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Revision 0

PUREX Storage Tunnels Inventory

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

P.O. Box 1600
Richland, Washington 99352

Approved for Public Release;
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Executive Summary

This document provides a bibliography of references for the inventory within Plutonium-Uranium Extraction (PUREX) Storage Tunnel 1 (218-E-14) and Storage Tunnel 2 (218-E-15).

- Chapter 1 contains the latest revision to the PUREX Storage Tunnel inventory graphics and the most recent inventory graphics previous to the current set.
- Chapter 2 contains updated inventory characterization data provided to the Washington State Department of Ecology.
- Chapter 3 contains a collection of inventory-related documents in chronological order.
- Chapter 4 contains potentially useful presentations not captured elsewhere.
- Chapter 5 provides a list of references.
- Appendix A contains photographs of the various positions within Tunnel 1.
- Appendix B contains photographs of the various positions within Tunnel 2.
- Appendix C contains resources related to the tunnels or process equipment.
- Appendix D contains photograph examples of items placed in the tunnels.

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Terms

CHPRC	CH2M HILL Plateau Remediation Company
CSER	Criticality Safety Evaluation Report
DID	Defense in Depth
DSA	Documented Safety Analysis
DSI	Don’t Say It – Write It
Ecology	Washington State Department of Ecology
IDMS	Integrated Document Management System
LPF	Leak Path Factor
LWTC	Liquid Waste Tank Car
PTS	Project Technical Services
PUREX	Plutonium-Uranium Extraction
RCRA	*Resource Conservation and Recovery Act of 1976*
SS	Safety Significant
WIDS	Waste Information Data System

1 Introduction

This document provides a bibliography for the inventory within the Plutonium-Uranium Extraction (PUREX) Facility Storage Tunnel 1 (218-E-14) and Storage Tunnel 2 (218-E-15).

This document was created to provide a degree of configuration control for the PUREX Storage Tunnel inventory graphics as they are used in several important documents including hazardous waste permits and safety basis documents. Additionally, this documents how the declared inventory has changed over time. The intent is to provide an analyst a place to start with respect to the inventory in the PUREX Storage Tunnels.

- Section 1.1 contains the latest revision to the PUREX Storage Tunnel inventory graphics.
- Section 1.2 contains the most recent inventory graphics previous to the current set.
- Chapter 2 contains updated inventory characterization data provided to the Washington State Department of Ecology (Ecology).
- Chapter 3 contains a collection of inventory-related documents in chronological order.
- Chapter 4 contains potentially useful presentations not captured elsewhere.
- Chapter 5 provides a list of references.
- Appendix A contains photographs of the various positions within Tunnel 1.
- Appendix B contains photographs of the various positions within Tunnel 2.
- Appendix C contains resources related to the tunnels or process equipment.
- Appendix D contains photographs of equipment representative of the items placed in the tunnels.

It is expected that this document will be revised when the inventory (or configuration) of the PUREX tunnels change or when additional relevant historical inventory listings are found. If there are any errors or relevant items omitted, please contact the author.

1.1 Current Tunnel Inventory Graphics

The most recent update to the PUREX Storage Tunnel 1 inventory graphics are provided in Figures 1-1 through 1-4.

Noteworthy changes include the following:

- Corrected errors
  - Revised 500 rem/hr to 0.5 rem/hr (Tunnel 2 #3)
  - Storage rack moved, belongs with the jumper cutter (Tunnel 2 #14)
  - Revised 1% grade to 0.1% grade (Tunnel 2)
  - Swapped position data based on field configuration (Tunnel 2 #26, #28)
  - Revised H-2-66012 to H-2-66092 (Tunnel 2 #4)

- Reorganized the data for consistency and ease of use
  - Date placed in tunnel on the first line
  - Component details in the middle
  - Hazmat and radiological data on the bottom
  - Converted mrem/hr to rem/hr for items 0.1 rem/hr and above
  - Semicolon separators
- Removed redundant or effectively irrelevant information
  - Removed concentrator months of service (Tunnel 1)
  - Removed FUG SER #762 (Tunnel 1 #4)[1]
  - Removed legacy railcar numbers
  - Removed specific tube bundle numbers (e.g., Tube Bundles 57, 60, 62…)
  - Removed "Assembly" from storage box description (Tunnel 2 #21)
- Updated railcar depictions to better resemble the items in the tunnels
- Updated Storage Tunnel 1 as grouted.

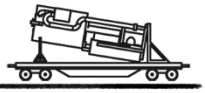
[1] Serial number; see Section 3.20 and H-2-53179-1.

PUREX STORAGE TUNNEL #1 (218-E-14)

TUNNEL IS AT CAPACITY AS OF 1/22/1965
TUNNEL IS GROUTED AS OF 11/16/2017

PUREX Storage Tunnel #1 is located at the southeast end of the PUREX Plant and is an extension of the railroad tunnel. The storage area is approximentely 109 meters long, 6.9 meters high, and 5.8 meters wide. The tracks have a 1 percent down-grade toward the south end of the tunnel. The capacity of the Storage Tunnel is 8 modified railroad cars, 12.8 meters long.

Position	
1. & 2.	CAR PLACED IN TUNNEL ON 6/60; HA COLUMN AND MISC. JUMPERS IN BOX (H-2-58372); HA COLUMN: 4,700 CU. FT.; 400 CURIES; JUMPERS: 2,190 CU. FT.; 2,000 CURIES; ~115 kg Pb; 5 rem/hr. @ 60'
3.	CAR PLACED IN TUNNEL ON 7/29/60; E-F11 (#1) (1WW WASTE) CONCENTRATOR; 1,900 CU. FT.; 40,000 CURIES; 12.5 rem/hr. @ 100'
4.	CAR PLACED IN TUNNEL ON 12/24/60; G-E2 CENTRUFUGE, 2 TUBE BUNDLES, MISC. JUMPERS; 2,465 CU. FT.; 3,000 CURIES; ~115 kg Pb; 1.5 rem/hr. @ 150'
5.	CAR PLACED IN TUNNEL ON 1/4/61; E-H4 (3WB) CONCENTRATOR; 2,336 CU. FT.; 1,000 CURIES; 0.15 rem/hr. @ 50'
6.	CAR PLACED IN TUNNEL ON 4/21/61; E-F6 (2WW WASTE) CONCENTRATOR; 2,336 CU. FT.; 700 CURIES; 5 rem/hr. @ 20'
7.	CAR PLACED IN TUNNEL ON 2/8/62; E-F11 (#2) (1WW WASTE) CONCENTRATOR; 2,336 CU. FT.; 40,000 CURIES; 25 rem/hr. @ 150'
8.	FLAT CAR 3621 PLACED IN TUNNEL ON 1/22/65; E-F6 (#3 SPARE) (2WW WASTE) CONCENTRATOR; 2,400 CU. FT.; 700 CURIES; 5 rem/hr. @ 20'



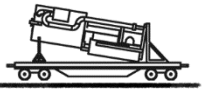
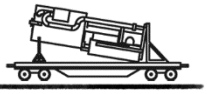
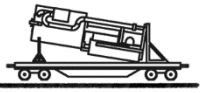
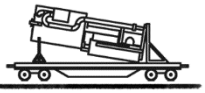





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Figure 1-1. PUREX Storage Tunnel 1 Inventory

PUREX STORAGE TUNNEL #2 (218-E-15)

PUREX Storage Tunnel #2 is located at the southeast end of the PUREX Plant and is an extension of the railroad tunnel. The storage area is approximately 514.5 meters long, 7.9 meters high and 10.4 meters wide. The tracks have a 0.1 percent downgrade toward the south end of the tunnel. The capacity of the Storage Tunnel is 38-40 modified railroad cars, 12.8 meters long. The Tunnel contains 28 cars as of 6/19/1996.

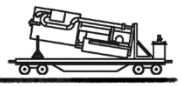
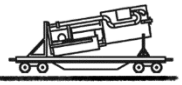
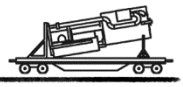
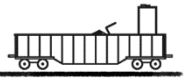
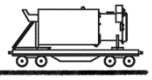
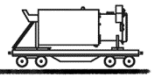
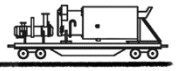
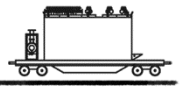
Position		
1.	CAR 61439 PLACED IN TUNNEL ON 12/12/67; E-F6 (2WW WASTE) CONCENTRATOR, TK-F15-2, TUBE BUNDLE, AGITATOR MOTORS; 2,400 CU. FT.; 700 CURIES; 1.3 rem/hr. @ 100'	
2.	CAR MILW 60883 PLACED IN TUNNEL ON 3/26/69; E-F6 (#5) CONCENTRATOR (PREVIOUSLY E-H4 3WB), 2 TUBE BUNDLES; 2,400 CU. FT.; 500 CURIES; 0.8 rem/hr. @ 2'	
3.	CAR 3612 PLACED IN TUNNEL ON 3/19/70; E-F6 (#6) (2WW WASTE) CONCENTRATOR, 2 TUBE BUNDLES; 2,400 CU. FT.; 700 CURIES; 0.5 rem/hr. @ 2'	
4.	CAR MILW 60033 PLACED IN TUNNEL ON 12/30/70; L-CELL PACKAGE IN A SEALED STEEL BOX (H-2-66092); 2,400 CU. FT.; 500 g Pu; 0.2 rem/hr. @ CONTACT	
5.	GONDOLA CAR 4610 PLACED IN TUNNEL ON 2/26/71; T-F2 SILVER REACTOR, T-F6 DEMISTER, VESSEL VENT LINE, STEEL CATWALK AND GUARD RAILS; 2,400 CU. FT.; 20 CURIES; ~625 kg Ag; 2 rem/hr. @ CONTACT	
6.	GONDOLA CAR 4611 PLACED IN TUNNEL ON 12/12/71; MODIFIED T-A3-1 TOWER, SCRUBBER, LID, VAPOR LINE; 2,400 CU. FT.; 10 CURIES; 1 rem/hr. @ CONTACT	
7.	CAR B58 (9' SHORTENED) PLACED IN TUNNEL ON 12/22/71; TK-A3 ANNULAR DISSOLVER; 2,400 CU. FT.; 50 CURIES; ~45 kg Hg; 5 rem/hr. @ 5'	
8.	CAR 19808 PLACED IN TUNNEL ON 8/29/72; A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQPT. USED WITH SUSPECTED CANISTERS; 800 CU. FT.; 17,500 CURIES; 10 rem/hr. @ 150'	
9.	CAR 19811 PLACED IN TUNNEL ON 9/30/72; TK-C3 ANNULAR DISSOLVER; 1,590 CU. FT.; 50 CURIES; ~45 kg Hg; 5 rem/hr. @ 5'	
10.	CAR CDX-1 PLACED IN TUNNEL ON 8/30/83; E-H4 (3WB) CONCENTRATOR, TUBE BUNDLE, PROTOTYPE COOLING COIL, F-F1 FILTER TANK; 2,400 CU. FT.; 500 CURIES; 0.8 rem/hr. @ 2'	
11.	CAR 3613 PLACED IN TUNNEL ON 1/18/86; TK-A3 ANNULAR DISSOLVER (#10) AND E-A2 HEATER (#6); 3,960 CU. FT.; 0.81 CURIES; ~40 kg Hg; ~43 kg Cd; 3 mrem/hr. @ 3'	
12.	CAR 3611 PLACED IN TUNNEL ON 1/20/86; WHITE BOX (H-2-58456) CONTAINING 8 TUBE BUNDLES, PG-J6 PULSE GENERATOR (#5), DISSOLVER LID, 9 DUMPING TRUNNIONS; 5,438 CU. FT.; 540 CURIES, 2 rem/hr. @ 3'	

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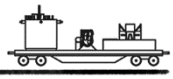
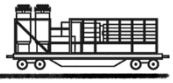
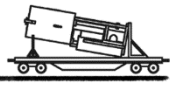
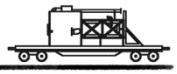
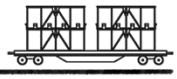
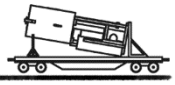
Figure 1-2. PUREX Storage Tunnel 2 Inventory Sheet 1

PUREX STORAGE TUNNEL #2 (218-E-15)

Position		
13.	CAR 19806 PLACED IN TUNNEL ON 1/21/86; TK-J5 2A FEED TANK (#30), E-F1 CONDENSER (#13), F12-B CELL BLOCK, DISSOLVER 4-WAY DUMPER, DISSOLVER YOKE, FLANGE PLATE; 2,500 CU. FT.; 90 CURIES; 3 rem/hr. @ 1'	
14.	CAR PX-10 PLACED IN TUNNEL ON 11/18/87; L-1 PULSER, 2 COLUMN CARTRIDGES, JUMPER CUTTER, STORAGE RACK, 3 JUMPER ALIGNMENT TOOLS, 9 EXTERIOR DUMPING TRUNNIONS, 10 PUMPS, 3 AGITATORS, 4 TUBE BUNDLES, 2 VENT JUMPERS, 7 YOKES; 50 TONS; 3,600 CU. FT.; 33,740 CURIES; 2,540 kg Pb; 5 rem/hr. @ 15' (REF: LETTER 12110-88-074)	
15.	CAR PX-9 PLACED IN TUNNEL ON 5/13/88; T-A2 SILVER REACTOR (#5 SPARE), S/R CRADLE, E-F2 STEAM HEATER, STORAGE LINER (H-2-65095) FILLED WITH CUT UP JUMPERS; 20 TONS; 2,775 CU. FT.; 240 CURIES; ~13 kg Cd; ~115 kg Ag; ~230 kg Pb; 20 mrem/hr. @ 20' (REF: LETTER 12110-88-074)	
16.	CAR PX-6 (H-2-99608) PLACED IN TUNNEL ON 4/6/89; E-J8-1 UNITIZED CONCENTRATOR (#1) (H-2-52477); ESTIMATED 42 TONS; 6,000 CU. FT.; 1.5 CURIES; 0.5 mrem/hr. @ 10' (REF: LETTER 12113-89-027)	
17.	CAR PX-19 PLACED IN TUNNEL ON 8/5/89; NORTH STORAGE LINER (H-2-65095) CONTAINING 6 PUMPS, AN AGITATOR AND CUT UP JUMPERS (14 TONS). SOUTH STORAGE LINER (H-2-65095) CONTAINING A PUMP, #15 YOKE, AND CUT UP JUMPERS (11.5 TONS); ESTIMATED 25.5 TONS; 2,574 CU. FT.; 3.0 CURIES; 80 mrem/hr. @ 1' (REF: LETTER 12113-89-051)	
18.	CAR PX-2 PLACED IN TUNNEL ON 4/8/94; T-F5 ACID ABSORBER (H-2-52535, H-2-52487, H-2-52488); ESTIMATED 22 TONS; 835 CU. FT.; 185 CURIES; 80 mrem/hr. @ CONTACT	
19.	CAR PX-23 PLACED IN TUNNEL ON 9/16/94; 4 METAL LINER STORAGE BOXES (H-2-65095) (H-2-100187) CONTAINING FAILED JUMPERS AND MISC. OBSOLETE CANYON EQUIPMENT; ESTIMATED 60 TONS; 4,032 CU. FT.; 927 CURIES; 30 mrem/hr. @ 2'	
20.	CAR PX-28 PLACED IN TUNNEL ON 1/27/95; E-H4-1 UNITIZED CONCENTRATOR (H-2-52477) (H-2-56213); ESTIMATED 40 TONS; 5,760 CU. FT.; 3,070 CURIES; ~8 kg Cr; 1 rem/hr. @ 5'	
21.	CAR PX-3609 PLACED IN TUNNEL ON 2/8/95; H4 CONCENTRATOR TOWER (H-2-58102), TK-E5 (H-2-52453), LEAD STORAGE BOX (H-2-131629), HOT SHOP "Q" COVER PLATE (H-2-52222), TUBE BUNDLE WASH CAPSULE (H-2-58647), DISSOLVER CHARGING INSERT (H-2-75875), LIFTING YOKE #7A (H-2-96837), LIFTING YOKE #9 (H-2-52458); ESTIMATED 44 TONS; 3,457 CU. FT.; 26,000 CURIES. ~1,930 kg Pb; 1 rem/hr. @ 4'	

HNF-62216

Figure 1-3. PUREX Storage Tunnel 2 Inventory Sheet 2

PUREX STORAGE TUNNEL #2 (218-E-15)

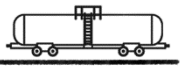
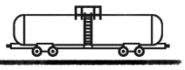
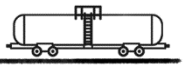
Position		
22.	CAR 3616 PLACED IN TUNNEL ON 3/11/96; METAL LINER BOX (H-2-65095) CONTAINING JUMPERS AND FAILED/ OBSOLETE CANYON EQUIPMENT, F7 NEUTRON MONITOR (H-2-75825), LEAD STORAGE BOX (H-2-131629) CONTAINING JUMPER COUNTERWEIGHTS AND MISC. LEAD ITEMS, SCRAP HOPPER (H-2-57347) CONTAINING MISC. CANYON EQUIPMENT, CANISTER CAPPING STATION (H-2-821831), TEST CANISTER CONTAINING VARIOUS LENGTHS OF CARBON STEEL PIPE; ESTIMATED 22 TONS; 1,712 CU. FT.; 15 CURIES; ~3,232 kg Pb; ~2 kg Cd; 0.1 rem/hr. @ 1'	
23.	CAR PX-31 PLACED IN TUNNEL ON 3/11/96; 2 BURIAL BOXES (H-2-100187) CONTAINING JUMPERS AND FAILED/OBSOLETE CANYON EQUIPMENT. LIFTING YOKE (H-2-99652); ESTIMATED 21 TONS; 2,116 CU. FT.; 2 CURIES; 10 mrem/hr. @ 1'	
24.	CAR PX-29 PLACED IN TUNNEL ON 4/26/96; CONCRETE BURIAL BOX (H-1-44980) STORING 8 CONTAINERS OF 324 BUILDING B-CELL WASTE; ESTIMATED 36 TONS; 1,890 CU. FT.; <244,000 CURIES; ~1,802 kg Pb; ~10.5 kg Cd; ~8.5 kg ABSORBED OIL; ~1 kg Cr; ~3 kg Ba; ~24 g Pu; ~15 mrem/hr. @ 150' (FOR DETAILS SEE PUREX WORK PLAN WP-P-95-60)	
25.	CAR 10A-3619 PLACED IN TUNNEL ON 6/12/96; CONCRETE BURIAL BOX (H-1-44980) STORING 9 CONTAINERS OF 324 AND 325 BUILDING HOT CELL WASTE; ESTIMATED 46.5 TONS; 1,890 CU. FT.; <1,750,000 CURIES; <1 g Pb; < 1 g Cd; ~2 g Cr; ~4 g Ba; ~43 g Pu; ~0.2 rem/hr. @ 150' (FOR DETAILS SEE PUREX WORK PLAN WP-P-96-015)	
26.	CAR HO-10H-18582 PLACED IN TUNNEL ON 6/19/96; 20,000-GALLON LIQUID WASTE TANK CAR (LWTC); EMPTY PER RCRA; ESTIMATED 30 TONS; 23 CURIES; ~11 g Pu; 0.65 rem/hr. @ 3'	
27.	CAR HO-10H-18579 PLACED IN TUNNEL ON 6/19/96; 20,000-GALLON LIQUID WASTE TANK CAR (LWTC); EMPTY PER RCRA; ESTIMATED 30 TONS; 9 CURIES; ~131 g Pu; 0.3 rem/hr. @ 3'	
28.	CAR HO-10H-18580 PLACED IN TUNNEL ON 6/19/96; 20,000-GALLON LIQUID WASTE TANK CAR (LWTC); EMPTY PER RCRA; ESTIMATED 30 TONS; 5 CURIES; ~53 g Pu; 0.1 rem/hr. @ 3'	

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Figure 1-4. PUREX Storage Tunnel 2 Inventory Sheet 3

1.2 Previous Tunnel Inventory Lists and Graphics

Previous to the set in Section 1.1, the last updated inventory graphics were found in a “Don’t Say It – Write It” (DSI) memo from C. R. Haas with the subject *PUREX Storage Tunnels* on 6/28/1996.

The inventory graphics from the Haas DSI are provided on the following pages in Figures 1-5 through 1-8. A complete copy of the 1996 Haas DSI is provided in Section 3.7.

PUREX #1 STORAGE TUNNEL (218-E-14)

TUNNEL IS AT ITS CAPACITY AS OF 1/22/65

PUREX #1 Storage Tunnel is located at the southeast end of the PUREX Plant and is an extention of the railroad tunnel. The storage area is approximately 109 meters long, 6.9 meters high and 5.8 meters wide. The tracks have a one percent down-grade toward the south end of the tunnel. The capacity of the Storage Tunnel is eight modified railroad cars, 12.8 meters long.

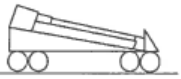
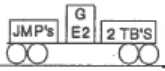
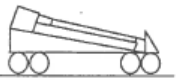
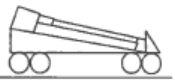
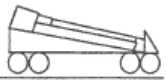
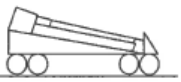
position		
1. & 2.	HA COLUMN AND MISC JUMPERS IN BOX PLACED IN TUNNEL #1 ON 6/60 HA 4,700 CU. FT., 400 CURIES, 5 rem/hr. @ 60', JUMPRS 2,190 CU. FT., 2,000 CURIES, Pb - ~115 Kg.	
3.	E-F11 #1 (1WW WASTE) CONCENTRATOR FAILED 7/24/60. PLACED IN TUNNEL #1 ON 7/29/60, 12.5 rem/hr. @ 100', 1,900 CU. FT., 40, 000 CURIES AFTER FIFTY-FIVE MONTHS SERVICE.	
4.	G-E2 CENTRIFUGE. MISC JUMPERS IN BOX AND TWO TUBE BUNDLES. PLACED IN TUNNEL #1 ON 12/24/60 (FUG SER# 762) 2,465 CU. FT., 3,000 CURIES, Pb - ~115 Kg., 1.5 rem/hr. @ 150'.	
5.	E-H4 (3WB) CONCENTRATOR FAILED 1/4/61. PLACED IN TUNNEL #1 ON 1/4/61, 150 mrem/hr. @ 50', 2,336 CU. FT., 1,000 CURIES. AFTER FIVE YEARS SERVICE.	
6.	E-F6 (2WW WASTE) ORIGINAL CONCENTRATOR FAILED 4/21/61. PLACED IN TUNNEL #1 ON 4/21/61, 5 rem/hr. @ 20', 2,336 CU. FT., 700 CURIES. AFTER FIVE YEARS FOUR MONTHS SERVICE.	
7.	E-F11 (1WW WASTE) #2 CONCENTRATOR FAILED 2/1/62. PLACED IN TUNNEL #1 ON 2/8/62, 25 rem/hr. @ 150', 2,336 CU. FT., 40,000 CURIES. AFTER EIGHTEEN MONTHS SERVICE.	
8.	E-F6 (2WW WASTE) #3 SPARE CONCENTRATOR FAILED 5/23/64. PLACED IN TUNNEL #1 ON 1/22/65 FLAT CAR 3621. 2,400 CU. FT., 700 CURIES, 5 rem/hr. @ 20'.	

Figure 1-5. Previous PUREX Storage Tunnel 1 Inventory

PUREX #2 STORAGE TUNNEL (218-E-15)

PUREX #2 Storage Tunnel is located at the southeast end of the PUREX Plant and is an extention of the railroad tunnel. The storage area is approximately 514.5 meters long, 7.9 meters high and 10.4 meters wide. The tracks have a one percent downgrade toward the south end of the tunnel. The capacity of the Storage Tunnel is 38-40 modified railroad cars, 12.8 meters long. The Tunnel contains 21 cars as of 2/95.

position	
1.	E-F6 # (2WW WASTE) CONCENTRATOR, TK F 15-2, ONE TUBE BUNDLE AND AGITATOR MOTORS PLACED IN TUNNEL ON 12/12/67 ON CAR 61439 2,400 CU. FT., 700 CURIES, 1.3 rem/hr. @ 100'.
2.	E-F6 #5 (E-H4 3WB) CONCENTRATOR, TWO TUBE BUNDLES PLACED IN TUNNEL ON 3/26/69 ON CAR MILW 60883 2,400 CU. FT., 500 CURIES, 800 mrem/hr. @ 2'.
3.	E-F6 #6 (2WW WASTE) CONCENTRATOR, TWO TUBE BUNDLES FAILED PLACED IN TUNNEL ON 3/19/70 ON CAR 3612. 2, 400 CU. FT., 700 CURIES, 500 rem/hr. @ 2'.
4.	L CELL PACKAGE IN A SEALED STEEL BOX (H2-66012) PLACED IN TUNNEL ON 12/30/70 ON CAR MILW 60033 2,400 CU. FT., 500 GRMS Pu, 200 mrem/hr. @ CONTACT.
5.	F2 SILVER REACTOR, F6 DEMISTER, VESSEL VENT LINE STEEL CAT-WALK AND GUARD RAILS. PLACED IN TUNNEL ON 2/26/71 ON GONDOLA CAR 4610. 2,400 CU. FT., 20 CURIES, Ag - ~625 Kg, 2 rem/hr. @ CONTACT.
6.	MODIFIED A3-1 TOWER, SCRUBBER, LID AND VAPOR LINE PLACED IN TUNNEL ON 12/12/71 ON GONDOLA CAR 4611. 2,400CU. FT., 10 CURIES, 1 rem/hr. @ CONTACT.
7.	A3 DISSOLVER PLACED IN TUNNEL ON 12/22/71 ON NINE FT. SHORTENED CAR B58 2,400 CU.FT., 50 CURIES, Hg - ~45 Kg, 5 rem/hr. @ 5'.
8.	A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQUIPT. USED WITH THE SUSPECTED CANISTERS, ON CAR 19808 PLACED IN TUNNEL ON 8/29/72. 800 CU. FT., 17,500 CURIES, 10 rem/hr. @ 150'.
9.	C3 DISSOLVER PLACED IN TUNNEL ON 9/30/72 ON CAR 19811 1590 CU. FT., 50 CURIES, Hg - ~45 Kg., 5 rem/hr. @ 5'.
10.	E-H4 (3WB) CONCENTRATOR, #61 TUBE BUNDLE, PROTOTYPE COOLING COIL AND A F-F1 FILTER TANK. PLACED IN TUNNEL 8/30/83 ON CAR CDX-1. 2,400 CU. FT., 500 CURIES, 800 mrem/hr. @ 2'.
11.	A3 DISSOLVER (VESSEL #10 AND HEATER VESSEL #6) PLACED IN TUNNEL ON 1/18/86 ON CAR 3613 3,960 CU. FT., 0.81 CURIES, Hg - ~40 Kg., Cd - ~43 Kg., 3 mrem/hr. @ 3'.
12.	WHITE BOX (H2-58456) CONTAINING EIGHT TUBE BUNDLES #S 57, 60, 62, 64, 67, 68, 74, AND 76 PULSER #5 AND OLD HEATER DISS LID OLD STYLE DUMPING TRUNNIONS (9), PLACED IN TUNNEL ON 1/20/86 ON CAR 3611 5,438 CU. FT., 540 CURIES, 2 rem/hr. @ 3'.

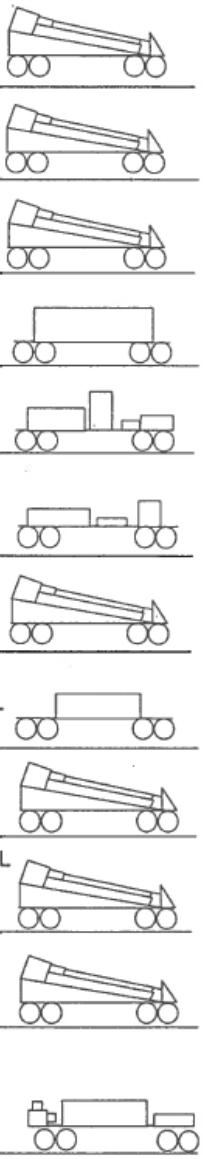


Figure 1-6. Previous PUREX Storage Tunnel 2 Inventory Sheet 1

PUREX #2 STORAGE TUNNEL (218-E-15)

position	
13.	J5 TANK (VESSEL #30). F1 COND (VESSEL #13) AND F12-B CELL BLK. OLD FOUR-WAY DUMPER. DISS YOKE AND FLANGE PLATE, 3 rem/hr. @ 1'. PLACED IN TUNNEL ON 1/21/86 ON CAR 19806. 2,500 CU. FT., 90 CURIES.
14.	L-1 PULSER, 2-COLUMN CARTRIDGES, 1-JUMPER CUTTER, 3-JUMPER ALIGNMENT TOOLS, 9-EXTERIOR DUMPING TRUNNIONS, 10-PUMPS, 3-AGITATORS, 4-TUBE BUNDLES, 2-VENT JUMPERS AND 7-YOKES. PLACED IN TUNNEL ON 11/18/87 ON CAR PX-10 (10A-19380) & RACK H2-96629.50. 50 TONS, 3,600 CU. FT., 33,740 CURIES(REF:LETTER 12110-88-074), Pb - ~2540 Kg., 5 rem/hr. @ 15'.
15.	SILVER REACTOR, E-F2 STEAM HEATER AND STORAGE LINER (H2-65095) FULL OF CUT UP JUMPERS PLACED IN TUNNEL ON 5/13/88 ON CAR PX-9 (10A-19809) & S/R CRADLE SK-GLR-11-2-87. 20 TONS, 2,775 CU. FT., 240 CURIES (REF: LETTER 12110-88-074), Cd - ~13 Kg., Ag - ~115 Kg., Pb - ~230 Kg., 20 mrem/hr. @ 20'.
16.	E-J8-1 UNITIZED CONCENTRATOR VESS #1 H2-52477, FAILED 3/11/89 PLACED ON STORAGE CAR H2-99608, PX-6 (10A-19028) AND INTO #2 TUNNEL 4/6/89 GRAVEYARDS. EST. 42 TONS, 6,000 CU. FT. 1.5 CURIES (REF: LETTER 12113-89-027), 0.5 mrem/hr. @ 10'.
17.	NORTH STORAGE LINER H2-65095 CONTAINING SIX PUMPS, ONE AGITATOR AND CUT UP JUMPER (14 TONS). SOUTH STORAGE LINER H2-65095 CONTAINING ONE PUMP, ONE #15 YOKE AND CUT UP JUMPERS (11.5 TONS). PLACED ON STORAGE CAR PX-19 (10A-19030) AND INTO #2 TUNNEL 8/5/89 DAYS. EST 25.5 TONS, 2,574 CU. FT. 3.0 CURIES (REF: LETTER 12113-89-051), 80 mrem/hr. @ 1'.
18.	T-F5 ACID ABSORBER, ID#1-T-F5/F-168713, H2-52535 AND H2-52487/488. PLACED ON STORAGE CAR PX-2 AND INTO #2 TUNNEL 4/8/94. EST 22 TONS, 835 CU. FT., 185 CURIES, 90 mrem/hr. @ CONTACT.
19.	FOUR METAL LINER STORAGE BOXES H-2-65095-3/H-2-100187-0 CONTAINING FAILED JUMPERS AND MISCELLANEOUS OBSOLETE CANYON EQUIPMENT ITEMS. PLACED ON STORAGE CAR PX-23 AND INTO #2 TUNNEL 9/16/94. EST 60 TONS, 4032 CU. FT., 927 CURIES, 30 mrem/hr. @ 2'.
20.	E-H4-1 UNITIZED CONCENTRATOR (H-2-52477/56213)/(E-H4-1). PLACED IN TUNNEL ON 1/27/95 ON CAR PX-28. EST 40 TONS, 5,760 CU. FT., 3,070 CURIES, Cr - ~8 Kg., 1000 mrem/hr. @ 5'.
21.	TANK E-5 (H-2-52453)/(F-166955), LEAD STORAGE BOX ASSEMBLY (H-2-131629)/(H-2-131629-1), H4 CONCENTRATOR TOWER (H-2-58102)/ (F-223017-CBT-4), HOT SHOP COVER PLATE (H-2-52222)/("Q"), TUBE BUNDLE WASH CAPSULE (H-2-58647), DISSOLVER CHARGING INSERT (H-2-75875)/ (H-2-75875-1), LIFTING YOKE #7A (H-2-96837), LIFTING YOKE #9 (H-2-52458). PLACED IN TUNNEL ON 2/8/95 ON CAR PX-3609. EST 44 TONS, 3,457 CU. FT., 26,000 CURIES, Pb - ~1930 Kg., 1000 mrem/hr. @ 4'.

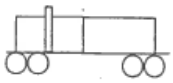
Figure 1-7. Previous PUREX Storage Tunnel 2 Inventory Sheet 2

PUREX #2 STORAGE TUNNEL (218-E-15)

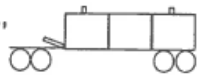
position

22. METAL LINER BOX (H-2-65095) CONTAINING JUMPERS AND FAILED/ OBSOLETE CANYON EQUIPMENT, F7 NEUTRON MONITOR (H-2-75825), LEAD STORAGE BOX (H-2-131629) CONTAINING JUMPER COUNTERWEIGHTS AND MISCELLANEOUS LEAD ITEMS, SCRAP HOPPER (H-2-57347) CONTAINING MISCELLANEOUS CANYON EQUIPMENT, CANISTER CAPPING STATION (H-2-821831), TEST CANISTER CONTAINING VARIOUS LENGTHS OF CARBON STEEL PIPE. PLACED IN TUNNEL 3-11-96 ON CAR #3616. ESTIMATED WEIGHT 22 TONS, 1,712 CU. FT., 15 CURIES, Pb - ~3,232 Kg., Cd - ~2 Kg., 100 mrem/hr. @ 1'.

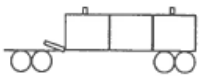
23. TWO BURIAL BOXES (H-2-100187) CONTAINING JUMPERS AND FAILED/ OBSOLETE CANYON EQUIPMENT, LIFTING YOKE (H-2-99652). PLACED IN TUNNEL 3-11-96 ON CAR #PX-31. ESTIMATED WEIGHT 21 TONS, 2,116 CU. FT., 2 CURIES, 10 mrem/hr. @ 1'.



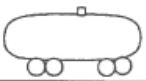
24. CONCRETE BURIAL BOX (H-1-44980) STORING 8 CONTAINERS OF 324 BUILDING, B-CELL WASTE. FOR ADDITIONAL DETAILS, SEE PUREX WORK PLAN WP-P-95-60. PLACED IN TUNNEL ON CAR #PX-29, ON APRIL 26, 1996. ESTIMATED WEIGHT 36 TONS, 1,890 CU. FT., < 244,000 CURIES, ~15 mrem/hr. @ 150'. Pb - ~1,802 kg., Cd - ~10.5 kg., absorbed oil - ~8.5 kg., Cr - ~1 kg., Ba - ~ 3 kg.



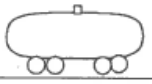
25. CONCRETE BURIAL BOX (H-1-44980) STORING 9 CONTAINERS OF 324 AND 325 BUILDING WASTE. FOR ADDITIONAL DETAILS, SEE PUREX WORK PLAN WP-P-96-015. PLACED IN TUNNEL ON CAR #10A-3619, ON JUNE 12, 1996. ESTIMATED WEIGHT 46.5 TONS, 1,890 CU. FT., < 1.75 M CURIES, ~200 mrem/hr. @ 150'. Ba - ~4 g., Cd - <1 g., Cr - ~ 2 g., Pb - < 1 g.



26. 20,000 GALLON LIQUID WASTE TANK CAR HO-10H-18580, EMPTY PER RCRA, PLACED IN TUNNEL ON JUNE 19, 1996, APPROXIMATELY 30 TONS, 5 CURIES, 100 mrem/hr. @ 3'.



27. 20,000 GALLON LIQUID WASTE TANK CAR HO-10H-18579, EMPTY PER RCRA, PLACED IN TUNNEL ON JUNE 19, 1996, APPROXIMATELY 30 TONS, 9 CURIES, 300 mrem/hr. @ 3'.



28. 20,000 GALLON LIQUID WASTE TANK CAR HO-10H-18582, EMPTY PER RCRA, PLACED IN TUNNEL ON JUNE 19, 1996, APPROXIMATELY 30 TONS, 23 CURIES, 650 mrem/hr. @ 3'.

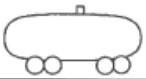


Figure 1-8. Previous PUREX Storage Tunnel 2 Inventory Sheet 3

2 PUREX Tunnel Inventory Characterization Tables

2.1 Introduction

This chapter contains the inventory characterization tables developed by CH2M HILL Plateau Remediation Company (CHPRC) for Ecology to support the 2018 *Resource Conservation and Recovery Act* (RCRA) permit modification request. These data were provided in CHPRC-1800452.1, "Contract Number DE-AC06-08RL14788 – Response to Completeness Determination and Notice of Deficiency for the Plutonium Uranium Extraction Plant Storage Tunnels, Class 3 Permit Modification Request," Attachment 5. What Chapter 2 represents is effectively a continuation of the inventory tables found in Section 3 of WHC-IP-0977, *Estimation of PUREX Equipment and Materials That are Candidates for Removal and Waste Processing During PUREX Plant Closure,* which stopped at Tunnel 2 Position 17.

2.1.1 Characterization/Mapping for PUREX Storage Tunnels

The following documentation summarizes the inventory contained within PUREX Storage Tunnel 1 and Tunnel 2. As received from Ecology, Tables 2-2 (*Ecology PUREX Storage Tunnel #1 Characterization/Mapping*) and 2-3 (*Ecology PUREX Storage Tunnel #2 Characterization/Mapping*) have been edited and updated to reflect available information. To assist in review and clarification of terminology, the following information is provided.

Except for instrumentation, a cell equipment piece is identified by a sequential combination of letters and numbers designating its description, cell location, and cell equipment number. For example, TK-F12 designates a tank (TK) in F Cell, vessel number 12. The principal descriptive identification letters are summarized in Table 2-1. See Section C.1.8 for additional details.

Table 2-1. Canyon Equipment Identification Letters

Letter	Equipment Piece
A	Agitator
E	Condenser, concentrator, heater (steam)
F	Filter
G	Centrifuge
H	Heater (electric)
J	Jet
JGV	Jet gang valve
PG	Pulse generator
PM	Pulse motor
P	Pump
SPLP	Sampler pot
TK	Tank
T	Tower (column)

The nine column headings in Table 2-2 and Table 2-3 are defined as follows:

Position:

This column shows the order the cars were placed in the tunnel, with the placement date in parenthesis underneath. The tunnel only has one entrance/exit, so position 1 contains the first rail car placed in the tunnel.

Equipment Stored:

This column shows the items cited on the inventory sheets, along with the PUREX Facility component number, if known.

Process Origin:

This column shows the plant subsystem with which this component was associated (e.g., Metal Dissolution & Feed Prep).

Process Streams:

This column shows the inlet and outlet process streams associated with this component.

Hazardous Constituents:

This column shows the known chemical hazards associated with the items in that position.

Grams Transuranic:

This column provides a conservative estimate in grams for known transuranic elements.

Radiological Inventory:

This column shows the total curie content of the inventory items, plus the recorded dose rate. These values are from when the rail car was placed in the tunnel. Additionally, total container volumes are provided with this data.

Estimated Radiation Type:

This column shows an estimation of the radiological inventory components (e.g., what percentage of the inventory are actinides, fission products, activation products).

Waste Codes:

This column indicates the dangerous waste codes associated with the items identified in the Hazardous Constituents column.

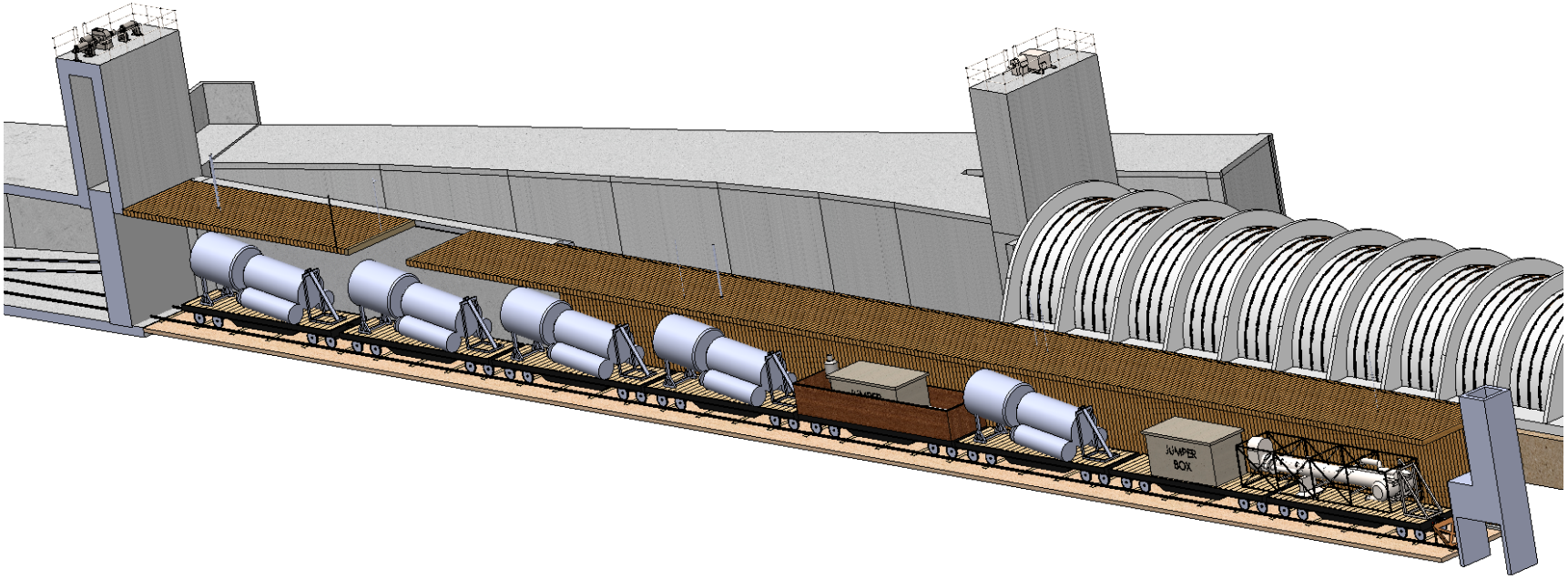


Figure 2-1. Ecology PUREX Storage Tunnel #1 Characterization/Mapping

Table 2-2. Ecology PUREX Storage Tunnel 1 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
1 & 2 (6/60)	T-H2 HA Column (H-2-58372) Jumpers in Box	First Decontamination and Partition Cycle	Inlet Streams HAF, CRD, HAS, 3WB-HA, HAX, Rec HNO_3, Water Outlet Streams HAP, HAW	~ 115 kg Pb (counterweights)	1,500	T-H2: 400 Ci 5 rem/hr @ 60' 4,700 ft^3 Jumpers: 2,000 Ci 2,190 ft^3	T-H2: 8% Actinides 92% Fission Products Jumpers: 16 % Actinides 83% Fission Products 1% Activation Products	Pb: D008
3 (7/29/60)	E-F11 Concentrator	Material Dissolution and Feed Preparation	Inlet Streams ASF, NaOH Outlet Streams ASW, Offgas	N/A	0	40,000 Ci 12.5 rem/hr @ 100' 1,900 ft^3	RuRh-106	N/A
4 (12/24/60)	G-E2 Centrifuge 2 Tube Bundles Jumpers in Box	Material Dissolution and Feed Preparation	Inlet Streams Decladding waste, Spent Metathesis Solution Outlet Streams Slurried Centrifuge Cake, Decladding Waste, Centrifuged Spent Metathesis Solution, Offgas	~ 115 kg Pb (counterweights)	130	3,000 Ci 1.5 rem/hr @ 150' 2,465 ft^3	1% Actinides 6% Fission Products 93% Activation Products	Pb: D008
5 (1/4/61)	E-H4 Concentrator	Backcycle Waste	Inlet Streams 3WF Outlet Streams 3WW and Offgas	N/A	2,900	1,000 Ci 150 mrem/hr @ 50' 2,336 ft^3	0.04% U 67% Pu 33% Fission Products	N/A
6 (4/21/61)	E-F6 Concentrator	Waste Concentration and Treatment	Inlet Streams 1WF, 1WR, Water, Offgas from 1WW Denitration Outlet Streams Offgas, 1WW	N/A	240	700 Ci 5 rem/hr @ 20' 2,336 ft^3	8% Actinides 92% Fission Products	N/A

Table 2-2. Ecology PUREX Storage Tunnel 1 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
7 (2/8/62)	E-F11 Concentrator	Material Dissolution and Feed Preparation	Inlet Streams ASF, NaOH Outlet Streams ASW, Offgas	N/A	0	40,000 Ci 25 rem/hr @ 150' 2,336 ft^3	RuRh-106	N/A
8 (1/22/65)	E-F6 Concentrator Rail Car HO-10A-3621	Waste Concentration and Treatment	Inlet Streams 1WF, 1WR, Water, Offgas from 1WW Denitration Outlet Streams Offgas, 1WW	N/A	240	700 Ci 5 rem/hr @ 20' 2,400 ft^3	8% Actinides 92% Fission Products	N/A

N/A = not applicable

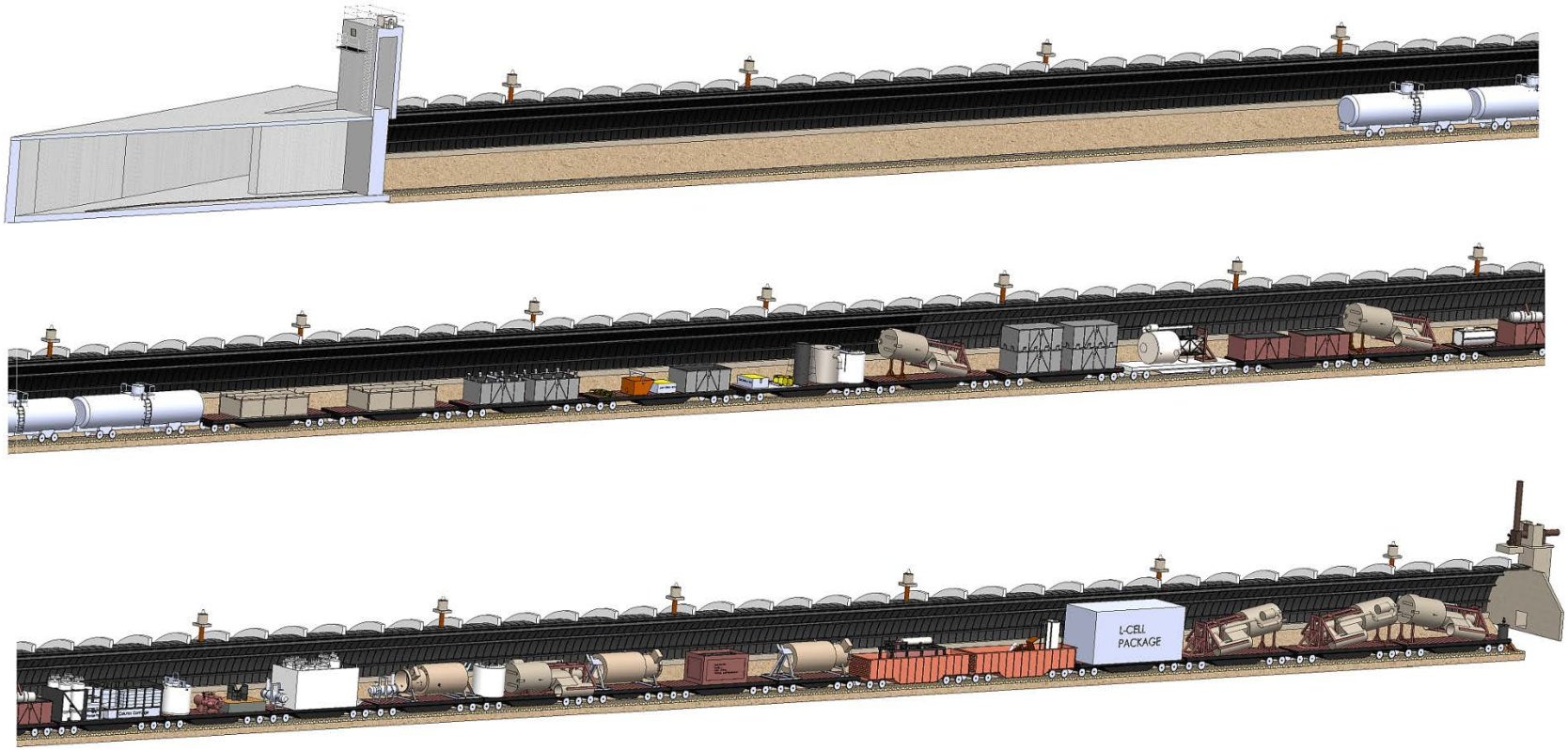


Figure 2-2. Ecology PUREX Storage Tunnel #2 Characterization/Mapping

Table 2-3. Ecology PUREX Storage Tunnel 2 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
1 (12/12/67)	E-F6 Concentrator Tube Bundle H-2-52550 TK-F15-2 Tank Agitator Motor Rail Car 61439	E-F6: Fission Product Waste Concentration TK-F15-2: Waste Concentration & Treatment	Inlet Streams E-F6: 1WF, 1WR, Water, TK-F15 Offgas TK-F15: 1WW, Sugar Outlet Streams E-F6: 1WW, Offgas to T-F6-2 TK-F15-2: 1WW, WRP, Offgas to E-F6	N/A	41	700 Ci 1.3 rem/hr @ 100' 2,400 ft^3	8% Actinides 92% Fission Products	N/A
2 (3/26/69)	E-F6 Concentrator (Previously E-H4) 2 Tube Bundles Rail Car MILW 60883	E-F6: Waste Concentration & Treatment Backcycle Waste	Inlet Streams E-F6: 1WF, 1WR, Water, TK-F15 Offgas Outlet Streams E-F6: 3WW, 1WW, Offgas to T-F6-2	N/A	29	500 Ci 0.8 rem/hr @ 2' 2,400 ft^3	8% Actinides 92% Fission Products	N/A
3 (3/19/70)	E-F6 Concentrator 2 Tube Bundles Rail Car 3612	Waste Concentration & Treatment	Inlet Streams E-F6: 1WF, 1WR, Water, TK-F15 Offgas Outlet Streams E-F6: 1WW, Offgas to T-F6-2	N/A	41	700 Ci 0.5 rem/hr @ 2' 2,400 ft^3	8% Actinides 92% Fission Products	N/A
4 (12/30/70)	L Cell Package Rail Car MILW 60033	Final Pu Cycles	Inlet Streams 2BP, HNO_3, 3AS, 3BX, 3AF, Water, 3AX, 3BP Outlet Streams 3AW, 3BW, PCP, Offgas	N/A	500	500 grams 0.2 rem/hr @ contact 2,400 ft^3	100% Pu	N/A

Table 2-3. Ecology PUREX Storage Tunnel 2 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
5 (2/26/71)	T-F2 Silver Reactor T-F6 Demister Vessel Vent Catwalk Guard Rails Gondola Car 4610	T-F2: Process Vent System (PVS) T-F6: Waste Concentration & Treatment	Inlet Streams T-F2: Vents from vessels & condensers T-F6: E-F6-1 Offgas, Water Outlet Streams T-F2: Vents from vessels & condensers (less free halogens) T-F6: AAF, 1WR	~625 kg Ag (Silver Salts as Silver Nitrates)	0	20 Ci 2 rem/hr @ contact 2,400 ft^3	I-129	Ag: D001 D011
6 (12/12/71)	T-A3-1 Downdraft Dissolver Condenser Tower (modified) Scrubber (likely T-A3 NH_3 Scrubber) Lid & Vapor Line Gondola Car 4611	T-A3-1 Mod: Material Dissolution & Feed Preparation Scrubber: Material Dissolution & Feed Preparation	Inlet Streams T-A3-1 Mod: TK-A3 Dissolver Offgas Scrubber: T-A3-1 Offgas, Water Outlet Streams T-A3-1 Mod: Offgas to Scrubber, Acid to TK-A3 Dissolver Scrubber: Acid to TK-A3, Waste & Fission Product to NH3 Catch Tank & Heater	N/A	0	10 Ci 1 rem/hr @ contact 2,400 ft^3	Ru-109	N/A
7 (12/22/71)	TK-A3 Annular Dissolver Rail Car B58 (Shortened 9 ft)	Material Dissolution & Feed Preparation	Inlet Streams Zircaloy Clad Metal Chemicals, Rec HNO_3, Metathesis solution Outlet Streams Recladding waste metathesis solution, dissolved Pu, U, or Np, & Offgas	~45 kg Hg (elemental)	2.9	50 Ci 5 rem/hr @ 5' 2,400 ft^3	8% Actinides 89% Fission Products 3% Activation Products	Hg: D009

Table 2-3. Ecology PUREX Storage Tunnel 2 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
8 (8/29/72)	A1W1 Fuel Ends New Production Reactor (NPR) Fuel Handling Equipment Steel Liner Box Rail Car 19808	Reactor Fuel (Idaho)	Spent Fuel - N/A	N/A	1,000	17,500 Ci 10 rem/hr @ 150' 800 ft^3	Unknown	N/A
9 (9/30/72)	TK-C3 Annular Dissolver Rail Car 19811	Material Dissolution & Feed Preparation	Inlet Streams Zircaloy Clad Metal Chemicals, Rec HNO_3, Metathesis solution Outlet Streams Recladding waste metathesis solution, dissolved Pu, U, or Np, & Offgas	~45 kg Hg (elemental)	2.9	50 Ci 5 rem/hr @ 5' 1,590 ft^3	8% Actinides 89% Fission Products 3% Activation Products	Hg: D009
10 (8/30/83)	E-H4 Concentrator (3WB) #61 Tube Bundle Prototype Cooling Coil F-F1 Filter Tank Rail Car CDX-1	E-H4: Backcycle Wash E-F1: Process Vent System (PVS)	Inlet Streams E-H4: 3WF F-F1: Halogen free vent from Silver Reactor Outlet Stream E-H4: 3WW, Offgas F-F1: Vent to building air filters	N/A	29	500 Ci 0.8 rem/hr @ 2' 2,400 ft^3	0.04% Actinides 67% Pu 33% Fission Products	N/A
11 (1/18/86)	TK-A3 Annular Dissolver (Vessel #10) E-A2 Steam Offgas Heater (Vessel #6) Rail Car 3613	Material Dissolution & Feed Preparation	Inlet Streams TK-A3: Zircaloy Clad Metal Chemicals, Rec HNO_3, Metathesis solution E-A2: NH_3 Scrubber Offgas Outlet Streams TK-A3: Recladding waste metathesis solution, dissolved Pu, U, or Np, & Offgas E-A2: Hot Offgas	~40 kg Hg (elemental) ~43 kg Cd (jacketing)	0.02	0.81 Ci 3 mrem/hr @3' 3,960 ft^3	8% Actinides 89% Fission Products 3% Activation Products	Hg: D009 Cd: D006 WT02

Table 2-3. Ecology PUREX Storage Tunnel 2 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
12 (1/20/86)	8 Tube Bundles PG-J6 Pulser #5 Dissolver Lid 9 Dumping Trunnions White Box (H-2-58456) Rail Car 3611	First Decontamina-tion & Partition Cycle	Inlet Streams 1BXF Outlet Streams 1BXF	N/A	31	540 Ci 2 rem/hr @ 3' 5,438 ft^3	16% Actinides 83% Fission Products 1% Activation Products	N/A
13 (1/21/86)	TK-J5 2A Feed Tank (Vessel #30) E-F1 Condenser (Vessel #13) F12-B Cell Block Dissolver 4-Way Dumper Dissolver Yoke Flange Plate Rail Car 19806	TK-J5: Final Pu Cycles E-F1: Process Vent System (PVS)	Inlet Streams TK-J5: 1BP, Fresh HNO_3 & 2AF-NO_3 E-F1: Vents from Vessels & Condensers Outlet Streams TK-J5: 2AF E-F1: Offgas & Condensate to TK-F12 via TK-F1	N/A	31	90 Ci 3 mrem/hr @ 1' 2,500 ft^3	94% Pu 6% Fission Products	N/A

Table 2-3. Ecology PUREX Storage Tunnel 2 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
14 (11/18/87)	L-1 Pulser 2 Column Cartridges Jumper Cutter Storage Rack 3 Jumper Alignment Tools 9 Exterior Dumping Trunnions 10 Pumps 3 Agitators 4 Tube Bundles 2 Vent Jumpers 7 Yokes Rail Car PX-10	Final Pu Cycles	Inlet Streams Serves T-L1 Column: 2AF, 2AX, Fresh HNO_3 & Water Outlet Streams Serves T-L1 Column: 2AP & 2AW	~2,540 kg Pb	1,900	33,740 Ci 5 rem/hr @ 15' 3,600 ft^3	16% Actinides 83% Fission Products 1% Activation Products	Pb: D008
15 (5/13/88)	T-A2 Silver Reactor (#5 Spare) E-F2 Steam Heater Burial Liner (H-2-65095) Jumpers S/R Cradle Rail Car PX-9	Process Vent System (PVS)	Inlet Streams T-A2: Vents from Vessels & Condensers E-F2: Dry Vent Gas from Condensers & Vessels Outlet Streams T-A2: Vents from Vessels & Condensers (less free halogens) E-F2: Hot dry vent gas	~13 kg Cd ~115 kg Ag (Silver Salts as Silver Nitrates) ~230 kg Pb	13	240 Ci 20 mrem/hr @ 20' 2,775 ft^3	15.5% Actinides 80.5% Fission Products 1% Activation Products (7.4 Ci I-129)	Ag: D011 D001 Cd: D006 WT02 Pb: D008
16 (3/11/89)	E-J8-1 Unitized Concentrator Vessel (H-2-52477) Rail CarPX-6	First Decontamina-tion & Partition Cycle	Inlet Streams 1CU, 3WD Outlet Streams 1UC, Offgas	N/A	0.4	1.5 Ci 0.5 mrem/hr @ 10' 6,000 ft^3	46% U 23% Pu 30% Fission Products	N/A

Table 2-3. Ecology PUREX Storage Tunnel 2 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
17 (8/5/89)	North Storage Liner (H-2-65095) 6 Pumps Agitator Cut Up Jumpers (14 tons) South Storage Liner (H-2-65095) Pump #15 yoke Cut Up Jumpers (15.5 tons) Rail Car PX-19	Various from PUREX Canyon	Various	N/A	0.1	3.0 Ci 80 mrem/hr @ 1' 2,574 ft^3	16% Actinides 83% Fission Products 1% Activation Products	N/A
18 (4/8/94)	T-F5 Acid Absorber Rail Car PX-2	Waste Concentration & Acid Recovery	Inlet Streams AAF from E-F6, AAR from E-F5, ANN, Water Outlet Streams AAA to TK-F3, Vapor to E-F6, Offgas to stack	N/A	14	185 Ci 90 mrem/hr @ contact 835 ft^3	8.3% Actinides 91.7% Fission Products	N/A
19 (9/16/94)	4 Metal Liner Storage Boxes (H-2-65095-3) (H-2-100187-0) Failed Jumpers Misc. Obsolete Canyon Equipment Rail Car PX-23	Various from PUREX Canyon	Various	N/A	130	927 Ci 30 mrem/hr @ 2' 4,032 ft^3	16% Actinides 83% Fission Products 1% Activation Products	N/A

Table 2-3. Ecology PUREX Storage Tunnel 2 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
20 (1/27/95)	E-H4-1 Unitized Concentrator (H-2-52477) (H-2-56213) Rail Car PX-28 (H-2-131680)	Backcycle Waste	Inlet Streams 3WF Outlet Stream 3WW, Offgas	~8 kg Cr	0	3,070 Ci 1 rem/hr @ 5' 5,760 ft^3	100% Fission Products	Cr: D007
21 (2/8/95)	TK-E5 Coating Waste Tank (H-2-52453) Lead Storage Box Assembly (H-2-131629) H4 Concentrator Tower (H-2-58102) Hot Shop "Q" Cover Plate (H-2-52222) Tube Bundle Wash Capsule (H-2-58647) Dissolver Charging Insert (H-2-75875) Lifting Yoke #7A (H-2-96837) Lifting Yoke #9 (H-2-52458) Rail Car PX-3609	TK E-5: Material Dissolution & Feed Preparation (Coating Waste) H4 Tower: Backcycle Waste	Inlet Streams E-H4: 3WF TK-E5: Metathesis Solution Outlet Stream E-H4: 3WW, Offgas TK-E5: Metathesis Solution to UGS	~1,830 kg of Pb	1,600	26,000 Ci 1 rem/hr @ 4' 3,457 ft^3	TK-E5: 6.9% Actinides 93.1% Fission Products E-H4: 100% Fission Products	Pb: D008

Table 2-3. Ecology PUREX Storage Tunnel 2 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
22 (3/11/96)	Metal Liner Box: (H-2-65095) Jumpers Failed Obsolete Equipment F7 Neutron Monitor Pig (H-2-75825) Lead Storage Box: (H-2-131629) Jumper Counterweights Misc. Lead Items Scrap Hopper: (H-2-57347) Misc. Canyon Equipment Canister Capping Station (H-2-821831) Test Canister Containing Carbon Steel Pipe (various lengths) Rail Car 3616	Various from PUREX Canyon	Various	~3,232 kg Pb ~2 kg Cd (sheets in pig)	2.1	15 Ci 100 mrem/hr @ 1' 1,712 ft^3		Cd: D006 WT02 Pb: D008

Table 2-3. Ecology PUREX Storage Tunnel 2 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
23 (3/11/96)	2 Burial Boxes: (H-2-100187) Jumpers Failed/Obsolete Canyon Equipment Lifting Yoke (H-2-99652) Rail Car PX-31	Various from PUREX Canyon	Various	N/A	0.3	2 Ci 10 mrem/hr @ 1' 2,116 ft^3	16% Actinides 83% Fission Products 1% Activation Products	N/A
24 (4/26/96)	Concrete Burial Box #5-50 8 containers of 324 Facility B-Cell Waste Railcar PX-29 (H-1-44980)	324 Facility B Cell Cleanout	Various	~1,802 kg Pb ~10.5 kg Cd ~8.5 kg Absorbed Mineral Oil ~1 kg Cr ~3 kg Ba	24	244,000 Ci ~15 mrem/hr @ 150' 1,890 ft^3	0.0% Actinides 100% Sr-90/Cs-137	Cr: D007 Cd: D006 WT02 Pb: D008 Mineral Oil: WT02 Ba: D005
25 (6/12/96)	Concrete Burial Box #23014 9 Containers of 324 & 325 Facility Waste Rail Car 10A-3619 (H-1-44980)	324 Facility B Cell Cleanout	Various	~4.2 g Ba 1 g Cd ~1.8 g Cr 1 g Pb	43	1,750,000 Ci ~200 mrem/hr @ 150' 1,890 ft^3	0.0% Actinides 100% Sr-90/Cs-137	Cr: D007 Cd: D006 WT02 Pb: D008 Ba: D005

Table 2-3. Ecology PUREX Storage Tunnel 2 Characterization/Mapping

Position (Placed)	Equipment Stored	Process Origin	Process Streams	Hazardous Constituents	Grams Transuranic (Estimated)	Radiological Inventory	Estimated Radiation Type (% of Ci)	Waste Codes
26 (6/19/96)	20,000 Gallon Liquid Waste Tank Car (LWTC) Rail Car HO-10H-18582 (H-6-326) Empty per RCRA	Liquid Waste Transportation from N Reactor or 300 Area to Tank Farms	Various	N/A	11	23 Ci 650 mrem/hr @ 3' ~30 tons	97% Actinides 3% Fission Products	N/A
27 (6/19/96)	20,000 Gallon Liquid Waste Tank Car (LWTC) Rail Car HO-10H-18579 (H-6-326) Empty per RCRA	Liquid Waste Transportation from N Reactor or 300 Area to Tank Farms	Various	N/A	130	9 Ci 300 mrem/hr @ 3' ~30 tons	90% Actinides 10% Fission Products	N/A
28 (6/19/96)	20,000 Gallon Liquid Waste Tank Car (LWTC) Rail Car HO-10H-18580 (H-6-326) Empty per RCRA	Liquid Waste Transportation from N Reactor or 300 Area to Tank Farms	Various	N/A	53	5.4 Ci 100 mrem/hr @ 3' ~30 tons	65% Actinides 35% Fission Products	N/A

N/A = not applicable

2.1.2 Additional Information

Stream	Function	1	2	3
1BP	1BS Column plutonium product stream to 2AF Tank			4-10
1BXF	1BX Column feed stream			4-10
1CU	1C Column uranium product stream			4-10
1UC	Concentrated uranium product from 1CU concentrator			4-10
1WF	Feed to E-F6-1 waste concentrator			4-31
1WR	Condensate from T-F6-2 demister	7.5.1.2		
1WW	Concentrated waste overflow from concentrator			4-31
2AF	2A Column feed stream			4-12
2AF-NO2 (See note)	Sodium nitrite stream to oxidize Pu from +3 to +4			4.4.3.1
2AP	2A Column plutonium product stream, to 2B Column			4-12
2AW	2A Column aqueous waste to backcycle system			4-12
2AX	2A Column extractant (organic)			4-12
2BP	2B Column plutonium product to 3A Column feed makeup			4-12
2WW	No. 2 acid concentrator concentrate		X.B.1	
3AF	3A Column feed stream			4-12
3AS	3A Column scrub, dilute nitric acid to remove fission products			4-12
3AW	3A Column aqueous waste routed to backcycle system			4-12
3AX	3A Column extractant (organic)			4-12
3BP	3B Column plutonium product			4-12
3BW	3B Column organic waste recycled to 1BX feed tank			4-12
3BX	3B Column strip solution, dilute nitric acid to remove plutonium			4-12
3WB	Aqueous acidic backcycle waste			4-10
3WB-HA	Backcycle waste to T-H2 (HA Column)			4-27
3WD	Backcycle waste concentrator condensate			4.4.1.5
3WF	Backcycle feed			4-27
3WW	Concentrated backcycle waste			4-27
AAA	18% HNO3 solution product from T-F5 routed to TK-F3			4-33
AAF	Acid absorber feed stream - vapor from waste concentrator E-F6-1			4-33
AAR	Acid absorber water to T-F5			4-33
ANN	ANN solution added to T-F5 to complex fluoride			4-33
ASF	Spent ammonia scrub water (concentrator feed)	Fig 7-13		
ASW	Concentrated waste routed to underground storage			4-5
CRD	Condensate recycle from E-J8-1 (uranium concentrator)	Fig C-9		
HAF	HA Column feed solution			4-10
HAP	HA Column product stream containing extracted Pu, U, and Np			4-10

Stream	Function	1	2	3
HAS	HA Column acidic scrub solution to remove fission products			4-10
HAW	HA Column aqueous waste			4-10
HAX	HA Column extractant (organic)			4-10
Metathesis solution	Converts UF4 remaining in dissolver to UO2 2H2O			4-2
PCP	Final plutonium product			4.4.11.3
Slurried Centrifuge Cake	Routes uranium solids to TK-E3			4-4
S/R	Silver Reactor			
WRP	Waste sent to TK-F8 for rework	7.5.2.7		

Notes: Dash separator used for tables "-"
Period separator used for sections "."

References	
1	SD-HS-SAR-001, Rev. 3
2	HW-31000
3	RHO-MA-116

Note: 2AF-NO_2 is listed as 2AF-NO_3 in original source document: Position 13 (WHC-IP-0977); believed to be an error upon further review

2.1.2.1 Excerpts from SD-HS-SAR-001

SD-HS-SAR-001, 1985, *PUREX Plant Final Safety Analysis Report*, Rev. 3, Rockwell Hanford Operations, Richland, Washington.

7.5.1.2 Equipment and Systems Description. The process flow diagram (Fig. 7-8) indicates equipment and primary process routes for the system. The functions, typical compositions, and flow rates of the high-level waste concentration streams are summarized in Table 7-20.

The HAW waste is collected in the high-level waste concentrator feed tank (TK-F7). It is then diluted with 1WF dilution water (recycled condensate from the E-F5 condenser) to improve the nitric acid recovery from the high-level waste. A very low flow of sugar solution is continuously added to TK-F7 to prevent ruthenium volatilization. The sugar reacts with nitric acid to form nitrite, which prevents ruthenium oxidation to volatile ruthenium oxide. The emerging stream from TK-F7 is called the 1WF stream and is pumped to the high-level waste concentrator (E-F6). The concentrator is generally operated at full capacity, so the volume of dilution water added varies with the HAW flow rate.

The vapors (water and nitric acid) from the boiling waste are passed through a mist eliminator in the deentrainment tower and another mist eliminator (T-F6-2) before going to the nitric acid recovery equipment. The offgas stream (AAF) is fed to the nitric acid recovery system (see Section 6.2). The condensate (1WR) formed in the second mist eliminator is returned to the solution section of the concentrator.

The combination of the deentrainment tower and the second mist eliminator effectively decontaminates the offgas stream from FP. A small flow of scrub water is added to both the tower and deentrainer during waste concentration to aid the deentrainment/decontamination process. The scrub water returns to the concentrator with the condensate as additional dilution water.

Liquid holdup in the waste concentrator is about 8,300 L, with an average residence time of about 26 h at an 318 L/h concentrate removal rate. The concentrated high-level waste (1WW) overflows continuously to a waste-receiver tank (TK-F26). In this tank, the 1WW is cooled and moved batchwise to the 1WW sample and denitration tank (TK-F15).

A second denitration tank (TK-F16) is available for further digestion if necessary. The waste is made alkaline and routed to the tank farm. The amount of 19M sodium hydroxide added is calculated to result in a 1M sodium hydroxide concentration in the alkaline waste. The calculation is based on a mole ratio of OH- to aluminum, iron, copper, H+ and F- of 4, 3, 3, 1, and 1, respectively, as being required for neutralization, and assumes the liquid volumes are additive.

To ensure adequate FP decontamination of the concentrator overheads, the deentrainer spray water and sugar flows to TK-F7 are maintained at specified rate sheet values. Also, "surging" the concentrator by too rapid a change in the boil-off rate must be avoided.

7.5.2.7 Waste Handling Rework. Plutonium or uranium waste solutions which are generated in solvent extraction processing and which require rework for recovery of product materials must undergo extensive pretreatment before return to the process. The waste rework tank (TK-F8) and condenser (E-F9), shown in Figure 7-14, are used to hydrolyze organics in the waste by boiling the material in reflux for about 3 wk. Dilute waste may also be concentrated in this tank in preparation for product recovery. During concentration, the E-F9 condensate is routed to the IWF tank, TK-F7. After processing, the liquid is introduced in small quantities to the PUREX Plant solvent extraction feed tanks.

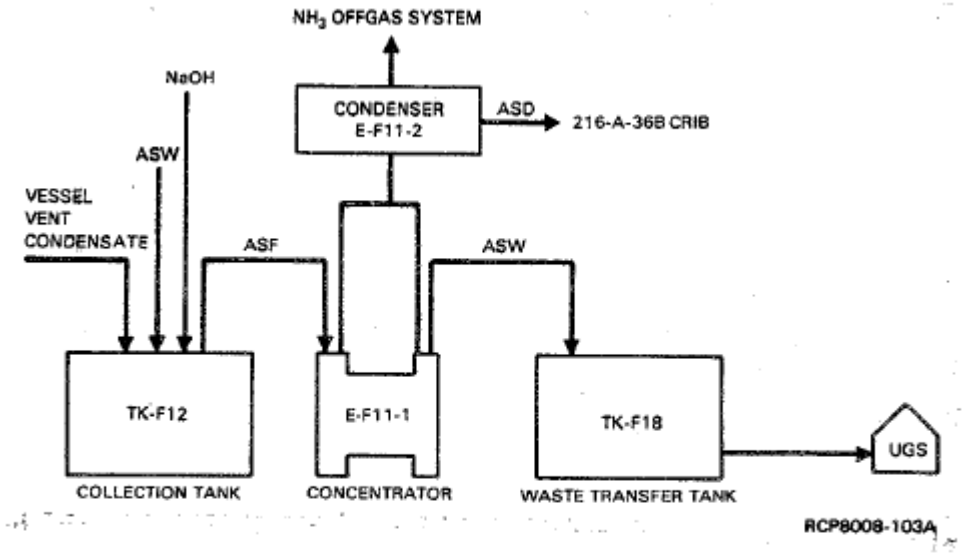


FIGURE 7-13. Ammonia Scrubber Waste Treatment (see Fig. 7-4).

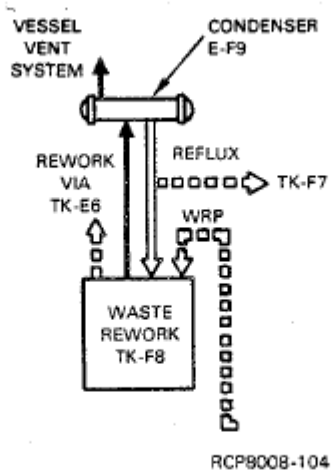


FIGURE 7-14. Waste Rework System.

TABLE 7-20. High-Level Waste Concentration and Sugar Denitration Streams.

Stream	Composition	Function	Flow* (L/min)
HAW	U - 1.4×10^{-5}M HNO_3 - 3.0M Al - 0.09M F^- - 0.02M Pu - 4.7×10^{-5}g/L	HA column waste stream	40.1
1WF-H_2O	HNO_3 - 0.1M AAD, recycled E-F5 condensate	Demineralized H_2O alternate added to dilute HAW in TK-F7 to allow more efficient concentrator operation and acid recovery	64.7
1WF-sugar	Sugar - 0.7M NaOH - 0.005M	Feed treatment in TK-F7 to suppress Ru volatilization from acid waste. NaOH added to prevent mold	.35
1WF	U - 5.3×10^{-6}M HNO_3 - 1.2M Al - 0.03M F^- - 0.008M Pu - 1.8×10^{-5}g/L	Feed to E-F6 waste concentrator	105.2
1WW	U - 1×10^{-4}M HNO_3 - 2.8M Al - 0.68M F^- - 0.14M Pu - 3.7×10^{-4}g/L	Concentrated waste overflow from concentrator	4.3
Denitration sugar	Sugar - 0.7M NaOH - 0.005M	Denitrate 1WW	1.1
ZAW	FP - 800 Ci/L U - 1×10^{-4}M HNO_3 - 0.0M Al - 0.68M F^- - 0.14M Pu - 3.7×10^{-4}g/L	Sugar-treated Zirflex acid waste which is then reacted with caustic	4.3

*Based on PUREX processing rate of 10 t of uranium a day.

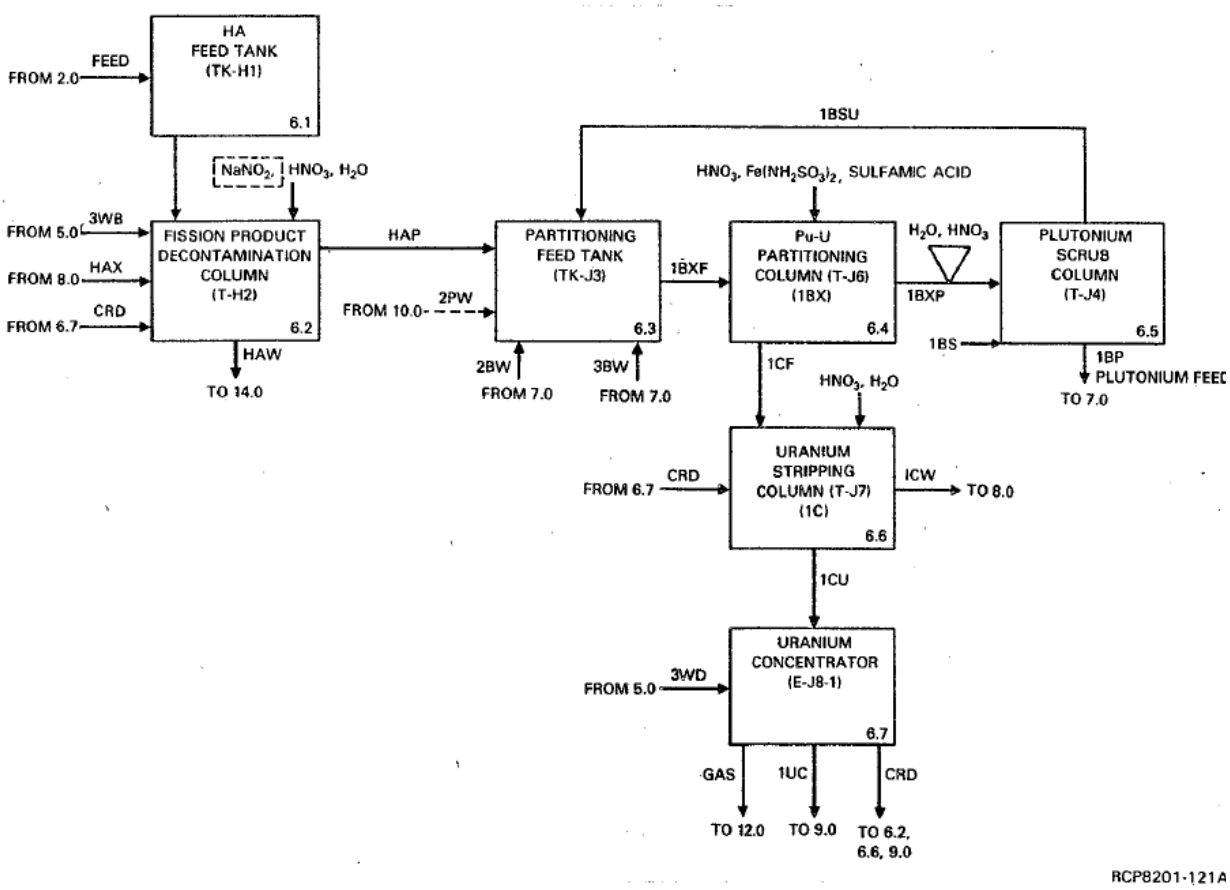


FIGURE C-9. Decontamination and Partitioning Cycle.

2.1.2.2 Excerpts from HW-31000

HW-31000, 1955, *PUREX Technical Manual*, Hanford Atomic Products Operation, Richland, Washington.

B. ACID RECOVERY PROCESS DESCRIPTION

1. General

The recovery of nitric acid from the aqueous waste streams in the Purex process results in a reduction in the volume of high-activity wastes which must be permanently stored in underground tanks as well as a reduction in the Plant's chemical (nitric acid and caustic) consumption. As indicated in Section A above, both of these reductions provide appreciable economic savings.

The acid recovery equipment includes two concentrators, an acid absorber, and a vacuum fractionator, together with accessory tanks and instruments. Process flow diagrams of the acid recovery and waste neutralization operations for the Purex Plant operating at HW #3 Flowsheet conditions are attached as Figures X-1, 2 and 3. Basically, nitric acid recovery is achieved by the use of a double distillation of the "hotter" Purex solvent-extraction waste and a single distillation of the "cooler" solvent-extraction wastes. The acid vapors from the concentration of the "hotter" waste (HAW) are totally condensed and combined with the "cooler" solvent-extraction wastes for a second distillation. Nitric acid is absorbed from the decontaminated dilute acid vapors from the second concentration and is vacuum fractionated to produce approximately 60 wt. per cent acid which is reused in the Plant. The concentrate from the "hot" waste evaporator is neutralized and routed to waste storage as discussed in Section C, below.

Acid recovery from the highly radioactive HAW waste stream is accomplished in the No. 1 Acid Concentrator. Here, a continuous concentration takes place producing a partially decontaminated, low-acidity overhead vapor and a high-acid concentrate (IWW) which contains essentially all the fission-product radioactivity which enters the Plant in the irradiated fuel elements. The concentrate is discharged to sampler and receiver tanks, neutralized, and sent to underground storage tanks. The overhead vapors (IWD) are condensed and combined with other low-activity streams (IAW, 2AW, 2DW) in the Acid Accumulator Tank, the composite stream (2WF) being continuously concentrated in the No. 2 Acid Concentrator. The concentrate (2WW) from this operation is routed to the Acid Recycle Tank for reuse in the process. The dilute acid overhead stream (2WD) from the concentrator is fed as a vapor to the Acid Absorber. Here, absorption occurs, producing a 30% nitric acid effluent and a low-acidity (0.01 M) decontaminated condensate suitable for discharge to caverns. The 30% acid product is charged (after sampling for radioactivity) to the Vacuum Fractionator for further concentration to produce 60% nitric acid product.*

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*) The Vacuum Fractionator will not be available during Purex start-up operations. Until it becomes available, the stripping section of the acid absorber will be operated--thus providing both absorption and stripping operations--to produce a 60% nitric acid product from this unit operating at essentially atmospheric pressure.

The low-acidity overhead vapors from the Vacuum Fractionator are combined with raw water in a barometric condenser and the combined stream is sent to a cavern for disposal.

Two methods of handling the waste concentrate from the "cold" waste evaporator (2WW) have been shown on Figures X-1, X-2, X-3. For the preferred flowsheet conditions (HW #3 Flowsheet) shown on the figures, the 2WW is routed back to the Dissolvers or Centrifuge Feed Tanks (via the Acid Recycle Tank and the Waste Rework Tank), where the acid is used either to dissolve uranium or to provide the needed HAF salting strength.* This mode of operation automatically recovers any uranium and plutonium lost in the aqueous wastes from the "cooler" solvent-extraction cycles. For the alternative flowsheet conditions shown on the figures, the 2WW is routed back to the No. 1 Concentrator, where it is combined with the HAW for concentration.

2.1.2.3 Excerpts from RHO-MA-116

RHO-MA-116, 1980, *PUREX Technical Manual*, Rockwell Hanford Operations, Richland, Washington.

TABLE 4-1. Zirflex Decladding Streams.

Stream	Composition	Function	Volume or Flow
Dilution Water	H_2O	Dilute Zirflex solution to desired concentration	1,440 gal
Zirflex Solution	NH_4F - 11.2M NH_4NO_3 - 1.0M	Dissolve Zircaloy cladding	1,440 gal
Charge	U - 22,500 lb Zircaloy-2 - 1,580 lb Pu[b] - 20,500 grams Np[b] - 340 grams	N Reactor fuel elements for processing	-
Dissolver Air Bleed	Air	Dilute hydrogen in off-gas during decladding	400 cfm
Steam Sparge	H_2O	Remove NH_3 to maintain desired pH	3,600 lb/hr for 7 hr
Water Makeup	H_2O	Maintain constant liquid level in dissolver during decladding	2,000 gal
Dilution Water	H_2O	Dilute decladding waste prior to cooling and jetting to reduce solids precipitation	950 gal
Decladding Waste	$(NH_4)_2ZrF_6$ - 0.50M NH_4F - 0.52M NH_4NO_3 - 0.11M U - 0.003M Pu - 0.004M U as entrained UF_4 - 180 lb	Remove dissolved zirconium fluoride ion and solids from dissolver	4,100 gal
Water Rinse	H_2O U as entrained UF_4 - 20 lb	Remove additional fluoride ion and solids from dissolver	500 gal
Dissolver Off-Gas	H_2 - 0.01% NH_3 - 3.1% H_2O - 78.2% Air - 18.7%	Gaseous effluent from dissolver during decladding	3,200 cfm @ 100°C
Condensate	NH_4OH - 1.4M	Condensate from downdraft condenser during decladding which is routed to catch tanks	5,000 gal
Downdraft Condenser Off-Gas	H_2 - 0.3% NH_3 - 5% H_2O - 4% Air - 91%	Off-gas from downdraft condenser routed to ammonia scrubber	520 cfm @ 30°C
Ammonia Scrub Water	H_2O	Remove ammonia from off-gas	25 gal/min for 8 hr (12,000 gal)
Ammonia Scrubber Off-Gas	H_2 - 0.3% NH_3 - 0.1% H_2O - 4% Air - 96%	Treated off-gas to main stack	500 cfm @ 30°C
Spent Ammonia Scrub Water	NH_4OH - 0.27M	Waste from ammonia scrubber	12,000 gal

[a] For processing of 0.947% U-235 enriched Mark IV uranium fuel from N Reactor.

