access to HR resources. The emotional reaction of fear of change is powerful. A People Center *located in* the facility and staffed full-time on a rotational basis allows people to talk and seek resources and information when they feel the need.

**Lesson No. 18.** People working themselves out of a job should be given access to information about future jobs long before their own jobs end. Otherwise, fear of unemployment may drive them away from the deactivating facility before they can accomplish the deactivation work.

**Lesson No. 19.** Different people respond best to different forms of communication. Facilities should use all avenues of communication, including written, graphic, and verbal.

**Lesson No. 20.** A charter, stating basic purpose, identity, and reason for being should be written by each team soon after its formation. A charter sets the tone for the "new world" of the reengineered facility.

**Lesson No. 21.** After a team begins to struggle with actual work problems, ongoing training is important. Training in specific skills such as problem-solving, communication, etc., should not begin immediately after team formation. If such training is mandated too soon, team members do not appreciate and even resist much of what is offered.

**Lesson No. 22.** Teams have five distinct stages of development: start-up, state of confusion, leader-centered, tightly formed, and self-directed. These stages must be recognized by management and organizational development personnel who facilitate the reengineering process. If these stages are not recognized as normal, facility leadership may think that reengineering has failed.

**Lesson No. 23.** Once a team is formed, it must be given cradle-to-grave responsibility for its work products. If control is taken away from the team, it may stop feeling responsible for the work and the reengineering experiment may fail.

**Lesson No. 24.** Teams must be physically colocated to bond and feel jointly responsible for work.

**Lesson No. 25.** Reengineering brings nonproductivity and egotism to light. Hiding such patterns is impossible in a reengineered structure. Surprises may await managers and coworkers when some employees reveal these attributes that make them less than cooperative.

**Lesson No. 26.** Reengineering is not a one-time activity; it is a way of thinking. Some problems will never be solved in a facility, and some may take long, slow, patient action to uncover and remedy. After reengineering, management and workers must remain vigilant for ways to smooth and improve. Reengineering is a neverending process.

**Lesson No. 27.** Teams should not be too large. A team of more than 20 people will have trouble focusing its discussions and reaching decisions.

**Lesson No. 28.** Not every job function or set of workers should be brought together in a team. Teams must have common goals to function. Workers in administrative support functions, facility support, and technical support, by the nature of their tasks, will not share the same goals. These workers should continue to be managed as groups.

**Lesson No. 29.** All key reengineering decisions in a deactivation project must be driven by the project's end points. If the end points are not in place, teams may be organized in ways that are less than optimal, budgeting and scheduling will not be efficient, and the project will flounder.

**Lesson No. 30.** One or two redeployment officers should be appointed in a deactivation project several months before the end of the project. As workscope begins to diminish visibly, people will become anxious about their job futures and may not perform optimally. However, the presence of dedicated redeployment officers working in their behalf relieves much of this anxiety and allows employees to focus on their work. Management and corporate support for redeployment efforts is essential.

**Lesson No. 31.** A short, high-level project plan prepared as a policy document would be a better tool for setting an overall deactivation strategy than a deactivation project management plan. Subplans dealing with various issues such as regulatory compliance, safety strategy, stakeholder involvement, etc., then could be issued as supporting or ancillary documents. This would allow each document to be revised and implemented quickly without waiting for total consensus on all aspects of the project.

**Lesson No. 32.** A deactivation project management plan should focus primarily on the baseline, baseline control, reporting, management, and summary sections. The project control system is crucial and should be consistent with project management methods rather than with operating methods.

**Lesson No. 33.** End point criteria *must* be developed at the start of a deactivation project so that they can be available as tools to set work priorities the work throughout the project. Much money, time, and effort will be saved if "right-to-left" (end-to-beginning) thinking is practiced. End point criteria should have been in place before PUREX schedules were developed and before other work planning went forward. End point criteria and end points must be set as a *first* priority in a deactivation project. They guide every aspect of the work, the budgeting, and the facility's organization.

**Lesson No. 34.** Because many years often pass or can be expected to pass between deactivation and ultimate D&D of major DOE facilities, the exact needs, methods, and end states of D&D in the 21st century cannot be anticipated. Therefore, developing a functional matrix-based approach to deciding which deactivation tasks add value to a project is better than establishing vague end point criteria. Such an approach must have joint participation and concurrence between the deactivation and D&D organizations.

**Lesson No. 35.** The sophisticated and interwoven objectives, fundamental tasks, levels, cases, and matrices developed in the PUREX and UO<sub>3</sub> Deactivation end point criteria compel all parties to take a justifiable, accountable look at why each task is done. Each task must have value to pass this test and be approved and executed. This approach results in cost savings and enhanced safety for deactivation workers because it eliminates some unnecessary tasks.

Another advantage of this method is its inherent ability to build consensus between the deactivation and D&D organizations and avoid costly disagreements at the time of facility turnover and beyond.

**Lesson No. 36.** End point specifications should state what work must be done (in specific terms), but not how it should be done. The "how" aspect should be written into work plans that follow closely on the end points.

**Lesson No. 37.** End points should be specifically written to ensure that visual verification is possible and can be agreed on easily by the deactivation and D&D organizations. If end points are not specific, agree ahead of time on the verification methods and standards. For example, visually verifying an end point that states "Resolve Serious Threats" or "Seal" is difficult. The criteria that constitute sufficient compliance need to be quantifiable and agreed on ahead of time.

**Lesson No. 38.** "Not applicable" can never close an end point. If an action truly is not applicable, it should not be an end point.

**Lesson No. 39.** Plans for post-deactivation S&M should be written before or along with end points so that S&M activities can be factored into end point development.

**Lesson No. 40.** Negotiated agreements and/or special requirements resulting from regulatory drivers or stakeholder interests need to be known and factored into end point planning. If specific commitments have been made for the facility or for or by the deactivation or D&D organizations, these need to be identified ahead of time.

**Lesson No. 41.** While engineering and technical end points can be closed with precision by facility personnel, administrative end points can be surprisingly burdensome. Administrative close-out requires foresight and planning, and should not be left until most of the personnel have left a facility. Attending to the details of closing out a large complex of buildings and leaving an understandable set of procedures and instructions for future personnel constitute a huge endeavor.

**Lesson No. 42.** The reasons for selecting each end point should be written up at the time the agreements are reached and should be made a part of the permanent deactivation project records.

**Lesson No. 43.** While the practice of generating fully developed, integrated, resource-loaded schedules is time consuming, it saves money for a large project in the long run. The cost and effort of producing the schedules are vastly surpassed by the savings that result from focusing the work and avoiding the work delays and duplication that would occur without such schedules.

**Lesson No. 44.** Organizations within old facilities and DOE sites often have strong emotional ties and commitments to these facilities. Also, the intimate familiarity of such persons with the facilities is invaluable in producing realistic estimates of how work must and will occur, given facility configurations and physical quirks. Such persons often need additional skill training in areas such as scheduling, but they are willing to learn new skills to stay with the facilities throughout deactivation. Their loyalty produces a

strong work ethic and is valuable to the project. Keeping the operating employees with the deactivation project also provides these employees with enhanced skills that can lead to better career opportunities after the deactivating facility closes.

**Lesson No. 45.** The specialized expertise of state-of-the-art firms using complex software definitely is needed in scheduling huge deactivation projects. Using schedules that are current, tied to costs, and readily adaptable to scope and budget changes and rebaselining efforts is so crucial to project success that it must be directed by experts.

**Lesson No. 46.** Because S&M tasks consume much of a facility's budget during the early years of a deactivation project, detailed scheduling attention should be given to these tasks. As requirements for S&M tasks decrease over the life of a deactivation project, this reduction of requirements must be reflected in the schedule.

**Lesson No. 47.** Schedules for large and complex deactivation projects need to be easy to change. They need to be "living" schedules because no person or collection of persons, however knowledgeable, can anticipate all the changes that will occur over the life of the project. Also, the schedule needs to recognize and incorporate the impacts of special tasks (such as responding to audits, providing special tours, etc.) that pull people away from their regular jobs.

**Lesson No. 48.** The software package chosen for a large deactivation project should be evaluated carefully before it is adopted. The sheer size and complexity of integrated, resource-loaded schedules that guide thousands of tasks demands software of huge capacity and flexibility. A change in software during a project can be disruptive, even if the new software has technical advantages. Such changes should be made only if the technical advantages are overwhelming.

**Lesson No. 49.** Winter weather must be considered when schedules are created. Some field work tasks cannot close during winter months, final punch list schedules can be used to capture tasks that spill over.

**Lesson No. 50.** DOE and its contractors need to understand the regulatory ramifications of shutdown orders on facilities, and work to minimize the impacts of unexpected changes in direction. Planning and communications between the DOE and its contractors should occur so that facility preparations for the consolidation and disposition of hazardous materials can begin before formal closure orders arrive. The PUREX Facility had a number of substances for which no RCRA permits existed after the operational/standby status of the facility changed. Also, NEPA documentation could have been prepared as part of and supporting the deactivation decision.

**Lesson No. 51.** Involving and informing regulators early in any regulatory process or negotiation is essential. A cooperative spirit is established by such actions, and joint efforts then can be directed at solutions rather than confrontational or penalty-based actions. The regulatory dilemmas inherent in the PUREX deactivation project and the first of this kind. Early and open communication with regulators was crucial to finding acceptable solutions to these dilemmas. Such communication should occur through every stage of the deactivation project.

**Lesson No. 52.** Regulatory issues and needs must be communicated by contractor and DOE experts to all the managers, engineers, and work planners at a facility. Just as the plant operating personnel understanding the methods and needs of the scheduling professionals contributed to better schedules, facility operators understanding regulatory requirements will (and did at PUREX) help ensure that regulatory mistakes and violations are avoided.

**Lesson No. 53.** For facilities in states that have negotiated special agreements (the Hanford Site's Tri-Party Agreement) with state and federal regulators such agreements can be used to break regulatory impasses that might be encountered under RCRA and other statutes. Because the Hanford Site Tri-Party Agreement has legal precedence over some other environmental laws, it can be useful in negotiating creative solutions to unique problems. One such prototypical solution might be the provision written into the Tri-Party Agreement that transitioning facilities do not need to prepare NOIs before modifying their RCRA Part A permits when additional hazardous waste units are discovered during deactivation.

**Lesson No. 54.** Emissions comparison documents, while initially useful, will not stand in lieu of full new permit applications for deactivation actions that generate radioactive air emissions. Radioactive air emissions are a subject of such intense public concern that, at least in Washington State, the WAC has been tightened to require full NOCs for deactivation activities that generate such emissions.

**Lesson No. 55.** The NEPA screening approach taken in the PUREX and UO<sub>3</sub> facility deactivations is extremely helpful and precedent-setting. Because an operational EIS existed, complying with NEPA requirements was possible without preparing a new EIS for deactivation. This action saved enormous amounts of time and money, and particularly should be highlighted and used at other facilities that are undergoing deactivation and that possess existing EIS documentation. In cases where deactivating facilities do not have operational EISs, other existing documentation at the facilities (such as Accelerated Hazards Reduction program documentation) should be examined to see if it can serve a similar function.

**Lesson No. 56.** The designing a noncontiguous boundary for those portions of deactivating facilities that are RCRA TSDs then writing the Part A permit specifically to those boundaries is creative and cost-effective. It forces monitoring and oversight only for the truly affected portions of large facilities. Carefully distinguishing between facilities that will function as long-term TSDs (the PUREX Tunnels), and those that will serve as interim TSDs (the PUREX Building) and permitting each type of TSD differently also is important.

**Lesson No. 57.** Categorizing process substances that have alternative uses or possible alternative definitions as materials other than waste is beneficial and cost effective. At PUREX, examples such as the disposition of the slightly contaminated nitric acid, the organic TBP/NPH solution, and the laboratory sample solutions demonstrate clearly the life-cycle savings that can be realized from not having to permit and monitor unnecessary substances as waste.

**Lesson No. 58.** The evolution of three types of documentation to serve different periods in the life cycle of transitioning TSDs is beneficial in that it leaves room for modifying long-term plans whenever D&D occurs. It would not be useful for today's decision makers to try to write the final closure plan for the PUREX facility not knowing the technology or public preferences and values of the future.

**Lesson No. 59.** As in the case of the PUREX stacks, deactivating facilities must scrutinize their diminishing emissions, effluents, etc., to identify when they may fall below regulatory criteria and allow lesser levels of monitoring and documentation. The result is cost and time savings.

**Lesson No. 60.** The CX that was prepared for "deactivation, deenergization, or isolation of unneeded plant systems and stabilization in Hanford facilities" is an example of a valuable concept. That is the concept of writing broad and inclusive Sitewide or complex-wide regulatory documentation whenever possible to avoid creating documentation for every small or repetitive action. Cost and time savings again result.

**Lesson No. 61.** Existing safety documentation from facility operational periods should be used creatively and carefully to begin deactivation project safety documentation. Revisions, comparisons, crosswalks, and other types of screening procedures can be used to determine which deactivation actions may be covered in existing documentation and which actions need supplementary coverage. Such comparisons, performed by those who know the facility well, are more cost effective and time efficient than preparing all new safety documentation for facility shutdowns.

**Lesson No. 62.** Workshops and other joint working efforts that bring together the principals interested in safety documentation (DOE, the operating contractor, and ITEs and other consultants) are important early in a deactivation project for brainstorming and establishing the major cornerstones of consensus about the safety documentation.

**Lesson No. 63.** Worker health and safety, always a DOE and contractor concern, has been elevated in recent years to even more important status. Often, worker safety and health will be the areas where older facility safety documentation falls short of modern standards. Incorporating worker safety and health considerations that are comparable to or exceed the levels demanded by OSHA into newer revisions or supplements to safety documentation is extremely important.

**Lesson No. 64.** Worker involvement (including the use of job screening devices that are operated by worker teams at their own personal computer work stations) and a graded approach to the levels of safety analysis required for various deactivation tasks are the two most important keys to making the safety analysis process useful, efficient, and satisfactory to all concerned. The graded approach is cost effective in that it does not demand a high level of analysis for simple jobs already covered in established procedures. Worker involvement is also cost effective in that it better assures that workers are participating willingly and without hesitation in the jobs that are required for facility deactivation.

**Lesson No. 65.** The S&M Plan to govern facility safety checks in the period between deactivation and D&D should be written by either the D&D organization or a joint team of deactivation/D&D personnel. The deactivation personnel are not familiar enough with the procedures and requirements of the D&D organization to write this plan alone. Also, the level of detail in the plan should be carefully assessed. Some plans could be simply a compilation of other orders, requirements, and procedures.

**Lesson No. 66.** BIO documents can serve as a useful alternative to writing lengthy safety analysis reports for deactivated facilities. However, to realize the most savings and efficiency, the BIOs should be written close to the end of the deactivation project with the understanding that their final approval will not occur until after the project ends.

**Lesson No. 67.** New techniques in fixing and sealing contamination can be used to reduce the possibility of contamination migration so that full removal and burial of contaminated equipment and duct work is not necessary during deactivation. NDA results and facility conditions should be carefully weighed. In some cases, physical glove box and duct removal may be the best and safest choice.

**Lesson No. 68.** Any unnecessary manipulations, separations, conversions, or handling of plutonium and uranium-bearing solutions should be avoided. The age of the process vessels in the PUREX Plant and at many other DOE facilities creates the need for renewed regulatory involvement if any further or different uses are made of this equipment. Also, worker and environmental risk increases every time additional processes are performed on plutonium and uranium materials.

**Lesson No. 69.** The cost savings associated with timely deactivation of large facilities such as the PUREX plant are so overwhelming and important that optional activities that involve keeping plant systems active must be declined. The PUREX facility is so complex and its internal systems so intertwined that the need to perform any activities associated with plutonium/uranium solutions meant that nearly all of the plant's systems would have to remain active. This would have slowed the overall deactivation project, and DOE's imperative need to proceed with deactivation would not have been met.

**Lesson No. 70.** The use of well-established, simple technologies that could be readily implemented contributed to the successful disposition of the D-5/E-6 material. Existing procedures and specifications also were used so that only minor piping changes within the PUREX facility were required. As a result of keeping it simple, significant cost savings were achieved and the activity was completed safely and ahead of schedule.

**Lesson No. 71.** Video taping the PUREX dissolver cells where the fuel was lying and all pertinent locations helped plan the fuel recovery and transfer activities. Taping also helped to assign recovered fuel Nuclear Material values, document canister loading, account for all fuel elements, and provide an ongoing method to review and learn from the previous day's activities. All work with sensitive materials such as spent fuel elements and other items with accountability requirements should be taped without editing and at the highest tape speeds, to provide the best opportunities for learning and improving the processes.

**Lesson No. 72.** Planning and surveying every step of the way when dealing with an activity involving radiological contamination outside of plant radiation zones leads to time savings in the end. Such activities have high visibility and involve many regulations and stipulations. Making sure all the surveys and preparations are done before starting the main activity will prevent any expensive work stoppages during the activity. At PUREX, identifying allowable contamination levels on the cask cars almost stopped the fuel transfer at the last minute.

**Lesson No. 73.** The EA process can be very time consuming. To expedite matters, processes that already are covered in existing documents should be identified, and the existing documentation included in the beginning. Early contact should be made with the EA review team to discuss and agree on what will be included. Also, the review team itself should be carefully chosen to include the people directly involved with the activity. They have expert knowledge and this knowledge should be tapped. The review team should not be expanded beyond essential personnel or the process may become unwieldy.

**Lesson No. 74.** Alternatives for the disposition of spent fuel are severely limited by considerations of the time and money it takes to satisfy regulatory requirements, safety considerations, and stakeholder concerns. The requirements to permit the movement of even small amounts of spent fuel away from the DOE site of origin are very significant and perhaps even prohibitive in today's climate. Therefore, spent fuel remaining at the end of processing activities should be dealt with on site, and should be grouped with other existing spent fuel.

**Lesson No. 75.** Operating personnel should be kept involved with every step of new equipment design, to improve its ease of use. Also, problems with the design can be identified early using the plant experience. Such problems may not necessarily be recognized even by a knowledgeable engineers. For example, by allowing the crane operator at PUREX to design his tools with minimal support by engineering, the tools were constructed quickly and accurately for use in the specific task.

**Lesson No. 76.** Equipment should be designed to be simple and rugged to ensure consistent operation and to avoid potential equipment failures. Such equipment may not be state of the art, and may not be able to perform intricate maneuvers, but the performance tradeoff in remaining operable and cost effective is worthwhile. Also, keep the design classification for new equipment should be kept at as low a level as possible, to allow for timely inspections and drawing development.

**Lesson No. 77.** Provision should always be made for cross-review of procedures when more than one organization is involved in an activity.

**Lesson No. 78.** When an activity (such as fuel transfer) is a high priority action for one project but not for another, understandings and agreements need to be reached at high management levels to determine which priority level will apply.

**Lesson No. 79.** Computer simulation of equipment is very helpful to engineers and operators both in evaluating use inside remote areas (such as the PUREX canyon) and in visualizing and planning activities.

**Lesson No. 80.** To the extent possible, keep the time between planning, documenting, and carrying out an activity as short as possible. When time elapses, documentation changes may be required, personnel assigned to the activity may change, and readiness reviews may become more extensive. Such changes add time to the overall activity schedule. At PUREX, some of the personnel familiar with fuel transfers were lost during the initial years after the Standby runs. When the time came for the final fuel transfers in 1995, some of the personnel in key positions had never done this activity before, so more extensive readiness reviews were needed.

**Lesson No. 81.** Finding an alternative use for a slightly contaminated process chemical and an interested buyer or consumer is better than having the material declared a waste. The same lesson was learned under similar circumstances for uncontaminated fresh chemicals that were sold from the PUREX Plant during the standby period.

**Lesson No. 82.** Public involvement, conducted as an honest and open attempt to communicate and find mutually satisfying solutions, can be the key to resolving seemingly intransigent issues. Also, public involvement uncovers true majority public sentiments, and prevents a vocal minority from inaccurately presenting "public" sentiments. (See Section 10.0)

**Lesson No. 83.** Some obstacles to moving nuclear process materials and other types of deactivation alternatives cannot be controlled or overcome by plant and DOE personnel. The historical/political climate toward nuclear materials is such that even the most preferred alternatives (from the technical perspective) sometimes cannot be implemented in every locality.

**Lesson No. 84.** Persistence and patience can find a destination and a cooperative customer when pursued over time. Many avenues should be explored.

**Lesson No. 85.** The lessons learned in deactivating the PUREX analytical laboratory closely follow those learned in connection with N-Cell, the PR room, Q-Cell, and the Sample Gallery. Individual systems inside large facilities cannot be kept open without the undue expense of maintaining at least portions of larger systems. There is an optimum time to deactivate a support facility and to move the needed services to other facilities. Also, modern contamination fixant techniques allow glove boxes and other large equipment pieces to be left inside facilities, while controlling contamination.

**Lesson No. 86.** Careful planning, involving many knowledgeable plant people, and conducting practice dry runs are key elements in achieving smooth, efficient, and low-exposure results when work is required in high-radiation areas.

**Lesson No. 87.** Establishing effective, early, and ongoing communication between facility and regulatory personnel is essential. Regulatory support and communication was an essential factor in determining the extent of flushing at PUREX, the sample analysis required, and the methods of flushing. Although interaction with regulators often costs time, ultimately it results in completing the project safely and ahead of schedule.

**Lesson No. 88.** Looking for ways to combine activities is important, especially when attempting to minimize waste production. The combination of recycling waste water from other sources and using the cascaded flushes method to flush the canyon vessels at PUREX reduced the anticipated waste volume by 50 percent. It also resulted in significant cost savings by completing the canyon vessel flushing project ahead of schedule.

**Lesson No. 89.** When ancillary facilities such as the PUREX Tunnels clearly have different missions and vastly different anticipated operating life spans, they should be separated administratively and treated differently in regulatory and physical planning.

**Lesson No. 90.** Existing ventilation systems can be modified in many ways, and many devices are available to help regulate them. At PUREX, as with the fuel removal equipment and procedures, the simplest methods were chosen because they were felt to be the most dependable. Systems that will require the least amount of maintenance are the best for long-term use in large facilities.

**Lesson No. 91.** In planning large deactivation activities, discern which outside resources have the necessary expertise and experience to validate the designs and obtain their help in reviewing plans. Make sure that the most expert reviews are conducted as early in the process as possible.

**Lesson No. 92.** Modifying older, existing equipment that must be reconfigured in deactivation projects often is not cost effective. Newer, modular equipment can offer savings in greater reliability, longer periods between maintenance, ease of access, and adherence to modern codes. Also, installing new equipment keeps construction workers out of the way of deactivation workers, preventing costly schedule interruptions.

**Lesson No. 93.** At UO<sub>3</sub>, the final flushes of the process vessels were included as part of the stabilization run activities. Because these flushes were considered part of operations, no RCRA permits were needed for the flush material and the RCRA 90-day clock for the UO<sub>3</sub> Facility did not start ticking until the final flushes were completed. By that time, almost all hazardous materials that might have been considered waste under a different timing structure had been removed from the plant. Other facilities should consider writing vessel and equipment flushes and other ancillary activities into their stabilization run plans.

**Lesson No. 94.** Issues such as which groups will perform deactivation tasks must be worked out globally at the start of a project. For example, the issue of which tasks constitute plant "modifications" can have legal (Davis-Bacon Act) and labor ramifications, and can slow or stop a deactivation project.

**Lesson No. 95.** The disposition of small equipment, tools, furniture, and other miscellaneous supplies and items might be viewed as a private business opportunity as facilities deactivate across the DOE complex. Facility managers considered the amount of time spent on such disposition disproportionately large and these activities had to compete with other deactivation tasks for the time of facility personnel. If such activities were privatized, more productive uses might be found for some of the equipment and waste burials might be minimized.

**Lesson No. 96.** When a facility is in the final stages of deactivation, high priorities are assigned to final close-out items. However, other organizations and facilities are not in the rush mode, and may not assign as high a priority to their interfaces and correspondence, sign-offs, etc., as the deactivating facility facing final deadlines. Leaving time for other organizations to work at their usual pace or on their usual cycles is important.

**Lesson No. 97.** Many final deactivation end points mandate posting signs at various places around facilities. Make a "signs map" ahead of time, make sure that all signs are physically prepared and accounted for on the map well before the deadlines.

**Lesson No. 98.** The hot-tap method of sealing pipes that are inaccessible or configured so that they cannot be drained by gravity, is a cost-effective way to ensure that contamination will not migrate out of such pipes over time in deactivated facilities. Deactivating facilities should be inspected for such piping situations and hot-tap drained before deactivation is complete.

**Lesson No. 99.** Public and tribal involvement is essential to the success of major deactivation projects. Such involvement should be started early, and should include initial efforts to assemble and distribute documents that allow nontechnical people to understand the history, operations and condition of large, complex facilities. Providing such documents can save plant personnel considerable time that might otherwise be spent answering repetitive questions. Communication also can prevent a domino effect of misunderstandings about the deactivation, based on basic misunderstandings of plant functions, layout, history, chemical and radiological inventory, and other topics. Plant tours are important to help stakeholders understand the scope of the physical plant, the deactivation project, and the work being performed.

**Lesson No. 100.** Once the common information base is established (the first phase of public involvement), the public involvement process should become a dialogue. Two-way, iterative communication is essential. Plant personnel must truly listen to the values, motivations, and concerns of stakeholders and be willing to change their ideas based on the input of others. The era of unilateral federal decisions clearly is over, and leadership in the new era means flexibility and trust. Compromises can be reached, and the value of obtaining the buy-in of regional stakeholders can ensure the long-term success of deactivation projects and other DOE missions.

**Lesson No. 101.** Communication with facility employees (a key stakeholder group) is essential, especially considering that employees of a successful deactivation project literally work themselves out of their jobs. They must be kept apprised of project goals and their roles in achieving these goals, and they must be given guidance on how and where their skills can be applied after deactivation.

**Lesson No. 102.** Stakeholder involvement includes many external review groups that have an interest in various aspects of a complex, prototypical facility such as the PUREX Plant. During 1993 and 1994, the PUREX Facility was subject to a spent fuel vulnerability assessment, a chemical vulnerability assessment, and a plutonium vulnerability assessment and reviews by the DNRFSB, the General Accounting Office, and DOE Headquarters special safety teams. It also

experienced a vast increase in requests for tours and media information associated with its being a deactivation project model. Supporting all these requests for information must be factored into deactivation project costs and personnel needs. However, one innovative cost-saving method adopted at PUREX and available to other plants is preparing video tours and information packages that can be duplicated and used many times.

**Lesson No. 103.** Communication and dialogue take many forms. Some groups, such as some Native Americans, prefer verbal to written communication. Flexibility and a variety of format must be used to reach all stakeholders.

**Lesson No. 104.** The biggest potential physical hazards in a deactivation project may not attract the most public comment and interest. At PUREX, the shipment of irradiated fuel rods to the 105-K West Basins generated vastly less public interest than the nitric acid shipment to England, yet the radionuclide inventory and hazardous nature of the spent fuel was much greater. The public will tell the facility managers what its interests are, and managers must listen and heed the public's perceptions.

## 12.0 ENDNOTES

- 1 Westinghouse Hanford Co., WHC-SP-1011, Rev.0.
- 2 Brogdon, Hamrick, and Cartmell, FO-94-001; Harlow, Hertzell, Grasher, Jasen, Hamrick, Sinnema, Main, and Cartmell, FO-94-019; Lundeen, Borisch, Proctor, Main, Cartmell, FO-94-022.
- 3 Harlow, Grasher, Hamrick, Sinnema, Main, Cartmell, TP-95-009; Harlow, Grasher, Hamrick, Davis, Main, Cartmell, TP-95-019; Cartmell, TP-95-023; Davis, Main, Cartmell, TP-95-026; Cartmell, TP-95-027; Cartmell, TP-95-034; Cartmell, TP-95-046; Cartmell, TP-95-058.
- 4 Cartmell, TP-96-002; Cartmell, TP-96-003; Cartmell, TP-96-004; Cartmell, TP-96-010; Cartmell, TP-96-015; Cartmell, TP-96-034.
- 5 *Slants and Trends*, June 27, 1996.
- 6 U.S. Department of Energy, DOE/EIS-0089D and DOE/EIS-0089.
- 7 Harty, WHC-SD-CP-PE-014, Rev. 0. Note: The recommendations, or "lessons learned" from the stabilization campaign appear on pp. 39-40 of this document.
- 8 Thompson, WHC-SD-CP-SSP-006, Rev. 0; Harlow, WHC-SD-CP-SSP-004, Rev. 0.
- 9 Gerber, WHC-MR-0437; Bixby, *Termination of the Plutonium-Uranium...*
- 10 Work Plans WP-P-90-003 through WP-P-90-036; WHC Internal Memo 12124-90-11; WHC Internal Memo 12124-90-25; WHC Internal Memo 12124-90-29; WHC Internal Memo 12124-90-44; WHC Internal Memo 12124-90-49; WHC Internal Memo 17523-90-58; WHC Internal Memo 17523-90-61; WHC Internal Memo 17524-90-66; WHC Internal Memo 17523-90-78; WHC Internal Memo 17523-90-85; WHC Internal Memo 12124-90-41.
- 11 Harlow, WHC-SD-CP-SSP-004, Rev. 0; Thompson, WHC-SD-CP-SSP-006, Rev. 0.
- 12 Mecca, Correspondence #9004625B; *PUREX Process Engineering*, WHC-SD-CP-OSR-006, Rev. 2, pp. 2-4.
- 13 Work Plans WP-P-91-001, WP-P-91-003-017, WP-P-91-019-021, WP-P-91-023-025, WP-P-91-029-031, WP-P-91-033-034, WP-P-91-090, WP-P-91-094, WP-P-91-096-099, WP-P-91-101-104, WP-P-91-106-108, WP-P-91-110-111, WP-P-91-113-114, WP-P-91-116-118, WP-P-91-125, WP-P-91-134, WP-P-91-137, WP-P-91-141-143, WP-P-91-145-150, WP-P-91-152, WP-P-91-154; WHC Internal Memo 17523-91-02, WHC Internal Memo 17523-91-11, WHC Internal Memo 17523-91-030, WHC Internal Memo 17523-91-040, WHC Internal Memo 17523-91-049, WHC Internal Memo 17523-91-065, WHC Internal Memo 17523-91-066, WHC Internal Memo 17523-91-083, WHC Internal Memo 17523-91-083, WHC Internal Memo 17523-91-091.
- 14 Bhatia, WHC Internal Memo 17522-91-048; Midgett, Correspondence #9254568.

- 15 WHC Work Plans WP-P-92-003-004, WP-P-92-008, WP-P-92-011, WP-P-92-015, WP-P-92-017-022, WP-P-92-029-031, WP-P-92-034-036, WP-P-92-040, WP-P-92-048, WP-P-92-052053, WP-P-92-055, WP-P-92-060, WP-P-92-064; WHC Internal Memo 17523-92-007, WHC Internal Memo 17523-92-009, WHC Internal Memo 17523-92-015, WHC Internal Memo 17523-92-022, WHC Internal Memo 17523-92-028, WHC Internal Memo 17523-92-034, WHC Internal Memo 17523-92-040, WHC Internal Memo 17523-92-047, WHC Internal Memo 17523-92-061.
- 16 Independent Technical Review Team, *Independent Technical Review...*, p. i-iii.
- 17 Independent Technical Review Team, *Independent Technical Review...*, p. iii-1.
- 18 Ibid. pp. I-10-11.
- 19 Ibid., pp. I-16, 17, 20, ad I-1-12.
- 20 Ibid.
- 21 Hammer and Champy, *Re-engineering the Corporation*, p. 2; Cartmell, TP-96-002; Cartmell, TP-96-003; Cartmell, TP-96-004; Cartmell, TP-96-010; Cartmell, TP-96-015; Cartmell, TP-96-034.
- 22 Hammer and Champy, *Re-engineering the Corporation*, pp. 2-5, 7, 9, 13, 17, 29, 32, 35.
- 23 Hammer and Champy, *Re-engineering the Corporation*, pp. 51, 53, 55-56, 58-59, 62-63, 65, 68, 70-72, 74, 76-77, 79, 83; Champy, *Re-engineering Management*, pp. 4-7.
- 24 "DOE to be Cut by \$10.6 Billion; EM Program to Focus on Risks," p. 1.
- 25 Blush and Heitman, *Train Wreck Along the River of Money*.
- 26 Aeppl, *Untidy Cleanup*, p. 1. See also: Lee, *Nuclear Plant Cleanup Assailed*; Lynch, "Hanford Dollars Squandered, Report Concludes."
- 27 Trego, "Reengineering Starts With a Clean Sheet of Paper."
- 28 CSC Index, CS21810-MXP-Plant CFA; CSC Index, CS21810-GPD-REQU; CSC Index, CS21810-JSW-Workshop2.
- 29 WHC Communications, "Grumbly Tells Hanford Managers to Plunge Into Change," citing T. Grumbly.
- 30 "Grumbly Seeks Savings in 'Budgetarily Challenged' Program," citing T. Grumbly.
- 31 CSC Index, CS21810-JSW-Workshop2; CSC Index, CS21810-MXP-Plant CFA; CSC Index, CS21810-KSW-DeacStep.

- 32 Hamrick and Gerber, WHC-SP-1147, Rev. 0.
- 33 Jasen, WHC-SP-1011 Rev. 0; Trego, "Reengineering Starts With a Clean Sheet of Paper."
- 34 CSC Index, CS21810-MXP-PlantCFA; CSC Index, CS21810-DGH-Pres; CSC Index, CS21810-SLP-PURLesLrnd.
- 35 CSC Index, CS21810-JSW-Workshop2; CSC Index, CS21810-MXP-PlantCFA; CSC Index, CS21810-SLP-ProcAssump.
- 36 L.F. Perkins, Jr., "Interview with M.S. Gerber," April 30, 1996.
- 37 CSC, CS21810-DGH-Pres.
- 38 L.F. Perkins, Jr., Interview with M.S. Gerber, April 30, 1996.
- 39 CSC Index, CS21810-SLP-GenOrgEnt; CSC Index, CS21810-MKB-JobDescr; CSC Index, CS21810-KSW-RoleDefs.
- 40 CSC Index, CS21810-SLP-PURLesLrnd.
- 41 CSC Index, CS21810-KSW-RoleDefs.
- 42 CSC Index, CS21810-SLP-PURLesLrnd.
- 43 U.S. DOE Communications Office, RL Announcement No. 96-078; WHC Communications Office, *Status of Project Hanford Management Contract*, June 19, 1996.
- 44 CSC Index, CS21810-SLP-PURLesLrnd.
- 45 Development Dimension International, *Team Start-up Kit Participant Booklet*.
- 46 Waterman, Waterman and Collard, *Toward a Career-Resilient Workforce*.
- 47 Turner, Interview with M.S. Gerber, June 25, 1996; CSC Index, CS21810-DGH-Pres; Executive Team; *Culture Change Activities at PUREX*.
- 48 CSC Index, CS21810-SLP-ProcAssump.
- 49 CSC Index, CS21810-GPD-IssuesLog.
- 50 U.S. DOE, DOE/EM-0246.
- 51 Hughes, WHC Internal Memo 85000-93-0012; Westinghouse Hanford Company, WHC-SP-1011 Draft, Appendix G; Westinghouse Hanford Company, WHC-SP-1011, Rev. 1.
- 52 Project, Time & Cost, Inc., *PUREX/U03 Facilities Deactivation Project*, Rev. 1.3; Cartmell, WHC-SP-1126, Vol. IV; Westinghouse Hanford Company, WHC-SP-1011D, Table 4.3.1, p. 4.3.2.
- 53 WHC, WHC-SP-1011D; Jasen, WHC-SP-1011.

- 54 KCM, Inc., *Westinghouse Hanford Company, PUREX/U03...*
- 55 KCM, Inc., *Westinghouse Hanford Company, PUREX/U03...*, p. 4 and Appendix F.
- 56 U.S. DOE, *Facility Deactivation End Points Handbook*, Draft Rev. 3.
- 57 Stefanski, WHC-SD-WM-TPP-052, Rev. 0.
- 58 Ibid.
- 59 Ibid. Hamrick, Correspondence #9456181.
- 60 Jasen, *PUREX Deactivation Process*.
- 61 Stefanski, WHC-SD-WM-TPP-053, Rev. 0.
- 62 Stefanski, WHC-SD-WM-TPP-053, Rev. 1; Villalobos, *Preliminary Plutonium Uranium Extraction (PUREX) Facility Surveillance and Maintenance Plan*.
- 63 Science Applications International Corporation (SAIC), *PUREX Deactivated End State Hazards Analysis*.
- 64 Project Software and Development, Inc., *Project Management...*
- 65 Mueller, WHC Internal Memo 17110-93-EAM-004; Project Software and Development, Inc., *PUREX/U03 Facilities Transition Scheduling Review*.
- 66 Quik-Net Graphics, *PUREX Transition Master Network*, Westinghouse Hanford Company, WHC-SP-1011D, pp. 4.2-2, 4.2-3; Cartmell, WHC-SP-1126 Vol. 1, Milestone TRP-95-216.
- 67 Westinghouse Hanford Company, WHC-SP-1011.
- 68 Bence, Correspondence #9458501D; Cameron, Correspondence #96-PID-CR-008.
- 69 Westinghouse Hanford Co., *PUREX Level 5 Critical Path*.
- 70 Bliss, Correspondence #9259564D; U.S. Department of Energy, DOE/RL-88-21; Bauer, *Material Management Issues...*
- 71 Midgett, *PUREX Project Management Plan Workshop*; Wiley, *Meeting Minutes: PUREX Deactivation Regulatory Workshop*; Westinghouse Hanford Company, WHC-SD-EN-TI-283, Rev.0. Note: The EPA and the Washington State DOH also were invited to the April 12 to 16 workshop to discuss the PUREX regulatory strategy, but these agencies did not send representatives.
- 72 U.S. DOE, DOE/RL-88-21, Form 3, Rev. 6, for the PUREX Plant.
- 73 Westinghouse Hanford Company, WHC-SP-1011D, Table G-2, p. G-4; Hamrick, Correspondence #9454651D; Mecca, *Permitting and Interim Status Requirements...*, with Enclosures 1, 2, and 3; Bowman and Strand, TPA Change Number P-06-96-01; Ecology, EPA and DOE, *Hanford Federal Facility Agreement and Consent Order*, 89-10, Rev. 4, Section 6.3.4; U.S. DOE,

DOE/RL-88-21, *PUREX Plant*, Rev. 7; Julian, Letter to Rasmussen and Hamrick, May 30, 1996.

- 74 Rasmussen and Mecca, *Resolution of Permitting and Interim Status Compliance Related Issues Associated with Transition of the Plutonium-Uranium Extraction (PUREX) Facility*, with Enclosure 1; Juraysi and Duncan, Letter to J.E. Rasmussen and J.E. Mecca, February 21, 1995; U.S. DOE, DOE/RL-88-21, *PUREX Plant*, Rev. 7.
- 75 Ecology, EPA, and DOE, *Hanford Federal Facility Agreement and Consent Order*, Action Plan Section 3.1; Butler, RE: Letter, R.G. Holt, DOE, R.E. Lerch, WHC...
- 76 Hetzer, *PUREX Weekly Status Report*, November 14, 1995.
- 77 Hamrick, Correspondence #9354325.1, with Enclosures; Bauer, Correspondence #9306277; Bauer, Correspondence #9402907; Holt, *Applicability of WAC 173-303 to Nitric Acid...*; Mecca, *Permitting and Interim Status Requirements...*; U.S. Rasmussen and Mecca, *Resolution of permitting and Interim Status Compliance Related Issues Associated with the Transition of the Plutonium-Uranium (PUREX) Facility*, with Enclosure 1; Juraysi and Duncan, Letter to J.E. Rasmussen and J.E. Mecca, February 21, 1995.
- 78 U.S. DOE, DOE/RL-95-78; U.S. DOE, DOE/RL-90-24.
- 79 Ecology, EPA and DOE, *Hanford Federal Facility Agreement and Consent Order*, Rev. 4, Section 8.1.2; Stefanski, WHC-SD-TTP-053, Rev. 1; Hamrick, Correspondence #9651858, with Enclosure; Sanders, Correspondence #96-TPD-055, with Enclosure.
- 80 Stanley/Tebb, Change Control #M-80-94-01 Draft; U.S. Department of Energy, DOE/RL-90-24, Rev. 1; Ecology, EPA and DOE, *Hanford Federal Facility Agreement and Consent Order*, Rev. 4, p. 201, and Appendix D.
- 81 Stanley/Tebb, Change Control #M-80-94-01 Draft; U.S. Department of Energy, DOE/RL-90-24, Rev. 1; Ecology, EPA and DOE, *Hanford Federal Facility Agreement and Consent Order*, Rev. 4, Appendix D.
- 82 Rasmussen, Correspondence #9307041, with Enclosure RHO-CD-569; Pontius, Letter to J.E. Rasmussen, August 1993; Bauer, Correspondence #9400858 with Enclosure; Nylander, RE: Letter, J.D. Bauer...; Bauer, Correspondence #9400831 with Enclosure; Conklin, Correspondence #AIR 94-311; Conklin, Correspondence #AIR 94-313; Bauer, Correspondence #94000850; Westinghouse Hanford Co. Air and Water Permits, Internal Memo 88300-94-041;
- 83 Washington State, WAC Chapter 246-247; U.S. DOE, DOE/RL-95-61; U.S. DOE, DOE/RL-95-95; Conklin, AIR-95-1201; Frankel, Letter to J.E. Rasmussen, December 6, 1995; Dunigan, 96-EAP-111 with Enclosure; Conklin, AIR-96-603; Washington State, WAC 246-247.

- 84 Wisness, Correspondence #9400891 with Enclosure; Bauer, Letter to J. McCormick, February 1994 with Enclosure; and Hamrick, Jasen, and Harlow, *PUREX/U03 Deactivation Project Quarterly Review*, October 31, 1994.
- 85 U.S. Department of Energy, DOE/EIS-0089.
- 86 Hamrick, Correspondence #9358853 with Attachment; Bracken, Mecca, Hunter, and Dunigan, *PUREX/U03 Deactivation Project NEPA Compliance Strategy Information Memo*; Wagoner, DOE Memorandum 93-PPO-002; Engelmann, Internal Memo #88800-94-012 with Enclosure; Engelmann, Internal Memo #88800-94-037, Rev. 1; Archer, DOE/EA-0988.
- 87 Reinkens, *PUREX/U03 Weekly Status Report*, 10/4/94; Holt, Applicability of WAC 173-303 to Nitric Acid..."; U.S. DOE, DOE/EA-1005D; Wagoner, Correspondence No. Incoming 9404847, with Enclosure; Engelmann, 94-PPO-26, with Enclosure; U.S. DOE, DOE/EA-0988.
- 88 Dunigan, Correspondence No. Incoming 9600388, with Enclosure.
- 89 Harvey, *No Known Affected Historic Properties*; U.S. DOE, Washington SHPO, and Advisory Council, "Draft Programmatic Agreement...[for] the Built Environment on the Hanford Site, Washington."
- 90 Ecology, EPA, DOE, *Hanford Federal Facility Agreement and Consent Order*, Milestone M-17-00; Berriochoa, "Ground Broken..."; "Everyone Tied Into TEDF," June 5, 1995; *Environmental Victory*, July 10, 1995.
- 91 Engelmann, Internal Memo 88800-94-200 with Attachment; Ecology, EPA and DOE, *Hanford Federal Facility Agreement and Consent Order*, Fifth Amendment, Appendix D; Rasmussen, "UO<sub>3</sub> Plant Storm Water Modification Information" with Enclosure.
- 92 Roemer, RHO-SD-HS-SAR-001; Yasutake, RHO-SD-CP-SAR-002; PUREX Process Control, RHO-CD-1540; Fox, RHO-RE-MA-5; Walser, WHC-CM-5-24, Addendum 1; Divencenzo and Peiffer, WHC-SD-CP-PLN-007; Mecca, *PUREX Safety Analysis Report Upgrade*; Walser, WHC-SD-CP-RD-020. NOTE: The full list of safety documentation that had been written for the PUREX Facility previous to RHO-SD-HS-SAR-001 and RHO-CD-1540 is too long to re-print herein. A complete list is available from Westinghouse Hanford Company Central Files.
- 93 Walser, WHC-SD-CP-RD-020; Risenmay, WHC-SD-CP-OSR-006, Rev. 1; PUREX Engineering Support, WHC-SD-CP-RD-021; Miska and Siemer, WHC-SD-CP-PHA-001; Westinghouse Hanford Company, OSD-P-154-00001.
- 94 Midgett, *PUREX Project Management Plan Workshop*; Walser, *Safety Analysis Strategy*; Johnson, 5480.23 Requirements Crosswalk...; Kerr, *Results of Safety Documentation Strategy...*; Johnson, Kerr, and Walser, *Crosswalk Documentation*; Kerr, *Worker Health and Safety...*; Walser, *OSR Applicability for PUREX Plant Deactivation...*; Walser, *Applicability of the Unreviewed Safety Question Process to Non-Reactor Nuclear Facilities...*; Peiffer, *Meeting Minutes, PUREX Deactivation Project Safety Strategy Workshop*; Roemer, WHC-SD-HS-SAR-001, Rev. 5; Walser, WHC-CM-5-24, Rev. 18; Walser, WHC-SD-CP-RD-020; Parkman,

WHC-SD-CP-OSR-006, Rev. 2; Westinghouse Hanford Company, WHC-SP-10011D, Appendix F.

- 95 Eng, *Worker Safety and Health Issues Related to the PUREX Deactivation Project.*
- 96 Domnoske, WHC-SD-CP-TI-189; Wagoner, 94-PPO-001; Enghusen, WHC-SD-CP-RD-021, Rev. 3; *Nuclear Safety and Radiological Analysis*, WHC-CM-4-46, Rev. 10; *PUREX/UO<sub>3</sub> Operations*, WHC-CM-5-9, Rev. 48.
- 97 DNFSB, Recommendation 90-2; DNFSB; Recommendation 95-2; O'Leary, Letter to J.T. Conway, January 17, 1996; Westinghouse Hanford Co., WHC-SD-MP-SRID-004, Rev. 0; Hamrick, Correspondence #9652217.
- 98 Dodd, WHC-SD-CP-HSP-002, Rev. 0; 29 CFR Section 1910.120 (1993); Los Alamos Technical Associates, *PUREX Hazards Baseline Document*; Los Alamos Technical Associates, *PUREX Hazards Identification Training*; American Institute of Chemical Engineers, *Guidelines for Hazard Evaluation Procedures*; Dodd, WHC Internal Memo 17700-94-017.
- 99 Bixby, *PUREX Deactivation Safety Strategy*; PHSA form in Dodd, WHC Internal Memo 17700-94-017.
- 100 *Industrial Safety and Fire Protection*, WHC-CM-4-3, Vols. 1, 2, 3; Alexander, WHC-CM-4-3, Vol. 4; Dodd, Hazards Assessment Chart, in WHC-SD-CP-HSP-002, Rev. 0; Harlow, WHC Internal Memo 17700-94-017; Walser, OSD--P-154-00001, Rev. A-0.
- 101 Bixby, *PUREX Deactivation Safety Strategy*; Eng, Letter to D.G. Hamrick, July 18, 1994; Dodd, WHC-SD-CP-HSP-002, Rev. 0; U.S. DOE, DOE/EH-0486.
- 102 WHC, WHC-SD-MP-SRID-004, Rev. 0.
- 103 CSC Index, CS21810-MXP-PlantCFA. See also: CSC Index, CS21810-KSW-SurvStep; CSC Index, CS21810-KSW-WrkCntrl.
- 104 Westinghouse Hanford Co., WHC-CM-3-5, Procedure 12-7; Westinghouse Hanford Co., *Qualitative Job Analysis*; Westinghouse Hanford Co., WHC-SD-MP-SRID-004, Rev. 0; Roemer, RHO-SD-HS-SAR-001. See also: Westinghouse Hanford Co., WHC-CM-4-46.
- 105 Westinghouse Hanford Co., WHC-SD-SQA-CSA-511, Rev. 0; Smith, *Cleanup Silences...*, citing G.D. Schein; "Silenced Alarm Means End of Era for PUREX."
106. Villalobos, HNF-SD-CP-AP-007.
107. U.S. DOE, DOE-STD-3011-94; WHC, HNF-SD-CP-HIE-002, Rev. 0; WHC, HNF-SD-CP-HIE-003, Rev. 0.
108. Dodd, HNF-SD-CP-ISB-004, Rev. 0; Dodd, HNF-SD-CP-ISB-005, Rev. 0.
- 109 Jasen, WHC-SP-1011, Rev. 0.
- 110 Cahow, RHO-CD-704; and Geier, WHC-SP-1479.