[b] Assumes fuel exposure of 2435 MWD/T, 12% Pu-240 content, 1825 grams Pu/ton U and 30 grams of Np/ton U.

TABLE 4-2. Metathesis Streams[a].

Stream	Composition	Function	Volume or Flow
KOH Makeup	KOH - 7.0M	Metathesis solution makeup	650 gal
Metathesis Solution	K^+ - 7.0M OH^- - 5.7M F^- - 1.3M	Converts UF_4 remaining in dissolver to $UO_2 \cdot 2H_2O$	1,500 gal
Water Add	H_2O	Maintain liquid level during metathesis digest	260 gal
Recycled Metathesis Solution	K^+ - 7.0M OH^- - 5.0M F^- - 2.0M	Partially used metathesis solution returned to TK-01 for use in next metathesis in dissolver or E Cell	1,500 gal
Heel Dilution Water/ Solution	K^+ - 1.2M OH^- - 0.8M F^- - 0.3M	Remove additional metathesis solution to TK-01	100 gal
Air Bleed	Air	Dilute off-gas	150 cfm
Air Sparge	Air	Suspend solids during digest	100 cfm for 4 hr
Metathesis Rinse Water/ Solution	KOH - 0.003M KF - 0.008M U - 5×10^{-5}M Pu - 4×10^{-7}M U as $UO_2 \cdot 2H_2O$ - 20 lb	Remove spent metathesis solution	1,500 gal
Heel Dilution Water/ Solution	KOH - 6×10^{-4}M KF - 1×10^{-3}M U - 8×10^{-6}M Pu - 7×10^{-8}M	Dilute and remove additional rinse solution	100 gal
Ammonia Scrub Water	H_2O	Remove ammonia from off-gas	10 gal/min for 2 hr 5 gal/min for 4 hr (2400 gal)
Metathesis Spent Scrub Water and Condensate from Downdraft Condenser	NH_4OH - Trace	Feed to ammonia waste concentrator	2,700 gal
Ammonia Scrubber Off-Gas	NH_3 - Trace	Disposal via main stack	400 cfm

[a]For processing of 0.947% U-235 enriched Mark IV uranium fuel from N Reactor.

TABLE 4-3. Head-End Waste Disposal Streams.[a]

Stream	Composition	Function	Volume or Flow
Sodium Hydroxide	NaOH - 19.0M	React with decladding waste and rinse from centrifuge which are added to the NaOH to drive off ammonia	730 gal
Scrub Water	H_2O	Remove ammonia from gases evolved from TK-E5 when wastes are added to NaOH solution	25 gal/min for 12 hr = 18,000 gal
Decladding Waste and Rinse	$(NH_4)_2ZrF_5$ - 0.43M NH_4F - 0.44M NH_4NO_3 - 0.09M U - 0.003M Pu 2x10-5M U as UF_4 - 100 lb	Feed to centrifuge	3,350 gal
Decladding Waste and Rinse	Same as above except UF_4 is removed	Waste from centrifuge for disposal via TK-E5	3,350 gal
TK-E5 Off-Gas	NH_3 - 19% H_2O - 10% Air - 71%	Remove ammonia generated in TK-E5 during reaction with NaOH	300 cfm at 45°C
Ammonia Scrubber Off-Gas	NH_3 - 0.1% H_2O - 4 % Air - 96 %	Route off-gas to ammonia stack	230 cfm at 35°C
Spent Ammonia Scrub Water	NH_4OH - 0.39M RuRh-106 - 65 μCi/gal	Route waste to ammonia waste concentrator	18,000 gal
Decladding Waste and Rinse	$ZrO_2 \cdot 2H_2O$ - 0.35M NaF - 2.5M $NaNO_3$ - 0.08M U - 0.002M Pu - 1x10-5M pH - 10.0 RuRh-106 - 1.3 μCi/gal Solids - 50%	Route waste to underground storage tank.	4,100 gal
Water Rinse	H_2O	Flush TK-E5 and line to underground storage tank	515 gal
Sodium Hydroxide	NaOH - 19M	React with decladding waste and rinse mixed with metathesis rinse	330 gal
Decladding Waste and Rinse Mixed with Metathesis Rinse	$(NH_4)_2ZrF_5$ - 0.19M NH_4F - 0.19M NH_4NO_3 - 0.04M KF - 0.004M U - 5 x 10-4M Pu - 1x10-6M U as UF_4 - 100 lb U as $UO_2 \cdot 2H_2O$ - 20 lb	Feed to centrifuge	3,350 gal
Decladding Waste and Rinse Mixed with Metathesis Rinse *	Same as above except uranium is removed	Waste from centrifuge for disposal via TK-E5	3,350 gal
Reacted Decladding Wastes and Dissolver Rinses	$ZrO_2 \cdot 2H_2O$ - 0.17M NaF - 1.2M $NaNO_3$ - 0.02M KF - 0.004M NaOH - 0.5M U - 5 x 10-4M Pu - 3 x 10-5M RuRh-106 - 6 x 10-5 μCi/gal Solids - 20%	Route waste to underground storage tank	3,700 gal
Water Rinse	H_2O	Rinse of centrifuge feed tank TK-E3 and centrifuge routed to TK-E5 for disposal and flush of line to underground storage tank	530 gal

[a]For processing of 0.947% U-235 enriched Mark IV uranium fuel from N-Reactor.

TABLE 4-4. Centrifuged Uranium Metathesis and Dissolution Streams.[a]

Stream	Composition	Function	Volume or Flow
Centrifuge Cake Removal Slurry Water	H_2O	Remove centrifuge cake to TK-E3 for metathesis.	240 gal
Slurried Centrifuge Cake	U as UF_4 - 200 lb U as $UO_2 \cdot 2H_2O$ - 20 lb	Route uranium solids to TK-E3.	250 gal
Spent Metathesis Solution to TK-E3	KOH - 4.2M KF - 1.7M	Metathesize UF_4 in cake slurry.	780 gal
Spent Metathesis Solution From TK-E3	KOH - 2.7M KF - 1.6M U - 5×10^{-5}M Pu - 4×10^{-7}M U as $UO_2 \cdot 2H_2O$ - 220 lb	Feed to centrifuge for recovery of $UO_2 \cdot 2H_2O$.	1070 gal
Centrifuged Spent Metathesis Solution	Same as above except $UO_2 \cdot 2H_2O$ is removed	Route waste to TK-E5 and then to underground storage tank.	1070 gal
Water Rinse	H_2O	Rinse TK-E3, centrifuge TK-E5 and line to underground storage tank.	530 gal
Centrifuge Cake Removal Slurry Solution	$Al(NO_3)_3$ - 0.6M	Slurry $UO_2 \cdot 2H_2$) centrifuge cake to TK-E1 and complex fluoride.	240 gal
Slurried Centrifuge Cake	$Al(NO_3)_3$ - 0.6M U as $UO_2 \cdot 2H_2O$ - 220 lb	Transfer cake slurry to TK-E1.	250 gal
Nitric Acid	HNO_3 - 12.2M	Dissolve uranium oxide in TK-E1.	50 gal
Dissolved Uranium	$UO_2(NO_3)_2$ - 0.37M $Al(NO_3)_2$ - 0.5 M F^- - 0.15M HNO_3 - 0.5M Pu - 0.002M	Feed addition to TK-D4.	300 gal

[a]For processing of 0.947% U-235 enriched Mark IV uranium fuel from N Reactor.

TABLE 4-5. Ammonia Scrubber Water and Ventilation System Steam Condensate Concentration and Disposal Streams.

Stream	Composition	Function	Volume or Flow
Decladding Condensate and Spent Ammonia Scrub Water From Dissolver Cells	NH_4OH - 0.58M RuRh-106 - 4 x 10^3 μCi/gal	Feed to concentrator.	17,700 gal
Metathesis Spent Ammonia Scrub Water	NH_4OH - Trace	Feed to concentrator.	2,700 gal
E-Cell Spent Ammonia Scrub Water	NH_4OH - 0.41M RuRh-106 - 65 μCi/gal	Feed to concentrator.	18,700 gal
Purex Vessel and Condenser Vent Jet Steam Condensate	H_2O HNO_3 - Trace	Feed to concentrator.	21,600 gal/day
NaOH Add	NaOH - 19M	Prevent formation of NH_4NO_3 from reaction of NH_4OH with trace quantities of HNO_3 in jet condensates.	1.1 gal
ASD Condensate	NH_4OH - 0.31M RuRh-106[b] - 10 μCi/gal	Route condensate with most of ammonia to 216-A-36-8 underground disposal trench or crib.	61,200 gal
Condenser Off-Gas	NH_3 - 1% H_2O - 4% Air - 95%	Route off-gas to ammonia stack.	130 cfm at 35°C
ASW	RuRh-106 - 61 Ci/day	Route concentrated waste to underground storage tank.	1,800 gal/batch as required

[a] For processing of 0.947% U-235 enriched Mark IV uranium fuel from N Reactor.

[b] RuRh-106 value based on processing 180-day cooled fuel. Value is 0.5 μCi/gal for 5-year cooled fuel.

TABLE 4-7. Uranium Dissolution, Feed Preparation, and Dissolver Off-Gas Treatment Streams.[a]

Stream	Composition	Function	Volume or Flow
Air Bleed	Air	Dilute and increase volume/velocity of off-gas.	150 cfm
Aluminum Nitrate	$Al(NO_3)_3$ - 1.6M	Complex residual fluoride in first cut.	575 gal
Nitric Acid	HNO_3 - 10.4M	Dissolve uranium metal in first cut.	2500 gal
Air Sparge	Air	Circulate solution; dilute and increase volume/velocity of off-gas.	60 cfm for 6 hours on each cut
Downdraft Condenser Off-Gas	NO_x - 23%	Route off-gas to treatment facilities (silver reactor, filters, backup facility) for 12 hours reaction time.	400 scfm
First Cut	$UO_2(NO_3)_2$ - 2.05M $Al(NO_3)_3$ - 0.29M F^- - 0.08M HNO_3 - 0.41M Pu - 3.8 g/gal	Route product dissolver solution to TK-03/04 storage.	3200 gal
Aluminum Nitrate	$Al(NO_3)_2$ - 1.6M	Complex residual fluoride in second cut.	140 gal
Nitric Acid	HNO_3 - 10.4M	Dissolve uranium metal in second cut.	1980 gal
Second Cut	$UO_2(NO_3)_2$ - 2.13M $Al(NO_3)_3$ - 0.10M F^- - 0.03M HNO_3 - 0.52M Pu - 3.9 g/gal	Route product dissolver solution to TK-03/04 storage.	2200 gal
First Rinse	H_2O	Dilute jet heel and transfer additional product from dissolver to TK-03/04.	100 gal
Second Rinse	H_2O	Same as first rinse.	200 gal
Dissolved Uranium From Centrifuge Cake	$UO_2(NO_3)_2$ - 0.37M $Al(NO_3)_3$ - 0.5M F^- - 0.15M HNO_3 - 0.5M Pu - 0.6 g/gal	Feed addition to TK-04.	300 gal
Uranyl Nitrate Solution	$UO_2(NO_3)_2$ - 1.77M $Al(NO_3)_3$ - 0.20M F^- - 0.05M HNO_3 - 0.4M Pu - 3.3 g/gal	Feed addition to TK-E6.	6400 gal
XA Absorber Water[b]	H_2O	Absorb NO_x in XA tower of backup facility.	8 gal/min
XA Reflux	HNO_3 - 2.0M	Cool tower to increase efficiency and absorb NO_x.	288 gal/min
XCA	HNO_3 - 2.0M	Route backup facility acid to TK-F3 for transfer to fractionator.	5.4 gal/min
XB Absorber Water[b]	H_2O	Absorb NO_x in XB tower of backup facility.	2.5 gal/min
XB Reflux	HNO_3 - 1.7M	Cool tower and absorb NO_x.	80 gal/min
XBA	HNO_3 - 1.7M	Route T-XB product from TK-XD to TK-XC for use in T-XA reflux and transfer to TK-F3.	2.1 gal/min
Backup Facility Off-Gas	NO_x - 3% for 12-hour reaction time in dissolvers.	Route off-gas to main stack.	600 scfm

[a] For processing of 0.947% U-235 enriched Mark IV fuel from N Reactor.

[b] Recycled AFD condensate from the acid fractionator may be used for these streams.

TABLE 4-10. First Decontamination and Partition Cycle Streams.

Stream	Composition	Function	Flow[a], gal/min.
HAF	U - 1.7M HNO_3 - 0.4M $Al(NO_3)_3$ - 0.2M F^- - 0.05M Pu - 3 g/gal Np - 0.05 g/gal	HA column feed solution.	4.2
HAX	TBP - 30% NPH - 70% HNO_3 - 0.01M	HA column extractant (organic).	23.2
HAW	HNO_3 - 2.96M Al - 0.08M F^- - 0.02M U - 1.4×10^{-4}M Pu - 1.8×10^{-4}M	HA column aqueous waste.	10.6
3WB	HNO_3 - 7.7M U - 0.08M Pu - 0.03 g/gal Np - Variable	Aqueous backcycle--additional salting strength for extraction section.	3.5
HA-NO_2	$NaNO_2$ - 0.77M	Neptunium valence adjustment to +6 to ensure extractability.	0.013
HAS	HNO_3 - 2.0M	HA column acidic scrub solution to remove fission products from organic.	3.6
HAP	U - 0.3M HNO_3 - 0.19M Pu - 0.5 g/gal Np - Variable	HA column product stream containing extracted plutonium, uranium, and neptunium.	24.0
1BXF	U - 0.22M HNO_3 - 0.17M Pu - 0.4 g/gal	1BX column feed stream containing extracted plutonium, uranium, and neptunium, and 1BSU, 2PW, 2BW and 3BW recycle streams.	33.0
1BX	HNO_3 - 0.3M Fe^{+2} - 0.028M NH_2SO_3 - 0.1M	1BX column plutonium partition stream--iron (+2) reduces plutonium valence from +4 to +3, plutonium is stripped into 1BX, sulfamic acid kills NO_2.	3.8
1BU	U - 0.22M HNO_3 - 0.065M Pu - 2.8×10^{-5} g/gal Np - Variable	1BX column uranium and neptunium product stream, organic.	33.0
1BXP	U - 0.08M HNO_3 - 1.5M Pu - 3.6 g/gal	1BX column plutonium product stream.	4.0
1BXP-HNO_3	HNO_3 - 10.4M	Recovered acid to increase 1BP acidity.	1.2

TABLE 4-10. First Decontamination and Partition Cycle Streams. (Continued)

Stream	Composition		Function	Flow[a], gal/min.
1BS	TBP NPH HNO_3	- 30% - 70% - 0.01M	Scrub uranium out of 1BXP, organic.	4.6
1BP	HNO_3 Pu U	- 3.4M - 2.5 g/gal - $1x10^{-4}$M	1BS column plutonium product stream to 2AF Tank.	5.1
1BSU	HNO_3 U Pu	- 0.3M - 0.07M - 0.3 g/gal	Uranium scrub stream, recycled to 1BXF Tank, organic.	4.6
1CX	HNO_3	- 0.01M	Strip uranium and neptunium from 1BU organic stream, very low acid.	27.0
1CU	U HNO_3 Pu	- 0.27M - 0.09M - $3x10^{-5}$ g/gal	1C column uranium product stream.	27.0
1CW	U HNO_3	- Trace - Trace	1C column waste to solvent treatment system 1.	32.0
1UC	U HNO_3 Pu	- 2.1M - 0.9M - $2.6x10^{-4}$ g/gal	Concentrated uranium product solution from 1CU concentrator.	3.5
1UD	HNO_3	- Trace	Process condensate from 1CU concentrator recycled for use in HAS, 1CX, and 2EX streams.	46.0

[a]Based on processing rate of 10 tons of uranium per day.

TABLE 4-11. Final Uranium Cycle Process Streams.

Stream	Composition	Function	Flow[a], gal/min.
2DF-HNO_3	HNO_3 - 10.4M	2D column feed nitric butt stream, to increase salting strength.	0.24
2DF-N_2H_4	N_2H_4 - 11.3M	Reduce nitrite (NO_2^-) with hydrazine.	0.002
2DF	HNO_3 - 1.5M U - 1.97M Np - Variable Pu - 2.4×10^{-4} g/gal	2D column uranium-neptunium aqueous feed, from 2DF tank.	3.8
2DX	TBP - 30% NPH - 70% HNO_3 - 0.01M	2D column organic stream, extracts uranium, leaves neptunium, plutonium, and FP's.	20.0
2DIS	HN - 0.04M	Reductant stream (HN) to reduce plutonium to valence +3.	0.74
2DS	H_2O	2D column scrub water to strip nitric acid and FP's from organic.	2.13
2DW	U - 0.07M HNO_3 - 1.0M Pu - 1.5×10^{-4} g/gal Np - Variable	2D column aqueous waste back-cycled to HA column via back-cycle waste concentrator system.	5.9
2DU (2EF)	U - 0.34M HNO_3 - 0.003M	2D column organic uranium product feed to 2E column.	20.7
2EX	HNO_3 - 0.01M	2E column aqueous strip (very dilute nitric acid). Strips uranium.	17.3
2EW	TBP - 30% NPH - 70% HNO_3 - Trace U - 3×10^{-6}M	2E column organic waste to solvent treatment system 2.	20.0
2EU	U - 0.38M HNO_3 - 0.011M	2E column aqueous uranium product to 2EU concentrator.	18.4

[a]Based on processing rate of 10 tons of uranium per day.

TABLE 4-12. Final Plutonium Cycle Process Streams.

Stream	Composition	Function	Flow[a], gal/min.
2AF-NO_2	$NaNO_2$ - 0.77M	Nitrite stream to oxidize Pu(+3) to Pu(+4).	0.31
2AF	HNO_3 - 3.3M NO_2^- - 0.002M Pu^{+4} - 2.4 g/gal	2A column feed stream, Pu(+4).	5.40
2AX	TBP - 30% NPH - 70% HNO_3 - 0.01M	2A column extractant, organic.	1.03
2AS	HNO_3 - 0.75M	2A column scrub. Dilute nitric acid removes FP's from plutonium-bearing organic.	0.33
2AW	HNO_3 - 2.3M Pu^{+4} - 0.015 g/gal	2A column aqueous waste to backcycle system.	6.30
2AP	HNO_3 - 0.17M Pu^{+4} - 12.3 g/gal	2A column plutonium product stream, to 2B column.	1.03
2BX	HNO_3 - 0.3M HN - 0.1M N_2H_4 - 0.05M	2B column stripping solution reduces Pu(+4) to Pu(+3) and kills nitrite.	0.40
2BS	TBP - 30% NPH - 70% HNO_3 - 0.01M	2B column uranium scrub stream, organic.	0.34
2BW	HNO_3 - 0.07M Pu^{+4} - 0.004 g/gal	2B column organic waste recycled to 1BX feed tank.	1.38
2BP	HNO_3 - 0.51M Pu^{+4} - 31.7 g/gal	2B column plutonium product to 3A column feed makeup.	0.40
3AF-NO_2	$NaNO_2$ - 0.77M	Nitrite stream to oxidize Pu(+3) to Pu(+4). Used only if necessary.	0.06
3AF-HNO_3	HNO_3 - 12.2M	Increases 3AF acidity.	0.18
3AF-DIL	HNO_3 - 1.2M	Dilute nitric acid stream to increase 3AF volume and flow rate. Used only during recycle of concentrated $Pu(NO_3)_4$ solutions.	
3AF	HNO_3 - 3.29M Pu^{+4} - 18.3 g/gal	3A column feed stream, Pu(+4).	0.69
3AS	HNO_3 - 1.2M	3A column scrub, dilute nitric acid removes FP's from plutonium-loaded organic.	0.13
3AX	TBP - 30% NPH - 70% HNO_3 - 0.01M	3A column extractant (organic).	0.17
3AW	HNO_3 - 2.95M Pu^{+4} - 0.34 g/gal	3A column aqueous waste routed to backcycle system.	0.82
3AP	HNO_3 - 0.19M Pu^{+4} - 73.3 g/gal	3A column plutonium product, to 3B column.	0.17
3BX	HNO_3 - 0.15M	3B column strip solution, dilute nitric acid to remove Pu(+4).	0.11
3BW	HNO_3 - 0.03M Pu^{+4} - 0.1 g/gal	3B column organic waste recycled to 1BX feed tank.	0.17
3BP	HNO_3 - 0.4M Pu^{+4} - 112.3 g/gal (29.8 g/L)	3B column plutonium product.	0.11

[a]Based on processing 10 tons of uranium per day.

TABLE 4-27. Backcycle Waste System Process Streams - Phase I.

Stream	Composition[a]	Function	Flow, gal/min
2NW	HNO_3 - 5.0M Pu - 0.006 g/ℓ Np - 0.0002 g/ℓ	Aqueous waste from 2N column	4.3
2DW	HNO_3 - 0.97M U - 0.073M Np - Variable	Aqueous waste from 2D column	5.9
2AW	HNO_3 - 2.9M Pu - 0.004 g/ℓ	Aqueous waste from 2A column	6.2
AAD	HNO_3 - 0.1M	Acid absorber process condensate (E-F5)	2.0
AFD	HNO_3 - 0.005M	Acid fractionator process condensate	6.6
3XW	HNO_3 - 5.1M Np - 0.14 g/ℓ	Aqueous wastes from Q Cell Np anion exchange process	0.03 (Avg) (Approximately 375 gal. in 3 batches over 10-day period)
3WF	HNO_3 - 1.8M U - 0.018M Pu - 0.002 g/ℓ	Backcycle feed	25.1
3WW	HNO_3 - 8.4M U - 0.082M Pu - 0.009 g/ℓ	Concentrated backcycle waste	5.3
3AW	HNO_3 - 3.0M Pu - 0.01 g/ℓ	Aqueous waste from 3A column	0.82
3WB	HNO_3 - 7.7M U - 0.071M Pu - 0.009 g/ℓ Np - Variable	Backcycle waste to TK-J21 and T-H2	6.1
3WB-2N	Same as 3WB	3WB to TK-J21	2.6
3WB-HA	Same as 3WB	3WB to T-H2 (HA column)	3.5

[a]Neptunium concentrations are highly variable, depending on feed and upstream process conditions.

TABLE 4-28. Backcycle Waste System Process Streams - Phases II, III.

Stream	Composition[a]	Function	Flow, gal/min
2DW, 2AW, AAD, AFD, 3AW	Same as Phase I	Same as Phase I	Same as Phase I
2NW-II	HNO_3 - 4.0M Np - 0.0002 g/ℓ	Aqueous waste 2N column Phase II	3.1
2NW-III	HNO_3 - 4.8M Np - 0.0002 g/ℓ	2N waste, Phase III	2.1
3WF	HNO_3 - 1.5M U - 0.018M Pu - 0.001 g/ℓ	Backcycle feed	23.8
3WW	HNO_3 - 8.4M U - 0.1M Pu - 0.007 g/ℓ	Concentrated backcycle waste	4.2
3WB	HNO_3 - 7.5M U - 0.1M Pu - 0.006 g/ℓ	Composite backcycle waste, to T-H2 (HA column)	5.0

[a]Neptunium concentrations are variable.

TABLE 4-31. High-Level Waste Concentration and Sugar Denitration Streams.

Stream	Composition	Function	Flow,[a] gal/min
HAW	U - 1.4×10^{-5}M HNO_3 - 3.0M Al - 0.09M F^- - 0.02M Pu - 1.8×10^{-4} g/gal	HA column waste stream	10.6
1WF-H_2O	HNO_3 - 0.1M AAD, Recycled E-F5 Condensate	Demineralized H_2O alternate added to dilute HAW in TK-F7 to allow more efficient concentrator operation and acid recovery.	17.1
1WF-Sugar	Sugar - 0.7M NaOH - 0.005M	Feed treatment in TK-F7 to suppress ruthenium volatilization from acid waste. NaOH added to prevent mold.	0.093
1WF	U - 5.3×10^{-6}M HNO_3 - 1.2M Al - 0.03M F^- - 0.008M Pu - 6.9×10^{-5} g/gal	Feed to E-F6-1 waste concentrator.	27.8
1WW	U - 1×10^{-4}M HNO_3 - 2.8M Al - 0.68M F^- - 0.15M Pu - 1.4×10^{-3} g/gal	Concentrated waste overflow from concentrator.	1.4
Denitration Sugar	Sugar - 0.7M NaOH - 0.005M	Denitrate 1WW.	0.3
ZAW	FP's - >3000 Ci/gal U - 1×10^{-4}M HNO_3 - 0.95M Al - 0.68M F^- - 0.15M Pu - 1.4×10^{-3} g/gal	Sugar-treated Zirflex acid waste to 244-AR vault.	1.4

[a]Based on Purex processing rate of 10 tons of uranium/day.

TABLE 4-33. Nitric Acid Absorption Streams.

Stream	Composition	Function	Flow, gal/min
AAF	Vapor HNO_3 - 1.1M	Acid absorber feed stream - vapor from waste concentrator (E-F6-1).	27.6
AAR	Recycled AAD; alternate demin. water	Acid absorber water to T-F5.	8.8
AAA	HNO_3 - 3.2M	18% HNO_3 solution product from T-F5 routed to TK-F3.	8.4
XCA	HNO_3 - 2.0M	HNO_3 recovered from dissolver off-gas by backup facility routed to TK-F3.	5.4
AAD	HNO_3 - 0.1M	Acid absorber condensate from E-F5 routed to AAR, TK-F7, and TK-F10.	29.8
ANN	ANN - 1.68M	ANN solution added to T-F5 to complex fluoride and thus reduce corrosion.	0.078

TABLE 4-35. Vacuum Fractionator Streams.

Stream	Composition	Function	Flow,[a] gal/min
UO_3 Plant Acid	HNO_3 - 10.4M	UO_3 Plant recovered acid.	1.3 (avg)
AFF	HNO_3 - 3.4M	Acid fractionator feed pumped from TK-U5. Mixture of AAA, XCA, and UO_3 acid.	15.1
AFR	Demin. water (alternate) HNO_3 - 0.005M AFD recycle	Reflux added to fractionator (T-U6).	2.3
AFA	HNO_3 - 10.4M	50% HNO_3 solution from fractionator, routed to storage tanks (TKs-U1, U2).	4.9
AFD-XA, X8	HNO_3 - 0.005M	Fractionator condensate routed to backup facility as absorber water.	5.4
AFD-F10	HNO_3 - 0.005M	Excess AFD routed to backcycle waste.	5.2

[a]Based on Purex Plant processing rate of 10 tons of uranium/day.

TABLE 4-37. Purex Plant Aqueous Effluents.

Discharge Stream	Flow Measurement	Sampling	Diversion	Radiation Monitoring	Emergency Sampling	Estimated Volume, 10^6 gal/year
Cooling Water (CWL to 216-A-25)	1) Weir 2) Dip Tube 3) Flow Integrator/ Totalizer	1) EMV Sampler 2) Tank Drain Sample	Retention Basin (Automatic)	Single Probe (non-redundant) (non-failsafe)	None	1100.0
Chemical Sewer (CSL to 216-B-3)	1) Parshall Flume 2) Flow Integrator/ Totalizer	Propor-tional	Retention Basin (Automatic)	Single Probe (Validated periodically by automatically actuated check source)	Automatic Verification Sample	230.0
Steam Condensate (SCD to 216-A-30)	1) Magnetic Flowmeter 2) Integrator/ Totalizer	1) EMV Sampler 2) Jug Pour Sample	Retention Basin (Automatic)	Single Probe (non-redundant) (non-failsafe)	Automatic Verification Sample	47.0
Process Condensate (PDD to 216-A-10)	1) Magnetic Flowmeter 2) Integrator/ Totalizer	Propor-tional	None	Single Probe (Validated periodically by automatically actuated check source)	Automatic Verification Sample	2.5
Ammonia Scrubber Waste Condensate (ASD to 216-A-36B)	1) Magnetic Flowmeter 2) Integrator/ Totalizer	Propor-tional	None	Single Probe (Validated periodically by automatically actuated check source)	Automatic Verification Sample	5.0
203A Discharge (PTD to 216-B-3)	Collection Tank Volume Measurements	1) P-Tank Condensate Line Sample 2) Sump Sample 3) Waste Pump Tank (TK-P5) Sample	Capability for recycle to 202A tanks in E or K Cells depending on U conc. and purity, or to TK-F10 for disposal to underground storage	Not Required (Collection Tank Sample Analysis)	Not Required	0.06

The normal rework routing of the five typical off-standard process streams is described below. In very unusual cases, off-standard first cycle uranium or second cycle plutonium streams may be reworked, but this procedure is not discussed.

- Final Uranium Product (2UC) - The final concentrated uranium product, which may require further decontamination from plutonium, FP's or nonradioactive contaminants, is sampled in TK-K6 and, if analyses indicate an off-standard condition, a transfer or series of transfers are scheduled. Routing may go directly to TK-E6 from TK-K6, or, more commonly, the stream is first routed to UNH storage TK-P1 and then to TK-E6 for reprocessing in the HA column. Routing is also possible from TK-K6 to TK-K1 for reprocessing of the solution in the final uranium cycle. Tank K6 or P1 solution is normally reprocessed via TK-E6 at the end of a processing campaign or during a spike fuel processing campaign if required to maintain a minimum uranium throughput rate of 7.5 tons per day. Rework of TK-K6 solution via TK-K1 is sometimes required for the first one or two batches of a campaign to produce specification material.

- Final Plutonium Product (PCP) - The final concentrated plutonium product, which may contain excessive uranium and/or FP concentrations, is sampled in TK-L9 and transferred either to the product loadout tank, the 3AF feed tank, TK-L3, or the rework receiver, TK-L11. From TK-L11, a special jet with a motive fluid (for criticality prevention) of cadmium nitrate and/or nitric acid solution transfers the rework solution in increments to TK-E6 where it is blended with uranium feed solution. Routing is also possible from TK-L11 to TK-L9 and then to TK-L3 for rework of solution through the third plutonium cycle. Plutonium product and rework handling are described further in Section 4.10.

- High-Level Waste (1WW) - Concentrated high-level waste, which may contain recoverable amounts of uranium and/or plutonium (more than 50 grams of plutonium), flows from the 1WW concentrator (E-F6), and is sampled in TK-F26 before sugar denitration. Composition of the stream and more details on waste handling are given in Section 4.8. The high-level salt waste must be reworked before sugar denitration to avoid process upsets. High losses should be detected in the HAW sample and correction should be made before a reworkable quantity of uranium or plutonium accumulates. High plutonium or uranium losses detectable in TK-F26 represent a considerable amount of off-standard waste in TK-F7 and the E-F6 concentrator.

3 PUREX Tunnel Inventory-Related Documentation

The following sections are organized in chronological order to the best extent possible. Each section starts with a clean introduction page (often empty) to allow for relevant comments, notes, or discussion of errors on future revisions.

3.1 (2020.07) CHPRC-04412, Rev. 0

CHPRC-04412, 2020, *Physical Condition of PUREX Storage Tunnels Post-Stabilization*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

CHPRC-04412 is a document developed by engineering that provides details of the PUREX tunnels that includes the physical configuration of the railcars and radiological data obtained during the grouting of the tunnels.

It is recommended that CHPRC-04412 be reviewed in parallel with this document; the following pages from Appendix B are provided as an example.

Riser 11 to Riser 12

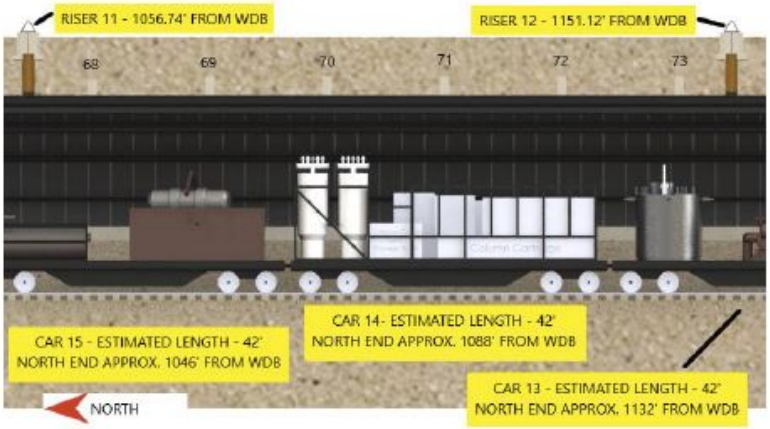


Figure B-58: Riser 11 to Riser 12 Tunnel Section.

Three rail cars are located between riser 11 and riser 12. Riser 12 is located 1151.12' from the south face of the WDB. Riser 12 is 94.38' south of riser 11.

Car #15 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

Car #14 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

Car #13 length is estimated 42', and contents are documented in HNF-SD-EN-WAP-007 Rev 4.

13.	CAR 19806 PLACED IN TUNNEL ON 1/21/86; TK-J5 2A FEED TANK (#30), E-F1 CONDENSER (#13), F12-B CELL BLOCK, DISSOLVER 4-WAY DUMPER, DISSOLVER YOKE, FLANGE PLATE; 2,500 CU. FT.; 90 CURIES; 3 rem/hr. @ 1'	
14.	CAR PX-10 PLACED IN TUNNEL ON 11/18/87; L-1 PULSER, 2 COLUMN CARTRIDGES, JUMPER CUTTER, STORAGE RACK, 3 JUMPER ALIGNMENT TOOLS, 9 EXTERIOR DUMPING TRUNNIONS, 10 PUMPS, 3 AGITATORS, 4 TUBE BUNDLES, 2 VENT JUMPERS, 7 YOKES; 50 TONS; 3,600 CU. FT.; 33,740 CURIES; 2,540 kg Pb; 5 rem/hr. @ 15' (REF: LETTER 12110-88-074)	
15.	CAR PX-9 PLACED IN TUNNEL ON 5/13/88; T-A2 SILVER REACTOR (#5 SPARE), S/R CRADLE, E-F2 STEAM HEATER, STORAGE LINER (H-2-65095) FILLED WITH CUT UP JUMPERS; 20 TONS; 2,775 CU. FT.; 240 CURIES; ~13 kg Cd; ~115 kg Ag; ~230 kg Pb; 20 mrem/hr. @ 20' (REF: LETTER 12110-88-074)	

Figure B-59: Details for Cars 13, 14, and 15 from HNF-SD-EN-WAP-007.

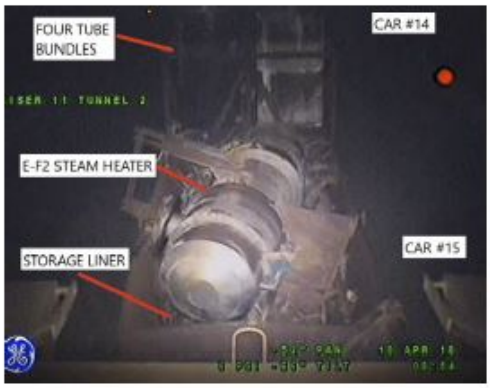


Figure B-60: Investigation View from Riser 11, Looking South at the Box on Car 15.

Figure B-61: Investigation View from Riser 11, Looking South at the Equipment on Cars 14 and 13.

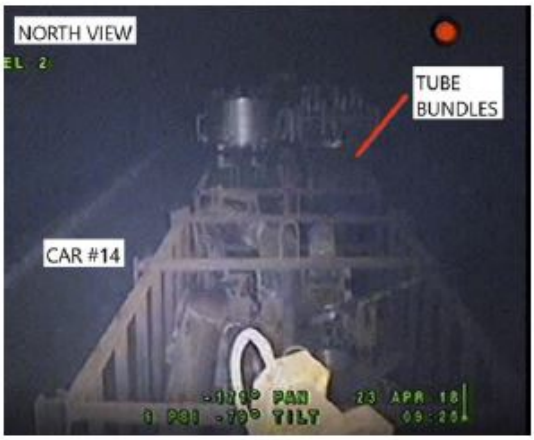


Figure B-62: Investigation View from Riser 12, Looking North at the Equipment on Car 14.

Figure B-63: Investigation View from Riser 12, Looking North at the Tank on Car 13.

After grouting, approximately 11 yd^3 of void space was left at the top of the tunnel above Car 15. Approximately 11.4 yd^3 of void space is left inside the rail car. Estimation based on 90% empty volume in the silver reactor, and 10% empty volume in the metal liner box and heater.

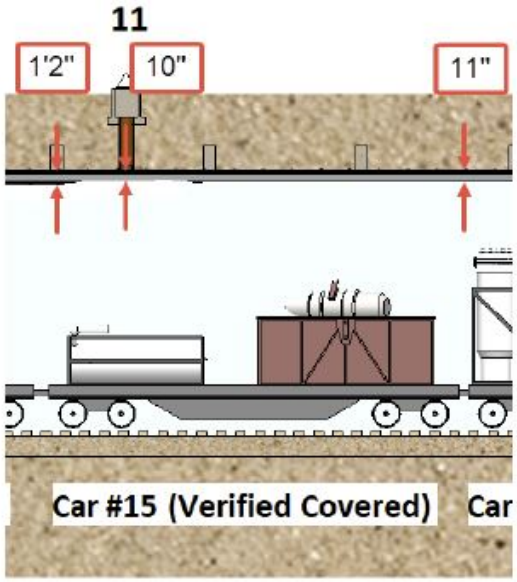


Figure B-64: Approximate Final Grout Profile above Car 15.

After grouting, approximately 11 yd^3 of void space was left at the top of the tunnel above Car 14. Approximately 24 yd^3 of void space is left inside the rail car. Estimation based on 90% empty volume in the tube bundles, and 10% empty volume in the miscellaneous equipment.

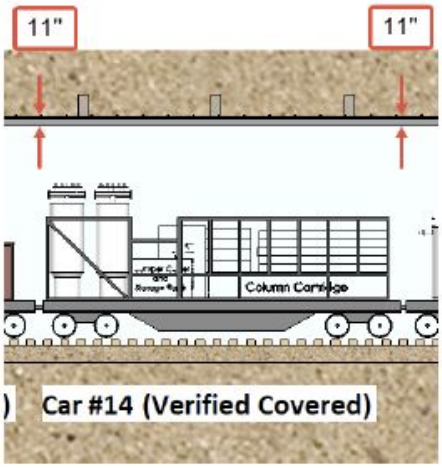


Figure B-65: Approximate Final Grout Profile above Car 14.

After grouting, approximately 10 yd^3 of void space was left at the top of the tunnel above Car 13. Approximately 42.1 yd^3 of void space is left inside the rail car. Estimation based on 90% empty volume in the tank (assumed capped), 90% empty volume in the condenser (assume capped), and 60% empty volume in the cell block.

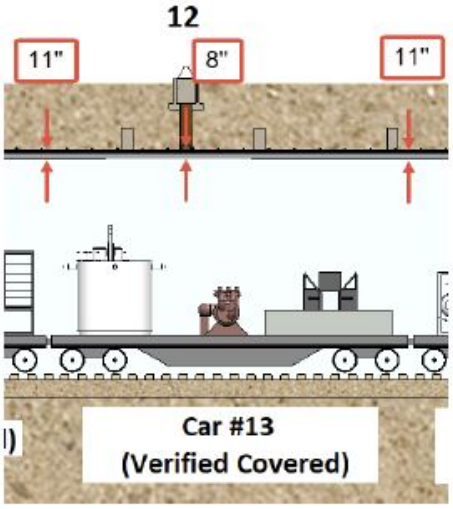


Figure B-66: Approximate Final Grout Profile above Car 13.

3.2 (2018.09) CP-14977, Rev. 11

CP-14977, 2018, *Plutonium Uranium Extraction Facility Documented Safety Analysis*, Rev. 11, CH2M HILL Plateau Remediation Company, Richland, Washington.

In Revision 11 of the PUREX Documented Safety Analysis (DSA), the radiological inventories are decayed to January 1, 2018.

The inventory for Tunnel 2 has been re-derived from historical documents.

C.2 PUREX Storage Tunnels

C.2.1 Overview

The radiological inventory of the PUREX Storage Tunnels is provided in HNF-SD-CP-HIE-002, *Plutonium-Uranium Extraction (PUREX) Facility Storage Tunnel Hazard Analysis*. A summary of the inventory by location, with the activity of the item when it was placed in the tunnel, is provided in Section C.3. The following sections describe the evaluation and assessment of the storage tunnel inventories.

The HNF-SD-CP-HIE-002 document provided the activity content (in curies) of the waste emplaced in the PUREX Storage Tunnels, from which an estimate of the current isotopic composition was made. The emplaced waste, except for specific quantities of plutonium as noted below, was assumed to be residuals from the processing of irradiated fuel. The nuclide mix was decay-corrected from January 1, 1997 to January 1, 2018. No nuclides were added or removed from those provided in HNF-SD-CP-HIE-002 aside from ^{241}Am ingrowth in Tunnel 2.

C.2.2 PUREX Storage Tunnel 1

There are eight modified railcars containing contaminated wastes in Storage Tunnel 1. The first railcar was placed in the storage tunnel in June 1960 and the last (eighth) railcar was emplaced in January 1965. Per HNF-SD-CP-HIE-002, these railcars contained a total of 87,800 Ci of activity when they were placed in Storage Tunnel 1.

For a starting point, Appendix B of HNF-SD-CP-HIE-002 was used. This reference was chosen due to it evaluating multiple other references, and being a long-accepted reference document, whose values are close to the majority of other reference documents that were reviewed.

In Appendix B, the inventory values were taken from "Tunnel #1 Curie Estimate Worksheet" on page 40. Half-life values were obtained from Nuclides and Isotopes, Chart of Nuclides, Rev 16, and specific activity values were obtained from RADIDOSE Version 3. The inventory was then decayed from January 1, 1997 to January 1, 2018, which is provided in Table C-7

As noted previously, Storage Tunnel 1 has been stabilized by being filled with an engineered grout, as described in CHPRC-03519, Rev 1, *PUREX Tunnel 1 Stabilization Specification*. Therefore, none of the Storage Tunnel 1 inventory can become MAR liable to release as the result of an accident. While there are no longer accidents involving Tunnel 1, these values are shown in Table C-9 to provide a consistent methodology for both Tunnels.

Table C-9. Storage Tunnel 1 Inventory

Isotope	1997 [Ci]	Halflife [y]	HC2 [g]	SA [Ci/g]	[DE-Ci/Ci]	2018 [g]	2018 [DE-Ci]	2018 [Ci]	HC2 Ratio
^{239}Pu	63	2.41E+04	9.00E+02	6.21E-02	1.00E+00	1,014	63	63	1.13E+00
^{241}Pu	438	1.44E+01	2.80E+01	1.03E+02	1.80E-02	2	3	159	5.53E-02
^{90}Sr	1,146	2.88E+01	1.60E+02	1.37E+02	4.80E-04	5	0	691	3.15E-02
^{137}Cs	1,390	3.01E+01	1.00E+03	8.70E+01	9.20E-05	10	0	857	9.85E-03
^{95}Zr	0	1.75E-01	6.90E+01	2.15E+04	5.00E-05	0	0	0	0.00E+00
^{95}Nb	0	9.59E-02	--	3.90E+04	3.00E-05	0	0	0	--
^{106}Ru	0	1.02E+00	1.90E+00	3.35E+03	1.58E-04	0	0	0	0.00E+00
All Pu	**501**					**1,015**	**66**	**222**	--
Major FP	**2,536**					**15**	**0**	**1,548**	--
Minor FP	**0**					**0**	**0**	**0**	--
Total:	**3,037**					**1,030**	**66**	**1,770**	**1.22E+00**

C.2.3 PUREX Storage Tunnel 2

Storage Tunnel 2 houses 28 railcars containing contaminated wastes. The first railcar was placed in the storage tunnel in December 1967 and the last railcar was placed in June 1996.

For a starting point with respect to Tunnel 2, two separate references were required. HNF-SD-CP-HIE-002, Appendix B was chosen for all the radiological inventory except the 324 Facility items (Tunnel Positions #24 and #25). The material from the 324 Facility had analysis performed on it beyond simple radioactive decay, and for that reason the numbers were not used. As with Tunnel 1, this reference was chosen due to it evaluating multiple other references, and being a long-accepted reference document with values reasonably close to many other accepted reference documents.

C.2.3.1 Inventory Excluding 324 Facility Items

On page 42 of HNF-SD-CP-HIE-002, there is a consolidated distribution of radionuclides for Tunnel 2 inventory, excluding the 324 items. This distribution is the starting point for the Tunnel 2 inventory, which is shown in Table C-10, along with the conversion factors used

Table C-10. Storage Tunnel 2 Inventory (Excluding 324 Waste Items)

Isotope	1997 [g]	[DE-Ci]	1997 [Ci]	Halflife [y]	SA [Ci/g]	[DE-Ci/Ci]	2018 [g]	[DE-Ci]	2018 [Ci]
^{238}Pu	27	428	464	**88**	1.71E+01	9.22E-01	23	362	393
^{239}Pu	4,350	270	270	**24,100**	6.21E-02	1.00E+00	4,348	270	270
^{240}Pu	509	116	116	**6,560**	2.28E-01	1.00E+00	508	116	116
^{241}Pu	108	200	11,100	**14**	1.03E+02	1.80E-02	39	73	4,039
^{241}Am	53	154	183	**433**	3.43E+00	8.40E-01	55	159	189
^{90}Sr	108	7	14,800	**29**	1.37E+02	4.80E-04	65	4	8,927
^{137}Cs	209	2	18,200	**30**	8.70E+01	9.20E-05	129	1	11,216
^{3}H	0	0	77	**12**	9.56E+03	5.20E-06	0	0	24
^{85}Kr	4	0	1,550	**11**	3.93E+02	0.00E+00	1	0	401
^{106}Ru	1	1	3,200	**1.0**	3.35E+03	1.58E-04	0	0	0
^{125}Sb	1	0	842	**2.8**	1.03E+03	2.80E-05	0	0	4
^{134}Cs	1	0	1,360	**2.1**	1.30E+03	1.32E-04	0	0	1
^{144}Ce	2	4	5,170	**0.8**	3.19E+03	7.20E-04	0	0	0
^{147}Pm	17	2	16,000	**2.6**	9.28E+02	1.00E-04	0	0	62
Totals:	**5,391**	**1,182**	**73,332**				**5,168**	**985**	**25,642**

Table C-10 then consolidates down to Table C-11. Table C-10 shows why the minor fission products can be omitted; the DE-Ci values associated with them are affectively zero, especially compared to the other nuclides.

Table C-11. Consolidated Tunnel 2 Inventory From 202A

Isotope	2018 [g]	[DE-Ci]	2018 [Ci]
^{238}Pu	23	362	393
^{239}Pu	4,348	270	270
^{240}Pu	508	116	116
^{241}Pu	39	73	4,039
^{241}Am	55	159	189
^{90}Sr	65	4	8,927
^{137}Cs	129	1	11,216
Totals:	**5,167**	**985**	**25,150**

C.2.3.2 324 Facility Waste Activity

For the waste items from the 324 Facility, the Haas DSI is used as a starting point for developing the inventory. The relevant pages from the Haas DSI are provided below in Figure C-1, Figure C-2, Figure C-3, and Figure C-4.

There were seventeen shipments from the 324 Facility to PUREX, two of which contained material that is considered dispersible and at least four that contain vitrified glass. The engineered containers holding the dispersible waste were transported to PUREX on a rail car in the 22.5 Ton cask, otherwise known as the Steel Waste Package (SWP) during shipments #7 and #8. These shipments are documented in manifests PNL-324-96-005 and PNL-324-96-012.

The remainder of the items were grouted into grout containers and shipped to PUREX by rail in the SEG cask.

A DSI issues by C.R. Haas on June 28, 1996 provides details on these items. Tables providing information on the 324 waste items from the Haas DSI are provided in Figures C-1 though C-4.

Note: See Section 3.7 for the Haas DSI.

Table C-12 contains the values provided in the Haas DSI. The Activation Nuclides column is used, the Curie Content column also includes ^{90}Y and ^{137m}Ba daughter products. Use of the daughter products will almost double the inventory, and their presence is already accounted for when using DE-Ci values.

In Table C-12, the rows 13, 14, 16, and 17 (shaded light gray) represent shipments of vitrified glass.

Table C-12. 324 Waste Item Shipments, 1997

Shipment	Pu [g]	^{137}Cs [Ci]	^{90}Sr [Ci]	^{134}Cs [Ci]	^{60}Co [Ci]	^{154}Eu [Ci]	^{155}Eu [Ci]	Pu [Ci]	Total [Ci]
1	0	234	37					0.0	**271**
2	0	88	110	0.0	0.0	0.0	0.0	0.0	**198**
3	0	525	656	0.0	0.1	0.1	0.0	0.0	**1,181**
4	0	554	692	0.1	0.1	0.1	0.0	0.0	**1,246**
5	0	200	250					0.0	**450**
6	1	103	39	0.1	0.1	0.2	0.0	0.0	**142**
7	9	10,000	5,580		0.1	6.6		0.5	**15,587**
8	14	59,600	43,200			2.1		0.9	**102,803**
9	0	14,900	2,790					0.0	**17,690**
10	0	16,300	3,220					0.0	**19,520**
11	0	30,700	6,070					0.0	**36,770**
12	0	44,300	55,300					0.0	**99,600**
13	0	34,800	43,500					0.0	**78,300**
14	2	271,000	110,000					0.1	**381,000**
15	1	15,200	43,000					0.1	**58,200**
16	23	97,400	30,800					1.4	**128,201**
17	17	39,400	14,100					1.0	**53,501**
All Disp	**23**	**69,600**	**48,780**	**0.0**	**0.1**	**8.6**	**0.0**	**1.4**	**118,390**
All Glass	**41**	**442,600**	**198,400**	**0.0**	**0.0**	**0.0**	**0.0**	**2.6**	**641,003**
All Other	**3**	**123,104**	**112,164**	**0.2**	**0.3**	**0.4**	**0.1**	**0.2**	**235,269**
Total:	**67**	**635,304**	**359,344**	**0.2**	**0.4**	**9.0**	**0.1**	**4.1**	**994,661**

Table C-13 provides the results of decaying, consolidating, and converting Table C-12 to Curies, DE-Ci, and grams.

Table C-13. 324 Waste Decayed and Consolidated, 2018

[Curies]	^{137}Cs	^{90}Sr	Pu	Total
All Disp	42,892	29,421	1.4	72,315
All Glass	272,760	119,664	2.6	392,427
All Other	75,865	67,651	0.2	143,516
Total:	**391,517**	**216,737**	**4.1**	**608,258**
[DE-Ci]	^{137}Cs	^{90}Sr	Pu	Total
All Disp	4	14	1.4	19
All Glass	0	0	0	0
All Other	7	32	0.2	40
Total:	**11**	**47**	**1.6**	**59**
[grams]	^{137}Cs	^{90}Sr	Pu	Total
All Disp	493	216	22.5	731
All Glass	3,136	877	41.2	4,054
All Other	872	496	2.8	1,371
Total:	**4,501**	**1,588**	**66.5**	**6,155**

In the DE-Ci portion of the table, the values for the vitrified glass were already very low, however values of 0 were entered manually due to the difficulty associated with receiving an inhaled dose from glass (ARFxRF=0).

From DOE-HDBK-3010-94, Section 4.3.1.1 Vitrified Waste:

> Monolithic borosilicate glasses incorporating high-level waste do not appear to have the potential to release any significant amount of non-volatile radionuclides. These materials would have been heated to temperatures exceeding those anticipated for most fire situation during formation and are not anticipated to undergo any chemical change under fire conditions.
>
> Notwithstanding, a bounding ARF and RF cannot be assessed at this time due to the lack of applicable data. From the information available, however, any release under industrial-type fire conditions appears to be negligible.

From DOE-HDBK-3010-94, Section 4.3.2.2 Blast Effects:

> For the pressure impulses generated by explosive events that may entrain and hurl aggregate materials, the crush-impact correlation presented in section 4.3.3 may be used to characterize the response provided an impact velocity can be estimated. No experimentally measured values for ARF and RF are available. If aggregate materials are

not hurled at considerable velocity, no significant airborne release is postulated. The potential releases for loose surface contamination on the solid are covered in Chapter 5.

The decayed, consolidated and converted 324 waste inventory, shipments of glass, is provided is Table C-14. This inventory has not been further consolidated into the remainder of the Storage Tunnel 2 inventory for the purpose of calculating dose consequences in RADIDOSE; the ^{137}Cs and ^{90}Sr waste have a higher solubility class associated with them. Since the exact isotopic composition of the Pu is not known, it is assigned the same isotopic composition as "Bounding Solid TRU Waste" in RADIDOSE, which corresponds to 12% ^{240}Pu.

Table C-14. Consolidated 324 Waste Items (No Glass)

Isotope	2018 [g]	[DE-Ci]	2018 [Ci]
^{238}Pu	0.02	0.32	0.35
^{239}Pu	21.25	1.32	1.32
^{240}Pu	3.28	0.75	0.75
^{241}Pu	0.28	0.52	28.68
^{242}Pu	0.01	0.00	0.00
^{241}Am	0.44	1.28	1.52
^{90}Sr	711	47	97,427
^{137}Cs	1,365	11	118,782
Totals:	2,102	62	216,242

To confirm the correct waste items are being assigned an ARFxRF value of zero, the inventory listings in DAH-8M400-95-015, *Radiological Consequence Analysis of a Hypothetical Release from PUREX Storage Tunnel No. 2 Associated with Interim Storage of Material from 324 Building*, Appendix A were reviewed. The tables in Appendix A of DAH-8M400-95-015 contain the isotopic makeup of the 324 waste items, including the glass waste. These values are provided in Table C-15.

Table C-12 shows that in the late 1990s shipments 13, 14, 16, and 17 had a combined total of ~641,000 Ci. Table C-15 shows a total of ~766,000 Ci of ^{137}Cs and ^{90}Sr. This confirms the correct shipments have been identified as containing vitrified glass waste.

Table C-15. DAH-8M400-95-015, Appendix A, Vitrified Glass Data Sheets

[curies]	Glass-1	Glass-2	Glass-3	Glass-4	Glass-5	Glass-6	Glass-7	Glass-8	Glass-9	Glass-10	Glass-11	Glass-12	Glass-13	Glass-14	Glass-14a	
Item	WSEP	ZVDP	ZVDP	ZVDP	ZVDP	WV1	WV2	FRG A	FRG B	FRG 4	FRG 13	FRG 19	RLFCM	RLFCM	RLFCM	Total
^{238}Pu						0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
^{239}Pu											0.0	0.0	0.0	0.0	0.0	**0**
^{240}Pu											0.0	0.0	0.0	0.0	0.0	**0**
^{241}Pu						0.0	0.0	0.0	0.0	0.0	0.4	0.6	0.3	0.3	0.1	**2**
^{241}Am											0.1	0.1	0.1	0.1	0.0	**0**
^{90}Sr	726	161	806	645	645	429	429	360	90	360	51,600	73,700	39,200	39,200	13,100	**221,451**
^{137}Cs	1,430	19,200	3,900	21,500	18,600	4,160	4,160	3,490	873	3,490	126,000	164,000	87,100	87,100	0	**545,003**
^{90}Y	726	161	806	645	645	429	429	360	90	360						**4,651**
^{134}Cs						6	6	5	1	5						**25**
^{137m}Ba	1,370	18,300	3,730	20,600	17,800	3,980	3,980	3,350	837	3,350						**77,297**
^{154}Eu						27	27	23	6	23						**106**
^{234}U											0	0	0	0	0	**0**
^{235}U						0	0	0	0	0	0	0	0	0	0	**0**
^{236}U											0	0	0	0	0	**0**
^{238}U						0	0	0	0	0	0	0	0	0	0	**0**
^{243}Am											0	0	0	0	0	**0**
^{243}Cm																**0**
Pu	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**2**
Cs/Sr	**2,156**	**19,361**	**4,706**	**22,145**	**19,245**	**4,589**	**4,589**	**3,850**	**963**	**3,850**	**177,600**	**237,700**	**126,300**	**126,300**	**13,100**	**766,454**
Total	**4,252**	**37,822**	**9,242**	**43,390**	**37,690**	**9,031**	**9,031**	**7,588**	**1,897**	**7,588**	**177,601**	**237,701**	**126,300**	**126,300**	**13,100**	**848,535**

C.2.3.3 324 Facility Waste Containers

In the mid-1990s, waste items were packaged in the 324 Facility hotcells, shipped to PUREX by rail, and then stored in Storage Tunnel 2 (218-E-15).

The items from the 324 facility are in two different configurations, which can be seen on the "Container Type" column of the Haas DSI, Figures C-1 and C-3. These configurations are identified on the Haas DSI as:

- 22.5 Ton
- SEG

The names come from the casks they were shipped to PUREX in. Further details, along with information about the waste can be found in DOE/RL-95-95 and WHC-SD-TP-SEP-042. Note that much of the documentation discusses shipping the items by truck, which was changed to rail shortly before they were shipped.

C.2.3.3.1 22.5 Ton Waste Containers

The containers shipped in the 22.5 Ton cask hold the dispersible 324 Facility hotcell waste. This waste consists of items such as dried melter feed and floor debris. An example is provided in Figure C-5.

Figure C-5. 324 Hotcell Floor Debris

This dispersible waste was packaged into Engineered Containers. The Engineered Containers are shown in Figure C-6 and Figure C-7; see H-3-308669 for more information.

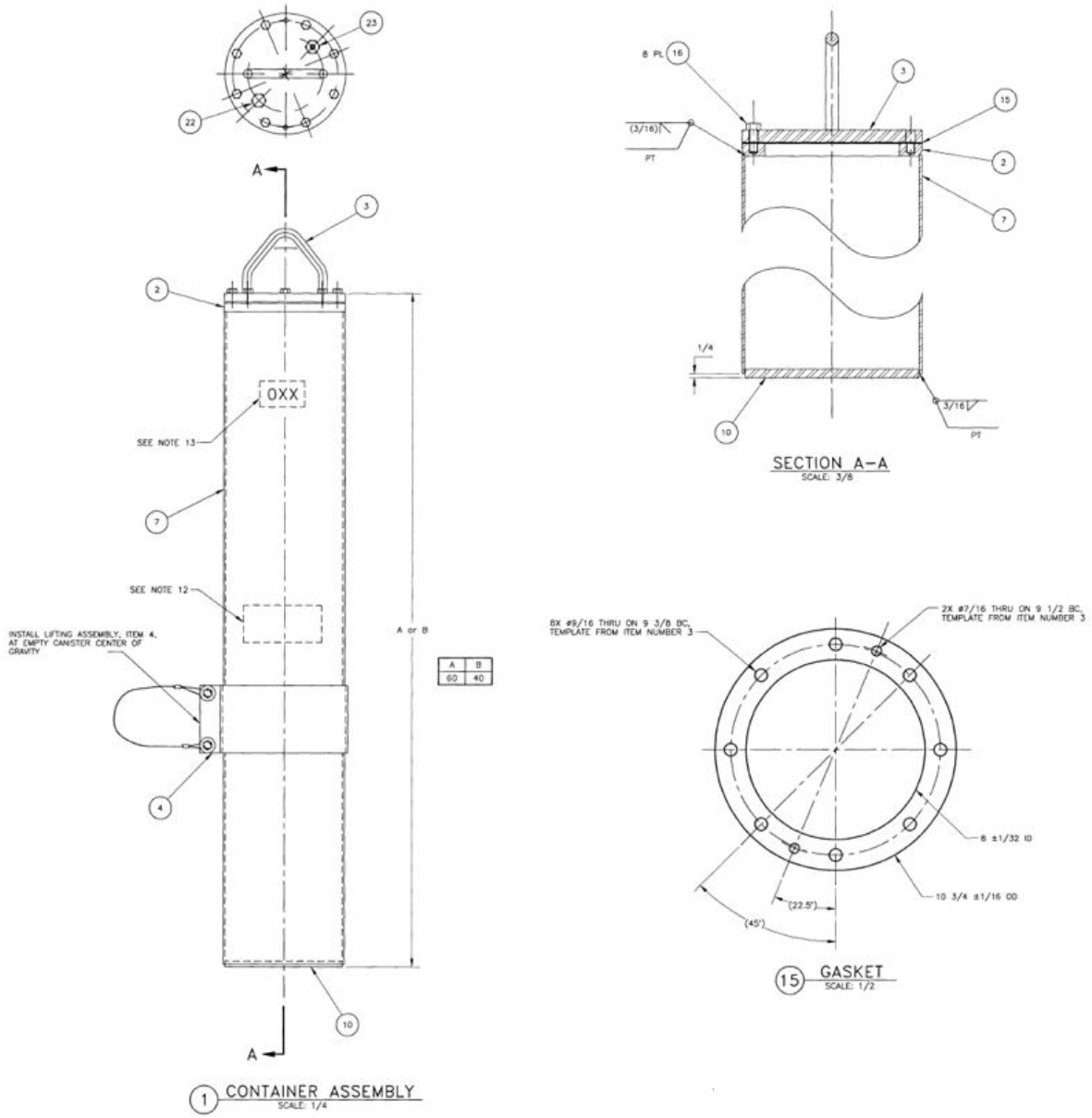


Figure C-6. Engineered Container Diagram

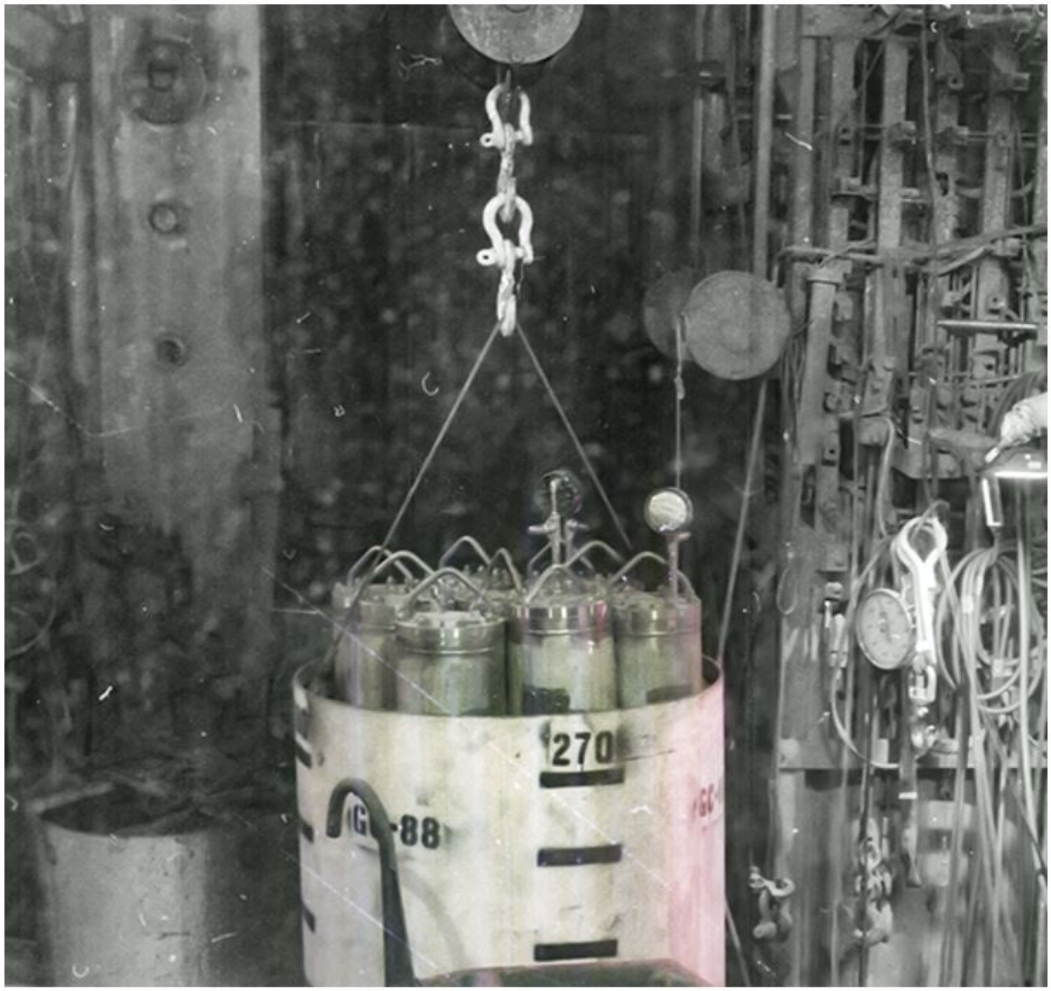


Figure C-7. Engineered Containers in 324 B-Cell

These Engineered Containers were then loaded into a Rectangular Overpack Disposal Container (RODC), which was shipped to PUREX in the 22.5 cask (H-3-70453). A drawing showing the configuration of the Engineered Containers within the RODC is shown in Figure C-8, and a photo of the RODC associated with manifest PNL-324-96-005, staged in PUREX G-Cell, is provided in Figure C-9.

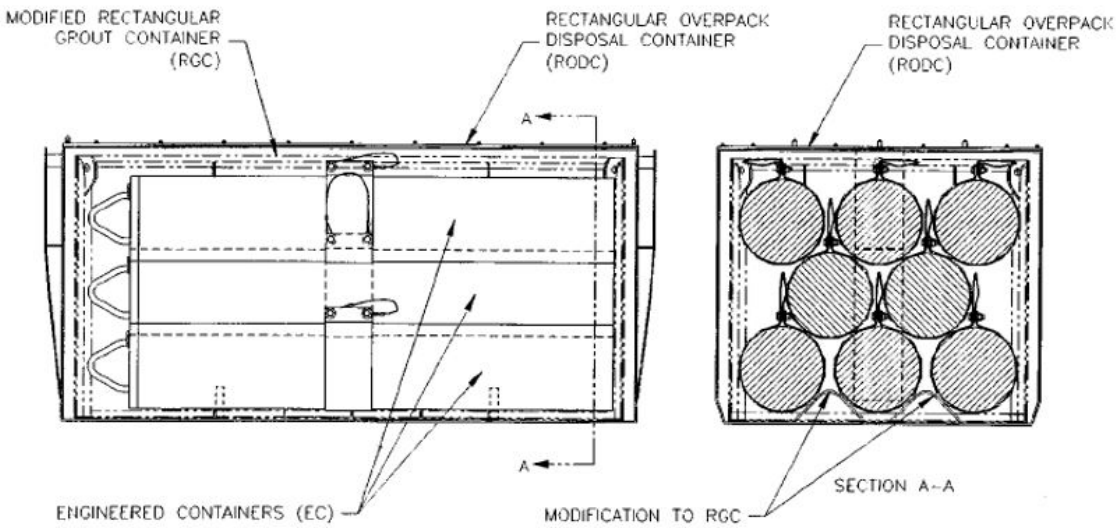


Figure C-8. Payload Configuration for Dispersible Waste

Figure C-9. RODC Staged in PUREX G-Cell

C.2.3.3.2 SEG Waste Containers

The containers shipped in the SEG cask liners contain the remainder of the 324 Facility waste. These items were loaded into grout containers shown in Figure C-10 (H-3-49415), grouted, placed in SEG cask liners shown in Figure C-11 and Figure C-12 (H-3-70273), and shipped to PUREX by rail in the SEG cask.

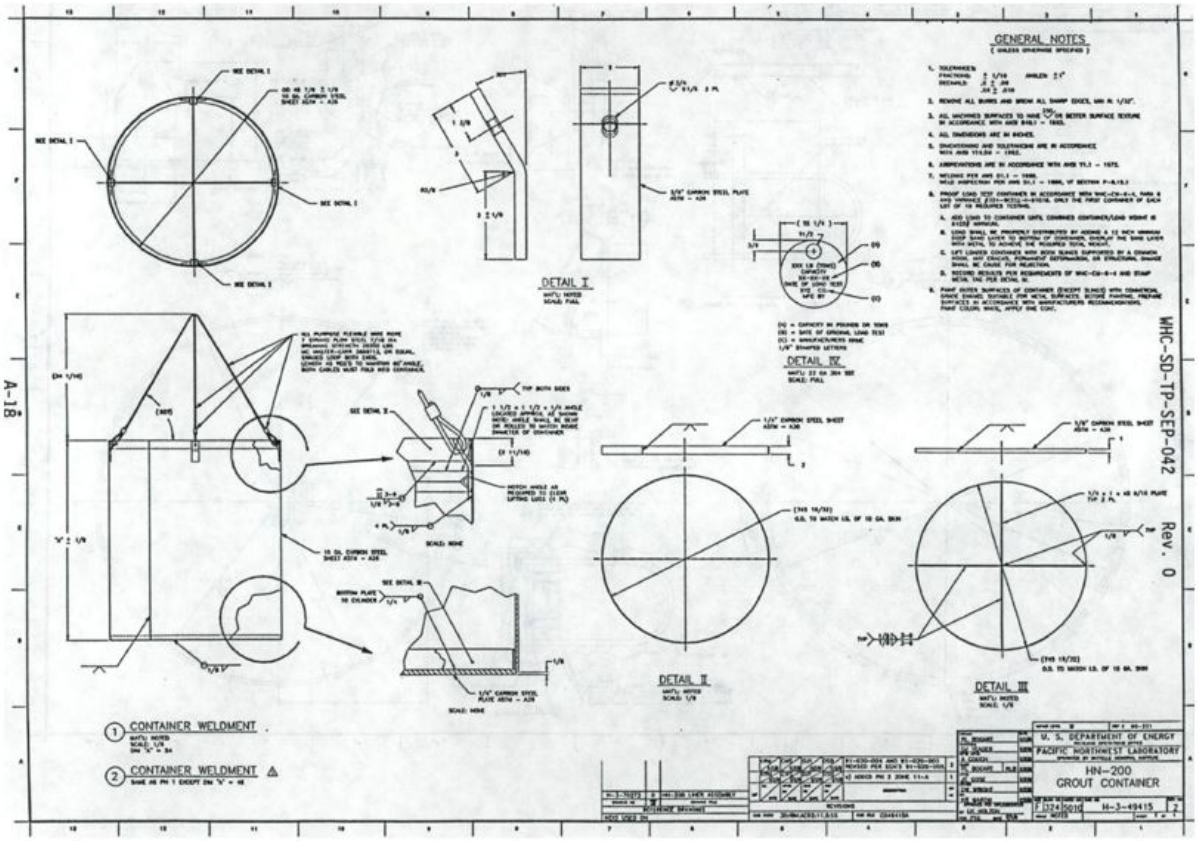


Figure C-10. Drawing of Grout Container

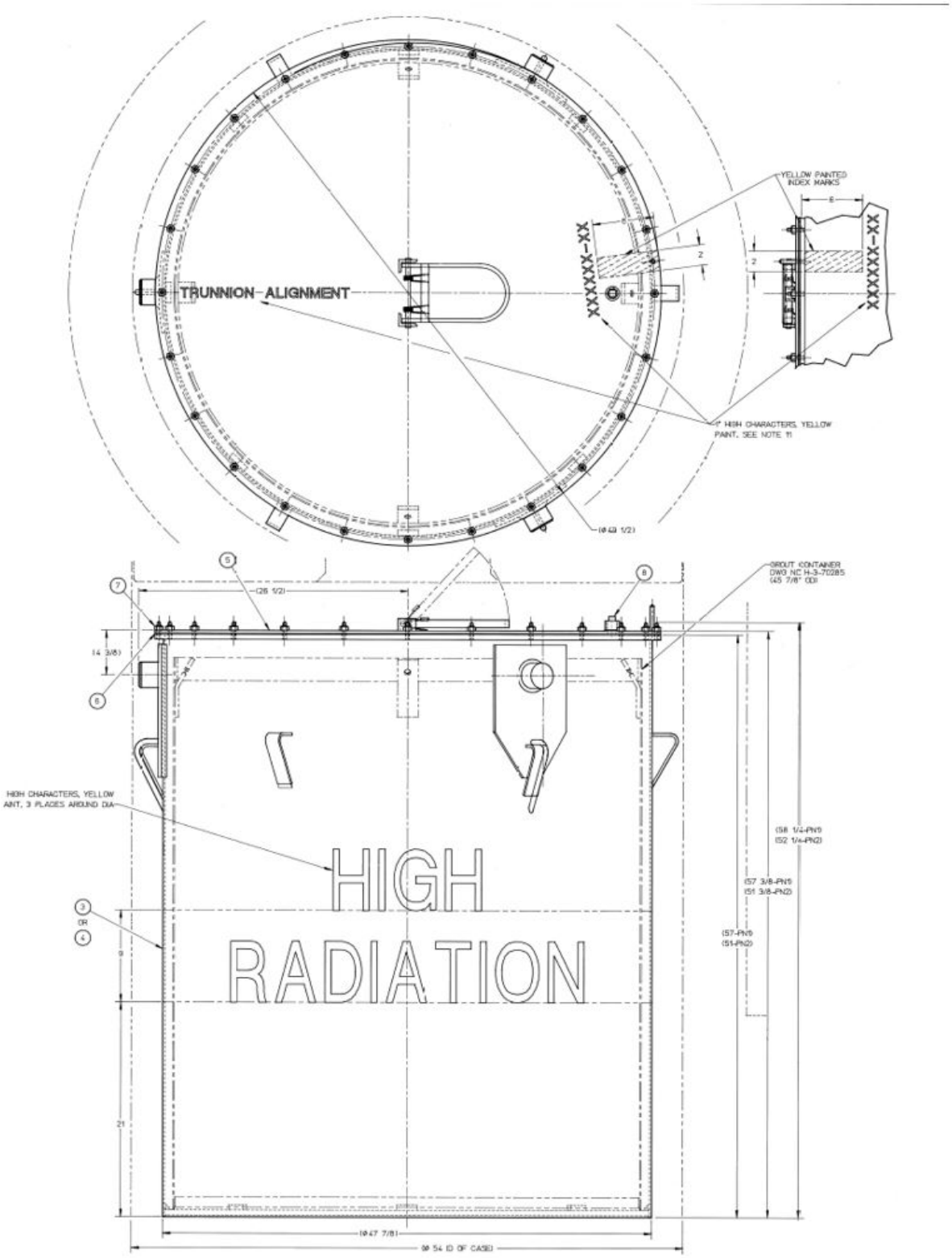


Figure C-11. Drawing of SEG Cask Liner

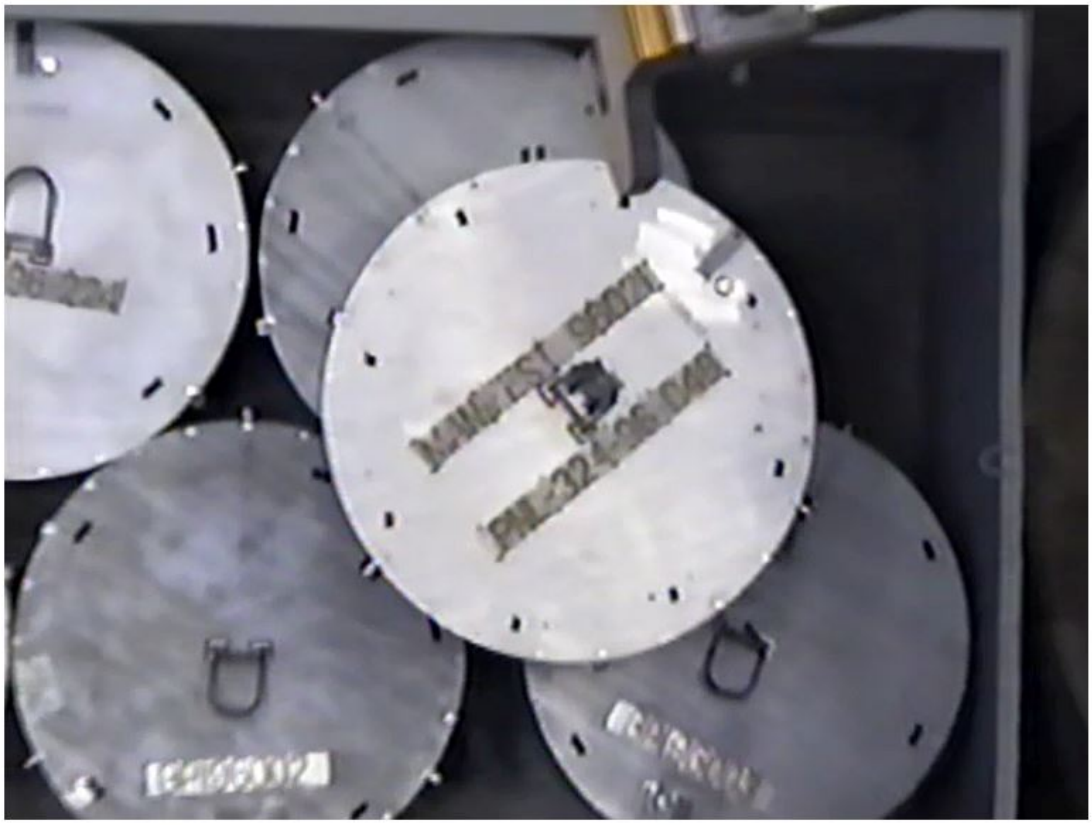


Figure C-12. SEG Cask Liner Packages Staged in G-Cell

C.2.3.3.3 Concrete Burial Boxes

Upon collection in the 202A canyon, the RODC holding the Engineered Containers and the SEG cask liners holding the grout containers were loaded into two concrete burial boxes (H-1-44908), and placed in Storage Tunnel 2 positions 24 and 25. Figure C-13 shows the loading plan for the burial box in position 24, Figure C-14 shows the loading plan for the burial box in position 25, and Figure C-15 is a photograph from inside the tunnel, showing both cars.

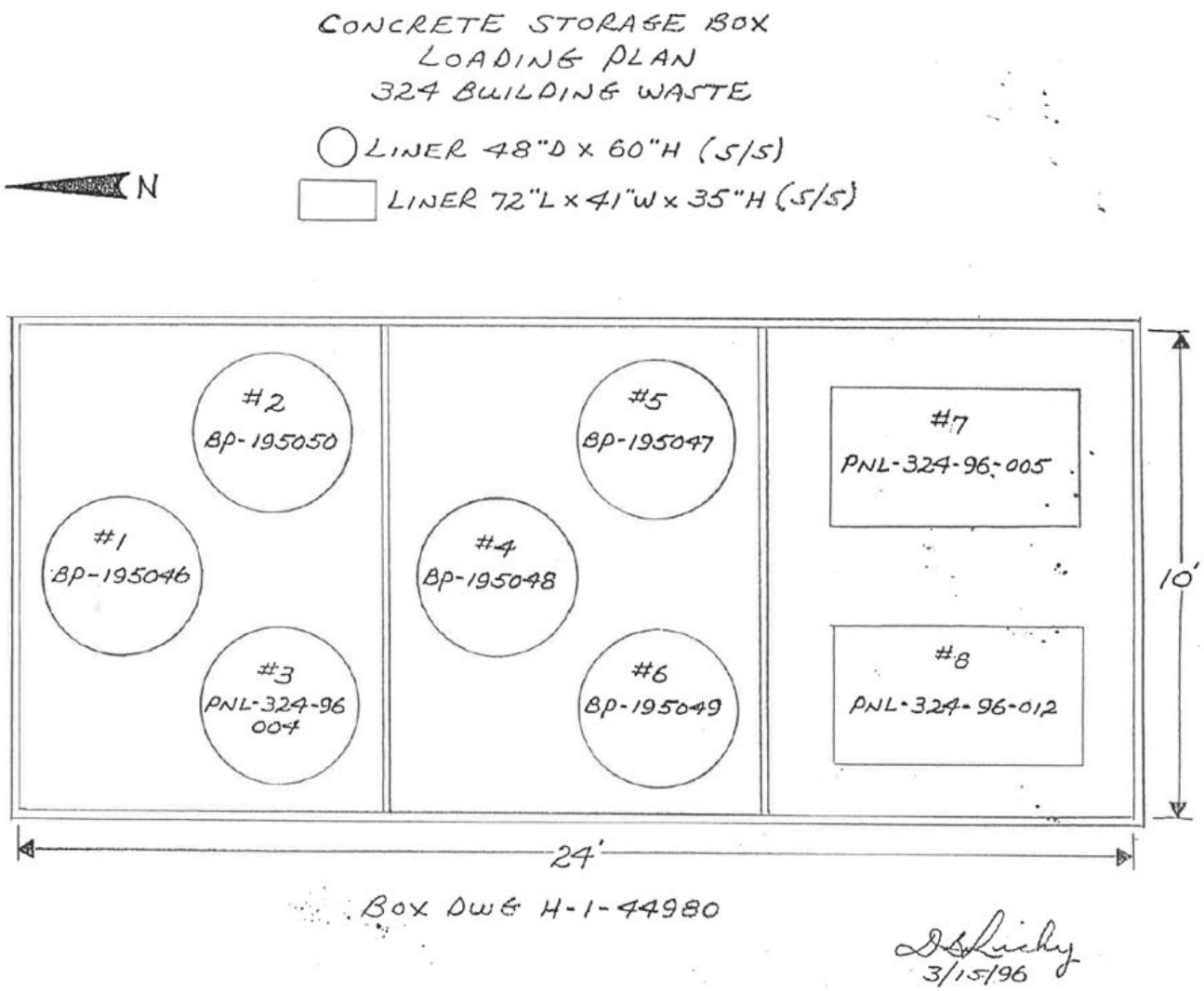


Figure C-13. Position 24 Loading Plan

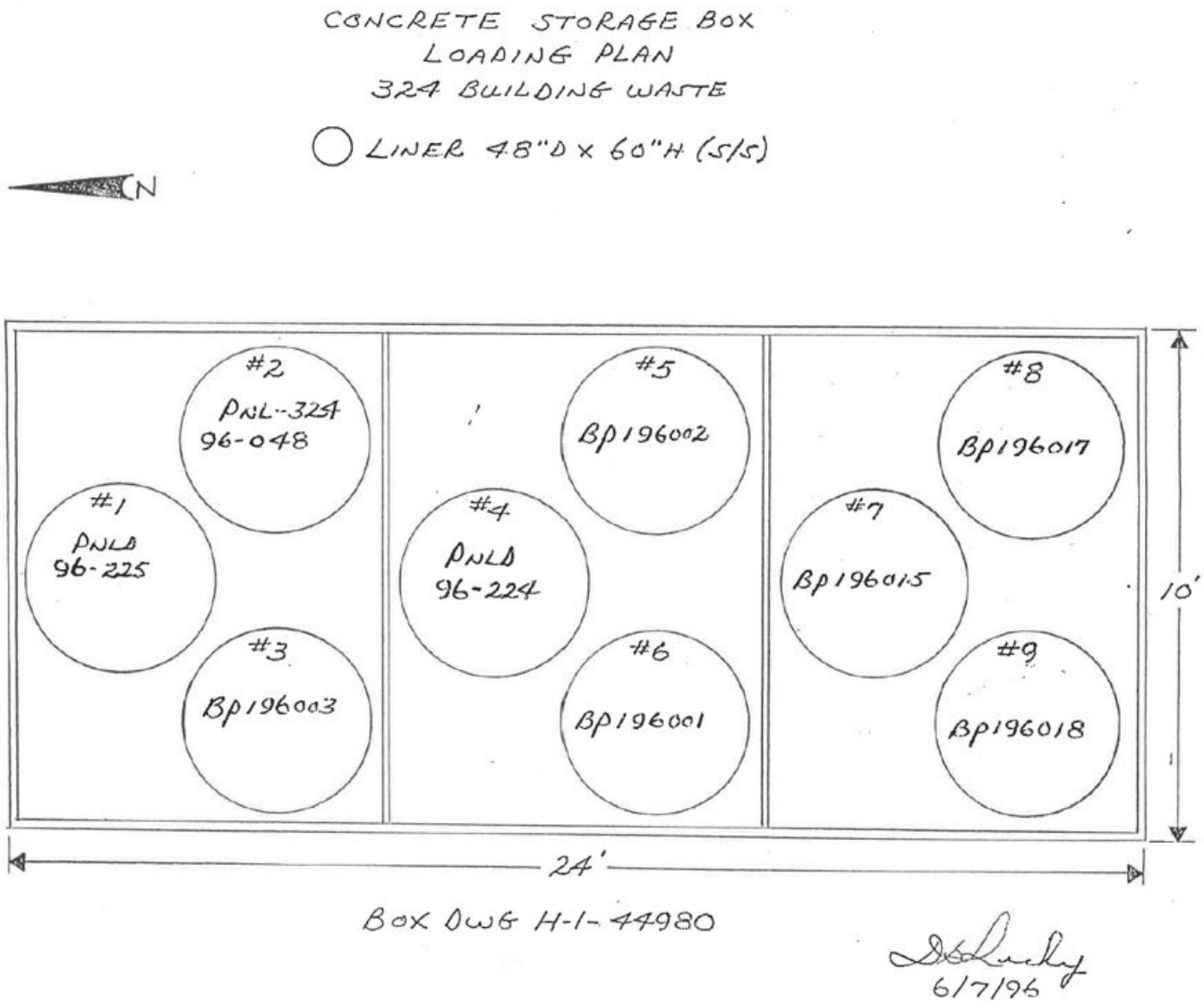


Figure C-14. Position 25 Loading Plan

Figure C-15. 324 Waste Items in Storage Tunnel 2

3.3 (2018.05) CHPRC-03416, Rev. 1

CHPRC-03416, 2018, *CSER 17-002: Criticality Safety Evaluation Report Grouting PUREX Tunnels*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington.

east and west footings carry the steel rails and permit soil loads to be transferred from one footing to the other. All timbers and rail ties are No. 1 Douglas Fir.