- 111 Westra, Tardiff, and Shrivastava, WHC-SD-CP-ES-159.
- 112 Enghusen, *PUREX N3 and N4 Glovebox Deactivation*; Westra and Matheison, WP-P-93-039, Rev. 1.
- 113 Jasen, WHC-SP-1011, Rev. 0, Appendix G; Work Plan WP-P-93-039; Bauer, Correspondence #9400831 with Enclosure; Westra, WP-P-95-045; Arthur, letter to A.G. Westra, May 20, 1996; Hess and Chiao, Memo to File 8M730-ALH/TC-96-001; Hamrick, Correspondence #9652754.
- 114 Reberger, RHO-CD-1418; Geier, WHC-SP-0479; Work Plan WP-P-91-094.
- 115 Jasen, WHC-SP-1011, Rev. 0, Appendix G; Hamrick, Correspondence #9652754.
- 116 Duckworth, HW-77678; Matheison, SD-SQA-CSA-032; Work Plan WP-P-92-055.
- 117 Jasen, WHC-SP-1011, Rev. 0, Appendix G; Hamrick, Correspondence #9652754.
- 118 Geier, WHC-SP-0479; Hodges, TRAC-0672.
- 119 Hamrick, Correspondence #9653226.
- 120 Harty, WHC-SP-1072.
- 121 Bixby, *Termination of the Plutonium-Uranium...*; Harty, WHC-SP-1072; Roemer, WHC-SD-HS-SAR-001, Rev. 5.
- 122 Westinghouse Hanford Company, WHC-SP-1011D, Appendix G; Harty, WHC-SP-1072; Jasen, WHC-SP-1011, Rev. 0, Appendix G; Hamrick, Correspondence #9552272.
- 123 Archer, DOE/EA-0988; Bixby, *Termination of the Plutonium-Uranium...*; Enghusen, *Alternatives for the Disposition of Fuel Stored...*; Westinghouse Hanford Company, WHC-SP-1011D, Appendix G; Jasen, WHC-SP-1011, Rev.0; Appendix G; Spent Nuclear Fuel Project, WHC-EP-0830.
- 124 U.S. DOE, DOE/EA-0988; U.S. DOE, DOE/RL-95-61.
- 125 Gore, WP-P-95-010; Enghusen, WP-P-95-038.
- 126 Enghusen, WP-P-95-038.
- 127 Hamrick, Correspondence #9555630.
- 128 Westinghouse Hanford Company, WHC-SP-1011D, Appendix G; Coppinger, HW-77080; Bray, HW-76973 REV; Jasen, WHC-SP-1011, Rev. 0, Appendix G.
- 129 Mecca, Correspondence #94-PPO-016; Hamrick, Correspondence #9453904; Mecca, Concurrence to Correspondence #9453904; Westinghouse Hanford Company Traffic Operations, *U.S. Department of Energy LSA/Nitric...*; Clements, Letter to H. R. O'Leary; Werner and Taub, *Disposition of PUREX Plant Nitric Acid: Technical, Cost and Policy Issues*; Grumbly,

Memorandum to H.A. O'Leary; Rasmussen, Correspondence #94-PCA-053 with Enclosure.

- 130 Rasmussen, Correspondence #94-PCA-053 with Enclosure; O'Leary, *Disposition of Hanford Nitric Acid*; Donn, *Justification for Plant Modification Costs and Payment*; Feldt and Weiner, *British Nuclear Fuels Facility Plant Modifications*; Westinghouse Hanford Company, WHC Subcontract No. MAR-SVV-382237; Nuclear Regulatory Commission, Export License #XSNM02827; U.S. Department of Energy, DOE/EA-1005; *Hanford Finishes Uranium Shipments*; Hetzer, *PUREX Weekly Status Report*, November 14, 1995; Penn, Jasen and Duncan, *Waste Not, Spend Not...*
- 131 Jasen, WHC-SP-1011 Rev. 0, Appendix G; Hunter, DOE Internal Memorandum 94-PPO-006; Dials, *Shipment of Solvent from Hanford...*; Conklin, *Approval for Transfer...*; Wendt, *Agreement by DOE-ID and the Idaho Department of Health...*; Hamrick, Correspondence #9357446; Halupa, WINCO Memorandum SMH-137-93; Romsos, Uniform Hazardous Waste Manifest #A3229; Associated press, *Idaho Accepts Last Load...*; Associated Press, *Andrus to Idaho's Senators...*; *The Navy Will Be Able to Send Spent Fuel...*
- 132 Duncan, *PUREX Organic Solvent Usage Variance Request*; Hunter, DOE Internal Memorandum 94-PPO-006; Jensen, DOE Internal Memorandum OPE-CPP-BSA-94055; Hamrick, Correspondence #9354325.1, with Enclosures; Wisness, Correspondence #9404281; Wagoner, Correspondence #9404847; Westinghouse Hanford Co., PEP #96-134.
- 133 Courtney and Clark, HW-32413 DEL; Carr, HW-24800-105; Dale, *Isolation of the PUREX Analytical Laboratory*; Sivula, *Lab Fight a Battle...*; Westinghouse Hanford Company, WHC-SP-1011D, Appendix G.
- 134 Jasen, WHC-SP-1011, Rev. 0, Appendix G; Stefanski, WHC-SD-WM-TPP-053, Rev. 1, pp. 560-596.
- 135 Carr, HW-24800-105; Barnard, *PUREX a Step Closer to D&D*; PUREX System Deactivation Engineering, Internal Memorandum 17710-94-020.
- 136 System Deactivation Engineering, Internal Memo 17710-94-020; Arthur, Letter to A.G. Westra, March 28, 1996.
- 137 U.S. EPA, 40 CFR Part 261, 1995.
- 138 Hamrick, Correspondence #9651967.
- 139 U.S. DOE, DOE/RL-90-24, Rev. 2.
- 140 Stefanski, WHC-SD-WM-TPP-053, Rev. 1, pp. 957-984.
- 141 Roemer, SD-HS-SAR-01, Rev. 3, pp. 1-15; Carville, WHC-IP-0249, pp. 4.10-15.
- 142 Independent Technical Review Team, *Independent Technical Review...*
- 143 KME Engineering, Inc., *PUREX Natural Ventilation Rate Study*; Hobart, WHC-SD-CP-CR-037, Rev. 0.

- 144 KCM, Inc., *HVAC Consolidation, and Surveillance...*; Massey, *PUREX HVAC/Electrical/Monitoring Design Review*; Los Alamos Technical Associates, *Final: Independent Design Review Document...*
- 145 Ellis and Woodworth, HNF-SD-CP-CR-037.
- 146 Nelson, WHC-SD-CP-ES-168.
- 147 Millward, WHC-SD-CP-TA-005, Rev. 0; Westra and Willis, WHC-SD-CP-SSP-008, Rev. 0.
- 148 Westra and Willis, WHC-SD-CP-SSP-008, Rev. 0.
- 149 Work Plans WP-UO-92-0061, WP-UO-93-001, WP-UO-93-004, WP-UO-93-005, WP-UO-93-013, WP-UO-93-006, WP-UO-0055, WP-UO-94-002; McKenna, "UO<sub>3</sub> Completes Deactivation Milestone Ahead of Schedule."
- 150 Rasmussen, Correspondence #9455363D; Reinkens, *PUREX/UO3 Weekly Status Report*, 9/27/94.
- 151 Work Plans WP-UO-94-010, WP-UO-94-012, WP-UO-94-008; Reinkens, *PUREX/UO3 Plant Weekly Status Reports for 9/20/94, 10/4/94*.
- 152 Hamrick, Correspondence #9456181; Hamrick, Correspondence #9550094D.
- 153 DOE, *Headquarters Public Participation...*; Westinghouse Hanford Company, WHC-SP-1011D, Appendix D.
- 154 Forehand, *PUREX PMP Workshop...*; Gerber, WHC-MR-0437; U.S. Department of Energy, *PUREX/UO<sub>3</sub> Plant Deactivation: The Transition...*; Gerber, *Umatilla Indian Involvement...*, citing J.R. Wilkinson; Jasen, *PUREX/UO<sub>3</sub> Deactivation Project...*; Hanford Advisory Board, *Tracking the Hanford Cleanup*, FY 1995.
- 155 Clements, Letter to H.R. O'Leary; Werner and Taub, *Disposition of PUREX Nitric Acid: Technical, Cost and Policy Issues*; O'Leary, *Disposition of Hanford Nitric Acid*; U.S. DOE, DOE/EA-1005; HazMat Transport News, *DOE Uses Interstate Routing...*; Penn, Jasen and Duncan, *Waste Not, Spend Not...*

## 13.0 BIBLIOGRAPHY

### 13.1 DOCUMENTARY SOURCES

- 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," *Code of Federal Regulation* (Washington, D.C.: U.S. Occupational Safety and Health Administration), 1993.
- 40 CFR 261, "Protection of Environment: Identification and Listing of Hazardous Waste," *Code of Federal Regulation* (Washington, D.C.: U.S. Environmental Protection Agency), 1995.
- 55 FR 9487, "DOE High Priority Defense Nuclear Facilities; Design, Construction, Operation and Decommissioning Standards," DNFSB Recommendation 90-2, *Federal Register* (Washington, D.C.) March 14, 1990.
- 58 FR 7883, "Discipline of Operations in a Changing Defense Nuclear Facilities Complex," DNFSB Recommendation 92-5, *Federal Register* (Washington, D.C.), February 10, 1993.
- 60 FR 54065, "Safety Management," DNFSB Recommendation 95-2, *Federal Register* (Washington, D.C.), October 19, 1995.
- Aappel, T., "Untidy Cleanup: Mess at A-Bomb Plant Shows What Happens If Pork Gets Into Play," in *Wall Street Journal* (New York), March 29, 1995.
- Alexander, D. J., *Industrial Safety Manual: Health and Safety Programs for Hazardous Waste Operations*, WHC-CM-4-3, Vol. 4 (Richland, Washington: Westinghouse Hanford Company), January 28, 1992.
- American Institute of Chemical Engineers (Center for Chemical Process Safety), *Guidelines for Hazard Evaluation Procedures*, 2nd edition, (New York: American Institute of Chemical Engineers), 1992.
- Archer, B. F., *Environmental Assessment: Transfer of Plutonium-Uranium Extraction Plant and 105-N Reactor Irradiated Fuel for Encapsulation and Storage at the 105-KE and 105-KW Reactor Fuel Storage Basins, 100 and 200 Areas, Hanford Site: Richland, Washington*, DOE/EA-0988, (Richland, Washington: U.S. Department of Energy, Richland Operations Office), October 1994.
- Arthur, R. J., "PNNL Non-Destructive Assay Results," letter to A. G. Westra (Richland, Washington: Pacific Northwest Laboratory), March 28, 1996.
- Arthur, R. J., "PNNL Non-Destructive Assay Results: 'N-Cell' Glove Boxes," letter to A. G. Westra (Richland, Washington: Pacific Northwest Laboratory), May 20, 1996.
- Associated Press, "Idaho Accepts Last Load of Waste," in *Tri-City Herald*, (Kennewick, Washington), August 19, 1989, p. A7.
- Associated Press, "Andrus to Idaho's Senators: Help Us Fight A-Waste," in *Tri-City Herald*, (Kennewick, Washington) October 4, 1991, p. A7.

- Bailey, R. W., "Completion of U.S. Department of Energy, Richland Operations Office, Milestone TRP-97-201, Plutonium Uranium Extraction Facility Canyon Flushing," letter to J. E. Mecca, Correspondence No. 9651967 (Richland, Washington: Westinghouse Hanford Company), April 29, 1996.
- Barnard, S. K., "PUREX a Step Closer to D&D," in *Hanford Reach*, (Richland, Washington: U.S. Department of Energy, Richland Operations Office), June 13, 1994), p. 6.
- Bauer, J. D. "Materials Management Issues Associated with the Plutonium-Uranium Extraction Plant," letter to D. B. Jansen (Richland, Washington: U.S. Department of Energy, Richland Operations Office), January 1993.
- Bauer, J. D., "Application for Variance from the State of Washington Dangerous Waste Regulations," letter to D. C. Nylander, Correspondence No. 9306277 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), November 5, 1993.
- Bauer, J. D., "Proposed Deactivation of Plutonium Uranium Extraction Plant-Requests for Concurrence," letter to A. W. Conklin, Correspondence No. 9400831 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), February 7, 1994, with enclosure: "Evaluation of Proposed PUREX Plant Deactivation Activities with Reference to Radionuclide Airborne Releases."
- Bauer, J. D., "Application for Approval of Modification for Plutonium-Uranium Extraction Deactivation," letter to J. McCormick (Richland, Washington: U.S. Department of Energy, Richland Operations Office), February 1994, with enclosure: "40 Code of Federal Regulations 61 Application for Approval of PUREX Deactivation."
- Bauer, J. D., "Application for Approval of Modification for Plutonium-Uranium Extraction Deactivation," letter to J. McCormick, Correspondence No. 9400850 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), March 2, 1994.
- Bauer, J. D., "Request for Concurrence with Emissions Evaluation for Approval of Deactivation of PUREX Plant Pursuant to Washington Administrative Codes 173-400 and 173-460," letter to D. Butler, Correspondence No. 9400858 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), March 10, 1994, with enclosure: "Evaluation of Proposed PUREX Deactivation Activities with Reference to Potential Toxic Air Pollutant Releases."
- Bauer, J. D., "Information to Support State of Washington Department of Ecology Response to Request for Variance from Solid Waste Designation for Organics from the Plutonium-Uranium Extraction Facility, letter to J. Stohr, Correspondence No. 9402907 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), April 1, 1994.
- Bence, P. J., "Change Request TP-95-009, Nitric Acid Environmental Assessment," letter to E. W. Higgins, Correspondence No. 9458501D (Richland, Washington, Westinghouse Hanford Company) April 25, 1995.

Berriochoa, M. V., "Ground Broken for Treated Effluent Facility This Week," in *Hanford Reach*, June 14, 1993.

Bhatia, R. K., *Closure of Chemical Addition in P&O Gallery*, WP-P-91-007, (Richland, Washington: Westinghouse Hanford Company), February 19, 1991.

Bhatia, R. K., *Drain/Flush 211-1 to AMU XTU Lines*, WP-P-91-024, (Richland, Washington: Westinghouse Hanford Company), April 19, 1991.

Bhatia, R. K., *Calibrate F Cell Sumps*, WP-P-91-025, (Richland, Washington: Westinghouse Hanford Company), April 23, 1991.

Bhatia, R. K., 1991, *TK-11 Drain & Flush*, WP-P-91-106, (Richland, Washington: Westinghouse Hanford Company), July 23, 1991.

Bhatia, R. K., *Drain & Flush 211-A*, WP-P-91-107 (Richland, Washington: Westinghouse Hanford Company), July 26, 1991.

Bhatia, R. K., "Removal Order of Excess Chemicals," Internal Memo No. 17522-91-048 (Richland, Washington: Westinghouse Hanford Company), August 21, 1991.

Bhatia, R. K., *Hydrogen Peroxide Loadout*, WP-P-91-137 (Richland, Washington: Westinghouse Hanford Company), October 1, 1991.

Bhatia, R. K., *D Cell Sump Integrity Assessment*, WP-P-91-147 (Richland, Washington: Westinghouse Hanford Company), November 22, 1991.

Bhatia, R. K., *E Cell Sump Integrity Assessment*, WP-P-91-148 (Richland, Washington: Westinghouse Hanford Company), November 22, 1991.

Bhatia, R. K., *SFB Sump Integrity Assessment*, WP-P-91-149 (Richland, Washington: Westinghouse Hanford Company), November 22, 1991.

Bhatia, R. K., *AVN TK-42 Drain & Flush*, WP-P-91-150 (Richland, Washington: Westinghouse Hanford Company), December 6, 1991.

Bhatia, R. K., *Nitric Acid (TK-12) Loadout*, WP-P-92-018 (Richland, Washington: Westinghouse Hanford Company), March 31, 1992.

Bhatia, R. K., *TBP Loadout*, WP-P-92-019 (Richland, Washington: Westinghouse Hanford Company), March 31, 1992.

Bhatia, R. K., *NPH Loadout*, WP-P-92-020 (Richland, Washington: Westinghouse Hanford Company), March 31, 1992.

Bhatia, R. K., *Bulk Tank Sampling - Tributyl Phosphate Loadout*, WP-P-92-021 (Richland, Washington: Westinghouse Hanford Company), April 3, 1992.

Bixby, W. W., "Termination of the Plutonium-Uranium Extraction (PUREX) Plant and Guidance to Proceed with Shutdown Planning and Terminal Cleanout Activities," memorandum to J. D. Waggoner (Washington, D.C.: U.S. Department of Energy), December 21, 1992.

- Bixby, W. W., "PUREX Deactivation Safety Strategy," internal memo to Assistant Manager for Waste Management, Richland, Operations Office (Washington, D.C.: U.S. Department of Energy), June 26, 1994.
- Bliss, R. J., "Material Management Issues Associated with the Plutonium-Uranium Extraction Plant," letter to J. R. Hunter, Correspondence No. 9259564D (Richland, Washington: Westinghouse Hanford Company), January 5, 1993.
- Blush, S. M., and T. H. Heitman, *Train Wreck Along the River of Money* (Washington, D.C.: Senate Committee on Energy and Natural Resources), March 1995.
- Bouten, J. S., *Panel B-1 Instrument Deactivation*, WP-P-93-009 (Richland, Washington: Westinghouse Hanford Company), March 2, 1993.
- Bowman, R. C., and C. P. Strand, *Federal Facility Agreement and Consent Order Change Control Form*, Change Number P-06-96-01 (Richland, Washington: Westinghouse Hanford Company), February 26, 1996.
- Bracken, G. J., J. E. Mecca, J. R. Hunter, and P. F. X. Dunigan, "PUREX/UO<sub>3</sub> Deactivation project National Environmental Policy Act Compliance Strategy Information Memo" (Richland, Washington: U.S. Department of Energy, Richland Operations Office), November 1993.
- Bray, L. A., *Denitration of PUREX Wastes with Sugar*, HW-76973, Rev. (Richland, Washington: General Electric Hanford Company), April 1963.
- Brogdon, R. C., Hamrick, D. G., Cartmell, D. B., *Change Control Request: FY 1994 PUREX Funding for Security Transition Program Office*, FO-94-001 (Richland, Washington: Westinghouse Hanford Company), October 1, 1993.
- Buckley, L. L., *J-Cell Canyon Floor Samples*, WP-P-90-023 (Richland, Washington: Westinghouse Hanford Company), July 17, 1990.
- Buckley, L. L., *TK-J1 Functional Test*, WP-P-90-030 (Richland, Washington: Westinghouse Hanford Company), September 25, 1990.
- Butler, D., "Re: Letter, R. G. Holt, U.S. Department of Energy, R. E. Lerch, WHC, to D. Butler, Ecology, 'Development of PUREX Deactivation Regulatory Compliance Approach,' DOE/RL-93-RPS-326, dated September 30, 1993," letter to R. G. Holt and R. E. Lerch (Olympia, Washington: Washington State Department of Ecology), March 14, 1994.
- Cahow, D. L., *PUREX Oxide Conversion Facility, Preliminary Safety Analysis Report*, RHO-CD-704 (Richland, Washington: Rockwell Hanford Operations), 1979.
- Cameron, K. D., "Approved Change Request TP-96-002, PUREX Phase II Schedule Changes," letter to President, Westinghouse Hanford Company, Correspondence No. 96-PID-CR-008 (Richland, Washington: U.S. Department of Energy), January 11, 1996.

Carr, P. S., Jr., *Completion Report: Expansion of 200 Area Facilities*, HW-24800-105 (Richland, Washington: General Electric Hanford Company), July 1, 1958.

Cartmell, D. B., *Transition Projects FY 1995 Multi-Year Program Plan (MYPP)/Fiscal Year Work Plan (FYWP) WBS 1.3.1 and 7.1*, WHC-SP-1126, Vol. IV (Richland, Washington: Westinghouse Hanford Company), September 1994.

Cartmell, D. B., *Change Control Request: PUREX Workscope and Budget Reductions*, TP-95-023 (Richland, Washington: Westinghouse Hanford Company), June 27, 1995.

Cartmell, D. B., *Change Control Request: Reduction of PUREX Canyon Workscope*, TP-95-034 (Richland, Washington: Westinghouse Hanford Company), June 27, 1995.

Cartmell, D. B., *Change Control Request: Phase II Schedule Changes*, TP-96-002 (Richland, Washington: Westinghouse Hanford Company), October 3, 1995.

Cartmell, D. B., *Change Control Request: PUREX Organic Disposal Carryover Workscope*, TP-96-003 (Richland, Washington: Westinghouse Hanford Company), October 3, 1995.

Cartmell, D. B., *Change Control Request: PUREX Electrical Modification Carryover Workscope*, TP-96-004 (Richland, Washington: Westinghouse Hanford Company), October 3, 1995.

Cartmell, D. B., *Change Control Request: Realign PUREX Resources per ABC Estimate*, TP-96-010 (Richland, Washington: Westinghouse Hanford Company), November 27, 1995.

Cartmell, D. B., *Change Control Request: PUREX Electrical Substation*, TP-96-015 (Richland, Washington: Westinghouse Hanford Company), January 15, 1996.

Cartmell, D. B., *Change Control Request: Facility Transition Consolidated Operations for Program Effectiveness*, TP-96-034 (Richland, Washington: Westinghouse Hanford Company), June 19, 1996.

Carville, R. R., *PUREX Power Manual*, WHC-IP-0249 (Richland, Washington: Westinghouse Hanford Company), August 1988.

Carville, R. R., *Pre-Filter Changeout, White Room Exhaust*, WP-P-90-004 (Richland, Washington: Westinghouse Hanford Company), March 5, 1990.

Carville, R. R., *Perform 291-AE Filter Changeout*, WP-P-90-009 (Richland, Washington: Westinghouse Hanford Company), April 10, 1990.

Champy, J., *Re-engineering Management* (New York: Harper Collins Publishers), 1995.

Clements, T., letter to H. R. O'Leary (Washington D.C.: Greenpeace), August 11, 1994.