All exterior surfaces of the timber structure are covered with roofing material. Cracks between timbers wider than ¾-in. were covered with 26-gauge galvanized steel that was nailed in place before roofing was placed. The entire structure is covered with earth fill to approximately 8 ft. This structure would also prevent water entry from the weather or watering activities at the soil surface.

A vent shaft is located at the south end of the tunnel to provide connection to a filter and fan for ventilation of the tunnel. The shaft is about 5 ft^2 and made of reinforced concrete. For deactivation, the vent shaft is sealed to prevent release of contamination.

2.1.1 Fissile Material Inventory for Tunnel 1

The first rail cars were put into the tunnel in June of 1960. The tunnel reached capacity of eight rail cars in 1965. Figures 2-2 and 2-3 provide brief descriptions of the equipment and curie contents in each rail car in the tunnel. Some of the equipment is in boxes while most of the equipment is large and was placed directly on rail cars. The rail cars serve as both transport and storage platforms. The description does not include a fissionable material inventory.

Table 3-3. Tunnel 1 Drawing Numbers and Process Information.

Car Number (Date)	Equipment Name	Cell Arrangement Drawing	Construction Drawing	Process	Inlet Streams	Outlet Streams
1 and 2 (06/60)	HA Column (T-H2)	H-2-53520	H-2-56753	First Decontamination and Partition Cycle (1st DAPC)	CRD, HAS, HAF, 3WB-HA, HAX, Rec HNO_3, and H_2	HAP and HAW
3 (07/29/60)	E-F11 Concentrator CB-1, UT-1 Acid Service	H-2-53512	H-2-56213	Metal Dissolution and Feed Preparation (MD and FP)	ASF and NaOH	ASW and Offgas
4 (12/24/60)	G-E2 Centrifuge	H-2-53505	H-2-52965 H-2-52995	MD and FP	Offgas, Decladding Waste, and Spent Metathesis Solution	Slurried Centrifuge Cake, Decladding Waste, and Centrifuged Spent Metathesis Solution
5 (01/04/61)	E-H4 Concentrator CB-5, UT-1	H-2-53521	H-2-66046	Backcycle Waste (BW)	3WF	3WW and Offgas
6 (04/21/61)	E-F6 Concentrator CB-2, AF-1 Acid Waste Service	H-2-53510	H-2-56213	Waste Concentration and Treatment (WC&T)	1WF, 1WR, H_2O_2, and Offgas from 1WW Denitration	Offgas and 1WW
7 (02/08/62)	E-F11 Concentrator	H-2-53512	H-2-56213	MD & FP	ASF and NaOH	ASW and Offgas
8 (01/22/65)	E-F6 Concentrator	H-2-53510	H-2-56213	WC&T	1WF, 1WR, H_2O_2, and Offgas from 1WW Denitration	Offgas and 1WW

Figure 2-2. Equipment Information for Tunnel 1 Rail Cars (ref. WHC-IP-0977 Table 3-3)

PUREX #1 STORAGE TUNNEL (218-E-14)

TUNNEL IS AT ITS CAPACITY AS OF 1/22/65

PUREX #1 Storage Tunnel is located at the southeast end of the PUREX Plant and is an extention of the railroad tunnel. The storage area is approximately 109 meters long, 6.9 meters high and 5.8 meters wide. The tracks have a one percent down-grade toward the south end of the tunnel. The capacity of the Storage Tunnel is eight modified railroad cars, 12.8 meters long.

position	
1. & 2.	HA COLUMN AND MISC JUMPERS IN BOX PLACED IN TUNNEL #1 ON 6/60 HA 4,700 CU. FT., 400 CURIES, 5 rem/hr. @ 60', JUMPRS 2,190 CU. FT., 2,000 CURIES, Pb - ~115 Kg.
3.	E-F11 #1 (1WW WASTE) CONCENTRATOR FAILED 7/24/60. PLACED IN TUNNEL #1 ON 7/29/60, 12.5 rem/hr. @ 100', 1,900 CU. FT., 40, 000 CURIES AFTER FIFTY-FIVE MONTHS SERVICE.
4.	G-E2 CENTRIFUGE. MISC JUMPERS IN BOX AND TWO TUBE BUNDLES. PLACED IN TUNNEL #1 ON 12/24/60 (FUG SER# 762) 2,465 CU. FT., 3,000 CURIES, Pb - ~115 Kg., 1.5 rem/hr. @ 150'.
5.	E-H4 (3WB) CONCENTRATOR FAILED 1/4/61. PLACED IN TUNNEL #1 ON 1/4/61, 150 mrem/hr. @ 50', 2,336 CU. FT., 1,000 CURIES. AFTER FIVE YEARS SERVICE.
6.	E-F6 (2WW WASTE) ORIGINAL CONCENTRATOR FAILED 4/21/61. PLACED IN TUNNEL #1 ON 4/21/61, 5 rem/hr. @ 20', 2,336 CU. FT., 700 CURIES. AFTER FIVE YEARS FOUR MONTHS SERVICE.
7.	E-F11 (1WW WASTE) #2 CONCENTRATOR FAILED 2/1/62. PLACED IN TUNNEL #1 ON 2/8/62, 25 rem/hr. @ 150', 2,336 CU. FT., 40,000 CURIES. AFTER EIGHTEEN MONTHS SERVICE.
8.	E-F6 (2WW WASTE) #3 SPARE CONCENTRATOR FAILED 5/23/64. PLACED IN TUNNEL #1 ON 1/22/65 FLAT CAR 3621. 2,400 CU. FT., 700 CURIES, 5 rem/hr. @ 20'.

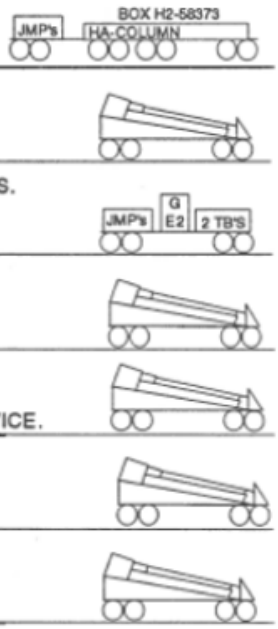


Figure 2-3. Tunnel 1 Contents
(ref. CP-14977 Figure C-3)

Table 2-1 provides an estimate of ^{239}Pu contents for each rail car. Note the total ^{239}Pu is derived from the total curie content provided in Table 2-1, 87.8 kCi, and the isotopics of the material being processed at PUREX at the time the rail cars were placed in the tunnel. The rail car ^{239}Pu content is then determined from the ratio of the rail car curie content to the total curie content. The difference between the ^{239}Pu masses in Table B-3 of the Criticality Safety Evaluation Report (CSER) HNF-14579; *Criticality Safety Evaluation Report CSER 03-002,*

Criticality Classification of PUREX Tunnels, (CSER 03-002); and Table C-9 of the Documented Safety Analysis (DSA), *Plutonium Uranium Extraction Facility Documented Safety Analysis* (CP-14977) is that CSER 03-002 considered the short-lived (days) fission products like Zirconium, Niobium, and Ruthenium in the tally of the original isotopics which will lower the ^{239}Pu mass. Both estimations ignore the origin of some of the equipment, namely Rail Cars 3 and 7. The equipment on these cars was from the acid recovery process where the ^{239}Pu content was extremely low. This is apparent in the rail car content lists in Figures 2-2 and 2-3 where the rail cars are noted to contain a concentrator from the acid recovery process on the back-end (waste) side of the PUREX process. Yet, these cars are noted to contain the most ^{239}Pu due to the cars' extremely high initial curie content, 40,000 Ci, which in actuality may be traced to Ruthenium and Rubidium contamination.

Table 2-1. Storage Tunnel 1 Contents per CSER and DSA

		CSER 03-002		CP-14977	
Location	**Volume (cu. ft.)**	**kCi ^{239}Pu**	**g ^{239}Pu**	**kCi ^{239}Pu**	**g ^{239}Pu**
1	4700	2	23.1	2	97.0
2	2190	0.4	4.6	0.4	19.4
3	1900	40	462.9	40	1940.8
4	2465	3	34.7	3	145.6
5	2336	1	11.6	1	48.5
6	2336	0.7	8.1	0.7	34.0
7	2336	40	462.9	40	1940.8
8	2400	0.7	8.1	0.7	34.0
Total		87.8	1016.0	87.8	4260.0

2.1.2 Grouting Storage Tunnel 1

The grouting operation was addressed in CHPRC-03394, 2017, *Conceptual Design Report for PUREX Tunnel 1 Grouting System*, Revision 0. The grouting process was conducted to minimize the stress upon the tunnel structure and to limit the potential of moving or shifting the equipment and boxes on the rail cars. A platform was constructed across the tunnel in order to provide workers access to the tunnel to inject the engineered grout material. The grout mixture had good flow characteristics to fill the entire tunnel. Several pours, called lifts, were used to ensure proper curing of the grout and to minimize movement of the rail cars, equipment, and boxes. The engineered grout was injected into the tunnel at the location of the roof timber failure and subsequent soil fill. Grout piping was routed under the timbers through the soil fill into open areas into the tunnel.

The engineered grout material was a formula bounded by the mixtures presented in Table 2-2. Appendix D provides details on the engineered grout composition and elemental weight

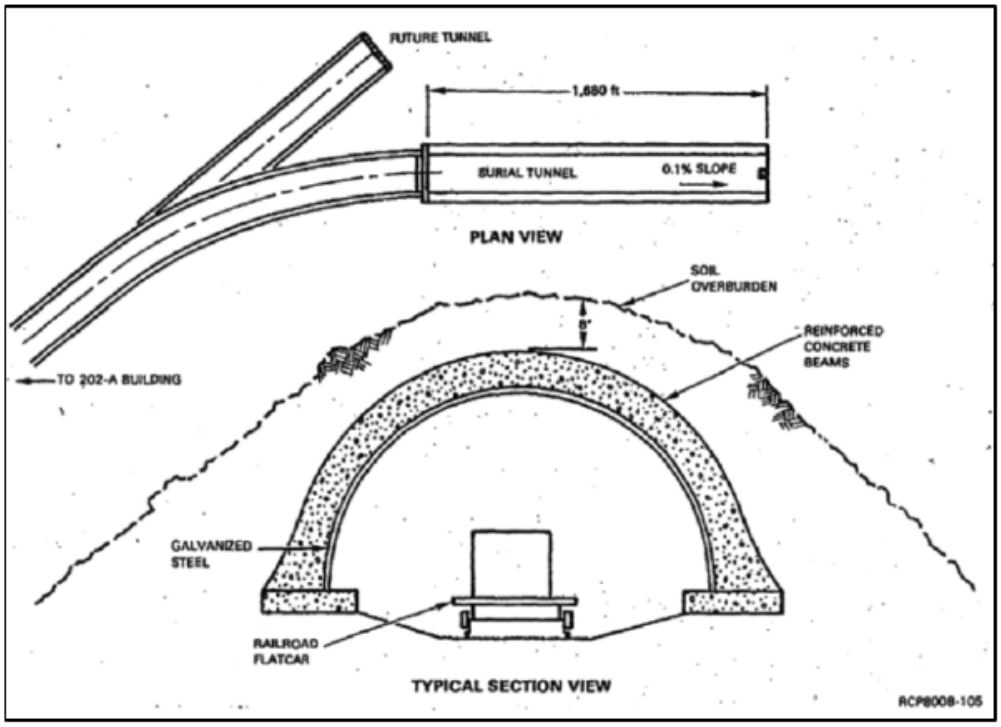


Figure 2-4. PUREX Storage Tunnel 2

2.2.1 Fissile Material Inventory for Tunnel 2

The first railroad car was put into the tunnel in December of 1967. The tunnel did not reach capacity. The 28th car was placed in the tunnel in June of 1996. Figure 2-5 provides brief descriptions of the equipment and curie contents in each rail car in the tunnel. Some of the equipment is in boxes while most of the equipment is large and was placed directly on rail cars. The rail cars serve as both transport and storage platforms. The description does not generally include a fissionable material inventory.

The first 23 items are PUREX equipment. The next two rail cars are 324 Facility equipment. The last three cars are 20,000-gal liquid waste tank railroad cars. The descriptions do not include a fissionable material inventory for the cars, except for car 4 and for the last five railroad cars. The sum of the plutonium for the last five cars (cars 24 to 28) is 262 grams. Car 4 is listed as having 500 grams.

The DSA for the PUREX facility, CP-14977 Revision 10, *Plutonium Uranium Extraction Facility Documented Safety Analysis*, provides the calculations to derive the plutonium content on the various rail cars in Appendix C.2.4. Appendix C.2.4 is copied verbatim in Appendix E of this document. In the calculations, the railcars are divided into four batches based on the date the railcars were placed into Tunnel 2. This was done to estimate the decayed curie content of the radionuclides present in the rail cars.

PUREX #2 STORAGE TUNNEL (218-E-15)

position	
22.	METAL LINER BOX (H-2-65095) CONTAINING JUMPERS AND FAILED/ OBSOLETE CANYON EQUIPMENT, F7 NEUTRON MONITOR (H-2-75825), LEAD STORAGE BOX (H-2-131629) CONTAINING JUMPER COUNTERWEIGHTS AND MISCELLANEOUS LEAD ITEMS, SCRAP HOPPER (H-2-57347) CONTAINING MISCELLANEOUS CANYON EQUIPMENT, CANISTER CAPPING STATION (H-2-821831), TEST CANISTER CONTAINING VARIOUS LENGTHS OF CARBON STEEL PIPE. PLACED IN TUNNEL 3-11-96 ON CAR #3616. ESTIMATED WEIGHT 22 TONS, 1,712 CU. FT., 15 CURIES, Pb - ~3,232 Kg., Cd - ~2 Kg., 100 mrem/hr. @ 1'.
23.	TWO BURIAL BOXES (H-2-100187) CONTAINING JUMPERS AND FAILED/ OBSOLETE CANYON EQUIPMENT, LIFTING YOKE (H-2-99652). PLACED IN TUNNEL 3-11-96 ON CAR #PX-31. ESTIMATED WEIGHT 21 TONS, 2,116 CU. FT., 2 CURIES, 10 mrem/hr. @ 1'.
24.	CONCRETE BURIAL BOX (H-1-44980) STORING 8 CONTAINERS OF 324 BUILDING, B-CELL WASTE. FOR ADDITIONAL DETAILS, SEE PUREX WORK PLAN WP-P-95-60. PLACED IN TUNNEL ON CAR #PX-29, ON APRIL 26, 1996. ESTIMATED WEIGHT 36 TONS, 1,890 CU. FT., < 244,000 CURIES, ~15 mrem/hr. @ 150'. Pb - ~1,802 kg., Cd - ~10.5 kg., absorbed oil - ~8.5 kg., Cr - ~1 kg., Ba - ~ 3 kg, ~24 g Pu.
25.	CONCRETE BURIAL BOX (H-1-44980) STORING 9 CONTAINERS OF 324 AND 325 BUILDING WASTE. FOR ADDITIONAL DETAILS, SEE PUREX WORK PLAN WP-P-96-015. PLACED IN TUNNEL ON CAR #10A-3619, ON JUNE 12, 1996. ESTIMATED WEIGHT 46.5 TONS, 1,890 CU. FT., < 1.75 M CURIES, ~200 mrem/hr. @ 150'. Ba - ~4 g., Cd - <1 g., Cr - ~ 2 g., Pb - < 1 g, ~43 g Pu.
26.	20,000 GALLON LIQUID WASTE TANK CAR HO-10H-18580, EMPTY PER RCRA, PLACED IN TUNNEL ON JUNE 19, 1996, APPROXIMATELY 30 TONS, 5 CURIES, 100 mrem/hr. @ 3', ~53 g Pu.
27.	20,000 GALLON LIQUID WASTE TANK CAR HO-10H-18579, EMPTY PER RCRA, PLACED IN TUNNEL ON JUNE 19, 1996, APPROXIMATELY 30 TONS, 9 CURIES, 300 mrem/hr. @ 3', ~131 g Pu.
28.	20,000 GALLON LIQUID WASTE TANK CAR HO-10H-18582, EMPTY PER RCRA, PLACED IN TUNNEL ON JUNE 19, 1996, APPROXIMATELY 30 TONS, 23 CURIES, 650 mrem/hr. @ 3', ~11 g Pu.

Figure 2-5. Tunnel 2 Contents (cont)

Given the long half-life for ^{239}Pu, the decay calculation do not appreciably impact the ^{239}Pu content. In any event, the fissile content of the railcars is summarized in Table 2-3, *Tunnel 2 Fissile Inventory*. The nuclide mix was assumed to be characteristic of N-Reactor Mark 1A fuel at 180 days after irradiation to 3000 MWd/t. Short half-life isotopes (such as ^{95}Zr, ^{95}Nb, ^{106}Ru, etc.) were ignored. The decay calculation focused on the equipment/waste that originated from PUREX. The plutonium content in Cars 24-28 needed to be added in for the grand total for the

inventory derived in CSER 02-003. Whilst the plutonium inventory from the Building 324 waste (cars 24 and 25) needs to be added to the total derived in the DSA, the grand totals are very close and CSER 02-003 rounded the value up to 4700 g ^{239}Pu. Note that the inventory calculations are undergoing revision to provide an inventory that is decayed to January 2018. The preliminary results indicate the plutonium inventory will be about the same, 4710 g versus 4708 g (ref. email from David M. Carson to Christopher J. Francy dated 05/08/2018). The email and attachment are provided in Appendix F of this document.

Table 2-3. Tunnel 2 Fissile Inventory

Location	Volume[a] (cu. Ft.)	CSER 02-003[b] g ^{239}Pu	DSA[c,d] g ^{239}Pu
1-9 4	19,190	-	948.6 420
10	2,400	-	24.3
11-17	25,837	-	1682
24-25	3,780	-	56.2
18-23 26-28	17,912 2,674	-	1470 164
1-23	65,339	4355	
24-25	3,780	67	
26-28	2,674	195	
Total	71,793	4617	4765

[a]Volumes as reported in Figure 2-5 of this document.
[b]Pu values for cars 24 – 28 assumed to be 100% ^{239}Pu
[c]Pu-239 masses calculated in Appendix C.2.4 of CP-14977 Rev. 10.
[d]Pu values for cars 4 and 26 – 28 assumed for reactor grade Pu at 12 wt.% ^{240}Pu

Apportioning the estimated plutonium content among the railcars in each batch using the DSA inventory numbers, see Table 2-4 *Tunnel 2 Fissile Inventory per Rail Car*, shows that cars 14 and 21 contain the majority of the plutonium – 2905 g or 61 percent of the total. A look at the equipment and waste on these railcars shows that the fissile material is split between several boxes and many items within the boxes. The plutonium exists as a fixed contamination layer on the various pieces of equipment. A look at the plutonium areal density and overall density demonstrates the diffuse nature of the plutonium. For the worse case, car 14, 1640 g of ^{239}Pu is spread over a volume of 3600 ft^3 (ref. Figure 2-5) for a density of 1.6 x 10^{-5} g/cc (1640 g/1.019 x 10^8 cc). Spreading the plutonium over the rail car base, which is 42 ft x 5 ft or 210 ft^2, would provide an areal density of 7.8 g ^{239}Pu per ft^2.

Table 2-4. Tunnel 2 Fissile Inventory Per Rail Car

Rail Car/Batch	Ci	Ci Fraction per Batch	Pu-239 Mass (g)
1	700	0.036	34.0
2	500	0.026	24.3
3	700	0.036	34.0
4	-	0.000	420
5	20	0.001	1.0
6	10	0.001	0.5
7	50	0.003	2.4
8	17500	0.896	850.0
9	50	0.003	2.4
Subtotal Batch 1 + Car 4	19530	1.000	1368.6
Subtotal Batch 2 (Car 10)	500	1	24.3
11	0.81	0.000	0.0
12	540	0.016	26.2
13	90	0.003	4.4
14	33740	0.975	1639.5
15	240	0.007	11.7
16	1.5	0.000	0.1
17	3	0.000	0.1
Subtotal Batch 3	34615.31	1.000	1682
18	185	0.006	9.0
19	927	0.031	45.1
20	3070	0.102	149.4
21	26000	0.861	1265.6
22	15	0.000	0.8
23	2	0.000	0.1
Subtotal Batch 4	30199	1.0	1470
24			20.2
25			36.1
26			44.5
27			110
28			9.2
Total	84844.3		4765.0

3.4 (2017.11) CHPRC-03519, Rev. 1

CHPRC-03519, 2017, *PUREX Tunnel 1 Stabilization Acceptance Specification*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington.

CHPRC-03519 documents the successful stabilization (grouting) of PUREX Tunnel 1 by Project Technical Services (PTS). While the grouting of Tunnel 1 effectively does not add or remove any inventory, the configuration of the preexisting inventory has been changed.

Attachment 2 – Verification Data

Fig	AC No	Location	Description	Photograph
Fig. 1	S1	Plenum Vent Shaft	9/27/2017 @ 1010 Camera Orientation: Looking North @ rail car 1 RR ties, railcar #1, and Southwest corner of tunnel wall is observed	
Fig. 2	S1	Plenum Vent Shaft	10/8/2017 @ 0245 Camera Orientation: Looking North @ rail car 1 Grout is observed flowing over tracks	
Fig. 3	S1	Plenum Vent Shaft	10/12/2017 @ 0243 Camera orientation: Looking North Prior to grout flowing	

Fig	AC No	Location	Description	Photograph
Fig. 4	S1	Plenum Vent Shaft	10/12/2017 @ 0243 Camera orientation: Looking North Grout can be observed flowing	
Fig. 5	S1	Plenum Vent Shaft	10/17/2017 @ 0245 Camera orientation: Looking north Grout is observed from previous shifts' grout lift	
Fig. 6	S1	Plenum Vent Shaft	10/17/2017 @ 0247 Camera orientation: Looking North Grout can be observed flowing	

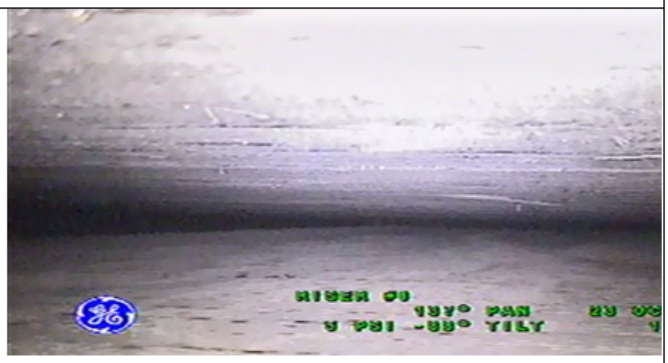
Fig	AC No	Location	Description	Photograph
Fig. 7	S1 S2	Plenum Vent Shaft	10/18/2017 @ 0537 Camera orientation: Looking North Grout has flowed into the air plenum to the maximum extent practicable	
Fig. 8	S2 S3	Riser 6	10/18/2017 @ 0245 Camera orientation: Looking South Reference faint image of *crescent* shaped top of tank in background	
Fig. 9	S2 S3	Riser 6	10/23/2017 @ 1129 Camera orientation: Looking South Grout has fully encapsulated rail cars	

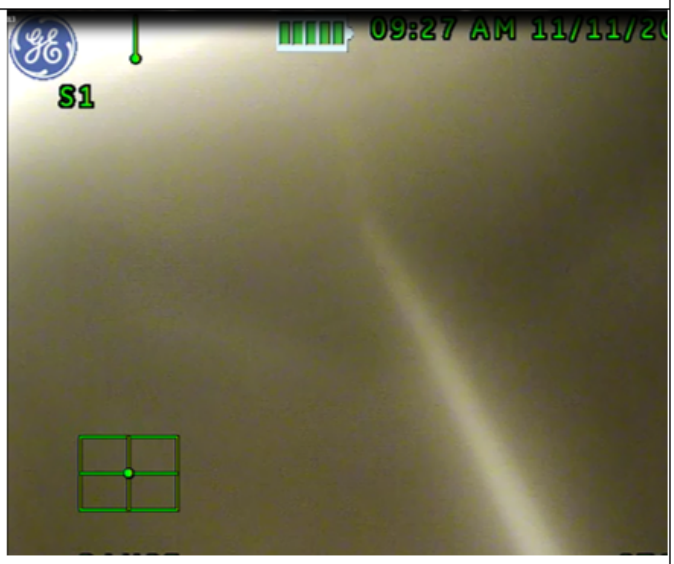
Fig	AC No	Location	Description	Photograph
Fig. 10	S2 S3	Riser 7	11/11/2017 @ 0958 Camera orientation: Top plane view (looking straight down) Grout level is approx. 6" from the roof timbers	
Fig. 11	S4	Vent Lance S1	11/11/2017 @ 0927 Camera orientation: Top plane view (looking straight down) Prior to occlusion, view is obscured due to air flow	

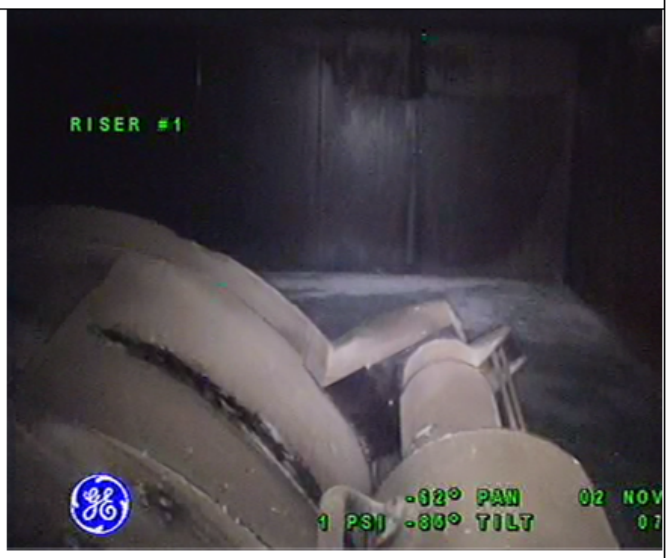
Fig	AC No	Location	Description	Photograph
Fig. 12	S4	Vent Lance S1	11/11/2017 @ 1011 Camera orientation: Top plane view (looking straight down) Air flow has stopped due to occlusion (clear view)	
Fig. 13	N1 N2	Riser 1	11/2/2017 @ 0707 Camera orientation: Looking North @ Water Fillable Door Grout is observed north of rail car 8 at the water fillable door	

Fig	AC No	Location	Description	Photograph
Fig. 14	N2	Riser 1	11/3/2017 @ 1408 Camera orientation: Looking East Fresh grout is observed flowing below the eye bolt	
Fig. 15	N2	Riser 1	11/6/2017 @ 0818 Camera orientation: Looking East After three (3) days of set time (weekend) grout shows no change in level	

Fig	AC No	Location	Description	Photograph
Fig. 16	N2 N3	Riser 1	11/6/2017 @ 1012 Camera orientation: Looking North and East @ Water Fillable Door Fresh grout Is observed approx. 2' below the roof timbers (ref. eye bolt)	
Fig. 17	N2 N3	Riser 1	11/8/2017 @ 0734 Camera orientation: Looking North and East @ Water Fillable Door After two (2) days of set time grout is observed approx. 2' below the eye bolt and shows no change in level	

Fig	AC No	Location	Description	Photograph
Fig. 18	N3	Riser 1	11/8/2017 @ 0733 Camera orientation: Looking South Grout is observed @ the bottom injection lance (background)	
Fig. 19	N3 N4	Riser 1	11/9/2017 @ 1016 Camera orientation: Top plane view (looking straight down) Camera was re-positioned to support efforts to "top off" the tunnel Grout is observed approaching camera	

3.5 (2003.09) CP-14977, Rev. 0

CP-14977, 2003, *Plutonium Uranium Extraction Facility Documented Safety Analysis*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

The inventory cited for the PUREX Storage Tunnels in the Documented Safety Analysis (DSA) is presented in this section. The inventory has effectively remained unchanged in CP-14977 Revision 0 through Revision 10 (2017). The changes made during that time were editorial in nature.

C.2.0 PUREX TUNNELS

C.2.1 Overview

The radiological inventory of the PUREX Tunnels is provided in HNF-SD-CP-HIE-002, *Plutonium-Uranium Extraction (PUREX) Facility Storage Tunnel Hazard Analysis*. A summary of the inventory by location, from HNF-SD-CP-HIE-002, is provided in Section C.3. The following sections describe the evaluation and assessment of the tunnel inventories.

The HNF-SD-CP-HIE-002 report provided the activity content (in curies) of the waste emplaced in the PUREX Tunnels, from which an estimate of the current isotopic composition was made. The emplaced waste, except for specific quantities of plutonium as noted below, was assumed to be residuals from the processing of irradiated fuel. That is, the nuclide mix of the residual waste was conservatively assumed to be characteristic of N-Reactor Mark 1A fuel at 180 days after irradiation to 3,000 MWd/t, not including the short-lived (<1 year half life) isotopes, as was discussed in Section C.1.2. The nuclide mix was decay corrected from the date of emplacement of the first waste in the tunnel to March 2003 to conservatively reflect the current state of the waste. Where emplacements of a known amount of plutonium were noted in HNF-SD-CP-HIE-002, the composition of this plutonium was taken to be appropriate to fuel-grade plutonium, but decay-corrected to March 2003 from the date of the first waste emplacement. Details of the calculations are discussed in the following sections.

C.2.2 PUREX Tunnel No. 1

There are eight modified railcars containing contaminated wastes in Tunnel No. 1. The first railcar was placed in the tunnel in June 1960 and the last (eighth) railcar was emplaced in January 1965. Per HNF-SD-CP-HIE-002, these railcars contained a total of 87,800 Ci of activity when they were placed in the tunnel.

As noted previously, the nuclide mix contributing to this total activity was assumed to be characteristic of N-Reactor Mark 1A fuel at 180 days after irradiation to 3,000 MWd/t. Except for relatively short (<~ 1 y) half-life isotopes (such as Zr-95, Nb-95, Ru-106, etc.) the composition by nuclide before correcting for decay is as shown in Table C-11, *Nuclide Composition of N-Reactor Mark 1A Fuel at 180 days After Irradiation to 3,000 MWd/t.*

Table C-11. Nuclide Composition of N Reactor Mark 1A Fuel at 180 days After Irradiation to 3,000 MWd/t.

Nuclide	Ci/t @ 180 d	g/t @ 180 d
Cs-137	1.20E+04	1.38E+02
Sr-90	1.00E+04	7.32E+01
Y-90[1]	1.00E+04	1.84E-02
I-129	2.80E-03	1.58E+01
Pu-238	3.68E+01	2.15E+00
Pu-239	1.18E+02	1.90E+03
Pu-240	6.79E+01	2.98E+02
Pu-241	6.79E+03	6.59E+01
Pu-242	2.42E-02	6.16E+00

[1]Y-90, the short-lived daughter of Sr-90, is in equilibrium with its parent; thus the activities are equal.

C.2.2.1 Current Total Activity in Tunnel No. 1.

If it is conservatively assumed that all 87,800 Ci of activity in Tunnel No. 1 consists of the Table C-11 nuclides in the relative amounts shown there at the date of emplacing the first railcar (June 1960), the amount of each nuclide in the total (in curies), at the time of emplacement can conservatively determined. Decay correcting each activity from June 1960 to March 2003 (an interval of 42.5 y) yields the current activity of each nuclide in Tunnel No. 1. Table C-12, *Decay-Corrected Composition of PUREX Tunnel No. 1 Activity,* shows the results of these calculations, including conversion of the current activity amounts to gram quantities.

Using the earliest emplacement date rather than the latest is conservative even though most of the dose contributing nuclides will have decayed more than they would have had a later date been chosen. This is because Am-241, a nuclide with a large dose conversion factor, increases over time since it is produced by the decay of Pu-241. No Am-241 is assumed present initially. Decay of the 432 year half life Am-241 over the 42.5 year period is very small and is conservatively neglected.

Table C-12. Decay-Corrected Composition of PUREX Tunnel No. 1 Activity.

Nuclide	Ci/t @ 6/60	Fractional Contribution	Ci in Tunnel @ 6/60	Ci in Tunnel @ 3/03	g in Tunnel @ 3/03
Cs-137	1.20E+04	3.08E-01	2.70E+04	1.01E+04	1.16E+02
Sr-90	1.00E+04	2.56E-01	2.25E+04	8.18E+03	5.99E+01
Y-90*	1.00E+04	2.56E-01	2.25E+04	8.18E+03	1.50E-02
Pu-238	3.68E+01	9.43E-04	8.28E+01	5.92E+01	3.46E+00
Pu-239	1.18E+02	3.02E-03	2.66E+02	2.65E+02	4.26E+03
Pu-240	6.79E+01	1.74E-03	1.53E+02	1.52E+02	6.67E+02
Pu-241	6.79E+03	1.74E-01	1.53E+04	1.98E+03	1.92E+01
Pu-242	2.42E-02	6.20E-07	5.45E-02	5.45E-02	1.39E+01
Am-241	--	--	--	4.43E+02	1.29E+02
I-129	2.80E-03	7.18E-08	6.30E-03	6.30E-03	3.57E+01
TOTAL	**3.90E+04**	**1.00E+00**	**8.78E+04**	**2.94E+04**	**5.31E+03**

C.2.3 PUREX Tunnel No. 2

Tunnel No. 2 houses 28 railcars containing contaminated wastes. The first railcar was placed in the tunnel in December 1967 and the last railcar was emplaced in June 1996. Because the time span between the first and last railcar placements is relatively large (~28.5 years), decay correcting the total activity in Tunnel No. 2 from the date of the first emplacement, as was done for Tunnel No. 1, would unreasonably overestimate the current Am-241 activity. Consequently, the emplacement span was divided into roughly 6-year intervals. The waste activity emplaced over each interval (referred to as a batch) was summed, the nuclide composition was determined as described in C.2.2 for Tunnel No. 1, and then decay-corrected to the present (March 2003) from the beginning date of the emplacement interval for the batch. In some cases, the emplaced waste is described in HNF-SD-CP-HIE-002 as a mass (i.e., gram quantity) of plutonium, with no activity information. In such cases the plutonium was assumed to have an isotopic composition at the date assumed for its emplacement characteristic of Mark 1A N-Reactor spent fuel 180 days after irradiation to 3000 MWd/t, as discussed in Section C.1.2. The current (March 2003) nuclide fractions were obtained by decay correcting each plutonium isotope from the date of emplacement. Am-241 produced in the decay of Pu-241 was included in the current mix.

The following analysis of the waste in PUREX Tunnel No. 2 does not include the activity associated with the 324/325 Building waste at positions 24 and 25 in the tunnel. This waste is presented in Table C-13, *Tunnel No. 2 Inventory –324 Waste*.

Table C-13. Tunnel No. 2 Inventory –324 Waste.

Radionuclide[1]	Curies (March 2003)	Grams (March 2003)
Sr-90	1.56E+05	1.15E+03
Y-90[2]	1.56E+05	2.87E-01
Cs-137	3.13E+05	3.60E+03

[1]This inventory includes trace quantities of plutonium that do not appreciably change the inventory or consequences.
[2]Y-90 is in equilibrium with Sr-90

Table C-14, *Tunnel No. 2 Waste Emplacement Details,* summarizes the waste activity, plutonium mass, and the start date of emplacement interval (the date from which decay-corrections were made) for each "batch" of contaminated waste stored in Tunnel No. 2. Table C-15, *Assumed Isotopic Composition of Plutonium at Emplacement,* shows the nuclide fractions for plutonium assumed at the time of its emplacement into Tunnel No. 2.

Table C-14. Tunnel No. 2 Waste Emplacement Details.

Batch No.	Position in tunnel	Total Activity, Ci	Pu, g	Batch Empl. Start Date
1	1-9	19,530	500	12/67
2	10	500	--	1/79
3	11-17	34,615	--	12/85
4	18-23[1] 26-28	30,236	195	12/91

[1]Positions 24 and 25 are Building 324/325 wastes.

Table C-15. Assumed Isotopic Composition of Plutonium at Emplacement.

Nuclide	g/t	Fraction	Percentage
Pu-238	2.13E+00	9.31E-04	0.0931
Pu-239	1.92E+03	8.39E-01	83.9
Pu-240	2.99E+02	1.31E-01	13.1
Pu-241	6.03E+01	2.64E-02	2.64
Pu-242	6.20E+00	2.71E-03	0.271

C.2.3.1 Summary for Batch 1

Batch 1 comprises emplacements in the period from 12/67 through 12/72, totaling 19,530 Ci in positions 1 through 9 in Tunnel No. 2, with one emplacement at position 4 of 500 g of plutonium

in December 1970. Table C-16, *Batch 1 Residual Waste Activity and Mass, by Nuclide, Decay Corrected to March 2003,* summarizes the activity, by nuclide, for the waste in this batch, decay corrected to March 2003 from December 1967, the beginning of the emplacement interval for Batch 1. Table C-17, *Batch 1 Plutonium Activity and Mass, by Nuclide, Decay Corrected to March 2003,* shows the current activity and gram quantities of the plutonium isotopes (plus Am-241 from the decay of Pu-241) for the 500 g plutonium emplacement.

Table C-16. Batch 1 Residual Waste Activity and Mass, by Nuclide, Decay Corrected to March 2003.

Nuclide	Ci/t @ 12/67	Fractional Contribution	Ci in Tunnel @ 12/67	Ci in Tunnel @ 3/03	g in Tunnel @ 3/03
Cs-137	1.20E+04	3.08E-01	6.01E+03	2.661E+03	3.056E+01
Sr-90	1.00E+04	2.56E-01	5.01E+03	2.163E+03	1.585E+01
Y-90	1.00E+04	2.56E-01	5.01E+03	2.163E+03	3.973E-03
Pu-238	3.68E+01	9.43E-04	1.84E+01	1.394E+01	8.139E-01
Pu-239	1.18E+02	3.02E-03	5.91E+01	5.901E+01	9.486E+02
Pu-240	6.79E+01	1.74E-03	3.40E+01	3.386E+01	1.485E+02
Pu-241	6.79E+03	1.74E-01	3.40E+03	6.230E+02	6.043E+00
Pu-242	2.42E-02	6.20E-07	1.21E-02	1.211E-02	3.083E+00
Am-241	--	--	--	9.250E+01	2.693E+01
I-129	2.80E-03	7.18E-08	1.40E-03	1.402E-03	7.934E+00
TOTAL	***3.90E+04***	***1.00E+00***	***1.95E+04***	***7.81E+03***	***1.19E+03***

C.2.3.2 Summary for Batch 2

Batch 2 consists of a single emplacement of 500 Ci of waste material at position 10 in Tunnel No. 2 during the period from 1/79 through 12/84. Table C-18, *Batch 2 Residual Waste Activity and Mass, by Nuclide, Decay Corrected to March 2003,* summarizes the activity, by nuclide, for the waste in this batch, decay corrected to March 2003.

Table C-17. Batch 1 Plutonium Activity and Mass, by Nuclide, Decay Corrected to March 2003.

Nuclide	g/t @ 12/67	g/t @ 3/03	Fraction of total	Ci in tunnel @ 3/03	g in tunnel @ 3/03
Pu-238	2.13E+00	1.61E+00	7.06E-04	6.05E+00	3.53E-01
Pu-239	1.92E+03	1.92E+03	8.40E-01	2.61E+01	4.20E+02
Pu-240	2.99E+02	2.98E+02	1.30E-01	1.49E+01	6.52E+01
Pu-241	6.03E+01	1.11E+01	4.84E-03	2.49E+02	2.42E+00
Pu-242	6.20E+00	6.20E+00	2.71E-03	5.33E-03	1.36E+00
Am-241	--	4.92E+01	2.16E-02	3.70E+01	1.08E+01
TOTAL		***2.28E+03***	***1.00E+00***	***3.33E+02***	***5.00E+02***

Table C-18. Batch 2 Residual Waste Activity and Mass, by Nuclide, Decay Corrected to March 2003.

Nuclide	Ci/t @ 1/79	Fractional Contribution	Ci in Tunnel @ 1/79	Ci in Tunnel @ 3/03	g in Tunnel @ 3/03
Cs-137	1.20E+04	3.08E-01	1.54E+02	8.782E+01	1.009E+00
Sr-90	1.00E+04	2.56E-01	1.28E+02	7.196E+01	5.271E-01
Y-90	1.00E+04	2.56E-01	1.28E+02	7.196E+01	1.321E-04
Pu-238	3.68E+01	9.43E-04	4.72E-01	3.894E-01	2.273E-02
Pu-239	1.18E+02	3.02E-03	1.51E+00	1.511E+00	2.429E+01
Pu-240	6.79E+01	1.74E-03	8.70E-01	8.680E-01	3.806E+00
Pu-241	6.79E+03	1.74E-01	8.70E+01	2.708E+01	2.627E-01
Pu-242	2.42E-02	6.20E-07	3.10E-04	3.101E-04	7.894E-02
Am-241	--	--	--	1.997E+00	5.814E-01
I-129	2.80E-03	7.18E-08	3.59E-05	3.589E-05	2.031E-01
TOTAL	**3.90E+04**	**1.00E+00**	**5.00E+02**	**2.636E+02**	**3.058E+01**

Table C-20. Batch 4 Residual Waste Activity and Mass, by Nuclide, Decay Corrected to March 2003.

Nuclide	Ci/t @ 1/91	Fractional Contribution	Ci in Tunnel @ 1/91	Ci in Tunnel @ 3/03	g in Tunnel @ 3/03
Cs-137	1.20E+04	3.08E-01	9.30E+03	7.008E+03	8.050E+01
Sr-90	1.00E+04	2.56E-01	7.75E+03	5.790E+03	4.241E+01
Y-90	1.00E+04	2.56E-01	7.75E+03	5.790E+03	1.063E-02
Pu-238	3.68E+01	9.43E-04	2.85E+01	2.589E+01	1.511E+00
Pu-239	1.18E+02	3.02E-03	9.15E+01	9.142E+01	1.470E+03
Pu-240	6.79E+01	1.74E-03	5.26E+01	5.256E+01	2.305E+02
Pu-241	6.79E+03	1.74E-01	5.26E+03	2.918E+03	2.830E+01
Pu-242	2.42E-02	6.20E-07	1.88E-02	1.876E-02	4.774E+00
Am-241	--	--	--	7.81E+01	2.274E+01
I-129	2.80E-03	7.18E-08	2.17E-03	2.170E-03	1.228E+01
TOTAL	**3.90E+04**	**1.00E+00**	**3.024E+04**	**2.175E+04**	**1.893E+03**

Table C-21. Batch 4 Plutonium Activity and Mass, by Nuclide, Decay Corrected to March 2003.

Nuclide	g/t @ 1/91	g/t @ 3/03	Fraction of total	Ci in tunnel @ 3/03	g in tunnel @ 3/03
Pu-238	2.13E+00	1.93E+00	8.46E-04	2.83E+00	1.65E-01
Pu-239	1.92E+03	1.92E+03	8.39E-01	1.02E+01	1.64E+02
Pu-240	2.99E+02	2.99E+02	1.31E-01	5.81E+00	2.55E+01
Pu-241	6.03E+01	3.34E+01	1.46E-02	2.94E+02	2.85E+00
Pu-242	6.20E+00	6.20E+00	2.71E-03	2.08E-03	5.29E-01
Am-241	--	2.69E+01	1.17E-02	7.87E+00	2.29E+00
TOTAL		***2.29E+03***	***1.00E+00***	***3.21E+02***	***1.95E+02***

Table C-22. Total (All Batches) Decay-Corrected Composition of PUREX Tunnel No. 2 Activity (Not Including 324/325 Waste).

Nuclide	Ci in Tunnel March 2003	g in Tunnel March 2003
Cs-137	1.674E+04	1.923E+02
Sr-90	1.377E+04	1.009E+02
Y-90[1]	1.377E+04	2.529E-02
Pu-238	7.736E+01	4.515E+00
Pu-239	2.929E+02	4.708E+03
Pu-240	1.681E+02	7.371E+02
Pu-241	6.614E+03	6.416E+01
Pu-242	6.006E-02	1.529E+01
Am-241	3.348E+02	9.748E+01
I-129	6.092E-03	3.448E+01
TOTAL	**5.177E+04**	**5.954E+03**

[1]Y-90 is in equilibrium with Sr-90

C.3 HAZARDOUS MATERIAL INVENTORIES

Table C-23, *Nonradiological Hazardous Material in Deactivation PUREX*, shows the nonradiological material assumed to be located in the deactivated PUREX facility.

Table C-23. Nonradiological Hazardous Material in Deactivated PUREX[1].

Building/Area	Material	Inventory
202-A	Lead	~40,000 lbs solid or as shielding
	Silver	<750 lbs
	Cadmium	283.8 lbs
	Mercury	250.8 lbs
Lab Annex	Lead	360 lbs
203-A	Residuals	None identified
U Cell	Asbestos	"Large amounts of friable"
211-A	Residuals	Inventory may include: nitric acid, sulfuric acid; sodium hydroxide; potassium hydroxide; trybutal phosphate; normal paraffin hydrocarbon; AFAN and ANN
214-A	Residuals	None identified
221-A	Residuals	None identified
294-A	Residuals	None identified

[1]Basis found in Appendix A of DOE/RL-98-35, *Surveillance and Maintenance Plan for the Plutonium-Uranium Extraction (PUREX) Facility.*

3.6 (2003.02) HNF-14579, Rev. 0

HNF-14579, 2003, *CSER 03-002: Criticality Classification of PUREX Tunnels*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

3.2 FISSIONABLE INVENTORY ON EQUIPMENT

The general procedure at the Hanford Site and at PUREX was to flush and drain failed equipment to leave only adherent contamination on the surface and in crevices. Although the CPS limits for rail cars discussed in Section 3.1 above would limit the box on a rail car or a rail car to 1000 grams total and 350 grams on a piece of equipment, the main point for criticality safety is that the fissionable material on the equipment is a thin layer on the surface or in crevices that can be characterized as contamination. Even the dried heals in tanks of flushing liquid would have a low enough concentration of plutonium that the resulting contamination would not have a compact shape with kilogram quantities of plutonium, but would be thin surface contamination. The plutonium on the equipment can be characterized as thin and dry.

Several documents have estimates of the PUREX Tunnels fissionable material inventory. Table 7-27 in WHC-SD-HS-SAR-001, Revision 5 (WHC 1996), gives no value for Tunnel 1 and 500 grams of ^{239}Pu as of September 30, 1973.

HNF-SD-CP-HIE-002, Revision 1(Dodd 1997), a hazard analysis, estimates the fissionable Curie values for several transuranic isotopes for the two PUREX Tunnels. The values for Tunnel # 1 are based on the Curie values specified for the rail cars being from 180-day Mark IA 12% Pu fuel. The table below lists the isotopic values from the worksheet in Appendix B of the hazard analysis for Tunnel # 1. Table B-3 in Appendix B to this CSER copies this table. The estimates of Curie values are decayed to 1997. The table below converts the Curie amounts to grams for the fissionable isotopes using handbook WHC-EP-0063-3 (WHC 1993) values for the conversion. These handbook FGE factors are used to convert other isotope grams to equivalent gram values of ^{239}Pu.

TUNNEL # 1

ISOTOPE	CURIES	Ci/g	GRAMS	FGE Factor	FGE
Pu-239	63	0.062	1016	1	1016
Pu-241	438	104	4	9/4	9
Am-241	52	3.42	15	9/480	0.3

This fissionable material estimate for Tunnel # 1 is 1 kg for the eight rail cars. Each rail car is 40 feet long and at least 6 feet wide. Each car is spaced several feet from another car. The kilocuries for each car is 2, 2, 40, 3, 1, 0.7, 40, and 0.7 in order of car position in the tunnel. Multiplying the 1 kg by the ratio of radioactivity, the cars have 22 g, 22 g, 447 g, 34 g, 8 g, 447 g, and 8 g. These amounts are less than a minimum critical mass for plutonium optimally mixed with water and fully reflected. The total of 1 kg is less than a minimum critical mass in Hanford soil. Given the form and distribution of the fissile material and the limited amount of fissionable material, criticality is considered incredible in Tunnel # 1. The distribution of the fissionable material in this tunnel allows it to be classified as a Limited Control Facility.

HNF-SD-CP-HIE-002 estimated the decayed Curie content of fissionable isotopes for rail cars 1 thru 23, 26, 27, and 28 in Tunnel # 2. These values are listed in the table Tunnel # 2 below. These values are different than the total Curie content of all radioactive isotopes listed in Table B-2. The changes include radioactive decay to 1995 and coordination of estimates in

several studies referenced in HNF-SD-CP-HIE-002. For the three liquid waste tank cars (26 thru 28), the entire Curie content is counted as ^{239}Pu. This assumption is conservative because the Curie amount agrees with the listed Pu mass for rail car 26 (5 Ci; 53 g Pu) and rail car 27 (9 Ci; 131 g Pu), but for rail car 28 (23 Ci; 11 g Pu) the Curie amount of 23 Ci would give a ^{239}Pu mass of 400 grams, a larger plutonium mass than the 11 g value listed in HNF-SD-CP-ISB-005 (FH 1997) for that car. HNF-SD-CP-ISB-005 gives the values of 24 and 43 g for the mass of plutonium on rail cars 24 and 25, respectively, that are from the 324 Facility. Adding these masses to those from the table of Tunnel # 2 FGE values and rounding up gives the total fissionable mass for Tunnel # 2 as 4700 grams.

TUNNEL # 2

ISOTOPE	CURIES	Ci/g	GRAMS	FGE Factor	FGE
Pu-239	270	0.062	4355	1	4355
Pu-241	11100	104	107	9/4	241
Am-241	183	3.42	54	9/480	1
Pu-240	116	0.226	513	9/400	12
Pu-238	464	17.1	27	9/80	3

The range of radioactive values for the rail cars in Tunnel # 2 vary from 0.81 to 33,740 Ci, with most values in the tens and hundreds. Factoring the fissionable mass by the rail car activity divided by the total activity would put most of the mass on the three highest activity cars (14, 21, and 8). The distribution of the 4700 grams among them would be about 2000 grams in car 14, 1500 in car 21, and 1000 grams in car 8. The remaining cars would have less than 200 grams. The car 4 listing does not include an activity value but does specify a plutonium content of 500 grams. The values of 1 to 2 kg for several rail cars shows that using listed activity is not an accurate method of proportioning the fissionable isotopes. As can be expected, not all of the discarded equipment had the same fraction of the contamination as fissionable isotopes. However, the summary listing of equipment on each rail car in HNF-SD-CP-ISB-005 (FH 1997) shows that each car had multiple items. All items are equipment; none are fuel rods or other concentrated fissionable material. Even if 2 kg of fissionable material were on one rail car, its form being a dry, insoluble adherent layer and its distribution being a thin contamination over a large surface area makes forming a criticality configuration incredible. Tunnel # 2 would also qualify as a Limited Control Facility.

3.3 MINIMUM CRITICAL MASS

The mass of fissionable material on a rail car appears to be at most a few kilograms. This agrees with the limit of a 1000 grams per burial box for CPSs since rail cars have room for more than one box or piece of equipment. CSAR 79-038 (Chiao 1979) and its addenda argue that the burial box is too large and the plutonium on flushed and drained equipment is too diffuse for criticality to be possible. There is no expectation that more than surface contamination is on equipment since the incentive was to produce all the plutonium possible in the 60s and 70s and more recently there is documentation of the limits on burial box mass and on equipment prepared for disposal. The equipment is to be drained and flushed so only surface contamination and material in crevices is present. Surface contamination has a low bulk density, much lower than

3.7 (1996.08) HNF-SD-CP-HIE-002, Rev. 0

HNF-SD-CP-HIE-002, 1997, *Plutonium-Uranium Extraction (PUREX) Facility Storage Tunnel Hazard Analysis*, Rev. 0, B&W Hanford Company, Richland, Washington.

Tunnel #1

The following sources cite the estimated curie content of the radioactive waste stored in Tunnel #1:

Citation	Estimate Date	Estimated Curies (Ci)
SD-HS-SAR-001, Rev. 3, Table 7-27	9-30-73	6,000
Bowersock 1991	6-30-91	4,000
LATA 1993	9-93	682
Dodd 1995 (Gretsinger Report)*	9-95	45,000

* This report assumed an overly conservative estimate of 50% Sr/50%Cs distribution from the initial source estimate (Appendix A).

The bases of these estimates were not readily available; therefore, the following assumptions were made to calculate a conservative estimate based upon the initial curies listed in Appendix A.

The curie content of the failed equipment was based on 180-day Mark IA 12% Pu fuel.

The following limited distribution was used for 180-day Mark IA Fuel (Willis 1996):

Sr-90	8.526×10^3 Ci/MTU
Cs-137	1.046×10^4 Ci/MTU
Zr-95	7.957×10^4 Ci/MTU
Nb-95	1.550×10^5 Ci/MTU
Pu-all	7.284×10^3 Ci/MTU
Pu-241*	7.067×10^3 Ci/MTU.

Based upon the respective percentages the curie content of the waste stored in Tunnel #1 decayed to 1997 is 3,100 curies (see attached worksheet). This value is consistent with the previously reported values with the exception of the value referenced in the Gretsinger report and thus was chosen to be used for this PHA.

Tunnel #1 Curie Estimate Worksheet					
Isotope	ci/MTU	% (Normalized)			
Sr-90	8 50e+03	0 0279804071			
Cs-137	1 00e+04	0 032918126			
Zr-95	8 00e+04	0 2633450083			
Nb-95	1 60e+05	0 52669001659			
Ru-106	3 80e+04	0 12508887894			
Pu-241	7 07e+03	0 0232632397			
Pu-239	2 17e+02	0 00071432			
Sum	3 04e+05				
					Curies Remaining
			% of Initial Estimate		Decayed 32 years
		Initial Estimate	due to Isotope	Half-life	(1997-1965)
Sr-90	0 0279804071	87800	2456 68	29 1	1146
Cs-137	0 032918126	87800	2890 21	30 3	1390
Zr-95	0 2633450083	87800	23121 69	0 17539726027	0
Nb-95	0 52669001659	87800	46243 38	0 0956164384	0
Ru-106	0 12508887894	87800	10982 80	1 02	0
Pu-241	0 0232632397	87800	2042 51	1 44e+01	438
Pu-239	0 00071432	87800	62 72	2 41e+04	63
Sum					
			87800		3037
where N=N0*exp -(ln2*T/T(1/2))					
N Curie		T Decay Time			
N0 Initial Curies		T(1/2) Half-life			

Tunnel #2

The following sources cite estimated curie content of the radioactive wastes stored in Tunnel #2 and were reviewed in estimating the current inventory of Tunnel #2 failed equipment.

Citation	Estimate Date	Estimated Curies (Ci)
SD-HS-SAR-001, Rev. 3, Table 7-27 (Positions 1-9)	9-30-73	20,000
Bowersock 1991		
Positions 1-9	6-30-91	2,000
Positions 10-17		32,000
Total		34,000
LATA 1993		
Positions 1-17	9-93	7,740
Dodd 1995 (Gretsinger Report)*		
Positions 1-17		42,718
Positions 18-21		30,182
Positions 1-21	9-95	72,900
DOE/RL-95-95	9-95	
Positions 1-21		~72,900 Ci[1]
Positions 22-23		17 Ci[2]
Positions 24-25		2.01×10^6
Total		2.08×10^6

* Assumed estimated curies of U_{237} (6.56E5) erroneous. Based on lack of Neptunium as an identified source a more reasonable conservative estimate of 6.56E0 was used. (Assumed typo in original report, i.e., "6.56E-5" transposed to "6.56E+5.")

From these estimates the Tunnel #2 total curie content can be assumed to be 2.08×10^6 Ci. However, for release fractions the Tunnel #2 curie estimates were broken into two components: (1) Curies in failed PUREX equipment/tanker cars, and (2) Curies in 324 waste.

[1] from Dodd 1995.

[2] Assumed Pu_{239}.

Estimated Curies from PUREX Equipment

For the inventory of material stored in Tunnel #2 (after reviewing the data of Bowersock positions (1-17) and Dodd for positions 1-21), it was determined that the value of 42,700 Ci decayed to 9/95 (Dodd, 1995) would be used as a bounding estimate for positions 1-21. For positions 22 and 23 it was assumed the curies resulted from 50%Cs/SR. For the rail tank cars (positions 26-2), it is assumed Pu_{239} accounts for the total curies. Adding to these values the curie content of the waste added in positions 1-21, gives an estimated curie content of ~73,000 Ci for the PUREX equipment and tanker cars. Based upon Dodd 1995 and above assumptions, the distribution of nuclides was simplified to:

H_3	7.73E+01 Ci
Kr_{85}	1.55E+03 Ci
Sr_{90}	1.48E+04 Ci
Ru_{106}	3.20E+03 Ci
Sb_{125}	8.42E+02 Ci
Cs_{134}	1.36E+03 Ci
Cs_{137}	1.82E+04 Ci
Ce_{144}	5.17E+03 Ci
Pm_{147}	1.60E+04 Ci
Am_{241}	1.83E+02 Ci
Pu_{238}	4.64E+02 Ci
Pu_{239}	2.70E+02 Ci
Pu_{240}	1.16E+02 Ci
Pu_{241}	1.11E+04 Ci

The material released from the 324 Building waste is analyzed in DAH-8M400-95-015 (Himes 1995), Radiological Consequence Analysis of a Hypothetical Release From PUREX Storage Tunnel No. 2 Associated With Interim Storage of Material From 324 Building. The analysis contained in Himes 1995for the $< 10\mu m$ particles was considered to bound the release during a seismic event. Therefore, from Himes 1995 the following nuclides are released:

Sr_{90}	2.76 Ci
Cs_{137}	5.49 Ci

3.8 (1996.06) Haas DSI

The June 1996 Haas DSI can also be found in Appendix G of HNF-2545, *Plutonium-Uranium Extraction Facility (PUREX) Plutonium and Fission Product Residual Estimates*.

DON'T SAY IT --- *Write It!*

DATE: June 28, 1996

TO:		
	R. W. Bailey	S6-15
	D. G. Hamrick	S6-15
	D. G. Harlow	S6-19
	J. P. Hayfield	S6-18
	S. W. Hildreth	S6-21
	G. J. LeBaron	S6-19
	D. B. Lichy	S6-01
	B. Oldfield	S6-19
	W. A. Peiffer	S6-19
	C. P. Strand	H6-24
	M. Thompson	S6-21
	C. N. Villalobos	S6-19
	C. D. Wollam	S6-22

FROM: C. R. Haas S6-21

Telephone: 373-7823

SUBJECT: PUREX Storage Tunnels

Attached for your information is a summary of the 17 shipments of waste received from the 324 Building, and an inventory list outlining the contents of the storage tunnels.

Chris

RECEIVED
JUL 03 1996
G.J. LeBARON

A-3000-723 (01/95) GEF014

324 BUILDING WASTE

Shipment #	Date Received	Package ID #	Gross Weight Kg (lbs)	Container Type	Waste Description
1	12-20-95	BP 195046	714 (1574)	SEG	Mild steel grout container, vacuum cleaner, steel disc; Paper HEPA filter media
2	1-3-96	BP 195047	982 (2165)	SEG	Mild steel grout container; Stainless steel shield plug; Paper HEPA filter media
3	1-10-96	BP 195048	865 (1907)	SEG	Mild steel grout container, cover plate, wire mesh; Stainless steel offgas jumper; Paper HEPA filter media
4	1-16-96	BP 195049	1232 (2716)	SEG	Mild steel grout container, cover plate, screens; Stainless steel electrode; Paper HEPA filter media
5	1-22-96	PNL-324-96-004	2523 (5562)	SEG	Mild steel grout container, 5-gallon bucket; Wood; Liquid metal seal solid flange; Lead shot, bricks; Window oil rags
6	1-31-96	BP 195050	797 (1757)	SEG	Mild steel grout container, steel plate; Paper HEPA filter media
7	3-1-96	PNL-324-96-012	2253 (4967)	22.5 Ton	Stainless steel engineered containers of hazardous and nonhazardous dispersible debris, special case waste container
8	3-6-96	PNL-324-96-005	1823 (4019)	22.5 Ton	Stainless steel engineered dispersible containers, can storage basket, hazardous feed cans
Total			11,189 (24,667)		

Shipments 1-8 moved to storage in tunnel #2, position 24, on April 26, 1996

C.R. Haas

1

324 BUILDING WASTE

Shipment #	Dose Rate @ Contact	Curie Content	Activation Nuclides	Pu Content (g)	Dangerous Waste	Waste Category/ Classification
1	120 Rem	5.41E+02	Cs-137 2.34E+02 Sr-90 3.65E+01	1.07E-02	N/A	Cat 3/TRU
2	1000 Rem	3.96E+02	Cs-137 8.80E+01 Sr-90 1.10E+02 Cs-134 1.00E-02 Co-60 1.00E-02 Eu-154 2.00E-02 Eu-155 2.00E-02	1.41E-01	N/A	Cat 3/TRU
3	1000 Rem	2.36E+03	Cs-137 5.25E+02 Sr-90 6.56E+02 Cs-134 4.00E-02 Co-60 5.00E-02 Eu-154 7.00E-02 Eu-155 3.00E-02	2.24E-01	N/A	Cat 3/TRU
4	1700 Rem	2.49E+03	Cs-137 5.54E+02 Sr-90 6.92E+02 Cs-134 5.50E-02 Co-60 7.40E-02 Eu-154 9.80E-02 Eu-155 3.30E-02	3.00E-01	N/A	Cat 3/TRU
5	340 R/Hr	9.00E+02	Cs-137 2.00E+02 Sr-90 2.50E+02	0.00	Pb ~ 1800 Kg Cd ~10.5 Kg Oil ~ 8.5 Kg	Cat 3/MW
6	200 Rem	2.84E+02	Cs-137 1.03E+02 Sr-90 3.90E+01 Cs-134 9.70E-02 Co-60 1.30E-01 Eu-154 1.70E-01 Eu-155 2.70E-02	7.75E-01	N/A	Cat 3/TRU
7	19K R/Hr	3.12E+04	Cs-137 1.00E+04 Sr-90 5.58E+03 Co-60 1.08E-01 Eu-154 6.56E+00	8.52E+00	Pb ~ <1 g Cr ~ <1 g Cd ~ <1 g	>Cat 3/TRU-M
8	22K R/Hr	2.05E+05	Cs-137 5.96E+04 Sr-90 4.32E+04 Eu-154 2.05E+00	1.40E+01	Pb ~ 1.5 Kg Cr ~1 Kg Ba ~ 3 Kg	>Cat 3/TRU-M
Total		~244,000 Ci		~24 g	Pb ~ 1802 Kg Cd ~ 10.5 Kg Oil ~ 8.5 Kg Cr ~ 1 Kg Ba ~ 3 Kg	

Shipments 1-8 moved to storage in tunnel #2, position 24, on April 26, 1996

C.R. Haas

2

324 BUILDING WASTE

Shipment #	Date Recevied	Package ID #	Gross Weight Kg (lbs)	Container Type	Waste Description
9	4-1-96	BP196003	2482 (5472)	SEG	Stainless steel grout container, engineered containers; refractory used in melter operations
10	4-28-96	BP196001	1778 (3920)	SEG	Stainless steel grout container; refractory used in melter operations
11	5-2-96	BP196002	2800 (6173)	SEG	Mild steel grout container; refractory brick/throat block refractory used in melter operations
12	5-7-96	PNLD-96-224	3332 (7346)	SEG	Mild steel grout container; stainless steel melter lid; Alfrax/Duraboard; grout
13	5-10-96	PNLD-96-225	2200 (4850)	SEG	Mild steel grout container; rubber hose; plastic; cloth; stainless steel; glass
14	5-23-96	BP196015	1115 (2458)	SEG	Mild steel grout container, funnel; glass
15	5-31-96	PNL-324-96-048	1550 (3417)	SEG	Mild steel grout container; stainless steel melter parts; paper HEPA filter media; SrF_2 capsules
16	6-3-96	BP196017	2818 (6213)	SEG	Mild steel grout container; melter glass canisters
17	6-8-96	BP196018	2818 (6213)	SEG	Mild steel grout container; melter glass canisters
Total			20,893 (46,062)		

Shipments 9-17 moved to storage in tunnel #2, position 25, on June 12, 1996

324 BUILDING WASTE

Shipment #	Dose Rate @ Contact	Curie Content	Activation Nuclides	Pu Content (g)	Dangerous Waste	Waste Category/ Classification
9	6159 R/Hr	3.54E+04	Cs-137 1.49E+04 Sr-90 2.79E+03	8.68E-02	N/A	>Cat 3/TRU
10	9550 R/Hr	3.90E+04	Cs-137 1.63E+04 Sr-90 3.22E+03	9.44E-02	N/A	>Cat 3/TRU
11	18372 R/Hr	7.35E+04	Cs-137 3.07E+04 Sr-90 6.07E+03	1.78E-01	N/A	>Cat 3/TRU
12	8169 R/Hr	1.99E+05	Cs-137 4.43E+04 Sr-90 5.53E+04	0.00	N/A	>Cat 3/LLW
13	1340 R/Hr	1.57E+05	Cs-137 3.48E+04 Sr-90 4.35E+04	0.00	N/A	>Cat 3/LLW
14	22K+ R/Hr	7.62E+05	Cs-137 2.71E+05 Sr-90 1.10E+05	1.75E+00	N/A	>Cat 3/TRU
15	4000 R/Hr	1.16E+05	Cs-137 1.52E+04 Sr-90 4.30E+04	1.00E+00	Ba ~ 4.2 g Cd ~ 1 g Cr ~ 1.8 g Pb ~ 1 g	>Cat 3/MW
16	20K+ R/Hr	2.56E+05	Cs-137 9.74E+04 Sr-90 3.08E+04	2.26E+01	N/A	>Cat 3/LLW
17	20K+ R/Hr	1.07E+05	Cs-137 3.94E+04 Sr-90 1.41E+04	1.69E+01	N/A	>Cat 3/LLW
Total		~1.75M Ci		~43.0 g	Ba ~ 4.2 g Cd ~ 1 g Cr ~ 1.8 g Pb ~ 1 g	

Shipments 9-17 moved to storage in tunnel #2, position 25, on June 12, 1996

C.R. Haas

4

PUREX
STORAGE TUNNEL #2

	Existing Inventory Tunnel #2 Positions 1-23	324 Building Shipments 1-8 Tunnel #2 Position 24	324 Building Shipments 9-17 Tunnel #2 Position 25	Liquid Waste Tank Cars Tunnel #2 Positions 26-28	Total in Storage Tunnel #2 June 1996
Estimated Total Source Term	~729,000 Ci	~244,000 Ci	~1.75M Ci	~38 Ci	~2.73M Ci
Estimated Total Plutonium Content	~500 g	~24 g	~43 g	~195 g	~762 g
Estimated Total Dangerous Waste	Pb ~ 7932 Kg Ag ~ 740 Kg Hg ~ 130 Kg Cd ~ 58 Kg Cr ~ 8 Kg	Pb ~ 1802 Kg Cd ~ 10.5 Kg Cr ~ 1 Kg Ba ~ 3 Kg Oil ~ 8.5 Kg	Pb ~ 1 g Cd ~ 1 g Cr ~ 2 g Ba ~ 4 g	N/A	Pb ~ 9734 Kg Ag ~ 740 Kg Hg ~ 130 Kg Cd ~ 68.5 Kg Cr ~ 9 Kg Ba ~ 3 Kg Oil ~ 8.5 Kg

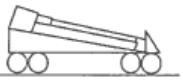
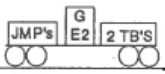
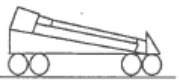
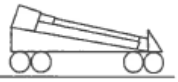
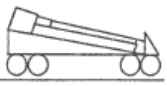
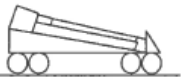
C.R. Haas

5

PUREX #1 STORAGE TUNNEL (218-E-14)

TUNNEL IS AT ITS CAPACITY AS OF 1/22/65

PUREX #1 Storage Tunnel is located at the southeast end of the PUREX Plant and is an extention of the railroad tunnel. The storage area is approximately 109 meters long, 6.9 meters high and 5.8 meters wide. The tracks have a one percent down-grade toward the south end of the tunnel. The capacity of the Storage Tunnel is eight modified railroad cars, 12.8 meters long.

position		
1. & 2.	HA COLUMN AND MISC JUMPERS IN BOX PLACED IN TUNNEL #1 ON 6/60 HA 4,700 CU. FT., 400 CURIES, 5 rem/hr. @ 60', JUMPRS 2,190 CU. FT., 2,000 CURIES, Pb - ~115 Kg.	
3.	E-F11 #1 (1WW WASTE) CONCENTRATOR FAILED 7/24/60. PLACED IN TUNNEL #1 ON 7/29/60, 12.5 rem/hr. @ 100', 1,900 CU. FT., 40, 000 CURIES AFTER FIFTY-FIVE MONTHS SERVICE.	
4.	G-E2 CENTRIFUGE. MISC JUMPERS IN BOX AND TWO TUBE BUNDLES. PLACED IN TUNNEL #1 ON 12/24/60 (FUG SER# 762) 2,465 CU. FT., 3,000 CURIES, Pb - ~115 Kg., 1.5 rem/hr. @ 150'.	
5.	E-H4 (3WB) CONCENTRATOR FAILED 1/4/61. PLACED IN TUNNEL #1 ON 1/4/61, 150 mrem/hr. @ 50', 2,336 CU. FT., 1,000 CURIES. AFTER FIVE YEARS SERVICE.	
6.	E-F6 (2WW WASTE) ORIGINAL CONCENTRATOR FAILED 4/21/61. PLACED IN TUNNEL #1 ON 4/21/61, 5 rem/hr. @ 20', 2,336 CU. FT., 700 CURIES. AFTER FIVE YEARS FOUR MONTHS SERVICE.	
7.	E-F11 (1WW WASTE) #2 CONCENTRATOR FAILED 2/1/62. PLACED IN TUNNEL #1 ON 2/8/62, 25 rem/hr. @ 150', 2,336 CU. FT., 40,000 CURIES. AFTER EIGHTEEN MONTHS SERVICE.	
8.	E-F6 (2WW WASTE) #3 SPARE CONCENTRATOR FAILED 5/23/64. PLACED IN TUNNEL #1 ON 1/22/65 FLAT CAR 3621. 2,400 CU. FT., 700 CURIES, 5 rem/hr. @ 20'.	

PUREX #2 STORAGE TUNNEL (218-E-15)

PUREX #2 Storage Tunnel is located at the southeast end of the PUREX Plant and is an extention of the railroad tunnel. The storage area is approximately 514.5 meters long, 7.9 meters high and 10.4 meters wide. The tracks have a one percent down-grade toward the south end of the tunnel. The capacity of the Storage Tunnel is 38-40 modified railroad cars, 12.8 meters long. The Tunnel contains 21 cars as of 2/95.

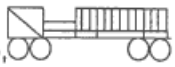
position	
1.	E-F6 # (2WW WASTE) CONCENTRATOR, TK F 15-2, ONE TUBE BUNDLE AND AGITATOR MOTORS PLACED IN TUNNEL ON 12/12/67 ON CAR 61439 2,400 CU. FT., 700 CURIES, 1.3 rem/hr. @ 100'.
2.	E-F6 #5 (E-H4 3WB) CONCENTRATOR, TWO TUBE BUNDLES PLACED IN TUNNEL ON 3/26/69 ON CAR MILW 60883 2,400 CU. FT., 500 CURIES, 800 mrem/hr. @ 2'.
3.	E-F6 #6 (2WW WASTE) CONCENTRATOR, TWO TUBE BUNDLES FAILED PLACED IN TUNNEL ON 3/19/70 ON CAR 3612. 2, 400 CU. FT., 700 CURIES, 500 rem/hr. @ 2'.
4.	L CELL PACKAGE IN A SEALED STEEL BOX (H2-66012) PLACED IN TUNNEL ON 12/30/70 ON CAR MILW 60033 2,400 CU. FT., 500 GRMS Pu, 200 mrem/hr. @ CONTACT.
5.	F2 SILVER REACTOR, F6 DEMISTER, VESSEL VENT LINE STEEL CAT-WALK AND GUARD RAILS. PLACED IN TUNNEL ON 2/26/71 ON GONDOLA CAR 4610. 2,400 CU. FT., 20 CURIES, Ag - ~625 Kg, 2 rem/hr. @ CONTACT.
6.	MODIFIED A3-1 TOWER, SCRUBBER, LID AND VAPOR LINE PLACED IN TUNNEL ON 12/12/71 ON GONDOLA CAR 4611. 2,400CU. FT., 10 CURIES, 1 rem/hr. @ CONTACT.
7.	A3 DISSOLVER PLACED IN TUNNEL ON 12/22/71 ON NINE FT. SHORTENED CAR B58 2,400 CU.FT., 50 CURIES, Hg - ~45 Kg, 5 rem/hr. @ 5'.
8.	A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQUIPT. USED WITH THE SUSPECTED CANISTERS, ON CAR 19808 PLACED IN TUNNEL ON 8/29/72. 800 CU. FT., 17,500 CURIES, 10 rem/hr. @ 150'.
9.	C3 DISSOLVER PLACED IN TUNNEL ON 9/30/72 ON CAR 19811 1590 CU. FT., 50 CURIES, Hg - ~45 Kg., 5 rem/hr. @ 5'.
10.	E-H4 (3WB) CONCENTRATOR, #61 TUBE BUNDLE, PROTOTYPE COOLING COIL AND A F-F1 FILTER TANK. PLACED IN TUNNEL 8/30/83 ON CAR CDX-1. 2,400 CU. FT., 500 CURIES, 800 mrem/hr. @ 2'.
11.	A3 DISSOLVER (VESSEL #10 AND HEATER VESSEL #6) PLACED IN TUNNEL ON 1/18/86 ON CAR 3613 3,960 CU. FT., 0.81 CURIES, Hg - ~40 Kg., Cd - ~43 Kg., 3 mrem/hr. @ 3'.
12.	WHITE BOX (H2-58456) CONTAINING EIGHT TUBE BUNDLES #S 57, 60, 62, 64, 67, 68, 74, AND 76 PULSER #5 AND OLD HEATER DISS LID OLD STYLE DUMPING TRUNNIONS (9), PLACED IN TUNNEL ON 1/20/86 ON CAR 3611 5,438 CU. FT., 540 CURIES, 2 rem/hr. @ 3'.

PUREX #2 STORAGE TUNNEL (218-E-15)

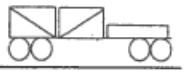
position

13. J5 TANK (VESSEL #30). F1 COND (VESSEL #13) AND F12-B CELL BLK. OLD FOUR-WAY DUMPER. DISS YOKE AND FLANGE PLATE, 3 rem/hr. @ 1'. PLACED IN TUNNEL ON 1/21/86 ON CAR 19806. 2,500 CU. FT., 90 CURIES.

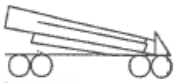
14. L-1 PULSER, 2-COLUMN CARTRIDGES, 1-JUMPER CUTTER, 3-JUMPER ALIGNMENT TOOLS, 9-EXTERIOR DUMPING TRUNNIONS, 10-PUMPS, 3-AGITATORS, 4-TUBE BUNDLES, 2-VENT JUMPERS AND 7-YOKES. PLACED IN TUNNEL ON 11/18/87 ON CAR PX-10 (10A-19380) & RACK H2-96629.50. 50 TONS, 3,600 CU. FT., 33,740 CURIES(REF:LETTER 12110-88-074), Pb - ~2540 Kg., 5 rem/hr. @ 15'.



15. SILVER REACTOR, E-F2 STEAM HEATER AND STORAGE LINER (H2-65095) FULL OF CUT UP JUMPERS PLACED IN TUNNEL ON 5/13/88 ON CAR PX-9 (10A-19809) & S/R CRADLE SK-GLR-11-2-87. 20 TONS, 2,775 CU. FT., 240 CURIES (REF: LETTER 12110-88-074), Cd - ~13 Kg., Ag - ~115 Kg., Pb - ~230 Kg., 20 mrem/hr. @ 20'.

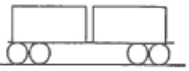


16. E-J8-1 UNITIZED CONCENTRATOR VESS #1 H2-52477, FAILED 3/11/89 PLACED ON STORAGE CAR H2-99608, PX-6 (10A-19028) AND INTO #2 TUNNEL 4/6/89 GRAVEYARDS. EST. 42 TONS, 6,000 CU. FT. 1.5 CURIES (REF: LETTER 12113-89-027), 0.5 mrem/hr. @ 10'.

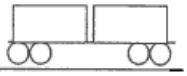


17. NORTH STORAGE LINER H2-65095 CONTAINING SIX PUMPS, ONE AGITATOR AND CUT UP JUMPER (14 TONS). SOUTH STORAGE LINER H2-65095 CONTAINING ONE PUMP, ONE #15 YOKE AND CUT UP JUMPERS (11.5 TONS). PLACED ON STORAGE CAR PX-19 (10A-19030) AND INTO #2 TUNNEL 8/5/89 DAYS. EST 25.5 TONS, 2,574 CU. FT. 3.0 CURIES (REF: LETTER 12113-89-051), 80 mrem/hr. @ 1'.

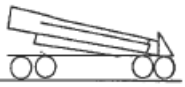
18. T-F5 ACID ABSORBER, ID#1-T-F5/F-168713, H2-52535 AND H2-52487/488. PLACED ON STORAGE CAR PX-2 AND INTO #2 TUNNEL 4/8/94. EST 22 TONS, 835 CU. FT., 185 CURIES, 90 mrem/hr. @ CONTACT.



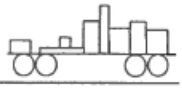
19. FOUR METAL LINER STORAGE BOXES H-2-65095-3/H-2-100187-0 CONTAINING FAILED JUMPERS AND MISCELLANEOUS OBSOLETE CANYON EQUIPMENT ITEMS. PLACED ON STORAGE CAR PX-23 AND INTO #2 TUNNEL 9/16/94. EST 60 TONS, 4032 CU. FT., 927 CURIES, 30 mrem/hr. @ 2'.



20. E-H4-1 UNITIZED CONCENTRATOR (H-2-52477/56213)/(E-H4-1). PLACED IN TUNNEL ON 1/27/95 ON CAR PX-28. EST 40 TONS, 5,760 CU. FT., 3,070 CURIES, Cr - ~8 Kg., 1000 mrem/hr. @ 5'.



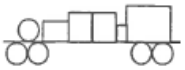
21. TANK E-5 (H-2-52453)/(F-166955), LEAD STORAGE BOX ASSEMBLY (H-2-131629)/(H-2-131629-1), H4 CONCENTRATOR TOWER (H-2-58102)/ (F-223017-CBT-4), HOT SHOP COVER PLATE (H-2-52222)/("Q"), TUBE BUNDLE WASH CAPSULE (H-2-58647), DISSOLVER CHARGING INSERT (H-2-75875)/ (H-2-75875-1), LIFTING YOKE #7A (H-2-96837), LIFTING YOKE #9 (H-2-52458). PLACED IN TUNNEL ON 2/8/95 ON CAR PX-3609. EST 44 TONS, 3,457 CU. FT., 26,000 CURIES, Pb - ~1930 Kg., 1000 mrem/hr. @ 4'.



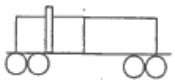
PUREX #2 STORAGE TUNNEL (218-E-15)

position

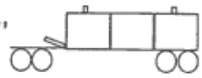
22. METAL LINER BOX (H-2-65095) CONTAINING JUMPERS AND FAILED/ OBSOLETE CANYON EQUIPMENT, F7 NEUTRON MONITOR (H-2-75825), LEAD STORAGE BOX (H-2-131629) CONTAINING JUMPER COUNTERWEIGHTS AND MISCELLANEOUS LEAD ITEMS, SCRAP HOPPER (H-2-57347) CONTAINING MISCELLANEOUS CANYON EQUIPMENT, CANISTER CAPPING STATION (H-2-821831), TEST CANISTER CONTAINING VARIOUS LENGTHS OF CARBON STEEL PIPE. PLACED IN TUNNEL 3-11-96 ON CAR #3616. ESTIMATED WEIGHT 22 TONS, 1,712 CU. FT., 15 CURIES, Pb - ~3,232 Kg., Cd - ~2 Kg., 100 mrem/hr. @ 1'.



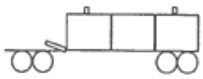
23. TWO BURIAL BOXES (H-2-100187) CONTAINING JUMPERS AND FAILED/ OBSOLETE CANYON EQUIPMENT, LIFTING YOKE (H-2-99652). PLACED IN TUNNEL 3-11-96 ON CAR #PX-31. ESTIMATED WEIGHT 21 TONS, 2,116 CU. FT., 2 CURIES, 10 mrem/hr. @ 1'.