- Conklin, A. W., *Approval for Transfer of 20,200 Gallons of Solvent from PUREX Facility (A PUREX Deactivation Activity)* (Olympia, Washington: Washington State Department of Health), September 3, 1993.
- Conklin, A. W., letter to J. D. Bauer, No. AIR-94-311 (Olympia, Washington: Washington State Department of Health), March 18, 1994.
- Conklin, A. W., letter to J. D. Bauer, No. AIR-94-313 (Olympia, Washington: Washington State Department of Health), March 30, 1994.
- Conklin, A. W., letter to J. E. Rasmussen, AIR-95-1201 (Olympia, Washington: Washington Department of Ecology), December 4, 1995.
- Conklin, A. W., letter to J. E. Rasmussen, AIR-96-603 (Olympia, Washington: Washington Department of Ecology), June 7, 1996.
- Coppinger, E. A., *Pilot Plant Denitration of PUREX Waste with Sugar*, HW-77080 (Richland, Washington: General Electric Hanford Company), March 29, 1963.
- Courtney, J. J., and B. E. Clark, Jr., *An Introduction to the PUREX Plant*, HW-32413-DEL (Richland, Washington: General Electric Hanford Company), July 15, 1954.
- CSC Index, *Westinghouse Hanford Company: Diagnostic Workshop*, CS21810-JSW-Workshop2 (San Francisco, California: CSC Index, Inc.), March 1995.
- CSC Index, *Westinghouse Hanford Company: Plant Team: Case for Action and Operating Vision*, CS21810-MXP-PlantCFA (San Francisco, California: CSC Index, Inc.), May 1995.
- CSC Index, *Westinghouse Hanford Company: Plant Team: Deactivation/Modification Process*, CS21810-KSW-DeacStep (San Francisco, California: CSC Index, Inc.), August 1995.
- CSC Index, *Westinghouse Hanford Company: Plant Team: Assumptions*, CS21810-SLP-ProcAssump (San Francisco, California: CSC Index, Inc.), October 1995.
- CSC Index, *Westinghouse Hanford Company: Plant Team: Generic Redesign Organizational Entities*, CS21810-SLP-GenOrgEnt (San Francisco, California: CSC Index, Inc.), October 1995.
- CSC Index, *Westinghouse Hanford Company: Plant Team: High Level Job Descriptions*, CS21810-MKB-JobDescr (San Francisco, California: CSC Index, Inc.), October 1995.
- CSC Index, *Westinghouse Hanford Company: Culture Change Activities*, CS21810-DGH-Pres (San Francisco, California: CSC Index, Inc.), October 1995.

CSC Index, *Westinghouse Hanford Company: Plant Team: Open Issues*, CS21810-GPD-IssueLog (San Francisco, California: CSC Index, Inc.), October 1995.

CSC Index, *Westinghouse Hanford Company: Plant Team: Work Team Roles*, CS21810-KSW-RoleDefs (San Francisco, California: CSC Index, Inc.), October 1995.

CSC Index, *Westinghouse Hanford Company: Requirements Team: Requirements Overview*, CS21810-GPD-REQR (San Francisco, California: CSC Index, Inc.), October 1995.

CSC Index, *Westinghouse Hanford Company: Requirements Team: Surveillance Operating Process*, CS21810-KSW-SurvStep (San Francisco, California: CSC Index, Inc.), October 1995.

CSC Index, *Westinghouse Hanford Company: Requirements Team: Work Control Process*, CS21810-KSW-WrkCntrl (San Francisco, California: CSC Index, Inc.), October 1995.

CSC Index, *Westinghouse Hanford Company: PUREX Reengineering Lessons Learned*, CS21810-SLP-PURLesLrnd (San Francisco, California: CSC Index, Inc.), December 1995.

Dale, T. R., *Isolation of the PUREX Analytical Laboratory* (Richland, Washington: Westinghouse Hanford Company), May 17, 1993.

Davis, K. A., T. L. Main, and D. B. Cartmell, *Change Control Request: Overhead Rate Reduction*, TP-95-026 (Richland, Washington: Westinghouse Hanford Company), June 29, 1995.

Development Dimensions International, *Team Start-up Kit Participant Booklet* (Pittsburgh, Pennsylvania: Development Dimensions International), 1992.

DeVries, M. L., *Splitting Tanks D-5/E-6 Solution for Cold Standby*, WP-P-91-114 (Richland, Washington: Westinghouse Hanford Company), August 29, 1991.

DeVries, M. L., *Drain Lines from TK-105 to TK-324*, WP-P-92-015 (Richland, Washington: Westinghouse Hanford Company), March 20, 1992.

DeVries, M. L., *Clean of First Stage Calciner*, WP-P-92-031 (Richland, Washington: Westinghouse Hanford Company), May 14, 1992.

DeVries, M. L., *Drying and Packing N-Cell Powder*, WP-P-92-040 (Richland, Washington: Westinghouse Hanford Company), June 22, 1992.

DeVries, M. L., *Clean Up for Second Stage Calciner*, WP-P-92-052 (Richland, Washington: Westinghouse Hanford Company), August 11, 1992.

DeVries, M. L., *Clean Out of Tanks TK-306-U, TK-307-U and TK-308-U*, WP-UO-93-001 (Richland, Washington: Westinghouse Hanford Company), January 26, 1993.

- Dials, G. E., "Shipment of Solvent from Hanford to the Idaho Chemical Processing Plant at the INEL (NP-MB-93337)," letter to D. L. Humphrey (Idaho Falls: U.S. Department of Energy), September 2, 1993.
- Divencenzo, E. P., and W. A. Peiffer, *Program Plan to Upgrade the PUREX Final Safety Analysis Report*, WHC-SD-CP-PLN-007 (Richland, Washington: Westinghouse Hanford Company), December 1990.
- Dodd, E. N., *PUREX Deactivation Health and Safety Documentation*, WHC-SD-CP-HSP-002, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), December 21, 1994.
- Dodd, E. N., "PUREX Integrated Safety Comparison," internal memo 17700-94-022 (Richland, Washington: Westinghouse Hanford Company), August 15, 1994.
- Dodd, E. N., *Plutonium Uranium Extraction (PUREX) End State Basis for Interim Operations*, HNF-SD-CP-ISB-004 (Richland, Washington: B&W Hanford Company), 1997.
- Dodd, E. N., *Plutonium Uranium Extraction (PUREX) Storage Tunnels Basis for Interim Operations*, HNF-SD-CP-ISB-005 (Richland, Washington: B&W Hanford Company), 1997.
- DOE, *Headquarters Public Participation Implementation Plan* (Washington, D.C.: U.S. Department of Energy), 1994.
- DOE, *Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans: DOE Standard*, DOE-STD-3011-94 (Washington, D.C.: U.S. Department of Energy), 1994.
- DOE, *Decommissioning Resource Manual*, DOE/EM-0246 (Washington, D.C.: U.S. Department of Energy), August 1995.
- DOE, *Integrating Safety and Health During Deactivation*, DOE/EH-0486 (Washington, D.C.: U.S. Department of Energy), September 29, 1995.
- DOE, *Facility Deactivation End Points Handbook*, Draft Rev. 3 (Washington, D.C.: U.S. Department of Energy), November 1995.
- "DOE to be Cut by \$10.6 Billion; EM Program to Focus on Risks," in *Nuclear Waste News* (Silver Springs, Maryland: Business Publishers, Inc.), December 22, 1994.
- "DOE Uses Interstate Routing for Nitric Acid Shipments" *HazMat Transport News*, (Silver Springs, Maryland: Business Publishers, Inc.), June 19, 1995.
- DOE-RL, *Draft Environmental Impact Statement, Operation of PUREX and Uranium Oxide Facilities*, DOE/EIS-0089D (Richland, Washington: U.S. Department of Energy, Richland Operations Office), May 1982.
- DOE-RL, *Addendum to Environmental Impact Statement, Operation of PUREX and Uranium Oxide Facilities*, DOE/EIS-0089 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), February 1983.

DOE-RL, *PUREX Storage Tunnels Dangerous Waste Permit Application*, DOE/RL-90-24, Rev. 1 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), December 1991.

DOE-RL, *Hanford Facility Dangerous Waste Part A Permit Application*, Form 3, Rev. 2, for the PUREX Plant, DOE/RL-88-21 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), 1992.

DOE-RL, *PUREX/UO<sub>3</sub> Plant Deactivation: The Transition to Decontamination and Decommissioning* (Richland, Washington: U.S. Department of Energy, Richland Operations Office), March 1994.

DOE-RL, *Environmental Assessment: Disposition and Transportation of Surplus Low Specific Activity Nitric Acid*, DOE/EA-1005D (Richland, Washington: U.S. Department of Energy, Richland Operations Office), February 1995.

DOE-RL, *Environmental Assessment: Transfer of Plutonium-Uranium Extraction Plant and N Reactor Irradiated Fuel for Storage at the 105-KE and 105-KW Fuel Storage Basins, Hanford Site, Richland, Washington*, DOE/EA-0988 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), July 1995.

DOE-RL, *Hanford Facility Dangerous Waste Part A Permit Application*, Form 3, Rev. 6, for the PUREX Plant, DOE/RL-88-21 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), August 21, 1995.

DOE-RL, *Hanford Facility Dangerous Waste Permit Application: PUREX Storage Tunnels*, DOE/RL-90-24, Rev. 2 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), November 1995.

DOE-RL, *Department of Energy Receives Three Proposals for the Project Hanford Management Contract*, RL Announcement No. 96-078 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), March 25, 1996.

DOE-RL, *Washington State Historic Preservation Office, and National Advisory Council on Historic Preservation, Draft: Programmatic Agreement Among the U.S. Department of Energy, the National Advisory Council on Historic Preservation and the Washington State Historic Preservation Office For the Maintenance, Deactivation, Alteration and Demolition of the Built Environment on the Hanford Site, Washington* (Richland, Washington: U.S. Department of Energy, Richland Operations Office), April 1996.

DOE-RL, *Hanford Facility Dangerous Waste Part A Permit Application*, Form 3, Rev. 7, for the PUREX Plant, DOE/RL-88-21 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), May 17, 1996.

DOE-RL, *PUREX Facility Preclosure Work Plan*, DOE/RL-95-78 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), June 1996.

Domnoske, L. A., *Technical Information for the PUREX Facility in Standby*, WHC-SD-CP-TI-189 (Richland, Washington: Westinghouse Hanford Company), January 1994.

Donn, S. G., "Justification for Plant Modifications Costs and Payment," letter to L. Weiner (Richland, Washington: British Nuclear Fuels, Ltd.), October 17, 1994.

Drivdahl, K. S., *TK-J2 Transfer to UGS*, WP-P-92-055 (Richland, Washington: Westinghouse Hanford Company), September 3, 1992.

Drivdahl, K. S., *Tank PS Transfer to Tank P3*, WP-P-92-064 (Richland, Washington: Westinghouse Hanford Company), November 16, 1992.

Drivdahl, K. S., *Measure Heels in 211-A Tanks*, WP-P-93-007 (Richland, Washington: Westinghouse Hanford Company), February 24, 1993.

Drivdahl, K. S., *Video Tape 211-A Tanks*, WP-P-93-008 (Richland, Washington: Westinghouse Hanford Company), February 25, 1993.

Drivdahl, K. S., *Flush 211-ATKS (11,12 42)*, WP-P-94-038 (Richland, Washington: Westinghouse Hanford Company), October 19, 1994.

DuBois, D. P., *Approval of Application to Construct No. PSD-X00-14* (Seattle, Washington: U.S. Environmental Protection Agency), 1980.

Duckworth, J. P., *PUREX Neptunium Recovery and Purification Information Manual*, HW-77678 (Richland, Washington: General Electric Hanford Company), April 1, 1963.

Duncan, R. A., *PUREX Organic Solvent Usage Variance Request* (Richland, Washington: Westinghouse Hanford Company), January 6, 1994.

Dunigan, P. F. X., "Categorical Exclusion for: Deactivation, De-Energization, or Isolation of Unneeded Plant Systems and Stabilization in Hanford Facilities, All Areas, Hanford Site, Richland, Washington," letter to R.H. Engelmann, Correspondence No. Incoming 9600388 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), February 1996, with enclosure *Categorical Exclusion for: Deactivation, De-Energization, or Isolation of Unneeded Plant Systems and Stabilization in Hanford Facilities, All Areas, Hanford Site, Richland, Washington*.

Dunigan, P. F. X., *Radioactive Air Emissions Notice of Construction (NOC) for Storage of Liquid Waste Tank Cars and the 325 Building Waste in the Plutonium Extraction (PUREX) Storage Tunnel Number 2*, 96-EAP-111 (Richland, Washington: U.S. Department of Energy), May 20, 1996, with enclosure *Radioactive Air Emissions Notice of Construction for Storage of Liquid Waste Tank Cars and the 325 Building Waste in the Plutonium Extraction (PUREX) Storage Tunnel Number 2*.

Ecology, EPA, and DOE, 1994, *Hanford Federal Facility Agreement and Consent Order*, Fifth Amendment (Olympia, Washington: Washington State Department Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy), July 1995.

*Ecology, EPA, and DOE, 1994, Hanford Federal Facility Agreement and Consent Order, Revision 4, Fifth and Sixth Amendments (Olympia, Washington: Washington State Department Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy), February 1996.*

*Eiholzer, S. M., Transfer of Flush Solution in Canyon Process Vessels, WP-P-90-036 (Richland, Washington: Westinghouse Hanford Company), December 20, 1990.*

*Eiholzer, S. M., Transfer of Flush Solution in Canyon Process Vessels, K&R Cell 1, WP-P-91-008 (Richland, Washington: Westinghouse Hanford Company), February 20, 1991.*

*Eiholzer, S. M., Transfer of Waste Solution in F Cell to UGS, WP-P-91-009 (Richland, Washington: Westinghouse Hanford Company), February 22, 1991.*

*Eiholzer, S. M., Transfer of Flush Solution in Canyon Process Vessels Final Layup, WP-P-91-015 (Richland, Washington: Westinghouse Hanford Company), March 13, 1991.*

*Eiholzer, S. M., Wet GB Flush N Cell, Wet Glove Box Flush, WP-P-91-016 (Richland, Washington: Westinghouse Hanford Company), March 20, 1991.*

*Eiholzer, S. M., Transfer of Solutions from TK-L11 to TK-E6, WP-P-92-017 (Richland, Washington: Westinghouse Hanford Company), March 30, 1992.*

*Eiholzer, S. M., Video Tape TK-P3-UNH/Organic Phase, WP-P-93-012 (Richland, Washington: Westinghouse Hanford Company), March 16, 1993.*

*Eiholzer, S. M., Drainage of Acid Line at P&O Gallery Nozzle KG-70, WP-P-93-026 (Richland, Washington: Westinghouse Hanford Company), June 15, 1993.*

*Eiholzer, S. M., Transfer of Solution from UNH Tanker to TK-P2, WP-P-93-029 (Richland, Washington: Westinghouse Hanford Company), September 2, 1993.*

*Eiholzer, S. M., H & J Cell Solution Transfer, WP-P-93-034 (Richland, Washington: Westinghouse Hanford Company), September 27, 1993.*

*Eiholzer, S. M., Operate Lab Water Still, WP-P-93-041 (Richland, Washington: Westinghouse Hanford Company), October 22, 1993.*

*Eiholzer, S. M., L-Cell Package Solution Transfer, WP-P-93-044 (Richland, Washington: Westinghouse Hanford Company), November 2, 1993.*

*Eiholzer, S. M., Flush UNH Tank Trailer, WP-P-94-026 (Richland, Washington: Westinghouse Hanford Company), May 15, 1994.*

*Eiholzer, S. M., Load 55-Gallon Drum with NaOH, WP-P-94-032 (Richland, Washington: Westinghouse Hanford Company), August 22, 1994.*

Eng, C. C., "Worker Safety and Health Issues Related to the PUREX Deactivation Project," memorandum to R. Martinez, Draft (Washington, D.C.: U.S. Department of Energy), July 1, 1993.

Eng., C. C., Letter to D. G. Hamrick (Washington, D.C.: U.S. Department of Energy), July 18, 1994.

Engelmann, R. H., "Categorically Excluded Actions: Plutonium-Uranium Extraction Facility Deactivation, 200 East Area, Hanford Site, Richland, Washington," Internal Memo 88800-94-012 (Richland, Washington: Westinghouse Hanford Company), March 3, 1994, with enclosure: *Categorically Excluded Actions, PUREX Facility Deactivation, 200 East Area, Hanford Site, Richland, Washington.*

Engelmann, R. H., "Information Bulletin: Plutonium-Uranium Extraction Plant Heating, Ventilation and Air Conditioning Modifications, 200 East Area, Hanford Site, Richland, Washington," Internal Memo 88800-94-037, Rev. 1 (Richland, Washington: Westinghouse Hanford Company), June 14, 1994.

Engelmann, R. H., *Information Bulletin: Plutonium-Uranium Extraction Plant Heating, Ventilating and Air Conditioning Modifications, 200 East Area, Hanford Site, Richland, Washington*, 94-PPO-26 (Richland, Washington: Westinghouse Hanford Company), June 1994, with enclosure: *Categorical Exclusion for Plutonium-Uranium Extraction Plant Heating, Ventilating and Air Conditioning Modifications, 200 East Area, Hanford Site, Richland, Washington.*

Engelmann, R. H., "Categorically Excluded Actions:  $UO_3$  Facility Deactivation, 200 East [sic] Area, Hanford Site, Richland, Washington," Internal Memo 88800-94-200 (Richland, Washington: Westinghouse Hanford Company), September 26, 1994, with attachment: *Categorically Excluded Actions:  $UO_3$  Facility Deactivation, 200 East [sic] Area, Hanford Site, Richland, Washington.*

Enghusen, M. B., *Flush TK20 for Coil Replacement*, WP-P-90-003 (Richland, Washington: Westinghouse Hanford Company), March 5, 1990.

Enghusen, M. B., *Vent Hydrazine Drums*, WP-P-90-027 (Richland, Washington: Westinghouse Hanford Company), August 6, 1990.

Enghusen, M. B., *Load 55-Gallon Drum with 25 NY.% NaOH*, WP-P-90-031 (Richland, Washington: Westinghouse Hanford Company), December 6, 1990.

Enghusen, M. B., *PUREX Chapter 11 Implementation Plan for Revision 6 of the PUREX Final Safety Analysis Report*, WHC-SD-CP-RD-021, Rev. 3 (Richland, Washington: Westinghouse Hanford Company), April 30, 1992.

Enghusen, M. B., *Dissolver Heels Inspection*, WP-P-93-030 (Richland, Washington: Westinghouse Hanford Company), September 7, 1993.

Enghusen, M. B., *Perform Three Well Cask Car PM Check*, WP-P-94-019 (Richland, Washington: Westinghouse Hanford Company), March 23, 1994.

Enghusen, M. B., *Transfer of Water from the Slug Storage Basin*, WP-P-94-024 (Richland, Washington: Westinghouse Hanford Company), April 26, 1994.

Enghusen, M. B., *PUREX N3 and N4 Glovebox Deactivation* (Richland, Washington: Westinghouse Hanford Company), April 26, 1994.

Enghusen, M. B., *Perform SPR Fuel Basket Load Test and Removal Evap*, WP-P-94-028 (Richland, Washington: Westinghouse Hanford Company), June 29, 1994.

Enghusen, M. B., *Alternatives for the Disposition of Fuel Stored in the PUREX Facility* (Richland, Washington: Westinghouse Hanford Company), July 1994.

Enghusen, M. B. and M. C. Hatch, *Fuel Rod Rinse Table Assembly*, H-2-821804.Sht 1 and H-2-821804.Sht 7 (Richland, Washington: Westinghouse Hanford Company), 1994.

Enghusen, M. B. and M. C. Hatch, *Fuel Rod Rinse Table Main Frame Assembly*, H-2-821804.Sht 2 (Richland, Washington: Westinghouse Hanford Company), 1994.

Enghusen, M. B. and M. C. Hatch, *Fuel Rod Rinse Table Sub-Frame Assembly*, H-2-821804.Sht 3 (Richland, Washington: Westinghouse Hanford Company), 1994.

Enghusen, M. B. and M. C. Hatch, *Fuel Rod Rinse Table, Assembly and Details*, H-2-821804.Sht 4 (Richland, Washington: Westinghouse Hanford Company), 1994.

Enghusen, M. B. and M. C. Hatch, *Fuel Rod Rinse Table Lifting Bail Assembly*, H-2-821804.Sht 5 (Richland, Washington: Westinghouse Hanford Company), 1994.

Enghusen, M. B. and M. C. Hatch, *Fuel Rod Rinse Table Dumping Trunnion Assembly*, H-2-821804.Sht 6 (Richland, Washington: Westinghouse Hanford Company), 1994.

Enghusen, M. B. and L. T. Aikin, *Fuel Rod Rinse Table Lifting Stirrup*, H-2-821804.Sht 8 (Richland, Washington: Westinghouse Hanford Company), 1994.

Enghusen, M. B. and M. C. Hatch, *Fuel Canister Capping Station, Assembly*, H-2-821831 (Richland, Washington: Westinghouse Hanford Company), 1994.

Enghusen, M. B., *Load N Reactor and SPR Fuel into Cask Cars and Ship to K Basins*, WP-P-95-038 (Richland, Washington: Westinghouse Hanford Company), September 18, 1995.

"Environmental Victory," in *Hanford Reach* (Richland, Washington: U.S. Department of Energy, Richland Operations Office), July 10, 1995, pp. 6-7.

- Ethington, P. R., *Clean Up Dry Glove Boxes*, WP-P-91-003 (Richland, Washington: Westinghouse Hanford Company), February 6, 1991.
- Ethington, P. R., *Perform Flush of the Backup Facility*, WP-P-91-014 (Richland, Washington: Westinghouse Hanford Company), March 11, 1991.
- Ethington, P. R., *PR Room Cleanup*, WP-P-91-094 (Richland, Washington: Westinghouse Hanford Company), June 24, 1991.
- Ethington, P. R., *Control B-2 Instrument Deactivation*, WP-P-93-003 (Richland, Washington: Westinghouse Hanford Company), February 11, 1993.
- Ethington, P. R., *Control B-3 Instrument Deactivation*, WP-P-93-004 (Richland, Washington: Westinghouse Hanford Company), February 16, 1993.
- Ethington, P. R., *Instruments Deactivation*, WP-P-93-005 (Richland, Washington: Westinghouse Hanford Company), February 17, 1993.
- Ethington, P. R., *Inhibit CAS System*, WP-P-93-013 (Richland, Washington: Westinghouse Hanford Company), March 17, 1993.
- Ethington, P. R., *Personal Area Radiation Monitor Deactivation*, WP-P-93-016 (Richland, Washington: Westinghouse Hanford Company), March 31, 1993.
- Ethington, P. R., *CAS Maintenance Work Plan*, WP-P-93-017 (Richland, Washington: Westinghouse Hanford Company), April 8, 1993.
- Ethington, P. R., *Concentrate Waste in Concentrator E-F11*, WP-P-93-046 (Richland, Washington: Westinghouse Hanford Company), November 2, 1993.
- Ethington, P. R., *Pump Out SX3*, WP-P-94-021 (Richland, Washington: Westinghouse Hanford Company), April 5, 1994.
- Everett, B. K., *Cleanout of Water Separator Tank F-620-1*, WP-P-93-028 (Richland, Washington: Westinghouse Hanford Company), August 16, 1993.
- "Everyone Tied into TEDF," in *Hanford Reach* (Richland, Washington: U.S. Department of Energy, Richland Operations Office), June 5, 1995, p. 3.
- Farren, J. D., *P-Tank Heel Consolidation*, WP-P-93-021 (Richland, Washington: Westinghouse Hanford Company), May 10, 1993.
- Farren, J. D., *211-A Facility Deactivation Activities*, WP-P-93-040 (Richland, Washington: Westinghouse Hanford Company), October 22, 1993.
- Farren, J. D., *Flush Back-Cycle Waste and Neptunium Package Vessel*, WP-P-93-043 (Richland, Washington: Westinghouse Hanford Company), November 1, 1993.
- Farren, J. D., *Organic Solvent Transfer to Tank-40*, WP-P-93-051 (Richland, Washington: Westinghouse Hanford Company), December 8, 1993.