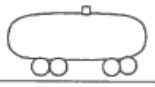
24. CONCRETE BURIAL BOX (H-1-44980) STORING 8 CONTAINERS OF 324 BUILDING, B-CELL WASTE. FOR ADDITIONAL DETAILS, SEE PUREX WORK PLAN WP-P-95-60. PLACED IN TUNNEL ON CAR #PX-29, ON APRIL 26, 1996. ESTIMATED WEIGHT 36 TONS, 1,890 CU. FT., < 244,000 CURIES, ~15 mrem/hr. @ 150'. Pb - ~1,802 kg., Cd - ~10.5 kg., absorbed oil - ~8.5 kg., Cr - ~1 kg., Ba - ~ 3 kg.



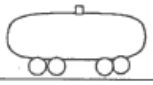
25. CONCRETE BURIAL BOX (H-1-44980) STORING 9 CONTAINERS OF 324 AND 325 BUILDING WASTE. FOR ADDITIONAL DETAILS, SEE PUREX WORK PLAN WP-P-96-015. PLACED IN TUNNEL ON CAR #10A-3619, ON JUNE 12, 1996. ESTIMATED WEIGHT 46.5 TONS, 1,890 CU. FT., < 1.75 M CURIES, ~200 mrem/hr. @ 150'. Ba - ~4 g., Cd - <1 g., Cr - ~ 2 g., Pb - < 1 g.



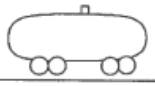
26. 20,000 GALLON LIQUID WASTE TANK CAR HO-10H-18580, EMPTY PER RCRA, PLACED IN TUNNEL ON JUNE 19, 1996, APPROXIMATELY 30 TONS, 5 CURIES, 100 mrem/hr. @ 3'.



27. 20,000 GALLON LIQUID WASTE TANK CAR HO-10H-18579, EMPTY PER RCRA, PLACED IN TUNNEL ON JUNE 19, 1996, APPROXIMATELY 30 TONS, 9 CURIES, 300 mrem/hr. @ 3'.



28. 20,000 GALLON LIQUID WASTE TANK CAR HO-10H-18582, EMPTY PER RCRA, PLACED IN TUNNEL ON JUNE 19, 1996, APPROXIMATELY 30 TONS, 23 CURIES, 650 mrem/hr. @ 3'.



3.9 (1996.05) 96-EAP-111

96-EAP-111, 1996, "Radioactive Air Emissions Notice of Construction for Storage of the Liquid Well Tank Cars and 325 Building Wastes in the PUREX Storage Tunnels," (letter from J. E. Rasmussen, RL, to A.W. Conklin, DOH and A. J. Frankel, EPA, May 20, 1996, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Table 1. Liquid Waste Tank Car Number 79, Inventory, Unabated Emissions, and Offsite Dose.

Radionuclide	Inventory (Ci)	Physical state adjustment factor	Unabated projected emissions (Ci)	Conversion factor	Unabated offsite dose mrem/year, TEDE	Dose percent of total
^{90}Sr	0.34	1 E-04	3.4 E-05	4.38 E-02	1.5 E-06	< 1
^{137}Cs	0.38	1 E-04	3.8 E-05	2.39 E-02	9.1 E-07	< 1
^{152}Eu	0.05	1 E-04	5.0 E-06	1.54 E-02	7.7 E-08	< 1
^{154}Eu	0.17	1 E-04	1.7 E-05	1.82 E-02	3.1 E-07	< 1
^{239}Pu*	8.1	1 E-04	8.1 E-04	8.67	7.0 E-03	100
Total	9.0		9.0 E-04		7.0 E-03	100

To calculate the abated emission and offsite dose, divide the inventory for each individual radionuclide by 2,000. The abated projected emissions is 4.5 E-07 curies and abated offsite dose is 3.5 E-06 mrem per year. The 2,000 factor for HEPA filtration is from published material**.

Table 2. Liquid Waste Tank Car Number 81, Inventory, Unabated Emissions, and Offsite Dose.

Radionuclide	Inventory (Ci)	Physical state adjustment factor	Unabated projected emissions (Ci)	Conversion factor	Unabated offsite dose mrem/year, TEDE	Dose percent of total
^{90}Sr	1.6	1 E-04	1.6 E-04	4.38 E-02	7.0 E-06	1.1
^{137}Cs	1.8	1 E-04	1.8 E-04	2.39 E-02	4.3 E-06	< 1
^{152}Eu	0.5	1 E-04	5.0 E-05	1.54 E-02	7.7 E-07	< 1
^{154}Eu	0.8	1 E-04	8.0 E-05	1.82 E-02	1.5 E-06	< 1
^{239}Pu*	0.7	1 E-04	7.0 E-05	8.67	6.1 E-04	98.0
Total	5.4		5.4 E-04		6.2 E-04	99.1

To calculate the abated emission and offsite dose, divide the inventory for each individual radionuclide by 2,000. The abated projected emissions is 2.7 E-07 curies and abated offsite dose is 3.1 E-07 mrem per year. The 2,000 factor for HEPA filtration is from published material**.

mrem = millirem.
Ci = curie.

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* Radionuclides that could contribute to greater than 10 percent of the potential to emit to the TEDE to the MEI.

** Source: *Unit Dose Calculation Methods and Summary of Facility Effluent Monitoring Plan Determinations*, WHC-EP-0498, Westinghouse Hanford Company, Richland, Washington, 1991.

Table 3. Liquid Waste Tank Car Number 82, Inventory, Unabated Emissions, and Offsite Dose.

Radionuclide	Inventory (Ci)	Physical adjustment factor	Unabated projected emissions (Ci)	Conversion factor	Unabated offsite dose mrem/year, TEDE	Dose percent of total
^{90}Sr	7.8	1 E-04	7.8 E-04	4.38 E-02	3.4 E-05	5
^{137}Cs	8.6	1 E-04	8.6 E-04	2.39 E-02	2.1 E-05	3.1
^{152}Eu	2.4	1 E-04	2.4 E-04	1.54 E-02	3.7 E-06	< 1
^{154}Eu	3.9	1 E-04	3.8 E-04	1.82 E-02	6.9 E-06	1
^{239}Pu*	0.7	1 E-04	7.0 E-05	8.67	6.1 E-04	90
Total	23.4		2.3 E-03		6.8 E-04	99.1

To calculate the abated emission and offsite dose divide the inventory for each individual radionuclide by 2,000. The abated projected emissions is 1.2 E-06 curies and abated offsite dose is 3.4 E-07 mrem per year. The 2,000 factor for HEPA filtration is from published materials**.

Table 4. Liquid Waste Tank Car Number 80, Inventory, Unabated Emissions, and Offsite Dose.

Radionuclide	Inventory (Ci)	Physical state adjustment factor	Unabated projected emissions	Conversion factor	Unabated offsite dose mrem/year, TEDE	Dose percent of total
^{90}Sr	0.6	1 E-04	6.0 E-05	4.38 E-02	2.9 E-06	< 1
^{137}Cs	0.7	1 E-04	7.0 E-05	2.39 E-02	1.8 E-06	< 1
^{152}Eu	0.2	1 E-04	2.0 E-05	1.54 E-02	3.2 E-07	< 1
^{154}Eu	0.3	1 E-04	3.0 E-05	1.82 E-02	6.2 E-07	< 1
^{239}Pu*	3.3	1 E-04	3.3 E-04	8.67	2.9 E-03	100
Total	5.1		5.1 E-04		2.9 E-03	100

To calculate the abated emissions and offsite dose, divide the inventory for each individual radionuclide by 2,000. The abated projected emissions is 2.7 E-07 curies and abated offsite dose is 1.5 E-06 mrem per year. The 2,000 factor for HEPA filtration is from published material**.

mrem = millirem.
Ci = curie.

---

* Radionuclides that could contribute to greater than 10 percent of the potential to emit to the TEDE to the MEI.

** Source: *Unit Dose Calculation Methods and Summary of Facility Effluent Monitoring Plan Determinations*, WHC-EP-0498, Westinghouse Hanford Company, Richland, Washington, 1991.

3.10 (1996.03) Haas DSI

D 9.5.2

DON'T SAY IT --- *Write It!*

DATE: June 3, 1996

TO: D. G. Harlow S6-19
S. W. Hildreth S6-21
G. J. LeBaron S6-19
W. A. Peiffer S6-19
C. D. Wollam S6-22

FROM: C. R. Haas S6-21
Telephone: 373-7823

cc:

SUBJECT: Liquid Waste Tank Cars

Attached for your information is a summary of the curie and plutonium content in the 4 liquid waste tank cars to be moved to Storage Tunnel #2.

Chris

RECEIVED
D. G. HARLOW
JUN 04 1996
ACTION
COPIES
ROUTE
FILE D9.5.2.

A-3000-723 (01/95) GEF014

LIQUID WASTE TANK CARS FOR STORAGE IN PUREX STORAGE TUNNEL #2

Radionuclide	Car #79	Car #80	Car #81	Car #82
^{90}Sr	0.34 Ci	0.6 Ci	1.6 Ci	7.8 Ci
^{137}Cs	0.38 Ci	0.7 Ci	1.8 Ci	8.6 Ci
^{152}Eu	0.05 Ci	0.2 Ci	0.5 Ci	2.4 Ci
^{154}Eu	0.17 Ci	0.3 Ci	0.8 Ci	3.9 Ci
^{239}Pu	8.1 Ci	3.3 Ci	0.7 Ci	0.7 Ci
Total Curies: ~43 Ci				

Pu Content in the LWTCs

Car #79: 130.6 grams

Car #80: 53.2 grams

Car #81: 11.3 grams

Car #82: 11.3 grams

Total Pu in four cars: ~206.4 grams

CR Haas

3.11 (1995.10) DOE/RL-95-95, Rev. 0

DOE/RL-95-95, 1995, *Radioactive Air Emissions Notice of Construction Transfer and Receipt of Waste in the 324 Building for Storage in PUREX Storage Tunnel Number 2*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

All instances of this document found to date are marked with DRAFT on the upper left corner, including those recorded in the Integrated Document Management System (IDMS).

APPENDIX B

SUPPORTING CALCULATIONS FOR THE EXISTING MATERIAL IN PUREX STORAGE TUNNEL NUMBER 2 SOURCE TERM DESCRIPTION

General Assumptions:

1. For conservatism, to determine the mass fractions of the radionuclides the Mark IA fuel was chosen. The Mark IA 12% fuel would have contained the larger amount of radionuclides.

2. The half life equation $N = N_o * e^{-(\ln 2 * T/T1/2)}$ was used. The half life of ^{137}Cs and ^{90}Sr are identical ($T_{1/2}$ = 30.249).

3. For conservatism, the material in the tunnels was grouped into timeframes for decay. Material stored in the tunnels for less than 30 years but greater than or equal to 20 years was assumed to decay 20 years. Material stored in the tunnels for less than 20 years but greater than or equal to 10 years was assumed to decay for 10 years. Material stored in the tunnels for less than 10 years was assumed to decay for 5 years.

Specific Assumptions:

1. Railroad Tunnel Positions 1 through 9 were grouped together for decay time. Waste materials were placed in the Tunnel between the years 1967 to 1972. Decay is assumed to be 20 years.

2. Railroad Tunnel Positions 10 through 12 were grouped together for decay time. Waste materials were placed in the Tunnel between the years 1983 through 1986. Decay is assumed to be 10 years.

3. Railroad Tunnel Positions 13 through 21 were grouped together. Waste materials were placed in the Tunnel between the years 1986 through 1995. Decay is assumed to be 5 years.

4. For position 4, the waste material is from L cell equipment. The L cell equipment only processed Pu. At burial, the estimate was that the package contained 500 grams Pu. The assumed breakdown was 5% ^{238}Pu and 95% ^{239}Pu. No other radionuclides are present.

The mass fractions of ^{238}Pu and ^{239}Pu are 0.05 and 0.95. Because there are two radionuclides or conversely two mass fractions, the curie content for position four can be calculated as follows:

Total mass (grams) of ^{238}Pu = 500 grams of total Pu at burial multiplied by 0.05

Total mass (grams) of ^{239}Pu = 500 grams of total Pu at burial multiplied by 0.95

The ^{238}Pu and ^{239}Pu curie content is obtain by multiplying the total mass of ^{238}Pu and ^{239}Pu by the specific activity for ^{238}Pu and ^{239}Pu.

The Pu curie content was added to ^{238}Pu and ^{239}Pu curie content for railroad positions 1 through 9 and decayed for 20 years by using the standard half-life equation stated in the general assumptions.

5. For positions 10 through 17, ^{137}Cs and ^{90}Sr in a 50/50 mixture accounted for 100% of the dose readings at the time of burial. Mass fractions at the time of burial for ^{137}Cs and ^{90}Sr are both 0.5.

By knowing the curie content of ^{137}Cs and ^{90}Sr at the time of burial for the railcars and the mass fractions of the radionuclides at T (time)=20, 10, and 5 years respectively, the activity of ^{137}Cs and ^{90}Sr and therefore the other radionuclides can be calculated.

By algebraically rearranging the standard half life equation, the fraction remaining (N/N_0) of ^{137}Cs and ^{90}Sr after T number of years can be expressed mathematically as follows:

$$N/N_0 = e^{-(\ln 2 * T/T1/2)} \qquad \text{Eqn. (1)}$$

Where N is the number of curies present after decay for T years (1995)
Where N_0 is the number of curies present at T=0 (burial)

The curies of ^{137}Cs and ^{90}Sr remaining after T years (1995) can be obtained by multiplying N/N_0 by the amount of curies at burial and is expressed mathematically as:

Curies of ^{137}Cs and ^{90}Sr remaining after T years (1995) = (Curies of ^{137}Cs and ^{90}Sr at burial)*(N/N_0) Eqn. (2)

Substituting Eqn. (1) into Eqn. (2) produces Eqn. (3)

Curies of ^{137}Cs and ^{90}Sr remaining after T years (1995) = (Curies of ^{137}Cs and ^{90}Sr at burial)*$e^{-(\ln 2 * T/T1/2)}$ Eqn. (3)

The mass fractions of ^{90}Sr and ^{137}Cs remaining after T years (1995) can be obtained by using ORIGEN2 numbers*. The mass fraction of ^{90}Sr and ^{137}Cs in the fuel can be determined by dividing the radionuclide curie content of any radionuclide by the sum of the curie content of all radionuclides of concern. The individual curie content and the total curie content are available from ORIGEN2.

For example, mass fraction of ^{137}Cs or X_R^{137Cs} = curies of ^{137}Cs divided by the total curies in the fuel.

To produce the total number of curies remaining in the tunnel after T years (1995) the two mass fractions are added together. The curies of ^{137}Cs and ^{90}Sr

*ORIGEN2 numbers (RHO 1985).

remaining after T years (from Eqn. (3)) is divided by the sum of the two mass fractions.

The mass fractions of the other Mark IA fuel radionuclides remaining after T=20, 10, and 5 years can be obtained by using ORIGEN2 numbers**. The mass fraction of any radionuclide in the fuel can be determined by dividing the radionuclide curie content of any radionuclide by the sum of the curie content of all radionuclides of concern. The individual curie content and the total curie content are available from ORIGEN2.

$$X_{RA} = C^{A}/C_{T} \qquad \text{Eqn. (4)}$$

Where X_{RA} = mass fraction of any radionuclide in the fuel

Where C^{A} = activity (curies) of any radionuclide in 1 ton fuel after T years of decay (1995)

Where C_{T} = activity (curies) of all radionuclides of concern in 1 ton fuel after T years of decay (1995)

The curie content of other individual radionuclides after T years of decay =

X_{RA}*(total number of curies remaining in the tunnel after T years)

6. For positions 1 through 3 and 5 through 9, all the radionuclides account for the 100% of the dose readings at the time of burial. Therefore, mass fractions of the radionuclides can be calculated by Eqn. (4).

The curie content of an individual radionuclide at burial = X_{RA} at T_{B} = 0 multiplied by the total curie content of waste material at burial C_{T}.

The curies (decayed to 1995) for the Mark IA fuel are calculated, by using the standard half-life equation stated in the general assumptions and decaying for 20 years.

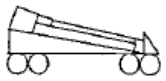
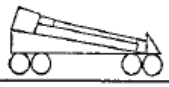
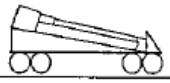
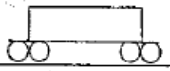
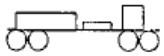
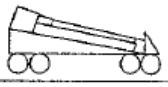
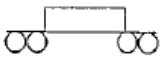
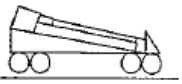
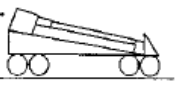
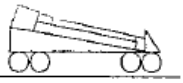
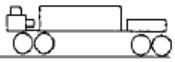
7. For positions 18 through 21, ^{137}Cs accounts for 100% of the dose readings at the time of burial. The inventory for positions 18 through 21 is calculated the same way as in Assumption 5, except that the mass fraction of ^{137}Cs is used instead of the sum of the mass fraction of ^{137}Cs and ^{90}Sr.

8. Once the curies for all the radionuclides have been calculated for 1995 levels, the like radionuclides can be directly added together.

**ORIGEN2 numbers (RHO 1985).

PUREX #2 STORAGE TUNNEL (218-E-15)

PUREX #2 Storage Tunnel is located at the southeast end of the PUREX Plant and is an extention of the railroad tunnel. The storage area is approximately 514.5 meters long, 7.9 meters high and 10.4 meters wide. The tracks have a one percent downgrade toward the south end of the tunnel. The capacity of the Storage Tunnel is 38-40 modified railroad cars, 12.8 meters long. The Tunnel contains 21 cars as of 2/95.

position		
1.	E-F6 # (2WW WASTE) CONCENTRATOR, TK F 15-2, ONE TUBE BUNDLE AND AGITATOR MOTORS PLACED IN TUNNEL ON 12/12/67 ON CAR 61439 2,400 CU. FT., 700 CURIES, 1.3 rem/hr. @ 100'.	
2.	E-F6 #5 (E-H4 3WB) CONCENTRATOR, TWO TUBE BUNDLES PLACED IN TUNNEL ON 3/26/69 ON CAR MILW 60883 2,400 CU. FT., 500 CURIES, 800 mrem/hr. @ 2'.	
3.	E-F6 #6 (2WW WASTE) CONCENTRATOR, TWO TUBE BUNDLES FAILED PLACED IN TUNNEL ON 3/19/70 ON CAR 3612. 2, 400 CU. FT., 700 CURIES, 500 rem/hr. @ 2'.	
4.	L CELL PACKAGE IN A SEALED STEEL BOX (H2-66012) PLACED IN TUNNEL ON 12/30/70 ON CAR MILW 60033 2,400 CU. FT., 500 GRMS PU, 200 mrem/hr. @ CONTACT.	
5.	F2 SILVER REACTOR, F6 DEMISTER, VESSEL VENT LINE STEEL CAT-WALK AND GUARD RAILS. PLACED IN TUNNEL ON 2/26/71 ON GONDOLA CAR 4610. 2,400 CU. FT., 20 CURIES, Ag - ~625 Kg, 2 rem/hr. @ CONTACT.	
6.	MODIFIED A3-1 TOWER, SCRUBBER, LID AND VAPOR LINE PLACED IN TUNNEL ON 12/12/71 ON GONDOLA CAR 4611. 2,400CU. FT., 10 CURIES, 1 rem/hr. @ CONTACT.	
7.	A3 DISSOLVER PLACED IN TUNNEL ON 12/22/71 ON NINE FT. SHORTENED CAR B58 2,400 CU.FT., 50 CURIES, Hg - ~45 Kg, 5 rem/hr. @ 5'.	
8.	A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQUIPT. USED WITH THE SUSPECTED CANISTERS, ON CAR 19808 PLACED IN TUNNEL ON 8/29/72. 800 CU. FT., 17,500 CURIES, 10 rem/hr. @ 150'.	
9.	C3 DISSOLVER PLACED IN TUNNEL ON 9/30/72 ON CAR 19811 1590 CU. FT., 50 CURIES, Hg - ~45 Kg., 5 rem/hr. @ 5'.	
10.	E-H4 (3WB) CONCENTRATOR, #61 TUBE BUNDLE, PROTOTYPE COOLING COIL AND A F-F1 FILTER TANK. PLACED IN TUNNEL 8/30/83 ON CAR CDX-1. 2,400 CU. FT., 500 CURIES, Hg - ~40 Kg., Cd - ~43 Kg., 800 mrem/hr. @ 2'.	
11.	A3 DISSOLVER (VESSEL #10 AND HEATER VESSEL #6) PLACED IN TUNNEL ON 1/18/86 ON CAR 3613 3,960 CU. FT., 0.81 CURIES, Hg - ~40 Kg., Cd - ~43 Kg., 3 mrem/hr. @ 3'.	
12.	WHITE BOX (H2-58456) CONTAINING EIGHT TUBE BUNDLES #S 57, 60, 62, 64, 67, 68, 74, AND 76 PULSER #5 AND OLD HEATER DISS LID OLD STYLE DUMPING TRUNNIONS (9), PLACED IN TUNNEL ON 1/20/86 ON CAR 3611 5,438 CU. FT., 540 CURIES, 2 rem/hr. @ 3'.	

PUREX #2 STORAGE TUNNEL (218-E-15)

position

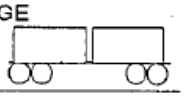
13. J5 TANK (VESSEL #30). F1 COND (VESSEL #13) AND F12-B CELL BLK. OLD FOUR-WAY DUMPER. DISS YOKE AND FLANGE PLATE, 3 rem/hr. @ 1'. PLACED IN TUNNEL ON 1/21/86 ON CAR 19806. 2,500 CU. FT., 90 CURIES.

14. L-1 PULSER, 2-COLUMN CARTRIDGES, 1-JUMPER CUTTER, 3-JUMPER ALIGNMENT TOOLS, 9-EXTERIOR DUMPING TRUNNIONS, 10-PUMPS, 3-AGITATORS, 4-TUBE BUNDLES, 2-VENT JUMPERS AND 7-YOKES. PLACED IN TUNNEL ON 11/18/87 ON CAR PX-10 (10A-19380) & RACK H2-96629.50. 50 TONS, 3,600 CU. FT., 33,740 CURIES(REF:LETTER 12110-88-074), FLUOROTHENE - ~180 Kg., Pb - ~2540 Kg., 5 rem/hr. @ 15'.

15. SILVER REACTOR, E-F2 STEAM HEATER AND STORAGE LINER (H2-65095) FULL OF CUT UP JUMPERS PLACED IN TUNNEL ON 5/13/88 ON CAR PX-9 (10A-19809) & S/R CRADLE SK-GLR-11-2-87. 20 TONS, 2,775 CU. FT., 240 CURIES (REF: LETTER 12110-88-074), Cd - ~13 Kg., Ag - ~115 Kg., Pb - ~230 Kg., 20 mrem/hr. @ 20'.

16. E-J8-1 UNITIZED CONCENTRATOR VESS #1 H2-52477, FAILED 3/11/89 PLACED ON STORAGE CAR H2-99608, PX-6 (10A-19028) AND INTO #2 TUNNEL 4/6/89 GRAVEYARDS. EST. 42 TONS, 6,000 CU. FT. 1.5 CURIES (REF: LETTER 12113-89-027), 0.5 mrem/hr. @ 10'.

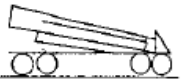
17. NORTH STORAGE LINER H2-65095 CONTAINING SIX PUMPS, ONE AGITATOR AND CUT UP JUMPER (14 TONS). SOUTH STORAGE LINER H2-65095 CONTAINING ONE PUMP, ONE #15 YOKE AND CUT UP JUMPERS (11.5 TONS). PLACED ON STORAGE CAR PX-19 (10A-19030) AND INTO #2 TUNNEL 8/5/89 DAYS. EST 25.5 TONS, 2,574 CU. FT. 3.0 CURIES (REF: LETTER 12113-89-051), 80 mrem/hr. @ 1'.



18. T-F5 ACID ABSORBER, ID#1-T-F5/F-168713, H2-52535 AND H2-52487/488. PLACED ON STORAGE CAR PX-2 AND INTO #2 TUNNEL 4/8/94. EST 22 TONS, 835 CU. FT., 185 CURIES, 90 mrem/hr. @ CONTACT.

19. FOUR METAL LINER STORAGE BOXES H-2-65095-3/H-2-100187-0 CONTAINING FAILED JUMPERS AND MISCELLANEOUS OBSOLETE CANYON EQUIPMENT ITEMS. PLACED ON STORAGE CAR PX-23 AND INTO #2 TUNNEL 9/16/94. EST 60 TONS, 4032 CU. FT., 927 CURIES, 30 mrem/hr. @ 2'.

20. E-H4-1 UNITIZED CONCENTRATOR (H-2-52477/56213)/(E-H4-1). PLACED IN TUNNEL ON 1/27/95 ON CAR PX-28. EST 40 TONS, 5,760 CU. FT., 3,070 CURIES, Cr - ~8 Kg., 1000 mrem/hr. @ 5'.



21. TANK E-5 (H-2-52453)/(F-166955), LEAD STORAGE BOX ASSEMBLY (H-2-131629)/(H-2-131629-1), H4 CONCENTRATOR TOWER (H-2-58102)/ (F-223017-CBT-4), HOT SHOP COVER PLATE (H-2-52222)/("Q"), TUBE BUNDLE WASH CAPSULE (H-2-58647), DISSOLVER CHARGING INSERT (H-2-75875)/ (H-2-75875-1), LIFTING YOKE #7A (H-2-96837), LIFTING YOKE #9 (H-2-52458). PLACED IN TUNNEL ON 2/8/95 ON CAR PX-3609. EST 44 TONS, 3,457 CU. FT., 26,000 CURIES, Pb - ~1930 Kg., 1000 mrem/hr. @ 4'.

3.12 (1995.09) 17700-95-013

17700-95-013, 1995, "Estimate of Curie Content in PUREX Storage Tunnels," (internal memo from E.N. Dodd to J.J. Luke, September 12, 1995), Westinghouse Hanford Company, Richland, Washington.

Westinghouse Hanford Company — **Internal Memo**

17700-95-013

From: PUREX Deactivation
Phone: 373-1293 S6-19
Date: September 12, 1995
Subject: ESTIMATE OF CURIE CONTENT IN PUREX STORAGE TUNNELS

To: J. J. Luke H6-25

cc:

R. C. Bowman	H6-24
M. B. Enghusen	S6-18
J. G. Granger	H6-25
M. M. Gretsinger	S6-19
C. R. Haas	S6-19
D. G. Hamrick	S6-15
D. G. Harlow	S6-19
G. J. LeBaron	S6-19
J. Lohrasbi	S6-17
B. Oldfield	S6-21
C. P. Strand	H6-24
A. G. Westra	S6-18

References:

1) DOE-RL-90-24, "PUREX Storage Tunnels Part B Dangerous Waste Permit Application," Westinghouse Hanford Company, Richland, WA.

2) WHC-SD-CP-TI-175, "Hanford Irradiated Fuel Inventory Baseline," Westinghouse Hanford Company, Richland, WA.

3) Microshield Software, Version 3.0, Grove Engineering, Inc., Rockville, MD.

In response to your inquiry as to the present curie content of the mixed waste in the PUREX Storage Tunnels, an estimate was made. This estimate is based on curie content recorded for each railcar at the time of storage; on the decay and isotopic content as reported in WHC-SD-TI-175 Rev. 1; and on extension of decay using the computer code Microshield 3.0. The assumptions made and results are attached.

E. N. Dodd III
Team Leader, PUREX Deactivation

crh/leh

Attachments 2

Hanford Operations and Engineering Contractor for the US Department of Energy

17700-95-013

ATTACHMENT 1

"Estimate of Curie Content in PUREX Storage Tunnels"

Assumptions

Consisting of 2 pages
including this page

Assumptions which were made to calculate the curie content for Tunnel 1 and 2 for the PUREX Storage Tunnels Inventory List are as follows:

- The curie content listed in the PUREX Storage Tunnels Inventory for Tunnel #1 positions 1-8 and Tunnel #2 positions 10 through 17 accounts for 50% Cs 137 and 50% Sr 90 assuming other radionuclides in Mark IA 12% Pu fuel have not been accounted for.
- The curie content listed in the Purex Storage Tunnels Inventory for Tunnel #2 positions 1-3 and 5-9 accounts for Mark IA 12% Pu Fuel, assuming that all radionuclides have been accounted for.
- The gram content listed in the PUREX Storage Tunnels Inventory for Tunnel #2 position 4 accounts for 5% Pu 238 and 95% Pu 239.
- The mrem/hr value listed in the PUREX Storage Tunnels Inventory for Tunnel #2 position 18-21 accounts for Cs 137 in Mark IA 12% Pu Fuel. The mr/hr values have been converted to curie of Cs 137 values using Microshield, and other radionuclides in Mark IA 12% Pu fuel have been included based on the ratio of that radionuclide remaining after five years decay of Mark IA 12% Pu Fuel.
- The Uranium content per metric ton in Mark IA 12% Pu Fuel is 2.5 times greater than the uranium content per metric ton in Mark IA 9% Pu Fuel.
- The half life of Cs 137 and Sr 90 are identical and have the value of 30.249 years.
- The fuel in Tunnel 1 position 1 through 8 has decayed for 30 years.
- The fuel in Tunnel 2 position 1 through 9 has decayed for 20 years.
- The fuel in Tunnel 2 position 10 through 12 has decayed for 10 years.
- The fuel in Tunnel 2 position 13 through 21 has decayed for 5 years.
- The half life equation, $N = N_0 * e^{(\ln 2 * T/T_{1/2})}$, accounts for the Curies (N) of the applicable radionuclide remaining after T years, where $T_{1/2}$ is the half life of the applicable radionuclide, and N_0 is the Curies of the radionuclide upon storage in the tunnels.

17700-95-013

ATTACHMENT 2

"Estimate of Curie Content in PUREX Storage Tunnels"

Conclusions

Consisting of 2 pages
including this page

Conclusions which were made from assumptions and calculations for Tunnel 1 and 2 for the PUREX Storage Tunnels for present-day radionuclide content are as follows:

- There are 783000 curies in Tunnel #1 and Tunnel #2 combined (See Table 1)
- There are 729000 curies in Tunnel # 2 (See Table 2)

Table 1
Curies Total
Tunnel #1&2

Element	Curies Total Tun1&2
H 3	1.24E+02
Kr85	2.30E+03
Sr 89	9.12E−06
Sr 90	3.44E+04
Y 91	3.47E−04
Nb 95	5.88E−03
Zr 95	2.65E−03
Ru 103	8.30E−09
Ru 106	3.20E+03
Sb 125	8.46E+02
Te 127	5.41E−02
Te 129	7.71E−13
Cs 134	1.36E+03
Cs 137	4.27E+04
Ce 141	1.36E−11
Ce 144	5.17E+03
Pm 147	1.61E+04
U 234	5.31E+01
U 235	2.87E−01
U 236	7.24E−01
U 237	6.56E+05
U 238	5.47E+00
Pu 238	6.64E+02
Pu 239	7.53E+02
Pu 240	3.92E+02
Am241	6.02E+02
Pu 241	1.84E+04
Pu 242	9.16E−02
sum	7.83E+05

Table 2
Curies Total
Tunnel #2

Element	Curies Total Tun#2
H 3	7.73E+01
Kr85	1.55E+03
Sr 89	9.12E−06
Sr 90	1.48E+04
Y 91	3.47E−04
Nb 95	5.88E−03
Zr 95	2.65E−03
Ru 103	8.30E−09
Ru 106	3.20E+03
Sb 125	8.42E+02
Te 127	5.41E−02
Te 129	7.71E−13
Cs 134	1.36E+03
Cs 137	1.82E+04
Ce 141	1.36E−11
Ce 144	5.17E+03
Pm 147	1.60E+04
U 234	2.96E+00
U 235	8.46E−02
U 236	2.14E−01
U 237	6.56E+05
U 238	1.61E+00
Pu 238	4.64E+02
Pu 239	2.43E+02
Pu 240	1.16E+02
Am241	1.83E+02
Pu 241	1.11E+04
Pu 242	2.70E−02
sum	7.29E+05

3.13 (1994.02) WHC-IP-0977

WHC-IP-0977, 1994, *Estimation of PUREX Equipment and Materials That are Candidates for Removal and Waste Processing During PUREX Plant Closure*, Los Alamos Technical Associates, Kennewick, Washington.

WHC-IP-0977 was used as a starting point for the tables in Chapter 2. This document contains the most comprehensive collection of data known at this time for the items in the PUREX Storage Tunnels up to Position 17 in Storage Tunnel 2 (218-E-15).

For ease of use, position numbers have been edited in to the left of tables (maroon font) when this data was omitted.

Figure 3-3. PUREX #1 Burial Tunnel (218-E-14).

TUNNEL IS AT ITS CAPACITY AS OF 1/22/65

Purex # one Burial Tunnel is located at the southeast end of the Purex building and is an extension of the railroad tunnel. The storage area is approximately 358 feet long, 22 1/2 feet high and 19 feet wide. The tracks have a one percent downgrade toward the south end of the tunnel. The capacity of the Burial Tunnel is eight modified railroad car, 40 to 42 feet long.

POSITION

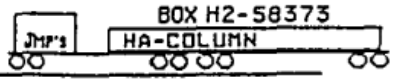
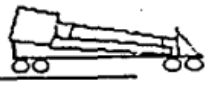
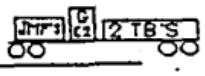
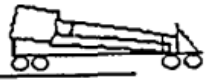
1 & 2.	HA COLUMN AND MISC JUMPERS IN BOX BURIED IN TUNNEL #1 ON 6/60 HA 4,700 CU. FT., 400 CURIES JMPRS 2,190 CU.FT., 2,000 CURIES	
3.	E-F11 #1 (1WW WASTE) CONCENTRATOR FAILED 7/24/60. BURIED IN TUNNEL #1 ON 7/29/60 1,900 CU. FT., 40,000 CURIES AFTER FIFTYFIVE MONTHS SERVICE	
4.	G-E2 CENTRIFUGE. MISC JUMPERS IN BOX AND TWO TUBE BUNDLES. BURIED IN TUNNEL #1 ON 12/24/60 (FUGE SER# 762) 2,465 CU. FT., 3,000 CURIES	
5.	E-H4 (3WB) CONCENTRATOR FAILED 1/4/61. BURIED IN TUNNEL #1 ON 1/4/61 2,336 CU. FT., 1,000 CURIES. AFTER FIVE YEARS SERVICE.	
6.	E-F6 (2WW WASTE) ORIGINAL CONCENTRATOR FAILED 4/21/61. BURIED IN TUNNEL #1 ON 4/21/61 2,336 CU. FT., 700 CURIES. AFTER FIVE YEARS FOUR MONTHS SERVICE.	
7.	E-F11 (1WW WASTE) #2 CONCENTRATOR FAILED 2/1/62. BURIED IN TUNNEL #1 ON 2/8/62 2,336 CU. FT., 40,000 CURIES. AFTER EIGHTEEN MONTHS SERVICE.	
8.	E-F6 (2WW WASTE) #2 SPARE CONCENTRATOR FAILED 5/23/64. BURIED IN TUNNEL #1 ON 1/22/65 ON FLAT CAR 3621. 2,400 CU. FT., 700 CURIES.	

Table 3-1. Inventory and Characteristics of Equipment Stored in PUREX Tunnel 1. (2 sheets)

TUNNEL INVENTORY

Listed below are the approximate sizes of the process equipment which has been placed in the PUREX storage tunnel 1. Also listed are the suspected hazardous constituents, and radiation dose estimated. Some figure of the equipment are attached to provide sizing details.

Sizing of the equipment is based on information provided by PUREX operations. Accurate records were not kept from the start of the tunnel operations. Therefore, a number of assumptions were made about the process equipment sent to the tunnels. It is recommended that prior to attempting removal of the process equipment, remote camera and radiation survey devices be sent into the tunnels to verify the size, position, and radiation dose levels of the process equipment.

- Ci = Curies
- NA Indicates No Information is Available
- O.D. Indicates Outer Diameter
- Volume Estimates Include Only Process Equipment

TUNNEL #1 (218-E-14)

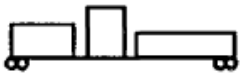
Position (Date of storage)	Layout (Assumed)	Contents	Dimensions	Estimated waste type	Initial dose reading / Estimated Ci content	Suspected hazardous constituents	Est. Volume (ft^3)	Notes
1 & 2 6/60		HA Column	40'11" x 8'2" x 6'	LLW-3	5 R/hr @ 60 ft / 400 Ci		4,700	1. Dose Conversion Supplied by PUREX Operations
		Jumper Box	18' x 8'11-1/4" x 8'3/4"	TRU	2,000 Ci	Lead ~250 lb	2,190	2. Assumptions: 50 Jumpers/Box, 100 lb Lead/Jmp, 5% jumper have lead, ∴ ~250 lb
3 7/29/60		E-F11 Concentrator	29'8" x 6'	LLW-1	12.5 R/hr @ 100 ft / 40,000 Ci		1,900	Tower removable, could take 12'6" from height
4 12/24/60		G-E2 Centrifuge	3' x 5' O.D.	LLW-1	1.5 R/hr @ 150 ft / 3,000 Ci		2,465	If G-E2 Centrifuge was stored with the motor, its dimensions are 7" x 10' x 13"
		Jumper Box	18' x 8'11-1/4" x 8'3/4"	LLMW		Lead ~250 lb		
		(2) Tube Bundles	Each @ 12'6" x 4'3"	LLW				

Table 3-1. Inventory and Characteristics of Equipment Stored in PUREX Tunnel 1. (2 sheets)

Position (Date of storage)	Layout (Assumed)	Contents	Dimensions	Estimated waste type	Initial dose reading --- Estimated Ci content	Suspected hazardous constituents	Est. Volume (ft^3)	Notes
5 1/4/61		E-H4 Concentrator	29'8" x 16'6" x 6'	TRU	150 R/hr @ 50 ft --- 3,000 Ci		2,465	See Position 3
6 4/21/61		E-F6 Concentrator	36'6" x 15' x 6'	TRU	5 R/hr @ 20 ft --- 700 Ci		2,338	
7 2/8/62		E-F11 Concentrator	29'6" x 6'	LLW-1	25 R/hr @ 150 ft --- 40,000 Ci		2,338	Portions Possibly Removed: De-entrainment Assembly, 7' x 5' O.D., Tower, 12'6" x 5'6" O.D.
8 1/22/65		E-F6 Concentrator	36'6" x 15' x 6'	TRU	700 Ci		2,400	See Position 6.

Table 3-2. Estimated Radioactivity for Major Equipment Stored in PUREX Tunnel 1.

	Storage date	Item	Assume 180 days initial (Ci)	Estimated radiation type percent of curies	Age end of 1993 (years)	Actinides 180 day (Ci)	FP + AP 180 day (Ci)	Actinides 1993 (Ci)	FP + AP 1993 (Ci)
	Railroad Tunnel #1 (218-E-14)								
1	June 1960	HA Column	400	8% actinides 92% FP	34	32	368	7.95 E+00	7.68 E+00
2	June 1960	Jumper Box	2,000	16% actinides 83% FP 1% AP	34	320	1,680	7.95 E+01	3.46 E+01
3	7/29/60	E-F11 Concentrator	40,000	RuRh-106	34	0	40,000	0	3.70 E-05
4	12/24/60	G-E2 Centrifuge/ jumper box/tube bundles	3,000	1% actinides 6% FP 93% AP	34	30	2,970	7.45 E+00	5.40 E+00
5	1/4/61	E-H4 Concentrator	3,000	0.04% U 67% Pu 33% FP	34	2,011	990	4.59 E+02	2.07 E+01
6	4/21/61	E-F6 Concentrator	700	8% actinides 92% FP	33	56	644	1.44 E+01	1.37 E+01
7	2/8/62	E-F11 Concentrator	40,000	RuRh-106	32	0	40,000	0	E.93 E-05
8	1/22/65	E-F6 Concentrator	700	8% actinides 92% FP	29	56	644	1.66 E+01	1.51 E+01

FP = Fission products
AP = Activation products.

Table 3-3. Tunnel 1 Drawing Numbers and Process Information.

Car Number (Date)	Equipment Name	Cell Arrangement Drawing	Construction Drawing	Process	Inlet Streams	Outlet Streams
1 and 2 (06/60)	HA Column (T-H2)	H-2-53520	H-2-56753	First Decontamination and Partition Cycle (1st D&PC)	CRD, HAS, HAF, 3WB-HA, HAX, Rec HNO_3, and H_2	HAP and HAW
3 (07/29/60)	E-F11 Concentrator CB-1, UT-1 Acid Service	H-2-53512	H-2-56213	Metal Dissolution and Feed Preparation (MD and FP)	ASF and NaOH	ASW and Offgas
4 (12/24/60)	G-E2 Centrifuge	H-2-53505	H-2-52965 H-2-52995	MD and FP	Offgas, Decladding Waste, and Spent Metathesis Solution	Slurried Centrifuge Cake, Decladding Waste, and Centrifuged Spent Metathesis Solution
5 (01/04/61)	E-H4 Concentrator CB-5, UT-1	H-2-53521	H-2-66046	Backcycle Waste (BW)	3WF	3WW and Offgas
6 (04/21/61)	E-F6 Concentrator CB-2, AF-1 Acid Waste Service	H-2-53510	H-2-56213	Waste Concentration and Treatment (WC&T)	1WF, 1WR, H_2O_2, and Offgas from 1WW Denitration	Offgas and 1WW
7 (02/08/62)	E-F11 Concentrator	H-2-53512	H-2-56213	MD & FP	ASF and NaOH	ASW and Offgas
8 (01/22/65)	E-F6 Concentrator	H-2-53510	H-2-56213	WC&T	1WF, 1WR, H_2O_2, and Offgas from 1WW Denitration	Offgas and 1WW

Figure 3-13. PUREX #2 Burial Tunnel (218-E-15). (2 sheets)

Purex # two Burial Tunnel is located at the southeast end of the Purex building and is an extention of the railroad tunnel. The storage area is approximately 1 688 feet long, 22 feet high and 34 feet wide. The tracks have a one percent downgrade toward the south end of the tunnel. The capacity of the Burial Tunnel is 38 -40 modified railroad cars, 40-42 feet long. The Tunnel contains 16 cars as of 4/6/88.

position	
1.	E-F6 #1 (2WW WASTE) CONCENTRATOR, TK F15-2, ONE TUBE BUNDLE AND AGITATOR MOTORS. BURIED IN TUNNEL ON 12/12/67 ON CAR 61439. 2,400 CU. FT., 700 CURIES.
2.	E-F6#5 (E-H4 3WB) CONCENTRATOR, TWO TUBE BUNDLES BURIED IN TUNNEL ON 3/26/69 ON CAR MILW 60883. 2,400 CU. FT., 500 CURIES.
3.	E-F6#6 (2WW WASTE) CONCENTRATOR, TWO TUBE BUNDLES FAILED BURIED IN TUNNEL ON 3/19/70 ON CAR 3612. 2,400 CU. FT., 700 CURIES.
4.	L CELL PACKAGE IN A SEALED STEEL BOX (H2-66012) BURIED IN TUNNEL ON 12/30/70 ON CAR MILW 60033 2,400 CU. FT., 500 GRMS PU.
5.	F2 SILVER REACTOR, F6 DEMISTER, VESSEL VENT LINE STELL CAT-WALK AND GUARD RAILS. BURIED IN TUNNEL ON 2/26/71 ON GONDOLA CAR 4610. 2,400 CU. FT., 20 CURIES.
6.	MODIFIED A3-1 TOWER, SCRUBBER, LID AND VAPOR LINE BURIED IN TUNNEL ON 12/12/71 ON GONDOLA CAR 4611. 2,400 CU.FT., 10 CURIES.
7.	A3 DISSOLVER BURIED IN TUNNEL ON 12/22/71 ON NINE FT. SHORTENED CAR B58 2,400 CU. FT., 50 CURIES.
8.	A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQUIPT. USED WITH THE SUSPECTED CANISTERS, ON CAR 19808 BURIED IN TUNNEL ON 8/29/72. 800 CU. FT., 17,500 CURIES.
9.	C3 DISSOLVER BURIED IN TUNNEL ON 9/30/72 ON CAR 19811 1590 CU. FT., 50 CURIES.
10.	E-H4 (3WB) CONCENTRATOR, #61 TUBE BUNDLE, PROTOTYPE COOLING COIL AND A F-F1 FILTER TANK. BURIED IN TUNNEL 8/30/83 ON CAR CDX-1. 2,400 CU. FT., 500 CURIES.
11.	A3 DISSOLVER (VESSEL # 10 AND HEATER (VESSEL #6) BURIED IN TUNNEL ON 1/18/86 ON CAR 3613 3,960 CU.FT., 0.81 CURIES.
12.	WHITE BOX (H2-58456) CONTAINING EIGHT TUBE BUNDLES #'S 57, 60,62,64,67,68,74, AND 76. PULSER #5 AND OLD HEATER. DISS LID OLD STYLE DUMPING TRUNNIONS(9), BURIED IN TUNNEL ON 1/20/86 ON CAR 3611, 5,438 CU. FT., 540 CURIES.
13.	J5 TANK (VESSEL #30), F1 COND (VESSEL #13) AND F12-B CELL BLK. OLD FOUR-WAY DUMPER, DISS YOKE AND FLANGE PLATE. BURIED IN TUNNEL ON 1/21/86 ON CAR 19806. 2,500 CU. FT., 90 CURIES.

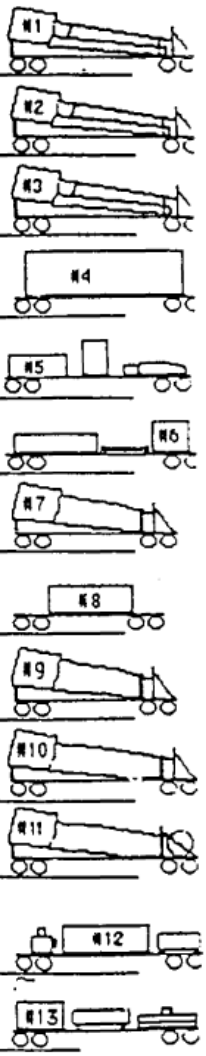


Figure 3-13. PUREX #2 Burial Tunnel (218-E-15). (2 sheets)

POSITION

S

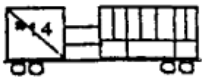
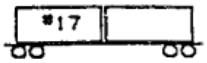
14.	L-1 PULSER, 2-COLUMN CARTRIDGES, 1-JUMPER CUTTER, 3-JUMPER ALIGNMENT TOOLS, 9-EXTERIOR DUMPING TRUNNIONS, 10-PUMPS, 3-AGITATORS, 4- TUBE BUNDLES, 2-VENT JUMPERS AND 7-YOKES. BURIED IN TUNNEL ON 11/18/87 ON CAR PX-10 (10A-19380) & RACK H2-96629. 50 TONS, 3,600 CU. FT., 33.750 CURIE (REF: LETTER 12110-88-074).	
15.	SILVER REACTOR, E-F2 STEAM HEATER AND BURIAL LINER(H2-65095) FULL OF CUT UP JUMPERS BURIED IN TUNNEL ON 5/13/88 ON CAR PX-9 (10A-19809) & S/R CRADLE SK-GLR-11-2-87. 20 TONS, 2,775 CU. FT., 240 CURIES (REF: LETTER 12110-88-074).	
16.	E-J8-1 UNITIZED CONCENTRATOR VESSEL #1 H2-52477, FAILED 3/11/89 PLACED ON BURIAL CAR H2-99608, PX-6 (10A-19028) AND INTO #2 TUNNEL 4/6/89 GRAVEYARDS. EST. 42 TONS, 6,000 CU. FT. 1.5 CURIES (REF: LETTER 12113-89-027).	
17.	NORTH BURIAL LINER H2-65095 CONTAINING SIX PUMPS, ONE AGITATOR AND CUT UP JUMPERS (14 TONS). SOUTH BURIAL LINER H2-65095 CONTAINING ONE PUMP, ONE #15 YOKE AND CUT UP JUMPERS (11.5 TONS). PLACED ON BURIAL CAR PX-19 (10A-19030) AND INTO #2 TUNNEL 8/5/89 DAYS. EST 25.5 TONS, 2,574 CU. FT. 3.0 CURIES. (REF: LETTER 12113-89-051)	

Table 3-4. Inventory and Characteristics of Equipment Stored in PUREX Tunnel 2. (5 sheets)

TUNNEL INVENTORY

Listed below are the approximate sizes of the process equipment which has been placed in the PUREX storage tunnel 2. Also listed are the suspected hazardous constituents, and radiation dose estimated. Some figure of the equipment are attached to provide sizing details.

Sizing of the equipment is based on information provided by PUREX operations. Accurate records were not kept from the start of the tunnel operations.

Therefore, a number of assumptions were made about the process equipment sent to the tunnels. It is recommended that prior to attempting removal of the process equipment, remote camera and radiation survey devices be sent into the tunnels to verify the size, position, and radiation dose levels of the process equipment.

- Ci = Curies
- NA Indicates No Information is Available
- O.D. Indicates Outer Diameter
- Volume Estimates Include Only Process Equipment

Tunnel #2 (218-E-15)

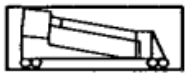
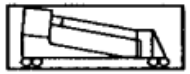
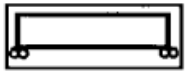
Position (Date of storage)	Layout (Assumed)	Contents	Dimensions	Estimated waste type	Initial dose reading / Estimated Ci Content	Suspected hazardous constituents	Est. Volume (ft^3)	Notes
1 12/12/67		E-F6 Concentrator	36'6" x 15' x 6'	TRU	1.3 R/hr @ 100 ft 5 R/hr @ 50 ft / 700 Ci		2,400	See Tunnel #1, Position 6
		Tube Bundles	12'6" x 4'3" O.D.	TRU				
		Agitator Motor	NA	LLW				
2 3/26/69		E-F6 Concentrator	36'6" x 15' x 6'	TRU	800 R/hr @ Coupling / 500 Ci		2,400	See Tunnel #1, Position 6 This Car Could Also Contain Tank F15-2. No information on This Tank is Available.
		(2) Tube Bundles	Each @ 12'6" x 4'3" O.D.	TRU				
3 3/19/70		E-F6 Concentrator	36'6" x 15' x 6'	TRU	10 R/hr F 500 R/hr @ 2 ft / 700 Ci		2,400	
		(2) Tube Bundles	Each @ 12'6" x 4'3" O.D.	TRU				
4 12/30/70		L Cell Package	14'8" x 16'8" x 36'	TRU	10-200 mR/hr	< 500g Pu	2,400	

Table 3-4. Inventory and Characteristics of Equipment Stored in PUREX Tunnel 2. (5 sheets)

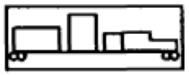
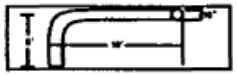
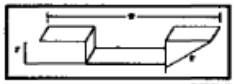
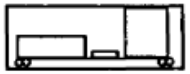
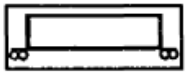
Position (Date of storage)	Layout (Assumed)	Contents	Dimensions	Estimated waste type	Initial dose reading / Estimated Ci Content	Suspected hazardous constituents	Est. Volume (ft^3)	Notes
5 2/26/71		F2 Silver Reactor	13'5" x 4'6" O.D.	LLMW >3	East 300 Mr/hr @ 2 ft West 2 R/hr @ 2 ft 20 Ci	1,375 lb Silver Salts as Silver Nitrate	2,400	The Silver Salts are a Mixture of Silver Nitrate, Silver Hallides, and Silver Fines
		F6 Demister	NA	TRU				
		Vessel Vent		TRU				
		Steel		LLW				
		Guard Rails		LLW				
6 12/12/71		Modified A3-1 Tower	19'7" x 4'4" O.D.	LLW-1	1 R/hr @ F Max @ Side 10 Ci		2,400	Distributer Ring, 6'6" O.D.
		Scrubber	12' x 2'6" O.D.	LLW-1				
		Lid & Vapor Line	7' O.D. Disk 6" x 10" O.D.	LLW-1				
7 12/22/71		A3 Dissolver	15'6" x 9'3" O.D.	LLMW	5 R/hr @ 5 ft 50 Ci	100 lb Mercury	2,400	
8 8/29/72		Steel Liner Box	18' x 8'11-1/4" x 8'3/4"	?	17,500 Ci		800	Fuel Ends and Fuel Handling Equipment are Contained in the Steel Liner Box
		AIWI Fuel Rods	7" x 7" x 6" 7" x 27" O.D.	HLW				
		NPR Fuel Handling Equipment	(2) 72" x 8" O.D. 10" x 12' O.D.	TRU				

Table 3-4. Inventory and Characteristics of Equipment Stored in PUREX Tunnel 2. (5 sheets)

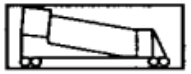
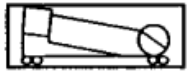
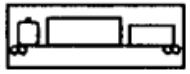
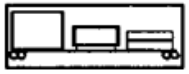
Position (Date of storage)	Layout (Assumed)	Contents	Dimensions	Estimated waste type	Initial dose reading / Estimated Ci Content	Suspected hazardous constituents	Est. Volume (ft^3)	Notes
9 9/30/72		C3 Dissolver	15'6" x 9'3" O.D.	LLW	50 Ci	100 lb Mercury	1,590	
10 8/30/83		E-H4 Concentrator	27'11" x 9'3" O.D.	TRU	500 Ci		2,400	
		Tube Bundles	12'6" x 4'3" O.D.	TRU				
		Cooling Coil	~15' x 5' O.D.					
		F-F1 Filter Tank	~ 10' x 10' O.D.	LLW				
11 1/18/86		A3 Dissolver Vessel	15'6" x 9'6" O.D.	LLMW	3 mR/hr @ 3 ft	84 lb Mercury	3,960	Wt. ~ 40 Tons Tipping Cradle was Welded to Rail Car
		Heater (Vessel #6)	11' x 5'10" x 2'8"	LLW	.81 Ci			
12 1/20/86		White Box (8 Tube Bundles)	~ 12'4" x 26' x 14'6"	LLW	2 R/hr @ Coupling ~3' 540 Ci		5,438	Wt ~ 60 Tons
		Pulser #3 Old Heater Dissolver Lid Trunnions	N/A	LLW				These Items Could be in the White Box, or Sitting on the Rail Car Bed.
13 1/21/86		J5 Tank Vessel	~ 10' x 12' O.D.	LLW	3 R/hr @ 1 ft 90 Ci		2,500	Outer Dimensions on the Equipment Account for the Largest Area Needed to Contain the Equipment. Equipment may Have Been Considerably Downsized by Removing Protruding Nozzles, Vent Lines, etc. Wt ~ 75 Tons
		F1 Condenser	~ 8' x 11' x 7'	LLW				
		F12-B Cell Block	15' x 10' x 3'	LLW				
		Dissolver 4-Way Dumper	Drawing NA	LLW				
		Dissolver Yoke	~ 10' x 12'	LLW				Depth of Yoke Not Available

Table 3-4. Inventory and Characteristics of Equipment Stored in PUREX Tunnel 2. (5 sheets)

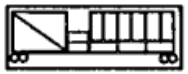
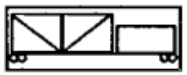
Position (Date of storage)	Layout (Assumed)	Contents	Dimensions	Estimated waste type	Initial dose reading / Estimated Ci Content	Suspected hazardous constituents	Est. Volume (ft^3)	Notes
13 1/21/86 Cont.		Flange Plate	2' x 2' O.D.	LLW				
14 11/18/87		L-1 Pulser (#53)	~ 9' x 5' x 5.5'	TRU	5 R/hr @ 15 ft / - 33,750 Ci	5,584 lb Lead	3,600	Wt. ~ 50 Tons
		(2) Column Cartridges	~ 21' x 41' O.D.	LLW				
		Jumper Cutter and Storage Rack	~ 7' x 3' x 5'	LLMW				
		(3) Jumper Alignment Tools	1' x 1', 1' x 2', 1' x 3'	LLW				
		(9) Exterior Dumping Trunnions	~ 2'3" x 1'4" x 5'5"	LLW				
		(10) Pumps	~ 2' x 15' each	LLW				
		(3) Agitators	~ 2' x 15' each	LLW				
		(4) Tube Bundles	12'6" x 4'3"	LLW				
		(2) Vent Jumpers	8' x 8' x 2' 10' x 4' x 4'	LLW				
		(7) Yokes	See Notes	LLW				Dimensions Vary H(4'-12')xW(6'-'10)xD(2'-5')
15 5/13/88		Silver Reactor	13'5' x 4'6"	LLMW >3	20 Mr/hr @ 20 ft / - 240 Ci	250 Lb. Silver Salts as Silver Nitrate 500 lb Lead	2,775	The Silver Salts are a Mixture of Silver Nitrate, Silver Hallides, and Silver Fines
		E-F2 Steam Heater (E-A2 #5)	11' x 5'10" x 2'8"	LLW				
		Burial Liner with Jumpers	8'3/4" x 18" x 8'11-1/4"	LLW				Wt. 20 Tons

Table 3-4. Inventory and Characteristics of Equipment Stored in PUREX Tunnel 2. (5 sheets)

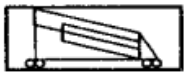
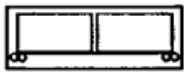
Position (Date of storage)	Layout (Assumed)	Contents	Dimensions	Estimated waste type	Initial dose reading --- Estimated Ci Content	Suspected hazardous constituents	Est. Volume (ft^3)	Notes
15 5/13/88 Cont.		S/R Cradle SK-GLR-11-2-87		LLW				
16 4/6/89		E-J8-1 Unitized Concentrator Vessel	28' x ~16' X ~17"	LLW	0.5 Mr/Hr @ 10 ft --- 1.5 Ci		6,000	Wt. 42 Tons, Car Also Contains Yoke Type 19, Lifting Rod and Hooks
17 8/5/89		North Burial Liner with Misc. Waste	8'3/4" x 18' x 8'11-1/4"	LLW	80 Mr/hr @ 1 ft --- 3 Ci		2,574	North ~ 14 Tons South ~ 11.5 Tons
		South Burial Liner with Misc. Waste	8'3/4" x 18' x 8'11-1/4"	LLW				

Table 3-5. Estimated Radioactivity for Major Equipment Stored in PUREX Tunnel 2. (3 sheets)

	Storage Date	Item	Initial Curies (Ci)	Estimated Radiation Type % of Curies	Age End of 1993 (Years)	Actinides 180 Day (Ci)	FP + AP 180 Day (Ci)	Actinides 1993 (Ci)	FP + AP 1993 (Ci)
1	12/12/67	E-F6 concentrator/tube bundle/agitator motor	700	8% actinides 92% FP	25	56	644	1.97 E+01	1.68 E+01
2	3/26/69	E-F6 concentrator/tube bundles	500	8% actinides 92% FP	25	40	460	1.41 E+01	1.20 E+01
3	3/19/70	E-F6 concentrator/tube bundles	700	8% actinides 92% FP	24	56	644	2.04 E+01	1.71 E+01
4	12/30/70	L Cell Package	---	100% Pu	24	-	-	-	-
5	2/26/71	F2 Silver reactor F6 demister/vent line/catwalk/guardrails	20	I-129	23	0	20	0	20
6	12/12/71	A3-1 Towers/scrubber/ lid/vapor line	10	RuRh-109	23	0	10	0	1.05 E-05
7	12/22/71	A3 dissolver	50	8% actinides 89% FP 3% AP	23	4	46	1.51 E+00	1.21 E+00
8	8/29/72	Liner box/fuel ends/NPR fuel handling equipment	17,500	8% actinides 89% FP 3% AP	22	1,400	16,100	5.49 E+02	4.36 E+02
9	9/30/72	C3 dissolver	50	8% actinides 89% FP 3% AP	22	4	46	1.57 E+00	1.25 E+00
10	8/30/83	E-H4 concentrator/tube bundle/cooling coil/ F-F1 filter tank	500	0.04% actinides 67% Pu 33% FP	11	335.2	165	2.08 E+02	6.81 E+00

Table 3-5. Estimated Radioactivity for Major Equipment Stored in PUREX Tunnel 2. (3 sheets)

	Storage Date	Item	Initial Curies (Ci)	Estimated Radiation Type % of Curies	Age End of 1993 (Years)	Actinides 180 Day (Ci)	FP + AP 180 Day (Ci)	Actinides 1993 (Ci)	FP + AP 1993 (Ci)
11	1/18/86	A3 dissolver/heater	0.81	8% actinides 89% FP 3% AP	8	0.0648	0.7452	4.58 E-02	3.73 E-02
12	1/20/86	White box (8 tube bundles)/pulser #5/ dissolver lid trunions	540	16% actinides 83% FP 1% AP	8	86.4	453.6	6.01 E+01	2.31 E+01
13	1/21/86	J5 Tank/F1 Condenser/ F12-B cell block/ dissolver 4-way dumper/ dissolver yoke/ flange plate	90	6% FP 94% Pu	8	84/6	5.4	6.00 E+01	2.77 E-01
14	11/18/87	L-1 pulser/2 column cartridges/jumper cutter and storage rack/ 3 jumper alignment tools/exterior dumping trunions/10 pumps/ 3 agitators/4 tube bundles/2 vent jumpers/7 yokes	33,750	16% actinides 83% FP 1% AP	7	5,400	28,350	3.98 E+03	1.56 E+03
15	5/13/88	silver reactor/ E-F2 steam heater/burial liner with jumpers/SR cradle	240	7.4 Ci I-129 15.5% actinides 80.5% FP 1% AP	6	37.2	202.8	2.85 E+01	1.91 E+01
16	4/6/89	E-J8-1 Concentrator	1.5	30% FP 46% U 23% Pu	5	1.05	0.45	9.51 E-01	2.90 E-02

Table 3-5. Estimated Radioactivity for Major Equipment Stored in PUREX Tunnel 2. (3 sheets)

Storage Date	Item	Initial Curies (Ci)	Estimated Radiation Type % of Curies	Age End of 1993 (Years)	Actinides 180 Day (Ci)	FP + AP 180 Day (Ci)	Actinides 1993 (Ci)	FP + AP 1993 (Ci)
17 8/5/89	2 burial liners with miscellaneous waste	3	16% actinides 83% FP 1% AP	5	0.48	2.52	3.85 E-01	1.61 E-01
Total		1.44 E+05	Total				5.53 E+03	2.21 E+03

FP = Fission products
AP = Activation products.

Table 3-6. Tunnel 2 Inventory. (4 sheets)

Car Number (Date)	Equipment Name	Cell Arrangement Drawing	Construction Drawing	Process	Inlet Streams	Outlet Streams
1 (12/12/67)	E-F6 Concentrator	H-2-53510	H-2-56213	Waste Concentration and Treatment (WC&T)	1WF, 1WR, H_2O_3, and offgas from 1WW Denitration	Offgas and 1WW
2 (03/26/69)	E-F4 Concentrator or E-F6 Concentrator	H-2-53521	H-2-58101	Backcycle Waste (BW)	3WF	3WW and offgas
		H-2-53510	H-2-56213	WC&T	1WF, 1WR, H_2O_3, and offgas from 1WW Denitration	Offgas and 1WW
	TK-F15-2 Tanks (perhaps)	H-2-53514	H-2-52453	WC&T	1WW, and sugar	1WW, WRP, and offgas
3 (03/19/70)	E-F6 Concentrator	H-2-53510	H-2-56213	WC&T	1WF, 1WR, H_2O_3, and offgas from 1WW Denitration	Offgas and 1WW
4 (12/30/70)	L Cell Package	H-2-53529	H-2-63607 H-2-63624 - H-2-63628	Final Pu Cycles (FPC)	2BP, HNO_3, 3AS, 3BX, 3AF, H_2O_3, 3AX, 3BP	3AW, 3BW, PCP, offgas
5 (02/26/71)	F2 Silver Reactor	H-2-53508	H-2-52467	Process Vent System (PVS)	Vents from vessels and condensers	Vents from vessels and condensers (less free halogens)
	F6 Demister	H-2-53510	H-2-57499	WC&T	E-F6-1 Condenser Offgas, and H_2O	AAF and 1WR

Table 3-6. Tunnel 2 Inventory. (4 sheets)

Car Number (Date)	Equipment Name	Cell Arrangement Drawing	Construction Drawing	Process	Inlet Streams	Outlet Streams
6 (12/12/71)	Modified A3-1 Downdraft Dissolver Condenser Tower	H-2-53500	H-2-52468 H-2-52529 H-2-66054	Material Dissolution and Feed Preparation (MD & FP)	A3 Dissolver Offgas	Offgas to Scrubber and Acid to A3 Dissolver
	Scrubber (probably T-A3 NH_3 Scrubber)	H-2-53500	H-2-66137	MD & FP	A3-1 Tower Offgas and H_2O	Acid to A3 Dissolver, waste and Fission Prod. to NH_3 Catch Tank, and offgas to NH_3 Catch Tank and heater
7 (12/22/71)	A3 (Annular) Dissolver	H-2-53500	H-2-59925 H-2-59927	MD & FP	Zircaloy Clad Metal Chemicals(?), Rec HNO_3, and Metathesis solution	Recladding waste metathesis solution, dissolved Pu, U, or Np, and Offgas
9 (09/30/72)	C3 (Annular) Dissolver	H-2-53502	H-2-59130	MD & FP	Zircaloy Clad Metal Chemicals(?), Rec HNO_3, and Metathesis solution	Recladding waste metathesis solution, dissolved Pu, U, or Np, and offgas

Table 3-6. Tunnel 2 Inventory. (4 sheets)

Car Number (Date)	Equipment Name	Cell Arrangement Drawing	Construction Drawing	Process	Inlet Streams	Outlet Streams
10 (08/03/83)	E-H4 Concentrator	H-2-53521	H-2-66104	BW	3WF	3WW and offgas
	F-F1 (Canyon) Filter Tank	H-2-53508	H-2-56989	PVS	Halogen free vent from Silver Reactor	Vent to building air filters
11 (01/18/86)	A3 (Annular) Dissolver Vessel	H-2-53500	H-2-68280	MD & FP	Zircaloy Clad Metal Chemicals(?), Rec HNO_3, and Metathesis Solution	Recladding waste metathesis solution, dissolved Pu, U, or Np, and offgas
	Heater Vessel #6 (E-A2) Steam Offgas Heater	H-2-53500	H-2-52473	MD & FP	NH_3 Scrubber Offgas	Hot offgas
12 (01/20/86)	Pulser #5 (PG-J6)	H-2-53524	H-2-52687	1st D&PC	1BXF	1BXF
13 (01/21/86)	(TK-J5 2A Feed Tank) JS Tank Vessel #30	H-2-53523	H-2-59968	FPC	1BP, Fresh HNO_3 and 2AF-NO_3	2AF
	F1 Condenser	H-2-53508	H-2-52480	PVS	Vents from Vessels and Condensers	Offgas and condensate to TK-F12 via TK-F1
14 (11/18/87)	L-1 Pulser	H-2-53528	H-2-56910	FPC	Serves T-LI Column which processes; 2AF, 2AX, Fresh HNO_3 and H_2O	Serves T-LI Column which makes 2AP and 2AW

Table 3-6. Tunnel 2 Inventory. (4 sheets)

Car Number (Date)	Equipment Name	Cell Arrangement Drawing	Construction Drawing	Process	Inlet Streams	Outlet Streams
15 (05/13/88)	Silver Reactor (probably E-F2)	H-2-53508	H-2-52467	PVS	Vents from Vessels and Condensers	Vents from vessels and condensers (less free halogens)
	E-F2 Steam (offgas) Heater	H-2-53508	H-2-52473	PVS	Dry Vent Gas from Condensers and Vessels	Hot dry vent gas
16 (04/06/89)	E-J8-1 Unitized Concentrator	H-2-53525	H-2-52477	1st D&PC	ICU and 3WD	1UC and offgas

3.14 (1993.04) WHC-EP-0646

WHC-EP-0646, 1993, *Characterization of Past and Present Solid Waste Streams from the Plutonium-Uranium Extraction Plant*, Westinghouse Hanford Company, Richland, Washington.

While the data in this document was simplified compared to other sources, it was retained for the notes written on Tunnel 2 Positions 11, 12, and 13 which may or may not be useful.

Figure 2-5. PUREX Burial Tunnel 2 (218-E-15). (2 sheets)

Purex # two Burial Tunnel is located at the southeast end of the Purex building and is an extention of the railroad tunnel. The storage area is approximately 1 688 feet long, 22 feet high and 34 feet wide. The tracks have a one percent downgrade toward the south end of the tunnel. The capacity of the Burial Tunnel is 38 -40 modified railroad cars, 40-42 feet long. The Tunnel contains 15 cars as of 5/13/88.

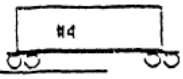
position

1. E-F6 # 1 (2WW WASTE) CONCENTRATOR, TK F15-2, ONE TUBE BUNDLE AND AGITATOR MOTORS. BURIED IN TUNNEL ON 12/12/67 ON CAR 61439. 2,400 CU. FT., 700 CURIES.

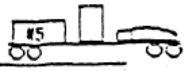
2. E-F6#5 (E-H4 3WB) CONCENTRATOR, TWO TUBE BUNDLES BURIED IN TUNNEL ON 3/26/69 ON CAR MILW 60883. 2,400 CU. FT., 500 CURIES.

3. E-F6#6 (2WW WASTE) CONCENTRATOR, TWO TUBE BUNDLES FAILED BURIED IN TUNNEL ON 3/19/70 ON CAR 3612. 2,400 CU. FT., 700 CURIES.

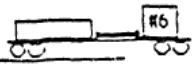
4. ~ELL PACKAGE IN A SEALED STEEL BOX (H2-66012) BURIED IN TUNNEL ON 12/30/70 ON CAR MILW 60033 2,400 CU. FT., 500 GRMS PU.



5. F2 SILVER REACTOR, F6 DEMISTER, VESSEL VENT LINE STELL CAT-WALK AND GUARD RAILS. BURIED IN TUNNEL ON 2/26/71 ON GONDOLA CAR 4610. 2,400 CU. FT., 20 CURIES.

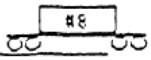


6. MODIFIED A3-1 TOWER, SCRUBBER, LID AND VAPOR LINE BURIED IN TUNNEL ON 12/12/71 ON GONDOLA CAR 4611. 2,400 CU. FT., 10 CURIES.



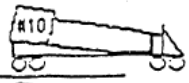
7. A3 DISSOLVER BURIED IN TUNNEL ON 12/22/71 ON NINE FT. SHORTENED CAR B58 2,400 CU. FT., 50 CURIES.

8. A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQUIPT. USED WITH THE SUSPECTED CANISTERS, ON CAR 19808 BURIED IN TUNNEL ON 8/29/72. 800 CU. FT., 17,500 CURIES.

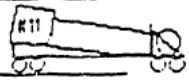


9. C3 DISSOLVER BURIED IN TUNNEL ON 9/30/72 ON CAR 19811 1590 CU. FT., 50 CURIES.

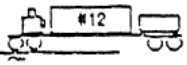
10. E-H4 (3WB) CONCENTRATOR, #61 TUBE BUNDLE, PROTOTYPE COOLING COIL AND A F-F1 FILTER TANK. BURIED IN TUNNEL 8/30/83 ON CAR CDX-1. 2,400 CU. FT., 500 CURIES.



11. A3 DISSOLVER (VESSEL # 10 AND HEATER (VESSEL #6) BURIED IN TUNNEL ON 1/18/86 ON CAR 3613 3,960 CU.FT., 0.81 CURIES 202A-WHC-86-01



12. WHITE BOX (H2-58456) CONTAINING EIGHT TUBE BUNDLES #'S 57, 60,62,64,67,68,74, AND 76. PULSER #5 AND OLD HEATER. DISS LID OLD STYLE DUMPING TRUNNIONS(9). BURIED IN TUNNEL ON 1/20/86 ON CAR 3611. 5,438 CU. FT., 540 CURIES 202A-WHC-86-02



13. J5 TANK (VESSEL #30), F1 COND (VESSEL #13) AND F12-B CELL BLK. OLD FOUR-WAY DUMPER, DISS YOKE AND FLANGE PLATE. BURIED IN TUNNEL ON 1/21/86 ON CAR 19806 2,500 CU. FT., 90 CURIES 202A-WHC-86-03

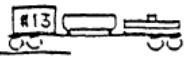


Figure 2-5. PUREX Burial Tunnel 2 (218-E-15). (2 sheets)

POSITION

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14. L-1 PULSER, 2-COLUMN CARTRIDGES, 1-JUMPER CUTTER, 3-JUMPER ALIGNMENT TOOLS, 9-EXTERIOR DUMPING TRUNNIONS, 10-PUMPS, 3-AGITATORS, 4- TUBE BUNDLES, 2-VENT JUMPERS AND 7-YOKES. BURIED IN TUNNEL ON 11/18/87 ON CAR PX-10 (10A-19380) & RACK H2-96629. 50 TONS, 3,600 CU. FT., 33,750 CURIE (REF: LETTER 12110-88-074).

15. SILVER REACTOR, E-F2 STEAM HEATER AND BURIAL LINER(H2-65095) FULL OF CUT UP JUMPERS BURIED IN TUNNEL ON 5/13/88 ON CAR PX-9 (10A-19809) & S/R CRADLE SK-GLR-11-2-87. 20 TONS, 2,775 CU. FT., 240 CURIES (REF: LETTER 12110-88-074).

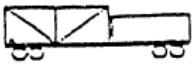


Table 2-2. Contents of Burial Tunnel 1.

Storage date	Item
June 1960	HA column and miscellaneous box
July 1960	E-F11 concentrator
December 1960	Miscellaneous jumpers, two-tube bundles, and an E4 centrifuge
January 1961	E-H4 concentrator
April 1961	E-F6 concentrator
February 1962	E-F11 concentrator
January 1965	E-F6 concentrator

3.15 (1991.11) 17210-91-068

17210-91-068, 1991, "PUREX #1 Storage Tunnel (218-E-14) and #2 Storage Tunnel (218-E-15) Update," (internal memo from J.R. Rapoza and D.B. Lichy to D.H. Shuford, November 6, 1991), Westinghouse Hanford Company, Richland, Washington.

Westinghouse
Hanford Company

Internal
Memo

From: PUREX Process Operations Support 17210-91-068
Phone: 3-3543 / 3-2623 S5-66
Date: November 6, 1991
Subject: PUREX #1 STORAGE TUNNEL (218-E-14) AND
#2 STORAGE TUNNEL (218-E-15) UPDATE

To: D.H. Shuford S5-66

cc:	R.W. Bailey	S5-66	G.J. LeBaron	S6-19
	R.V. Bowersock	S6-19	J.C. Midgett	S6-15
	T.L. Cox	S5-65	W.E. Ross	S5-15
	M.W. Ellis	S6-19	R.C. Roal	S6-08
	R.A. Eschenbaum	S6-16	D.J. Washenfelder	S6-18
	D.G. Harlow	S6-19	DHS: JRR : DBL	LB/File

The last railroad flat car stored in the PUREX #2 tunnel was PX-19 (old car # 10A-19030) on August 5, 1989. The load included two storage liners containing miscellaneous canyon waste, cut up jumpers and failed pumps. The main reason for this memo is to update the Storage Tunnel #1 and #2 history documentation and to bring to the attention of those concerned, that the procedures for storage tunnel use will need to be updated before any other PUREX failed equipment can be stored in the #2 tunnel.

At present PUREX Storage Tunnel# 1 is at capacity containing eight (8) railroad flatcars. PUREX Storage Tunnel# 2 has storage space for an additional twenty three (23) railroad flatcars. Seventeen (17) of the estimated forty (40) storage spaces are presently filled.

If there are any questions, please do not hesitate to contact either Jim Rapoza at 3-3543 or Dave Lichy at 3-2623.

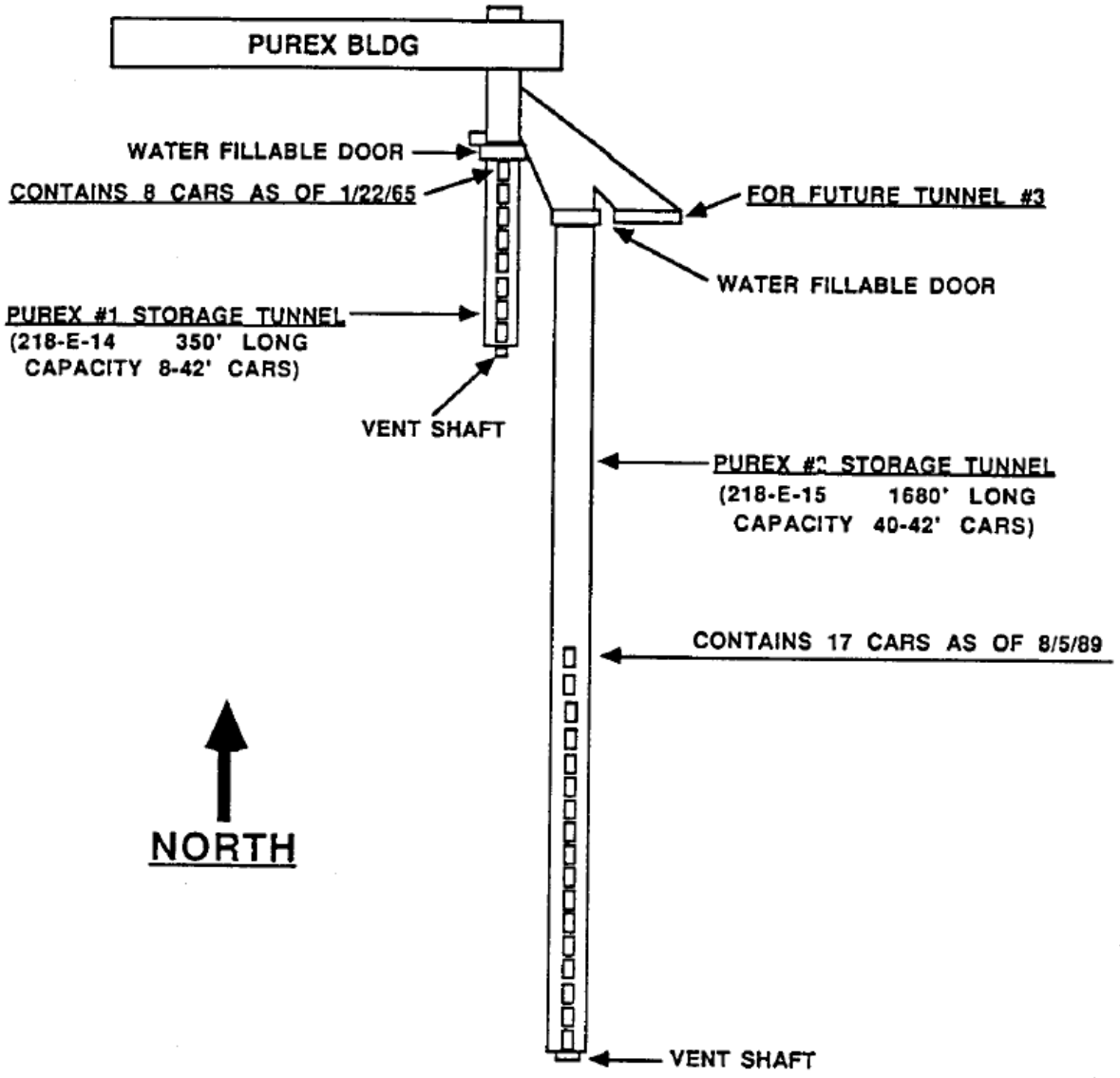
attachments: #1 PUREX tunnels #1 and #2 layout
#2 Purex Storage Tunnel #1 (218-E-14) data
#3 PUREX Storage Tunnel #2 (218-E-15) data

J.R. Rapoza, Canyon Equipment
Planner/Historian
PUREX Process Operations Support

D.B. Lichy, Canyon Remote
Maintenance Planner
PUREX Process Operations Support

54-1600-081

Hanford Operations and Engineering Contractor for the US Department of Energy



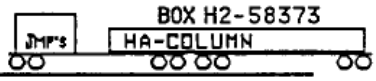
ATTACHMENT# 1

PUREX # 1 STORAGE TUNNEL (218-E-14)
TUNNEL IS AT ITS CAPACITY AS OF 1/22/65

PUREX #1 Storage Tunnel is located at the southeast end of the PUREX Building and is an extension of the railroad tunnel. The storage area is approximately 350 feet long, 22 feet high and 19 feet wide. The tracks have a one percent downgrade toward the south end of the tunnel. The capacity of the tunnel is eight railroad cars, 40 to 42 feet long.

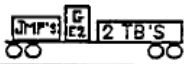
POSITION

1&2 HA COLUMN AND MISC JUMPERS IN BOX
STORED IN TUNNEL #1 ON 6/60.
HA 4,700 CU. FT., 400 CURIES
JUMPERS 2,190 CU. FT., 2,000 CURIES



3 E-F11 #1 (1WW WASTE) CONCENTRATOR FAILED 7/24/60
AFTER 55 MONTHS SERVICE, STORED IN TUNNEL #1 ON 7/29/60,
1,900 CU. FT., 40,000 CURIES

4 G-E2 CENTRIFUGE, MISC JUMPERS IN BOX AND TWO TUBE BUNDLES
STORED IN TUNNEL #1 ON 12/24/60 (FUGE SER# 762)
2,465 CU. FT. 3,000 CURIES



5. E-H4 (3WB) CONCENTRATOR FAILED 1/4/61.
STORED IN TUNNEL #1 ON 1/4/61
2,336 CU. FT., 1,000 CURIES. AFTER FIVE YEARS OF SERVICE.

6. E-F6 (2WW WASTE) ORIGINAL CONCENTRATOR FAILED 4/21/61.
STORED IN TUNNEL #1 ON 4/21/61
2,336 CU. FT., 700 CURIES. AFTER FIVE YEARS & FOUR MONTHS SERVICE.

7. E-F11 (1WW WASTE) #2 CONCENTRATOR FAILED 2/1/62.
STORED IN TUNNEL #1 ON 2/8/62
2,336 CU. FT., 40,000 CURIES. AFTER EIGHTEEN MONTHS SERVICE.

8. E-F6 (2WW WASTE) #2 SPARE CONCENTRATOR FAILED 5/23/64.
STORED IN TUNNEL #1 1/22/65 ON FLATCAR 3621.
2,400 CU. FT., 700 CURIES.

ATTACHMENT # 2

PUREX #2 STORAGE TUNNEL (218-E-15)

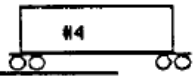
Purex #2 Storage Tunnel is located at the southeast end of the PUREX Building and is an extention of the railroad tunnel. The storage area is approximately 1680 feet long, 22 1/2 feet high and 19 feet wide. The tracks have a 1/10 percent downgrade toward the south end of the tunnel. The capacity of the Storage Tunnel is 40 railroad cars, 42 feet long.
The Tunnel contains 17 cars as of 8/5/89.

1. E-F6&1 (2WW WASTE) CONCENTRATOR, TK F15-2, ONE TUBE BUNDLE AND AGITATOR MOTORS. STORED IN TUNNEL ON 12/12/67 ON CAR 61439. 2,400 CU.FT., 700 CURIES.

2. E-F6#5 (E-H4 3WB) CONCENTRATOR TWO TUBE BUNDLES STORED IN TUNNEL ON 3/26/69 ON RR CAR MILW 60883 2,400 CU. FT., 500 CURIES.

3. E-F6#6 (2WW WASTE) CONCENTRATOR, TWO TUBE BUNDLES STORED IN TUNNEL ON 3/19/70 ON RR CAR 3612. 2,400 CU. FT., 700 CURIES.

4. L CELL PACKAGE IN A SEALED STEEL BOX (H2-66092) STORED IN TUNNEL ON 12/30/70 ON RR CAR MILW 60033 2,400 CU. FT., < 500 GRMS PU.



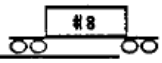
5. F2 SILVER REACTOR, F6 DEMISTER, VESSEL VENT LINE, STEEL CATWALK AND GUARDRAILS. STORED IN TUNNEL ON 2/26/71 ON RR GONDOLA CAR 4610. 2,400 CU. FT., 20 CURIES.

6. MODIFIED A3-1 TOWER, SCRUBBER, LID AND VAPOR LINE STORED IN TUNNEL ON 12/12/71 ON GONDOLA CAR 4611. 2,400 CU. FT., 10 CURIES.

S

7. A3 DISSOLVER STORED IN TUNNEL ON 12/22/71 ON 9 FT. SHORTENED RR CAR B58 2,400 CU. FT., 50 CURIES.

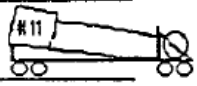
8. A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQUIPT. USED WITH THE SUSPECTED CANISTERS, ON CAR 19808 STORED IN TUNNEL ON 8/29/72. 800 CU. FT., 17,500 CURIES.



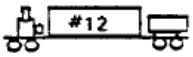
9. C3 DISSOLVER STORED IN TUNNEL ON 9/30/72 ON RR CAR 19811 1,590 CU. FT., 50 CURIES.

10. E-H4 (3WB) CONCENTRATOR, #61 TUBE BUNDLE, PROTOTYPE COOLING COIL AND A F-F1 FILTER TANK. STORED IN TUNNEL 8/30/83 ON RR CAR CDX-1. 2,400 CU. FT., 500 CURIES.

11. A3 DISSOLVER (VESSEL#10) AND HEATER (VESSEL#6) STORED IN TUNNEL ON 1/18/86 ON RR CAR 3613; 3,960 CU.FT., 0.81 CURIES.



12. WHITE BOX (H2-58456) CONTAINING EIGHT TUBE BUNDLES 57, 60, 62, 64, 67, 68, 74, & 76, PULSER#5, AN OLD HEATER, DISS. LID,AND 9 OLD STYLE DUMPING TRUNNIONS. STORED IN TUNNEL ON 1/20/86 ON RR CAR 3611. 5,438 CU. FT., 540 CURIES.



13. J5 TANK (VES# 30), F1 COND. (VES# 13) AND F12-B CELL BLOCK, OLD 4-WAY DUMPER, DISS YOKE AND FLANGE PLATE. STORED IN TUNNEL 1/21/86 ON RR CAR 19806. 2,500 CU. FT., 90 CURIES.

attachment # 3 page 1 of 2

PUREX #2 STORAGE TUNNEL (218-E-15)

POSITION

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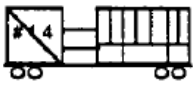
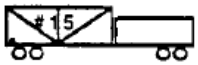
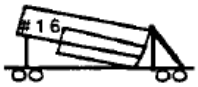
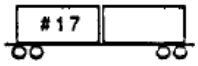
14.	L-1 PULSER, 2-COLUMN CARTRIDGES, 1-JUMPER CUTTER, 3-JUMPER ALIGNMENT TOOLS, 9-EXTERIOR DUMPING TRUNNIONS, 10-PUMPS, 3-AGITATORS, 4- TUBE BUNDLES, 2-VENT JUMPERS AND 7-YOKES. STORED IN TUNNEL ON 11/18/87 ON CAR PX-10 (10A-19380) & RACK H2-96629. 50 TONS, 3,600 CU. FT., 33.750 CURIE (REF: LETTER 12110-88-074).	
15.	SILVER REACTOR, E-F2 STEAM HEATER AND BURIAL LINER(H2-65095) FULL OF CUT UP JUMPERS STORED IN TUNNEL ON 5/13/88 ON CAR PX-9 (10A-19809) & S/R CRADLE SK-GLR-11-2-87. 20 TONS, 2,775 CU. FT., 240 CURIES (REF: LETTER 12110-88-074).	
16.	E-J8-1 UNITIZED CONCENTRATOR VESSEL#1 H2-52477, FAILED 3/11/89 PLACED ON STORAGE CAR H2-99608, PX-6 (10A-19028) AND INTO #2 TUNNEL 4/6/89 GRAVEYARDS. EST. 42 TONS, 6,000 CU. FT. 1.5 CURIES (REF: LETTER 12113-89-027).	
17.	NORTH BURIAL LINER H2-65095 CONTAINING SIX PUMPS, ONE AGITATOR AND CUT UP JUMPERS (14 TONS). SOUTH BURIAL LINER H2-65095 CONTAINING ONE PUMP, ONE #15 YOKE AND CUT UP JUMPERS (11.5 TONS). PLACED ON STORAGE CAR PX-19 (10A-19030) AND INTO #2 TUNNEL 8/5/89 DAYS. EST 25.5 TONS, 2,574 CU. FT. 3.0 CURIES. (REF: LETTER 12113-89-051)	

attachment # 3 page 2 of 2

3.16 (1991.06) Bowersock DSI

DON'T SAY IT --- Write It!

DATE: June 26, 1991

TO: J. C. Midgett S6-15

FROM: R. V. Bowersock S6-19

Telephone: 373-2135

cc: G. J. LeBaron S6-19
C. R. Miska S6-17
J. R. Rapoza S5-66
W. E. Ross S5-66
R. L. Walser S6-17

also mail copy for RW Bell Dailey S5-66
Don Hallow 5-72
ML Sullivan and 3 Extras

SUBJECT: **ROM ESTIMATE OF CURIE CONTENT IN PUREX STORAGE TUNNELS**

In response to your inquire as to the curie content of the radioactive waste stored in the PUREX Storage Tunnels, a rough order of magnitude estimate was made. This estimate is based on curie content recorded for each railcar at the time of storage; on the decay and isotopic content as reported in the FSAR, SD-HS-SAR-001 Rev 3, Table 7-27; and on extension of decay using the computer code RadDecay 3.03 by Grove Engineering, Inc. The results are tabulated below:

	9-30-73 (1)	6-30-91 (2)	Assumptions
Tunnel #1	6,000 Ci	4,000 Ci	Source: 50/50 ^{90}Sr & ^{137}Cs
Tunnel #2			
Pos. 1 thru 9	20,000	2,000	Source: ^{60}Co
Pos. 10 thru 17	-	32,000 (3)	Source: 50/50 ^{90}Sr & ^{137}Cs

(1) From SD-HS-SAR-001 Rev 3, Table 7-27
(2) ROM estimate rounded to nearest 1,000 Ci
(3) ~35,000 Ci total added to Tunnel 2 between 8-30-83 and 8-5-89

54-3000-101 (9/59) (EF) GEF014
DSI

Additional PUREX Storage Tunnel storage information is tabulated below.

	Storage Position	Date Stored	Ci @ Storage	Major Equip. Items
Tunnel #1	3	7-29-60	40,000	E-F11 Concentrator
	7	2-08-62	40,000	E-F11 Concentrator
	1 thru 8	6-60 - 1-65	89,800	
Tunnel #2	8	8-29-72	17,500	A1W1 fuel ends, NPR fuel handling equip.
	14	11-18-87	33,750	L-1 pulsar, 4 tube bundles, 2 column cart., align. tools
	1 thru 9	12-67 - 9-72	19,190	
	10 thru 17	8-83 - 8-89	33,750	

If you have questions concerning any of the above information, please call me on Ext. 3-2135.

54-3000-101 (9/59) (EF) GEF014
DSI

3.17 (1990.09) WHC-SD-EN-ES-003

WHC-SD-EN-ES-003, 1990, *PUREX Storage Tunnels Disposal Alternatives Engineering Study*, Westinghouse Hanford Company, Richland, Washington.

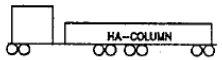
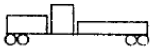
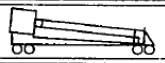
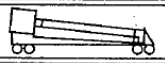
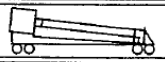
TUNNEL INVENTORY

Listed below are the approximate sizes of the process equipment which has been placed in the PUREX storage tunnels. Also listed are the suspected hazardous constituents, and radiation dose estimates. Some figures of the equipment are attached to provide sizing details.

Sizing of the equipment is based on information provided by PUREX operations. Accurate records were not kept from the start of the tunnel operations. Therefore, a number of assumptions were made about the process equipment sent to the tunnels. It is recommended that prior to attempting removal of the process equipment, remote camera and radiation survey devices be sent into the tunnels to verify the size, position and radiation dose levels of the process equipment.

- Ci = Curies
- NA Indicates No Information Is Available
- O.D. Indicates Outer Diameter
- Volume Estimates Include Only Process Equipment

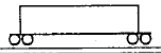
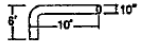
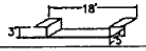
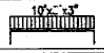
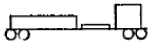
TUNNEL #1 (218-E-14)

POSITION (Date of Storage)	LAYOUT (Assumed)	CONTENTS	DIMENSIONS	REFERENCE	INITIAL DOSE READING / ESTIMATED Ci CONTENT[1]	SUSPECTED HAZARDOUS CONSTITUENTS	EST. VOLUME (FT.^{3})	NOTES
1 & 2		HA Column	40'11" x 8'2" x 6'	A-1	5 R/hr @ 60' / 400 Ci		4,700	1 Dose Conversion Supplied by PUREX Operations
6/60		Jumper Box	18' X 8'11-1/4" X 8'3/4"	N/A	2000 Ci	Lead ~ 250 lbs [2]	2,190	2 Assumptions: 50 Jumpers/Box, 100 Lb. Lead/Jmp, 5% Jumper Have Lead, ∴ ~ 250 Lb
3 7/29/60		E-F11 Concentrator	29'8" x 6'	A-2	12.5 R/hr @ 100' / 40,000 Ci		1,900	Tower Removable, Could Take 12'6" From Height
4		G-E2 Centrifuge	3' x 5' O.D.	A-3	1.5 R/hr @ 150' / 3,000 Ci		2,465	If G-E2 Centrifuge Was Stored with the Motor, Its Dimensions are 7' x 10' x 13'
		Jumper Box	18' x 8'11-1/4" x 8'3/4"	N/A		Lead ~ 250 lbs [2]		
12/24/60		(2) Tube Bundles	Each @ 12'6" x 4'3"	N/A				
5 1/4/61		E-H4 Concentrator	29'8" x 16'6" x 6'	A-4	150 mR/hr @ 50' / 3,000 Ci		2,465	See Position 3
6 4/21/61		E-F6 Concentrator	36'6" x 15' x 6'	A-5	5 R/hr @ 20' / 700 Ci		2,336	Portions Possibly Removed: De-Entrainment Assembly, 7' x 5' O.D., Tower, 12'6" x 5'6" O.D.
7 2/8/62		E-F11 Concentrator	29'6" x 6'	A-2	25 R/hr @ 150' / 40,000 Ci		2,336	
8 1/22/65		E-F6 Concentrator	36'6" x 15' x 6'	A-5	700 Ci		2,400	See Position 6

JMF\121789-1

TUNNEL #2 (218-E-15)

- Ci = Curies
- NA Indicates No Information is Available
- O.D. Indicates Outer Diameter
- Volume Estimates Include Only Process Equipment

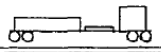
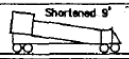
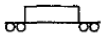
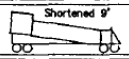
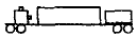
POSITION (Date of Storage)	LAYOUT (Assumed)	CONTENTS	DIMENSIONS	REFERENCE	INITIAL DOSE READING / ESTIMATED CI CONTENT	SUSPECTED HAZARDOUS CONSTITUENTS	EST. VOLUME (FT.^{3})	NOTES
1		E-F6 Concentrator	36'6" x 15' x 6'	A-5	1.3 R/hr @ 100' 5 R/hr @ 50' 700 Ci		2,400	See Tunnel #1, Position 6
		Tube Bundle	12'6" x 4'3" O.D.	N/A				
12/12/67		Agitator Motor	NA	N/A				
2		E-F6 Concentrator	36'6" x 15' x 6'	A-5	800 mR/hr @ Coupling 500 Ci		2,400	See Tunnel #1, Position 6 This Car Could Also Contain Tank F15-2. No Information on This Tank is Available.
3/26/69		(2) Tube Bundles	Each @ 12'6" x 4'3" O.D.	N/A				
3		E-F6 Concentrator	36'6" x 15' x 6'	A-5	10 R/hr F 500 R/HR @ 2' 700 Ci		2,400	See Tunnel #1, Position 6
3/19/70		(2) Tube Bundles	Each @ 12'6" x 4'3" O.D.	N/A				
4 12/30/70		L-Cell Package	14'8" x 16'8" x 36'	N/A	10-200 mR/hr	< 500 Gr. PU	2,400	
5		F2 Silver Reactor	13'5" x 4'6" O.D.	A-6	East 300 Mr/hr @ 2"	1,375 Lbs. Silver Salts as Silver Nitrate	2,400	The Silver Salts are a Mixture of Silver Nitrate, Silver Halides, and Silver Fines.
		F6 Demister	NA	N/A				
		Vessel Vent Line		N/A				
		Steel Catwalk		N/A	West 2 R/hr @ 2" 20 Ci			
2/26/71		Guard Rails		N/A				
6		Modified A3-1 Tower	19'7" x 4'4" O.D.	A-6	1 R/hr @ F Max @ Side 10 Ci		2,400	Distributer Ring, 6'6" O.D. See Drawing
12/12/71		Scrubber	12' x 2'6" O.D.	A-6				**

** ** Figure A-3 is the generalized drawing of the dissolver cell equipment. Actual dimensions of the specific dissolver cells are not available, although these give a good approximation.

JMF\122869-1

TUNNEL #2 (218-E-15)

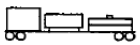
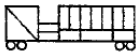
- Ci = Curies
- N/A Indicates no Information Is Available
- O.D. Indicates Outer Diameter
- Volume Estimates Include Only Process Equipment

POSITION (Date of Storage)	LAYOUT (Assumed)	CONTENTS	DIMENSIONS	FIGURE	INITIAL DOSE READING / ESTIMATED Ci CONTENT	SUSPECTED HAZARDOUS CONSTITUENTS	EST. VOLUME (FT.^{3})	NOTES
6 (Cont.) 12/12/71		Lid & Vapor Line	7' O.D. Disk 6" x 10' O.D.	A-6				
7 12/22/71		A3 Dissolver	15'6" x 9'3" O.D.	A-6	5 R/hr @ 5' / 50 Ci	100 lb Mercury	2,400	
8 8/29/72		Steel Liner Box	18' x 8'11-1/4" x 8'3/4"	N/A	17,500 Ci		800	Fuel Ends and Fuel Handling Equipment are Contained in the Steel Liner Box.
		AIWI Fuel Ends	7" x 7" x 6" 7" x 27" O.D.	N/A				
		NPR Fuel Handling Equipment	(2) 72" x 8" O.D. ~10" x 12' O.D.	N/A				
9 9/30/72		C3 Dissolver	15'6" x 9'3" O.D.	A-6	50 Ci	100 lb Mercury	1,590	
10 8/30/83		E-H4 Concentrator	27'11" x 9'3" O.D.	A-4	500 Ci		2,400	
		Tube Bundle	12'6" x 4'3" O.D.	N/A				
		Cooling Coil	~15' x 5' O.D.	N/A				
		F-F1 Filter Tank	~10' x 10' O.D.	A-7				
11 1/18/86		A3 Dissolver Vessel	15'6" x 9'6" O.D.	A-6	3 mR/hr @ 3' / .81 Ci	84 lb Mercury	3,960	Wt. ~ 40 Tons Tipping Cradle was Welded to Rail Car
		Heater (Vessel #6)	11' x 5'10" x 2'8"	A-6				
12 1/20/86		White Box (8 Tube Bundles)	~12'4" x 26' x 14'6"	N/A	2 R/hr @ Coupling ~3' / 540 Ci		5,438	Wt. ~ 60 Tons
		Pulser #5 Old Heater Dissolver Lid Trunnions	N/A	N/A				These Items Could be in the White Box, or Sitting on the Rail Car Bed.

JMF\010290-1

TUNNEL #2 (218-E-15)

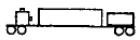
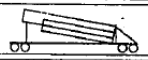
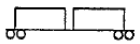
- CI = Curies
- NA Indicates No Information Is Available
- O.D. Indicates Outer Diameter
- Volume Estimates Include Only Process Equipment

POSITION (Date of Storage)	LAYOUT (Assumed)	CONTENTS	DIMENSIONS	REFERENCE	INITIAL DOSE READING / ESTIMATED CI CONTENT	SUSPECTED HAZARDOUS CONSTITUENTS	EST. VOLUME (FT.^{3})	NOTES
13		J5 Tank Vessel	~10' x 12' O.D.	N/A	3 R/hr @ 1' / 90 CI		2,500	Outer Dimensions on the Equipment Accout for the Largest Area Needed to Contain the Equipment. Equipment may Have Been Considerably Downsized by Removing Protruding Nozzles, Vent Lines, etc.
		F1 Condenser	~6' x 11' x 7'	N/A				
		F12-B Cell Block	15' x 10' x 3'	N/A				
		Dissolver 4-Way Dumper	Drawing NA	N/A				Wt. ~ 75 Tons
		Dissolver Yoke	~10' x 12'	N/A				Depth of Yoke Not Available
1/21/86		Flange Plate	2" x 2' O.D.	N/A				
14		L-1 Pulser (#53)	~9' x 5' x 5.5'	N/A	5 R/hr @ 15' / 33,750	5,584 Lbs. Lead	3,600	Wt. ~ 50 Tons
		(2) Column Cartridges	~21' x 41" O.D.	N/A				
		Jumper Cutter and Storage Rack	~7' x 3' x 5'	N/A				
		(3) Jumper Alignment Tools	1' x 1', 1'x 2', 1' x 3'	N/A				
		(9) Exterior Dumping Trunnions	~2'3" x 1'4" x 5'5"	N/A				
		(10) Pumps	~2' x 15' each	N/A				
		(3) Agitators	~2' x 15' each	N/A				
		(4) Tube Bundles	12'6" x 4'3"	N/A				
11/18/87		(2) Vent Jumpers	8' x 8' x 2' 10' x 4' x 4'	N/A				

JMF\010390-1

TUNNEL #2 (218-E-15)

- Ci = Curies
- NA Indicates No Information Is Available
- O.D. Indicates Outer Diameter
- Volume Estimates Include Only Process Equipment

POSITION (Date of Storage)	LAYOUT (Assumed)	CONTENTS	DIMENSIONS	REFERENCE	INITIAL DOSE READING / ESTIMATED Ci CONTENT	SUSPECTED HAZARDOUS CONSTITUENTS	EST. VOLUME (FT.^{3})	NOTES
14 (Cont.)		(7) Yokes	See Notes	N/A				Dimensions Vary H(4'-12') x W(6'-10") x D(2'-5')
15		Silver Reactor	13'5" x "	Figure A-6	20 Mr/HR @ 20' / 240 Ci	250 Lb. Silver Salts as Silver Nitrate 500 Lb. Lead	2,775	The Silver Salts are a Mixture of Silver Nitrate, Silver Halides, and Silver Fines.
		E-F2 Steam Heater (E-A2 #5)	11' x 5'10" x 2'8"	N/A				
		Burial Liner w/ Jumpers	8'3/4" x 18' x 8'11-1/4"	N/A				Wt. 20 Tons
5/13/88		S/R Cradle SK-GLR-11-2-87		N/A				
16 4/6/89		E-J8-1 Unitized Concentrator Vessel	28' x ~16' x ~17'	N/A	0.5 mR/hr @ 10' / 1.5 Ci		6,000	Wt. 42 Tons Car also Contains Yoke Type 19, Lifting Rod and Hooks.
17		North Burial Liner w/ Misc. Waste	8'3/4" x 18' x 8'11-1/4"	N/A	80 Mr/HR @ 1' / 3 Ci		2,574	North ~ 14 Tons
8/5/89		South Burial Liner w/ Misc. Waste	8'3/4" x 18' x 8'11-1/4"	N/A				South ~ 11.5 Tons

JMF\010390-2

3.18 (1990.01) 12152-90-11

12152-90-11, 1990, "Classification of Residual Tank Heels in PUREX Tunnels," (internal memo from R.V. Bowersock to D.K. Bailey et al., January 25, 1990), Westinghouse Hanford Company, Richland, Washington.

RECEIVED
JAN 25 1990
G.J. LeBARON

Westinghouse Hanford Company

Internal Memo

From: PUREX Regulatory Compliance 12152-90-11
Phone: 373-2135 S5-80
Date: January 25, 1990
Subject: CLASSIFICATION OF RESIDUAL TANK HEELS IN THE PUREX STORAGE TUNNELS

To:

D. K. Bailey	S6-08	K. M. Leonard	R2-73
J. D. Bauer	B3-15	D. L. Parker	H4-57
J. R. Bellomy	H4-57	M. A. Payne	S5-66
R. C. Bowman	H4-57	S. M. Price	H4-57
J. H. Ellis	S5-66	J. R. Rapoza	S5-66
L. A. Garner	H4-50	W. E. Ross	S5-66
S. D. Godfrey	S5-80	D. H. Shuford	S6-02
K. A. Hadley	R2-42	C. D. Wollam	S5-80
P. F. Kison	S5-66	RVB/File/LB	
R. J. Landon	B2-19		
G. J. LeBaron	S5-80		

Attached for your information is a white paper entitled "Classification of Residual Tank Heels in the PUREX Storage Tunnels." This paper presents pertinent information concerning the equipment in the tunnels so a decision could be made as to whether heels in the vessels constitute dangerous waste as defined by the State of Washington Administrative Code WAC 173-303.

Based upon the logic and factual data presented, it was concluded that the residual liquid heels currently in the PUREX Storage Tunnels do not constitute dangerous waste. Operating procedures will be prepared requiring flushing, as verified by sample analysis, of future vessels selected for tunnel storage to assure any residual heel is not corrosive as defined in WAC 173-303-090(6a).

Should you have any questions concerning the data presented, please call me.

Robert V. Bowersock
R. V. Bowersock, Principal Engineer
PUREX Regulatory Compliance

no

54-7600-081

Hanford Operations and Engineering Contractor for the US Department of Energy

CLASSIFICATION OF RESIDUAL TANK HEELS IN THE PUREX STORAGE TUNNELS

I. INTRODUCTION

Several large vessels and other miscellaneous equipment that have been removed from the PUREX Plant are stored within the PUREX Storage Tunnels. This used equipment has either failed or become obsolete and, due to the high radiation levels associated with the equipment, it has been deemed not feasible to repair or modify this equipment. Some of the equipment has been in storage for nearly thirty years, and is scheduled to remain in storage until closure of the facility.

The PUREX Storage Tunnels have an interim status permit with Washington State Department of Ecology (Ecology). This permit covers storage of mixed wastes containing elemental lead, elemental mercury and silver nitrate as the dangerous waste component. The question has been raised if residual liquid heels in any of these vessels constitute a dangerous waste and, therefore, must be identified as such in a revision to the Part A Dangerous Waste Permit Application to Ecology?

II. HISTORIC BACKGROUND

The PUREX Storage Tunnels are an integral part of the PUREX Plant. The tunnels are used for interim storage of failed process equipment that are too radioactive and bulky for removal from the PUREX Plant. Failed equipment selected for storage in the storage tunnels is loaded onto old railroad cars that serve both as a transport and storage platform while the equipment is in storage. A remote-controlled, battery-powered locomotive (Little Toot) is used to position the rail car into the storage tunnel. The failed equipment, along with the transporter rail car, remains in the storage tunnel until significant radioactive decay has occurred to justify its retrieval for preparation/packaging for permanent disposal (e.g. burial). Theoretically, each piece of equipment is retrievable. However, since the equipment is stored on a single, dead end, rail spur per storage tunnel; equipment can only be removed in the reverse order to that of being placed into storage, (i.e., first in, last out).

Construction of Tunnel 1 was completed in 1956 as part of the PUREX construction project. The first failed equipment item to be placed in the storage tunnel was an HA Column which was approximately 41 feet long. Due to its length, two rail cars coupled together were required as a transporter. This failed HA column, along with a box of miscellaneous pipe jumpers, were placed in Tunnel 1 in June, 1960. The remaining six positions (total capacity eight rail cars) were filled between June, 1960 and January, 1965 at which time the water-fillable entry door was sealed closed and door opening hoists were deactivated electrically, as was the tunnel exhaust system.

Tunnel 2 was constructed in 1964. The first storage position was filled in December, 1967. As of October 1, 1989, a total of 17 rail cars have been

stored within Tunnel 2. Tunnel 2 has a storage capacity of forty, 40 foot long rail cars.

Although the PUREX Storage Tunnels are an integral part of the PUREX Plant, their operation is under a separate dangerous waste unit of the permit application with the Washington State Department of Ecology (Ecology). The Part A permit application (Form 3) for the storage tunnels was submitted to Ecology December 3, 1987. This permit application lists elemental lead, elemental mercury, and silver nitrate as being the only dangerous waste components of mixed wastes stored in the PUREX Storage Tunnels.

There are a total of 17 vessels currently stored within the PUREX Storage Tunnels that could contain dangerous waste heels. A breakdown as to type of vessel and storage location is given in Table 1.

TABLE 1.

VESSELS STORED IN THE PUREX STORAGE TUNNELS

	Tunnel 1	Tunnel 2*	Total
Concentrators	5	5	10
Dissolvers	0	3	3
Tanks	0	2	2
Centrifuges	1	0	1
Columns	1	0	1
	7	10	17

* Through September 1989

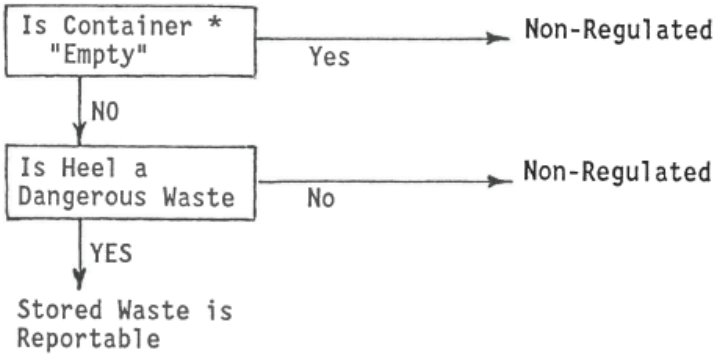
Documentation as to actual volume and chemical composition of the liquid heel remaining in each vessel at its time of storage is not available. High radiation levels within the tunnels prevents entry to make direct measurements or take samples of any residual heel that may remain today.

III. DISCUSSION

The purpose of this paper is to present the available, pertinent information concerning the equipment in the tunnels so a decision can be made as to whether heels in the vessels constitute dangerous waste as defined by the State of Washington Administrative Code WAC 173-303.

To resolve the residual heel question concerning the vessels currently in storage, the following logic diagram is utilized.

DECISION LOGIC



In accordance with WAC 173-303-160(2a), a container is "empty" when:

- "All waste in it has been taken out that can be removed using practices commonly employed to remove materials from that type of container," (e.g., pumping, aspirating).

AND

- The volume of waste remaining in containers of capacity greater than one hundred ten gallons "is no more than 0.3 percent of the container's total capacity."

Table 2 lists the jet heels associated with each of the 17 vessels currently in the PUREX Storage Tunnels.

* The PUREX Storage Tunnels are currently permitted as a container storage system (S01). Each of the rail cars is considered to be a "container" due to its portability. A revision to Form 3 is being proposed that would change the process code from S01 (container storage) to S05 (miscellaneous units) per 40 CFR 264 Subpart X. This change, however, should not affect the "container" characteristics applicable to the discarded process equipment being stored on the rail car.

TABLE 2

VESSEL HEELS

	Number	Total Capacity	Jet Heel	% Full	"Empty"
Concentrators					
E-F6	4	2167 gal	~5 gal	0.24	Yes
E-F11	2	2590	~15	0.58	No
E-H4	3	2678	113	4.22	No
E-J8	1	3738	~9	0.24	Yes
	10				
Dissolvers					
A-3	2	4745	20	0.42	No
C-3	1	5055	20	0.40	No
	3				
Tanks					
F15	1	5130	2.3	0.04	Yes
J5	1	368	1	0.27	Yes
	2				
Centrifuge					
G-E2	1	192	2.2	1.15	No
Column					
HA	1	1850	4	0.22	Yes
	17				

Of the 17 vessels in storage, eight may be considered to be "empty" since the heel is <0.3 percent of capacity. Therefore, 8 of the 17 vessels in the storage tunnels are non-regulated because they are "empty."

The second step in the logic network is to identify if the heel in the non-empty vessels constitute a dangerous waste. Table 3 presents the most probable composition of the residual heel in each vessel assuming the vessel was removed from service at the end of its normal operating cycle and received no further rinsing in preparation for storage.

TABLE 3.

VESSEL HEEL COMPOSITION

	Number	Heel	% Full	Composition*	Corrosive**
Concentrators					
E-F11	2	~15 gal	0.58	Bottoms NH_4OH trace	No
E-H4***	3	~113 gal	4.22	HNO_3 8.3M U 20-30 G/L Pu .005-.007 G/L	Yes
Dissolvers					
A-3/C-3	3	~20 gal	0.42	Heel Dilution Solution OH^- 1.1×10^{-3} M F^- 5.7×10^{-4} M	No
Centrifuge					
G-E2	1	~2.2 gal	1.15	Rinse Water	No

* Reference PUREX flow sheets: SK-2-23920 Rev. 2
SK-2-28921 Rev. 2
SK-2-23939 Rev. 3

** Within the corrosive pH range $\leq 2 \geq 12.5$ as defined in WAC 173-303-090(6a)

*** Locations of E-H4 Concentrators:

Location		Date Stored
Tunnel 1	Pos 5	Jan 1961
Tunnel 2	Pos 2	Mar 1969
Tunnel 2	Pos 10	Aug 1983

None of the chemical constituents of the potential heels shown in Table 3 are listed as dangerous waste in the discarded chemical products list, WAC 173-303-9903 or the dangerous waste constituents list, WAC 173-303-9905. Except for 8.3 M nitric acid, the equivalent concentrations of the other constituents are not toxic as defined under WAC 173-303-084(5). For nitric acid solutions, the characteristic of corrosivity is more restrictive than its toxicity; therefore, corrosivity was used as the measure to define if the waste is regulated. Six of the nine vessels listed in Table 3 do not contain a heel that is corrosive as defined in WAC 173-303-090(6a); therefore, these heels are non-regulated.

Of the 17 vessels stored in the PUREX Storage Tunnels, eight vessels do not contain dangerous waste heels because they are "empty" and six vessels do not contain a heel that is a dangerous waste. Therefore, only three vessels (all E-H4 concentrators) might contain a corrosive heel unless the vessels were adequately rinsed prior to storage or the residual heel has evaporated to eight gallons or less, "empty". Although documentation as to actual flushing procedures followed for these specific concentrators are not available, it has been common practice to thoroughly flush failed equipment to reduce the plutonium content to <15 grams as indicated by analysis of successive flush solution samples prior to removal at the equipment from the canyon (PUREX Control Manual WAC-CM-5-24 p. 15-69). However, to reduce a 113 gallon heel of 8.3M HNO_3 to <0.01M HNO_3(pH~2) or to <0.0007M HNO_3 (to account for re-concentration of the residual acid on evaporation to "empty"), would require multiple flushing varying from three, 100 percent of vessel

capacity flushes, to six to eight flushes using a flush volume at only 10 percent of vessel capacity. This degree of flushing would far exceed that which would be required to reduce the plutonium content to <15 grams, the prevailing criteria at the time the vessels were prepared for storage. Without hard evidence as to flushing procedure followed or chemical or pH analysis of the final flush solution, it must be assumed that the residual heel remaining at time of storage was corrosive (pH<2).

Is must be determined if it is reasonable to assume that the residual heels have evaporated. The bottom footnote of Table 3 gives the dates the three E-H4 concentrators were placed into storage. The concentrator in Position 5 of Tunnel 1 has been in storage for nearly 29 years, the first four of which took place when the tunnel exhaust system was in use. For the concentrators in Positions 2 and 10 of Tunnel 2, the storage time has been 20.5 years and 6 years respectively. Tunnel 2 exhaust system has been in operation the full time.

It is common practice to plug or cap the nozzles that would be on the down side when the vessel is positioned on the rail car. This is done to prevent spillage of any liquid remaining in the vessel thus minimizing the spread of radioactive contamination during transport of the vessel to the storage position within the storage tunnel. It is also common practice to leave up side nozzles and particularly large openings, such as tube bundle ports, uncovered. Since considerable time has taken place since the E-H4 concentrators have been placed in storage, and since the vessels were not sealed closed, it is reasonable to assume that any residual heel left in vessel at the time of storage has evaporated.

IV. CONCLUSIONS

Based upon the logic and factual data presented above, it can be concluded that of the 17 vessels stored within the PUREX storage tunnels:

- 8 vessels had such small residual heels that they may be considered to be "empty" as defined in WAC 173-303-150(2a).
- 6 of the "non-empty" vessels had residual heels that would not be corrosive as defined in WAC 173-303-090(6a).
- 3 of the "non empty" vessels probably had corrosive residual heels at the time of storage, but due to evaporation over the years, these final three vessels have joined the "empty" category.

Therefore, there are no residual liquid heels currently in the PUREX storage tunnels that constitute being a dangerous waste.

V. FUTURE RESIDUAL HEELS

Operating procedures for preparation of failed equipment selected for storage within the PUREX Storage Tunnel will be revised to require adequate flushing, as verified by sample analysis, to assure any residual heel is not corrosive as defined in WAC 173-303-090(6a). Documentation of the flushing procedure followed and laboratory analysis obtained will be included as part of the storage records.

Prepared by: Robert V. Bowersock
R. V. Bowersock, Principal Engineer
PUREX Regulatory Compliance

Concurrence: G. J. LeBaron
G. J. LeBaron, Manager
PUREX Regulatory Compliance
27 Nov 89
Date

Roger J. Landon
R. J. Landon, Manager
Regulatory Analysis
1/19/90
Date

Approval: M. A. Payne
M. A. Payne, Manager
PUREX Facility
1/22/90
Date

3.19 (1989.09) Notes: Flushing of Equipment

The author of the notes is currently unknown; however, the notes are included for completeness.

(3 Pages)

9-7-89

Flushing of Equipment

Nov. '57 Trench Burial of HA Column

Extensive flushing between 11-26-57 to 11-30-57 (5 days ~100 hr)
"The flushes consisted of the following: steam, hot water, nitric acid, water, caustic-tartaric acid, water, oxalic acid, water, potassium permanganate-caustic, water, nitric acid-ferrous sulfamate, and water."
"Samples of flushes were not obtained due to a plugged jumper, hence data as to the progress of the decontamination were not obtained."

Apr. 19, 1961 F6 Concentrator for Storage in T1P6

A. Preparation
1. "Make sure the decontamination flushes are complete and that the concentrator is completely empty."
7. "Thoroughly flush the exterior of F6 but do not allow water to enter the top flange on the demister. Use hot water."

B. Concentrator Disposal
5. Install wood plugs in all nozzles of F6 (12 2"/3" nozzles listed)
8. Install covers on tube bundles wells and make up inspect nozzle.

May 22, 1968 Trench Burial of F-6 Tube Bundle

"The crane operator on the 12-8 shift has been instructed to flush down the F-6 Tube Bundle before putting it in the burial box. In doing so when the water hit the Tube Bundle a cloud of steam came causing the CRM in the crane to go up."

Flushing of Equip. Cont.

p.2
9-7-89

April 20, 1961 Trench Burial of 80 jumpers and 2 column cartridges (~43 ton)

"The jumpers and equipment discarded were pre-washed before deposit in the burial box."

March 23, 1970 FG Concentrator Stored in T2 R3 (3-19-70)

The failed FG concentrator was moved from F6 spot to F11 spot on 6/19/61. A water supply flex was installed from LL nozzle to FG110A and a jet was installed on the OD nozzle to jet flush water to the cell floor using FG97 as a steam supply. By trial and error it was determined a 30-minute water addition time would add 300 gal. of water which could be jetted out in 6 min. "This was done many, many times in the next 9 months."

In March, 1970, the concentrator was given two washdowns with the high pressure flushing wand.

On March 17, two failed tube bundles which had been chemically cleaned and flushed in the F17 decontamination capsule were moved from G4 storage spot to deck and given a high pressure water flush.

March 18, the pans were set on the burial car and filled with Speedy Dry.

During the burial, "The building tunnel was contaminated with loose, dry particles that read up to 500 R."

Flushing of Equip Cell

p.3
9-7-89

March 5, 1985 A3 Dissolver (Transport to pool cell storage) T2P11 4/18/86 ?

a) Leave dissolver lid in place

b) Install 16" blank on OG flange 'V'

c) install wooden plugs in nozzle (28)

d) Blank mercury nozzle 'AC' and 'L' (3" 'V')

e) Remove fuel pieces from dissolver "ledge"

f) Remote washdown of dissolver (exterior)

Now A3 Dissolver had new lid & new dissolver insert and reinstalled dissolver tower and moderator.

3.20 (1989.08) 12113-89-051

12113-89-051, 1989, "PUREX Tunnel Burial (218-E-15)," (internal memo from J.R. Rapoza and D.B. Lichy to D.G. Panther, August 7, 1989), Westinghouse Hanford Company, Richland, Washington.

Westinghouse Hanford Company

Internal Memo

From: PUREX / U03 Operations & Outage Planning 12113-89-051
Phone: 3-3543/3-2623
Date: AUGUST 7, 1989
Subject: **PUREX #2 TUNNEL BURIAL (218-E-15)**

To: D.G. Panther S5-66

cc:	R.V. Bowersock	S5-80	M.A. Payne	S5-66
	J.S. Hill	H4-57	B.E. Poremba	R1-35
	P.F. Kison	S5-65	G.R. Tardiff	S5-80
	T.R. Pauly	R2-93		
	JRR/DBL File/Lb			

On August 5, 1989, PUREX performed a burial in the #2 Burial Tunnel. The burial was made on railroad flat car PX-19 (old car #10A-19030). To eliminate the possibility of the car coupling to the car ahead of it and/or the brakes locking, the south coupler and the brakes of the burial flatcar were disabled.

EQUIPMENT BURIED:

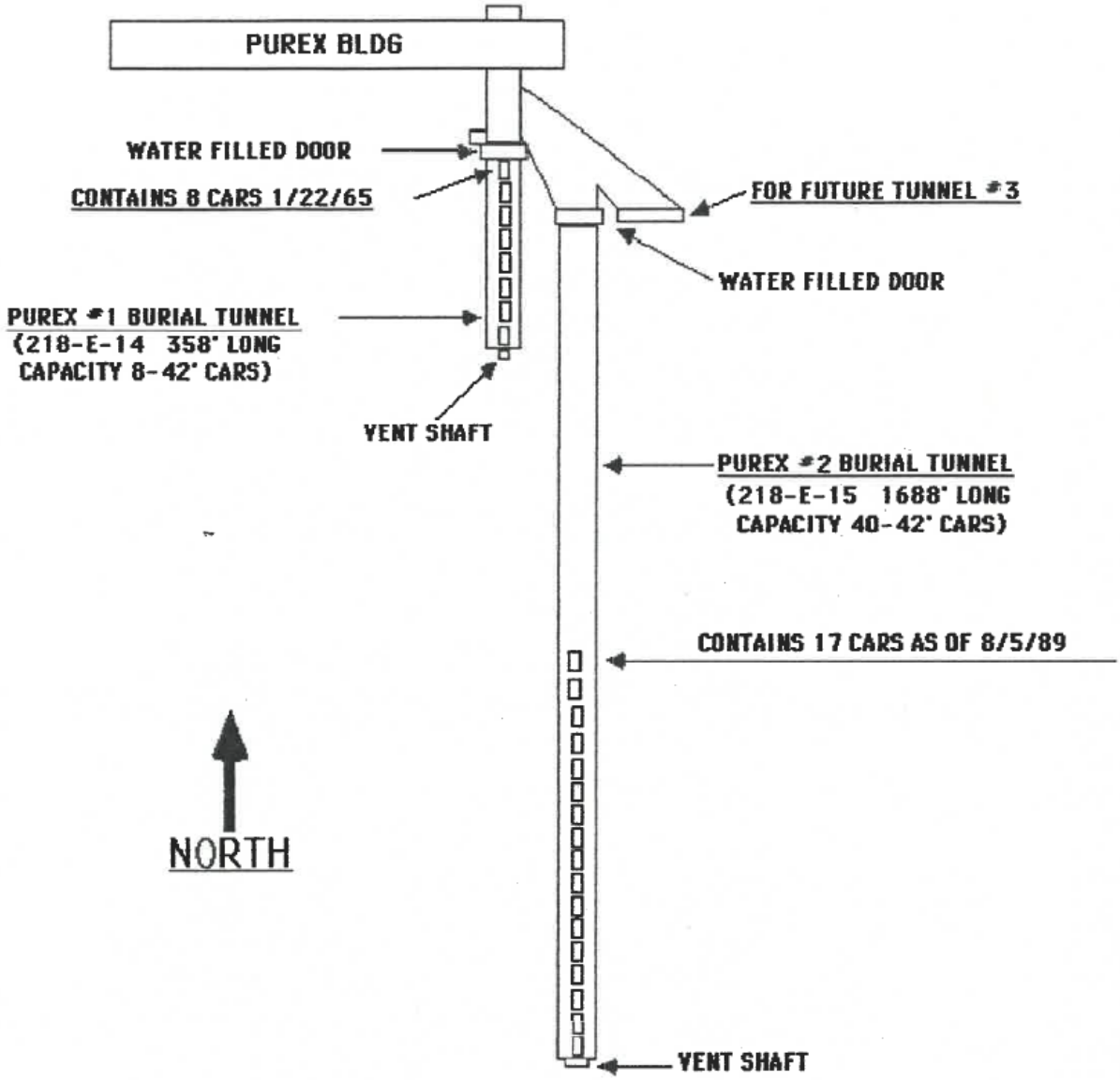
o Burial liner H2-65095 weighing 28,000#, containing miscellaneous canyon waste, cut up jumpers, six pumps and one agitator, was placed on the north end of RR flatcar PX-19.

o Burial liner H2-65095 weighing 23,000#, containing miscellaneous canyon waste, cut up jumpers, one pump and one #15 yoke, was placed on the south end of RR flatcar PX-19.

Purex #2 Burial Tunnel is located at the southeast end of the Purex building and is an extension of the railroad tunnel (See attachment#1). The storage area is approximately 1,688' long, 22' high and 34' wide. The tracks have a one percent downgrade toward the south end of the tunnel. The capacity of the burial tunnel is 38-40 railroad cars, at 40-42 feet in length. The #2 tunnel contains 17 cars as of August 8, 1989, (see attachment# 4).

J.R. Rapoza, Planner/Scheduler
PUREX/U03 Operations & Outage Planning
JRR

D.B. Lichy, Planner/Scheduler
PUREX/U03 Operations & Outage Planning

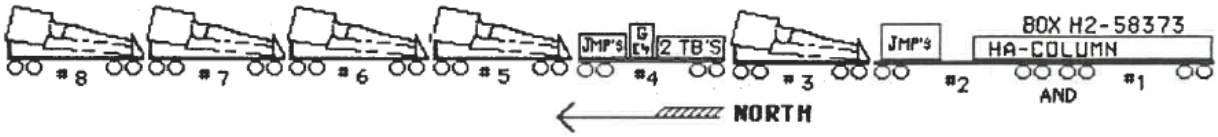


ATTACHMENT # 1

PUREX # 1 BURIAL TUNNEL (218-E-14)

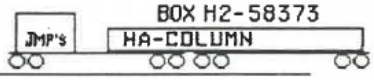
TUNNEL IS AT ITS CAPACITY AS OF 1/22/65

Purex # one Burial Tunnel is located at the southeast end of the Purex building and is an extension of the railroad tunnel. The storage area is approximately 358 feet long, 22 1/2 feet high and 19 feet wide. The tracks have a one percent downgrade toward the south end of the tunnel. The capacity of the Burial Tunnel is eight modified railroad car, 40 to 42 feet long.

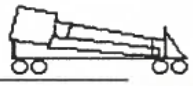


POSITION

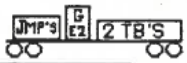
1 & 2. HA COLUMN AND MISC JUMPERS IN BOX
BURIED IN TUNNEL #1 ON 6/60
HA 4,700 CU. FT., 400 CURIES
JMPRS 2,190 CU.FT., 2,000 CURIES



3. E-F11 #1 (1WW WASTE) CONCENTRATOR FAILED 7/24/60.
BURIED IN TUNNEL #1 ON 7/29/60
1,900 CU. FT., 40,000 CURIES AFTER FIFTYFIVE MONTHS SERVICE



4. G-E2 CENTRIFUGE. MISC JUMPERS IN BOX AND TWO TUBE BUNDLES.
BURIED IN TUNNEL #1 ON 12/24/60 (FUGE SER#. 762)
2,465 CU. FT., 3,000 CURIES

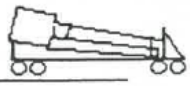


5. E-H4 (3WB) CONCENTRATOR FAILED 1/4/61.
BURIED IN TUNNEL #1 ON 1/4/61
2,336 CU. FT., 1,000 CURIES. AFTER FIVE YEARS SERVICE.

6. E-F6 (2WW WASTE) ORIGINAL CONCENTRATOR FAILED 4/21/61.
BURIED IN TUNNEL #1 ON 4/21/61
2,336 CU. FT., 700 CURIES. AFTER FIVE YEARS FOUR MONTHS SERVICE.

7. E-F11 (1WW WASTE) #2 CONCENTRATOR FAILED 2/1/62.
BURIED IN TUNNEL #1 ON 2/8/62
2,336 CU. FT., 40,000 CURIES. AFTER EIGHTEEN MONTHS SERVICE.

8. E-F6 (2WW WASTE) #2 SPARE CONCENTRATOR FAILED 5/23/64.
BURIED IN TUNNEL #1 ON 1/22/65 ON FLAT CAR 3621.
2,400 CU. FT., 700 CURIES.



ATTACHMENT # 2

PUREX # 2 BURIAL TUNNEL (218-E-15)

Purex # two Burial Tunnel is located at the southeast end of the Purex building and is an extention of the railroad tunnel. The storage area is approximately 1 688 feet long, 22 feet high and 34 feet wide. The tracks have a one percent down-grade toward the south end of the tunnel. The capacity of the Burial Tunnel is 38 -40 modified railroad cars, 40-42 feet long. The Tunnel contains 16 cars as of 4/6/88.

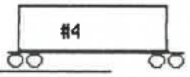
position

1. E-F6 #1 (2WW WASTE) CONCENTRATOR, TK F15-2, ONE TUBE BUNDLE AND AGITATOR MOTORS. BURIED IN TUNNEL ON 12/12/67 ON CAR 61439. 2,400 CU. FT., 700 CURIES.

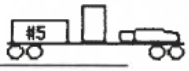
2. E-F6#5 (E-H4 3WB) CONCENTRATOR, TWO TUBE BUNDLES BURIED IN TUNNEL ON 3/26/69 ON CAR MILW 60883. 2,400 CU. FT., 500 CURIES.

3. E-F6#6 (2WW WASTE) CONCENTRATOR, TWO TUBE BUNDLES FAILED BURIED IN TUNNEL ON 3/19/70 ON CAR 3612. 2,400 CU. FT., 700 CURIES.

4. L CELL PACKAGE IN A SEALED STEEL BOX (H2-66012) BURIED IN TUNNEL ON 12/30/70 ON CAR MILW 60033 2,400 CU. FT., 500 GRMS PU.



5. F2 SILVER REACTOR, F6 DEMISTER, VESSEL VENT LINE STELL CAT-WALK AND GUARD RAILS. BURIED IN TUNNEL ON 2/26/71 ON GONDOLA CAR 4610. 2,400 CU. FT., 20 CURIES.



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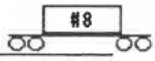
6. MODIFIED A3-1 TOWER, SCRUBBER, LID AND VAPOR LINE BURIED IN TUNNEL ON 12/12/71 ON GONDOLA CAR 4611. 2,400 CU.FT., 10 CURIES.

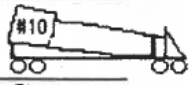
7. A3 DISSOLVER BURIED IN TUNNEL ON 12/22/71 ON NINE FT. SHORTENED CAR B58 2,400 CU. FT., 50 CURIES.

8. A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQUIPT. USED WITH THE SUSPECTED CANISTERS, ON CAR 19808 BURIED IN TUNNEL ON 8/29/72. 800 CU. FT., 17,500 CURIES.

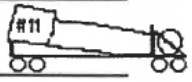


9. C3 DISSOLVER BURIED IN TUNNEL ON 9/30/72 ON CAR 19811 1590 CU. FT., 50 CURIES.

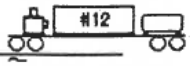
10. E-H4 (3WB) CONCENTRATOR, #61 TUBE BUNDLE, PROTOTYPE COOLING COIL AND A F-F1 FILTER TANK. BURIED IN TUNNEL 8/30/83 ON CAR CDX-1. 2,400 CU. FT., 500 CURIES.



11. A3 DISSOLVER (VESSEL # 10 AND HEATER (VESSEL #6) BURIED IN TUNNEL ON 1/18/86 ON CAR 3613 3,960 CU.FT., 0.81 CURIES.



12. WHITE BOX (H2-58456) CONTAINING EIGHT TUBE BUNDLES #'S 57, 60,62,64,67,68,74, AND 76. PULSER #5 AND OLD HEATER. DISS LID OLD STYLE DUMPING TRUNNIONS(9), BURIED IN TUNNEL ON 1/20/86 ON CAR 3611 . 5,438 CU. FT., 540 CURIES.



13. J5 TANK (VESSEL #30), F1 COND (VESSEL #13) AND F12-B CELL BLK. OLD FOUR-WAY DUMPER. DISS YOKE AND FLANGE PLATE. BURIED IN TUNNEL ON 1/21/86 ON CAR 19806. 2,500 CU. FT., 90 CURIES.

attachment # 3

PUREX #2 BURIAL TUNNEL (218-E-15)

POSITION

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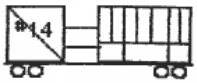
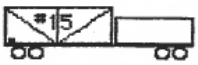
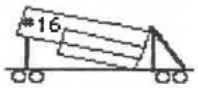
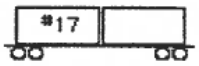
14.	L-1 PULSER, 2-COLUMN CARTRIDGES, 1-JUMPER CUTTER, 3-JUMPER ALIGNMENT TOOLS, 9-EXTERIOR DUMPING TRUNNIONS, 10-PUMPS, 3-AGITATORS, 4- TUBE BUNDLES, 2-VENT JUMPERS AND 7-YOKES. BURIED IN TUNNEL ON 11/18/87 ON CAR PX-10 (10A-19380) & RACK H2-96629. 50 TONS, 3,600 CU. FT., 33.750 CURIE (REF: LETTER 12110-88-074).	
15.	SILVER REACTOR, E-F2 STEAM HEATER AND BURIAL LINER(H2-65095) FULL OF CUT UP JUMPERS BURIED IN TUNNEL ON 5/13/88 ON CAR PX-9 (10A-19809) & S/R CRADLE SK-GLR-11-2-87. 20 TONS, 2,775 CU. FT., 240 CURIES (REF: LETTER 12110-88-074).	
16.	E-J8-1 UNITIZED CONCENTRATOR VESSEL #1 H2-52477, FAILED 3/11/89 PLACED ON BURIAL CAR H2-99608, PX-6 (10A-19028) AND INTO #2 TUNNEL 4/6/89 GRAVEYARDS. EST. 42 TONS, 6,000 CU. FT. 1.5 CURIES (REF: LETTER 12113-89-027).	
17.	NORTH BURIAL LINER H2-65095 CONTAINING SIX PUMPS, ONE AGITATOR AND CUT UP JUMPERS (14 TONS). SOUTH BURIAL LINER H2-65095 CONTAINING ONE PUMP, ONE #15 YOKE AND CUT UP JUMPERS (11.5 TONS). PLACED ON BURIAL CAR PX-19 (10A-19030) AND INTO #2 TUNNEL 8/5/89 DAYS. EST 25.5 TONS, 2,574 CU. FT. 3.0 CURIES. (REF: LETTER 12113-89-051)	

attachment # 4

3.21 (1989.04) 12113-89-027

12113-89-027, 1989, "PUREX #2 Tunnel Burial (218-E-15)," (internal memo from J.R. Rapoza and D.B. Lichy to W.E. Ross, April 7, 1989), Westinghouse Hanford Company, Richland, Washington.

Westinghouse Hanford Company

ATTACHMENT 4

Internal Memo

From: PUREX Maintenance Planning
Phone: 3-3543/3-2623 S5-66
Date: April 7, 1989
Subject: PUREX #2 TUNNEL BURIAL (218-E-15)

12113-89-027

To: W. E. Ross S5-66

cc: R. V. Bowersock ~~H4-57~~ S5-80
W. H. Harty, Jr. S5-66
T. R. Pauly R2-93
JRR/DBL File/Lb
M. A. Payne S5-66
B. E. Poremba R1-35
G. R. Tardiff S5-66
J. S. Hill H4-57

On April 6, 1989, PUREX performed a burial in the #2 Burial Tunnel. The burial was made on railroad flat car PX-6 (old car #10A-19028). The RR flatcar was modified by installing a steel deck with tipping and support cradles H-2-99608, Rev 0. To elimate the possibility of the car coupling to the car ahead of it and/or the brakes locking, the south coupler and brakes of the burial flatcar were disabled.

EQUIPMENT BURIED:

- E-J8-1 Unitized Concentrator H-2-52477, weighing approximately 40 tons, volume of 6,000 cubic feet and an estimated 1.5 curies (see attachment #4).
- Two each Yoke type #29 lifting rods and hooks H-2-99652.

PUREX #2 Burial Tunnel is located at the southeast end of the PUREX building and is an extension of the railroad tunnel (see attachment #1). The tracks have a one percent downgrade toward the south end of the tunnel. The storage area is approximately 1,688' long, 22' high and 34' wide. The capacity of the burial tunnel is 38-40 railroad cars, at 40-42' in length. The #2 Burial Tunnel contains sixteen (16) cars as of April 6, 1989, (see attachment #4).

J. R. Rapoza, Planner/Scheduler
PUREX Maintenance Planning

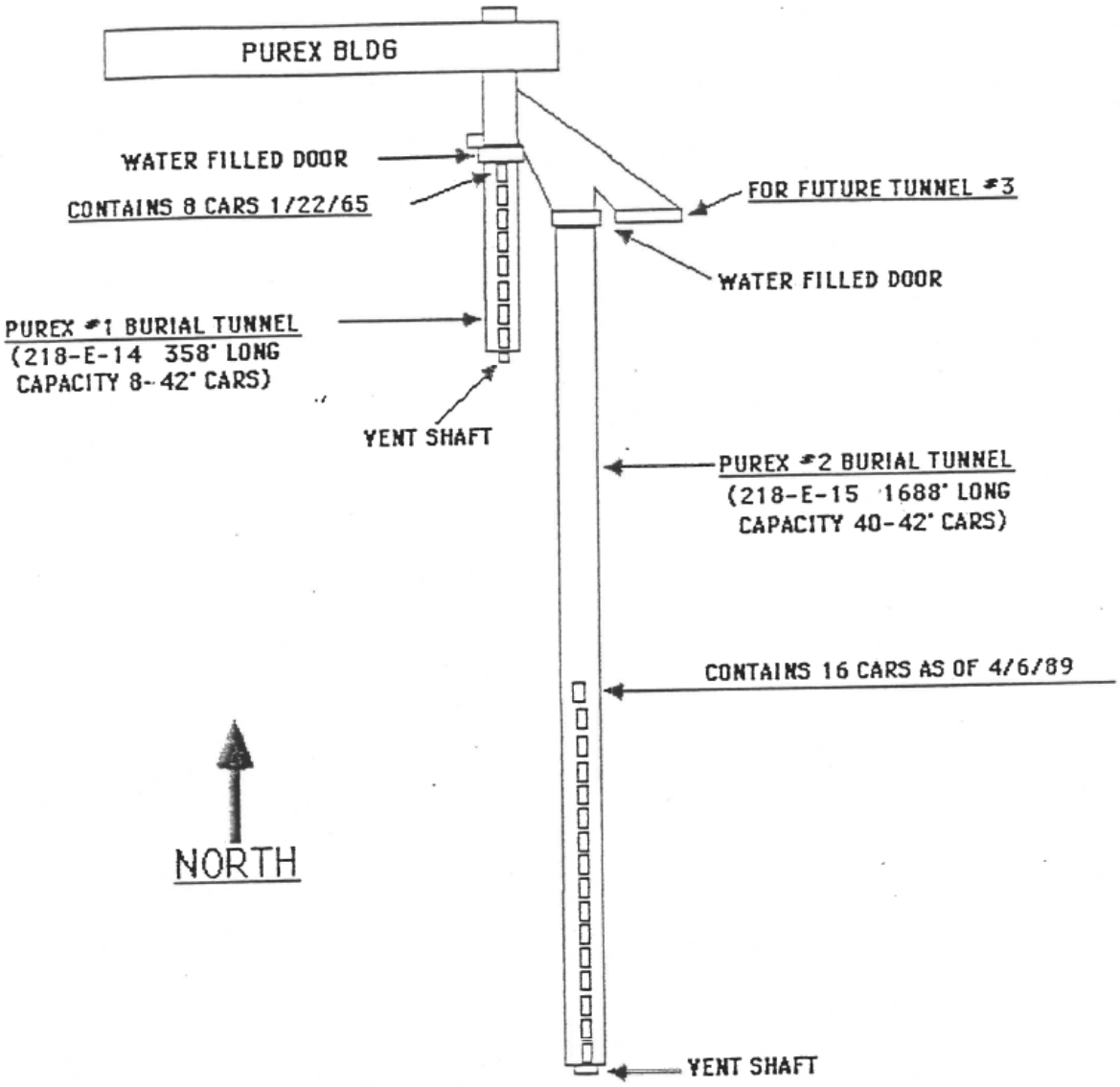
D. B. Lichy, Planner/Scheduler
PUREX Maintenance Planning

crm

12113

0.5 n/R @ 10 FT
x 3 = 1.5 CURIES

Attachments - 4

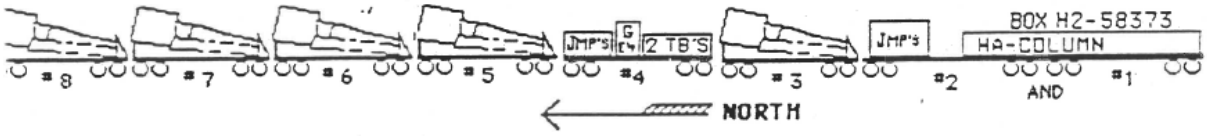


ATTACHMENT # 1

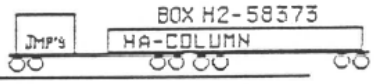
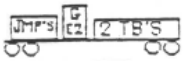
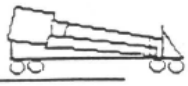
PUREX # 1 BURIAL TUNNEL (218-E-14)

TUNNEL IS AT ITS CAPACITY AS OF 1/22/65

Purex # one Burial Tunnel is located at the southeast end of the Purex building and is an extension of the railroad tunnel. The storage area is approximately 358 feet long, 22 1/2 feet high and 19 feet wide. The tracks have a one percent down-grade toward the south end of the tunnel. The capacity of the Burial Tunnel is eight modified railroad car, 40 to 42 feet long.



POSITION

1 & 2.	HA COLUMN AND MISC JUMPERS IN BOX BURIED IN TUNNEL #1 ON 6/60 HA 4,700 CU. FT., 400 CURIES JMPRS 2,190 CU.FT., 2,000 CURIES	
3.	E-F11 #1 (1WW WASTE) CONCENTRATOR FAILED 7/24/60. BURIED IN TUNNEL #1 ON 7/29/60 1,900 CU. FT., 40,000 CURIES AFTER FIFTYFIVE MONTHS SERVICE	
4.	G-E2 CENTRIFUGE. MISC JUMPERS IN BOX AND TWO TUBE BUNDLES. BURIED IN TUNNEL #1 ON 12/24/60 (FUGE SER# 762) 2,465 CU. FT., 3,000 CURIES	
5.	E-H4 (3WB) CONCENTRATOR FAILED 1/4/61. BURIED IN TUNNEL #1 ON 1/4/61 2,336 CU. FT., 1,000 CURIES. AFTER FIVE YEARS SERVICE.	
6.	E-F6 (2WW WASTE) ORIGINAL CONCENTRATOR FAILED 4/21/61. BURIED IN TUNNEL #1 ON 4/21/61 2,336 CU. FT., 700 CURIES. AFTER FIVE YEARS FOUR MONTHS SERVICE.	
7.	E-F11 (1WW WASTE) #2 CONCENTRATOR FAILED 2/1/62. BURIED IN TUNNEL #1 ON 2/8/62 2,336 CU. FT., 40,000 CURIES. AFTER EIGHTEEN MONTHS SERVICE.	
8.	E-F6 (2WW WASTE) #2 SPARE CONCENTRATOR FAILED 5/23/64. BURIED IN TUNNEL #1 ON 1/22/65 ON FLAT CAR 3621. 2,400 CU. FT., 700 CURIES.	

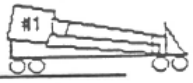
ATTACHMENT # 2

PUREX # 2 BURIAL TUNNEL (218-E-15)

Purex # two Burial Tunnel is located at the southeast end of the Purex building and is an extention of the railroad tunnel. The storage area is approximately 1 688 feet long, 22 feet high and 34 feet wide. The tracks have a one percent down-grade toward the south end of the tunnel. The capacity of the Burial Tunnel is 38 -40 modified railroad cars, 40-42 feet long. The Tunnel contains 16 cars as of 4/6/88.

position

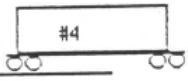
1. E-F6 #1 (2WW WASTE) CONCENTRATOR, TK F15-2, ONE TUBE BUNDLE AND AGITATOR MOTORS. BURIED IN TUNNEL ON 12/12/67 ON CAR 61439. 2,400 CU. FT., 700 CURIES.



2. E-F6#5 (E-H4 3WB) CONCENTRATOR, TWO TUBE BUNDLES BURIED IN TUNNEL ON 3/26/69 ON CAR MILW 60883. 2,400 CU. FT., 500 CURIES.

3. E-F6#6 (2WW WASTE) CONCENTRATOR, TWO TUBE BUNDLES FAILED BURIED IN TUNNEL ON 3/19/70 ON CAR 3612. 2,400 CU. FT., 700 CURIES.

4. L CELL PACKAGE IN A SEALED STEEL BOX (H2-66012) BURIED IN TUNNEL ON 12/30/70 ON CAR MILW 60033 2,400 CU. FT., 500 GRMS PU.

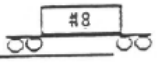


5. F2 SILVER REACTOR, F6 DEMISTER, VESSEL VENT LINE STELL CAT-WALK AND GUARD RAILS. BURIED IN TUNNEL ON 2/26/71 ON GONDOLA CAR 4610. 2,400 CU. FT., 20 CURIES.

6. MODIFIED A3-1 TOWER, SCRUBBER, LID AND VAPOR LINE BURIED IN TUNNEL ON 12/12/71 ON GONDOLA CAR 4611. 2,400 CU.FT., 10 CURIES.

7. A3 DISSOLVER BURIED IN TUNNEL ON 12/22/71 ON NINE FT. SHORTENED CAR B58 2,400 CU. FT., 50 CURIES.

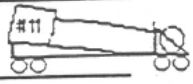
8. A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQUIPT. USED WITH THE SUSPECTED CANISTERS, ON CAR 19808 BURIED IN TUNNEL ON 8/29/72. 800 CU. FT., 17,500 CURIES.



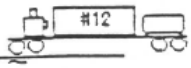
9. C3 DISSOLVER BURIED IN TUNNEL ON 9/30/72 ON CAR 19811 1590 CU. FT., 50 CURIES.

10. E-H4 (3WB) CONCENTRATOR, #61 TUBE BUNDLE, PROTOTYPE COOLING COIL AND A F-F1 FILTER TANK. BURIED IN TUNNEL 8/30/83 ON CAR CDX-1. 2,400 CU. FT., 500 CURIES.

11. A3 DISSOLVER (VESSEL # 10 AND HEATER (VESSEL #6) BURIED IN TUNNEL ON 1/18/86 ON CAR 3613 3,960 CU.FT., 0.81 CURIES.



12. WHITE BOX (H2-58456) CONTAINING EIGHT TUBE BUNDLES #'S 57, 60,62,64,67,68,74, AND 76. PULSER #5 AND OLD HEATER. DISS LID OLD STYLE DUMPING TRUNNIONS(9), BURIED IN TUNNEL ON 1/20/86 ON CAR 3611. 5,438 CU. FT., 540 CURIES.



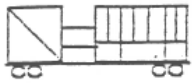
13. J5 TANK (VESSEL #30), F1 COND (VESSEL #13) AND F12-B CELL BLK. OLD FOUR-WAY DUMPER, DISS YOKE AND FLANGE PLATE. BURIED IN TUNNEL ON 1/21/86 ON CAR 19806. 2,500 CU. FT., 90 CURIES.

attachment # 3

PUREX #2 BURIAL TUNNEL (218-E-15)

POSITION

S

14.	L-1 PULSER, 2-COLUMN CARTRIDGES, 1-JUMPER CUTTER, 3-JUMPER ALIGNMENT TOOLS, 9-EXTERIOR DUMPING TRUNNIONS, 10-PUMPS, 3-AGITATORS, 4- TUBE BUNDLES, 2-VENT JUMPERS AND 7-YOKES. BURIED IN TUNNEL ON 11/18/87 ON CAR PX-10 (10A-19380) & RACK H2-96629. 50 TONS, 3,600 CU. FT., 33.750 CURIE (REF: LETTER 12110-88-074).	
15.	SILVER REACTOR, E-F2 STEAM HEATER AND BURIAL LINER(H2-65095) FULL OF CUT UP JUMPERS BURIED IN TUNNEL ON 5/13/88 ON CAR PX-9 (10A-19809) & S/R CRADLE SK-GLR-11-2-87. 20 TONS, 2,775 CU. FT., 240 CURIES (REF: LETTER 12110-88-074).	
16.	E-J8-1 UNITIZED CONCENTRATOR VESSEL #1 H2-52477, FAILED 3/11/89 PLACED ON BURIAL CAR H2-99608, PX-6 (10A-19028) AND INTO #2 TUNNEL 4/6/89 GRAVEYARDS. EST. 42 TONS, 6,000 CU. FT. 1.5 CURIES (REF: LETTER 12113-89-027).	

attachment # 4

3.22 (1988.06) Table: PUREX In Cell Equipment (Buried)

The table below was scanned in from a printed report from a dot matrix printer and has not been found in a released document to date.

This table confirms the information *FUG SER #762* provided in Figure 1-5, Tunnel 1 Position 4 is a serial number. See the following table, six rows down.

"PUREX IN CELL EQUIPMENT TABLE (BURIED)" JIM RAPOZA 3-3543

EQUIPT.	FAB'D ID/DISCRIP	VES #	PRES. POS.	F-NUMBER	AS-BUILT#	CONST. H2#	CVI	YOKE & #	ASSOC. EQUIPT.	COMMENTS
SILVER REACTOR	6475-2005-0-T-F2	5	BURIED	166665	H2-52555	H2-52467				"MFTR. MATT CORCORAN" BURIED NEAR T PLANT 1982. PET 79-128
SILVER REACTOR	1 T-A2-F2 MOD. J	2	BURIED	166015	H2-52555	H2-52467				"MFTR. MATT CORCORAN" BURIED IN TUNNEL# 2, 2/26/71.
OFF GAS HEATER (STEAM)	E-A2 #1 SPARE	06	BURIED	168845	H2-52530	H2-52473		# 1 H2-94263		FAILED, TUBE LEAKS, BURIED 1/18/86 IN # 2 TUNNEL ON RR CAR 3613.
CONCENTRATOR	E-H4-1	03	BURIED		H2-52532 H2-52536 H2-53537 H2-52550	H2-52477	8158			E-H4-1 CONC. FAILED 1/4/61, BURIED #1 TUNNEL 1/4/61
CONDENSER	E-F1 O.S. (OLD VESSEL#13)	23	BURIED	166736	H2-52551	H2-52480				INSTALLED IN E-F11-2, 5/15/70. ON DECK AT PUREX (OLD VESSEL# 13) BURIED IN BURIAL TUNNEL# 2, 1/21/86
CENTRIFUGE	0-G-E2 48" SOLIDS-LIQUID SER# 762	03	BURIED	028649	H2-53179	H2-52995 H2-52965	8406			IN BURIAL TUNNEL # 1 12/24/60, REMOVED FROM G-E2 POSITION.
CENTRIFUGE	0-G-G3 48" LIQUID-LIQUID SER# 766	09	BURIED ?	168727	H2-53180	H2-52995 H2-52965	8406		H2-53190, H2-58365 H2-53189,	CAN NOT LOCATE, COULD BE VESSEL # 8 PER J.C. WILLI.
CONCENTRATOR	E-F6 #6 SPARE (OLD VESSEL #4)	11	BURIED		H2-52532 H2-52536 H2-53537 H2-52550	H2-56213	8158			E-F6 (2WW) FAILED, BURIED #2 TUNNEL 3/19/70
CONCENTRATOR	E-F6 #1 SPARE	05	BURIED		H2-52532 H2-52536 H2-53537 H2-52550	H2-56213	8158			E-F6 (2WW) FAILED , BURIED #2 TUNNEL 12/12/67
CONCENTRATOR	E-F11 #1 SPARE	07	BURIED		H2-52532 H2-52536 H2-53537 H2-52550	H2-56213	8158			E-F11 #1 CONC. FAILED 7/24/60, BURIED #1 TUNNEL 7/29/60
CONCENTRATOR	E-F6 #5 SPARE (OLD VESSEL #3)	10	BURIED		H2-52532 H2-52536 H2-53537 H2-52550	H2-56213	8158			E-H4 FAILED, BURIED #2 TUNNEL 3/26/69
CONCENTRATOR	E-F6 #2 SPARE	06	BURIED		H2-52532 H2-52536 H2-53537 H2-52550	H2-56213	8158			E-F6 (2WW) FAILED 5/23/64, BURIED #1 TUNNEL 1/22/65
CONCENTRATOR	E-F6	04	BURIED		H2-52532 H2-52536 H2-53537 H2-52550	H2-56213	8158			E-F6 (2WW) FAILED 4/21/61, BURIED #1 TUNNEL 4/21/61
CONCENTRATOR	E-F11 #2 SPARE	08	BURIED		H2-52532 H2-52536 H2-53537 H2-52550	H2-56213	8158			E-F11 #2 CONC. FAILED 2/1/62, BURIED #1 TUNNEL 2/8/62

6/30/88 1

"PUREX IN CELL EQUIPMENT TABLE (BURIED)" JIM RAPOZA 3-3543

EQUIPT.	FAB'D ID/DISCRIP	VES #	PRES. POS.	F-NUMBER	AS-BUILT#	CONST. H2#	CVI	YOKE & #	ASSOC. EQUIPT.	COMMENTS
PULSER	PG-L1 #1 SMALL, N/A STROKE	53	BURIED	167480	H2-53177	H2-56910 STEARNS ROGERS			DUNNAGE H2-56912	INSTALLED IN L1 1/1/55, FAILED AND REMOVED 4/17/87 DAMAGED PISTON ROD,GUIDE BARS & YOKE. REMOVED GOOD MOTOR USED ON 1PG L1 #56. BURIED 11/17/87 #2 TUNNEL PX #10 RR CAR H2-96629.
FILTER	FI-A1 #4 SPARE	4	BURIED	182007	H2-52527	H2-56989	8488	#3 H2-94264 ASSY#1	YOKE# 11 H2-52485 SUPPORT DUNNAGE H2-56991.	REMOVED 7/19/83, BURIED IN TUNNEL #2 8/27/83.
CARTRIDGE		01	BURIED			H2-57684				FAILED, BURIED 11/18/87 ON RR CAR PX-10 IN #2 TUNNEL.
CARTRIDGE		03	BURIED			H2-58383				FAILED, BURIED 11/18/87 ON RR CAR PX-10 IN #2 TUNNEL.
OFF GAS HEATER (STEAM)	E-A2 #3 SPARE	04	BURIED	166084	H2-52530	H2-58514				FAILED 5/68, BURIED
OFF GAS HEATER (STEAM)	E-A2 #4 SPARE	05	BURIED	166164	H2-52530	H2-58514		# 1 H2-94263		INSTALLED 11/77, FAILED 11/22/84, BURIED 1/20/86 IN #2 TUNNEL ON RR CAR 3611.
DISSOLVER TOWER	2-T-A3-1 DOWN DRAFT CONDENSER	05	BURIED	222349	H2-59935	H2-58529				BURIED IN BURIAL TUNNEL #2 12/21/71 FROM "A" CELL.
DISSOLVER ANNULAR	TANK C3	03	BURIED		H2-59131	H2-59130	1			MODIFIED, FAILED 1/10/72. IN BURIAL TUNNEL # 2 8/30/72.
DISSOLVER ANNULAR	TANK A3	01	BURIED		H2-59926	H2-59925 H2-59927	1			IN BURIAL TUNNEL # 2 12/22/71.
TANK	TK-J5	30	BURIED	223676	H2-59968	H2-59968 H2-59969 H2-59970 H2-59971		#6 H2-94265		COIL FAILED, BURIED IN PUREX BURIAL TUNNEL #2 ON 1/21/86.
CONCENTRATOR RE-BOILER	6475-2005-5-TB -F6	CB-5	BURIED	NOT ISSUED	H2-58101	H2-66104				FLAT-BOTTOM DESIGN, INSTALLED IN E-H4-1 9/5/68, FAILED 8/23/83 BURIED IN TUNNEL# 2 8/30/83
DISSOLVER ANNULAR	TANK A3 #4 SPARE 6475-2005-4-TK -A3	10	BURIED	258501	H2-68280	H2-68280	1	OLD YOKE H2-59902 ASSY#2	TK-A3 # 3 SPARE TURNED OUT TO BE A MODERATOR (201M) H2-68273/74322.	INSTALLED 7/81, FAILED,REMOVED 3/17/85. IN BURIAL TUNNEL # 2, 1/18/86 ON RR CAR 3613.
PULSER	2 PG-G2 #2 LARGE, LONG STROKE	11	BURIED	168816		STEARNS ROGERS	7335			BURIED IN A K3 FILTER BOX 200E BURIAL GROUND 10/27/83.
PULSER	PG-H3 #2 LARGE, LONG STROKE	03	BURIED	167307	H2-53178	STEARNS ROGERS	7335			BURIED 4/1/84 BY J.A.J. PIECES THAT WHERE IN HOT SHOP.

6/30/88 2

"PUREX IN CELL EQUIPMENT TABLE (BURIED)" JIM RAPOZA 3-3543

EQUIPT.	FAB'D ID/DISCRIP	VES #	PRES. POS.	F-NUMBER	AS-BUILT#	CONST. H2#	CVI	YOKE & #	ASSOC. EQUIPT.	COMMENTS
PULSER	PG-J6 #2 LARGE, LONG STROKE	05	BURIED	167100	H2-53178	STEARNS ROGERS	7335			BURIED IN R.R. TUNNEL #2 ON CAR #3611,1/20/86.

6/30/88 3

3.23 (1988.05) 12110-88-074

12110-88-074, 1988, "PUREX #2 Tunnel Burial (218-3-15)," (internal memo from J.R. Rapoza and D.B. Lichy to P.G. Martell, May 13, 1988), Westinghouse Hanford Company, Richland, Washington.

Westinghouse
Hanford Company

Internal
Memo

From: PUREX Production Control
Phone: 3-3543/3-2623
Date: May 13, 1988
Subject: PUREX #2 TUNNEL BURIAL (218-3-15)

12110-88-074

To: P. G. Martell S5-66

cc: B. R. Dickey S5-66
W. H. Harty, Jr. S5-66
T. R. Pauly R2-93
B. E. Poremba R1-35
G. R. Tardiff S5-66

On November 18, 1987 PUREX performed a burial in the #2 Burial Tunnel. The burial was made on railroad flat car PX-10 (old car #10A-19380) a steel deck car with burial rack H-2-96629, Rev-0. The south coupler and the brakes of the burial flatcar were disabled so as not to allow coupling to the car ahead of it or the brakes locking. Contents weighing approximately 50 tons, volume of 3,600 cubic feet and an estimated 33,750 curies.

Containing the following items:

2 each COLUMN CARTRIDGES (ID unknown)
1 each L-1 PULSER (Pulser #53)
1 each JUMPER CUTTER and STORAGE RACK
3 each JUMPER ALIGNMENT TOOLS (Weights)
9 each EXTERIOR DUMPING TRUNNIONS (H-2-94402)
10 each PUMPS (J 13P-D5; 36, 62, 64, 65, 68, 69 and 70P-F13; 1 and 2P-H1
3 each AGITATORS (13A-D2, 35 and 45A-E3)
4 each TUBE BUNDLES (#75, 77, 78 and 80)
2 each VENT JUMPERS (H-2-56623 and 53955)
7 each YOKES (#3 H-2-52458, #8 H-2-52458, #19 H-2-94270/58108, #6 H-2-52458, #11A H-2-53458, #10 H-2-52458)

On May 13, 1988 PUREX performed a burial in the #2 Burial Tunnel. The burial was made on railroad flatcar PX-9 (old car #10A-19809) with burial cradle SK-GLR-11-2-87. The south coupler and the brakes of the burial flatcar were disabled so as not to allow coupling to the car ahead of it or the brakes locking. Contents weighting approximately 20 tons, volume of 2,775 cubic feet and an estimated 240 curies

Containing the following items:

5T-A2 #5 SPARE Silver Reactor
Burial Liner Full of Jumpers
E-F2 Steam Heater (E-A2 #5 SPARE)

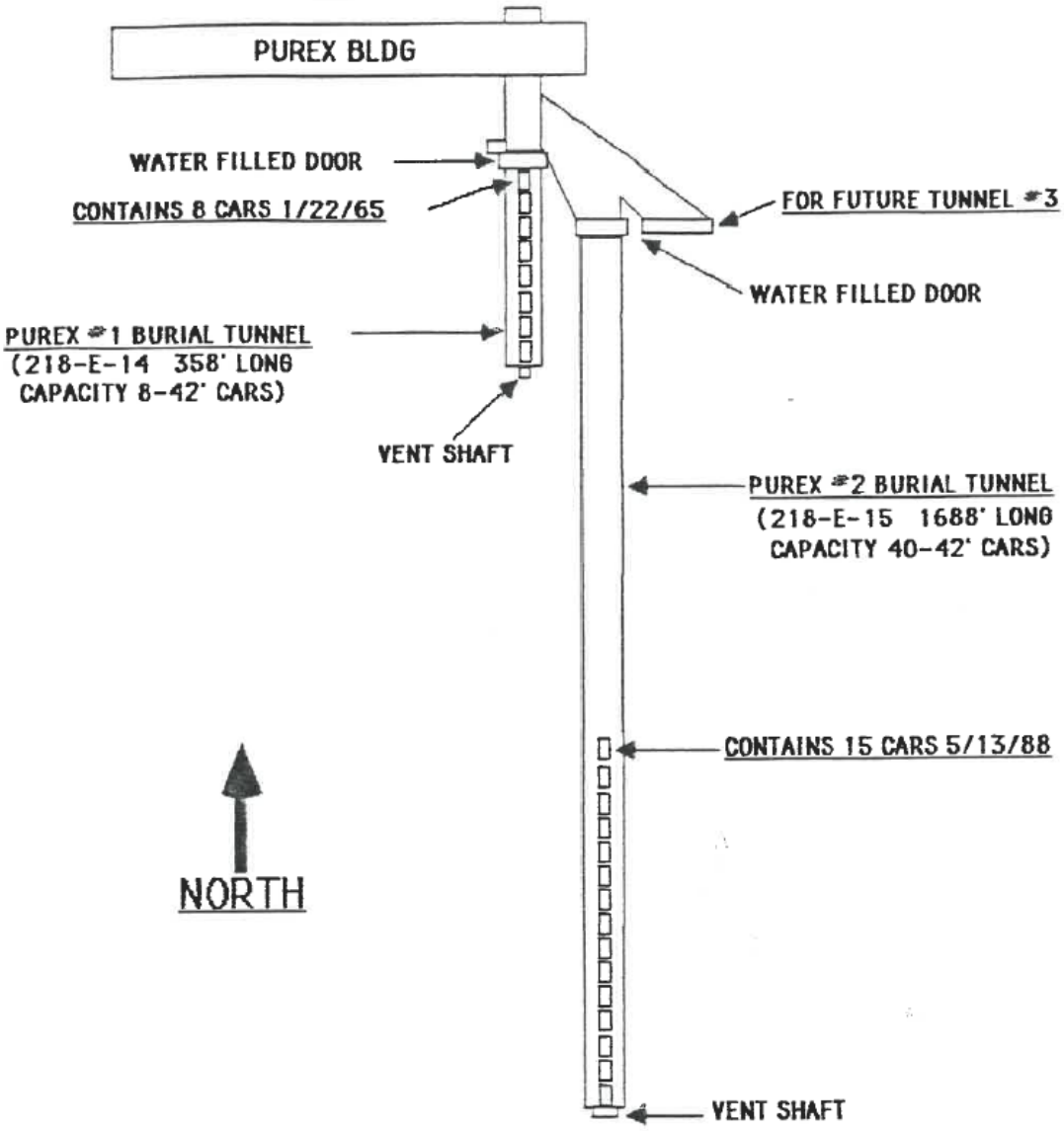
P. G. Martell
Page 2
May 13, 1988

PUREX #2 Burial Tunnel is located at the southeast end of the PUREX building and is an extension of the railroad tunnel (see Attachment #1). The storage area is approximately 1,688 feet long, 22 feet high and 34 feet wide. The tracks have a one percent downgrade toward the south end of the tunnel. The capacity of the Burial Tunnel is 38-40 railroad cars, 40-42 feet in length. The #2 tunnel contains 15 cars as of May 13, 1988.