- Farren, J. D., *Removal of NaOH Tanks from 215-A Facility*, WP-P-94-010 (Richland, Washington: Westinghouse Hanford Company), January 27, 1994.
- Farren, J. D., *Removal of Pumps from 211-A Facility*, WP-P-94-011 (Richland, Washington: Westinghouse Hanford Company), January 27, 1994.
- Farren, J. D., *Flush Neptunium Storage Tank, Tank J-2*, WP-P-94-029 (Richland, Washington: Westinghouse Hanford Company), August 8, 1994.
- Farren, J. D., *Flush U-Cell Vessels*, WP-P-94-033 (Richland, Washington: Westinghouse Hanford Company), August 23, 1994.
- Feldt, L., and L. Weiner, "British Nuclear Fuels Facility Plant Modifications," memorandum to file (Washington, D.C.: U.S. Department of Energy), October 19, 1994.
- Forehand, G. D., *PUREX PMP Workshop: Stakeholder Working Session* (Richland, Washington: Westinghouse Hanford Company), April 14, 1993.
- Fox, R. D., *PUREX Process Control Manual*, RHO-RE-MA-5 (Richland, Washington: Rockwell Hanford Operations), July 13, 1983.
- Frankel, A., letter to J. E. Rasmussen (Seattle, Washington: U.S. Environmental Protection Agency), December 6, 1995.
- Geier, R. G., *PUREX Technical Manual: Chemical Processing*, WHC-SP-0479 (Richland, Washington: Westinghouse Hanford Company), September 1979.
- Geiger, J. L., *Combined Flush For Ventilation System 1*, WP-P-91-020 (Richland, Washington: Westinghouse Hanford Company), March 28, 1991.
- Geiger, J. L., *Install Cascade Impacter on PR Stack Sampler System*, WP-P-92-003 (Richland, Washington: Westinghouse Hanford Company), January 13, 1992.
- Geiger, J. L., *Install Cascade Impacter on PR Stack*, WP-P-92-004 (Richland, Washington: Westinghouse Hanford Company), January 14, 1992.
- Geiger, J. L., *Install Cascade Impacter on PUREX Main Stack*, WP-P-92-022 (Richland, Washington: Westinghouse Hanford Company), April 8, 1992.
- Geiger, J. L., *Install Laser Spectrometer on PR 296-A-1 Stack Cam*, WP-P-92-029 (Richland, Washington: Westinghouse Hanford Company), May 14, 1992.
- Geiger, J. L., *Install Laser Spectrometer on PR 296-A-1 Roof Location*, WP-P-92-030 (Richland, Washington: Westinghouse Hanford Company), May 14, 1992.
- Gerber, M. S., *A Brief History of the PUREX and UO<sub>3</sub> Facilities*, WHC-MR-0437 (Richland, Washington: Westinghouse Hanford Company), November 1993.
- Gerber, M. S., "Umatilla Indian Involvement at PUREX Praised," in *Hanford Reach* (Richland, Washington, U.S. Department of Energy, Richland Operations Office), October 10, 1994, p. 11.

Gonsalves, E., *Description of the 224-U Legacy Equipment*, WP-UO-94-008 (Richland, Washington: Westinghouse Hanford Company), July 12, 1994.

Gore, D., *Dissolver Heels Passivation*, WP-P-93-047 (Richland, Washington: Westinghouse Hanford Company), November 2, 1993.

Gore, D., *Dissolver Cell Fuel Retrieval and Packaging*, WP-P-95-010 (Richland, Washington: Westinghouse Hanford Company), March 13, 1995.

Gregonis, R. A., *Perform HEPA Filter Changeout* (FH-V11-4-10/291-AE), WP-P-91-029 (Richland, Washington: Westinghouse Hanford Company), May 7, 1991.

Gregonis, R. A., *Assembly of PUREX Canyon Exhaust Fan EF-U11-1*, WP-P-93-023 (Richland, Washington: Westinghouse Hanford Company), May 25, 1993.

Gregonis, R. A., *Perform HEPA Filter Change-Out* (FH-V11-4-9/291-AE), WP-P-93-038 (Richland, Washington: Westinghouse Hanford Company), October 21, 1993.

Gregonis, R. A., *Drain Water from BT#2 Exhaust System* (EF-V-12-1/296-A), WP-P-93-054 (Richland, Washington: Westinghouse Hanford Company), December 30, 1993.

Gregonis, R. A., *Disassembly of PUREX Exhaust Fan EF-V-11-2*, WP-P-94-007 (Richland, Washington: Westinghouse Hanford Company), January 10, 1994.

Gregonis, R. A., *Assembly of PUREX Exhaust Fan EF-V-11-2*, WP-P-94-008 (Richland, Washington: Westinghouse Hanford Company), January 10, 1994.

"Grumbly Seeks Savings in 'Budgetarily Challenged' Program," in *Energy Daily* (Washington, D.C.: King Communications Group), February 7, 1995.

Grumbly, T. P., memorandum to H.R. O'Leary (Washington, DC: U.S. Department of Energy), September 3, 1994.

Halupa, S., "Plutonium Uranium Extraction Plant Organic," memorandum to D. G. Hamrick, Memorandum No. SMH-137-93 (Idaho Falls: Westinghouse Idaho Nuclear Company, Inc.), September 2, 1993.

Ham, J. E., *Nitric Acid Transfer from U1 & U2 to F3*, WP-P-92-053 (Richland, Washington: Westinghouse Hanford Company), August 31, 1992.

Ham, J. E., *Instrument Deactivation Test*, WP-P-92-060 (Richland, Washington: Westinghouse Hanford Company), October 27, 1992.

Hammer, M., and J. Champy, *Re-engineering the Corporation* (New York: Harper Collins Publishers), 1993.

Hamrick, D. G., "Plutonium Uranium Extraction Plant Organic," letter to S. M. Halupa, Correspondence No. 9357446 (Richland, Washington: Westinghouse Hanford Company), August 31, 1993.

Hamrick, D. G., "National Environmental Policy Act Compliance for Deactivation of the Plutonium-Uranium Extraction Plant and the Uranium Oxide Plant," letter to J. E. Mecca, Correspondence No. 9358853 (Richland, Washington: Westinghouse Hanford Company), October 12, 1993, with enclosure: *PUREX/UO<sub>3</sub> Deactivation*.

Hamrick, D. G., "Information Bulletin: Disposal of Tri-N-Butylphosphate from the Plutonium-Uranium Extraction Facility, 200 East Area, Hanford Site, Richland, Washington," letter to J. E. Mecca, Correspondence No. 9354325.1 (Richland, Washington: Westinghouse Hanford Company), April 12, 1994, with enclosures: *Categorical Exclusion for the Disposal of Tri-N-Butylphosphate from the Plutonium-Uranium Extraction Facility, 200 East Area, Hanford Site, Richland, Washington*; Information Bulletin; Signature Page; National Environmental Policy Act Categorical Exclusion Determination.

Hamrick, D. G., "Memorandum of Understanding - Plutonium-Uranium Extraction Plant Low-Specific Activity Nitric Acid Shipments," letter to J. E. Mecca, Correspondence No. 9453904 (Richland, Washington: Westinghouse Hanford Company), June 3, 1994.

Hamrick, D. G., *Cold Standby Operating Specifications*, OSD-P-154-00001, Rev. A-0 (Richland, Washington: Westinghouse Hanford Company), June 30, 1994.

Hamrick, D. G., "Permitting and Interim Status Requirements Associated with Deactivation of the Plutonium-Uranium Extraction Facility," letter to J. E. Mecca, Correspondence No. 9454651D (Richland, Washington: Westinghouse Hanford Company), July 11, 1994.

Hamrick, D. G., "Request for the U.S. Department of Energy, Richland Operations Office (RL) Plateau Remediation Division Approval of the Uranium Trioxide (UO<sub>3</sub>) Deactivation End Point Criteria," letter to O. A. Farabee, Correspondence No. 9456181 (Richland, Washington: Westinghouse Hanford Company), September 15, 1994.

Hamrick, D. G., W. G. Jasen, and D. G. Harlow, *PUREX/UO<sub>3</sub> Deactivation Project Quarterly Review, October 31, 1994* (Richland, Washington: Westinghouse Hanford Company), October 31, 1994.

Hamrick, D. G. and M. S. Gerber, *PUREX/UO<sub>3</sub> Facilities Deactivation Lessons Learned History*, WHC-SP-1147, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), January 1995.

Hamrick, D. G., "Request for Transmittal of Memorandum of Agreement for Uranium Trioxide Facility Transfer," letter to O. A. Farabee and J. K. Erickson, Correspondence No. 9550094D (Richland, Washington: Westinghouse Hanford Company), January 9, 1995.

Hamrick, D. G., "Completion of Removing Process Waste From Plutonium Uranium Extraction Tanks D5 and E6," letter to J. E. Mecca, Correspondence No. 9552272 (Richland, Washington: Westinghouse Hanford Company), May 10, 1995.

Hamrick, D. G., "Completion of Spent Fuel Transfer From The Plutonium Uranium Extraction Facility to K-Basins," letter to J. E. Mecca, Correspondence No. 9555630 (Richland, Washington: Westinghouse Hanford Company), October 17, 1995.

Hamrick, D. G., "Transmittal of Preliminary Plutonium Uranium Extraction Facility Surveillance and Maintenance Plan," letter to J. E. Mecca, Correspondence No. 9651858 (Richland, Washington: Westinghouse Hanford Company), April 26, 1996, with enclosure: C. N. Villalobos, *Preliminary Plutonium Uranium Extraction (PUREX) Facility Surveillance and Maintenance Plan*.

Hamrick, D. G., "Performance Based Fee 96-116, 'Complete Glovebox (N-Cell, PR-Room, and Q-Cell) Stabilization at Plutonium Uranium Extraction Facility,' and PUREX Facility Transition Project Milestone TRP-96-202 'Complete N Cell Stabilization,'" letter to J. E. Mecca, Correspondence No. 9652754 (Richland, Washington: Westinghouse Hanford Company), June 20, 1996.

Hamrick, D. G., "Plutonium Uranium Extraction Facility Standards/Requirements Identification Document," letter to J. E. Mecca, Correspondence No. 9652217 (Richland, Washington: Westinghouse Hanford Company), June 24, 1996.

Hamrick, D. G., "Completion of Transition Projects, Plutonium Uranium Extraction Facility, Hanford Federal Facility Agreement and Consent Order," letter to J. E. Mecca, Correspondence No. 9653226 (Richland, Washington: Westinghouse Hanford Company), July 26, 1996.

Hanford Advisory Board, *Tracking the Hanford Cleanup, FY 1995* (Richland, Washington: U.S. Department of Energy, Richland Operations Office), 1995.

"Hanford Finishes Uranium Shipments," in *Tri-City Herald*, November 7, 1995, p. A7.

Harlow, D. G., *PUREX Transition to Standby Subprogram Plan*, WHC-SD-CP-SSP-004, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), February 7, 1991.

Harlow, D. G., J. W. Ryan, J. S. Hertzell, A. A. Grasher, W. G. Jasen, D. G. Hamrick, S. L. Sinnema, T. L. Main, D. B. Cartmell, *Change Control Request: Disposal of Nitric Acid to BNFL/D5/E6 to Tank Farms*, FO-94-019 (Richland, Washington: Westinghouse Hanford Company), May 10, 1994.

Harlow, D. G., "Unreviewed Safety Question Procedure Changes," internal memo 17700-94-017 (Richland, Washington: Westinghouse Hanford Company), June 9, 1994.

Harlow, D. G., A. A. Grasher, D. G. Hamrick, S. L. Sinnema, T. L. Main, D. B. Cartmell, *Change Control Request: Nitric Acid Environmental Assessment*, TP-95-009 (Richland, Washington: Westinghouse Hanford Company), January 1995.

Harlow, D. G., A. A. Grasher, D. G. Hamrick, K. A. Davis, T. L. Main, D. B. Cartmell, *Change Control Request: PUREX Organic Disposal*, TP-95-019 (Richland, Washington: Westinghouse Hanford Company), May 23, 1995.

Harrow, D. G., *L-Cell Entry I*, WP-P-90-020 (Richland, Washington: Westinghouse Hanford Company), July 5, 1990.

Harrow, D. G., *L-11 Criticality Drain Recovery Plan*, WP-P-90-033 (Richland, Washington: Westinghouse Hanford Company), December 17, 1990.

Harty, D. P., *PUREX Stabilization Run*, WHC-SD-CP-PE-014, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), August 1990.

Harty, D. P., *Flush L-Cell*, WP-P-93-042 (Richland, Washington: Westinghouse Hanford Company), October 26, 1993.

Harty, D. P., *Disposition of PUREX Facility Tanks D5 and E6 Uranium and Plutonium Solutions*, WHC-SP-1072 (Richland, Washington: Westinghouse Hanford Company), December 1993.

Harty, D. P., *Preliminary Support Activities for D5/E6 Flushing*, WP-P-94-018 (Richland, Washington: Westinghouse Hanford Company), March 16, 1994.

Harty, D. P., *Transfer D5/E6 Material to Tank Farms*, WP-P-94-022 (Richland, Washington: Westinghouse Hanford Company), April 6, 1994.

Harvey, D. W., "No Known Affected Historic Properties," letter to W. J. Jasen (Richland, Washington: Pacific Northwest Laboratory), February 28, 1994.

Hauber, R. D. "U.S. Nuclear Regulatory Commission Export License," No. XSNM02827 (Washington, D.C.: U.S. Nuclear Regulatory Commission), November 22, 1994.

Hess, A. L. and T. Chiao, "Applicability of CSER-86-001, Addendum 1, to Painting Inside of N3/N4 Gloveboxes in PUREX to Fix Residual Plutonium," memo to file, 8M730-ALH/TC-90-001 (Richland, Washington: Westinghouse Hanford Company), May 21, 1996.

Hetzer, L. E., *PUREX Weekly Status Report* (Richland, Washington: Westinghouse Hanford Company), November 14, 1995.

Hobart, R. L., *SCD Effluent Heater Source Blanking, 202-A*, WP-P-91-030 (Richland, Washington: Westinghouse Hanford Company), May 8, 1991.

Hobart, R. L., *CWL Flow Test*, WP-P-92-035 (Richland, Washington: Westinghouse Hanford Company), June 5, 1992.

Hobart, R. L., *Chiller*, WP-P-92-036 (Richland, Washington: Westinghouse Hanford Company), June 5, 1992.

Hobart, R. L., *CWL Effluent Heater Source Blanking, 202-A*, WP-P-91-031 (Richland, Washington: Westinghouse Hanford Company), May 22, 1991.

- Hobart, R. L., *PUREX HVAC Supply Air Data Collection*, WP-P-93-036 (Richland, Washington: Westinghouse Hanford Company), October 12, 1993.
- Hobart, R. L., *White Room Flow Diversion*, WP-P-94-012 (Richland, Washington: Westinghouse Hanford Company), January 27, 1994.
- Hobart, R. L., *PUREX Heating, Ventilation and Air Conditioning (HVAC) System Consolidation Document*, WHC-SD-CP-CR-037, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), October 30, 1995.
- Hodges, W. R., *Radiological History of the PUREX Facility, 1955 to 1989*, TRAC-0672 (Richland, Washington: Westinghouse Hanford Company), August 1989.
- Holt, R. G., "Applicability of Washington 173-303 to Nitric Acid at PUREX and Planned Transfer to British Nuclear Fuels Ltd. (BNFL)," letter to D. Lundstrom (Richland, Washington: U.S. Department of Energy), September 23, 1994, with enclosure: *White Paper, Regulatory Status of Nitric Acid at PUREX identified in a contract for Use by BNFL*.
- Hughes, M. C., "PUREX Deactivation Criteria for Acceptance by Decontamination and Decommissioning (D&D)," Internal Memo 85000-93-0012 (Richland, Washington: Westinghouse Hanford Company), March 25, 1993.
- Hunter, J. R., "Beneficial Use of PUREX Plant Organic Solvent Inventory," memorandum to T. F. Burns, 94-PPO-006 (Richland, Washington: U.S. Department of Energy), February 8, 1994.
- Hunter, J. R., "Energy Policy Act of 1982 Impact Upon Proposal to Make PUREX LEU Nitric Acid Available for Use by Others," letter to President, Westinghouse Hanford Company, Correspondence No. 94-PPO-016 (Richland, Washington: U.S. Department of Energy), March 31, 1994.
- Independent Technical Review Team, *Independent Technical Review of the Hanford PUREX Plant Transition to Deactivation*, (Washington, D.C.: U.S. Department of Energy), October 1992.
- Industrial Safety and Fire Protection, *Industrial Safety Standards*, WHC-CM-4-3, Vol 1 (Richland, Washington: Westinghouse Hanford Company), December 1987.
- Industrial Safety and Fire Protection, *Industrial Safety Manual Safety Guides*, WHC-CM-4-3, Vol 2 (Richland, Washington: Westinghouse Hanford Company), December 1987), and as revised July 19, 1994.
- Industrial Safety and Fire Protection, *Industrial Safety Manual*, WHC-CM-4-3, Vol 3 (Richland, Washington: Westinghouse Hanford Company), December 1987, as revised May 25, 1993.
- Jasen, W. G., *PUREX/UO<sub>3</sub> Deactivation Project Public Involvement Process* (Richland, Washington: Westinghouse Hanford Company), April 6, 1994.

Jasen, W. G., *PUREX/UO<sub>3</sub> Deactivation Project Management Plan*, WHC-SP-1011, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), August 1994.

Jasen, W. G., *PUREX Deactivation Process* (Richland, Washington: Westinghouse Hanford Company), May 6, 1996.

Jensen, W. D., "Confirmation of Intended Reuse of Excess PUREX Material, OPE-CPP-BSA-94055," memorandum to J. R. Hunter (Idaho Falls, Idaho: U.S. Department of Energy), February 17, 1994.

Johnson, D. L., *Main Stack Flow Probe Examination*, WP-P-93-022 (Richland, Washington: Westinghouse Hanford Company), May 25, 1993.

Johnson, D. L., *Main Stack Characterization Work Plan*, WP-P-93-024 (Richland, Washington: Westinghouse Hanford Company), June 11, 1993.

Johnson, D. L., *Main Stack Measurement Validation Work Plan*, WP-P-93-027 (Richland, Washington: Westinghouse Hanford Company), July 14, 1993.

Johnson, D. L., *Main Stack Sampler Installation for DOH*, WP-P-93-033 (Richland, Washington: Westinghouse Hanford Company), September 21, 1993.

Johnson, D. L., *Flush F and U Cell Equipment*, WP-P-94-015 (Richland, Washington: Westinghouse Hanford Company), February 7, 1994.

Johnson, L. E., *5480.23 Requirements Crosswalk (Strategy and Process)*, *PUREX Deactivation Project Safety Strategy Workshop* (Richland, Washington: Westinghouse Hanford Company), June 11, 1993.

Johnson, L. E., N. R. Kerr, and R. L. Walser, *Crosswalk Documentation*, (Richland, Washington: Westinghouse Hanford Company), June 1993.

Julian, R. J., letter to J. E. Rasmussen and D. G. Hamrick (Kennewick, Washington: Washington State Department of Ecology), May 30, 1996.

Juraysi, M. and D. Duncan, letter to J. E. Rasmussen and J. E. Mecca (Kennewick, Washington: Washington State Department of Ecology), February 21, 1995.

KCM, Inc., *Westinghouse Hanford Company, PUREX/UO<sub>3</sub> Deactivation Project Modified Value Engineering Study* (Seattle, Washington: KCM, Inc.), March 1994.

KCM, Inc., *HVAC Consolidation, and Surveillance and Maintenance, PUREX Deactivation Project Modified Value Engineering Study* (Seattle, Washington: KCM, Inc.), June 1995.

Kerr, N. R., *Results of 5480.23 Crosswalk: PUREX Deactivation Projects Safety Documentation Strategy* (Richland, Washington: Westinghouse Hanford Company), June 11, 1993.

Kerr, N. R., *Worker Health and Safety: PUREX Deactivation Projects Safety Documentation Strategy* (Richland, Washington: Westinghouse Hanford Company), June 11, 1993.

KME Engineering, Inc., *PUREX Natural Ventilation Rate Study* (KME Engineering, Inc.), December 5, 1995.

Lee, G., "Nuclear Plant Cleanup Assailed," in *Washington Post* (Washington, D.C.), March 15, 1995.

Lobsenz, G., "O'Leary OKs Contested Nitric Acid Sale," in *Energy Daily* (Washington, D.C.), Vol. 22, No. 200, October 19, 1994.

Los Alamos Technical Associates, *PUREX Hazards Identification Training* (Kennewick, Washington: Los Alamos Technical Associates), June 30, 1994.

Los Alamos Technical Associates, *PUREX Hazards Baseline Document* (Kennewick, Washington: Los Alamos Technical Associates), July 1, 1994.

Los Alamos Technical Associates and British Nuclear Fuels, Ltd., *Final: Independent Design Review Document for the PUREX HVAC, Electrical, and Monitoring System Designs* (Richland, Washington: Los Alamos Technical Associates), March 1996.

Lundeen, J. O., R. R. Borisch, K. J. Proctor, T. L. Main, D. B. Cartmell, *Change Control Request: Project Time and Cost Expense Carryover Funding*, FO-94-022 (Richland, Washington: Westinghouse Hanford Company), May 9, 1994.

Lynch, J., "Hanford Dollars Squandered, Report Concludes," in *Spokesman-Review* (Spokane, Washington), March 15, 1995.

Margolin, D., *U-Cell Preparation for NDE*, WP-P-91-096 (Richland, Washington: Westinghouse Hanford Company), June 24, 1991.

Margolin, D., *NDE of U-Cell Waste Tank System*, WP-P-91-097 (Richland, Washington: Westinghouse Hanford Company), June 24, 1991.

Margolin, D., *NDE of M-Cell Waste Tank System*, ES F-11, WP-P-91-098 (Richland, Washington: Westinghouse Hanford Company), June 24, 1991.

Margolin, D., *M-Cell Prep Work (E5,F15)*, WP-P-91-104 (Richland, Washington: Westinghouse Hanford Company), July 22, 1991.

Massey, C. J., *PUREX HVAC/Electrical/Monitoring Design Review* (Richland, Washington: Los Alamos Technical Associates), March 8, 1996.

Matheison, W. E., *CSAR 80-018, Addendum 13, CAD's Servicing of Q Cell*, SD-SQA-CSA-032 (Richland, Washington: Rockwell Hanford Operation), December 8, 1986.

Matheison, W. E., *Facility Work Plan for Inhibiting CAS for Repair in PIV Rm*, WP-P-93-032 (Richland, Washington: Westinghouse Hanford Company), September 20, 1993.

McBride, D. J., *Flush Duct from 291-AE to Exhaust Fan Plenum*, WP-P-91-019 (Richland, Washington: Westinghouse Hanford Company), March 22, 1991.

McBride, D. J., *Sample Ductwork for Elevated main Stack Release*, WP-P-91-101 (Richland, Washington: Westinghouse Hanford Company), June 27, 1991.

McElfresh, A. J. and K. A. Williams, *Lifting Yoke Slug Bucket*, H-2-83605, Rev. 1 (Richland, Washington: Westinghouse Hanford Company), 1994.

McElfresh, A. J. and M. C. Hatch, *Fuel Rod Retrieval Device*, H-2-83634, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), 1994.

McElfresh, A. J. and K. S. Williams, *Basket Yoke Assembly*, H-1-50434, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), 1994.

McElfresh, A. J. and M. C. Hatch, *Slug Bucket Overpak Assembly*, H-2-821814, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), 1994.

McElfresh, A. J. and M. C. Hatch, *Lifting Yoke Overpak Assembly and Details*, H-2-821799, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), 1994.

McElfresh, A. J. and M. C. Hatch, *Fuel Grabber, Assembly and Details*, H-2-821803.Sht 1 (Richland, Washington: Westinghouse Hanford Company), 1994.

McElfresh, A. J. and M. C. Hatch, *Fuel Grabber, Assembly and Details*, H-2-821803.Sht 2 (Richland, Washington: Westinghouse Hanford Company), 1994.

McElfresh, A. J. and M. C. Hatch, *Fuel Grabber, Assembly and Details*, H-2-821803.Sht 3 (Richland, Washington: Westinghouse Hanford Company), 1994.

McElfresh, A. J. and L. T. Aikin, *Canister Cover Installer, Assembly and Details*, H2-821832 (Richland, Washington: Westinghouse Hanford Company), 1994.

McElfresh, A. J. and L. T. Aikin, *Canister Cover Installer Impact Wrench Extension*, H-2-821833 (Richland, Washington: Westinghouse Hanford Company), 1994.