J. R. Rapoza, Planner/Scheduler
PUREX Production Control

D. B. Lichy, Planner/Scheduler
PUREX Production Control

emd

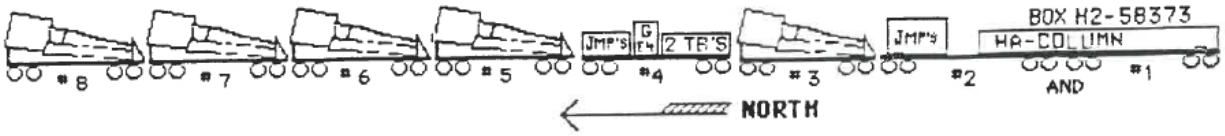


ATTACHMENT# 1

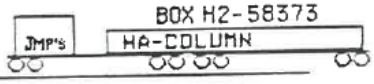
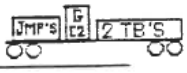
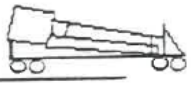
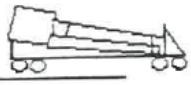
PUREX # 1 BURIAL TUNNEL (218-E-14)

TUNNEL IS AT ITS CAPACITY AS OF 1/22/65

Purex # one Burial Tunnel is located at the southeast end of the Purex building and is an extension of the railroad tunnel. The storage area is approximately 358 feet long, 22 1/2 feet high and 19 feet wide. The tracks have a one percent down-grade toward the south end of the tunnel. The capacity of the Burial Tunnel is eight modified railroad car, 40 to 42 feet long.



POSITION

1 & 2.	HA COLUMN AND MISC JUMPERS IN BOX BURIED IN TUNNEL #1 ON 6/60 HA 4,700 CU. FT., 400 CURIES JMPRS 2,190 CU.FT., 2,000 CURIES	
3.	E-F11 #1 (1WW WASTE) CONCENTRATOR FAILED 7/24/60. BURIED IN TUNNEL #1 ON 7/29/60 1,900 CU. FT., 40,000 CURIES AFTER FIFTYFIVE MONTHS SERVICE	
4.	G-E2 CENTRIFUGE. MISC JUMPERS IN BOX AND TWO TUBE BUNDLES. BURIED IN TUNNEL #1 ON 12/24/60 (FUGE SER# 762) 2,465 CU. FT., 3,000 CURIES	
5.	E-H4 (3WB) CONCENTRATOR FAILED 1/4/61. BURIED IN TUNNEL #1 ON 1/4/61 2,336 CU. FT., 1,000 CURIES. AFTER FIVE YEARS SERVICE.	
6.	E-F6 (2WW WASTE) ORIGINAL CONCENTRATOR FAILED 4/21/61. BURIED IN TUNNEL #1 ON 4/21/61 2,336 CU. FT., 700 CURIES. AFTER FIVE YEARS FOUR MONTHS SERVICE.	
7.	E-F11 (1WW WASTE) #2 CONCENTRATOR FAILED 2/1/62. BURIED IN TUNNEL #1 ON 2/8/62 2,336 CU. FT., 40,000 CURIES. AFTER EIGHTEEN MONTHS SERVICE.	
8.	E-F6 (2WW WASTE) #2 SPARE CONCENTRATOR FAILED 5/23/64. BURIED IN TUNNEL #1 ON 1/22/65 ON FLAT CAR 3621. 2,400 CU. FT., 700 CURIES.	

ATTACHMENT # 2

PUREX # 2 BURIAL TUNNEL (218-E-15)

Purex # two Burial Tunnel is located at the southeast end of the Purex building and is an extention of the railroad tunnel. The storage area is approximately 1688 feet long, 22 feet high and 34 feet wide. The tracks have a one percent downgrade toward the south end of the tunnel. The capacity of the Burial Tunnel is 38-40 modified railroad cars, 40-42 feet long. The Tunnel contains 15 cars as of 5/13/88.

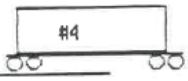
position

1. E-F6 #1 (2WW WASTE) CONCENTRATOR, TK F15-2, ONE TUBE BUNDLE AND AGITATOR MOTORS. BURIED IN TUNNEL ON 12/12/67 ON CAR 61439. 2,400 CU. FT., 700 CURIES.

2. E-F6#5 (E-H4 3WB) CONCENTRATOR, TWO TUBE BUNDLES BURIED IN TUNNEL ON 3/26/69 ON CAR MILW 60883. 2,400 CU. FT., 500 CURIES.

3. E-F6#6 (2WW WASTE) CONCENTRATOR, TWO TUBE BUNDLES FAILED BURIED IN TUNNEL ON 3/19/70 ON CAR 3612. 2,400 CU. FT., 700 CURIES.

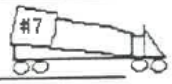
4. L CELL PACKAGE IN A SEALED STEEL BOX (H2-66012) BURIED IN TUNNEL ON 12/30/70 ON CAR MILW 60033 2,400 CU. FT., 500 GRMS PU.



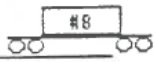
5. F2 SILVER REACTOR, F6 DEMISTER, VESSEL VENT LINE STELL CAT-WALK AND GUARD RAILS. BURIED IN TUNNEL ON 2/26/71 ON GONDOLA CAR 4610. 2,400 CU. FT., 20 CURIES.

6. MODIFIED A3-1 TOWER, SCRUBBER, LID AND VAPOR LINE BURIED IN TUNNEL ON 12/12/71 ON GONDOLA CAR 4611. 2,400 CU.FT., 10 CURIES.

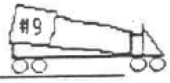
7. A3 DISSOLVER H-2-59925 thru 59927 Check Dwgs. for Hg in Dissolvers BURIED IN TUNNEL ON 12/22/71 ON NINE FT. SHORTENED CAR B58 2,400 CU. FT., 50 CURIES.



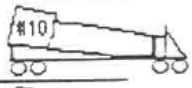
8. A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQUIPT. USED WITH THE SUSPECTED CANISTERS, ON CAR 19808 BURIED IN TUNNEL ON 8/29/72. 800 CU. FT., 17,500 CURIES.



9. C3 DISSOLVER ~~H-2-75760 for how much Hg in dissolvers~~ BURIED IN TUNNEL ON 9/30/72 ON CAR 19811 1590 CU. FT., 50 CURIES. ~~H-2-75760~~ ~~H-2-94406~~ H-259130

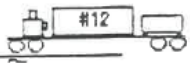


10. E-H4 (3WB) CONCENTRATOR, #61 TUBE BUNDLE, PROTOTYPE COOLING COIL AND A F-F1 FILTER TANK. BURIED IN TUNNEL 8/30/83 ON CAR CDX-1. 2,400 CU. FT., 500 CURIES.



11. A3 DISSOLVER (VESSEL # 10 AND HEATER (VESSEL #6) H-2-68280 BURIED IN TUNNEL ON 1/18/86 ON CAR 3613 3,960 CU.FT., 0.81 CURIES.

12. WHITE BOX (H2-58456) CONTAINING EIGHT TUBE BUNDLES #'S 57, 60,62,64,67,68,74, AND 76. PULSER #5 AND OLD HEATER. DISS LID OLD STYLE DUMPING TRUNNIONS(9), BURIED IN TUNNEL ON 1/20/86 ON CAR 3611. 5,438 CU. FT., 540 CURIES.



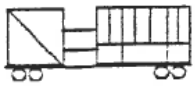
13. J5 TANK (VESSEL #30), F1 COND (VESSEL #13) AND F12-B CELL BLK. OLD FOUR-WAY DUMPER, DISS YOKE AND FLANGE PLATE. BURIED IN TUNNEL ON 1/21/86 ON CAR 19806. 2,500 CU. FT., 90 CURIES.

attachment # 3

PUREX #2 BURIAL TUNNEL (218-E-15)

POSITION

14. L-1 PULSER, 2-COLUMN CARTRIDGES, 1-JUMPER CUTTER, 3-JUMPER ALIGNMENT TOOLS, 9-EXTERIOR DUMPING TRUNNIONS, 10-PUMPS, 3-AGITATORS, 4- TUBE BUNDLES, 2-VENT JUMPERS AND 7-YOKES. BURIED IN TUNNEL ON 11/18/87 ON CAR PX-10 (10A-19380) & RACK H2-96629. 50 TONS, 3,600 CU. FT., 33.750 CURIE (REF: LETTER 12110-88-074).



15. SILVER REACTOR, E-F2 STEAM HEATER AND BURIAL LINER(H2-65095) FULL OF CUT UP JUMPERS BURIED IN TUNNEL ON 5/13/88 ON CAR PX-9 (10A-19809) & S/R CRADLE SK-GLR-11-2-87. 20 TONS, 2,775 CU. FT., 240 CURIES (REF: LETTER 12110-88-074).

S

attachment # 4

3.24 (1988.01) WIDS

The pages below were obtained from the Waste Information Data System (WIDS) in 1988.

WASTE INFORMATION DATA SYSTEM

RADIONUCLIDE INVENTORY

FOR

218-E-14

(in curies)

H-3:	0.00000	Ce-141:	0.00000
C-14:	0.00000	Ce-144:	0.00000
Mn-54:	0.00000	Pr-144:	0.00000
Co-60:	0.00000	Pm-147:	0.00000
Ni-63:	0.00000	Eu-152:	0.00000
Kr-85:	0.00000	Eu-154:	0.00000
Sr-90:	915.50000	Eu-155:	0.00000
Y-91:	0.00000	Th-232:	0.00000
Nb-95:	0.00000	U-233:	0.00000
Zr-95:	0.00000	U-234:	0.00000
Tc-99:	0.00000	U-235:	0.00000
Ru-103:	0.00000	U-238:	0.00000
Ru-106:	0.00006	Np-237:	0.00000
Sn-113:	0.00000	Pu-238:	0.00000
Sb-125:	0.00000	Pu-239:	0.00000
I-129:	0.00000	Pu-240:	0.00000
Am-241:	0.00000	Pu-241:	0.00000
Cs-134:	0.00000	Pu-242:	0.00000
Cs-137:	1019.00000	Co-58:	0.00000
Fe-59:	0.00000	Na-22:	0.00000

Inventory Total U (curies) :	0.00000
Inventory Total Pu (curies) :	0.00000
Site Reported Total (curies) :	3810.00000
Total Reported Alpha (curies) :	0.00000
Total Reported Beta (curies) :	3950.00000
Total Reported Gamma (curies) :	0.00000

Total volume disposed (cu. m.): 563

These values are decayed through : 09/30/87

Last Updated : January 27, 1988

Note: Interpret zero entries as implying an absence of data or the possibility of a trace activity level.

WIDS

SITE NAME 218-E-14 Page 3

COMMENTS :

Contents of the burial ground:

Tunnel 1	Car Position	Date	Vol (cu ft)	Decayed MFP (ci)
	1 & 2	6/60	6,190	2,400
	3	7/29/60	1,900	40,000
	4	12/23/60	2,465	3,000
	5	1/5/61	2,336	1,000
	6	4/21/61	2,336	700
	7	2/1/62	2,336	40,000
	8	5/23/64	2,400	700

WIDS

SITE NAME 218-E-15 Page 3

COMMENTS :

Contents:
Tunnel 2

Car Position	Date	Volume (cu ft)	Decayed MFP	Pu (gms)
1	12/12/67	2,400	700	-
2	3/26/69	2,400	500	-
3	3/19/70	2,400	700	-
4	12/30/70	2,400	-	-
5	2/26/71	2,400	20	<500
6	12/21/71	2,400	10	-
7	12/22/71	2,400	50	-
8	8/29/72	800	17,500	-
9	9/30/72	1,594	50	

WASTE INFORMATION DATA SYSTEM

RADIONUCLIDE INVENTORY

FOR

218-E-15

(in curies)

H-3:	0.00000	Ce-141:	0.00000
C-14:	0.00000	Ce-144:	0.00000
Mn-54:	0.00000	Pr-144:	0.00000
Co-60:	0.00000	Pm-147:	0.00000
Ni-63:	0.00000	Eu-152:	0.00000
Kr-85:	0.00000	Eu-154:	0.00000
Sr-90:	8742.00000	Eu-155:	0.00000
Y-91:	0.00000	Th-232:	0.00000
Nb-95:	0.00000	U-233:	0.00000
Zr-95:	0.00000	U-234:	0.00000
Tc-99:	0.00000	U-235:	0.00000
Ru-103:	0.00000	U-238:	0.00000
Ru-106:	0.53980	Np-237:	0.00000
Sn-113:	0.00000	Pu-238:	1.36000
Sb-125:	0.00000	Pu-239:	28.42820
I-129:	0.00000	Pu-240:	7.03780
Am-241:	0.00000	Pu-241:	19.69500
Cs-134:	0.00000	Pu-242:	0.00040
Cs-137:	9570.00000	Co-58:	0.00000
Fe-59:	0.00000	Na-22:	0.00000

Inventory Total U (curies) :	0.00000
Inventory Total Pu (curies) :	56.52140
Site Reported Total (curies) :	36760.00000
Total Reported Alpha (curies) :	0.00000
Total Reported Beta (curies) :	893.00000
Total Reported Gamma (curies) :	0.00000

Total volume disposed (cu. m.): 541

These values are decayed through : 09/30/87

Last Updated : January 27, 1988

Note: Interpret zero entries as implying an absence of data or the possibility of a trace activity level.

3.25 (Unknown) Pages from J-1866-10

This excerpt was found in a file cabinet containing other tunnel-related documentation. A full copy of the report has yet to be located.

From reviewing documents in IDMS, it appears that J-1866 was a prefix used by the company Hart Crowser who was contracted to prepare environmental related documentation in the late 1980s. This is all that is currently known about these data.

3.9.1.4 Description of the Storage Unit

Tables 3.9.1 and 3.9.2 below present inventories of the failed equipment currently stored in the PUREX tunnels.

TABLE 3.9.1

PUREX NUMBER 1 BURIAL TUNNEL INVENTORY

Burial Car No.	Burial Date	Contents
1 & 2	06/60	HA Separations Column Box of Miscellaneous Jumpers
3	7/24/60	E-F11, 1WW Waste Cencentrator
4	12/24/60	G-E4 Centrifuge Two Concentrator Tube Bundles Box of Miscellaneous Jumpers
5	1/4/61	E-H4, 3WB Concentrator
6	4/21/61	E-F6, 2WW Waste Concentrator
7	2/8/62	E-F11, 1WW Waste Concentrator
8	1/22/65	E-F6, 1WW Waste Concentrator

J-1866-10
Page 3

TABLE 3.9.2
PUREX NUMBER 2 BURIAL TUNNEL INVENTORY

Burial Car No.	Burial Date	Contents
1	12/12/67	E-F6, 1WW Concentrator One Concentrator Tube Bundle F15-2 Tank
2	3/26/69	E-H4, 3WB Concentrator Two Concentrator Tube Bundles
3	3/19/70	E-F6 Concentrator Two Concentrator Tube Bundles
4	12/30/70	Sealed Steel Box, L Cell Package
5	2/26/71	F2 Silver Reactor F6 Demister Guard Rails, Platforms, Vent Lines, Tripods
6	12/21/71	Modified A3-1 Tower and Scrubber Modified Lid and Vapor Line
7	12/22/71	A-3 Annular Dissolver on Shortened Car
8	8/29/72	Steel Liner Box, End of A1W1 Fuels Carbon Steel Apron and Carrier from NPR
9	9/30/72	C-3 Annular Dissolver on Shortened Car
10	8/30/83	E-H4, 3WB Concentrator, Prototype Cooling Coil, F-F1 Filter Tank
11	1/18/86	Dissolver Tipping Cradle and Yoke, A-3 Annular Dissolver, Steam Heater
12	1/20/86	Eight Tube Bundles, Dissolver Lid and Dumping Trunnions, Pulse Generator, Steam Heater
13	1/21/86	Tank J-5, F-1 Condenser, F-12 Cell Block, Dissolver Yoke, Flange Plate, Dissolver Four-Way Dumper

3.26 (1986.02) 37200-86-017

37200-86-017, 1986, "PUREX Tunnel Burials," (internal letter from D.B. Lichy and J.R. Rapoza to P.G. Martell, February 24, 1986), Rockwell Hanford Operations, Richland, Washington.

Glenn / Jim / Buescher / RAV

Internal Letter

Rockwell International

Date: February 24, 1986

No. 37200-86-017

TO: (Name, Organization, Internal Address)
P. G. Martell

FROM: (Name, Organization, Internal Address, Phone)
D. B. Lichy
J. R. Rapoza

Subject: PUREX Tunnel Burials

On the January 18, 20, and 21, 1986, PUREX performed three burials in the #2 Burial Tunnel. The burials were made on railroad flat bed cars that were to be disposed of because of obsolete brakes. The south coupler and brakes of each burial railroad car were disabled so as not to allow coupling to the car ahead of it or the brakes locking.

Reference: Attachment #3.

The January 18, 1986 burial using railroad car #3613 with a tipping cradle welded to it, had contents weighing approximately 40 tons, a volume of 3.960 cubic feet, and an estimated 0.81 curies.
Containing the following items:
- Dissolver Tipping Cradle and Yoke
- A3 Dissolver (vessel #10)
- Steam heater (vessel #6)

3,960?

The January 20, 1986 burial using railroad car #3611, with transfer box (H-2-58456) had contents weighing approximately 60 tons, a volume of 5,438 cubic feet, and an estimated 540 curies.
Containing the following items:
- Eight Tube Bundles, #'s 57, 60, 62, 64, 67, 68, 74, and 76
- Dissolver Lid and (9) Dumping Trunnions
- Pulser #5
- An old Steam Heater

The January 21, 1986 burial using railroad car #19806, had contents weighing approximately 75 tons, a volume of 2,500 cubic feet, and an estimated 90 curies.
Containing the following items:
- Tank J5 (vessel #30)
- F1 Condenser (vessel #13)
- F12-B Cell Block
- Dissolver Four-Way Dumper
- Dissolver Yoke
- Flange Plate

RECEIVED
R.A. VAN METER
FEB 24 1986
ACTION
ROUTE
COPIES
FILE

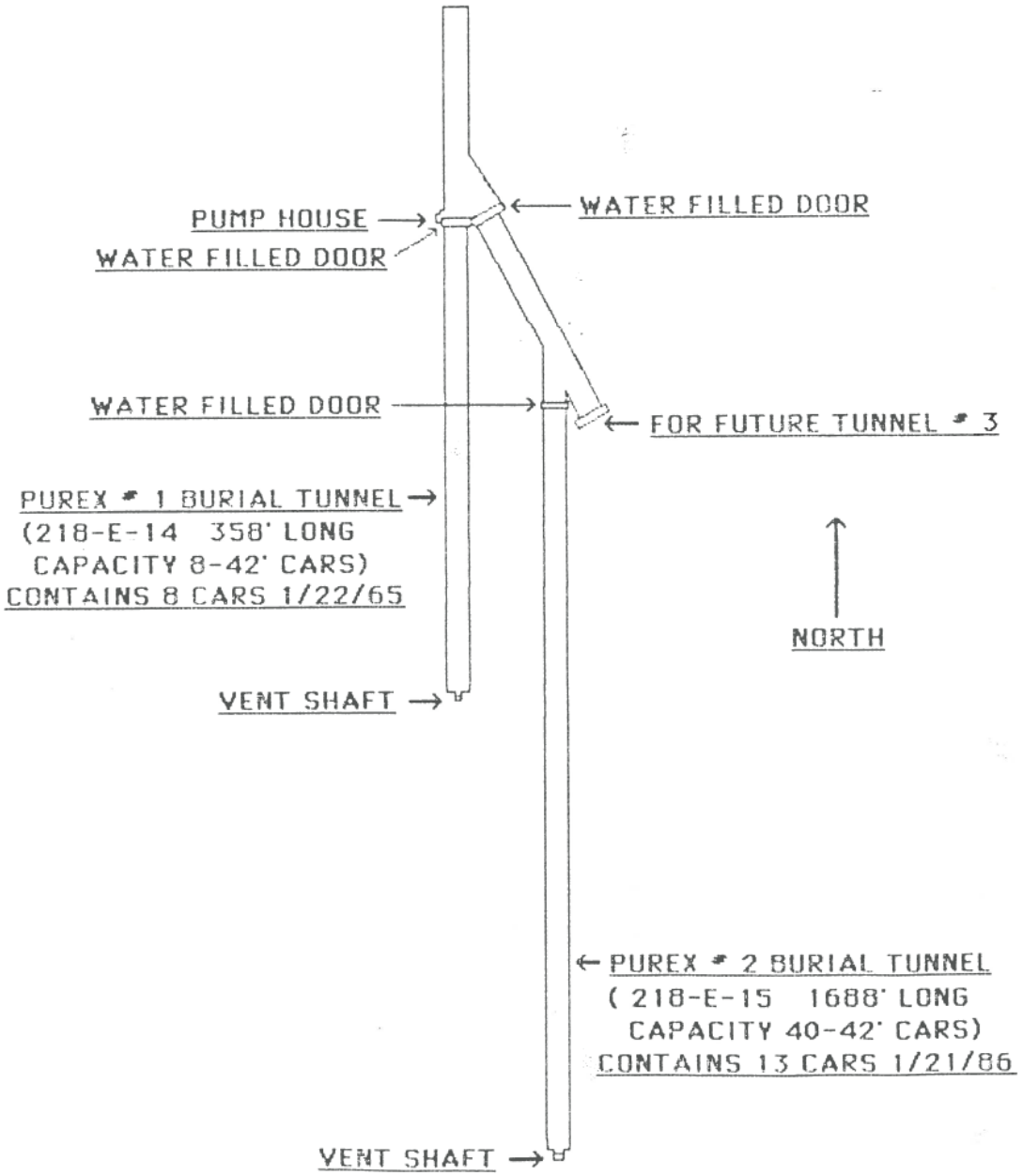
It should be noted that this is not an easy task to perform, and completing three such burials in four days shows an excellent job done by all.

D. B. Lichy, Rem. Maint. Planner
PUREX Maint. Planning & Control

J. R. Rapoza, Senior Planner
PUREX Maint. Planning & Control

DBL/JRR/vh

cc: G. T. Dukelow W. M. Harty B. E. Poremba R. A. Van Meter J. A. Voogd

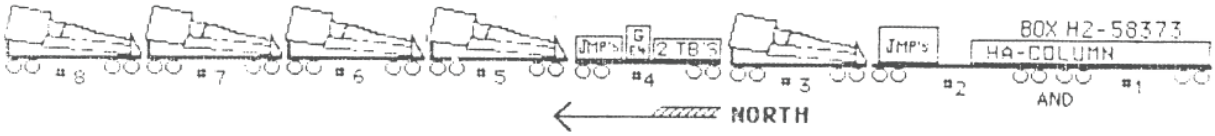


ATTACHMENT # 1

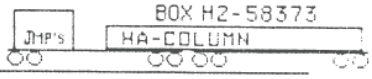
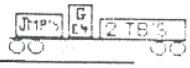
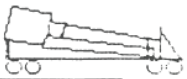
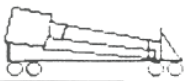
PUREX # 1 BURIAL TUNNEL (218-E-14)

TUNNEL IS AT ITS CAPACITY AS OF 1/22/65

Purex # one Burial Tunnel is located at the southeast end of the Purex building and is an extension of the railroad tunnel The storage area is approximately 358 feet long, 22 1/2 feet high and 19 feet wide. The tracks have a one percent down-grade toward the south end of the tunnel. The capacity of the Burial Tunnel is eight modified railroad car, 40 to 42 feet long.



POSITION

1 & 2.	HA COLUMN AND MISC JUMPERS IN BOX BURIED IN TUNNEL #1 ON 6/60 HA 4,700 CU. FT., 400 CURIES JMPRS 2,190 CU.FT., 2,000 CURIES	
3.	E-F11 #1 (1WW WASTE) CONCENTRATOR FAILED 7/24/60. BURIED IN TUNNEL #1 ON 7/29/60 1,900 CU. FT., 40,000 CURIES AFTER FIFTYFIVE MONTHS SERVICE	
4.	G-E4 CENTRIFUGE. MISC JUMPERS IN BOX AND TWO TUBE BUNDLES. BURIED IN TUNNEL #1 ON 12/24/60 2,465 CU. FT., 3,000 CURIES	
5.	E-H4 (3WB) CONCENTRATOR FAILED 1/4/61. BURIED IN TUNNEL #1 ON 1/4/61 2,336 CU. FT., 1,000 CURIES. AFTER FIVE YEARS SERVICE.	
6.	E-F6 (2WW WASTE) ORIGINAL CONCENTRATOR FAILED 4/21/61. BURIED IN TUNNEL #1 ON 4/21/61 2,336 CU. FT., 700 CURIES AFTER FIVE YEARS FOUR MONTHS SERVICE.	
7.	E-F11 (1WW WASTE) #2 CONCENTRATOR FAILED 2/1/62. BURIED IN TUNNEL #1 ON 2/8/62 2,336 CU. FT., 40,000 CURIES AFTER EIGHTEEN MONTHS SERVICE.	
8.	E-F6 (2WW WASTE) #2 SPARE CONCENTRATOR FAILED 5/23/64. BURIED IN TUNNEL #1 ON 1/22/65 ON FLAT CAR 3621. 2,400 CU. FT., 700 CURIES.	

ATTACHMENT # 2

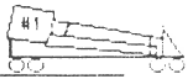
PUREX # 2 BURIAL TUNNEL (218-E-15)

TUNNEL HAS STORAGE FOR 25 MORE CARS 1/21/86

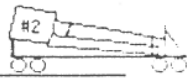
Purex # two Burial Tunnel is located at the southeast end of the Purex building and is an extention of the railroad tunnel. The storage area is approximately 1 688 feet long, 22 feet high and 34 feet wide. The tracks have a one percent down-grade toward the south end of the tunnel. The capacity of the Burial Tunnel is 38 -40 modified railroad cars, 40-42 feet long. The Tunnel contains 1 3 cars as of 1/21/86.

position

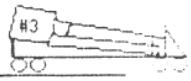
1. E-F6 #1 (2WW WASTE) CONCENTRATOR, TK F15-2, ONE TUBE BUNDLE AND AGITATOR MOTORS. BURIED IN TUNNEL ON 12/12/67 ON CAR 61439. 2,400 CU. FT., 700 CURIES.



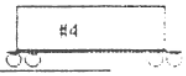
2. E-F6#5 (E-H4 3WB) CONCENTRATOR, TWO TUBE BUNDLES BURIED IN TUNNEL ON 3/26/69 ON CAR MILW 60883. 2,400 CU. FT., 500 CURIES.



3. E-F6#6 (2WW WASTE) CONCENTRATOR, TWO TUBE BUNDLES FAILED BURIED IN TUNNEL ON 3/19/70 ON CAR 3612. 2,400 CU. FT., 700 CURIES.

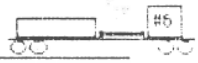


4. L CELL PACKAGE IN A SEALED STEEL BOX (H2-66012) BURIED IN TUNNEL ON 12/30/70 ON CAR MILW 60033 2,400 CU. FT., 500 GRMS PU.

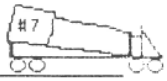


5. F2 SILYER REACTOR, F6 DEMISTER, VESSEL VENT LINE STELL CAT-WALK AND GUARD RAILS. BURIED IN TUNNEL ON 2/26/71 ON GONDOLA CAR 4610. 2,400 CU. FT., 20 CURIES.

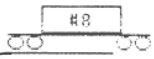
6. MODIFIED A3-1 TOWER, SCRUBBER, LID AND VAPOR LINE BURIED IN TUNNEL ON 12/12/71 ON GONDOLA CAR 4611. 2,400 CU. FT., 10 CURIES.



7. A3 DISSOLVER BURIED IN TUNNEL ON 12/22/71 ON NINE FT. SHORTENED CAR B58 2,400 CU. FT., 50 CURIES.

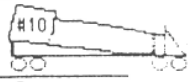


8. A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQUIPT. USED WITH THE SUSPECTED CANISTERS, ON CAR 19808 BURIED IN TUNNEL ON 8/29/72. 300 CU. FT., 17,500 CURIES.

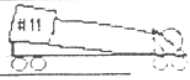


9. C3 DISSOLVER BURIED IN TUNNEL ON 9/30/72 ON CAR 19811 1590 CU. FT., 50 CURIES.

10. E-H4 (3WB) CONCENTRATOR, #61 TUBE BUNDLE, PROTOTYPE COOLING COIL AND A F-F1 FILTER TANK. BURIED IN TUNNEL 8/30/83 ON CAR CDX-1. 2,400 CU. FT., 500 CURIES.

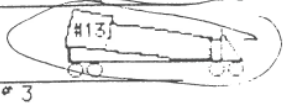


11. A3 DISSOLVER (VESSEL # 10 AND HEATER (VESSEL #6) BURIED IN TUNNEL ON 1/18/86 ON CAR 3613 3,960 CU FT., 0 81 CURIES



12. WHITE BOX (H2-58456) CONTAINING EIGHT TUBE BUNDLES #'S 57, 60,62,64,67,68,74, AND 76. PULSER #5 AND OLD HEATER. DISS LID OLD STYLE DUMPING TRUNNIONS(9), BURIED IN TUNNEL ON 1/20/86 ON CAR 3611 5,438 CU. FT., 540 CURIES.

13. J5 TANK (VESSEL #30), F1 COND (VESSEL #13) AND F12-B CELL BLK. OLD FOUR-WAY DUMPER, DISS YOKE AND FLANGE PLATE. BURIED IN TUNNEL ON 1/21/86 ON CAR 19806 2,500 CU. FT., 90 CURIES



ATTACHMENT # 3

3.27 (1986) SD-657-ES-001

SD-657-ES-001, 1986, *Engineering Study New PUREX Equipment Burial Tunnel*, Rockwell Hanford Operations, Richland, Washington.

1.0 INTRODUCTION

1.1 BACKGROUND

During construction of the PUREX Plant the Number 1 Burial Tunnel was incorporated as an integral part of the plant and was completed in 1956. The burial tunnel consists of three areas: the water filled door, the storage area, and the vent shaft. The storage area is 358 feet long, 22 feet high, and 19 feet wide.

The first two cars were loaded into the tunnel in June 1960. Between that date and January 1965, six more cars were put into the tunnel. After the last car was put into the tunnel the water filled door was sealed with a fiberglass sealant across the cracks and the electrical supply was fixed so that the door cannot be opened inadvertently.

The contents of the cars in the tunnel are shown in Table 1.

Table 1

PUREX Number 1 Burial Tunnel Inventory

Burial Car No.	Burial Date	Contents
1 & 2	06/60	HA Separations Column Box of Miscellaneous Jumpers
3	07/24/60	E-F11, 1WW Waste Concentrator
4	12/24/60	G-E4 Centrifuge Two Concentrator Tube Bundles Box of Miscellaneous Jumpers
5	01/04/61	E-H4, 3WB Concentrator
6	04/21/61	E-F6, 2WW Waste Concentrator
7	02/08/62	E-F11, 1WW Waste Concentrator
8	01/22/65	E-F6, 1WW Waste Concentrator

Burial Tunnel Number 2 was completed in 1964. The tunnel contains the same three areas as Burial Tunnel Number 1. The storage area is 1688 feet long, 34 feet wide, and 22 feet above the tunnel track. It is shaped like a quonset hut. The maximum clearance dimensions are 19 feet wide and 21 feet 6 inches high (above the track). Burial is accomplished by using the PUREX car mover (remote controlled locomotive) to push the burial cars into the tunnel.

The first burial car was placed in the tunnel in December 1967. Between that date and the present 12 more cars were added.

The contents of the cars in the tunnel are shown in Table 2.

Table 2
PUREX Number 2 Burial Tunnel Inventory

Burial Car No.	Burial Date	Contents
1	12/12/67	E-F6, 1WW Concentrator One Concentrator Tube Bundle F15-2 Tank
2	03/26/69	E-H4, 3WB Concentrator Two Concentrator Tube Bundles
3	03/19/70	E-F6 Concentrator Two Concentrator Tube Bundles
4	12/30/70	Sealed Steel Box, L Cell Package
5	02/26/71	F2 Silver Reactor F6 Demister Guard Rails, Platforms, Vent Lines, Tripods
6	12/21/71	Modified A3-1 Tower and Scrubber Modified Lid and Vapor Line
7	12/22/71	A-3 Annular Dissolver on Shortened Car
8	08/29/72	Steel Liner Box, End of A1W1 Fuels Carbon Steel Apron and Carrier from NPR
9	09/30/72	C-3 Annular Dissolver on Shortened Car
10	08/30/83	E-H4, 3WB Concentrator, Prototype Cooling Coil, F-F1 Filter Tank
11	01/18/86	Dissolver Tipping Cradle and Yoke, A-3 Annular Dissolver, Steam Heater
12	01/20/86	Eight Tube Bundles, Dissolver Lid and Dumping Trunnions, Pulse Generator, Steam Heater
13	01/21/86	Tank J-5, F-1 Condenser, F-12 Cell Block, Dissolver Yoke, Flange Plate, Dissolver Four-Way Dumper

3.28 (1985.06) SD-HS-SAR-001, Rev. 3

SD-HS-SAR-001, 1985, *PUREX Plant Final Safety Analysis Report*, Rev. 3, Rockwell Hanford Operations, Richland, Washington.

Revision 3 is provided due to not having access to earlier revisions. It is unknown if the declared inventory in Storage Tunnels 1 and 2 changed between Revisions 0 and 3.

TABLE 7-24. PUREX Plant Effluents--Solids.

Source	Type	Volume (m^3)	Total curies
1972--Operating			
202-A building	Industrial	354	30,600
	TRU	98	19.75
	Non-TRU	51	0.35
202-A laboratory	Industrial	-	-
	TRU	92	145.2
	Non-TRU	47	18.2
1976--Standby			
202-A building	Industrial	-	-
	TRU	-	-
	Non-TRU	11	0.9
202-A laboratory	Industrial	-	-
	TRU	0.6	0.003
	Non-TRU	4	-

TABLE 7-25. Contents of Burial Tunnel 1.

Storage date	Item
June 1960	HA column and miscellaneous box
July 1960	E-F11 concentrator
December 1960	Miscellaneous jumpers, two tube bundles, and an E4 centrifuge
January 1961	E-H4 concentrator
April 1961	E-F6 concentrator
February 1962	E-F11 concentrator
January 1965	E-F6 concentrator

TABLE 7-26. Contents of Burial Tunnel 2.

Storage date	Item
December 12, 1967	1-E-F6 concentrator pushed to end of tunnel on flatcar
March 26, 1969	5-E-F6 concentrator pushed to position 2 on flatcar
March 19, 1970	6-E-F6 concentrator pushed to position 3 on flatcar
December 30, 1970	L cell package on flatcar; container is shown in drawing H-2-66012
February 26, 1971	F2 silver reactor, F6 demister, vessel vent line, steel catwalks, and guard rails
December 12, 1971	A3-1 tower, scrubber, vapor line, A3 pot lid
December 22, 1971	A3 dissolver (car was shortened about 9 ft)
August 29, 1972	A1W1 fuel ends in standard liner box and new production reactor fuel-handling equipment used with suspected canisters. High radioactivity from the liner box; estimated 17,500 Ci
August 30, 1972	C3 annular dissolver (car was shortened about 9 ft)

TABLE 7-27. PUREX Equipment Storage Tunnels Inventory[a]--September 30, 1973.

	Tunnel 1	Tunnel 2	Total[b]
Volume (m^3)	565	565	1,130
Total MFP (Ci)[c]	6,000	20,000	26,000
^{90}Sr (Ci)	1,000	40	1,000
^{106}Ru (Ci)	1	7	8
^{137}Cs (Ci)	1,000	40	1,000
^{60}Co (Ci)	-	20,000	20,000
^{239}Pu (g)	-	500	500

[a]The estimated inventories (or concentrations) of radionuclides are reported to one significant figure to reflect the uncertainty in the data.

[b]Totals do not necessarily equal the sum of individual contributions because of rounding of the data.

[c]Curies shown are decayed to September 30, 1973.

3.29 (1980.09) RHO-CD-1076

RHO-CD-1076, 1980, *Structural Evaluation of the PUREX No. 1 Burial Tunnel*, Rockwell Hanford Operations, Richland, Washington.

HISTORY

Construction and Burials

Construction of the burial tunnel was completed in 1956 and the first two burial cars were loaded into it in June, 1960. Between this date and January, 1965, six more cars were loaded into the tunnel. Table 1 contains a list of the burial cars and their contents. During the loading of the number seven car, the burial tunnel was pressurized due to the heat given off by the contents of the car. To alleviate this problem, a blower fan and filter were connected to the vent shaft. Also, two air sample and temperature probe risers were mounted in the roof of the tunnel to allow occasional monitoring of the tunnel environment. These risers were placed at locations 60 and 240 feet south of the water filled door enclosure (see figure 2). After the last car was loaded in 1965, the water filled door was deactivated.

TABLE 1: PUREX NO. 1 BURIAL TUNNEL INVENTORY

Burial Car No.	Burial Date	Contents	Initial Dose Rate
1 & 2	6-60	HA Separations Column Box of Misc. Jumpers	5 r/hr @ 60'
3	7-24-60	E-F11, 1WW Waste Concentrator	12.5 r/hr @ 100'
4	12-24-60	G-E4 Centrifuge Two Concentrator Tube Bundles Box of Misc. Jumpers	1.5 r/hr @ 150'
5	1-4-61	E-H4, 3WB Concentrator	150 mr/hr @ 50'
6	4-21-61	E-F6, 2WW Waste Concentrator	5 r/hr @ 20'
7	2-8-61	E-F11, 1WW Waste Concentrator	25 r/h @ 150'
8	1-22-65	E-F6, 1WW Waste Concentrator	Unrecorded

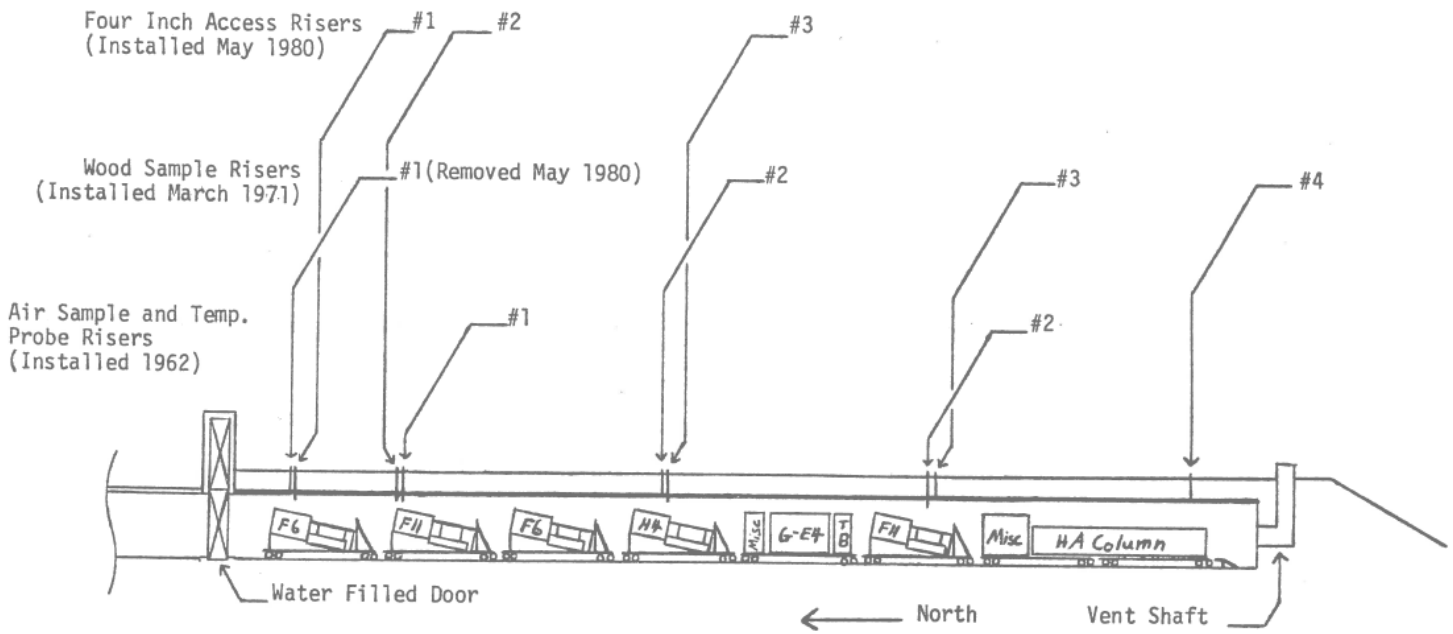


FIGURE 2: PUREX NO. 1 BURIAL TUNNEL

3.30 (1979.02) RHO-CD-673

RHO-CD-673, 1979, *Handbook, 200 Areas Waste Sites*, Rockwell Hanford Operations, Richland, Washington.

RHO-CD-673
I. SE

CONTAMINATED SOLIDS STORAGE AND BURIAL SITES

Name/Type of Facility	Past Designation	Number
Purex Tunnel No. 1	Facility Type Tunnel	218-E-14

Location	Service Dates	Status
200 East, S.E. Quadrant About 500 ft south of Purex.	6/60-5/64	Inactive

Site Coordinates	Reference Drawings	Elevations	
N-39555, W-48020 N-39196, W-48020	H-2-55586 H-2-55587	Ground Water Table Site Depth	~719 ft ~402 ft(1973) ~ 19 ft

Source and Description of Waste

Large equipment, (approximately 2×10^4 ft^3).

Description of Facility

Tunnel running north and south, 360 ft long. Surface area: 2.16×10^4 ft^2

Radionuclide Content (calculated from discharge data)

Radionuclide	At Time of Burial
Total Beta, Ci	8.8×10^4
^{90}Sr, Ci	1.8×10^3
^{106}Ru, Ci	3.8×10^3
^{137}Cs, Ci	1.9×10^3

Tunnel 1

Car Position	Date	Volume (ft^3)	Decayed MFP (Ci)	Pu (Gms)
1&2	6/60	6,190	2,400	--
3	7/29/60	1,900	40,000	--
4	12/23/60	2,465	3,000	--
5	1/5/61	2,336	1,000	--
6	4/21/61	2,336	700	--
7	2/1/62	2,336	40,000	--
8	5/23/64	2,400	700	--

RHO-CD-673

CONTAMINATED SOLIDS STORAGE AND BURIAL SITES

I. SE

Name/Type of Facility	Past Designation	Number
Purex Tunnel No. 2	Facility Type Tunnel	218-E-15

Location	Service Dates	Status
200 East, S.E. Quadrant About 2200 ft south of Purex to end of tunnel.	12/67	Active

Site Coordinates	Reference Drawings	Elevations	
N-39366, W-47960 N-37670, W-47960	H-2-58191 H-2-58192	Ground Water Table Site Depth	719 ft 402 ft(1973) ~8 ft

Source and Description of Waste

Large equipment, (approximately 1.9×10^4 ft^3).

Description of Facility

(1) Tunnel running north-south, approximately 1600 ft long. Surface Area: 1.02×10^5 ft^2.

Radionuclide Content (calculated from discharge data)

Radionuclide	At Time of Burial
Pu, g	500
Total Beta, Ci	2.0×10^4
^{90}Sr, Ci	40
^{106}Ru, Ci	87
^{137}Cs, Ci	43
Misc. Radionuclides	1.0×10^4

Tunnel 2

Car Position	Date	Volume (ft^3)	Decayed MFP (Ci)	Pu (Gms)
1	12/12/67	2,400	700	--
2	3/26/69	2,400	500	--
3	3/19/70	2,400	700	--
4	12/30/70	2,400	--	--
5	2/26/71	2,400	20	<500
6	12/21/71	2,400	10	--
7	12/22/71	2,400	50	--
8	8/29/72	800	17,500	--
9	9/30/72	1,594	50	--

3.31 (1975.12) ERDA-1538

ERDA-1538, 1975, *Final Environmental Statement, Waste Management Operations*, U.S. Energy Research & Development Administration, Washington, D.C.

Radionuclide	Quantity (Ci) (decayed through 1972)
Long Half-Life (>1 Year)	
^{60}Co	30,000
^{90}Sr	30
^{239}Pu	0.4
Short Half-Life (<1 Year)	
^{65}Zn	1,000
^{54}Mn, ^{95}Zr	4,000

The approximate inventories of solid waste disposal in the 200 Areas through 1972 summarized below are shown in Appendix II.1-C, Part 6.

Radionuclide	Quantity
U	6×10^8 g
^{239}Pu	4×10^5 g
^{90}Sr	1×10^4 Ci
^{106}Ru	3×10^3 Ci
^{137}Cs	1×10^4 Ci
Other radioactive materials	4×10^5 Ci

II.1.1.4.1.2 Facilities [X.4, X.24]

Inventories of radioactive materials estimated to be contained in nonoperating reactors and reactor facilities through 1972[3] as summarized below are shown in Appendix II.1-B, Part β.

Radionuclide	Quantity (Ci)
Reactors	
^{60}Co	70,000
Reactor Facilities	
^{90}Sr, ^{137}Cs, ^{239}Pu, ^{152}Eu	800
^{60}Co	2,000
^{59}Fe	150,000

Inventories of radioactive materials estimated to be contained in the two Purex equipment storage tunnels through September 1973 as summarized below are shown in Appendix II.1-C, Part 6.

Radionuclide	Quantity
Mixed Fission Products	30,000 Ci
^{90}Sr	1,000 Ci
^{106}Ru	8 Ci
^{137}Cs	1,000 Ci
^{60}Co	20,000 Ci
^{239}Pu	<500 g

The estimated decayed inventory of radioactive materials stored in tanks in the 200 Areas through 1980[11] and 2000 are summarized below.

TABLE II.1-C-24

ESTIMATED DECAYED STATUS OF SOLID WASTE[a] BURIAL GROUNDS IN THE 200 AREAS THROUGH 1972

BURIAL GROUND 200 EAST AREA	VOLUME (CUBIC FEET)	URANIUM (GRAMS)	PLUTONIUM (GRAMS)	TOTAL (CURIES)	^{90}Sr (CURIES)	^{137}Cs (CURIES)	^{106}Ru (CURIES)
DRY WASTE NO. 001	1.1×10^5	4×10^5	9×10^2	5×10^0	1×10^0	1×10^0	9×10^{-7}
DRY WASTE NO. 12A	5.4×10^5	1×10^6	9×10^3	7×10^1	1×10^1	2×10^1	3×10^{-1}
DRY WASTE NO. 12B	2.6×10^5	7×10^3	1×10^3	2×10^3	2×10^2	2×10^2	6×10^1
MINOR CONSTRUCTION NO. 4	5.6×10^4	1×10^3	1×10^1	5×10^{-1}	1×10^{-1}	1×10^{-1}	2×10^{-6}
CONSTRUCTION (NO NUMBER)	8.0×10^4	2×10^3	2×10^1	6×10^{-1}	1×10^{-1}	2×10^{-1}	3×10^{-5}
222 VAULTS	6.0×10^3	1×10^3	1×10^0	3×10^1	7×10^0	8×10^0	6×10^{-6}
INDUSTRIAL WASTE NO. 002	3.2×10^5	3×10^5	8×10^2	1×10^3	3×10^2	3×10^2	6×10^{-4}
INDUSTRIAL WASTE NO. 005	1.1×10^5	1×10^5	6×10^2	4×10^2	1×10^2	1×10^2	2×10^{-3}
INDUSTRIAL WASTE NO. 05Z	2.2×10^6	1×10^5	1×10^3	1×10^3	2×10^2	2×10^2	3×10^{-2}
INDUSTRIAL WASTE NO. 010	5.3×10^5	8×10^5	5×10^3	5×10^4	4×10^3	5×10^3	2×10^3
TOTAL 200-E[b]	2.2×10^6	3×10^6	2×10^4	6×10^4	5×10^3	6×10^3	2×10^3

BURIAL GROUND 200 WEST AREA	VOLUME (CUBIC FEET)	URANIUM (GRAMS)	PLUTONIUM (GRAMS)	TOTAL (CURIES)	^{90}Sr (CURIES)	^{106}Ru (CURIES)	^{137}Cs (CURIES)	OTHER RADIOACTIVE (CURIES)
DRY WASTE NO. 001	2.5×10^5	7×10^5	9×10^4	9×10^0	2×10^0	2×10^{-6}	2×10^0	
DRY WASTE NO. 002	3.0×10^5	1×10^6	1×10^5	3×10^1	6×10^0	1×10^{-4}	7×10^0	
DRY WASTE NO. 003	3.9×10^5	7×10^7	7×10^4	5×10^1	1×10^1	3×10^{-3}	1×10^1	
222-T VAULTS	2.4×10^3	3×10^2	3×10^{-1}	4×10^1	9×10^0	9×10^{-6}	1×10^1	
222-S VAULTS	5.6×10^3	7×10^2	7×10^{-1}	2×10^2	5×10^1	6×10^{-3}	6×10^1	
INDUSTRIAL WASTE NO. 001	4.8×10^5	9×10^5	2×10^3	2×10^3	6×10^2	1×10^{-3}	6×10^2	
INDUSTRIAL WASTE NO. 002	6.7×10^5	2×10^6	6×10^3	2×10^4	3×10^3	1×10^2	4×10^3	
DRY WASTE NO. 03A	1.8×10^5	9×10^6	4×10^3	1×10^5	3×10^2	1×10^2	3×10^2	1×10^5
DRY WASTE NO. 04A	6.2×10^5	5×10^8	4×10^4	3×10^2	5×10^1	2×10^0	5×10^1	
DRY WASTE NO. 04B	3.0×10^5	4×10^6	2×10^4	2×10^5	3×10^2	9×10^1	3×10^2	2×10^5
CAISSON - NO. 1	2.2×10^2	2×10^5	5×10^2	1×10^2	1×10^1	2×10^0	2×10^1	
CAISSON - NO. 2	8.0×10^0		$5 \times 10^-$	3×10^0	4×10^{-1}	8×10^{-2}	4×10^{-1}	
CAISSON - NO. 3	1.7×10^2	1×10^5	5×10^2	3×10^3	3×10^2	8×10^1	4×10^2	
CAISSON - NO. 4	5.4×10^1	5×10^4	7×10^2	1×10^4	1×10^3	4×10^2	1×10^3	
CAISSON - ALPHA 1	2.0×10^2	4×10^4	1×10^3	4×10^4	7×10^2	4×10^2	7×10^2	1×10^4
TOTAL 200-W[b]	3.2×10^6	6×10^8	4×10^5	4×10^5	7×10^3	1×10^3	7×10^3	3×10^5
TOTAL 200 AREAS[b]	5.4×10^6	6×10^8	4×10^5	5×10^5	1×10^4	3×10^3	1×10^4	3×10^5

(a) The estimated inventories or concentration of radionuclides are reported to one significant figure to reflect the uncertainty in the data.
(b) Totals do not necessarily equal the sum of individual contributions because of rounding of the data.

TABLE II.1-C-25

PUREX EQUIPMENT STORAGE TUNNELS[a] INVENTORY[b]--SEPTEMBER 30, 1973

	Tunnel No. 1	Tunnel No. 2	Total[c]
Volume, ft^3	20,000	20,000	40,000
Total MFP, Ci[d]	6,000	20,000	30,000
^{90}Sr, Ci	1,000	40	1,000
^{106}Ru, Ci	1	7	8
^{137}Cs, Ci	1,000	40	1,000
^{60}Co, Ci	--	20,000	20,000
^{239}Pu, g	--	<500	<500

(a) Currently the distribution of waste plutonium stored on the Hanford site is 40% in tanks, 39% in solid sites and 21% in liquid disposal sites. The total amount of plutonium in these sites is estimated to be 940 kg ± 30%. Although to retrieve essentially all of the plutonium is technically feasible, it may not be economically justifiable.
(b) The estimated inventories (or concentrations) of radionuclides are reported to one significant figure to reflect the uncertainty in the data.
(c) Totals do not necessarily equal the sum of individual contributions because of rounding of the data.
(d) Curies shown are decayed to September 30, 1973.

3.32 (1973.03) ARH-7262

ARH-7262, 1973, *Input and Decayed Values of Radioactive Solid Wastes Buried in the 200 Areas Through 1971*, Atlantic Richfield Hanford Company, Richland, Washington.

TABLE 1 (CONTINUED) PAGE 4

	VOLUME (CU FT)	PU (GM)	BETA (CI)	SR-90 (CI)	RU-106 (CI)	CS-137 (CI)	OTHERS (CI)	U (KGM)	AREA (SQ FT)	OTHERS (GM)
INDUSTRIAL WASTE NO. 010										
1960	.560+05	.535+03	.300+04	.597+02	.128+03	.637+02		.106+03	.822+05	
1961	.510+05	.530+03	.300+04	.597+02	.128+03	.637+02		.105+03	.749+05	
1962	.590+05	.535+03	.400+04	.796+02	.171+03	.850+02		.110+03	.866+05	
1963	.459+05	.530+03	.200+04	.398+02	.857+02	.425+02		.105+03	.674+05	
1964	.408+05	.535+03	.200+04	.398+02	.857+02	.425+02		.105+03	.599+05	
1965	.865+05	.535+03	.870+04	.173+03	.373+03	.185+03		.110+03	.127+06	
1966	.351+05	.535+03	.420+04	.835+02	.180+03	.892+02		.105+03	.515+05	
1967	.534+05	.275+03	.650+04	.129+03	.278+03	.138+03		.550+02	.783+05	
1968	.295+05		.712+05	.142+04	.305+04	.151+04			.316+05	
1969	.178+05		.595+05	.118+04	.255+04	.126+04			.300+05	
1970	.120+05	.916+03	.255+05	.507+03	.109+04	.541+03			.163+05	
1971	.261+05		.175+04	.347+02	.747+02	.371+02			.348+05	
SUM THRU 71	.513+06	.493+04	.191+06	.380+04	.819+04	.406+04		.801+03	.741+06	
DECAY THRU 71	.513+06	.493+04	.333+05	.349+04	.119+04	.375+04		.801+03	.741+06	
PUREX TUNNEL NO. 1										
1960	.106+05		.454+05	.903+03	.194+04	.964+03			.216+05	
1961	.467+04		.170+04	.338+02	.728+02	.361+02				
1962	.234+04		.400+05	.796+03	.171+04	.850+03				
1964	.240+04		.700+03	.139+02	.300+02	.149+02				
SUM THRU 71	.200+05		.878+05	.175+04	.376+04	.186+04			.216+05	
DECAY THRU 71	.200+05		.596+04	.135+04	.336+01	.146+04			.216+05	
PUREX TUNNEL NO. 2										
1967	.240+04		.700+03	.139+02	.300+02	.149+02			.102+06	
1969	.240+04		.500+03	.994+01	.214+02	.106+02				
1970	.480+04	<.500+03	.700+03	.139+02	.300+02	.149+02				
1971	.720+04		.800+02	.159+01	.343+01	.170+01				
SUM THRU 71	.168+05	<.500+03	.198+04	.394+02	.848+02	.421+02			.102+06	
DECAY THRU 71	.168+05	<.500+03	.444+03	.368+02	.182+02	.395+02			.102+06	
200-E TOTAL	.218+07	.193+05	.339+06	.674+04	.145+05	.720+04		.274+04	.305+07	.560+02
200-E DECAY TOTAL	.218+07	.193+05	.442+05	.567+04	.128+04	.612+04		.274+04	.305+07	.560+02

3.33 (1971.12) Survey 12 71 236

Survey 12 71 236, 1971, "Burial of A Cell Dissolver, (in new tunnel #7)," (radiation survey report, Burial Monitor J.C. Greer, December 22, 1971), Atlantic Richfield Hanford Company, Richland, Washington.

Atlantic Richfield Hanford Company

SURVEY # 12 71 236

BURIAL OF A CELL DISSOLVER
(IN NEW TUNNEL #7)

DATE OF BURIAL: 12-22-71

DOSE RATE AND SMEAR DATA:

DISSOLVER AT VERT DOOR	10 MRADS/HR F
DISSOLVER AT YELLOW LINE	50 MRADS/HR F
DISSOLVER UNDER OVER-HEAD DOOR	5000 MRADS/HR 5'
SMEARS OF TRACKS @ DROPOFF	1500 C/M
SMEARS OF TRACKS BETWEEN YELLOW LINE AND VERT DOOR	100,000 C/M.

BURIAL COMPLETED WITH NO PROBLEMS.

MONITOR FOR BURIAL: JC GREER

JRH/RWS/bs

3.34 (1971.12) Survey 12 71 226

Survey 12 71 226, 1971, "Burial of A Dissolver Tower, (in new tunnel #6)," (radiation survey report, Burial Monitor J.C. Greer, December 21, 1971), Atlantic Richfield Hanford Company, Richland, Washington.

Atlantic Richfield Hanford Company

SURVEY # 12 71 226

BURIAL OF A DISSOLVER TOWER
(IN NEW TUNNEL #6)

DATE OF BURIAL: 12-21-71

DOSE RATE AND SMEAR DATA:

@ GONDOLA CAR WITH EQUIP.		
END OF CAR	50 MRADS/HR	F
MAX. AT SIDE	1000 MRADS/HR	F
AVE IN TUNNEL	20 MRADS/HR	F
SMEARS OF TRACKS - BEHIND YELLOW LINE	8000 C/M	
SMEARS OF TRACKS - FROM YELLOW LINE TO VERT. DOOR	2000 C/M	
SMEARS OF TRACKS UNDER OVERHEAD DOOR	50 MRADS/HR	2"

MONITOR FOR BURIAL : JC GREER

BURIAL COMPLETED WITH NO PROBLEMS

JRH/BWS/bs

3.35 (1971.04) Equipment Stored in PUREX Tunnel

1971, "Equipment Stored in PUREX Tunnel," (internal memo from O.F. Beauliee to R.E. Roberts, April 2, 1971), Atlantic Richfield Hanford Company, Richland, Washington.

Atlantic Richfield Hanford Company

Date: April 2, 1971

To: R. E. Roberts

From: O. F. Beaulieu

Subject: EQUIPMENT STORED IN PUREX TUNNEL

Date: 2/26/71

Car: 4610 - Steel Gondola

Equipment: F2 Silver Reactor

Dunnage failure.

F6 Demister.

F1-F2 Vapor Line.

Lifting bail corroded away.

A3 Vapor Line.

Obsolete

JA Jones L Cell working platform.

Job Completed

Assorted steel beams - tripods - rails, etc.

House cleaning

Pre-Storage Treatment: High pressure water flush.

Pu Content: None

Containment: None

Liquid Content: None

Radiation: Maximum 2000 M rads on east side of car - 150 on west side - 50 at coupling.

OFB:FMD:ssa

cc: FM Drum
GL Ritter
File

3.36 (1971.02) Survey 2 71 218

Survey 2 71 218, 1971, "Burial of Gondola Car, (in new tunnel 5)," (radiation survey report, Burial Monitor J.C. Greer, February 26, 1971), Atlantic Richfield Hanford Company, Richland, Washington.

Atlantic Richfield Hanford Company

2 71 218

BURIAL OF GONDOLA CAR
(IN NEW TUNNEL 5)

DATE OF BURIAL: 2-26-71

DOSE RATE AND SMEAR DATA:

@ COUPLING	10 MRADS/HR	F
@ EAST SIDE OF CAR	300 MRADS/HR	2"
@ WEST SIDE OF CAR	2000 MRADS/HR	2"

Smears of RR Tracks at yellow line
5 MRADS/HR 2"
Inside of vert. door 40,000 C/M

MONITOR FOR BURIAL: J C GREER.

WDK/BWS/bs

3.37 (1970.12) Survey 12 70 221, 1971

Survey 12 70 221, 1971, "Old L Cell Package (in new tunnel 4)," (radiation survey report, Burial Monitor D.B. Dabling et al., December 12, 1970), Atlantic Richfield Hanford Company, Richland, Washington.

Atlantic Richfield Hanford Company

SURVEY # 12 70 221

12 70 222

12 70 228

"OLD" L" CELL PACKAGE (IN NEW TUNNEL 4)

DATE OF BURIAL: 12-30-70 + 1-4-71

DOSE RATE DATA AND SMEARS:	TO LOWER PACKAGE AND	100 MRADS/HR	F
	SECURE SOUTH END	200 MRADS/HR	F
	NORTH WEST SIDE	10 MRADS/HR	F
	TO INSTALL STUDS	50 MRADS/HR	F

EVENTS OF HAPPENINGS: BURIAL OF "OLD L CELL PACKAGE WENT OFF AS PLANNED. TUNNEL FLOOR AND TRACKS WAS CONTAMINATED ON DRY RUN. AFTER SEVERAL SHIFTS OF DECONTAMATION - FLOOR AND TUNNEL WAS RELEASED.

MONITOR FOR BURIAL: DB DABLING, DD HINKLE, HODGES, KULICK, OB KROLL, VE ERICKSON.

WDK/BWS/bs

3.38 (1970.03) Survey 3 70 205

Survey 3 70 205, 1970, "F-6 Concentrator in New Tunnel (3)," (radiation survey report, March 19, 1970), Atlantic Richfield Hanford Company, Richland, Washington.

Atlantic Richfield Hanford Company

3 70 205

3 70 206

3 70 211

F-6 CONCENTRATOR IN NEW TUNNEL (3)

DATE OF BURIAL: 3-19-70

DOSE RATE AND SMEAR DATA:

@ TUNNEL ENTRANCE	10 mr/hr	F
@ YELLOW LINE	150 mr/hr	F
@ CONCENTRATOR ON CAR	10 Rad/hr	F
@ UNDER OVERHEAD DOOR	500 Rad/hr	2'
TO HOOK UP SLAVE	50 mr/hr	F
TO RELAMP TROLLY	100 mr/hr	F
@ TOP OF WEST CRANE	1000 - 3000 mr/hr	F
@ SLAVE CRANE CAB	3000 mr/hr	F
@ CAB DOOR	100 mr/hr	F

SMEARS OF FLOOR INSIDE VERTICIAL DOOR
250 MRAD/hr 2"

EVENTS OF HAPPENINGS: BURIAL OF F-6 CONCENTRATOR IN THE BURIAL TUNNEL. HAD CRANE TROUBLE AS THE UNIT WAS BEING SET ON THE FLAT. FINALLY GOT IT DOWN. . . BACK IN TUNNEL. TUNNEL FLOOR HOT . . . TO 500 rads/hr. SEVERAL DAYS NEEDED TO CLEAN TUNNEL. BUT FINALLY GOT IF FAIRLY CLEAN.

MONITORS FOR BURIAL AND CLEAN UP: ALL MONITORS AT PUREX

54-6000-030 (10-68)
AEC-RL RICHLAND, WASH.

3.39 (1967.12) Survey 12 67 126

Survey 12 67 126, 1967, "F-6 Concentrator," (radiation survey report, December 12, 1967), Atlantic Richfield Hanford Company, Richland, Washington.

Atlantic Richfield Hanford Company

12 67 126

12 67 176

12 67 182

12 67 183

F-6 CONCETRATOR

DATE OF BURIAL: December 12, 1967

CONCRETE BURIAL BOX: 19 FEET LONG
10 FEET 10 INCHES WIDE
6 FEET HIGH

DOSE RATE AND SHEAR DATA:

TO OBSERVE F-6 CONCETRATOR ON BURIAL CAR FROM EAST TUNNEL ENTRANCE	1300	MR/hr	100'
TOP OF STAIRS EAST ENTRANCE BURIAL TRAIN PASSING	4000	MR/hr	F
OBSERVE TRAIN WHEN IT STOPPED AT CURVE	250	MR/hr	F
DR OUTSIDE OF CLOSED DOOR DURING LOADING	400		F
DR LOADING COMPLETED	300		F
DR TO RIDE FLAT CAR ON DRY RUN (UNDER OVERHEAD DOOR)	700		F
DOSE RATE THRU OPEN PLUG WHEN BOX PASSED	350		F
DR ON CRUD UNDER OVERHEAD DOOR (GEN)	1200	MRADS	
DR 10' SOUTH OF ANTI-COUPLING DEVISE IN WEST GUTTER	5000	18"	1000 18"
DR 50' BEFORE WATER FILLED DOOR WEST SIDE	5000	14"	1000 14"
DR ON TOP OF DONKEY AFTER BURIAL	30		
SHEARS OF WHEELS ON DONKEY	30,000	c/m	
SHEARS OF RAILS AND FLOOR	150	MRAD	direct.

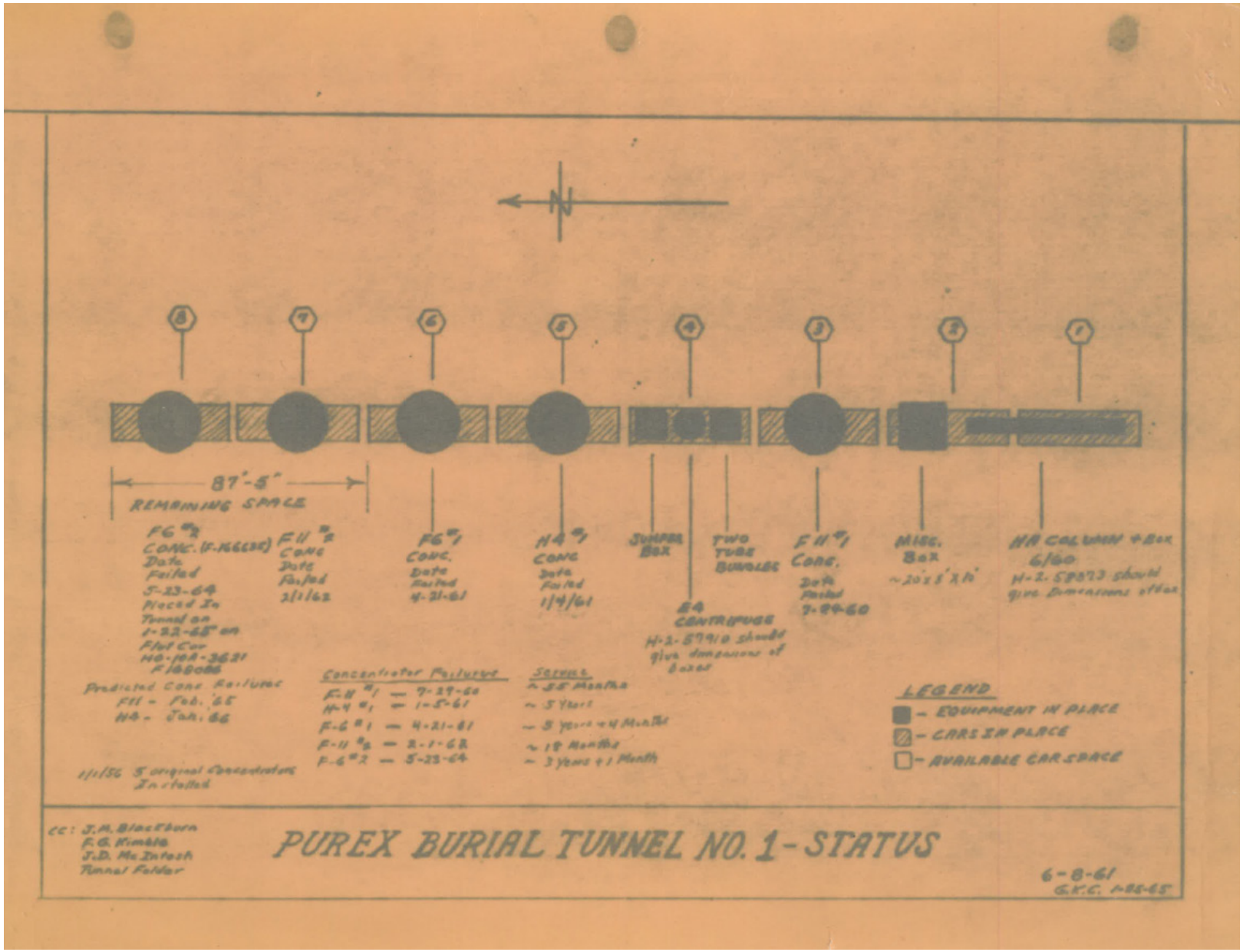
COULD NOT GET THE BOX LOADED THE FIRST TRY. HAD TO UNHOOK THE CAR FROM THE CAR PULLER AND LET THE CAR FLOAT. BURIAL WENT VERY SMOOTHLY WITH NO CONTAMINATION SPREAD. A JOB WELL DONE.

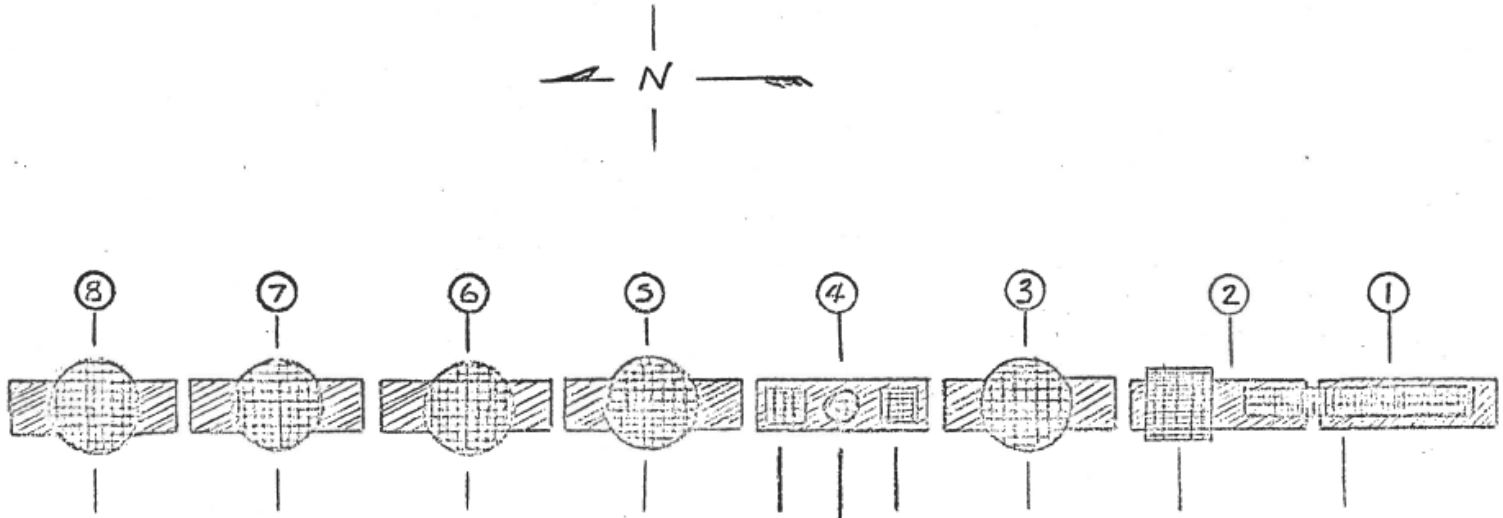
WDK/BWS/bs

54-6000-030 (8-67)

3.40 (1965.01) PUREX Burial Tunnel No 1 - Status

The original source of these status sheets is unknown.


N
8
7
6
5
4
3
2
1
87'-5"
REMAINING SPACE
F6 #2 CONC. (F-RECEIVE) Date Failed 5-23-64 Placed In Tunnel on 1-22-65 on Flat Car HO-10A-3631 F168088
F11 #2 CONC Date Failed 2/1/62
F6 #1 CONC. Date Failed 4-21-61
H4 #1 CONC Date Failed 1/4/61
JUMPER BOX
TWO TUBE BUNDLES
E4 CENTRIFUGE H-2-57910 should give dimensions of boxes
F11 #1 CONC. Date Failed 7-29-60
MISC. BOX ~20'x5'x7'h'
HA COLUMN + BOX 6/60 H-2-58873 should give dimensions other
Predicted Conc Failures
F11 - Feb. '65
H4 - Jan. 66
1/1/56 5 original Concentrators Installed
Concentrator Failures
F-11 #1 — 7-29-60
H-4 #1 — 1-5-61
F-6 #1 — 4-21-61
F-11 #2 — 2-1-62
F-6 #2 — 5-23-64
Service
~ 55 Months
~ 5 Years
~ 5 Years + 4 Months
~ 18 Months
~ 3 Years + 1 Month
LEGEND
- EQUIPMENT IN PLACE
- CARS IN PLACE
- AVAILABLE CAR SPACE
cc: J.M. Blackburn
F.G. Kimble
J.D. McIntosh
Tunnel Folder
PUREX BURIAL TUNNEL NO. 1 - STATUS
6-8-61
G.K.C. 1-25-65



Concentrator Failures	Service
F-11 #1 - 7-29-60	55 months
H-4 #1 - 1-05-61	5 years
F-6 #1 - 4-21-61	5 years & 4 months
F-11 #2 - 2-01-62	18 months
F-6 #2 - 5-23-64	

1/1/56 5 ORIGINAL CONCENTRATORS INSTALLED

LEGEND
- Equipment in Place
- Cars in Place

PUREX STORAGE TUNNEL NO. 1-STATUS 1-22-65

3.41 (1962.02) Concentrator Replacement Schedule and History of Last Replacement

Dave Dyer

February 22, 1962

CONCENTRATOR REPLACEMENT SCHEDULE
AND HISTORY OF LAST REPLACEMENT

	Shifts Req'd	Remarks
OUTSIDE PREPARATION		
1. PREPARE BURIAL CAR FOR CONCENTRATOR BURIAL.	6	
A. Remove all timbers from flat car.		
B. Fab. and install dunnage. (Dunnage must be centered for balance of load.)		
C. Fab. and install drip pan. (Amercoat inside.)		
D. Fab. and install remote braking mechanism. (On north end of car.)		
E. Remove coupler from south end of car.		
F. Install rings on burial car for car puller. (On northeast end of car.)		
G. Freon test spare concentrator before moving.		
H. Lay concentrator on burial rack for fit, etc. (Need 3900 Manitowac 60 ton crane.)		
I. Check stability of rack and car.		
J. Check car balance with load.		
K. Make short dry run with load.		
L. Load 50 bags speedy-dri on brial car.		
2. LOAD SPARE CONCENTRATOR AND MAKE READY FOR SHIPMENT.	6	
A. Position shipping racks on flat car. (Center for proper load balance.)		
B. Move concentrator from burial car to shipping car.		
C. Make certain of fit and balance before shipment.		
D. Perform Freon leak tests.		
3. PREPARE BLANKS FOR BURIAL OF CONCENTRATOR.	1	
A. Fabricate two tube bundle opening blanks with bail and neoprene gasket sealed to bottom side, place free nuts on blanks.		
B. Provide nozzle blanks as follows: 4 each 3" vertical; 2 each 2" vertical; 1 each 2" vertical 3-way inst.; 1 each 2" horizontal		
C. Provide steel blank for condenser outlet on tower place free nuts on blank.		
D. Move blanks to building before burial car.		

Concentrator Replacement Schedule February 22, 1962

	Shifts Req'd	Remarks
4. PREPARE BLANKS AND GASKETS FOR NEW CONCENTRATOR.	1-1/2	
A. Condenser to concentrator remote gasket. B. Tube bundle remote gaskets. C. S/S free nuts for old or new tube bundles. D. Pub. nozzle blanks as follows: 6 each 2" vertical 2 each 3" vertical 1 each 2" vertical 3-way inst. 1 each 2" horizontal E. Advise Shops on blank and remote gaskets. Install at Shop or ship to building?		
CANYON PREPARATION		
5. PERFORM TRANSFER OF FAILED CONCENTRATOR TUBE BUNDLES TO T PLANT.	5	Two trips
A. Obtain equipment transport box. B. Inspect box for adequacy and leak potentials. C. Place tube bundle capsules in burial box. D. Position capsules for tube bundle fit.		
6. PREPARE CRANES FOR COUPLED REMOTE WORK PRIOR TO EQUIPMENT CHANGE.	2	Two checks
A. Perform mechanical and electrical inspections, of main west crane including cables. B. Ditto Slave crane. C. Couple slave and west crane together and check and correct all operating functions. D. Check out limits which cut power when Slave & Main cranes get to far apart. E. Make certain by-pass functions satisfactorily when this condition occurs.		
7. INSPECT CAR PULLER.	1	
A. Make certain that car puller is working satisfactorily. B. Install new shear pin.		

	Shifts Req'd	Remarks
8. INSPECT WATER FILLED DOOR.	1	
A. Make certain that water filled door will open and close satisfactorily.		
B. Make certain water turns on and off.		
C. Drain door and lock out in open position just prior to burial.		
9. MAKE CERTAIN CONCENTRATOR LIFTING YOKE IS AVAILABLE AND SATISFACTORY.	1/2	
A. Provide and place wood dunnage on deck for condenser. (See attached sketch.)	1	
10. FLUSH CONCENTRATOR AND PREPARE FOR BURIAL.	13	
A. Perform internal flushes and remove any visible crud.		
B. De-energize electrical circuits.		
C. Blank electrical heads.		
D. Perform external flushes.		
E. Remove jumpers.		
F. Remove condenser.		
G. Remove tube bundles.		
H. Empty seal pot.		
I. Blank openings.		
J. Flush exterior again.		
K. Inspect corrosion damage of dunnage to determine stability for placing on burial rack.		
L. Make TV checks of dunnage and leak areas inside of tube bundle chest.	1	
M. Check heat source in concentrator possibly need thermoim.		
11. REMOVE AND BURY CONCENTRATOR.	1/2	2-8-62
A. Remove RR stops from front of water filled door.		
B. Put Speedy-Dri in drip pan just prior to moving burial car in tunnel. (50 bags)		
C. Tape measure tunnel burial space remaining before burial. (87' 5")		
D. Provide overall length of burial car. (42' 4")		
12. WHEN CONCENTRATOR HAS BEEN REMOVED FROM CELL CAUTION CRANE OPERATORS NOT TO DISTRUB CELL FLOOR FOOTING PADS IN CASE ANCHOR BOLTS SHOULD BE EATEN OFF.		

	Shifts Req'd	Remarks
13. PLACE RR CAR STOPS IN FRONT OF WATER FILLED DOOR BEFORE BRINGING IN NEW CONCENTRATOR.		
14. INSTALL NEW CONCENTRATOR.	5	

A. Install tube bundles with S/S free nuts.
B. Install condenser.
C. Install jumpers.
D. Leak check.

HISTORY

1. F-11 concentrator was discovered leaking excessively on February 1, 1962. Leaks were noted on the bottom of west tube bundle section in the vicinity of three or four o'clock. Later checks initiated on graveyard shift on February 2nd, revealed leaks on the bottom of main tower section between the tube bundles chests. Leaks were calculated to be three gallons per minute.

2. Replacement was completed on February 13th.

3. DELAYS DURING EQUIPMENT CHANGES.

1st Delay - 4 hours

The 2900 Manitowoc 60 ton crane would not handle loading of spare concentrator on burial rack and car. Forty hours overtime and 1/2 shift delay in burial schedule resulted in obtaining the 3900 Manitowoc crane from 100 Areas. Cost $1,100.00.

2nd Delay - 2-1/2 hours

After spare concentrator was removed from burial car after dry run an overall measurement was made from end of car to the end of the coupler. The measurement that was thought to be 41' 6" turned out to be 44' 4". An additional delay of 2-1/2 hours was required for RR crews to cut off the south end of car and also provide a recess in the frame to receive the coupler from the car buried previously. Subsequent length of car from end of coupler to inside of recess was 42' 4".

3rd Problem (5:00 PM) but not necessarily a delay 2-8-62.

After failed concentrator was placed on burial car successfully the coupled cranes were moved toward the WCMP to be uncoupled; however, after reaching the vicinity of F-Cell travel power was lost to both cranes when the main crane over traveled the slave, tripping the realite limit switches. F-Cell was still open with readings in crane way up to 3500 MR/hr approximately 100 MR/hr at the crane entrance. Entry to crane way was made from Lab. Equipment Room to save exposure. Power was restored two hours later by pulling realite cord with broom and energizing by-pass circuit (push button) in crane cab.

3rd Delay - 76 hours - (9-1/2 shifts) before new concentrator could be brought into tunnel. 2-11-62 9:00 PM

F-11 new behind water-filled door, steamed from tube bundle blank 2 to 3 inches wide and 2 to 3 feet in distance when tipped on its side, and also spilled liquid to the tunnel floor (possibly from seal pot) reading 5 R at some distance. Water-filled door overflowed when controls showed that the flow was off - but it wasn't. Tunnel flooded from drop off to the filled door, draining slowly if at all. Seven cars outside, four are hot, seven extremely hot cars pulled back into the tunnel, hosed down the cars in the tunnel. Cleaning was interrupted at a point considered reasonably safe to bring in new concentrator without serious contamination spread.

4th Delay - 176 hours - 22 shifts - after new concentrator was buttoned-up and ready for service on A to 12 Shift 2-13-62 start-up was 8:00 AM 2-19-62.

Continued cleaning in RR tunnel was necessary before start-up or cask cars could be brought in for charging. Because of suspected leaks of air born contamination which included ruthenium from around the water-filled door, it was decided to seal the door.

A. Breathing air pressure was raised from 10 to 16 psig and a six outlet air manifold was provided in tunnel.

B. Tubiac scaffold 18' 8" wide and 17' high was installed on a RR push car and pushed back to position in front of water-filled door. (Tight fit should be 18' wide.)

C. Two light standards with three spot lights each, were moved from trap pit #2 and placed in front of door for lighting.

D. The top and sides of door were sealed with muslin and Gaco Neoprene cement, N-700-A. Oakum and Duxseal were used across the bottom and around the rails. Plywood backing was used around the 4" inlet and 6" overflow pipes and 1/2" soft rubber backing was used to fill large cracks around side and top before Gaco Neoprene cement and muslins were applied.

E. The floor drain in front of water-filled door was sealed also the others.

Start-up of Plant 2-19-62 - 8:00 AM.

4. INFORMATION THAT MIGHT EXPEDITE FUTURE REPLACEMENT OF THIS NATURE.

A. Have 3900 Manitowac crane available for loading spare concentrator.

B. Obtain the shortest RR flat car for burial of concentrator.

C. Measure burial car overall length (coupler to coupler) immediately after one has been obtained for mounting burial racks.

D. Hot liquid in the concentrator seal pot appears to hold the greatest potential for spilling liquids on the floor of the tunnel. Investigation reveals that this usually occurs on the floor west of the flat car which is the same side as the seal pot and dump-cemer. The seal pot should be jetted out before burial.

E. All known crud must be removed from concentrator before burial.

F. Make thorough check of water-filled door prior to burial. Water supply valves not used for some time don't always seat properly. Make certain that valves don't leak through. Water leakage adds to contamination problems. (Fill it to high level alarm.)

G. Tunnel should be thoroughly cleaned of all debris (sand, tumble weeds, rags). All floor drains should be open and individually checked to determine if draining properly.

H. Burial string should be composed of flats and cask cars only.

I. Physically measure burial string before burial to determine position of front of car relative to water-filled door.

J. After burial do not permit railroad engine crew to pull cars out of tunnel into out unless first surveyed. A complete understanding should be integrated before burial, on how cars should be handled under various conditions.

5. COMMENTS

A. 2-8-62

After the cranes were coupled starting at 3:00 PM the F-11 concentrator was removed from F-Cell and placed on the burial rack by 4:45 PM. (45 minutes) The failed concentrator was pushed back in the burial tunnel completing same at 5:35 PM.

B. 2-11-62 Interrupted tunnel cleaning for new concentrator.

After new concentrator was placed in tunnel ready for pick-up at 9:20 PM it was placed in the cell by 9:50 PM (total time for this operation - 30 minutes).

Measurements revealed 17" clearance on east side between wide part of concentrator and tunnel door. The same measurement would apply on west side except for angle iron guide bracket, which reduced the clearance to 6". Roy Hibbard has been asked to contact Ed Stall to have this changed or removed for more clearance. Final results were to the effect that the guide brackets are no longer needed. F.E.O has been advised accordingly.