McElfresh, A. J. and L. T. Aikin, *Fuel Rod Wash Bucket Assembly*, H2-821830 (Richland, Washington: Westinghouse Hanford Company), 1994.

McKenna, W. J., "UO<sub>3</sub> Completes Deactivation Milestone Ahead of Schedule," in *Hanford Reach* (Richland, Washington: U.S. Department of Energy, Richland Operations Office), March 7, 1994.

Mecca, J. E., "Production Planning Assumptions for PUREX," letter to Westinghouse Hanford Company, No. 9004625B (Richland, Washington: U.S. Department of Energy, Richland Operations Office), October 1990.

Mecca, J. E., "PUREX Final Safety Analysis Report Upgrade," letter to President, Westinghouse Hanford Company (Richland, Washington: U.S. Department of Energy, Richland Operations Office), January 25, 1991.

Mecca, J. E., "Memorandum of Understanding - Plutonium Uranium Extraction Plant (PUREX) Low-Specific Activity Nitric Acid Shipments," letter to D. G. Hamrick, concurrence with Correspondence No. 9453904 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), June 17, 1994.

Mecca, J. E., "Permitting and Interim Status Requirements Associated with Deactivation of the Plutonium-Uranium Extraction Facility," letter to D. L. Lundstrom (Richland, Washington: U.S. Department of Energy, Richland Operations Office), 1994, with three enclosures: *PUREX Vessel Regulatory Status, PUREX Process Codes and Descriptions, and Justification for Excluding Certain Units from the PUREX Part A Permit Application*.

Meehen, D., *Clean Out of Tanks TK-302 and TK-303*, WP-UO-92-0061 (Richland, Washington: Westinghouse Hanford Company), August 18, 1992.

Midgett, J. C., "Sale of Plutonium-Uranium Extraction Plant Bulk Chemicals," letter to J. E. Mecca, Correspondence No. 9254568 (Richland, Washington: Westinghouse Hanford Company), June 23, 1992.

Midgett, J. C., *PUREX Project Management Plan Workshop* (Richland, Washington: Westinghouse Hanford Company), April 12-16, 1993.

Millward, G. E. *Safety Evaluation to Support the Planned UO<sub>3</sub> Stabilization Campaign*, WHC-SD-CP-TA-005, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), April 1992.

Miska, C. R. and J. M. Siemer, *PUREX Preliminary Hazards Analysis*, WHC-SD-CP-PHA-001 (Richland, Washington: Westinghouse Hanford Company), June 27, 1991.

Mueller, E. A., "CY-93 Shutdown Schedule," Internal Memo 17110-93-EAM-004 (Richland, Washington: Westinghouse Hanford Company), January 20, 1993.

Nelson, D. E., *Design Requirements, PUREX Electrical Substation*, WHC-SD-CP-ES-168 (Richland, Washington: Westinghouse Hanford Company), October 3, 1996.

Nelson, D. W., *L-Cell Entry Gross Characterization*, WP-P-94-020 (Richland, Washington: Westinghouse Hanford Company), March 29, 1994.

Nuclear Safety and Radiological Analysis, *Non-Reactor Facility Safety Analysis Manual*, WHC-CM-4-46, Rev. 10 (Richland, Washington: Westinghouse Hanford Company), August 3, 1994.

- Nylander, D. C., "Re: Letter, J. D. Bauer to D. Butler, 'Request for Concurrence with Emissions Evaluation for Approval of Deactivation of PUREX Plant Pursuant to Washington 173-400 and 173-460,' Dated March 10, 1994," letter to J. D. Bauer (Olympia, Washington: Washington State Department of Ecology), April 11, 1994.
- O'Leary, H. R., "Disposition of Hanford Nitric Acid," Memorandum to T. P. Grumbly (Washington, D.C.: U.S. Department of Energy), October 11, 1994.
- Pajunen, A. L. and R. L. Dirkes, *NO<sub>x</sub> Emissions from Hanford Nuclear Fuels Reprocessing Plants*, RHO-CD-569 (Richland, Washington: Rockwell Hanford Operations, September 15, 1978).
- Parkman, D. B., *Flushing and Draining AMU Tanks*, WP-P-90-035 (Richland, Washington: Westinghouse Hanford Company), December 19, 1990.
- Parkman, D. B., *Tank-207 (AFAN) Loadout*, WP-P-91-001 (Richland, Washington: Westinghouse Hanford Company), January 8, 1991.
- Parkman, D. B., *Raw Water and Air/Stream Sparger Isolation*, WP-P-91-005 (Richland, Washington: Westinghouse Hanford Company), February 14, 1991.
- Parkman, D. B., *Demin Water and TK Coil Isolation*, WP-P-91-006 (Richland, Washington: Westinghouse Hanford Company), February 14, 1991.
- Parkman, D. B., *Sampler Raw Water Isolation*, WP-P-91-010 (Richland, Washington: Westinghouse Hanford Company), February 26, 1991.
- Parkman, D. B., *Chemical Addition Isolation*, WP-P-91-011 (Richland, Washington: Westinghouse Hanford Company), February 26, 1991.
- Parkman, D. B., *Transfer TK-G7 to UGS*, WP-P-91-012 (Richland, Washington: Westinghouse Hanford Company), February 27, 1991.
- Parkman, D. B., *Transfer TK-F16 to UGS*, WP-P-91-013 (Richland, Washington: Westinghouse Hanford Company), March 8, 1991.
- Parkman, D. B., *Process Tank Isolation*, WP-P-91-021 (Richland, Washington: Westinghouse Hanford Company), April 2, 1991.
- Parkman, D. B., *Transfer NPH Drums to TK-55*, WP-P-91-090 (Richland, Washington: Westinghouse Hanford Company), June 5, 1991.
- Parkman, D. B., *KOH Loadout*, WP-P-91-103 (Richland, Washington: Westinghouse Hanford Company), July 19, 1991.
- Parkman, D. B., *SCD Isolation (Continue)*, WP-P-91-108 (Richland, Washington: Westinghouse Hanford Company), July 31, 1991.
- Parkman, D. B., *Tank Farm 215-A Isolation*, WP-P-91-116 (Richland, Washington: Westinghouse Hanford Company), September 6, 1991.

- Parkman, D. B., *Drain and Flush TK-50*, WP-P-91-117 (Richland, Washington: Westinghouse Hanford Company), September 6, 1991.
- Parkman, D. B., *Flush TK-151*, WP-P-91-118 (Richland, Washington: Westinghouse Hanford Company), September 6, 1991.
- Parkman, D. B., *Transfer TK-R1A to TK-G5*, WP-P-91-152 (Richland, Washington: Westinghouse Hanford Company), December 10, 1991.
- Parkman, D. B., *Drum Out NaOH*, WP-P-91-154 (Richland, Washington: Westinghouse Hanford Company), December 26, 1991.
- Parkman, D. B., *Flush TK-204 & N243 Header*, WP-P-92-034 (Richland, Washington: Westinghouse Hanford Company), June 1, 1992.
- Parkman, D. B., *Applicability of PUREX Operational Safety Requirements During Shutdown/Standby*, WHC-SD-CP-OSR-006, Rev. 2 (Richland, Washington: Westinghouse Hanford Company), June 18, 1992.
- Parkman, D. B., *Organic Removal From P-Tanks*, WP-P-92-048 (Richland, Washington: Westinghouse Hanford Company), July 27, 1992.
- Parkman, D. B., *Flushing the UNH Concentration System*, WP-UO-93-004 (Richland, Washington: Westinghouse Hanford Company), April 30, 1993.
- Parkman, D. B., *Flush the Acid Recovery System*, WP-UO-93-005 (Richland, Washington: Westinghouse Hanford Company), April 30, 1993.
- Parkman, D. B., *Transfer TK-X-30 and TK-C-2 to TK-C-1*, WP-UO-93-013 (Richland, Washington: Westinghouse Hanford Company), July 26, 1993.
- Parkman, D. B., *Flush K-Cell*, WP-P-93-037 (Richland, Washington: Westinghouse Hanford Company), October 18, 1993.
- Parkman, D. B., *Flush Cladding Waste Cycle*, WP-P-93-045 (Richland, Washington: Westinghouse Hanford Company), November 2, 1993.
- Parkman, D. B., *Flush G and R Cells*, WP-P-93-053 (Richland, Washington: Westinghouse Hanford Company), December 14, 1993.
- Parkman, D. B., *Flush HA Column and Associated Equipment*, WP-P-94-003 (Richland, Washington: Westinghouse Hanford Company), January 10, 1994.
- Peiffer, W. A., *Meeting Minutes, PUREX Deactivation Project Safety Strategy Workshop* (Richland, Washington: Westinghouse Hanford Company), June 11, 1993.
- Penn, H. R., W. G. Jasen, and R. A. Duncan, "Waste Not, Spend Not: The PUREX Radioactive Nitric Acid Shipping Campaign," in *Radwaste* (LaGrange Park, Illinois: American Nuclear Society), July 1996.
- Pontius, A., letter to J. E. Rasmussen (Seattle, Washington: U.S. Environmental Protection Agency), August 25, 1993.

Praga, A. N., *M-Cell Prep Work (F16,F18)*, WP-P-91-110 (Richland, Washington: Westinghouse Hanford Company), August 16, 1991.

Praga, A. N., *NDE of M-Cell Waste Tanks (F16,F18)*, WP-P-91-111 (Richland, Washington: Westinghouse Hanford Company), August 16, 1991.

Project Software and Development, Inc., *PUREX/UO<sub>3</sub> Facilities Transition Scheduling Review* (Cambridge, Massachusetts: Project Software and Development, Inc.), 1993.

Project Software and Development, Inc., *Project Management: PUREX/UO<sub>3</sub> Outage Planning* (Cambridge, Massachusetts: Project Software and Development, Inc.), July 1993.

Project Time & Cost, Inc., *PUREX/UO<sub>3</sub> Deactivation Project, Estimate Revision 1.3* (Atlanta, Georgia: Project, Time & Cost, Inc.), December 1, 1993.

PUREX Effluent Systems, "BiWeekly Briefing Report, 1-13-90 to 2-9-90," Internal Memo 12124-90-11 (Richland, Washington: Westinghouse Hanford Company), February 16, 1990.

PUREX Effluent Systems, "BiWeekly Report for Period Ending April 6, 1990," Internal Memo 12124-90-25 (Richland, Washington: Westinghouse Hanford Company), April 9, 1990.

PUREX Effluent Systems, "Bi-Weekly Report for Period Ending April 20, 1990," Internal Memo 12124-90-29 (Richland, Washington: Westinghouse Hanford Company), April 24, 1990.

PUREX Effluent Systems, "Monthly Report for June," Internal Memo 12124-90-41 (Richland, Washington: Westinghouse Hanford Company), June 21, 1990.

PUREX Effluent Systems, "Bi-Monthly Briefing," Internal Memo 12124-90-44 (Richland, Washington: Westinghouse Hanford Company), July 6, 1990.

PUREX Effluent Systems, "Monthly Report for July," Internal Memo 12124-90-49 (Richland, Washington: Westinghouse Hanford Company), July 20, 1990.

PUREX Effluent Systems, "Monthly Report for September," Internal Memo 17523-90-58 (Richland, Washington: Westinghouse Hanford Company), September 19, 1990.

PUREX Effluent Systems, "Bi-Monthly Report," Internal Memo 17523-90-61 (Richland, Washington: Westinghouse Hanford Company), October 5, 1990.

PUREX Effluent Systems, "October Monthly Report," Internal Memo 17523-90-66 (Richland, Washington: Westinghouse Hanford Company), October 23, 1990.

PUREX Effluent Systems, "Monthly Report for November," Internal Memo 17523-90-78 (Richland, Washington: Westinghouse Hanford Company), November 19, 1990.

PUREX Effluent Systems, "Bi-Weekly Report for November," Internal Memo 17523-90-85 (Richland, Washington: Westinghouse Hanford Company), December 7, 1990.

PUREX Effluent Systems, "Monthly Report, January," Internal Memo 17523-91-02 (Richland, Washington: Westinghouse Hanford Company), January 17, 1991.

PUREX Effluent Systems, "Monthly Report for February 1991," Internal Memo 17523-91-11 (Richland, Washington: Westinghouse Hanford Company), February 19, 1991.

PUREX Effluent Systems, "Monthly Report for April 1991," Internal Memo 17523-91-30 (Richland, Washington: Westinghouse Hanford Company), April 15, 1991.

PUREX Effluent Systems, "Monthly Report for May 1991," Internal Memo 17523-91-040 (Richland, Washington: Westinghouse Hanford Company), May 20, 1991.

PUREX Effluent Systems, "Monthly Report for June 1991," Internal Memo 17523-91-049 (Richland, Washington: Westinghouse Hanford Company), June 18, 1991.

PUREX Effluent Systems, "PUREX Raw Water Pipe Rupture," Internal Memo 17523-91-065 (Richland, Washington: Westinghouse Hanford Company), August 8, 1991.

PUREX Effluent Systems, "Monthly Report for August 1991," Internal Memo 17523-91-066 (Richland, Washington: Westinghouse Hanford Company), August 19, 1991.

PUREX Effluent Systems, "Operational Excellence - October 1991," Internal Memo 17523-91-083 (Richland, Washington: Westinghouse Hanford Company), October 18, 1991.

PUREX Effluent Systems, "Operational Excellence Report - November 1991," Internal Memo 17523-91-091 (Richland, Washington: Westinghouse Hanford Company), November 18, 1991.

PUREX Effluent Systems, "Operational Excellence Report - February 1992" Internal Memo 17523-92-007 (Richland, Washington: Westinghouse Hanford Company), February 18, 1992.

PUREX Effluent Systems, "Operational Excellence Report - March 1992" Internal Memo 17523-92-009 (Richland, Washington: Westinghouse Hanford Company), March 16, 1992.

PUREX Effluent Systems, "Operational Excellence Report - April 1992" Internal Memo 17523-92-015 (Richland, Washington: Westinghouse Hanford Company), April 21, 1992.

PUREX Effluent Systems, "Operational Excellence Report - May 1992" Internal Memo 17523-92-022 (Richland, Washington: Westinghouse Hanford Company), May 19, 1992.

PUREX Effluent Systems, "Operational Excellence Report - June 1992" Internal Memo 17523-92-028 (Richland, Washington: Westinghouse Hanford Company), June 17, 1992.

PUREX Effluent Systems, "Operational Excellence Report - July 1992" Internal Memo 17523-92-034 (Richland, Washington: Westinghouse Hanford Company), July 23, 1992.

PUREX Effluent Systems, "Operational Excellence Report - August 1992" Internal Memo 17523-92-040 (Richland, Washington: Westinghouse Hanford Company), August 18, 1992.

PUREX Effluent Systems, "Operational Excellence Report - September 1992" Internal Memo 17523-92-047 (Richland, Washington: Westinghouse Hanford Company), September 16, 1992.

PUREX Effluent Systems, "Operational Excellence Report - November 1992" Internal Memo 17523-92-061 (Richland, Washington: Westinghouse Hanford Company), December 10, 1992.

PUREX Engineering Support, *Implementation Plan for Revision 6 of the PUREX Final Safety Analysis Report*, WHC-SD-CP-RD-021, Chapter 11 (Richland, Washington: Westinghouse Hanford Company), 1991.

PUREX Process Control, *PUREX Plant Operations Safety Requirements*, RHO-CD-1540 (Richland, Washington: Rockwell Hanford Operations), September 30, 1981.

PUREX System Deactivation Engineering, *L Cell Floor Plutonium Estimates*, Internal Memo 17710-94-020 (Richland, Washington: Westinghouse Hanford Company), October 19, 1994.

PUREX/UO<sub>3</sub> Operations, *PUREX/UO<sub>3</sub> Plant Administration*, WHC-CM-5-9, Rev. 48 (Richland, Washington: Westinghouse Hanford Company), April 4, 1994.

Quik-Net Graphics, *PUREX Master Logic Network* (Richland, Washington: Westinghouse Hanford Company), August 17, 1993.

Rasmussen, J. E., "Request for Concurrence with Interpretation of Applicability of Permit PSD-X80-14 to Deactivation of PUREX Facility," Letter to A. Pontius, Correspondence No. 9307041 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), July 29, 1993, with three enclosures: *PUREX Goal Statement*; D. M. Dubois, *Approval of Application to Construct No. PSD-X80-14*; and A. J. Pajunen and R. L. Dirkes, *NO<sub>x</sub> Emissions from Hanford Nuclear Fuels Reprocessing Plants*, RHO-CD-569.

Rasmussen, J. E., "UO<sub>3</sub> Plant Storm Water Modification Information," letter to A. W. Conklin, Correspondence No. 9455363D (Richland, Washington: U.S. Department of Energy, Richland Operations Office), August 1994, with enclosure: *UO<sub>3</sub> Plant Storm Water Modification Information*.

- Rasmussen, J. E., "Applicability of Washington 173-303 to Nitric Acid at PUREX and Planned Transfer to British Nuclear Fuels Ltd. (BNFL)," letter to D. L. Lundstrom, Correspondence No. 94-PCA-053 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), September 23, 1994, with enclosure: *Whitepaper: Regulatory Status of Nitric Acid at PUREX Identified in a Contract for Use by BNFL*.
- Rasmussen, J. E., and J. E. Mecca, "Resolution of Permitting and Interim Status Compliance Related Issues Associated with Transition of the Plutonium-Uranium Extraction (PUREX) Facility," letter to R. F. Stanley and D. R. Sherwood (Richland, Washington: U.S. Department of Energy, Richland Operations Office), October 28, 1994, with enclosure: *Tentative Agreements Regarding the Applicability of Washington Administrative Code (WashingtonC) 173-303 to the Transition of PUREX*.
- Rasmussen, J. H., *Clean Out ED-6 Concentrator*, WP-UO-93-015 (Richland, Washington: Westinghouse Hanford Company), October 4, 1993.
- Rasmussen, J. H., *Powder Handling System Cleanout*, WP-UO-93-014 (Richland, Washington: Westinghouse Hanford Company), January 13, 1994.
- Rasmussen, J. H., *Flush Out Neutralization System*, WP-UO-94-012 (Richland, Washington: Westinghouse Hanford Company), September 22, 1994.
- Reberger, D. W., *PUREX Product Removal Room Upgrade*, RHO-CD-1418 (Richland, Washington: Rockwell Hanford Operations), April 1981.
- Reberger, D. W., *TBP Spill Clean-Up, 211-A*, WP-P-90-021 (Richland, Washington: Westinghouse Hanford Company), July 6, 1990.
- Reberger, D. W., *D4 Solids Sampling*, WP-P-90-028 (Richland, Washington: Westinghouse Hanford Company), August 28, 1990.
- Reberger, D. W., *PM on 4 80 V West Normal #1 Cubicle 9A*, WP-P-91-034 (Richland, Washington: Westinghouse Hanford Company), June 6, 1991.
- Reinkens, M. M., *PUREX/UO<sub>3</sub> Weekly Status Report, 9/20/94* (Richland, Washington: Westinghouse Hanford Company), September 20, 1994.
- Reinkens, M. M., *PUREX/UO<sub>3</sub> Weekly Status Report, 9/27/94* (Richland, Washington: Westinghouse Hanford Company), September 27, 1994.
- Reinkens, M. M., *PUREX/UO<sub>3</sub> Weekly Status Report, 10/4/94* (Richland, Washington: Westinghouse Hanford Company), October 4, 1994.
- Risenmay, H. R., *TK-05 Isolation and Restoration*, WP-P-90-005 (Richland, Washington: Westinghouse Hanford Company), March 15, 1990.
- Risenmay, H. R., *TK-05 Tank and Dip Tube Flush for Calibration*, WP-P-90-006 (Richland, Washington: Westinghouse Hanford Company), March 15, 1990.
- Risenmay, H. R., *TK-D5 Calibration*, WP-P-90-007 (Richland, Washington: Westinghouse Hanford Company), March 15, 1990.

- Risenmay, H. R., *TK-E5 Calibration*, WP-P-90-008 (Richland, Washington: Westinghouse Hanford Company), April 9, 1990.
- Risenmay, H. R., *TK-F15 Calibration*, WP-P-90-010 (Richland, Washington: Westinghouse Hanford Company), April 12, 1990.
- Risenmay, H. R., *TK-F18 Calibration*, WP-P-90-011 (Richland, Washington: Westinghouse Hanford Company), April 25, 1990.
- Risenmay, H. R., *TK-F16 Integrity Assessment*, WP-P-90-012 (Richland, Washington: Westinghouse Hanford Company), May 2, 1990.
- Risenmay, H. R., *TK-A3-4 Integrity Assessment*, WP-P-90-013 (Richland, Washington: Westinghouse Hanford Company), May 3, 1990.
- Risenmay, H. R., *TK-B3-4 Integrity Assessment*, WP-P-90-015 (Richland, Washington: Westinghouse Hanford Company), May 7, 1990.
- Risenmay, H. R., *TK-C3-4 Integrity Assessment*, WP-P-90-016 (Richland, Washington: Westinghouse Hanford Company), May 7, 1990.
- Risenmay, H. R., *TK-E3-2 Integrity Assessment*, WP-P-90-017 (Richland, Washington: Westinghouse Hanford Company), May 8, 1990.
- Risenmay, H. R., *TK-F12 Integrity Assessment*, WP-P-90-018 (Richland, Washington: Westinghouse Hanford Company), June 29, 1990.
- Risenmay, H. R., *E-F11 Integrity Assessment*, WP-P-90-022 (Richland, Washington: Westinghouse Hanford Company), July 11, 1990.
- Risenmay, H. R., *TK-G7 Integrity Assessment*, WP-P-90-024 (Richland, Washington: Westinghouse Hanford Company), July 23, 1990.
- Risenmay, H. R., *TK-U3 Integrity Assessment*, WP-P-90-025 (Richland, Washington: Westinghouse Hanford Company), July 27, 1990.
- Risenmay, H. R., *TK-U4 Integrity Assessment*, WP-P-90-026 (Richland, Washington: Westinghouse Hanford Company), July 27, 1990.
- Risenmay, H. R., *TK-G6 Calibration*, WP-P-90-029 (Richland, Washington: Westinghouse Hanford Company), August 30, 1990.
- Risenmay, H. R., *Pump S-PA & S-PC Pumps to CSL*, WP-P-91-004 (Richland, Washington: Westinghouse Hanford Company), February 6, 1991.
- Risenmay, R. R., *Applicability of PUREX Operational Safety Requirements During Shutdown/Standby*, WHC-SD-CP-OSR-006, Rev. 1 (Richland, Washington: Westinghouse Hanford Company), February 6, 1991.
- Risenmay, H. R., *Calciner Clean Out*, WP-UO-93-006 (Richland, Washington: Westinghouse Hanford Company), May 10, 1993.
- Risenmay, H. R., *H Calciner Clean Out*, WP-UO-0055 (Richland, Washington: Westinghouse Hanford Company), January 19, 1994.

Risenmay, H. R., *UO<sub>2</sub> Plant Instrument Inactivation*, WP-UO-94-002 (Richland, Washington: Westinghouse Hanford Company), February 22, 1994.

Risenmay, H. R., *Clean Acid Header Drop Legs*, WP-UO-94-010 (Richland, Washington: Westinghouse Hanford Company), May 26, 1994.

Roemer, J. J., *PUREX Plant Final Safety Analysis Report*, RHO-SD-HS-SAR-001 (Richland, Washington: Rockwell Hanford Operations), 1983.

Roemer, J. J., *PUREX Plant Final Safety Analysis Report*, WHC-SD-HS-SAR-001, Rev. 5 (Richland, Washington: Westinghouse Hanford Company), 1990.

Romsos, M. R., "Uniform Hazardous Waste Manifest," No. A3229 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), August 1993.

Sanders, G. H., "Transmittal of Preliminary Plutonium Uranium Extraction Facility Surveillance and Maintenance Plan," letter to M. A. Wilson, Correspondence No. 96-TPD-055 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), May 16, 1996, with enclosure: C. N. Villalobos, *Preliminary Plutonium Uranium Extraction (PUREX) Facility Surveillance and Maintenance Plan*.

SAIC, *PUREX Deactivated End State Hazards Analysis*, (Richland, Washington: Science Applications International Corporation), February 1996.

Sheehan, J. S., *Work Plan (Drum Repack)*, WP-P-90-014 (Richland, Washington: Westinghouse Hanford Company), May 7, 1990.

Shrivastava, N., *Removal of Small Equipment from N-Cell Glove Boxes*, WP-P-93-039 (Richland, Washington: Westinghouse Hanford Company), October 22, 1993.

Shrivastava, N., *Flush N-Cell Closed Loop Cooling System*, WP-P-94-017 (Richland, Washington: Westinghouse Hanford Company), February 28, 1994.

"Silenced Alarm Marks End of an Era for PUREX" in *Hanford Reach* (Richland, Washington: U.S. Department of Energy, Richland Operations Office), July 8, 1996, p. 1.

Sivula, C., "Lab Fight a Battle in War Over Cleanup Schedule" in *Tri-City Herald* (Kennewick, Washington), September 23, 1992, p. A8.

Slaathaug, E. J., *Installation of Heaters in Tank 34*, WP-P-90-032 (Richland, Washington: Westinghouse Hanford Company), December 7, 1990.

Slaathaug, E. J., *Flushing and Draining of P&O Gallery Headers*, WP-P-90-034 (Richland, Washington: Westinghouse Hanford Company), December 19, 1990.

"Slants and Trends," in *Nuclear Waste News* (Silver Springs, Maryland: Business Publishers, Inc.), June 27, 1996.

- Smith, E., "Cleanup Silences PUREX Alarm Forever" in *Tri-City Herald* (Kennewick, Washington), June 21, 1996, p. A3.
- Spent Nuclear Fuel Project, *Hanford Spent Nuclear Fuel Project Recommended Path Forward*, WHC-EP-0830 (Richland, Washington: Westinghouse Hanford Company), October 1994.
- Stanley, R., and T. Tebb, "Federal Frailty Agreement and Consent Order Change Control Form," Change #M-80-94-01 Draft (Olympia, Washington: Washington State Department of Ecology), September 28, 1994.
- Stefanski, L. D., *UO<sub>3</sub> Deactivation End Point Criteria*, WHC-SD-WM-TPP-052, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), September 1994.
- Stefanski, L. D., *PUREX Deactivation End Point Criteria*, WHC-SD-WM-TTP-053, Rev. 1 (Richland, Washington: Westinghouse Hanford Company), August 23, 1995.
- System Deactivation Engineering, "L Cell Floor Plutonium Estimates," internal memo to R. W. Bailey, Correspondence No. 17710-94-020 (Richland, Washington: Westinghouse Hanford Company), October 19, 1994.
- Tardiff, G. R., *Process Tank Isolation*, WP-P-91-017 (Richland, Washington: Westinghouse Hanford Company), March 20, 1991.
- Tardiff, G. R., *Neutralization of Oxalate Ion in TK-E6*, WP-P-91-141 (Richland, Washington: Westinghouse Hanford Company), October 18, 1991.
- "The Navy Will Be Able To Send Spent Fuel to INEL," in *Nuclear News* (LaGrange, Illinois), Vol. 36, No. 11, September 1993, pp. 83-84.
- Thompson, R. J., *PUREX Environmental/Waste Management Subprogram Plan*, WHC-SD-CP-SSP-006, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), March 11, 1991.
- Trego, A. L., "Reengineering Starts With a Clean Sheet of Paper" in *Manage* (Dayton, Ohio: National Management Association), July 1996, pp. 17-20.
- Villalobos, C. N., *Preliminary Plutonium Uranium Extraction (PUREX) Facility Surveillance and Maintenance Plan* (Richland, Washington: Westinghouse Hanford Company), August 1996.
- Von Bargen, B. H., *TK-R1 Oxalic-HN03 Flush*, WP-P-90-019 (Richland, Washington: Westinghouse Hanford Company), July 2, 1990.
- Wagoner, J. D., "PUREX/UO<sub>3</sub> Deactivation Project National Environmental Policy Act (NEPA) Compliance Strategy," Memorandum 93-PPO-002 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), December 2, 1993.

Wagoner, J. D., "Approval of Hanford PUREX Authorization Basis for Deactivation," letter to President, Westinghouse Hanford Company, 94-PP0-001 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), March 2, 1994.

Wagoner, J. D., "Categorical Exclusion for Disposal of Tri-N-Butylphosphate for the Plutonium-Uranium Extraction Facility, 200 East Area, Hanford Site, Richland, Washington," letter to R. H. Engelmann, Correspondence No. 9404847 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), August 2, 1994.

Wagoner, J. D., "Categorical Exclusion for Disposal of Tri-N-Butyl Phosphate from the Plutonium-Uranium Extraction Facility, 200 East Area, Hanford Site, Richland, Washington," Correspondence No. Incoming 9404847 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), August 1994, with enclosure: *Categorical Exclusion for Disposal of Tri-N-Butyl Phosphate from the Plutonium-Uranium Extraction Facility, 200 East Area, Hanford Site, Richland, Washington*.

Walser, R. L., *PUREX Process Control Manual*, WHC-CM-5-24, Addendum 1 (was RHO-RE-MA-5) (Richland, Washington: Westinghouse Hanford Company), 1991.

Walser, R. L., *Application of Standardized Operational Safety Requirement Criteria to PUREX Operational Safety Criteria*, WHC-SD-CP-RD-020 (Richland, Washington: Westinghouse Hanford Company), September 1991.

Walser, R. L., *PUREX Process Control Manual*, WHC-CM-5-24, Rev. 18 (Richland, Washington: Westinghouse Hanford Company), December 1992.

Walser, R. L., *Safety Analysis Strategy* (Richland, Washington: Westinghouse Hanford Company), April 14, 1993.

Walser, R. L., *OSR Applicability Statements for PUREX Plant Deactivation: PUREX Deactivation Project Safety Strategy Workshop* (Richland, Washington: Westinghouse Hanford Company), June 11, 1993.

Walser, R. L., *Application of the Unreviewed Safety Question Process to Non-Reactor Nuclear Facilities: PUREX Deactivation Project* (Richland, Washington: Westinghouse Hanford Company), June 11, 1993.

WAC 246-247, "Radiation Protection - Air Emissions" (Olympia, Washington: Washington Administrative Code), March 4, 1994, pp. 1-10.

Waterman, R. H., Jr., J. A. Waterman, and B. A. Collard, "Toward a Career-Resilient Workforce," in *Harvard Business Review* (Cambridge, Massachusetts: Harvard University), July-August 1994, pp. 87-95.

Wendt, K. M., "Agreement by DOE-ID and the Idaho Department of Health and Welfare for Receiving Organic Solvent from the Hanford Reservation as Fuel for the Idaho Chemical Processing Plant (ICPP) Calciner," memorandum to M. B. Hinman (Idaho Falls, Idaho: Westinghouse Idaho Nuclear Company, Inc.), August 31, 1993.

- Werner, J. D. and S. Taub, "Disposition of PUREX Plant Nitric Acid: Technical, Cost and Policy Issues," memorandum to W. W. Bixby (Washington, D.C.: U.S. Department of Energy), August 16, 1994.
- Westra, A. G. and W. L. Willis, *UO<sub>3</sub> Plant Terminal Cleanout and Deactivation Plan*, WHC-SD-CP-SSP-008, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), July 1993.
- Westra, A. G., *Flush and Deactivate Type C Samples*, WP-P-94-004 (Richland, Washington: Westinghouse Hanford Company), January 10, 1994.
- Westra, A. G., *Stabilize and Deactivate Type B&B Modified Samples*, WP-P-94-005 (Richland, Washington: Westinghouse Hanford Company), January 10, 1994.
- Westra, A. G., *Stabilize and Deactivate Type A&A Modified Samples*, WP-P-94-006 (Richland, Washington: Westinghouse Hanford Company), January 10, 1994.
- Westra, A. G., *Flush Recovered Acid Headers*, WP-P-94-034 (Richland, Washington: Westinghouse Hanford Company), September 1, 1994.
- Westra, A. G., *Paint Interior of N Cell Glove Boxes*, WP-P-95-045 (Richland, Washington: Westinghouse Hanford Company), August 1, 1995.
- Westra, A. G., G. R. Tardiff, and N. Shrivastava, *N-Cell Deactivation Study*, WHC-SD-CP-ES-159 (Richland, Washington: Westinghouse Hanford Company), November 1993.
- Westra, A. G., and W. E. Matheison, *N Cell Small Equipment Removal*, WP-P-93-039, Rev. 1 (Richland, Washington: Westinghouse Hanford Company), April 14, 1994.
- WHC, *Safety Analysis Manual*, WHC-CM-4-46 (Richland, Washington: Westinghouse Hanford Company), September 30, 1988.
- WHC, *Cold Standby Operating Specifications*, OSD-P-154-00001 (Richland, Washington: Westinghouse Hanford Company), 1991.
- WHC, *Document Control and Records Management Manual*, WHC-CM-3-5 (Richland, Washington: Westinghouse Hanford Company), June 24, 1992.
- WHC, *PUREX/UO<sub>3</sub> Deactivation Project Management Plan*, WHC-SP-1011D (Richland, Washington: Westinghouse Hanford Company), September 1993.
- WHC, *Agreement Between BNFL, Inc. and Westinghouse Hanford Company for the Use of PUREX LSA Nitric Acid*, WHC Subcontract No. MAR-SVV-382237 (Richland, Washington: Westinghouse Hanford Co), October 24, 1994.
- WHC, *Data Quality Objective for PUREX Deactivation Flushing*, WHC-SD-EN-TI-283, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), January 1995.
- WHC, *Qualitative Job Analysis* (Richland, Washington: Westinghouse Hanford Company), 1995.

WHC, *CSER 96-012: Facility Reclassification and Criticality Alarm System Shutoff for De-Activated PUREX*, (Richland, Washington: Westinghouse Hanford Company), June 1996.

WHC, *Notice of Completion: FY 1996 Performance Evaluation Plan (PEP) Item: Complete the Transfer of PUREX Organic to DSSI*, PEP 96-134 (Richland, Washington: Westinghouse Hanford Company), June 11, 1996.

WHC, *Plutonium Uranium Extraction Facility (PUREX) Standards and Requirements Identification Document*, WHC-SD-MP-SRID-004, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), June 19, 1996.

WHC, *PUREX People Center News* (Richland, Washington: Westinghouse Hanford Company), June 21, 1996.

WHC, *PUREX Storage Tunnel Hazards Analysis*, HNF-SD-CP-HIE-002, Rev. 0 (Richland, Washington: Westinghouse Hanford Company), August 16, 1996.

WHC, *PUREX Level 5 Critical Path Schedule* (Richland, Washington: Westinghouse Hanford Company), August 26, 1996.

WHC Air and Water Permits, "Activity Report for Week Ending March 18, 1994," Internal Memo No. 8300-94-041 (Richland, Washington: Westinghouse Hanford Company), March 18, 1994.

WHC Communications, "Grumbly Tells Hanford Managers to Plunge into Change" (Richland, Washington: Westinghouse Hanford Company), February 9, 1995.

WHC Communications, *Status of Project Hanford Management Contract* (Richland, Washington: Westinghouse Hanford Company), June 19, 1996.

WHC Executive Team, *Culture Change Activities at PUREX* (Richland, Washington: Westinghouse Hanford Company), October 20, 1995.

WHC Traffic Operations, *U.S. Department of Energy LSA/Nitric Acid Transportation Plan to British Nuclear Fuels, Ltd.*, (Richland, Washington: Westinghouse Hanford Company), June 7, 1994.

Wiley, K. L., *Meeting Minutes: PUREX Deactivation Regulatory Workshop*, (Richland, Washington: Westinghouse Hanford Company), April 22, 1993.

Wisness, S. H., "Toxic Air Pollutant Inventory for Deactivation of the Plutonium Uranium Extraction Plant," letter to D. C. Nylander, Correspondence No. 9400891 (Richland, Washington: U.S. Department of Energy,) May 12, 1994, with enclosure: *TAPs Inventory in Pipe and Operating Gallery, Deactivation Vs. Operation.*

Wisness, S. H., "Response to Voluntary Compliance Letter Concerning Organic Waste in a Tank Trailer at the Plutonium-Uranium Extraction Facility," letter to D. L. Lundstrom, Correspondence No. 9404281 (Richland, Washington: U.S. Department of Energy, Richland Operations Office), June 28, 1994.

- Woodworth, H. R., *Changeout Pre-filter PR Room Exhaust*, WP-P-91-023 (Richland, Washington: Westinghouse Hanford Company), April 16, 1991.
- Woodworth, H. R., *Disassembly of EF-V11-01 Fan*, WP-P-91-033 (Richland, Washington: Westinghouse Hanford Company), May 29, 1991.
- Woodworth, H. R., *Reassembly of EF-1-/EF-V11-1 Fan*, WP-P-91-099 (Richland, Washington: Westinghouse Hanford Company), June 26, 1991.
- Woodworth, H. R., *Reassembly of SF-V10-1A/SF-1A*, WP-P-91-102 (Richland, Washington: Westinghouse Hanford Company), July 12, 1991.
- Woodworth, H. R., *Exhaust Plenum Entry Decon*, WP-P-91-146 (Richland, Washington: Westinghouse Hanford Company), November 18, 1991.
- Yasutake, K. M., *UO<sub>2</sub> Plant Safety Analysis Report*, RHO-SD-CP-SAR-002 (Richland, Washington: Rockwell Hanford Operations), September 1983.
- Young, K. J., *Assessment of Dangerous Waste Pipe in U-Cell*, WP-P-91-113 (Richland, Washington: Westinghouse Hanford Company), August 28, 1991.
- Young, K. J., *Assessment of Dangerous Waste Piping in the Lab*, WP-P-91-125 (Richland, Washington: Westinghouse Hanford Company), September 16, 1991.
- Young, K. J., *Assessment of Dangerous Waste Piping in U-Cell Sumps*, WP-P-91-134 (Richland, Washington: Westinghouse Hanford Company), October 1, 1991.
- Young, K. J., *Assessment of Dangerous Waste Piping From F-18*, WP-P-91-142 (Richland, Washington: Westinghouse Hanford Company), October 22, 1991.
- Young, K. J., *Assessment of Dangerous Waste Piping From F-16*, WP-P-91-143 (Richland, Washington: Westinghouse Hanford Company), October 25, 1991.
- Young, K. J., *Assessment of Dangerous Waste Piping in E-Cell*, WP-P-91-145 (Richland, Washington: Westinghouse Hanford Company), October 31, 1991.
- Young, K. J., *Assessment of TK-U3, U4 Supports*, WP-P-92-011 (Richland, Washington: Westinghouse Hanford Company), March 5, 1992.

### 13.2 ORAL HISTORY INTERVIEWS

(M. S. Gerber, Interviewer)

Akre, E. M., Hanford Site 1135 Jadwin Building, June 20, 1996.

Brown, J. K., Hanford Site 1135 Jadwin Building, June 20, 1996.

Dodd, E. N., III, Hanford Site MO 273, July 12, 1996

Granger, J. G., Hanford Site 2440 Stevens Building, July 11, 1996

Harlow, D. G., Hanford Site 200 East Area, MO 273, May 1, 1996.

Hayfield, J. P., Hanford Site 200 East Area, MO 273, May 1, 1996.

LeBaron, G. J., Hanford Site 200 East Area, MO 273, July 10, 1996

Lindemuth-Will, G. E., Hanford Site 200 East Area, MO 273, June 25, 1996.

Oswald, J. F., Hanford Site 1135 Jadwin Building, June 20, 1996.

Perkins, L. F., Jr., Hanford Site 2704-S Building, April 30, 1996.

Peiffer, W. A., Hanford Site 200 East Area, MO 273, May 1, 1996.

Robertson, J. R., Hanford Site 2440 Stevens Building, July 8, 1996.

Russcher, G. E., Hanford Site MO 273, July 12, 1996.

Strand, C. P., Hanford Site 2440 Stevens Building, July 2, 1996.

Stefanski, L. D., Hanford Site MO 273, June 28, 1996.

Taylor, S. N., Hanford Site 200 East Area, MO 273, June 27, 1996.

Turner, S. J., Hanford Site 2753-E Building, June 25, 1996.

Zinsli, L. C., Hanford Site MO 273, August 22, 1996.

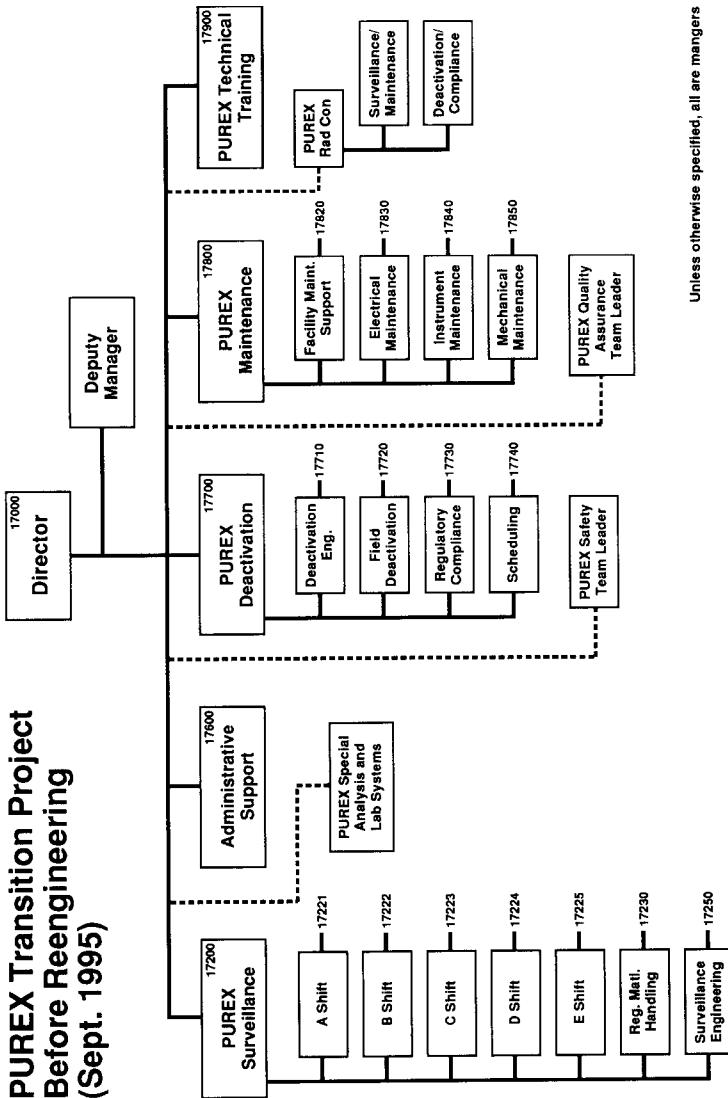
**APPENDIX A**

**PUREX ORGANIZATIONAL CHARTS  
BEFORE AND AFTER REENGINEERING**

This page intentionally left blank.

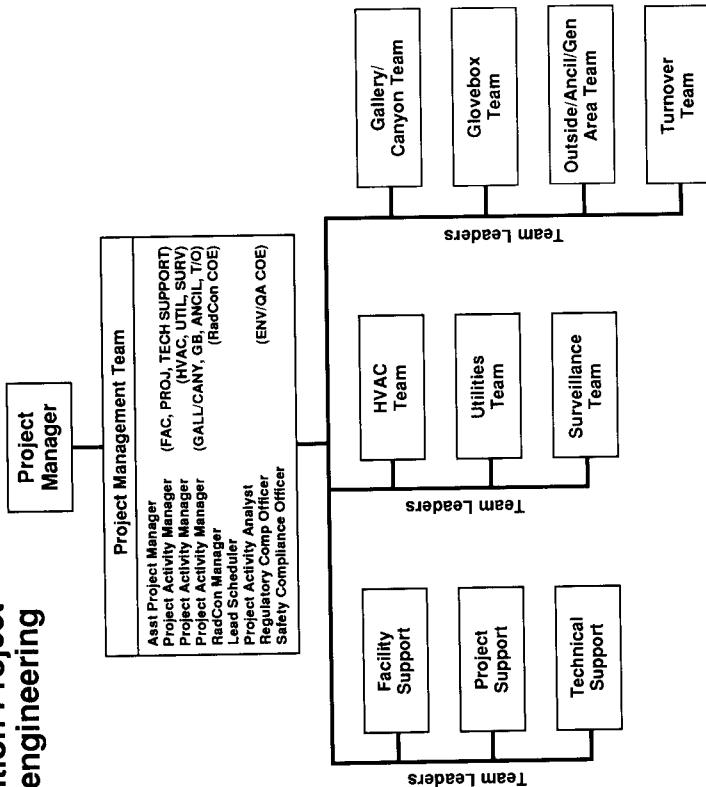
## PUREX Transition Project Before Reengineering (Sept. 1995)

HNF-SP-1147, REV 2



Unless otherwise specified, all are managers

**PUREX Transition Project  
1700 After Reengineering  
May 1996**



**APPENDIX B**

**INITIAL PUREX TEAMS CREATED IN DECEMBER 1996**

This page intentionally left blank.

Surveillance Team

- Team Leader
- Clerk (shared)
- Power Operator (3)
- RCT (4)
- Nuclear Process Operator (NPO) (8)
- Configuration Control Specialist
- Process Engineer (2)
- Plant Engineer

Turnover/Endpoints Management Team

- Team Leader
- Plant Engineer (2)
- Records Specialist (2)
- Engineer

Heating, Ventilation, and Air Conditioning Team

- Team Leader
- Planner
- Process Engineer
- Electrical Engineer
- Electrician
- Millwright (2)
- RCT (3)
- Power Operator
- Clerk (shared)
- Mechanical Engineer (3)
- Plant Engineer
- Instrument Technician
- Pipefitter
- Rigger (2)
- NPO (2)
- Scheduler

Glove Box Stabilization Team

- Team Leader
- NPO (5)
- RCT

Utilities Consolidation Team

- Team Leader
- Secretary
- Electrician (5)
- Power Operator (2)
- NPO (2)
- Environmental Engineer
- Engineering Technician
- Scheduler
- Task Manager
- Clerk (shared)
- Pipefitter
- Millwright (2)
- RCT (3)
- Electrical Engineer (3)
- Mechanical Engineer
- Plant Engineer (2)
- Planner
- Instrument Technician (2)

Canyon/Galleries Team

- |                      |                        |
|----------------------|------------------------|
| • Team Leader        | • Planner              |
| • Plant Engineer (2) | • Process Engineer (2) |
| • RCT (4)            | • NPO (6)              |
| • Crane Operator     | • Pipefitter           |
| • Electrician (2)    |                        |

Ancillary Structures/Outside Areas

- |                  |                    |
|------------------|--------------------|
| • Team Leader    | • Clerk            |
| • NPO (8)        | • RCT (5)          |
| • Scheduler      | • Process Engineer |
| • Pipefitter (2) |                    |

Facility Support

- |                                      |                       |
|--------------------------------------|-----------------------|
| • Team Leader                        | • Clerk               |
| • Secretary                          | • RCT (7)             |
| • Plant Engineer (3)                 | • Scheduler           |
| • Records Specialist                 | • Insulator (2)       |
| • Light Duty Truck Driver (2)        | • Painter (3)         |
| • Instrument Technician (4)          | • Tool Crib Attendant |
| • Material Coordinator (3)           | • NPO Chief Steward   |
| • Hazardous Materials Specialist (2) |                       |
| • Plant Engineer-Resource Broker (2) |                       |

Project Support Team

- |   |                      |
|---|----------------------|
| • Team Leader                                 | • Records Clerk (2)  |
| • Secretary                                   | • Engineering Writer |
| • Administration Specialist (3)               | • Trainer (2)        |
| • Project Control Analyst (2)                 | • Plant Engineer (2) |
| • Scheduler                                   |                      |
| • Administration Specialist/Employee Concerns |                      |

Technical Support Team

- |                                       |                        |
|---------------------------------------|------------------------|
| • Team leader                         | • Secretary            |
| • Quality Engineer                    | • Quality Technician   |
| • Engineering Technician              | • Project Specialist   |
| • Principal Engineer (2)              | • Plant Engineer       |
| • Radiation Control Expert (3)        | • Scientist            |
| • Engineer                            | • Industrial Hygienist |
| • Planner                             |                        |
| • Engineer, Regulatory Compliance (2) |                        |

**Project Management Team**

- PUREX Deactivation Director
- Project Activity Manager (3)
- Radiation Control Manager
- Assistant Project Manager/Team Leader
- Project Activity/Accounting Analyst
- Regulatory Compliance Officer
- Safety Compliance Officer
- Lead Scheduler
- Coach (3)
- Secretary (3)

This page intentionally left blank.