C. Maintenance overtime associated with tunnel clean-up, scaffold and sealing door was:

Manhours 185.5 hours $1,513.00

Material charges for sealants, scaffolding, hoses, etc. amounted to approximately $1,700.00.

D. When failed concentrator was placed on burial car in RR tunnel radiation levels in crane cab and outside tunnel door were 3 MR/hr and 25 R respectively.

E. Lift of slave crane is 44' and height of concentrator and yoke is 38' 7" which gives deck clearance of 5' 5".

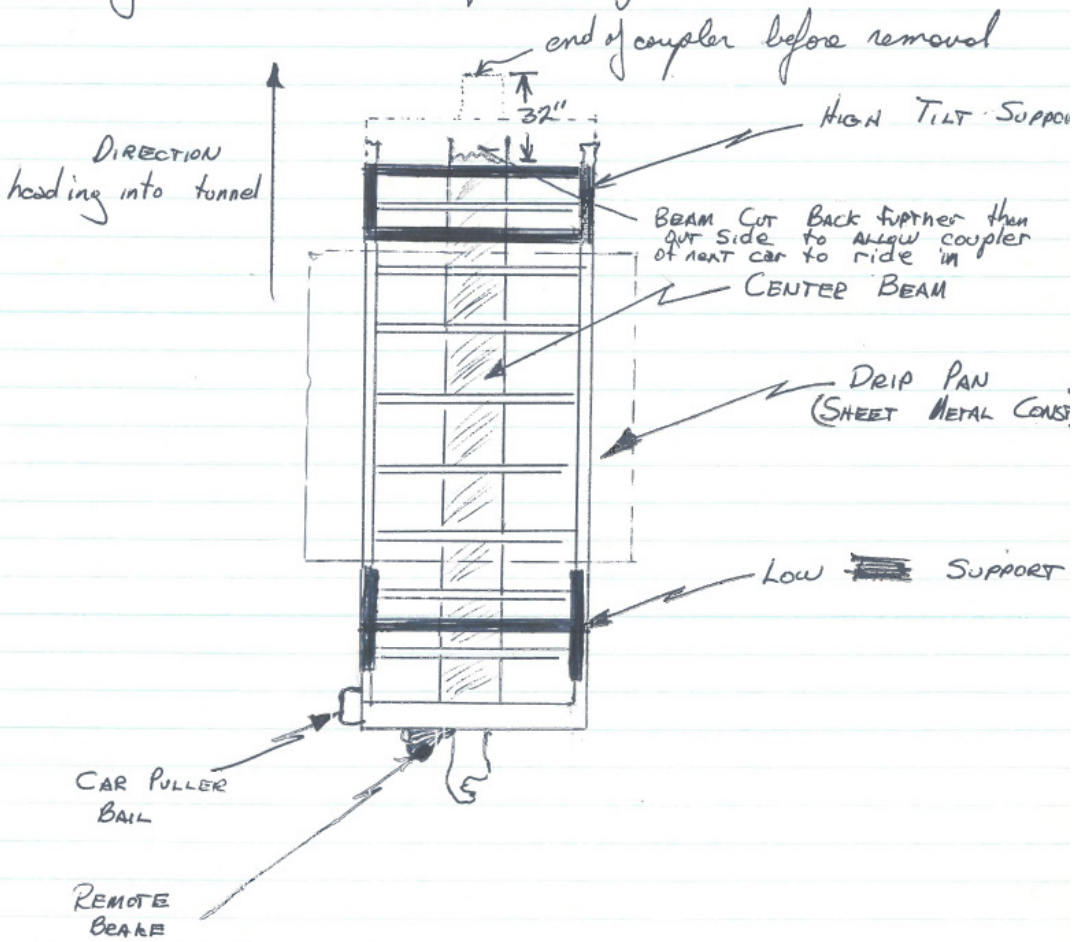
R. De Jongsehr

3.42 (1962.02) F-11 Concentrator Burial Car Modifications

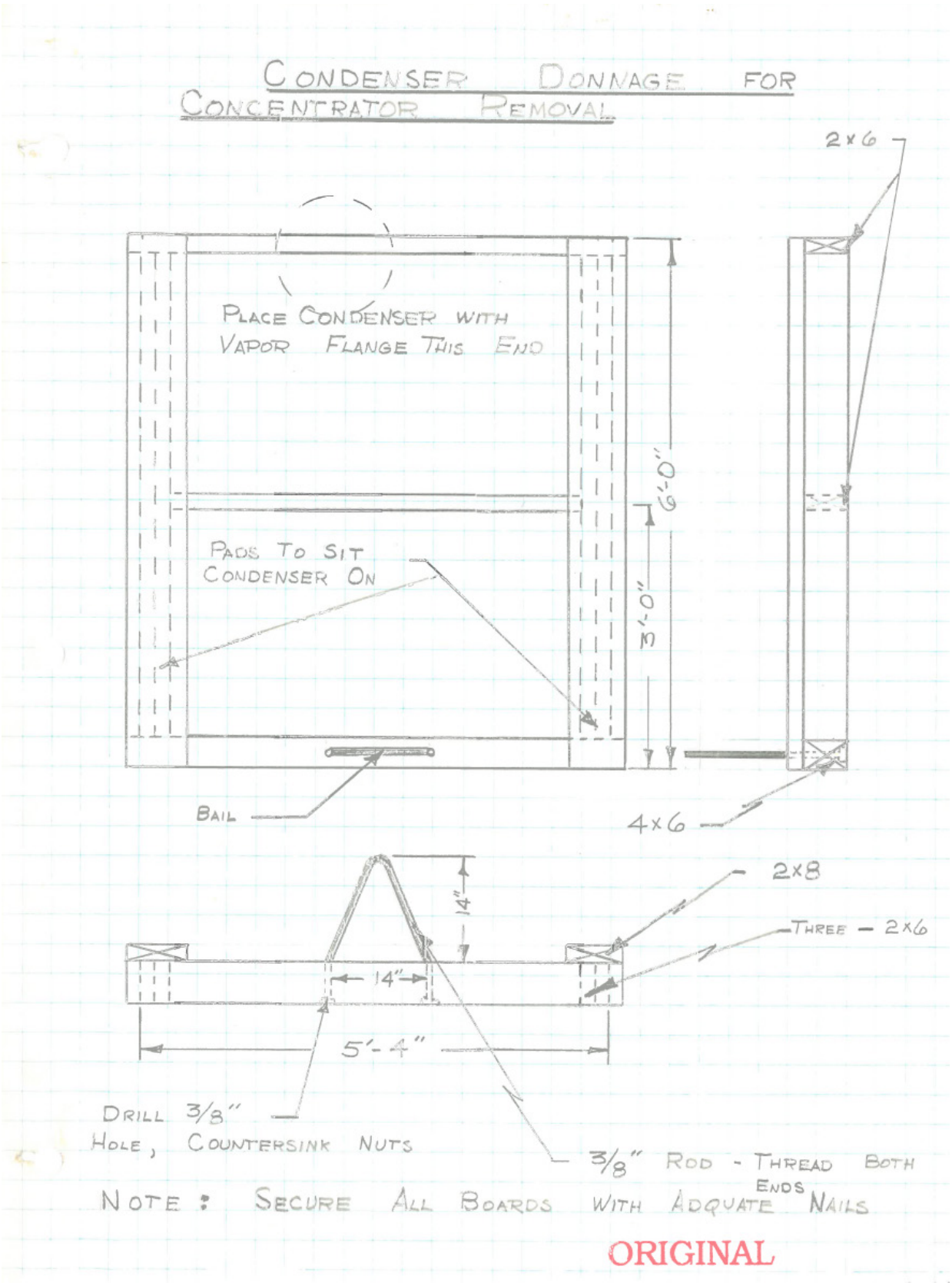
FEB 8 1962

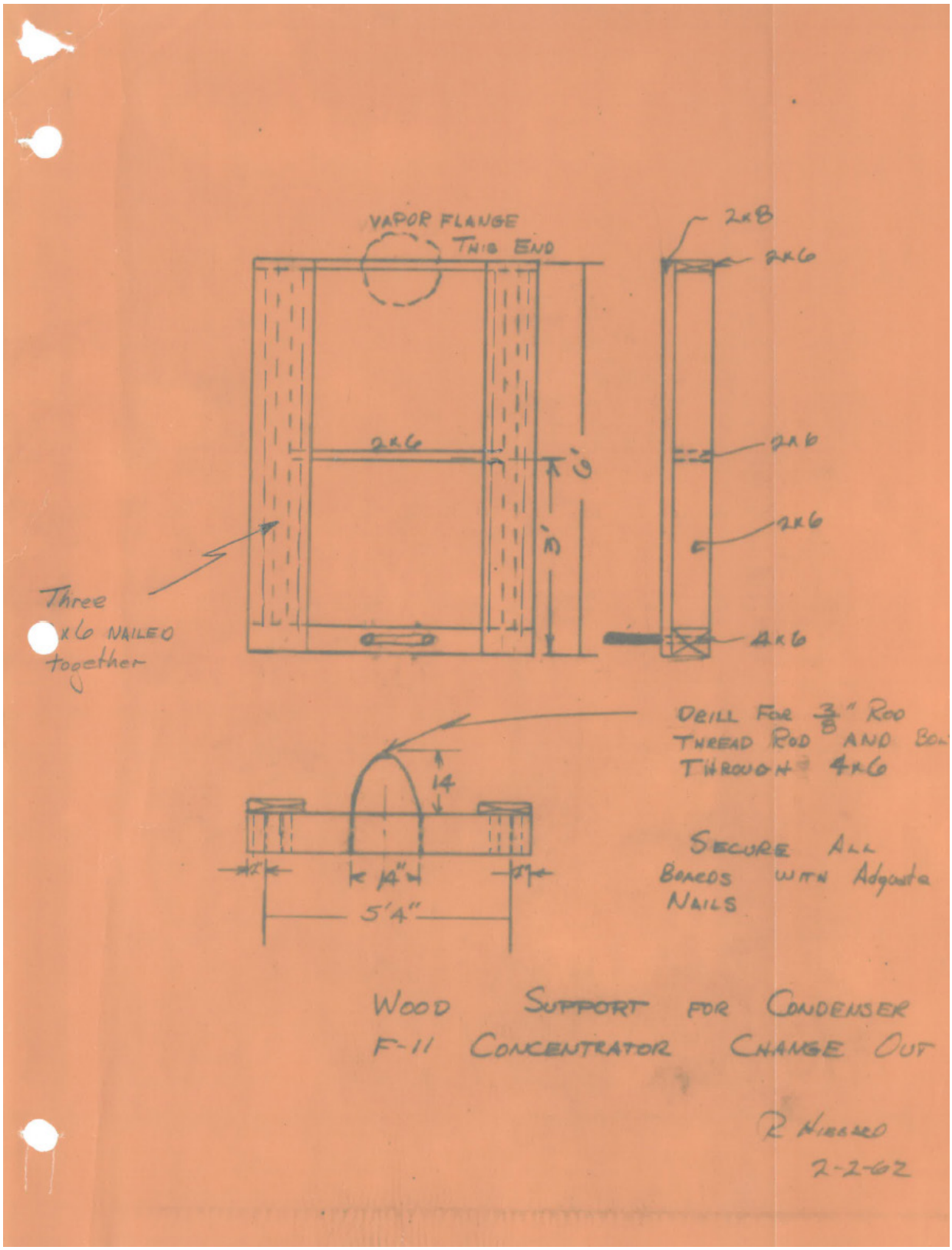
F-11 CONCENTRATOR BURIAL CAR AND MODIFICATIONS

A 44ft. flat car was modified to carry the F-11 concentrator into the Burial tunnel on Feb. 8. The end with the high tilt support was shortened by 32" to allow room for 1 more car in the tunnel. The bed of the car was modified as follows.



length of car after modifications — 42' 4"
length of Burial tunnel before placement of the car — 87' 5"


CONDENSER DONNAGE FOR CONCENTRATOR REMOVAL
2x6
PLACE CONDENSER WITH VAPOR FLANGE THIS END
6'-0"
3'-0"
PADS TO SIT CONDENSER ON
BAIL
4x6
2x8
14"
THREE - 2x6
14"
5'-4"
DRILL 3/8" HOLE, COUNTERSINK NUTS
3/8" ROD - THREAD BOTH ENDS
NOTE: SECURE ALL BOARDS WITH ADQUATE NAILS
ORIGINAL


VAPOR FLANGE
THIS END
2x8
2x6
2x6
2x6
2x6
4x6
Three
x6 NAILED
together
DRILL FOR 3/8" ROD
THREAD ROD AND BOL
THROUGH 4x6
14
14"
5'4"
SECURE ALL
BOARDS WITH Adjustable
NAILS
WOOD SUPPORT FOR CONDENSER
F-11 CONCENTRATOR CHANGE OUT
R NIBARED
2-2-62

T K Andrews
7618

February 2, 1962

CONCENTRATOR REPLACEMENT SCHEDULE

	No. of Shifts Required	Completion Date
OUTSIDE PREPARATION		
1. PREPARE BURIAL CAR FOR CONCENTRATOR BURIAL.		
A. Remove timbers from flat car.		
B. Fab. and install dunnage.		
C. Fab. and install drip pan. (Asbestos inside)		
D. Fab. and install remote braking mechanism.		
E. Remove coupler from end of car.		
F. Install rings on burial car for car puller.		
G. Freon test spare concentrator before moving.		
H. Lay concentrator on burial rack for fit, etc.		
I. Check stability of rack and car.		
J. Check car balance with load.		
K. Make short dry run with load.		
2. LOAD SPARE CONCENTRATOR AND MAKE READY FOR SHIPMENT.		
A. Position shipping racks on flat car.		
B. Move concentrator from burial car to shipping car.		
C. Make certain of fit and balance before shipment.		
D. Perform Freon leak tests.		
3. PREPARE BLANKS FOR BURIAL OF CONCENTRATOR.		
A. Fabricate two tube bundle opening blanks with bail and neoprene gasket sealed to bottom side, seal or tape free nuts to blanks.		
B. Provide nozzle blanks as follows: 4 each 3" vertical; 2 each 2" vertical; 1 each 2" vertical 3-way inst.; 1 each 2" horizontal		
C. Provide steel blank for condenser outlet on tower seal or tape free nuts to blank.		
D. Move blanks to building before burial car.		
4. PREPARE BLANKS AND GASKETS FOR NEW CONCENTRATOR.		
A. Condenser to concentrator remote gasket.		
B. Tube bundle remote gaskets.		
C. S/S free nuts for old or new tube bundles.		
D. Fab. nozzle blanks as follows: 5 each 2" vertical; 1 each 3" vertical; 1 each 2" vertical 3-way inst.; 1 each 2" horizontal		
E. Advise Shops on blank and remote gaskets. Install at Shop or ship to building?		

	No. of Shifts Required	Completion Date
CANYONS PREPARATION		
5. PERFORM TRANSFER OF FAILED CONCENTRATOR TUBE BUNDLES TO T PLANT.		
A. Obtain equipment transport box.		
B. Inspect box for adequacy and leak potentials.		
C. Place tube bundle capsules in burial box.		
D. Position capsules for tube bundle fit.		
6. PREPARE CRANES FOR COUPLED RENEWAL WORK PRIOR TO EQUIPMENT CHANGES.		
A. Perform mechanical and electrical inspections, of main west crane including cables.		
B. Ditto Slave crane.		
C. Couple slave and west crane together and check and correct all operating functions.		
7. INSPECT CAR PULLER.		
A. Make certain that car puller is working satisfactorily.		
8. INSPECT WATER FILLED DOOR.		
A. Make certain that water filled door will open and close satisfactorily.		
9. MAKE CERTAIN CONCENTRATOR LIFTING YOKE IS AVAILABLE AND SATISFACTORY.		
A. Provide and place wood dunnage on deck for condenser.		
10. FLUSH CONCENTRATOR AND PREPARE FOR BURIAL.		
A. Perform internal flushes.		
B. De-energize electrical circuits.		
C. Blank electrical heads.		
D. Perform external flushes.		
E. Remove jumpers.		
F. Remove condenser.		
G. Remove tube bundles.		
H. Blank openings.		
I. Flush exterior again.		
J. Inspect corrosion damage of dunnage to determine stability for placing on burial rack.		
K. Make TV checks of dunnage and leak areas inside of tube bundle chest.		
L. Check heat source in concentrator possibly need therein.		

	No. of Shifts Required	Completion Date

11. REMOVE AND BURY CONCENTRATOR.

    A. Put Speedy-Dri in drip pan just prior to moving burial car in tunnel.
    B. Tape measure tunnel burial space remaining (').

12. WHEN CONCENTRATOR HAS BEEN REMOVED FROM CELL CAUTION CRANE OPERATORS NOT TO DISTURB CELL FLOOR FOOTING PADS IN CASE ANCHOR BOLTS SHOULD BE WATER OFF.

13. INSTALL NEW CONCENTRATOR.

    A. Install tube bundles with 5/8 free nuts.
    B. Install condenser.
    C. Install jumpers.
    D. Leak check.

HISTORY

A. F-11 concentrator was discovered leaking excessively on February 1, 1962. Leaks were noted on the bottom of west tube bundle section in the vicinity of three or four O'clock. Later checks initiated on graveyard shift on February 2nd, revealed leaks on the bottom of main tower section between the tube bundles chests. Leaks were calculated to be three gallons per minute.

B. Replacement was completed on February _____.

C. Record any information which might have caused delays during equipment changes.

_____

_____

_____

D. Record any information that might expedite future replacements of this nature.

_____

_____

_____

R De Jongrehv

3.43 (1961.01) Burial of H-4 Concentrator

BURIAL OF H-4 CONCENTRATOR

1. Buried behind water filled door in railroad tunnel extension.

2. Buried January 4, 1961

3. Dose Rates:

Maximum dose rate at tunnel door while loading	100 mr/hr
Maximum dose rate at tunnel door after loading	15 mr/hr
Inspect concentrator from approximately 40 feet	150 mr/hr
Inspect H-4 from water filled door after conc. in place	150 mr/hr

3.44 (1960.09) H-4 Concentrator Change

84-6000-302

CHEMICAL PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

September 12, 1960

F. A. Dreher (2)
Contact Engineer
Purex Operation

H-4 CONCENTRATOR CHANGE

The two attached lists show the blanks that are required to bury the old H-4 concentrator and to outfit the new concentrator.

Other work required for the change-out includes:

1. Re-shape the lagging around the DD nozzle to allow clearance for fingers when installing a jumper in this nozzle.

2. Ream out nozzle BB to allow entry stub to fit into nozzle.

Lagging sent - pickup 9-9-60 - 7
Gave to Stell 9-12-60 - 7

3. Fabricate a thermohm jumper to fit the off-set nozzle (A) on new concentrator. Print # H2-57790 and 57791 -

4. Fabricate a flexible jet jumper to allow flushing of H-4 while a Birch run is being conducted. Jumper is to fit in nozzle DD of H-4 and discharge to trench nozzle JT 80. Steam can be supplied via nozzle HG 2.

Carl E King

Purex - Processing Operation

CE King:vs
Attachment
cc: JM Blackburn
R De Jong
SG Smolen
File

4 PUREX Tunnel Inventory-Related Presentations

This chapter contains presentations relevant to the inventory within the PUREX Tunnels that were not captured elsewhere and would likely be useful.

4.1 Location of Mercury in PUREX Annual Dissolvers

The following set of slides provides information as to where exactly on the annular dissolvers the elemental mercury is located.

PUREX Tunnel 2 Annular Dissolvers

Review of Mercury
Inventory by C.J. Francy

CH2MHILL
Plateau Remediation Company

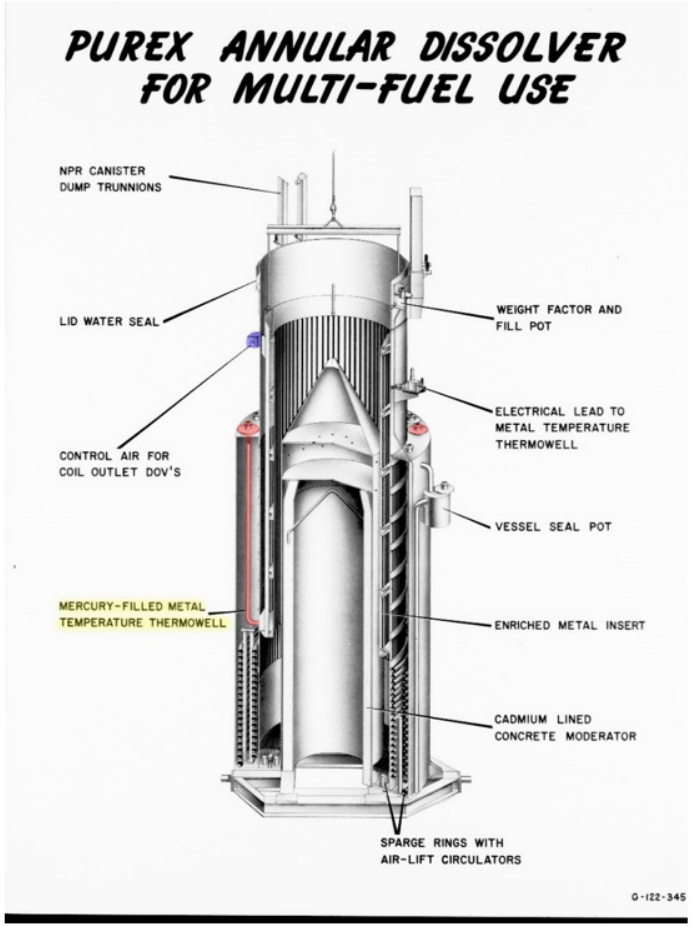
June 2018

PUREX Annular Dissolver

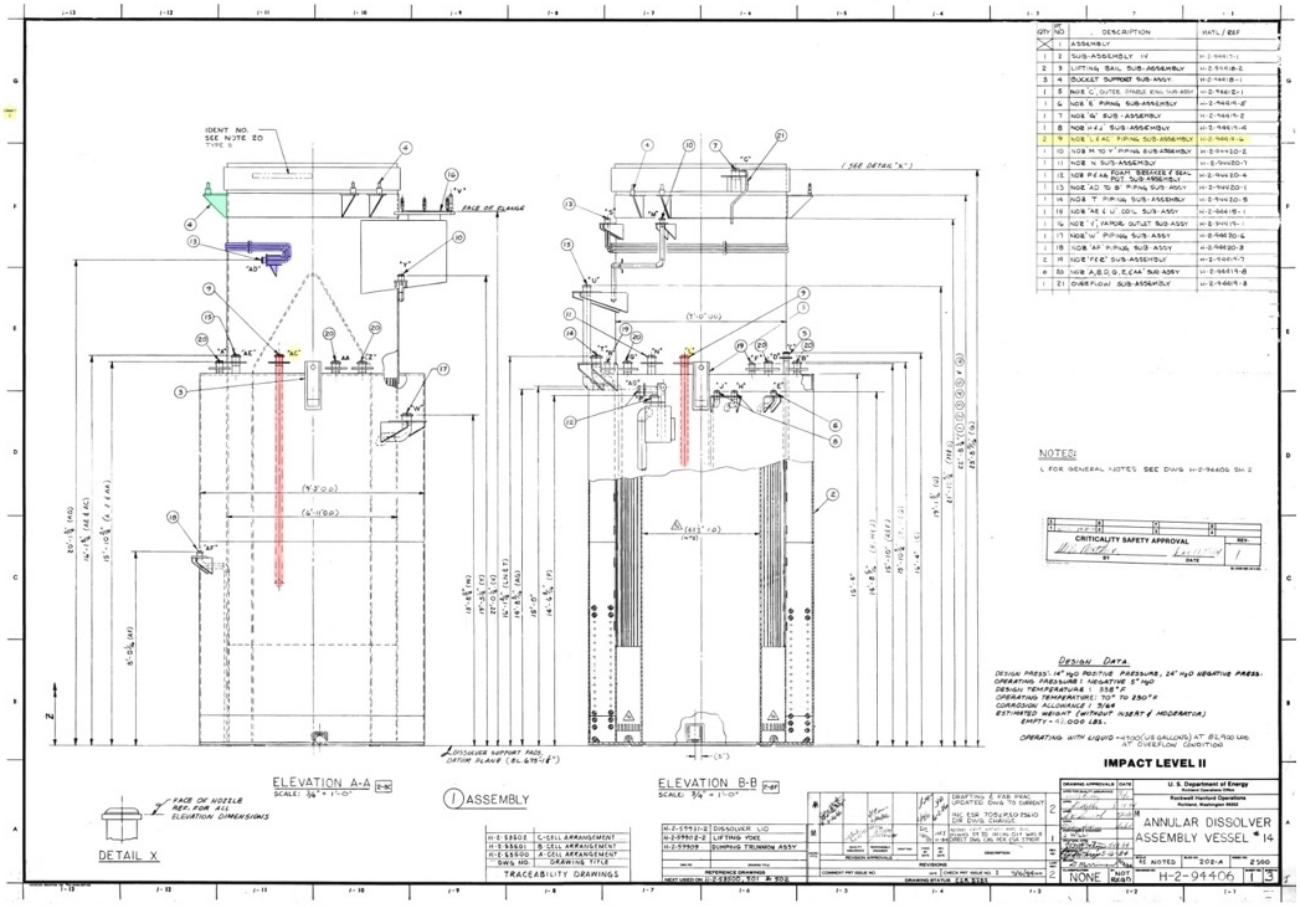
The PUREX Annular Dissolvers contain elemental mercury (Hg) which is still present.

The mercury is contained within 2 thermowells, directly opposite of each other

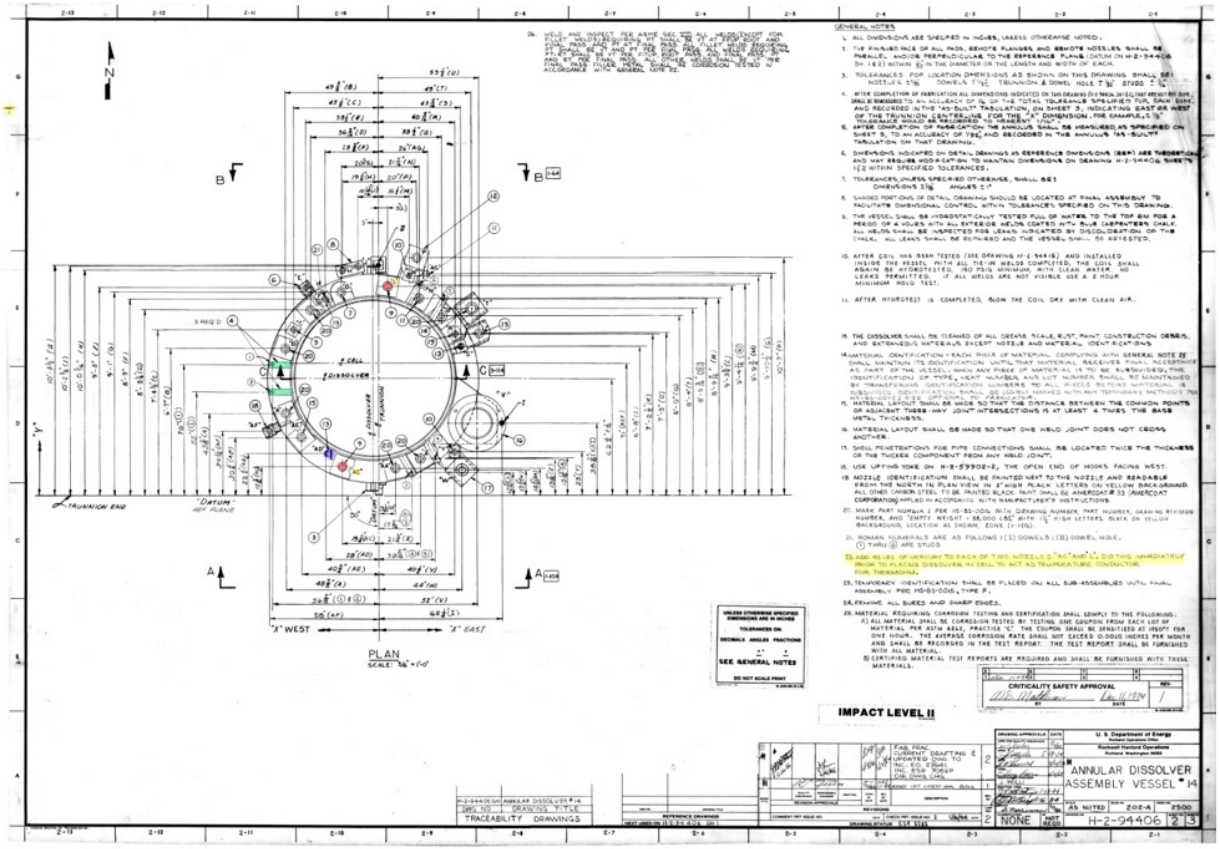
The mercury containing thermowells are colored red on all subsequent images



Engineering Drawing H-2-94406-1

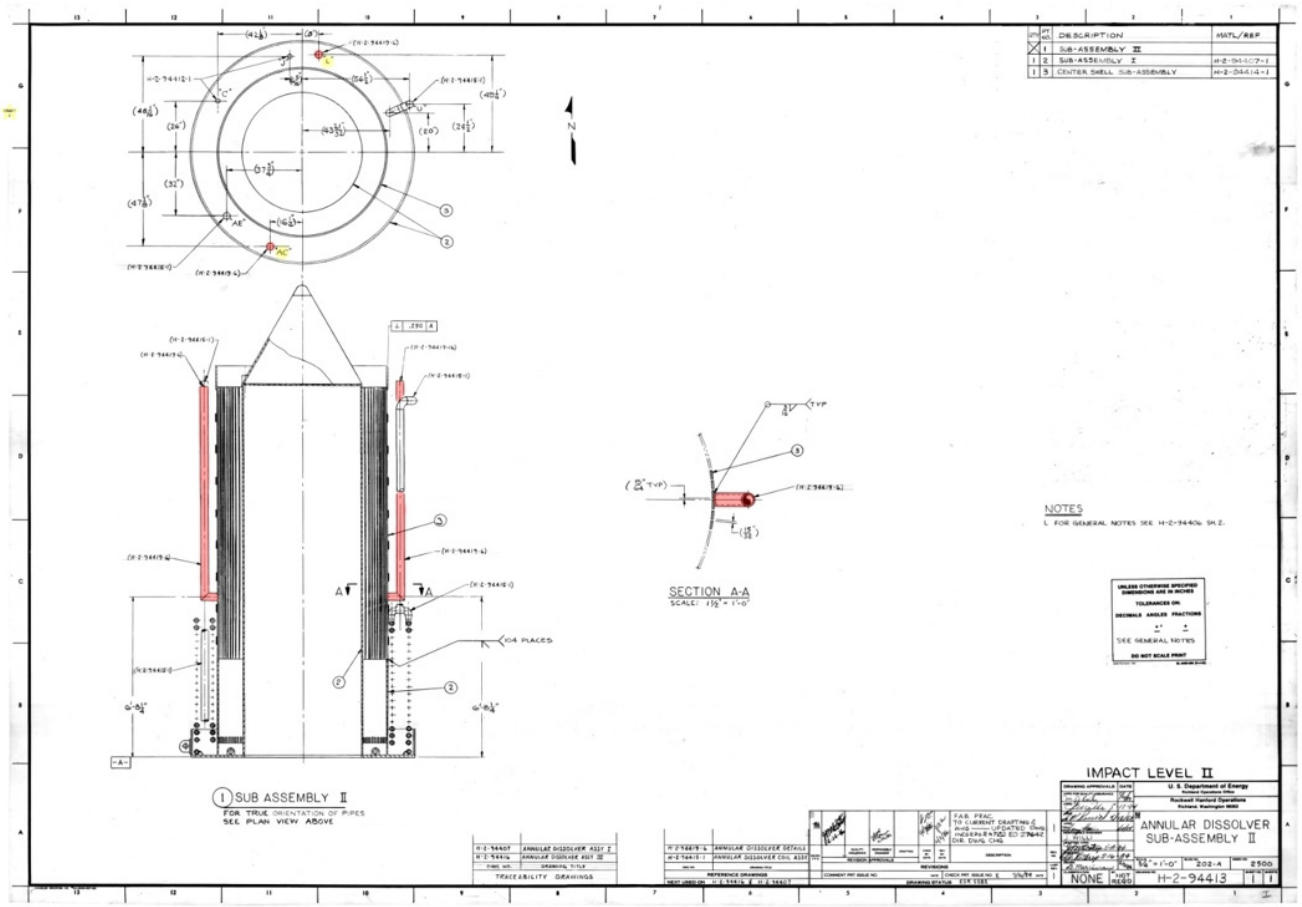


Engineering Drawing H-2-94406-2



22. Add 42 lbs. of mercury to each of two nozzles “AC” and “L”. Do this immediately prior to placing dissolver in cell to act as temperature conductor for thermohm.

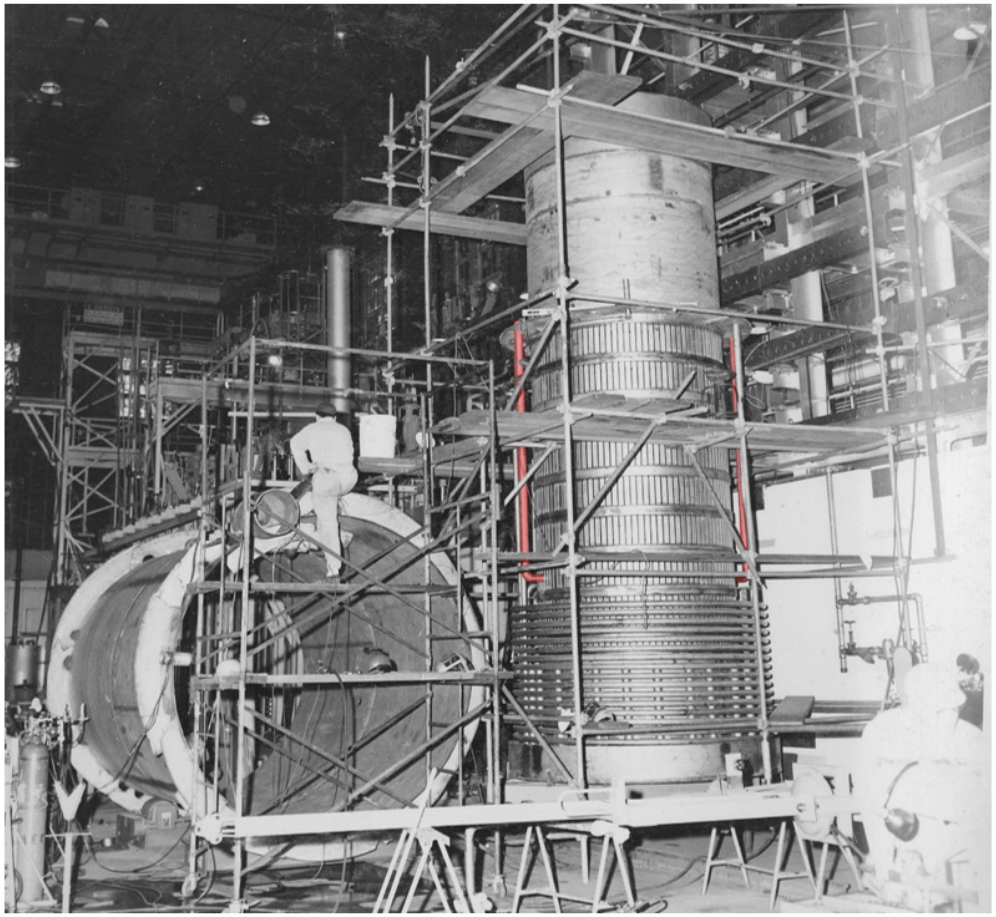
Engineering Drawing H-2-94413



Assembly Photo

The PUREX Annular Dissolver is being assembled in 200 East

The thermowells are colored red



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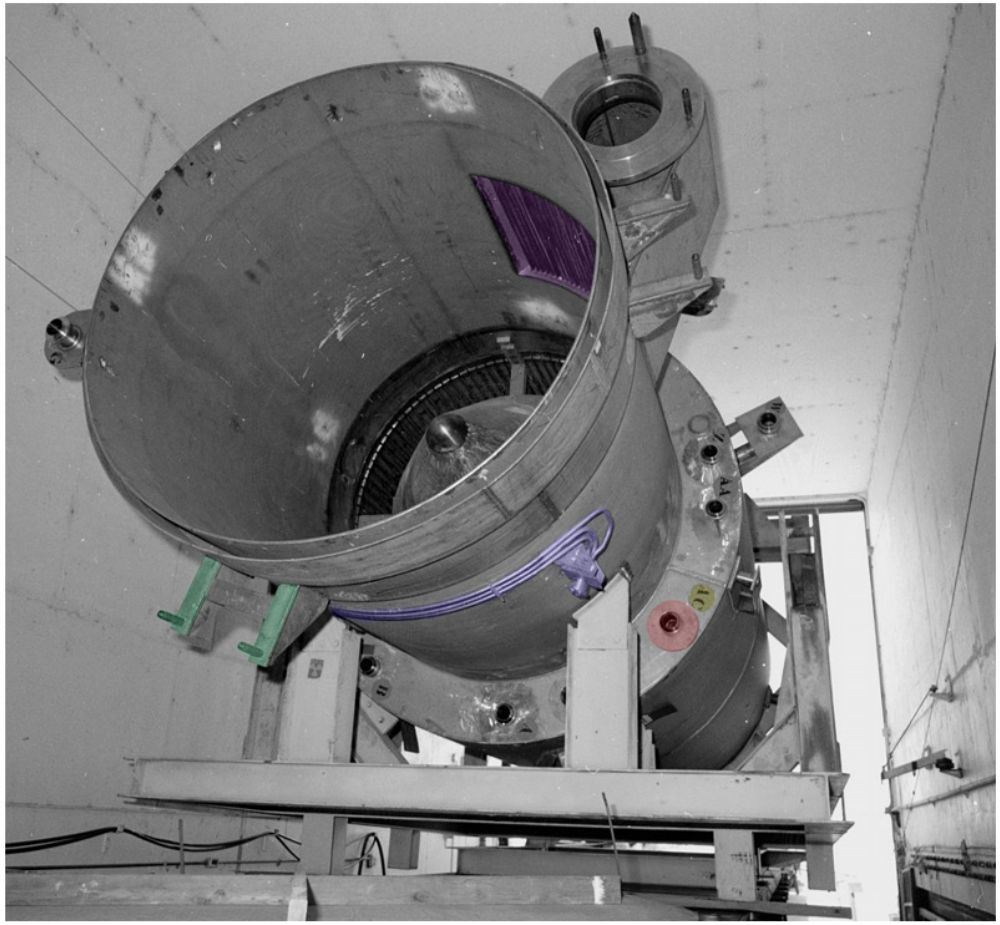
Transportation Photo

The photo to the right shows a replacement dissolver on a rail car, in the PUREX rail tunnel

Thermowell AC can be seen lower center-right. Thermowell L is 180 degrees opposite.



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Storage Tunnel 2 Position 9

Image rotated and made black and white to aid in identifying the thermowell.

Image as seen from the camera placed into the tunnel through the open rise above.

Possible Caps

Exact component used to cap the open thermowell not currently known, assume it is similar to those shown to the right based on photos.

4.2 Nuclear Safety Review of 324 Facility Items

The following set of slides were created by Nuclear Safety as an informal presentation to provide information on the contents of the railcars in positions 24 and 25, as well as qualitatively show what is protecting the material from being released.

324 Facility Waste in PUREX Tunnel 2

Nuclear Safety Review of PUREX
Tunnel 2 Positions 24 and 25
C.J. Francy

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Plateau Remediation Company

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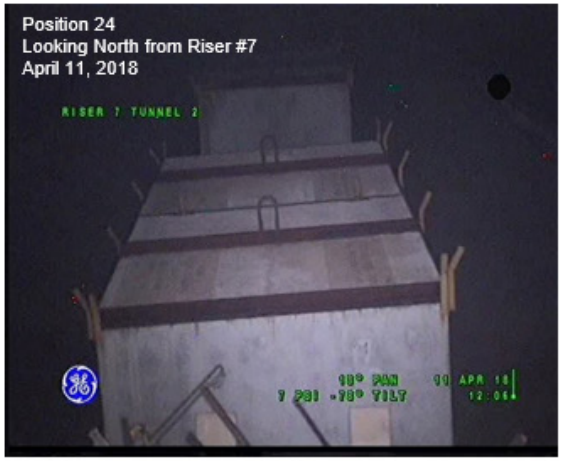
PUREX Tunnel 2 Positions 24 & 25

	324 Building Shipments 1-8 Tunnel #2 Position 24	324 Building Shipments 9-17 Tunnel #2 Position 25
Estimated Total Source Term	~244,000 Ci	~1.75M Ci
Estimated Total Plutonium Content	~24 g	~43 g
Estimated Total Dangerous Waste	Pb ~ 1802 Kg Cd ~ 10.5 Kg Cr ~ 1 Kg Ba ~ 3 Kg Oil ~ 8.5 Kg	Pb ~ 1 g Cd ~ 1 g Cr ~ 2 g Ba ~ 4 g



Dispersible waste inventory total:

- 167,000 curies at 4/1996
- 99,700 curies decayed to 1/2018

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Barriers Against Release

Soil Overburden (3' SS Credited)

Tunnel Structure (D.I.D. Credited)

Concrete Burial Box

Cask Liners (D.I.D. Credited)

Form or Engineered Containers

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PUREX Storage Tunnel Soil Overburden

Storage Tunnel 2 has approximately 8' of soil overburden

- Closest 3' to the tunnel credited as Safety Significant (SS)
- Provides a Leak Path Factor (LPF) of 0.5 in the DSA

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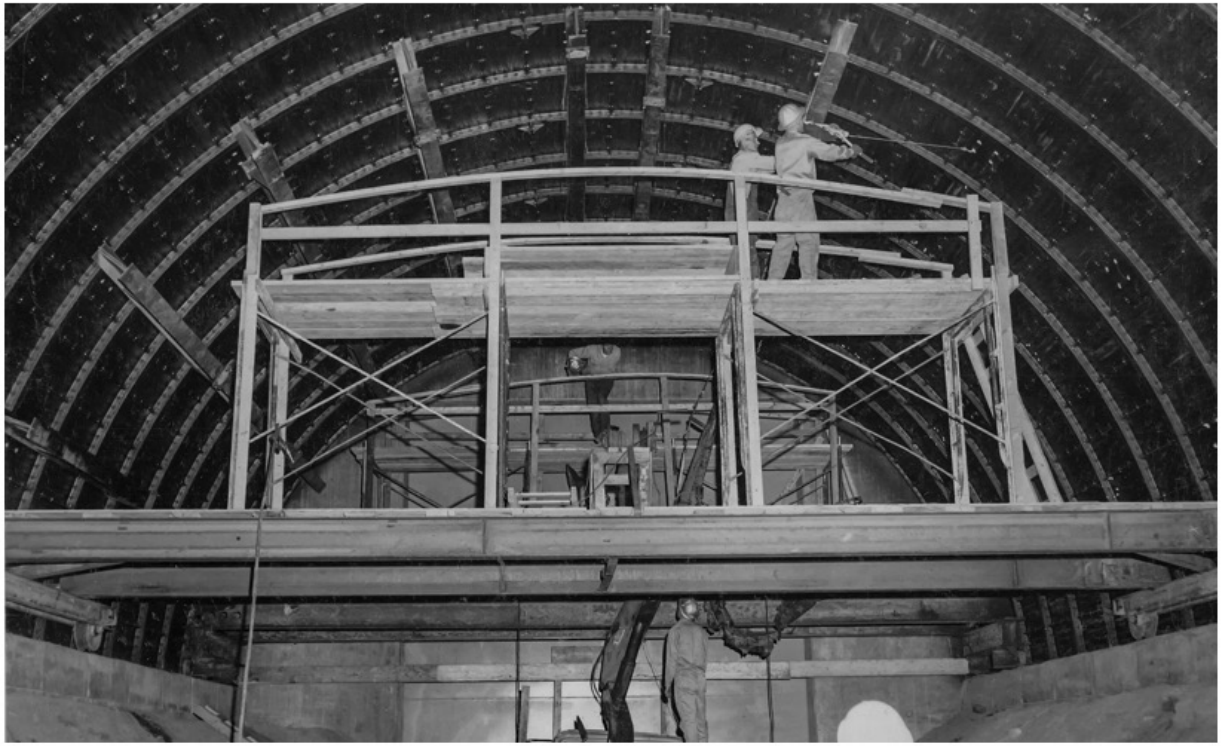
PUREX Storage Tunnel 2 Structure



Structure credited as Defense in Depth (DID) in the DSA

- 10.4m diameter steel semicircular roof (0.5 cm plate)
- Internal I-beams attached to external reinforced concrete arches
- Connected to 1.8m x 1.2m concrete beams on each side

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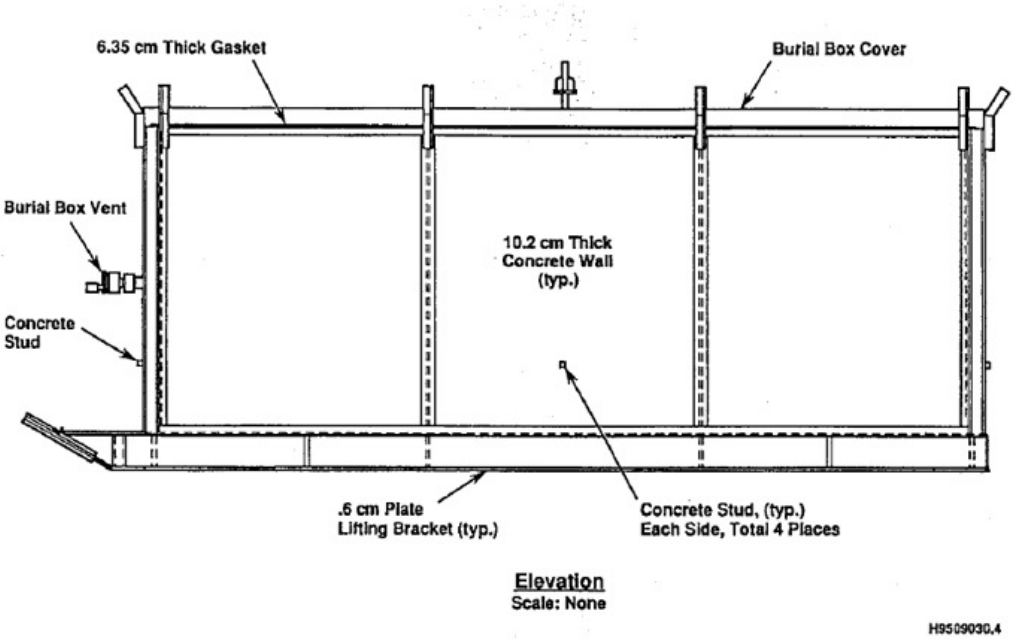
Concrete Burial Boxes



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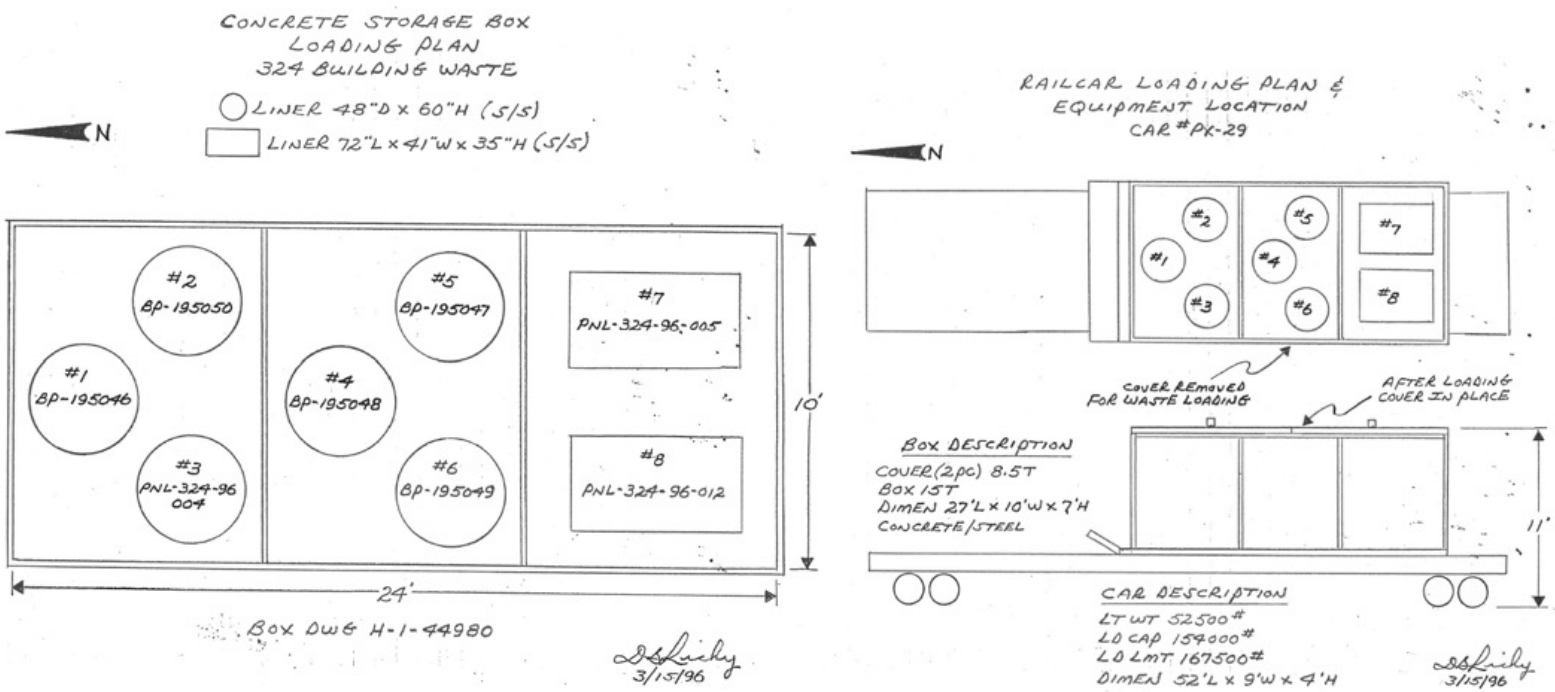
Position 24 Loading Plan



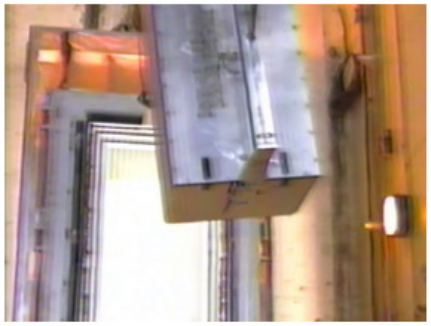
100% of the inventory considered dispersible is contained within #7 and #8

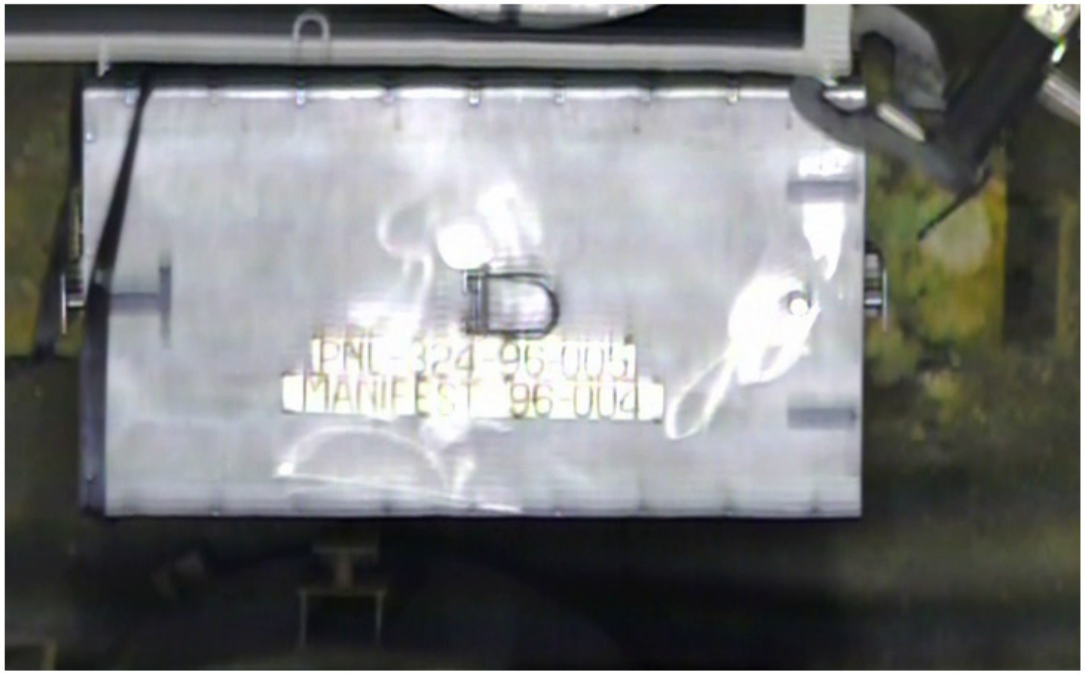
Position 24 Inventory

Shipment #	Dose Rate @ Contact	Curie Content	Activation Nuclides	Container Type	Waste Description
1	120 Rem	5.41E+02	Cs-137 2.34E+02 Sr-90 3.65E+01	SEG	Mild steel grout container, vacuum cleaner, steel disc; Paper HEPA filter media
2	1000 Rem	3.96E+02	Cs-137 8.80E+01 Sr-90 1.10E+02 Cs-134 1.00E-02 Co-60 1.00E-02 Eu-154 2.00E-02 Eu-155 2.00E-02	SEG	Mild steel grout container; Stainless steel shield plug; Paper HEPA filter media
3	1000 Rem	2.36E+03	Cs-137 5.25E+02 Sr-90 6.56E+02 Cs-134 4.00E-02 Co-60 5.00E-02 Eu-154 7.00E-02 Eu-155 3.00E-02	SEG	Mild steel grout container, cover plate, wire mesh; Stainless steel offgas jumper; Paper HEPA filter media
4	1700 Rem	2.49E+03	Cs-137 5.54E+02 Sr-90 6.92E+02 Cs-134 5.50E-02 Co-60 7.40E-02 Eu-154 9.80E-02 Eu-155 3.30E-02	SEG	Mild steel grout container, cover plate, screens; Stainless steel electrode; Paper HEPA filter media
5	340 R/Hr	9.00E+02	Cs-137 2.00E+02 Sr-90 2.50E+02	SEG	Mild steel grout container, 5-gallon bucket; Wood; Liquid metal seal solid flange; Lead shot, bricks; Window oil rags
6	200 Rem	2.84E+02	Cs-137 1.03E+02 Sr-90 3.90E+01 Cs-134 9.70E-02 Co-60 1.30E-01 Eu-154 1.70E-01 Eu-155 2.70E-02	SEG	Mild steel grout container, steel plate; Paper HEPA filter media
7	19K R/Hr	3.12E+04	Cs-137 1.00E+04 Sr-90 5.58E+03 Co-60 1.08E-01 Eu-154 6.56E+00	22.5 Ton	Stainless steel engineered containers of hazardous and nonhazardous dispersible debris, special case waste container
8	22K R/Hr	2.05E+05	Cs-137 5.96E+04 Sr-90 4.32E+04 Eu-154 2.05E+00	22.5 Ton	Stainless steel engineered dispersible containers, can storage basket, hazardous feed cans
Total		~244,000 Ci			

Shipments 1-8 moved to storage in tunnel #2, position 24, on April 26, 1996

22.5 Ton Cask Liners





22.5 Ton cask liners housing the Engineered Containers, which hold:

- Dispersible debris
- Dried melter feed

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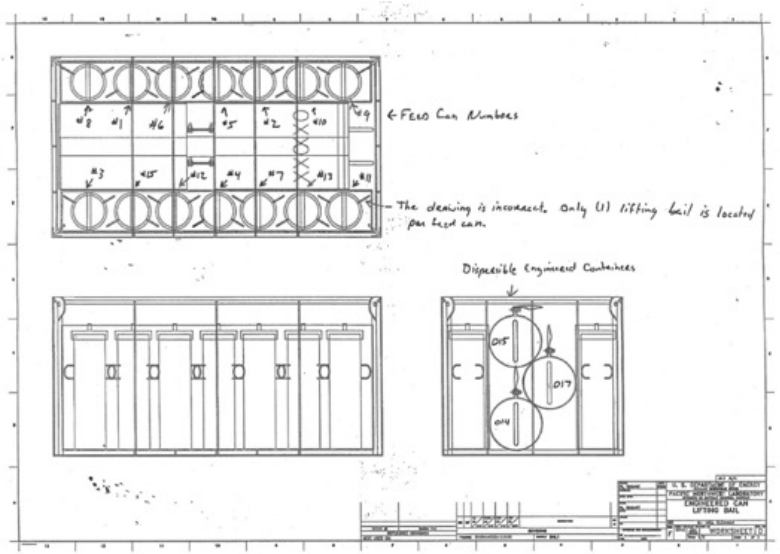
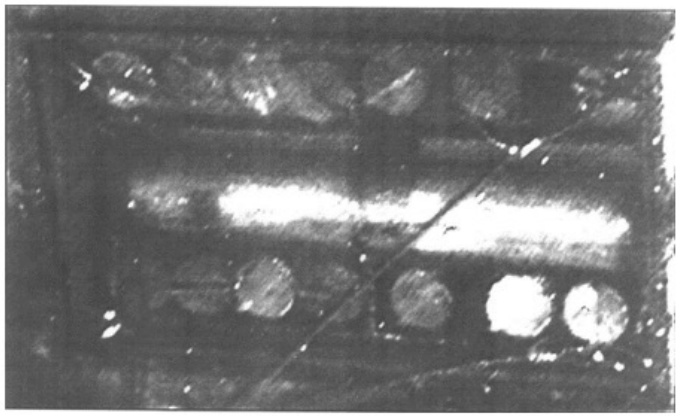
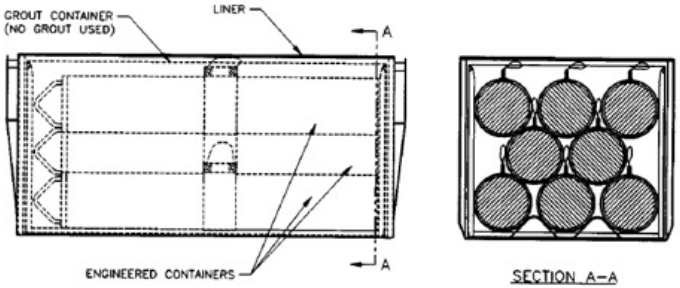
Engineered Container Arrangement







Arrangement of the Engineered Containers within the two 22.5 Ton Cask Liners

Engineered Container Details

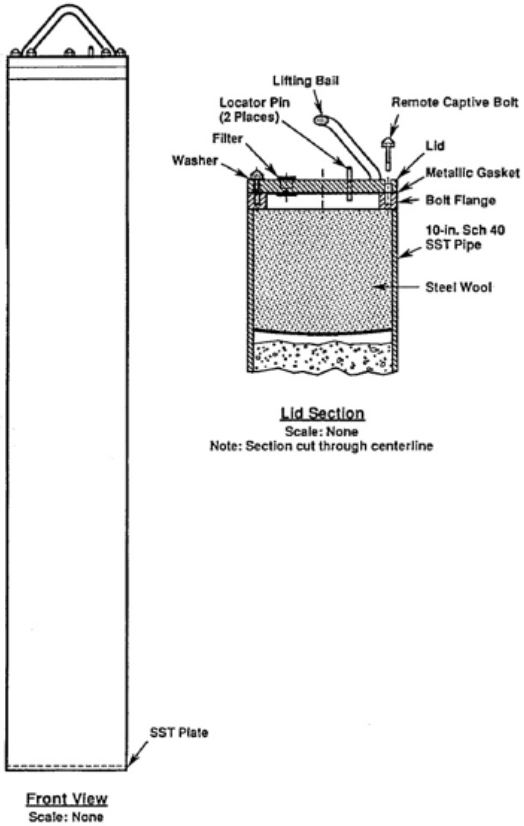
8.1.1 Passive Systems for Storage of the Dispersible Debris and Dried Melter Feed

The passive system for the potentially dispersible debris consists of five engineered barriers that contain the source term. The engineered barriers preclude the radionuclide source term from becoming directly airborne and also provide radiation shielding. During cleanup of B-Cell the dispersible particulate waste was placed into engineered handling containers.

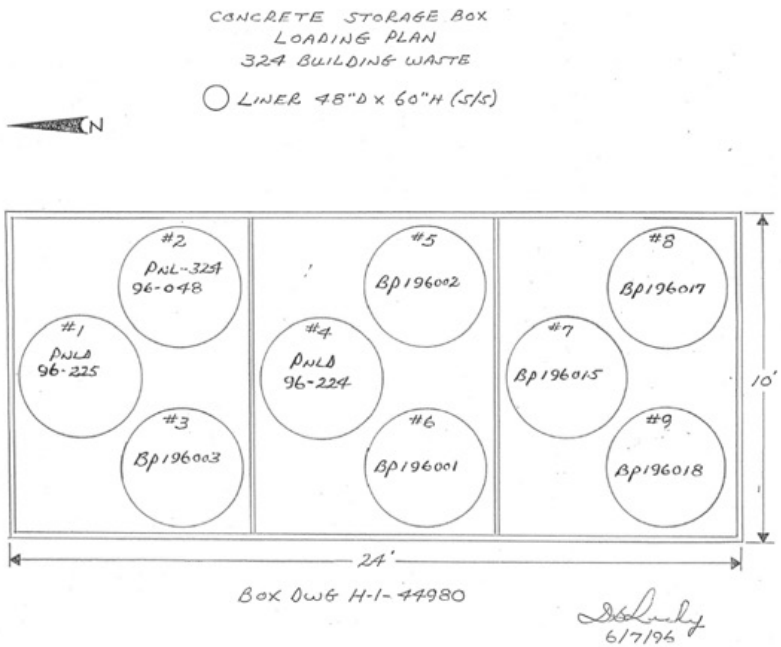
The waste that is considered potentially dispersible particulates is further identified as potentially dispersible debris and dried melter feed. The potentially dispersible debris has been placed into 10 engineered handling containers (refer to Figure 8-1). The dimensions of the engineered handling containers are 27.3 centimeters (outer diameter) by 168 centimeters long. The potentially dispersible debris handling containers are stainless steel with gasketed bolt-on lids. Each lid is equipped with a HEPA filter to preclude pressure buildup in the container. The engineered handling container is considered the first engineered barrier.

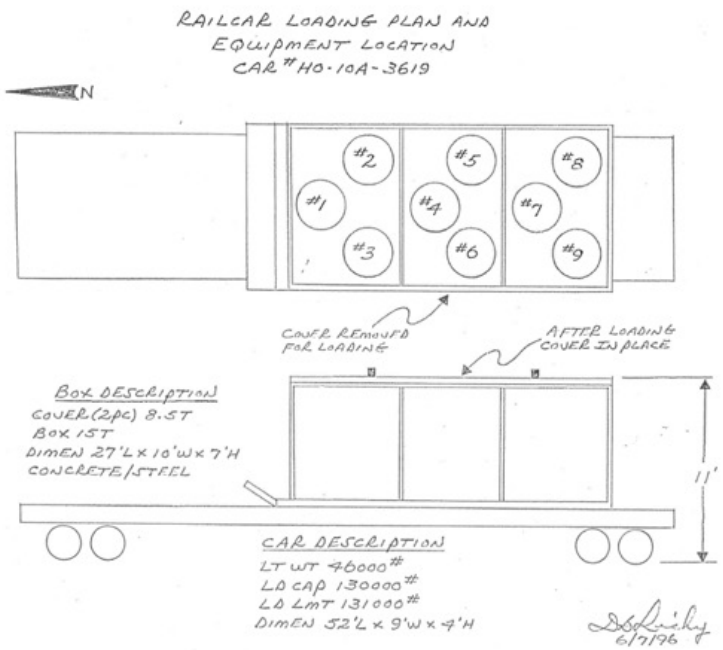
The dispersible debris handling containers will be placed horizontally in the transportation cask liners for the 22.5-ton transportation cask. Once the handling containers are placed into the transportation cask liners, the debris could move and thereby plug the metal HEPA filters. To prevent the debris from moving, and plugging the HEPA filter, two additional engineered barriers will be installed. The second barrier will be different mesh sizes of steel wool that will be inserted into the handling containers and will restrain the debris. The third barrier will be the installation of legs on the handling containers so the containers lay with the HEPA filter at the top of the lid when placed into the 22.5-ton transportation cask liners. The fourth barrier is the 22.5-ton transportation cask liner. The liner is equipped with a HEPA filter to preclude pressure buildup in the container. The fifth barrier is the General Purpose Concrete Box. The General Purpose Concrete Box is discussed in Section 8.2.

The dried melter feed has been placed into 15 handling containers that are 16.8 centimeters (outer diameter) by 61 centimeters long. The dried melter feed handling containers are stainless steel with a threaded screw-on aluminum lid. A barrier of different mesh sizes of steel wool will be inserted into each container to restrain the dried melter feed. The dried melter feed engineered handling containers will be placed in the SEG* cask liner in the vertical position so the HEPA filters will not be vulnerable to plugging.



Position 25 Loading Plan





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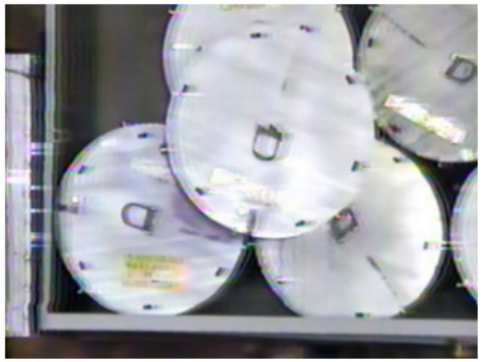
Position 25 Inventory

Shipment #	Dose Rate @ Contact	Curie Content	Activation Nuclides	Container Type	Waste Description
9	6159 R/Hr	3.54E+04	Cs-137 1.49E+04 Sr-90 2.79E+03	SEG	Stainless steel grout container, engineered containers; refractory used in melter operations
10	9550 R/Hr	3.90E+04	Cs-137 1.63E+04 Sr-90 3.22E+03	SEG	Stainless steel grout container; refractory used in melter operations
11	18372 R/Hr	7.35E+04	Cs-137 3.07E+04 Sr-90 6.07E+03	SEG	Mild steel grout container; refractory brick/throat block refractory used in melter operations
12	8169 R/Hr	1.99E+05	Cs-137 4.43E+04 Sr-90 5.53E+04	SEG	Mild steel grout container; stainless steel melter lid; Alfrax/Duraboard; grout
13	1340 R/Hr	1.57E+05	Cs-137 3.48E+04 Sr-90 4.35E+04	SEG	Mild steel grout container; rubber hose; plastic; cloth; stainless steel; glass
14	22K+ R/Hr	7.62E+05	Cs-137 2.71E+05 Sr-90 1.10E+05	SEG	Mild steel grout container, funnel; glass
15	4000 R/Hr	1.16E+05	Cs-137 1.52E+04 Sr-90 4.30E+04	SEG	Mild steel grout container; stainless steel melter parts; paper HEPA filter media; SrF_2 capsules
16	20K+ R/Hr	2.56E+05	Cs-137 9.74E+04 Sr-90 3.08E+04	SEG	Mild steel grout container; melter glass canisters
17	20K+ R/Hr	1.07E+05	Cs-137 3.94E+04 Sr-90 1.41E+04	SEG	Mild steel grout container; melter glass canisters
Total		~1.75M Ci			

Shipments 9-17 moved to storage in tunnel #2, position 25, on June 12, 1996

Grout Containers Within SEG 3-82B Cask Liners



Grout Containers inside of SEG 3-82B cask liners

- Stainless steel construction instead of painted low carbon steel used for LLW

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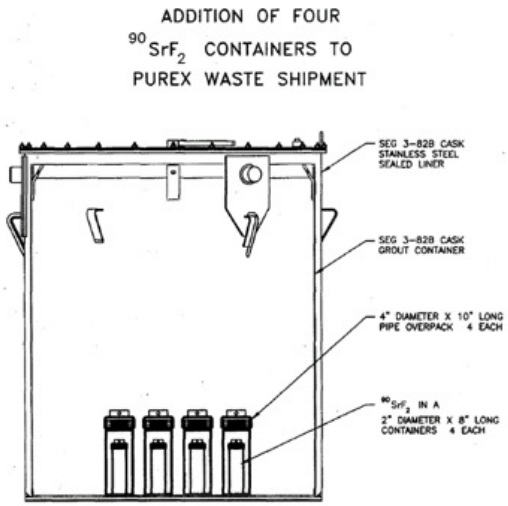
Grout Containers



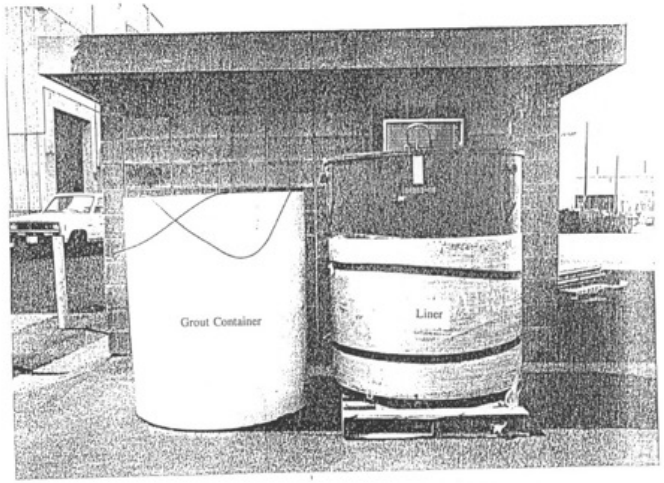


Figure 3.1. Grout Container and Liner for SEG 3-82B Transportation Cask

Category 3 LLW contains greater concentrations of radioactive material than Category 1 and often must be remotely handled to minimize worker radiation dose. Category 3 LLW is packaged in 55-gallon drums, TMB-V containers, or the container system associated with the SEG-3-82B Transportation Cask (previously designated the Hittman Nuclear HN-200 Transportation Cask).

An inner grout container, which contains the waste, is filled with grout after LLW loading and placed into a liner, which is then loaded into the transportation cask and taken to the CWC. Figure 3.1 shows the grout container and the liner. The grout container has a packaged waste volume of 47 ft^3, and the liner has an external volume of 76 ft^3.

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Appendix A

Tunnel 1 (218-E-14) Photographs

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A1 Introduction

This appendix provides photographs of the positions within Storage Tunnel 1 (218-E-14).

Unless otherwise noted, these images were obtained in the fall of 2017 via remote cameras inserted into risers during the stabilization/grouting of the tunnel. If photographs of a position are not provided, then none are known to exist at this time.

Figure A-1. Photograph 14718-NEG-E

1. & 2. CAR PLACED IN TUNNEL ON 6/60;
HA COLUMN AND MISC. JUMPERS IN BOX (H-2-58372);
HA COLUMN: 4,700 CU. FT.; 400 CURIES; JUMPERS: 2,190 CU. FT.;
2,000 CURIES; ~115 kg Pb; 5 rem/hr. @ 60'

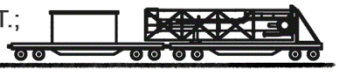

Figure A-2. Position 1; As Seen from the South Ventilation Plenum

Figure A-3. Position 1; Before Grouting Operations

3. CAR PLACED IN TUNNEL ON 7/29/60;
E-F11 (#1) (1WW WASTE) CONCENTRATOR;
1,900 CU. FT.; 40,000 CURIES; 12.5 rem/hr. @ 100'

Figure A-4. Riser 9 Location

Figure A-5. Riser 9 Obstruction

No known photos of Position 3 are available due to Riser #9 being obstructed.

4. CAR PLACED IN TUNNEL ON 12/24/60;
G-E2 CENTRUFUGE, 2 TUBE BUNDLES, MISC. JUMPERS;
2,465 CU. FT.; 3,000 CURIES; ~115 kg Pb; 1.5 rem/hr. @ 150'

Figure A-6. Position 4; G-E2 Centrifuge and Jumper Box

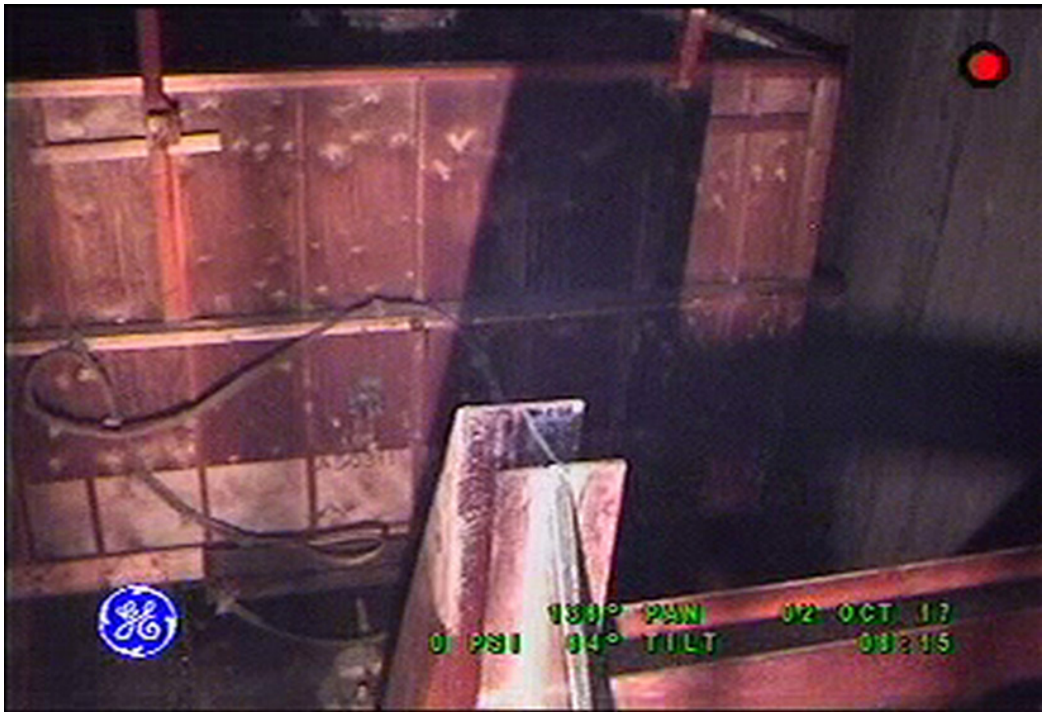

Figure A-7. Position 4; Wooden Burial Box

5. CAR PLACED IN TUNNEL ON 1/4/61;
E-H4 (3WB) CONCENTRATOR;
2,336 CU. FT.; 1,000 CURIES; 0.15 rem/hr. @ 50'

Figure A-8. Position 5; E-H4 Concentrator

Figure A-9. Position 5; E-H4 Concentrator

6. CAR PLACED IN TUNNEL ON 4/21/61;
E-F6 (2WW WASTE) CONCENTRATOR;
2,336 CU. FT.; 700 CURIES; 5 rem/hr. @ 20'

Figure A-10. Position 6; E-F6 Concentrator

Figure A-11. Position 6; E-F6 Concentrator

7. CAR PLACED IN TUNNEL ON 2/8/62;
E-F11 (#2) (1WW WASTE) CONCENTRATOR;
2,336 CU. FT.; 40,000 CURIES; 25 rem/hr. @ 150'

Figure A-12. Position 7; E-F11 Concentrator Under Collapse Backfill

Figure A-13. Position 7; E-F11 Concentrator Directly Below the Collapse Site

8. FLAT CAR 3621 PLACED IN TUNNEL ON 1/22/65;
E-F6 (#3 SPARE) (2WW WASTE) CONCENTRATOR;
2,400 CU. FT.; 700 CURIES; 5 rem/hr. @ 20'

Figure A-14. Position 8; E-F6 Concentrator

Figure A-15. Position 8; Bottom of E-F6 is Punctured

218-E-14 Exit

Figure A-16. Water Fillable Door Beyond Position 8; Tunnel 1 Exit

Figure A-17. Water Fillable Door; Tunnel 1 Exit

218-E-14 Entrance

Figure A-18. Exit B-20 Immediate Left; Tunnel 1 Entrance Straight Ahead; 9/19/1996

Figure A-19. Water Fillable Door; Tunnel 1 Entrance; 9/19/1996

Miscellaneous Additional

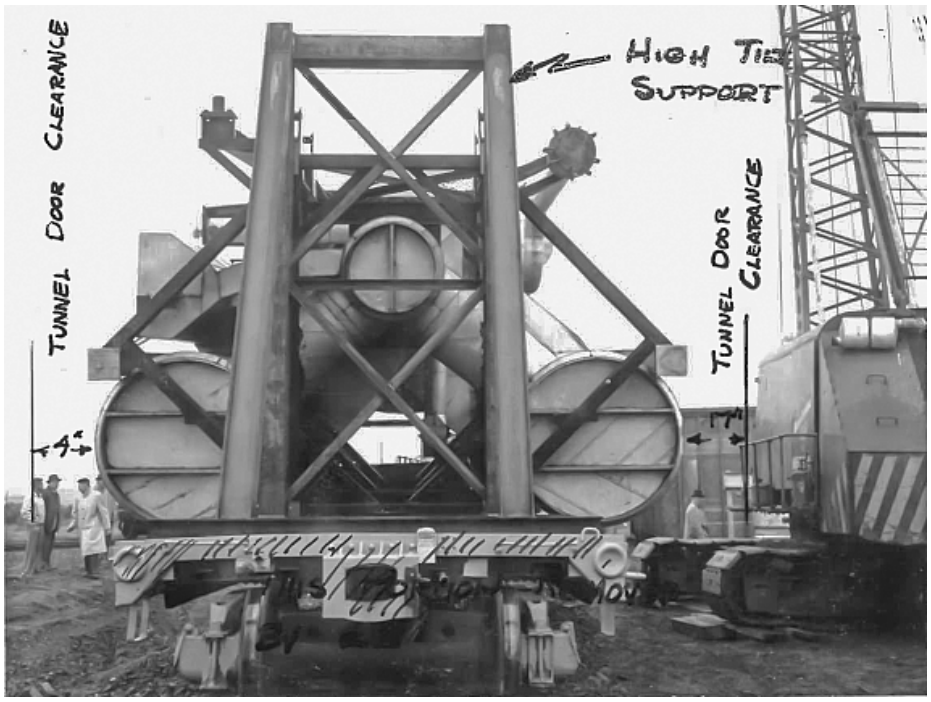

Figure A-20. Photograph Dated 2/7/1962

Figure A-21. Photograph Dated 2/7/1962

Miscellaneous Additional

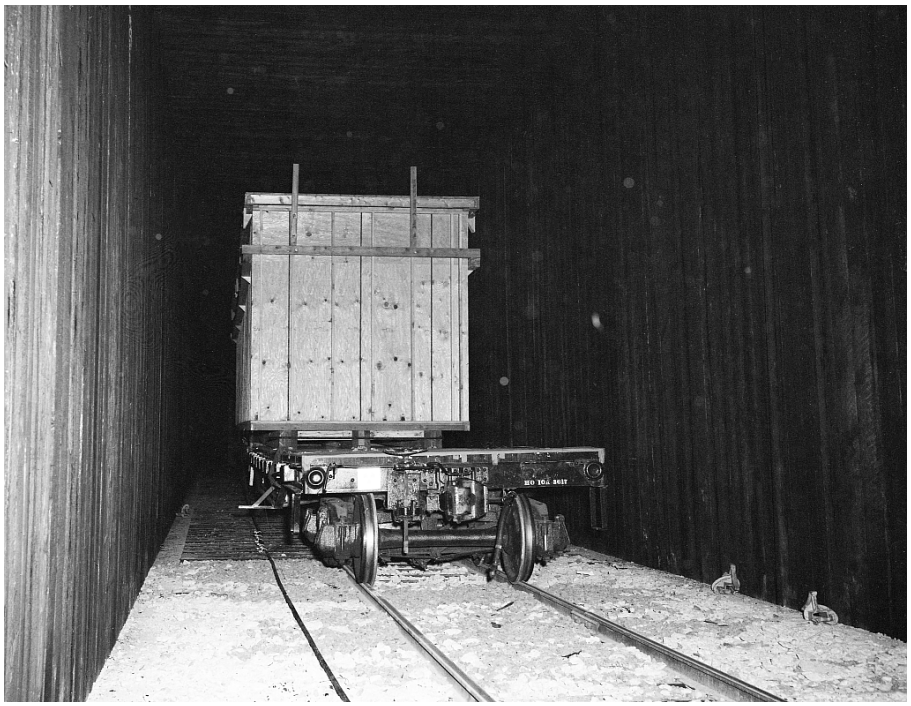

Figure A-21. Wooden Burial Box in Tunnel 1 (18755-4)

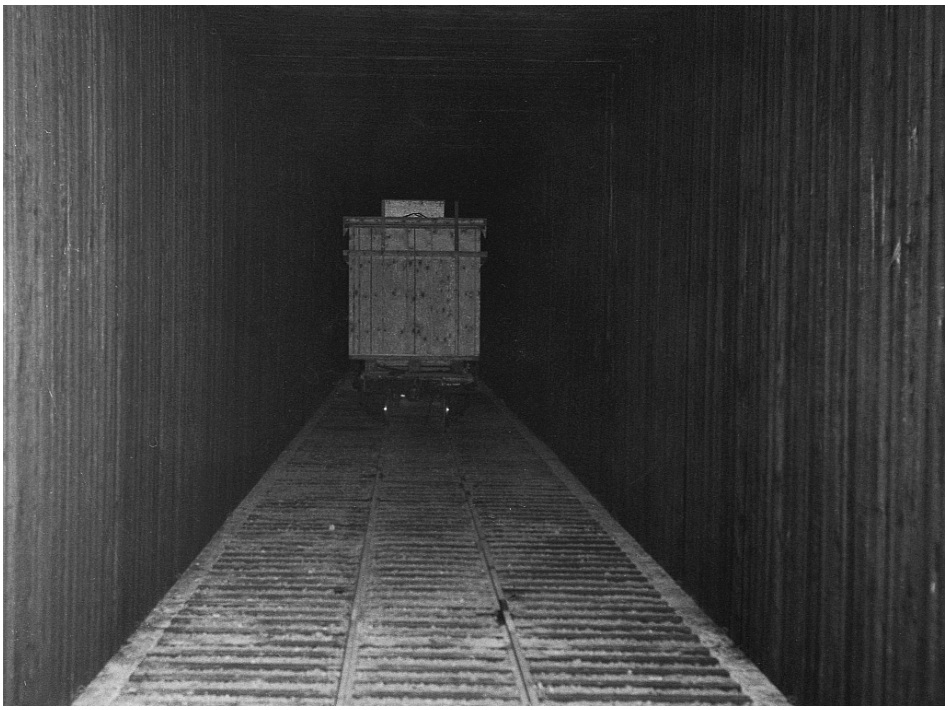

Figure A-22. Wooden Burial Box in Tunnel 1 (18755-5)

This is from a set of photos likely taken during a dry run for the placement of Position #4; in Figure A-22 there is no centrifuge motor as seen in Figure A-6.