APPENDIX C

TABLE OF PROCESS VESSELS AND CHEMICALS IN THE PUREX PLANT, COMPILED FOR  
REGULATORY STREAMLINING SUBMITTAL

This page intentionally left blank.

## APPENDIX C

TABLE OF PROCESS VESSELS AND CHEMICALS IN THE PUREX PLANT, COMPILED FOR  
REGULATORY STREAMLINING SUBMITTAL

Table C-1. PUREX Plant Vessels.

Vessel ID	Location	Capacity [L (gal)]
TK-D5	D-Cell	19,851 (5,244)
TK-E5	E-Cell	19,873 (5,250)
TK-E6	E-Cell	19,813 (5,234)
TK-F3	F-Cell	19,964 (5,274)
TK-F4	F-Cell	19,593 (5,176)
T-F5	F-Cell	1,132 (299)
E-F11	F-Cell	9,804 (2,590)
TK-F15	F-Cell	19,419 (5,130)
TK-F16	F-Cell	19,870 (5,249)
TK-F18	F-Cell	19,798 (5,230)
TK-G1	G-Cell	18,662 (4,930)
TK-G2	G-Cell	7,064 (1,866)
T-G2	G-Cell	8,248 (2,179)
TK-G5	G-Cell	55,403 (14,636)
TK-G7	G-Cell	50,827 (13,427)
TK-G8	G-Cell	19,881 (5,252)
TK-H1	H-Cell	19,593 (5,176)
T-H2	H-Cell	7,003 (1,850)
E-H4	H-Cell	10,137 (2,678)
TK-J1	J-Cell	19,926 (5,264)
TK-J3	J-Cell	19,911 (5,260)
T-J6	J-Cell	6,057 (1,600)
T-J7	J-Cell	6,730 (1,778)
TK-J21	J-Cell	1,162 (307)
T-J22	J-Cell	568 (150)
T-J23	J-Cell	393 (104)
TK-K1	K-Cell	19,828 (5,238)
T-K2	K-Cell	5,194 (1,372)
T-K3	K-Cell	6,507 (1,719)
TK-K6	K-Cell	19,593 (5,176)
T-L2	L-Cell	447 (118)
TK-L3	L-Cell	488 (129)
T-L4	L-Cell	139 (37)
TK-M2	M-Cell	6,852 (1,810)
TK-Q21	Q-Cell*	81 (21)
TK-Q22	Q-Cell*	968 (256)
TK-R1	R-Cell	18,121 (4,787)
TK-R2	R-Cell	6,746 (1,782)
T-R2	R-Cell	8,282 (2,188)
TK-R7	R-Cell	35,174 (9,292)
TK-U3	U-Cell	31,124 (8,222)
TK-U4	U-Cell	31,184 (8,238)
TK-P4	203-A	402,930 (106,443)
TK-40	211-A	247,360 (65,346)
TK-156	AMU	1,533 (405)
Total Capacity		1,263,233 (333,712)

\* Q-Cell is located in the storage gallery.

This page intentionally left blank.

**APPENDIX D**

**PUREX AND UO<sub>3</sub> M-80 TRI-PARTY AGREEMENT MILESTONES**

This page intentionally left blank.

## APPENDIX D

PUREX AND UO<sub>3</sub> M-80 TRI-PARTY AGREEMENT MILESTONES

- M-80-00 Complete PUREX and UO<sub>3</sub> Plant Facility Transition Phase and Initiate the Surveillance and Maintenance Phase
- M-80-00-T01 Issue U.S. Department of Energy-Approved End Point Criteria for the UO<sub>3</sub> Plant
- M-80-00-T02 Complete All UO<sub>3</sub> Plant Transition Activities and Initiate Surveillance and Maintenance Phase
- M-80-00-T03 Submit Options and Recommendations for Final Management of Tank 40 Organic material to the U.S. Environmental Protection Agency and/or the Washington State Department of Ecology in Accordance with Their Respective Authorities
- M-80-00-T04 Complete Removal of Concentrated (Recovered) 203-A Nitric Acid at PUREX
- M-80-00-T05 Complete Implementation of Selected Alternative for Management of Spent Fuel from PUREX
- M-80-00-T06 Complete Deactivation of the PUREX Plant 211-A Area
- M-80-00-T07 Complete Deactivation of the PUREX Plant Sample Gallery
- M-80-01 Complete Deactivation of PUREX Plant R-Cell
- M-80-02 Submit the End Point Criteria and Surveillance and Maintenance Plan in Support of the PUREX Preclosure Work Plan
- M-80-02-T01 Submit PUREX End Point Criteria for Transition of PUREX
- M-80-02-T02 Submit PUREX Surveillance and Maintenance Plan
- M-80-03 Remove Process Waste Solutions from Tanks D5 and E6
- M-80-04 Complete Deactivation of the PUREX Plant U-Cell/Fractionator
- M-80-05 Complete Deactivation of the PUREX Plant Aqueous Makeup Area
- M-80-06 Complete Deactivation of the PUREX Plant Canyon
- M-80-07 Complete Deactivation of the PUREX Plant 203-A Area
- M-80-08 Document Hazardous Substances/Dangerous Wastes Remaining Within the PUREX Plant

This page intentionally left blank.

**APPENDIX E**  
**JOB HAZARDS ANALYSIS FORM**

This page intentionally left blank.

PHSA Rank:

0

**Qualitative Job Analysis**

10-Sep-96

JHA ID:	2A-9609-102	Work Request ID:	
Work Title:			
Facility/Area	Walk-Through Conducted: <input type="checkbox"/>		
Description:			
Other Activities:			
<b>Involvement</b>			
Industrial Safety	<input type="checkbox"/>	Fire Protection	<input type="checkbox"/>
Industrial Hygien	<input type="checkbox"/>	RadCon	<input type="checkbox"/>
		Quality Assurance	<input type="checkbox"/>
		Environmental	<input type="checkbox"/>
		Nuclear Safety	<input type="checkbox"/>
		Criticality Safety Rep	<input type="checkbox"/>
<b>Determination</b>			
<ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> If the current activity is fully covered by an RWP check this box. Fully covered means that the RWP must cover all types of activities included in this planned activity (such as breaching lines, tanks, etc.)</li> <li><input checked="" type="checkbox"/> If the work activity is being performed per an approved (active) procedure, check this box.</li> <li><input checked="" type="checkbox"/> If the activity does not involve equipment replacement/repair or if the repair is like for like, check this box.</li> <li><input checked="" type="checkbox"/> If the safe completion of this work activity will not require a Caution or a Danger tag, then check this box.</li> <li><input checked="" type="checkbox"/> Review the current Safety Equipment List (SEL), if the work activity does not involve any equipment identified on the SEL, then check the box.</li> <li><input checked="" type="checkbox"/> If the safe completion of this activity does not require a permit, such as a Confined Space Permit, etc, then check this box.</li> <li><input checked="" type="checkbox"/> If all instructions for waste generation, handling and disposal related to materials involved in this work activity are approved, then check this box.</li> </ul>			
<b>PHSA</b>			
TYPE OF PROCESS	TYPE OF OPERATION	EVENT OF CONCERN/SCENARIO	
<input type="checkbox"/> Chemical	<input type="checkbox"/> Fixed Facility	<input type="checkbox"/> Single failure	
<input type="checkbox"/> Electrical	<input type="checkbox"/> Transportation	<input type="checkbox"/> Loss of function	
<input type="checkbox"/> Physical	<input type="checkbox"/> Permanent	<input type="checkbox"/> Procedure	
<input type="checkbox"/> Electronic	<input type="checkbox"/> Temporary	<input type="checkbox"/> Multiple failure	
<input type="checkbox"/> Mechanical	<input type="checkbox"/> Continuous	<input type="checkbox"/> Process upset	
<input type="checkbox"/> Computer	<input type="checkbox"/> Semi-Batch	<input type="checkbox"/> Software	
<input type="checkbox"/> Biological	<input type="checkbox"/> Batch	<input type="checkbox"/> Hardware	
<input type="checkbox"/> Human		<input type="checkbox"/> Simple loss of containment	
		<input type="checkbox"/> Human event	
Complexity/Size	Probability of Occurrence	Likelihood of Occurrence	
Team/Experience	Severity of Consequence	Work Environment	
<input type="checkbox"/> Length - With similar process		<input type="checkbox"/> Significant Changes Involved	

<b>ENVIRONMENTAL</b>	
<b>AIR</b>	<input type="checkbox"/> New activity <input type="checkbox"/> New source <input type="checkbox"/> Modification <input type="checkbox"/> Involves open burning or training fires
<b>MISCELLANEOUS</b>	<input type="checkbox"/> Includes disposal of inert waste at a non-approved disposal site <input type="checkbox"/> Includes construction of a solid waste facility <input type="checkbox"/> Installs, removes, or modifies an underground storage tank <input type="checkbox"/> Includes demolition, cleanup and/or renovation involving asbestos
<b>DANGEROUS WASTE</b>	
	<input type="checkbox"/> Includes treatment, storage, and/or disposal of dangerous waste <input type="checkbox"/> Generates or manages contaminated equipment
<b>WATER</b>	
	<input type="checkbox"/> Involves a new or existing liquid discharge to the ground or river <input type="checkbox"/> Modify an existing, approved wastewater treatment system <input type="checkbox"/> Modify an existing drinking water system <input type="checkbox"/> Requires work over, in, or adjacent to a surface water body <input type="checkbox"/> Installation or modification of a septic system
<b>WORKER SAFETY</b>	
	<input type="checkbox"/> Fall hazards over 6ft. <input type="checkbox"/> Energy sources <input type="checkbox"/> Temporary Electrical <input type="checkbox"/> Electrical hazards <input type="checkbox"/> De-energize equipment <input type="checkbox"/> Fire or explosion <input type="checkbox"/> Walking or working surfaces <input type="checkbox"/> Excavation <input type="checkbox"/> Demolition
<b>NUCLEAR</b>	
	<input type="checkbox"/> Work involving or impacting Criticality Alarm <input type="checkbox"/> Plant location <input type="checkbox"/> Fissionable materials in excess of 15g <input type="checkbox"/> Criticality Prevention Specifications (CPS) or posting <input type="checkbox"/> OSD/OSR limits <input type="checkbox"/> Activity to be performed on OSD/OSR System
<b>EXPOSURE</b>	
	<input type="checkbox"/> Welding or cutting or burning or hot work <input type="checkbox"/> Hazardous Waste operation <input type="checkbox"/> Lead handling or abatement <input type="checkbox"/> Confined space entry <input type="checkbox"/> Noise or noise producing <input type="checkbox"/> Contaminated soil or evacuation or disruption <input type="checkbox"/> Temperature extreme
	<input type="checkbox"/> Tank or line or vessel opening or breach <input type="checkbox"/> Painting <input type="checkbox"/> Asbestos handling or abatement <input type="checkbox"/> Chemical/HazMat use/involvement <input type="checkbox"/> Mercury work <input type="checkbox"/> Beryllium work <input type="checkbox"/> Carcinogen work <input type="checkbox"/> Dust Producing

**PHSA Rank:**

8

## Qualitative Job Analysis

10-Sep-96

**Comments:**

1. *What is the name of the author of the book?*

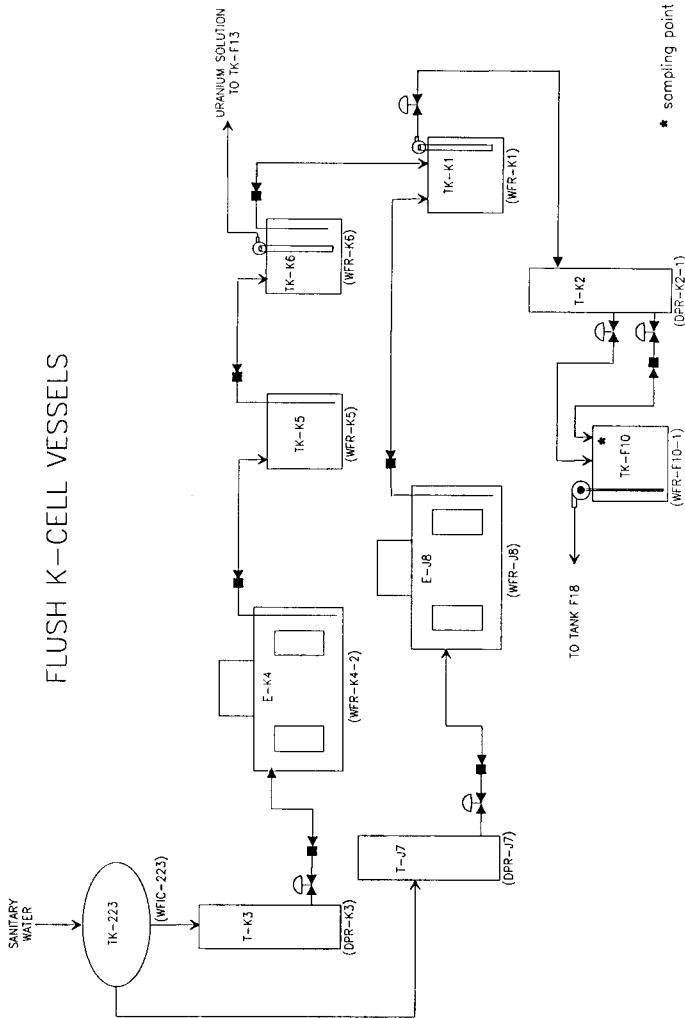
**PERSONS COMPLETING JHA:**      **Team:**

This page intentionally left blank.

**APPENDIX F**  
**FLUSH K-Cell CHART**

This page intentionally left blank.

## FLUSH K-CELL VESSELS



This page intentionally left blank.

**APPENDIX G**

**DRAWING OF SIMPLIFIED PUREX EXISTING HVAC FLOW AND PROJECTED CONSOLIDATED FLOW**

This page intentionally left blank.

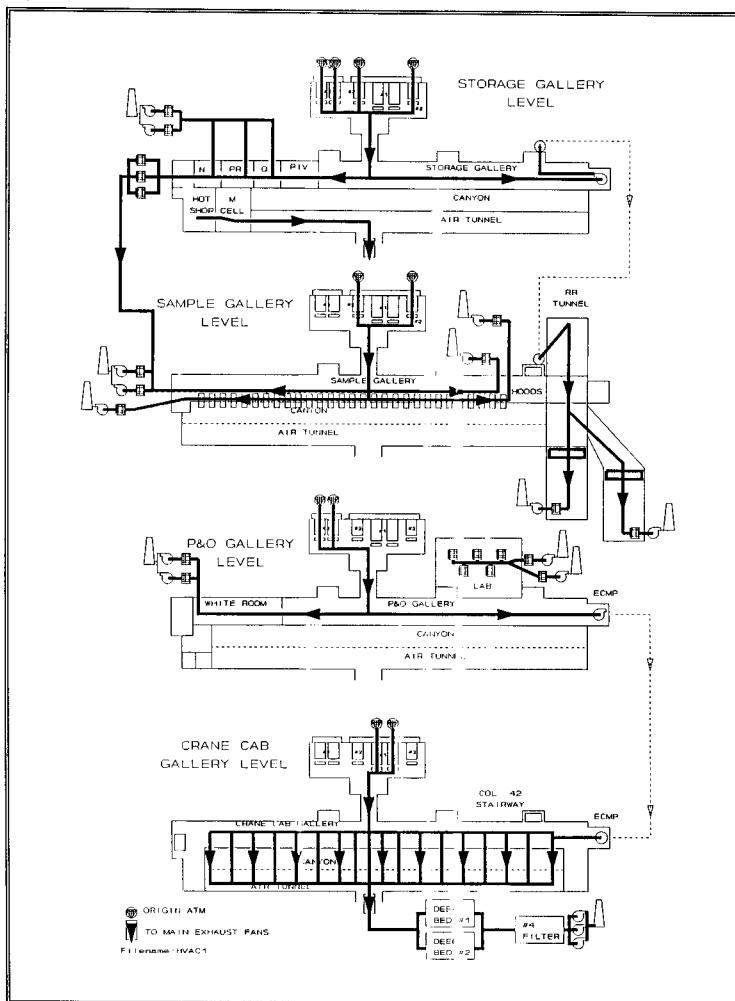


Figure 2. SIMPLIFIED EXISTING PUREX FLOW SCHEMATIC

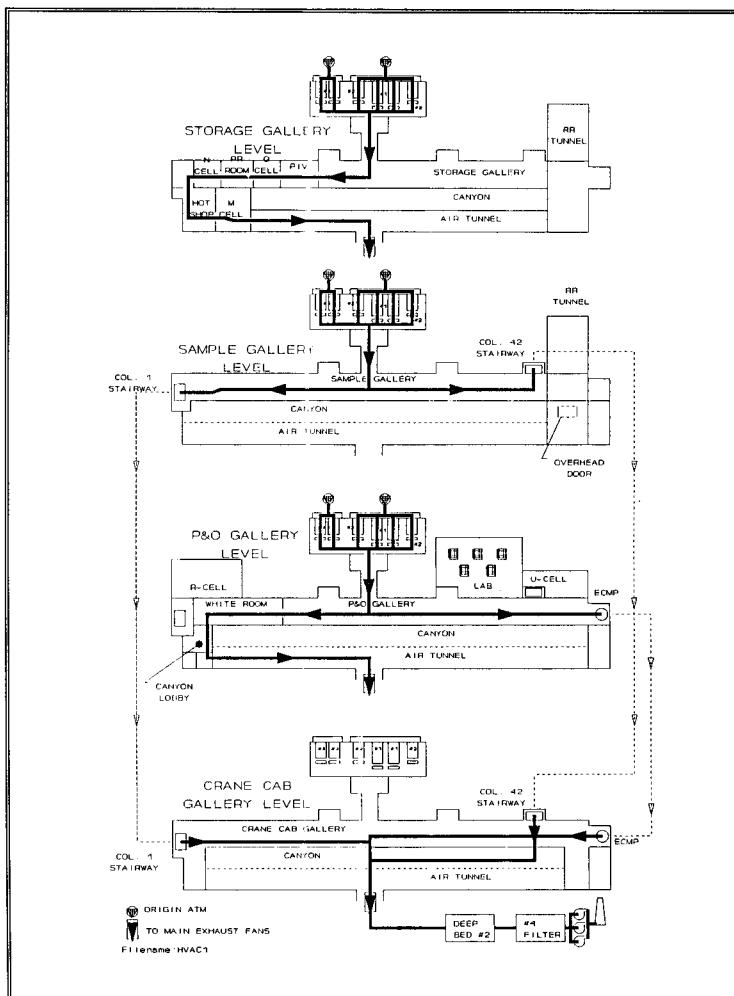


Figure 3. PUREX HVAC CONSOLIDATION FLOW SCHEMATIC

**DISTRIBUTION (cont)**Number of CopiesONSITE

6	<u>Bechtel Hanford, Inc.</u>	
	R. G. Egge	T7-05
	R. P. Henckel	X5-53
	G. M. MacFarlan	X5-53
	T. E. Marceau	H0-02
	J. J. McGuire	X5-53
	M. R. Morton	H0-18
1	<u>Duke Engineering and Services, Inc.</u>	
	W. D. Adair	H6-21
50	<u>Fluor Daniel Hanford Co.</u>	
	J. C. Britton	B3-30
	M. S. Gerber (45)	B3-26
	L. C. Olguin	N1-26
	E. S. McGinley II	H8-68
	G. W. Reddick, Jr	N1-26
	E. L. Reynolds	N1-26
5	<u>Lockheed Martin Services, Inc.</u>	
	Central Files	B1-07
	EDMC	H6-06
	OSTI (2)	H6-08
	TFIC	R1-28
1	<u>Pacific Northwest National Laboratory</u>	
	Hanford Technical Library	P8-55
1	<u>Waste Management Federal Service of Hanford, Inc.</u>	
	G. C. Triner	T3-05
	J. A. Winterhalder	H6-51

## DISTRIBUTION (cont)

Number of Copies

## ONSITE

1 Washington State Department of Ecology

R. J. Julian B5-18

63 B&W Hanford Company

R. W. Bailey (25)	S6-15
D. M. Bogen	T5-50
D. B. Cartmell	R3-50
F. R. Crawford	T5-50
M. W. Ellis	S6-15
K. A. Hadley	R3-56
E. R. Hamm	R2-40
J. P. Hayfield, Jr.	S6-15
G. O. Hayner	L5-65
S. A. Hays (3)	S6-81
W. F. Heer	H5-31
R. E. Heineman, Jr.	S4-49
T. E. Huber	T5-50
W. G. Jasen	T4-52
G. J. LeBaron	S6-15
J. D. Legard	S6-15
E. F. Loika	N2-51
G. L. McCormick	R3-56
C. H. Merry	S6-15
B. Oldfield	R3-56
W. A. Peiffer	S6-15
L. F. Perkins	T6-14
R. D. Redekopp	T5-15
J. R. Robertson	T5-54
J. L. Ryan	S6-15
C. D. Sorensen	T5-50
L. D. Stefanski	S6-15
J. M. Steffen	N1-47
D. M. Turner	R3-56
E. C. Vogt	R3-56
A. G. Westra	S6-60
L. C. Zinsli	S6-15

**DISTRIBUTION (cont)**

Number of Copies

OFFSITE

1      Oak Technologies, Inc.  
P. O. Box 720  
Washington Grove, Maryland 20880-0720

C. A. Negin

1      Polestar Applied Technology, Inc.  
Four Main Street  
Los Altos, California 94022

J. DeVine

2      Scientech, Inc.  
11140 Rockville Pike  
Suite 500  
Rockville, Maryland 20855

W. Bixby  
H. Burton  
B. Lippy

1      Washington State Historical Society  
315 North Stadium Way  
Tacoma, Washington 98403

D. Nicandri

ONSITE

23      U.S. Department of Energy,  
Richland Operations Office

L. K. Bauer	H0-12
J. K. Erickson	K8-50
R. X. Gonzalez	R3-79
J. M. Hennig	A5-15
P. M. Knollmeyer	A5-11
D. W. Lloyd	R3-79
J. E. Mecca	R3-79
S. K. Moy	S7-55
L. L. Piper	A7-50
L. E. Rogers (10)	R3-79
L. D. Romine	R3-79
J. D. Wagoner	A7-50
J. K. Yerxa	A7-75
Reading Room	H2-53

**DISTRIBUTION**

Number of Copies

OFFSITE

- 5        U.S. Department of Energy-  
          Headquarters  
          1000 Independence Avenue, S.W.  
          EM-60, Room 58086  
          Washington, D.C.
- C. C. Eng  
          B. Nelson  
          S. Purvis  
          R. Scott  
          L. Weiner
- 1        U.S. General Accounting Office  
          P. O. Box 578  
          Richland, Washington 99352  
          J. Cass
- 1        Booz, Allen & Hamilton  
          3285C Coachmans Way  
          Roswell, Georgia 30075  
          D. Humenansky
- 1        Gamma Engineering Corporation  
          15815 Crabbs Branch Way  
          Rockville, Maryland 20855  
          H. Feinroth
- 1        MPR Associates, Inc.  
          320 King Street  
          Alexandria, Virginia 22314-3238  
          D. Chapin
- 1        National Academy of Sciences  
          Board on Radioactive Waste Management  
          2101 Constitution Avenue, N.W.  
          Washington, D.C. 20418  
          R. Andrews