Appendix B

Tunnel 2 (218-E-15) Photographs

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B1 Introduction

This appendix provides photographs of the positions within Storage Tunnel 2 (218-E-15).

Unless otherwise noted, these images were obtained in the spring of 2018 via remote cameras as part of characterization activities to support stabilization/grouting of the tunnel. If photographs of a position are not provided, then none are known to exist at this time.

Figure B-1. Photograph 39108-9

1. CAR 61439 PLACED IN TUNNEL ON 12/12/67;
E-F6 (2WW WASTE) CONCENTRATOR, TK-F15-2, TUBE BUNDLE,
AGITATOR MOTORS; 2,400 CU. FT.; 700 CURIES; 1.3 rem/hr. @ 100'

Figure B-2. Position 1; E-F6 Concentrator

Figure B-3. Position 1; E-F6 Concentrator

2. CAR MILW 60883 PLACED IN TUNNEL ON 3/26/69;
E-F6 (#5) CONCENTRATOR (PREVIOUSLY E-H4 3WB), 2 TUBE BUNDLES;
2,400 CU. FT.; 500 CURIES; 0.8 rem/hr. @ 2'

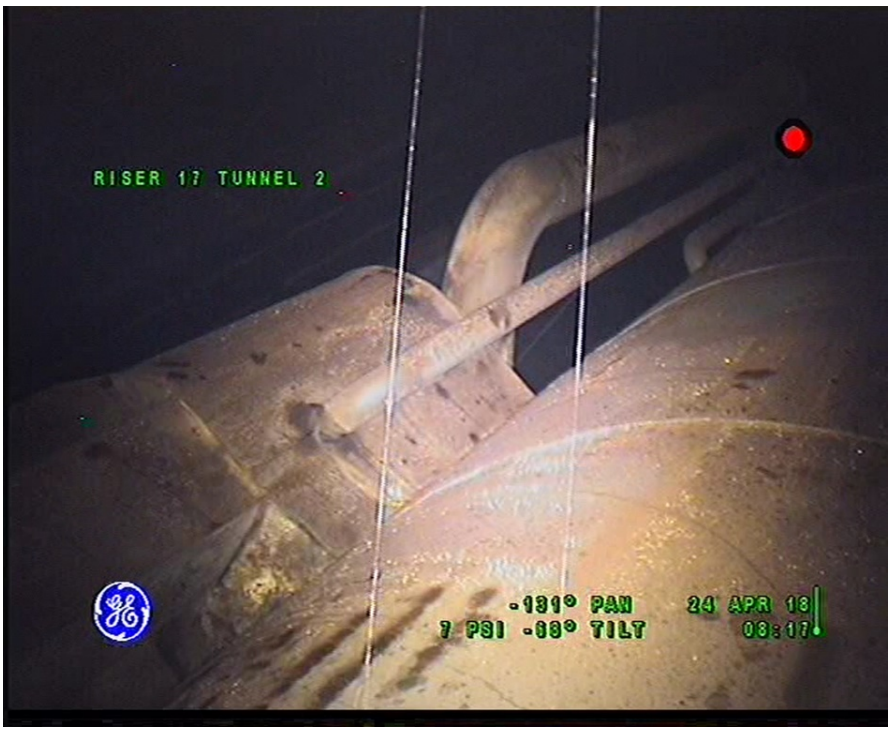

Figure B-4. Position 2; E-F6 Concentrator

Figure B-5. Position 2; E-F6 Concentrator

3. CAR 3612 PLACED IN TUNNEL ON 3/19/70;
E-F6 (#6) (2WW WASTE) CONCENTRATOR, 2 TUBE BUNDLES;
2,400 CU. FT.; 700 CURIES; 0.5 rem/hr. @ 2'

Figure B-6. Position 3; E-F6 Concentrator, Top

Figure B-7. Position 3; E-F6 Concentrator, Bottom

4. CAR MILW 60033 PLACED IN TUNNEL ON 12/30/70;
L-CELL PACKAGE IN A SEALED STEEL BOX (H-2-66092);
2,400 CU. FT.; 500 g Pu; 0.2 rem/hr. @ CONTACT

Figure B-8. Position 4; L-Cell Package

Figure B-9. Position 4; L-Cell Package

5. GONDOLA CAR 4610 PLACED IN TUNNEL ON 2/26/71;
T-F2 SILVER REACTOR, T-F6 DEMISTER, VESSEL VENT LINE, STEEL CATWALK
AND GUARD RAILS; 2,400 CU. FT.; 20 CURIES; ~625 kg Ag; 2 rem/hr. @ CONTACT

Figure B-10. Position 5; T-F2 Silver Reactor

Figure B-11. Position 5; Steel Catwalk

6. GONDOLA CAR 4611 PLACED IN TUNNEL ON 12/12/71;
MODIFIED T-A3-1 TOWER, SCRUBBER, LID, VAPOR LINE;
2,400 CU. FT.; 10 CURIES; 1 rem/hr. @ CONTACT

Figure B-12. Position 6; Modified T-A3-1 Tower

Figure B-13. Position 6; Modified T-A3-1 Tower

7. CAR B58 (9' SHORTENED) PLACED IN TUNNEL ON 12/22/71;
TK-A3 ANNULAR DISSOLVER;
2,400 CU. FT.; 50 CURIES; ~45 kg Hg; 5 rem/hr. @ 5'

Figure B-14. Position 7; TK-A3 Annular Dissolver, Top

Figure B-15. Position 7; TK-A3 Annular Dissolver, Bottom

8. CAR 19808 PLACED IN TUNNEL ON 8/29/72;
A1W1 FUEL ENDS IN STEEL LINER BOX AND NPR FUEL HANDLING EQPT. USED
WITH SUSPECTED CANISTERS; 800 CU. FT.; 17,500 CURIES; 10 rem/hr. @ 150'

Figure B-16. Position 8; Fuel Handling Equipment and Canisters

Figure B-17. Position 8; Steel Liner Box

9. CAR 19811 PLACED IN TUNNEL ON 9/30/72;
TK-C3 ANNULAR DISSOLVER;
1,590 CU. FT.; 50 CURIES; ~45 kg Hg; 5 rem/hr. @ 5'

Figure B-18. Position 9; TK-C3 Annular Dissolver

Figure B-19. Position 9; Thermowell Shown Center Left (Green)

10. CAR CDX-1 PLACED IN TUNNEL ON 8/30/83;
E-H4 (3WB) CONCENTRATOR, TUBE BUNDLE, PROTOTYPE COOLING COIL,
F-F1 FILTER TANK; 2,400 CU. FT.; 500 CURIES; 0.8 rem/hr. @ 2'

Figure B-20. Position 10; E-H4 Concentrator

Figure B-21. Position 10; E-H4 Concentrator

11. CAR 3613 PLACED IN TUNNEL ON 1/18/86;
TK-A3 ANNULAR DISSOLVER (#10) AND E-A2 HEATER (#6);
3,960 CU. FT.; 0.81 CURIES; ~40 kg Hg; ~43 kg Cd; 3 mrem/hr. @ 3'

Figure B-22. Example of a Riser Plug in Place

Figure B-23. Example of a Riser Plug Removed

No known photos of Position 11 are available due to Riser #13 being stuck.

12. CAR 3611 PLACED IN TUNNEL ON 1/20/86;
WHITE BOX (H-2-58456) CONTAINING 8 TUBE BUNDLES, PG-J6 PULSE GENERATOR (#5), DISSOLVER LID, 9 DUMPING TRUNNIONS;
5,438 CU. FT.; 540 CURIES, 2 rem/hr. @ 3'

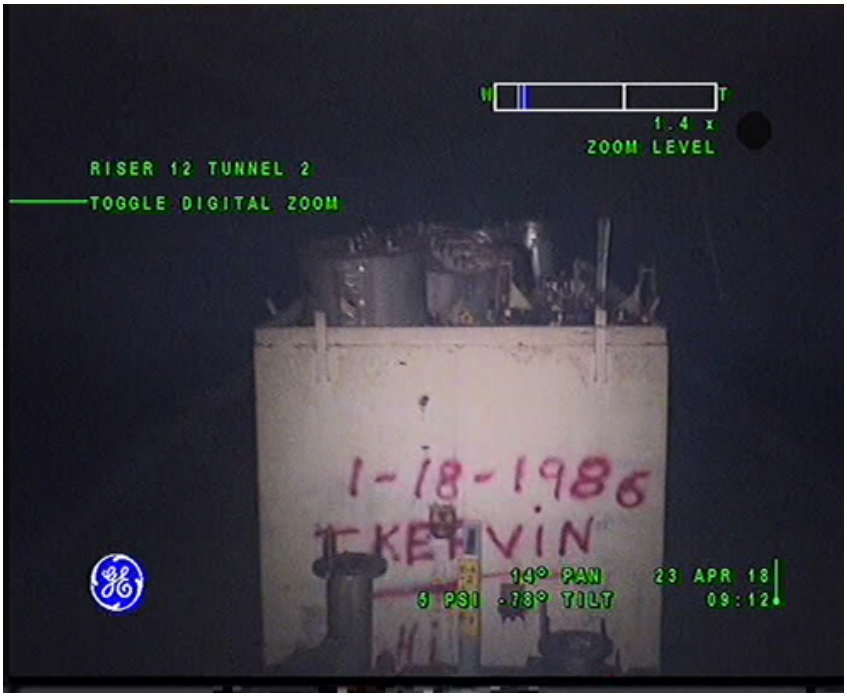

Figure B-24. Position 12; White Box Containing Tube Bundles

Figure B-25. Position 12; Tube Bundles

13. CAR 19806 PLACED IN TUNNEL ON 1/21/86;
TK-J5 2A FEED TANK (#30), E-F1 CONDENSER (#13), F12-B CELL BLOCK,
DISSOLVER 4-WAY DUMPER, DISSOLVER YOKE, FLANGE PLATE;
2,500 CU. FT.; 90 CURIES; 3 rem/hr. @ 1'

Figure B-26. Position 13; TK-J5 2A Feed Tank

Figure B-27. Position 13; Dissolver 4-Way Dumper

14. CAR PX-10 PLACED IN TUNNEL ON 11/18/87;
L-1 PULSER, 2 COLUMN CARTRIDGES, JUMPER CUTTER, STORAGE RACK,
3 JUMPER ALIGNMENT TOOLS, 9 EXTERIOR DUMPING TRUNNIONS, 10 PUMPS,
3 AGITATORS, 4 TUBE BUNDLES, 2 VENT JUMPERS, 7 YOKES; 50 TONS;
3,600 CU. FT.; 33,740 CURIES; 2,540 kg Pb; 5 rem/hr. @ 15'
(REF: LETTER 12110-88-074)

Figure B-28. Position 14; Tube Bundles

Figure B-29. Position 14; Jumper Cutter

15. CAR PX-9 PLACED IN TUNNEL ON 5/13/88;
T-A2 SILVER REACTOR (#5 SPARE), S/R CRADLE, E-F2 STEAM HEATER,
STORAGE LINER (H-2-65095) FILLED WITH CUT UP JUMPERS; 20 TONS;
2,775 CU. FT.; 240 CURIES; ~13 kg Cd; ~115 kg Ag; ~230 kg Pb;
20 mrem/hr. @ 20' (REF: LETTER 12110-88-074)

Figure B-30. Position 15; T-A2 Silver Reactor

Figure B-31. Position 15; E-F2 Steam Heater

16. CAR PX-6 (H-2-99608) PLACED IN TUNNEL ON 4/6/89;
E-J8-1 UNITIZED CONCENTRATOR (#1) (H-2-52477); ESTIMATED 42 TONS;
6,000 CU. FT.; 1.5 CURIES; 0.5 mrem/hr. @ 10' (REF: LETTER 12113-89-027)

Figure B-32. Position 16; E-J8-1 Unitized Concentrator, Bottom

Figure B-33. Position 16; E-J8-1 Unitized Concentrator, Top

17. CAR PX-19 PLACED IN TUNNEL ON 8/5/89;
NORTH STORAGE LINER (H-2-65095) CONTAINING 6 PUMPS, AN AGITATOR AND CUT UP JUMPERS (14 TONS). SOUTH STORAGE LINER (H-2-65095) CONTAINING A PUMP, #15 YOKE, AND CUT UP JUMPERS (11.5 TONS); ESTIMATED 25.5 TONS; 2,574 CU. FT.; 3.0 CURIES; 80 mrem/hr. @ 1' (REF: LETTER 12113-89-051)

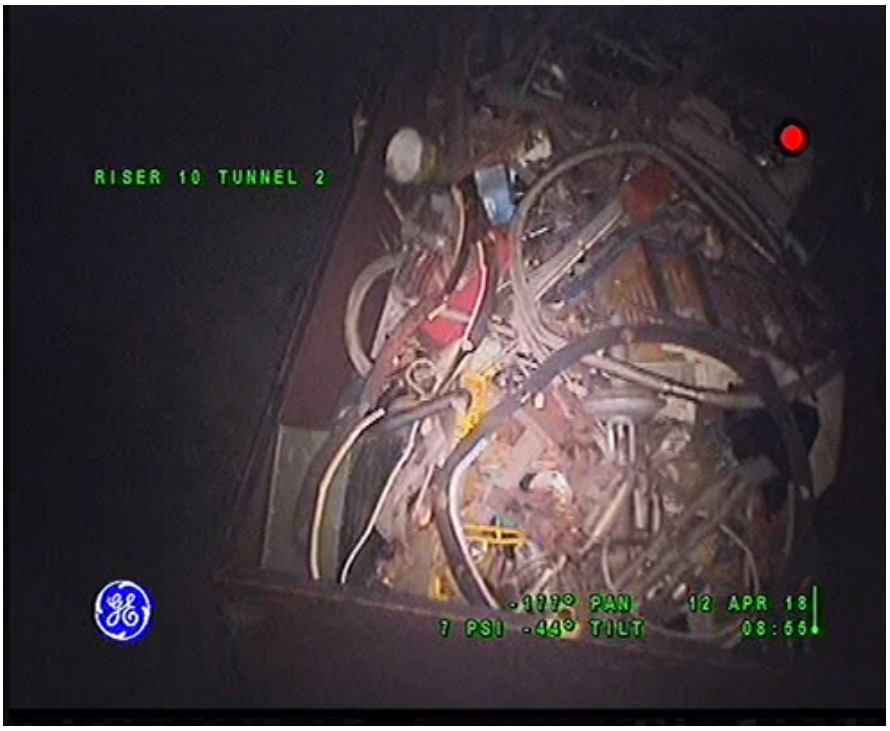

Figure B-34. Position 17; North Storage Liner

Figure B-35. Position 17, South Storage Liner

18. CAR PX-2 PLACED IN TUNNEL ON 4/8/94;
T-F5 ACID ABSORBER (H-2-52535, H-2-52487, H-2-52488); ESTIMATED 22 TONS;
835 CU. FT.; 185 CURIES; 80 mrem/hr. @ CONTACT

Figure B-36. Position 18; T-F5 Acid Absorber

Figure B-37. Position 18; T-F5 Acid Absorber

19. CAR PX-23 PLACED IN TUNNEL ON 9/16/94;
4 METAL LINER STORAGE BOXES (H-2-65095) (H-2-100187) CONTAINING
FAILED JUMPERS AND MISC. OBSOLETE CANYON EQUIPMENT;
ESTIMATED 60 TONS; 4,032 CU. FT.; 927 CURIES; 30 mrem/hr. @ 2'

Figure B-38. Position 19; Top of Metal Liner Storage Boxes

Figure B-39. Position 19; Side of Metal Liner Storage Boxes

20. CAR PX-28 PLACED IN TUNNEL ON 1/27/95;
E-H4-1 UNITIZED CONCENTRATOR (H-2-52477) (H-2-56213);
ESTIMATED 40 TONS; 5,760 CU. FT.; 3,070 CURIES; ~8 kg Cr; 1 rem/hr. @ 5'

Figure B-40. Position 20; E-H4-1 Unitized Concentrator, Bottom

Figure B-41. Position 20; E-H4-1 Unitized Concentrator, Top

21. CAR PX-3609 PLACED IN TUNNEL ON 2/8/95;
H4 CONCENTRATOR TOWER (H-2-58102), TK-E5 (H-2-52453), LEAD STORAGE BOX (H-2-131629), HOT SHOP "Q" COVER PLATE (H-2-52222), TUBE BUNDLE WASH CAPSULE (H-2-58647), DISSOLVER CHARGING INSERT (H-2-75875), LIFTING YOKE #7A (H-2-96837), LIFTING YOKE #9 (H-2-52458); ESTIMATED 44 TONS; 3,457 CU. FT.; 26,000 CURIES. ~1,930 kg Pb; 1 rem/hr. @ 4'

Figure B-42. Position 21; H4 Concentrator Tower

Figure B-43. Position 21; Lead Storage Box

22.	CAR 3616 PLACED IN TUNNEL ON 3/11/96; METAL LINER BOX (H-2-65095) CONTAINING JUMPERS AND FAILED/ OBSOLETE CANYON EQUIPMENT, F7 NEUTRON MONITOR (H-2-75825), LEAD STORAGE BOX (H-2-131629) CONTAINING JUMPER COUNTERWEIGHTS AND MISC. LEAD ITEMS, SCRAP HOPPER (H-2-57347) CONTAINING MISC. CANYON EQUIPMENT, CANISTER CAPPING STATION (H-2-821831), TEST CANISTER CONTAINING VARIOUS LENGTHS OF CARBON STEEL PIPE; ESTIMATED 22 TONS; 1,712 CU. FT.; 15 CURIES; ~3,232 kg Pb; ~2 kg Cd; 0.1 rem/hr. @ 1'

Figure B-44. Position 22; Metal Liner Box

Figure B-45. Position 22; Scrap Hopper

23. CAR PX-31 PLACED IN TUNNEL ON 3/11/96;
2 BURIAL BOXES (H-2-100187) CONTAINING JUMPERS AND FAILED/OBSOLETE CANYON EQUIPMENT. LIFTING YOKE (H-2-99652); ESTIMATED 21 TONS;
2,116 CU. FT.; 2 CURIES; 10 mrem/hr. @ 1'

Figure B-46. Position 23; Burial Box

Figure B-47. Position 23; Lifting Yoke

24. CAR PX-29 PLACED IN TUNNEL ON 4/26/96;
CONCRETE BURIAL BOX (H-1-44980) STORING 8 CONTAINERS OF 324 BUILDING B-CELL WASTE; ESTIMATED 36 TONS; 1,890 CU. FT.; <244,000 CURIES;
~1,802 kg Pb; ~10.5 kg Cd; ~8.5 kg ABSORBED OIL; ~1 kg Cr; ~3 kg Ba; ~24 g Pu;
~15 mrem/hr. @ 150' (FOR DETAILS SEE PUREX WORK PLAN WP-P-95-60)

Figure B-48. Position 24; Concrete Burial Box Containing 8 Cask Liners

Figure B-49. Position 24; Concrete Burial Box

25. CAR 10A-3619 PLACED IN TUNNEL ON 6/12/96;
CONCRETE BURIAL BOX (H-1-44980) STORING 9 CONTAINERS OF 324 AND 325 BUILDING HOT CELL WASTE; ESTIMATED 46.5 TONS; 1,890 CU. FT.;
<1,750,000 CURIES; <1 g Pb; < 1 g Cd; ~2 g Cr; ~4 g Ba; ~43 g Pu;
~0.2 rem/hr. @ 150' (FOR DETAILS SEE PUREX WORK PLAN WP-P-96-015)

Figure B-50. Position 25; Concrete Burial Box Containing 9 Cask Liners

Figure B-51. Position 25; Concrete Burial Box

26. CAR HO-10H-18582 PLACED IN TUNNEL ON 6/19/96;
20,000-GALLON LIQUID WASTE TANK CAR (LWTC); EMPTY PER RCRA;
ESTIMATED 30 TONS; 23 CURIES; ~11 g Pu; 0.65 rem/hr. @ 3'

Figure B-52. Position 26; Liquid Waste Tank Car HO-10H-18582

Figure B-53. Position 26; Liquid Waste Tank Car HO-10H-18582

27. CAR HO-10H-18579 PLACED IN TUNNEL ON 6/19/96;
20,000-GALLON LIQUID WASTE TANK CAR (LWTC); EMPTY PER RCRA;
ESTIMATED 30 TONS; 9 CURIES; ~131 g Pu; 0.3 rem/hr. @ 3'

Figure B-54. Position 27; Liquid Waste Tank Car HO-10H-18579

Figure B-55. Position 27; Liquid Waste Tank Car HO-10H-18579

28. CAR HO-10H-18580 PLACED IN TUNNEL ON 6/19/96;
20,000-GALLON LIQUID WASTE TANK CAR (LWTC); EMPTY PER RCRA;
ESTIMATED 30 TONS; 5 CURIES; ~53 g Pu; 0.1 rem/hr. @ 3'

Figure B-56. Position 28; Liquid Waste Tank Car HO-10H-18580

Figure B-57. Position 28; Liquid Waste Tank Car HO-10H-18580

218-E-15 Exit

Figure B-58. Water Fillable Door; Tunnel 2 Exit

Figure B-59. Space Between the Door and Position 28

218-E-15 Entrance

Figure B-60. Water Fillable Door; Tunnel 2 Entrance; 9/19/1996

Figure B-61. Water Fillable Door Post-Deactivation; Tunnel 2 Entrance; 9/19/1996

Miscellaneous Additional

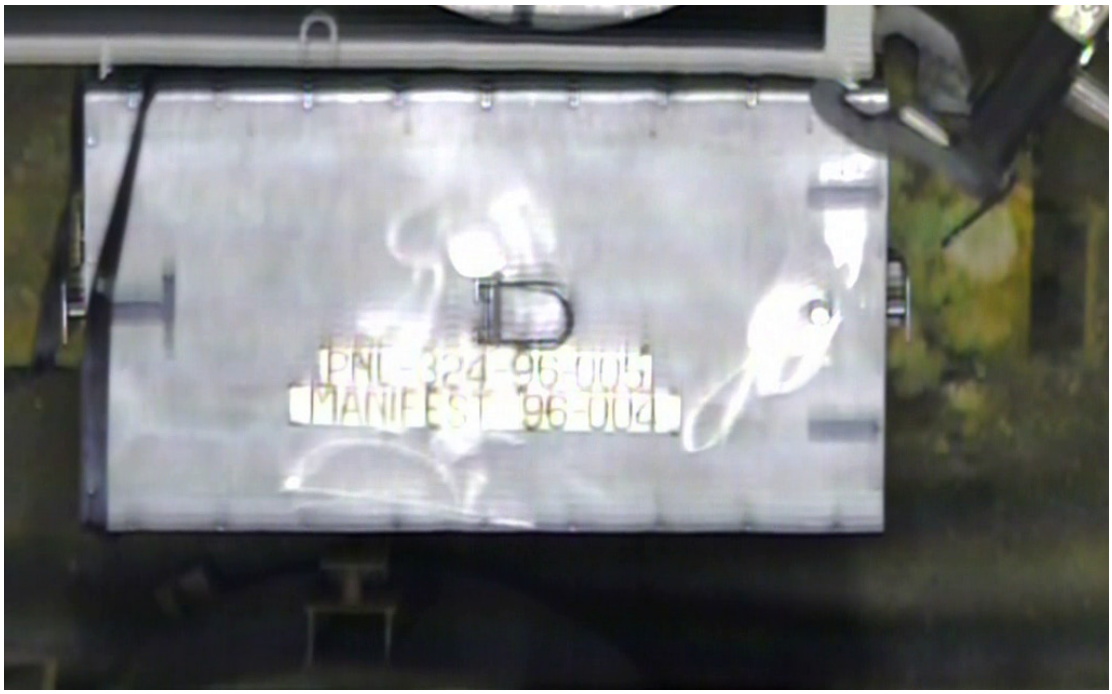

Figure B-62. 324 Facility Waste in 22.5 Ton Cask Liner Staged in G Cell

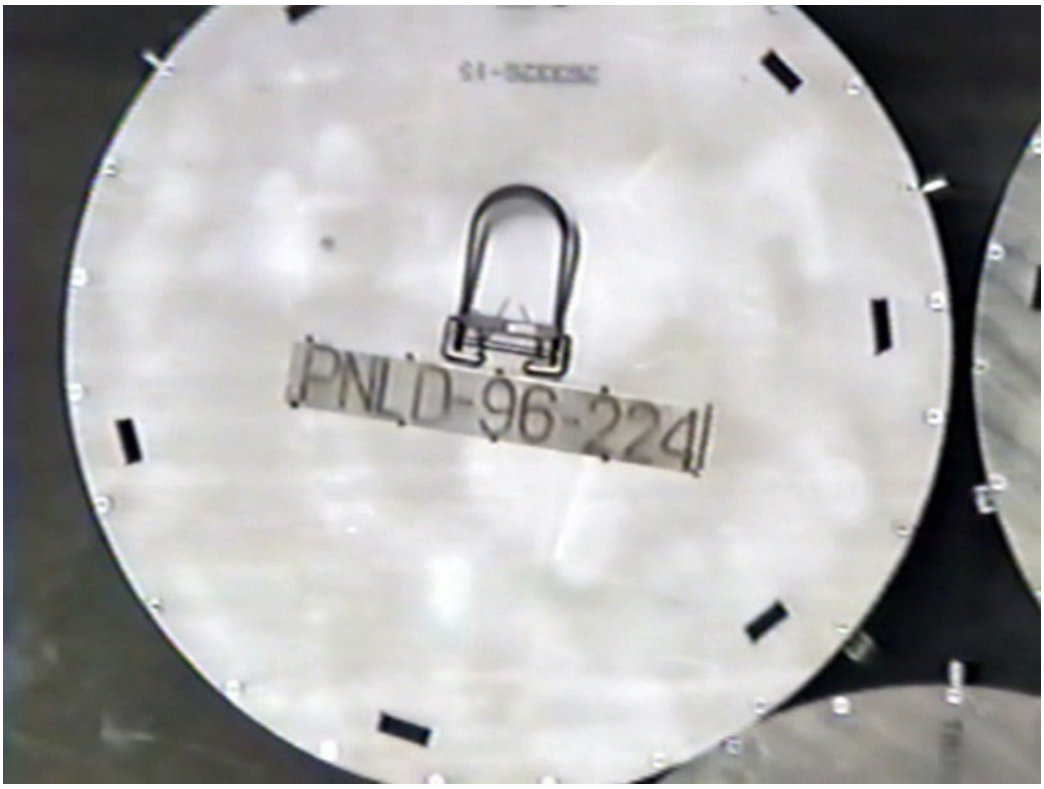

Figure B-63. 324 Facility Waste in SEG Cask Liner Staged in G Cell

Miscellaneous Additional

Figure B-64. East Side of South Wall

Figure B-65. West Side of South Wall

The figures above support the possibility of TK-F15-2 on Position 1 being an error. This item first appeared in SD-637-ES-001 and is questioned later in WHC-SD-EN-ES-003, *PUREX Storage Tunnels Disposal Alternatives Engineering Study.*

B2 Reference

WHC-SD-EN-ES-003, 1990, *PUREX Storage Tunnels Disposal Alternatives Engineering Study*, Westinghouse Hanford Company, Richland, Washington.

Appendix C

Related Information

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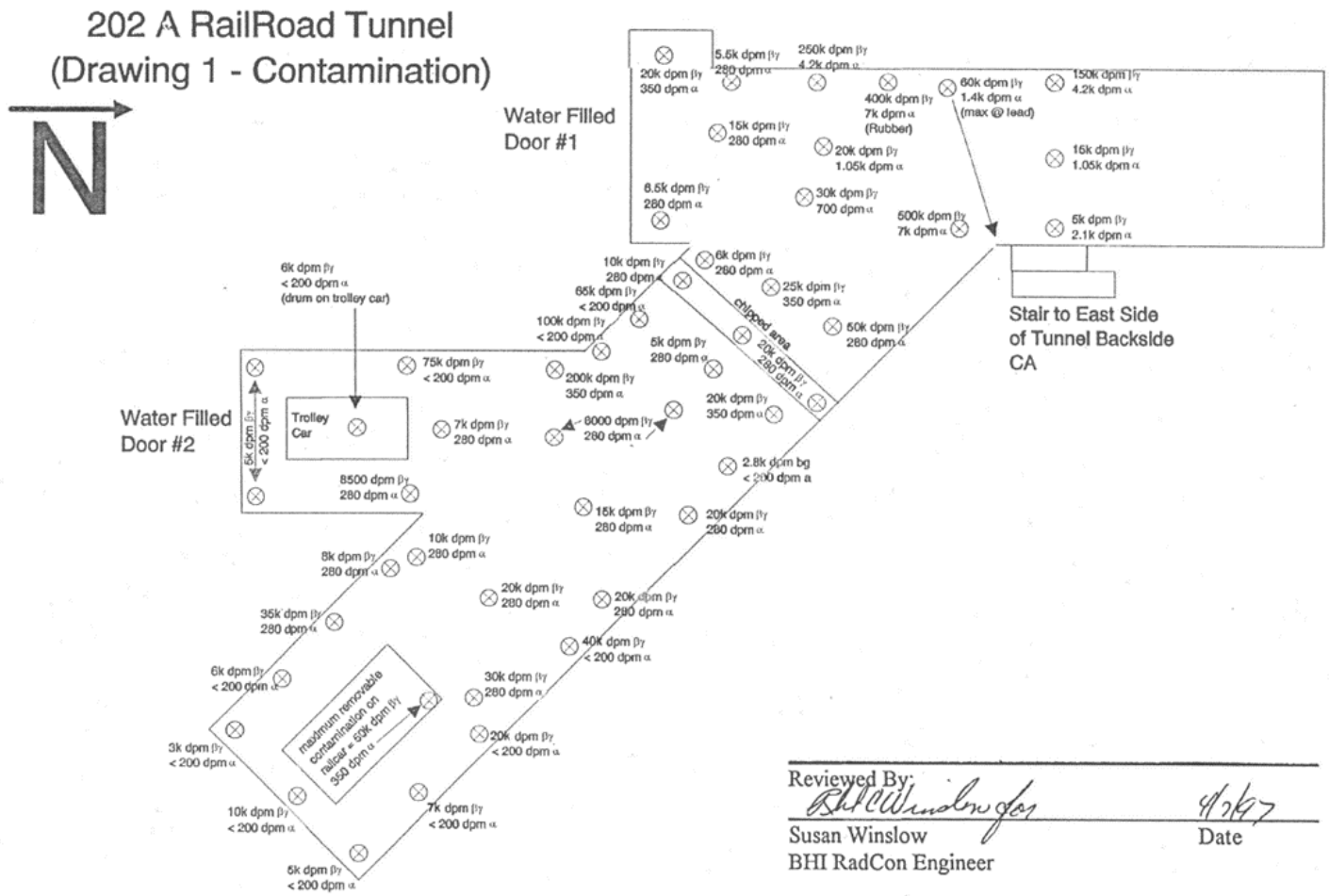
C1 Introduction

This appendix provides information that may be useful to understand the items placed in the tunnel, or other indirectly related data not captured elsewhere.

C1.1 (1997.04) Survey 216515 - 202A Railroad Tunnel



Reviewed By: 4/7/97
Susan Winslow — Date
BHI RadCon Engineer

Not all survey points taken have been shown on this map.
Refer to Radiological Survey 216515 for further information.

Drawn 10/28/96

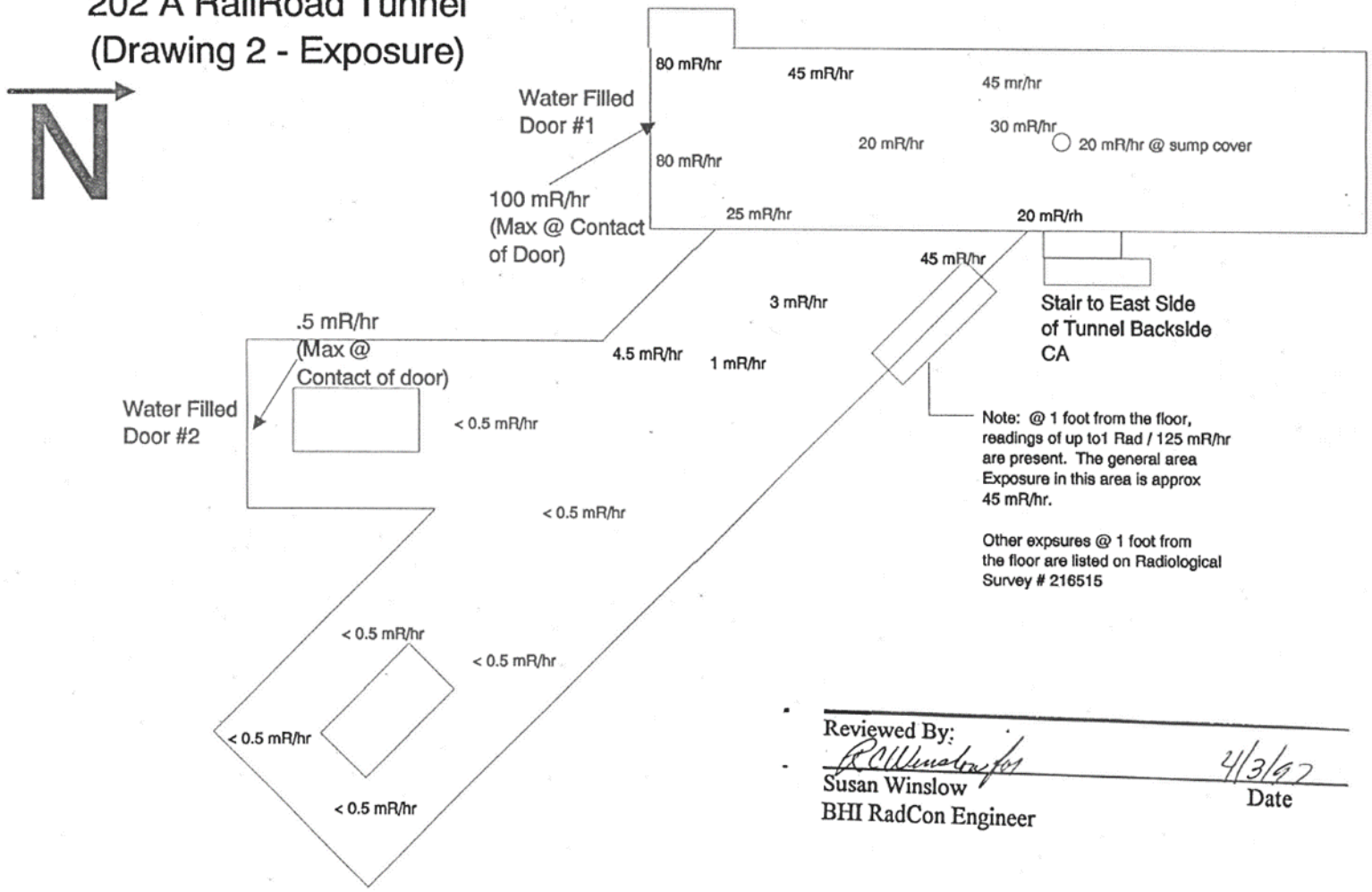
Any Direct or Fixed readings are green.

⊗ = Smears > 1000 d/m βγ, 20 d/m α are listed in red.

⊗ = Tech Smears < Table 2-2 of HSRCM-1

General Area (field) exposure rates in blue.

202 A RailRoad Tunnel
(Drawing 2 - Exposure)



Reviewed By:
R. C. Winslow for
Susan Winslow
BHI RadCon Engineer

4/3/97
Date

Any Direct or Fixed readings are green.

⊗ = Smears > 1000 d/m βγ, 20 d/m α are listed in red.

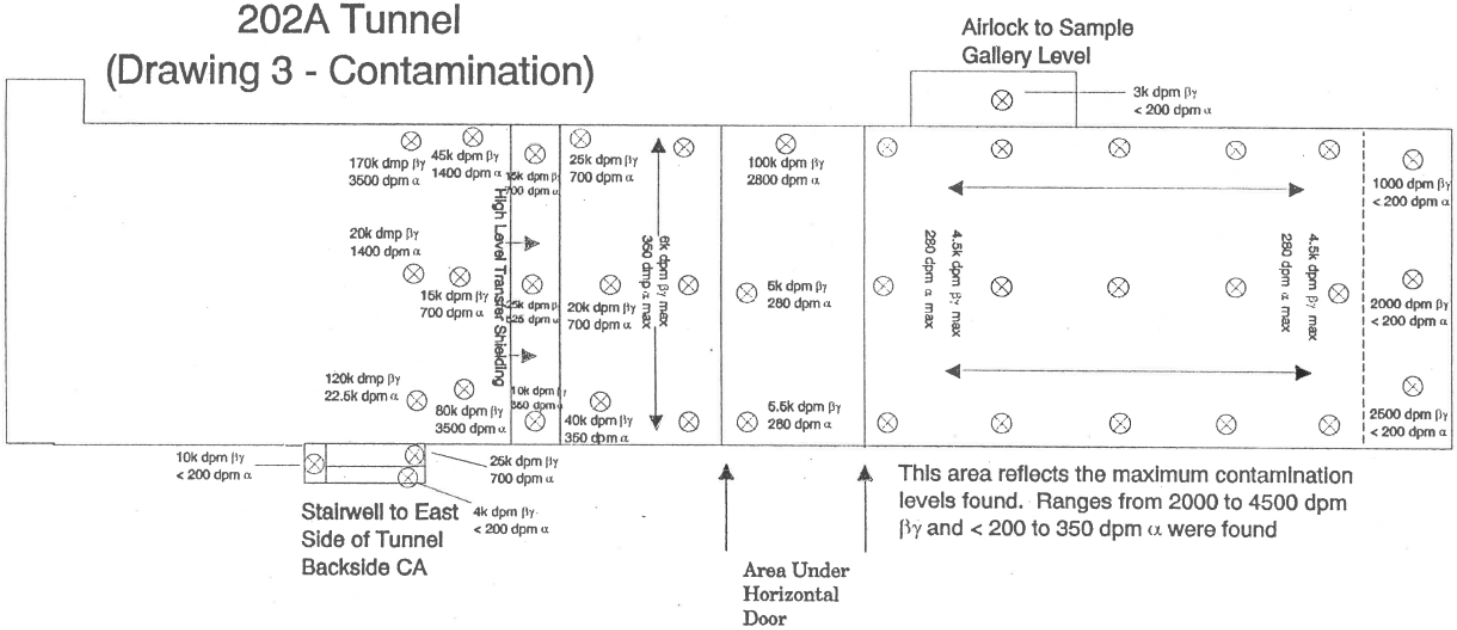
⊗ = Tech Smears < Table 2-2 of HSRCM-1 Rev 2

General Area (field) exposure rates in blue.

Refer Survey # 216515

Drawn 10/29/96

202A Tunnel
(Drawing 3 - Contamination)



N

Any Direct or Fixed readings are green.

⊗ = Smears > 1000 d/m βγ, 20 d/m α are listed in red.

⊗ = Tech Smears < Table 2-2 of HSRCM-1

General Area (field) exposure rates in blue.

Reviewed By: 4/7/97

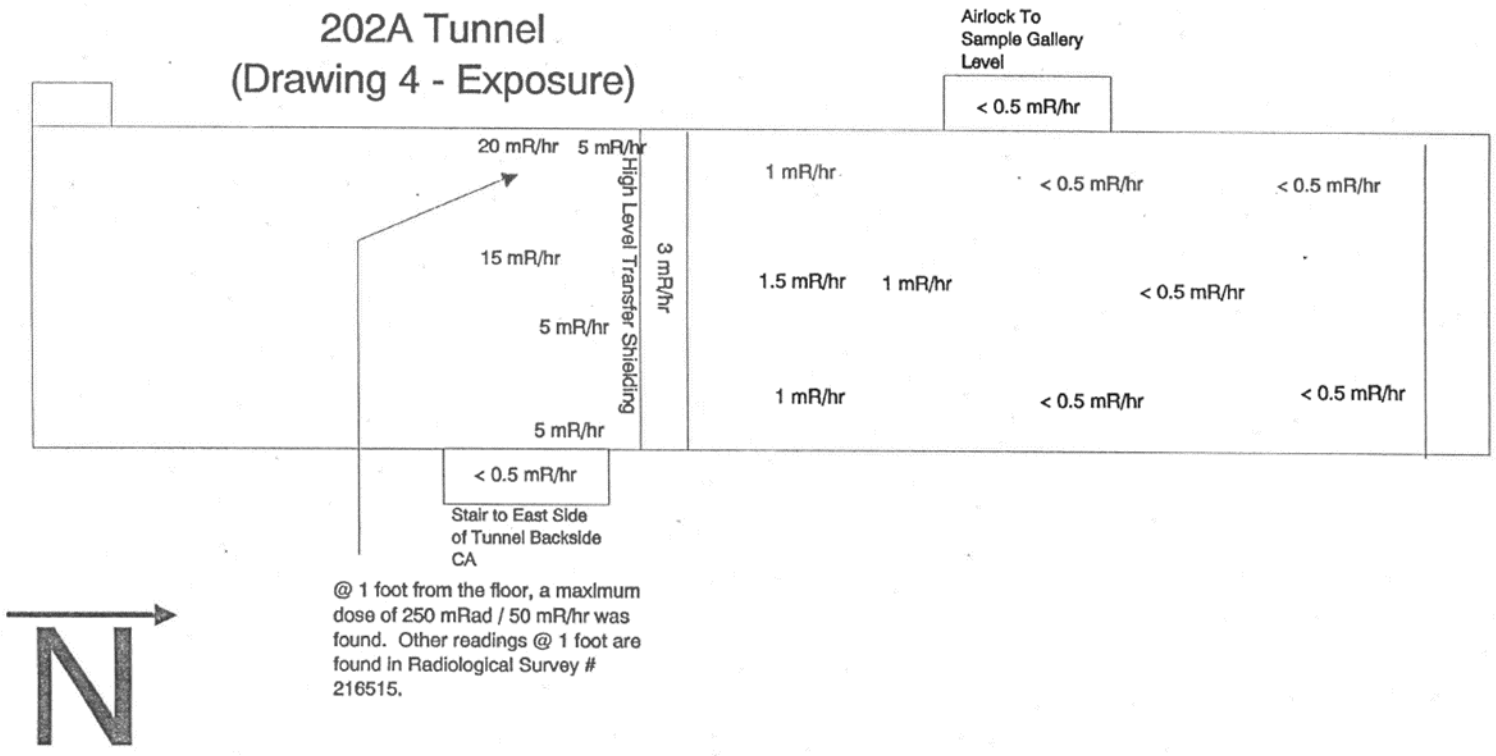
Susan Winslow — Date

BHI RadCon Engineer

Not all survey points taken have been shown on this map.
Refer to Radiological Survey 216515 for further information.

Drawn 10/28/96

202A Tunnel
(Drawing 4 - Exposure)



@ 1 foot from the floor, a maximum dose of 250 mRad / 50 mR/hr was found. Other readings @ 1 foot are found in Radiological Survey # 216515.

Reviewed By: RL Winslow for 4/3/97
Susan Winslow — Date
BHI RadCon Engineer

Reference Survey # 216515

Drawn 10/29/96

Any Direct or Fixed readings are green.

⊗ = Smears > 1000 d/m βγ, 20 d/m α are listed in red.

⊗ = Tech Smears < Table 2-2 of HSRCM-1

General Area (field) exposure rates in blue.

C1.2 (1996.08) J3-2A-96-00793 - J3 Support Request - Seal Tunnel 2 Door

Also see Appendix B, Figure B-61.

==========J-3 PRE-APPROVED SUPPORT REQUEST (W130)==========
Page: 1 13:28:03 05 AUG 1996

Job Number J3-2A-96-00793
Trend 34B *DEACT (ENG/PLANNING INSP)*

==========

1. Requested By Name TALLENT,BL
   Org. 17310 Telephone No. 3-1268 MSIN S5-52

2. Charge Code KP4BA

3. Date of Request 08/05/96

4. Response Required ASAP

APPROVAL DESIGNATOR NA

5. Type of Work 34 ENG & PLANNING INSPECTION

6. Location

   Facility 2A *PUREX*
   Bldg/Rm 202A/RRT Other DOOR #2 Other
   Panel/Equipment/Component

7. Description

Supplemental Information not referenced by Endpoints

RWP A-036.

FOAM BOTTOM OF RRT #2 WATER FILLED DOOR.
INITIAL/DATE J 8-7-96

PRIMER TOP AND SIDES OF RRT #2 WATER FILLED DOOR.
INITIAL/DATE RW 8-7-96

APPLY (24") FAST FLASH TAPE TO TOP AND SIDES OF RRT #2 WATER FILLED DOOR.
INITIAL/DATE DA 8-8-96

HOUSEKEEP WORK AREA AND DISPOSE OF WASTE IN PROPER RECEPTACLE.
INITIAL/DATE DAR 8-8-96

RETURN J3 TO BRENDA TALLENT FOR HVAC FILE.

	Signature	Date
8. Concurrence	[illegible]	8-5-96
9. Craft Complete	[illegible]	8-8-96
10. Field Work Complete	Brenda Tallent	8-8-96
Canceled		

11. Resources Required

Res Code	Description	Servicing Org.	Act Hrs
04	*NUCLEAR OPERATORS*		48
54	*RADIATION PROTECTION TECH.*		48
25	*Painter*		16

LOCKOUT REQUIRED Y ____ N ✓
RWP REQUIRED ____ ==========J-3 PRE-APPROVED SUPPORT REQUEST (W130)==========
RWP # A-036 SUB SPECIFIC # ____

SPECIAL WASTE INSTRUCTIONS REQUIRED
☐ YES
☑ NO

C1.3 (1989.08) Radiological History of the PUREX Facility 1955 to 1989

164324327, 1989, *Radiological History of the PUREX Facility, 1955 to 1989*, Westinghouse Hanford Company, Richland, Washington.

R.R. TUNNEL

The PUREX R.R. Tunnel consists of three separate sections: Main Tunnel, Burial Tunnel #1 and Burial Tunnel #2.

The Main Tunnel is posted as a Surface Contamination Area from the roll-up-door to the "yellow line". From the "yellow line" south is posted as an Airborne Area. Floor contamination levels from the roll-up door to the yellow line will usually measure from 5,000 to 10,000 d/m beta. During major contamination spreads beyond the yellow line, contamination levels have been detected in excess of 20 Rads/hr.

In the early 1960's, the main tunnel was grossly contaminated during the burial of an F-6 concentrator. Radiation levels south of the drop-off, from floor contamination were in excess of 20 Rads/hr. During this incident the foremost problem was how the tunnel could be decontaminated and expend the least personnel exposure. Operations management decided to bring an old automobile (1958 Chevrolet) into the R.R. Cut, remove the tires, place it on the R.R. track rails and drive it into the tunnel containing a two man decontamination crew equipped with water hoses. The purpose was to flush down the highly contaminated R.R. Tunnel floor from inside the automobile utilizing the chassis as shielding. This plan was abandoned when it was brought up that the engine may die while the car was in the tunnel, thereby trapping the crew in a highly radioactive area. The automobile was later removed from the R.R. Cut and buried in the dry waste burial ground. After an extensive decontamination effort, the Tunnel was eventually decontaminated using high pressure fire hoses and manual scrubbing under water.

As a result of the previously described tunnel contamination incident, certain sections of the tunnel gutters and floor drains still measure up to 3 Rads/hr at contact.

Approximately between the tunnel drop-off and the water filled door, a PUREX/Tank Farm process transfer line crosses beneath the tunnel floor. This transfer line is shielded with 4" of lead to reduce radiation exposure to personnel who might be in the general vicinity during a transfer. Dose rates of 2 R/hr have been detected at the edge of the lead shielded during transfers.

The R.R. Tunnel has one air sampling location. The pick-up point is located near the yellow-line, on the wall next to the doorway from the tunnel to the sample gallery. Due to the inadequacy of tunnel air sampling capabilities the entire tunnel area is placed on respiratory protection status whenever the roll-up door is closed.

At one time during the early campaign, the tunnel air sample (T-1) experienced a buildup of airborne radioactivity. For a short period, no source for the high air concentrations could be determined. The buildup continued until air sample results were approaching supplied air limits. It was eventually determined that the only source for this mystery would have to be from Burial Tunnel #1. At this time tunnel #1 was filled with highly

radioactive process equipment and the water filled door closed. It was determined that the process equipment in Tunnel #1 was generating high thermal temperatures, causing the burial tunnel to pressurize thereby forcing contaminated air out from around the water filled door into the tunnel proper. Sealing the water filled door by recaulking solved the airborne problem.

Early day fuel cask cars were equipped with lift-off lids. The lids were removed from the cask cars in the tunnel by the remote crane in preparation for charging fuel to the dissolvers. All three lids were removed from the cask cars and set down on the car decks. This procedure resulted in high levels of removable contamination on the cask car exteriors. Many long manhours of labor were expended decontaminating cars to the point where they could be safely shipped back to the reactor areas. In the late 1960's, cask cars were modified with roll-up lids which eliminated a major portion of cask car contamination.

There were many instances of fuel loaded cask cars arriving at PUREX with the drain valve on the water shielding section, leaking. Low level beta contamination was occasionally detected along the railroad right-of-way as a result of the leaking valves. Drain valves were later removed from cask cars.

In the late 1950's, a cask car arrived at PUREX with a dose rate of 1 R/hr emanating from the side of the car (normal dose rates at the side of the cask cars were 10 to 30 mR/hr). Investigation revealed that an irradiated fuel element had fallen from the bucket during loading and lodged between the inner cask and the outer wall. The fuel was charged to the dissolvers and the car sent back to the 100-Areas where the dropped fuel element was removed without incident.

Contaminated shielding water in the cask cars was also another major source of cask car contamination. When the fuel elements were transferred out of the casks to the dissolvers, contaminated water would drip from the canisters to the exterior surfaces of the cask car. The problem of cask car contamination was partially eliminated when cask car clean-out flushing frequencies were increased and crane operator procedures changed requiring the fuel canisters to hang and drip-dry over the open cask prior to moving them to the dissolvers.

During construction of the PUREX plant the #1 Burial Tunnel was incorporated as an integral part of the plant and was completed in 1956. Highly radioactive process equipment with high contamination spread potentials were placed on old railroad flatcars and pushed to the back of the burial tunnel for "permanent" storage. The first two cars were pushed into burial tunnel #1 in June 1960. Between that date and January 1965, six more cars were put into the tunnel, completely filling it. Burial Tunnel #2 construction was started and completed in 1964. The length of Burial Tunnel #1 is 358 feet and the length of #2 is 1688 feet. Burial Tunnel #2 has a capacity of 38 to 40 railroad cars and as of 4-6-89, contained 16 cars. The normal procedure for moving burial cars to the rear of the burial tunnel was by the use of a locomotive engine pushing a long string of spacer flatcars with the burial

car at the far end. The spacer cars were becoming contaminated on a regular basis using this method, requiring many man hours of decontamination effort. A small remotely controlled battery powered locomotive engine was special ordered. It was eventually nicknamed "Little-Toot". The engine could be covered with plastic for contamination control and be remotely operated to push the burial cars into the tunnel and return. A problem was experienced using this method when "little-Toot" returned from a mission into the burial tunnel. The wheels became contaminated resulting in the train tracks becoming contaminated in the main section of the tunnel. Some instances did occur when this situation was not realized immediately and contamination was subsequently transferred onto the main line railings by the locomotive engine. Many manhours were expended in summer and winter months decontaminating train rails.

Different types of detergents and cleaning agents were used for decontaminating rails. Surface contamination could be wiped from the rails to the point where they were non smearable. Then the following day smearable contamination would again be detected on the rails. It was determined that contaminated liquid would seep into the pours of the rails where oxidation would take place from a chemical reaction and then reappear on the rail surfaces. Several attempts at rail decontamination on subsequent days were needed before the rail surfaces could finally be released.

Burial Tunnel #3 location is adjacent to #2, but has not been constructed.

A skin contamination incident occurred during a movement into the burial tunnel in the late 1960's. An operations and a maintenance supervisor decided to try and determine for themselves when the burial box was positioned at the very back of the burial tunnel. They proceeded to remove the cap from a vertical 3 inch diameter riser that extended out of the top of the burial tunnel and by looking down through it, determine when the burial car passed beneath. As the car passed by the riser, contaminated air was forced up through the riser, resulting in gross skin contamination to the face of both employees. They were not wearing respiratory protection at the time. This incident resulted in both employees receiving 5 and 10% MPBB Ru^{106} fission product deposition.

VACUUM FRACTIONATOR (206-A)

The Vacuum Fractionator facility first came on line in 1957 and is used for the recovery and concentration of nitric acid during fuel reprocessing. Floor contamination varies depending upon process line leakage and the extent of decontamination effort expended. Smears of the Fractionator floor measuring 100,000 d/m beta are not uncommon. Radiation dose rates are usually highest on the side of the U-5 tank and the radiation dose rate at the two entry doors will average 5 to 15 mR/hr under normal operating conditions. The highest area of floor contamination is located between the U-5 and U-6 tanks where pump leakage has occurred on numerous occasions. During the contaminated recovered acid problem that occurred in December of 1986, dose rates in the fractionator building increased notably.

C1.4 (1985.06) SD-HS-SAR-001, Rev 3

GLOSSARY OF PUREX FLOWSHEET ACRONYM MEANINGS

INTRODUCTION

Generally, the flowsheet acronyms are descriptive of the process function but there are some incongruities: the flowsheet has been changed but the old acronym has been retained. Equipment numbers are included in the glossary for correlation with flowsheet acronyms. A pictorial schematic of the PUREX process with flowsheet acronyms and equipment numbers is shown on Drawing H-2-53497 (not included). Typical acronyms are given below:

TYPICAL ACRONYMS:

AAD: Acid absorber distillate. Vapor from the first cycle waste Concentrator E-F6 is stripped of acid in the acid absorber T-F5. The lean vapor leaving the acid absorber is condensed (AAD) in Condenser E-F5.

AAR: Acid absorber reflux. Part of the condensate from E-F5 is recycled as lean feed to the acid absorber.

AFD: Acid fractionator distillate. This is the condensed lean vapor from the acid fractionator T-U6.

AFR: Acid fractionator reflux. Part of the distillate from the concentration of nitric acid in the acid fractionator T-U6 will be reintroduced into the tower of the acid fractionator to strip the vapors of acid.

ASD: Ammonia scrubber distillate. This condensate is produced in the decontamination of ammonia scrubber waste by evaporation in the E-F11 Concentrator.

HAS: HA (column) scrub. Scrub solution for the HA column (T-H2) removes some of the fission products extracted in the organic phase.

1CU: One - "C" (column) uranium. After the initial decontamination of uranium and plutonium are separated into two separate streams-an aqueous and an organic. The uranium in the organic phase is back-extracted into the aqueous phase in the 1C column; the 1CU is the 1C column product.

1CX: One - "C" (column) extractant. This is a weak acid stream used to back-extract the uranium from the organic into the aqueous phase.

1UC: First (cycle) uranium concentrate. The 1CU is concentrated in E-J8 before the second cycle.

1UD: First (cycle) uranium distillate. This is the process condensate from Concentrator E-J8.

1WF: First (cycle) waste feed. Tank F7 is feed tank for the high-level waste Concentrator E-F6.

2AW: Second "A" (column) waste. This column is used for the intermediate purification of plutonium. The column equipment number is T-L2.

2DF: Two - "D" (column) feed. Final purification of the uranium is by aqueous-organic contact in column T-K2.

2DW: Two - "D" (column) waste. This stream is the largest flow in the 3WF.

2EU: Two - "E" (column) uranium. The uranium-rich organic from the 2D column is back-extracted into the aqueous phase in the 2E column (T-K3). The aqueous phase is the 2EU.

2EX: Two - "E" (column) extractant. This is a weak nitric acid stream used to back-extract the uranium from the organic phase in column T-K3.

2UD: Second (cycle) uranium distillate. The 2EU is concentrated to product specifications in the 2EU Concentrator E-K4. The 2UD is the process condensate from this concentrator.

3WB: Third waste backcycle. (The three is misleading.) This acronym is used in reference to the backcycle waste evaporator E-H4.

3WD: Third (backcycle) waste feed. Sort of misleading; the three is used to pertain to the fact that this was part of a third cycle opera-tion. All the second cycle wastes are concentrated and recycled for additional recovery.

3WW: (Backcycle) waste. The 3W prefix used to be consistent with other backcycle terms. The 3WW is concentrated bottoms from the E-H4 Concentrator.

HISTORY OF PUREX PLANT

This appendix presents a thorough discussion of the history of the Plutonium-Uranium Reduction Extraction (PUREX) Plant.

The PUREX Plant was committed to radioactive service in 1956 as a major producer of weapons-grade plutonium from irradiated uranium metal reactor elements. When it was shut down in 1972, the plant was a major facility of the then U.S. Atomic Energy Commission (AEC) effort to supply spent fuel separation capability to a variety of programs. Eight phases are discernible in the history of the facility (roughly 1954 to the present):

- A 2-yr building period
- A 4-mo testing period
- Startup
- Refinement
- Increasing versatility
- Standby
- Upgrading
- Startup.

Efforts to refine and improve flowsheets and processes preceded radioactive operation and continue to the present. Multipurpose use of the plant became a defined objective by 1960, and by the time the plant was placed on standby, it was processing entirely different materials from those originally processed and will continue in this manner for future operations.

PLANT MISSION

Originally, the PUREX Plant reprocessed irradiated, aluminum-clad, reactor fuel elements, employing a wet chemical process to separate fission products (FP) from the uranium and plutonium. This process resulted in uranium nitrate and plutonium nitrate, with both chemicals emerging in a highly purified state. The uranium nitrate was subsequently converted to uranium oxide (UO_3) and shipped offsite for enrichment and reuse as reactor fuel. The plutonium nitrate was further processed onsite and was eventually used in weapons fabrication.

The fuel elements involved in the original process were low-burnup elements in the 250-700 MWd/t range. These elements could be handled at the PUREX Plant following short cooling periods (90 to 120 d) and yielded small amounts of plutonium (a few grams per tonne). With this fuel, plant capacity was far in excess of the original design basis.

Table B-1 lists other materials processed by the PUREX Plant with the respective dates the various feed stocks were introduced. With minor exceptions, all of the processed materials were irradiated in Hanford Site reactors.

TABLE B-1. Fuels Reprocessed at the PUREX Plant.

Time period	Fuel
January 1956	"72" metal (natural U) Al-clad, low Pu g/t (weapons grade)
August 1958	First Np recovery
October to December 1960	Began recovery of FP, ^{90}Sr, and ^{137}Cs
August 1962	"72" metal (natural) Al-clad, moderate Pu g/t (fuels grade)
November 1965	"72" metal (natural) Al-clad, moderate Pu g/t (fuels grade); SEFOR[a] campaign(s)
February 1966	"95" metal (enriched) eventually both weapons
January 1965, May 1966, September 1970	Al-clad thoria target elements; oxide powder in 1965 and 1966; compressed wafers in 1970
June/July 1967	Zircaloy-clad "95" (enriched) metal and "1.25" (spike)--both from N Reactor
February 1968	Al-clad natural U from older Hanford Site reactors and Zircaloy-clad 210 (2.1% ^{235}U) "Coproduct" from N Reactor
February 1969	PRTR[b], Zircaloy-clad PuO_2 (initially less than 1% Pu), UO_2 (1970--0.5, 1.0, 2.0, 4.0)
January and June 1972	Mixed oxide scrap (PuO_2-UO_2) in mild-steel cans; Zircaloy-clad mixed oxide
May 1982	Pu-Al and U-Al alloy (PRTR and Phoenix Reactors)

[a]Southeast Fast Oxide Reactor.

[b]Plutonium recycle test reactor.

Representative plant performance is shown in Table B-2, giving the relative purity of products obtained.

TABLE B-2. Historical PUREX Plant Performance.

Process	1956[a]	1959[b]	1967	1971
Separation ratios				
U from Pu[c]	10^7	10^7	10^7	10^7
Pu from U[d]	4×10^4	4×10^4	6×10^5	6×10
Plutonium decontamination				
FP from Pu	10^7[e]	10^8	10^8	10^8
First-cycle decontamination factor	3.5×10^5[f]	2×10^4	5×10^3	2×10^3
Second-cycle decontamination factor	30	2×10^3	2×10^3	1×10^3
Anion exchange	-	3	10	-
Third-cycle decontamination factor	-	-	-	50
Uranium decontamination				
FP from U	10^6	5×10^6	10^7	10^7
First-cycle decontamination factor	4.5×10^5[f]	2×10^4	3×10^3	2×10^3
Second-cycle decontamination factor	13	5×10^2	1.5×10^3	5×10^3
Silica gel	(4 to 10)[g]	-	2	-
Acid recovery				
Dissolving	-	85%	-	85%
Solvent extraction	65%	95%	-	95%
Sugar denitration	-	-	-	75%
Pu/U recovery	98%	99.9%	-	-
Solvent recovery	99%	99.7%	-	99.8%

[a]HW-31000.(1)
[b]HW-60116.(2)
[c]Pu/U in feed divided by Pu/U in product.
[d]U/Pu in feed divided by U/Pu in product.
[e]Pu reworked at Z Plant.
[f]Based on codecontamination and partition cycles.
[g]Initial decontamination factors were not as good as planned; ZrNb was the primary problem.

PLANT FLOWSHEET EVOLUTION

Modifications have been made to the PUREX flowsheet as information became available to increase capacity, decrease operating costs, reduce waste losses, and improve product purity. Major flowsheet modifications fall into six categories: (1) optimization of the original flowsheet within the objectives of the original plant mission, (2) modifications for neptunium recovery, (3) modifications for thorium processing, (4) modifications for increased processing flexibility (primarily in the headend), (5) modifications for reduced environmental releases, and (6) modification for plutonium oxide production.

The following discussion is confined to the actual, documented flowsheets. A large number of process tests were performed over the years, but not all of the tests resulted in flowsheet modifications.

Brief discussions of PUREX-type flowsheets (of which there are innumerable variants) appear in Chapters IV and VI of the PUREX Technical Manual and Chapter IV of the Reactor Handbook, Vol. II.[3,4] The development of the PUREX process was a major AEC activity involving efforts at Oak Ridge National Laboratory (ORNL), Knolls Atomic Power Laboratory, and the Hanford Site. The Hanford Site PUREX Plant flowsheet was demonstrated on a hot pilot plant scale at ORNL and in cold pilot plant work at Hanford in the 300 Area. Cold run operability tests in the plant itself were performed on what was then designated the HW 3 flowsheet. An increased capacity flowsheet (HW 4) was developed prior to hot startup, but was never used. The HW 3 flowsheet was modified, based on operational experience during cold run testing, and reissued as the PUREX Plant flowsheet (PPF) I. This flowsheet was, in turn, replaced within 6 mo of hot startup by PPF II. The changes were made primarily to improve ^{95}Zr-Nb decontamination. Conversion of the solvent extraction system from a three-cycle to a two-cycle scheme, with separate concentration and reuse of second-cycle aqueous waste streams, was accomplished and documented. With some modifications, the PUREX Plant two-cycle flowsheet was used throughout the remaining uranium-plutonium production campaigns. Updated versions were issued in 1968 for aluminum-clad fuels and in 1972 for Zircaloy-clad fuels. The current flowsheet, including the "Zirflex" process for decladding and dissolution of Zircaloy-clad N Reactor fuel, was updated in 1977. The latest flowsheet incorporated the processing of 6%, 9%, and 12% ^{240}Pu material, eliminated the recovery of neptunium and added the production of plutonium oxide (see Figure 6-1).[5]

A thorium process flowsheet was developed in 1965, modified after a PUREX Plant process test, and used for thorium processing campaigns in 1966 and 1970.

FEED PREPARATION PROCESSES

In the original feed preparation process for aluminum-clad fuel, the fuel elements were declad with a sodium hydroxide solution, containing sodium nitrate to suppress formation of hydrogen gas. After rinsing the

bare metal fuel elements, two or more dissolution cuts were taken with nitric acid, the number depending on the total metal inventory remaining in the dissolver. The individual cuts or batches of the resulting uranyl nitrate solution were then transferred to feed storage tanks. The feed was clarified by batch centrifugation. After clarification, the dissolved metal solution was chemically adjusted to assure reasonably uniform nitric acid and uranyl nitrate concentrations and then used as feed for the solvent extraction system.

Feed clarification was discontinued in March 1959. Rinsing between coating removal and nitric acid dissolution, coupled with various jetleg-length changes and allowance for solids settling, eliminated the need for centrifugation. In 1963, chemical adjustment of the feed was discontinued after demonstrated uniformity of dissolved metal solution.

The Zirflex process for chemically decladding and dissolving Zircaloy-clad uranium metal fuel elements was developed to permit reprocessing of Zircaloy-clad fuels in the existing Hanford Site production fuel reprocessing plants. The Hanford reprocessing facilities do not possess mechanical means (i.e., chop, shear, or extrude) for breaching the fuel cladding.

The Zirflex process consists of the following steps:

1. Dissolution of the Zircaloy by a mixture of ammonium fluoride-ammonium nitrate (AFAN) solution

2. Methathesis of uranium and plutonium tetrafluorides to uranium and plutonium dioxides with potassium hydroxide

3. Centrifugation of cladding waste solutions, spent metathesis solutions, and various rinses for recovery of product prior to discharge of the cladding waste to underground storage

4. Dissolution of the uranium metal with nitric acid in one or more cuts (with aluminum nitrate added to complex residual fluoride)

5. Dissolution of the cake removed from the centrifuge in nitric acid-aluminum nitrate for eventual incorporation in the solvent extraction feed.

The only significant modification to the original process was to make up an AFAN solution of the desired concentration and add the amount to the dissolver prior to charging, rather than adding a concentrated AFAN solution to boiling dissolver water. This modification was necessary to provide sufficient nitrate ion concentration in solution at the start of the decladding reaction to suppress hydrogen evolution.

Dissolver offgas treatment for the decladding process consists of ammonia removal in the downdraft condenser and water scrubber, deentrainment, offgas heating, iodine removal by passage through a packed tower containing silver nitrate-coated Beryl saddles, filtration, and discharge via the 200-ft stack. Offgas treatment for the uranium dissolution process consists of condensate recyle to the dissolver, deentrainment, offgas heating, passage through a packed tower containing silver nitrate-coated Beryl saddles for iodine removal, filtration, and additional nitric acid and iodine removal in the backup facility.

The backup nitric acid recovery system was originally installed as a dual purpose unit: the first column performing additional nitric acid absorption, the second operating as a caustic scrubber for radioiodine removal. The iodine removal in the first tower proved satisfactory. This, coupled with no measurable decline in efficiency, resulted in elimination of the caustic scrub for iodine removal in favor of additional acid recovery. As a result of increased cooling time of the fuel (to at least 180 d), radioiodine (^{131}I) levels declined to the point where operation of the silver reactors was no longer required. These were last regenerated in April 1968.

The chronology of the feed preparation processes is given in Table B-3.

SOLVENT EXTRACTION AND PRODUCT HANDLING, 1956-72

The basic startup flowsheet was a three-cycle system employing a codecontamination cycle; a partition cycle consisting of an extraction column, partition column, a scrub column ancillary to the partition column, and a uranium stripping column; and separate, final decontamination cycles consisting of extraction and strip columns for the plutonium and uranium streams. The breakdown is shown in Table B-4.

With the exception of the aqueous plutonium stream from the partition column, each aqueous product stream exiting from a cycle was concentrated. All extraction column losses were actual; however, high product content waste was generally recycled.

The basic operating features of this flowsheet were as follows:

- Rigid control of uranium saturation in the HA, 1A, and 2D Columns
- Uranium-plutonium separation by plutonium reduction to the inextractable III valence using ferrous ion (as ferrous sulfamate with sulfamic acid as a holding reductant) in the 1BX and 2DF streams, and an oxidizing step prior to the second plutonium cycle.

TABLE B-3. Feed Preparation Headend Chronology.

Time period	Feed preparation
March 1956	Switch from batch nitric acid addition to continuous acid addition during cut to eliminate ^{131}I surge
September 1957	Backup offgas treatment facility on-line for improved acid recovery and ^{131}I removal
June 1958	T-XB switched from caustic to acid scrubber
June 1958	Prototype silver reactor installed as temporary replacement for original
June 1958	NH_3 scrubber installed
March 1960	Discontinued feed centrifugation (free centrifuges and E cell tankage for FP recovery)
October 1963	Discontinued feed adjustment
August 1965	Thoria process test. The A3 annular dissolver installed (testing continued through September)
January 1966	B3 annular dissolver installed
January 1966	216-A-36-A crib out of service, distributor extended (became 36-B), a consequence of (1) solution carry-over during dissolution into the NH_3 scrubber catch tank and (2) contamination of NH_3 scrubber waste with dissolver solution via the downdraft condenser and piping. The problem noted with the A3 dissolver was solved on the B3 and subsequent dissolver vessels by raising the elevation of the dissolver vent connection on the dissolver and by installing isolation valves between the dissolver and NH_3 waste tank. In addition, routine condenser and scrubber flushing at the conclusion of the fuel dissolution step was begun.[6]
September 1966	Thoria campaign; C3 annular dissolver installed
January 1967	First test of Zirflex process
February 1968	First use of dissolver insert to reduce annulus (for nuclear criticality prevention) during coproduct processing
December 1969	Eliminated continuous AFAN solution
December 1970	Thoria campaign
January 1971	Leaks were found in all three dissolver cells. Operation was resumed with a new B3 dissolver and the A3 dissolver coil discharge routed to a backup concentrator.
September 1971	New C3 dissolver installed
December 1971	Plate coil on an old B3 dissolver--refurbished assembly installed on A3 dissolver

TABLE B-4. System Breakdown.

Flowsheet designation	Canyon position[a]	Cycle[b]	Product	Function
HA	(H2)	1	CO	Extraction/scrub
HC	(H3)	1	CO	Strip
1A	(J2	2	CO	Extraction/scrub
1BX	(J6)	2	CO	Partition
1BS	(J4)	2	Pu	Scrub
1C	(J7)	2	U	Strip
2A	(L1)	3	Pu	Extraction/scrub
2B	(L2)	3	Pu	Strip
2D	(K2)	3	U	Extraction/scrub
2E	(K3)	3	U	Strip

[a]For example, the H2 position is the second equipment position in H cell.

[b]Carbon dioxide means uranium and plutonium as a coproduct.

The following modifications were made during the first year of hot operation for improved ^{95}Zr-Nb decontamination performance:

- C-type columns were changed from organic continuous to aqueous continuous operation (this minimized carryover of interfacial materials containing high FP activity)
- Uranium feed concentration to the HA column was increased and control of the uranium saturation of the organic phase was tightened
- Feed acidities to the HA, 1A, 2D, and 2A columns were decreased
- HA column temperature was reduced
- 1BX stream acidity was decreased
- Treatment of uranium product with silica gel for additional Zr-Nb decontamination factor was initiated.

Final three-cycle operation improvements consisted of:

- Conversion of 2D column to organic continuous operation and installation of a scrub section cartridge of improved design

- Treatment of plutonium product in a new, semicontinuous, anion-exchange system (installed in a portion of the regulated shop and designated as N cell)

- Improvements to the solvent treatment flowsheet.

Two-cycle operation was tested in the plant in March 1958 and the following equipment modifications were made in June:

- Bottom-interface HA column installed

- The HC column became a scrub column associated with the HA column

- The 1A column was removed

- The backcycle waste system was established using the HCP concentrator (E-H4) to evaporate aqueous waste streams from the 2D and 2A columns and N cell for recycle to the HA column

- TK-F10 was used to combine waste streams.

The installation of backcycle capability, in turn, permitted tighter (higher) saturation in the 2A and 2D columns with concomitant improvements in product quality.

Subsequent major flowsheet changes through the 1972 plant shutdown were:

- Neptunium recovery on a campaign basis using existing columns (this capability resulted because neptunium accumulates in the backcycle waste system)

- Installation of neptunium recovery equipment (another solvent extraction system plus ion exchange product treatment)

- Installation of improved scrub section cartridges and larger diameter columns

- Installation of a third plutonium solvent extraction cycle to replace the anion exchange system to provide increased reliability, capacity, and safety.

Two continuing programs that merit more detailed attention are: (1) improvements in solvent* and solvent treatment and (2) alternate reductants for partitioning.

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*The term solvent, as used in this discussion, refers to the mixture of tributyl phosphate (TBP), the actual process solvent, and inert hydrocarbon diluent.

Most of the problems associated with FP decontamination in the PUREX solvent extraction process were attributable to solvent deterioration resulting from radiation exposure. This was one reason for placing column interfaces at the opposite end of the columns from the product stream exit. Gross quantities of FP tended to accumulate at the interface in an interface layer consisting of degraded solvent. Consequently, any entrainment or column upset could result in contamination of the stream exiting the disengaging section containing the interface.

The solvent diluent used had a profound effect on solvent quality. The original diluent was a kerosene-type mixture of saturated and unsaturated hydrocarbons which was, in essence, a specific distillation cut (Shell Spray Base E 2342). In September 1961, this was changed to Soltrol-170, a mixture of highly branched aliphatic hydrocarbons with properties similar to Shell Spray Base. Some initial improvement was noted, but this dissipated after a relatively short time. In February 1966, a switch was made to a normal paraffin hydrocarbon (NPH) mixture (containing m-decane tetradecane). Evaluation of contrasting run periods proved straight chain hydrocarbon superiority in terms of process performance.

Improved solvent treatment processes evolved as well. Initially, aqueous sodium carbonate washing was performed in the 10 and 20 pulse columns, followed by centrifugation to remove entrained aqueous carbonate and solids. Shortly after startup, carbonate washing on a batch basis was started in the 10F pump tank (TK-G1). However, activity in solvent treatment system 1 continued to be a problem. A nitric acid scrub was then used in the 10 column (in place of carbonate) with marked improvement in both 10 column stability and solvent quality. In late 1957, $KMnO_4$ was added to the aqueous wash in TK-G1, a turbo-mixer was installed in receiver TK-G7, and centrifugation of the 10 column product was discontinued. A caustic wash was used with the turbo-mixer. Later, the same changes were made to solvent treatment system 2, the only exception being no turbo-mixer installation in R cell.

Due to declining FP activity in the plant feed (longer cooled reactor fuel), improved FP decontamination in the first cycle as a result of fluoride complexing of ^{95}Zr-Nb during processing of N Reactor fuel (Zirflex Tonic effect), and the stability of the NPH, it was found prior to shutdown that the turbo-mixer operation was not needed. The usage of $KMnO_4$ was reduced by 60% by lowering the concentration in the wash solution by 33% and eliminating the use of a more concentrated $KMnO_4$ add stream to the system 1 wash solution. Further reductions in the Na_2CO_3- $KMnO_4$ usage were made by reusing more of the system 2 wash solution in system 1.

The search for an alternate to ferrous sulfamate as a plutonium reductant was motivated primarily by the waste management program. The iron and sulfates contribute to the total bulk of nonvolatile salt in the waste and adversely affected the waste fractionization effort in B Plant.

Plant tests have been performed with the following:

- Ferrous nitrate stabilized with hydrazine
- Uranium IV stabilized with hydrazine
- Hydroxylamine nitrate (HN)--stabilized with hydrazine
- HN in conjunction with lesser amounts of ferrous ion.

The HN stabilized with hydrazine is used in the 2D column feed and 2B column strip. The neptunium recovery system requires some ferrous ion and holding reductant due to the high nitric acid concentration and the radiolytically produced nitrite in the backcycle. The uranium IV, while demonstrated in the 1BX stream on a test basis, is not readily available for use. The tests with HN in the 1BX stream were successful, but proved too costly. The FeSA-SA system is preferred for nuclear criticality prevention. All other reducing systems require more administrative and engineered safeguards.

Solvent extraction chronology is shown in Table B-5.

WASTE TREATMENT

The waste treatment system at hot startup consisted of two cycles. A primary, high-level, waste concentrator (E-F11) evaporated the waste stream from the first extraction column. A second concentrator (E-F6) received aqueous waste streams from subsequent cycle extraction columns and the condensate from the E-F11-2 and vessel vent system condensers. The overheads from E-F6 were routed through an acid absorber-fractionator (T-F5). Two functions were performed by this system: nitric acid removal and recovery for recycle and waste volume reduction. Minimizing radioactivity in the concentrator overheads and recovering nitric acid were the primary justifications for double distillation of the HAW (HW column waste).

It was recognized during the final plant construction phase that an atmospheric acid absorber-fractionator would limit plant operating rates and have a short service life. An ancillary vacuum fractionator package was, therefore, procured and placed in operation in 1957.

TABLE B-5. Solvent Extraction Chronology. (Sheet 1 of 2)

Time period	Solvent extraction
April to May 1955	Extended scrub portions of HA and 1A columns based on hot semiworks test experience. This required chipping 5 ft of concrete out of the cell floor at the H2 and J2 positions
April 1956	Batch washing in TK-G1 of system 1 solvent initiated
During 1956	C-type columns converted to aqueous-continuous (top interface) operation
November 1956	2D column converted to organic-continuous (bottom interface) operation
May 1957	Semicontinuous anion exchange treatment of Pu product stream (2BP) initiated. Sulfuric acid added to 2BX to permit reduced 2BX flow
December 1957	HA column converted to organic-continuous (bottom interface) operation. Began continuous $KMnO_4$ solvent washing
March 1958	First test of two-cycle flowsheet, bypassing HC and 1A columns. Converted 10 column to dilute acid scrub
June 1958	First attempt to recover Np (campaign basis from 1WW). Implemented two-cycle system
February 1960	Solvent quality deteriorated to the point where it had to be discarded and replaced with fresh solvent
September 1961	Switched from Shell Spray Base diluent to Soltrol-170
October 1962	Began Np recovery on a continuous basis
January 1965	Process test of modified Thorex solvent extraction flowsheet successful
February 1966	Switched from Soltrol-170 to NPH diluent
May 1966	Performed Th campaign
July 1967	First N Reactor fuels processing campaign, "tonic" effect (enhanced ^{95}Zr-Nb decontamination factor) noted; (attributed to F^- in November 1969). Ferrous nitrate/hydrazine tested in 1BX
September 1969	Replaced sulfamic acid with hydrazine (1BX)
October 1969	1UD recycle (to 1CX)
January 1970	Deliberate butting of HAF with fluoride for decontamination factor enhancement

TABLE B-5. Solvent Extraction Chronology. (Sheet 2 of 2)

Time period	Solvent extraction
April 1970	Tested U(IV) as alternate 1BX reductant
May 1970	Tested HN in 2DIS
July to December 1970	Performed second Th campaign
April 1971	Third Pu cycle installed
August 1971	HAO stream eliminated for improved Np recovery. Use of TK-J2 eliminated. Second- and third-cycle organic waste streams routed directly to 1BXF tank (TK-J3)

The most significant change in the waste treatment system consisted of conversion to a single cycle. This change became feasible after converting to the two-cycle solvent extraction system with backcycle waste concentration, reducing the volume to be concentrated in the waste treatment system. In addition, sodium nitrite was added to suppress ruthenium volatilization into the overheads of concentrator E-F6 and a prototype demister was installed in the E-F6 offgas, markedly reducing activity in the overheads.

Another concern was volume reduction of high-level waste due to the high cost of underground storage tanks. Efforts toward this end involved reduction of nonvolatile components (previously discussed in the flowsheet section), increased concentration of high-level waste (eventual four-fold concentrator bottoms flow reduction), and denitration of the high-level waste. The process required alkalinization of the waste with sodium hydroxide prior to storage in the underground, carbon steel waste tanks. After extensive laboratory study, equipment for a process utilizing formaldehyde to destroy nitric acid in the waste stream (1WW) without adding nonvolatile constituents to reduce sodium hydroxide additions was installed and briefly used in the plant. The reaction proved quite violent, causing excessive entrainment of 1WW in the gaseous products, resulting in high activity in the recovered acid. Sugar (sucrose) was tested as an alternative, proving eminently suitable, and was used after October 1963.

Two other topics merit discussion: intermediate-level waste disposal and plant rework of high-level-waste-containing product. Sump wastes and drainage from miscellaneous contaminated areas (i.e., sampler cave drains) are collected in TK-F18. This material may generally be disposed of to either nonboiling or boiling waste storage. If reworked due to high product content, it is processed through TK-F8.

The TK-F8 proved very beneficial to the PUREX process. It is a standard tank equipped with a large steam coil and a condenser with capability to reflux by condensate return to F8 or concentrate by condensate disposal to TK-F7. Most material to be reworked contains some solvent. During prolonged refluxing, the solvent is degraded to nonvolatile phosphates, with the majority of the organic destroyed. Small batches of this rework material may then be blended with feed going to the first extraction column. The F18 and F8 operations have remained essentially unchanged throughout the history of the plant.

High-level waste without associated solvent may be reworked directly without F8 reflux. It has been found that F6 bottoms may be reworked with only occasional process upset, that partially sugar denitrated 1WW cannot be reworked without serious process upset, and that post-sugar/post-high-temperature digestion 1WW can be reworked with some beneficial effects on first-cycle decontamination.

High-level waste treatment and acid recovery chronology are shown in Table B-6.

TABLE B-6. High-Level Waste Treatment and Acid Recovery Chronology.

Time period	High-level waste treatment and acid recovery
February 1957	Vacuum fractionator on-line
September 1958	Tested anion exchange for product recovery from concentrated first-cycle waste
September 1962	E-F11 (evaporator) shut down; single evaporation cycle waste treatment initiated
August 1963	Test denitration of 1WW using formaldehyde
September 1963	Successful sugar denitration of PUREX 1WW
November 1966	First $SO_4^{=}$-free 1WW campaign
November 1967	First condensate recycle system, F5 condensate used as reflux (acid absorber distillate)
March 1971	E-F11 used to concentrate sump material and coil condensate and cooling water

MAJOR EQUIPMENT CHANGES, 1954 to 1972

A chronology of equipment changes is given in Table B-7. Equipment changes preceded plant construction. One of the earliest, significant decisions concerning plant equipment involved redesign of the first-generation concentrator to provide removable steam tube bundles. Based on laboratory information and offsite experience, the tube bundle failure rate due to corrosion was expected (and subsequently found) to be considerably more frequent than originally believed.

TABLE B-7. Chronology of Major Equipment Changes, 1956 to 1972. (Sheet 1 of 2)

Time period	Major equipment changes
Mid-1954	Removable tube bundles on all concentrators
April to May 1955	Went to longer scrub sections on HA and 1A columns. Required deepening cells
November 1955	Pumps placed in E6 to H1, E5 to E6 (jet dilution too great)
May 1956	Unidiameter 1A column installed, replacing L cell package (went to single stripper and a concentrator)
November 1956	T-K2 (2D) bottom interface column with "Zebra" (both stainless steel and plastic plates) scrub cartridge installed
April 1957	Ti tube bundle installed in the Pu product concentrator
November 1957	Bottom interface Zebra scrub cartridge HA installed
January 1958	N Cell Pu anion exchange system installed
February 1958	Replaced silver reactor
March 1958	G7 turbo-mixer installed
June 1958	HC and 1A columns removed; HS column and TK-J2 installed
December 1958	Second 40-ton crane installed
June 1960	Installed new HS, 1C, and 2E column
February 1961	Replaced 2A column (which was a packed column) with one with a cartridge
August 1961	Replaced concentrator tube bundle steam traps on trap pits south of 202-A with in-cell, diaphragm-operated valves
August to October 1962	Installed Np recovery and purification equipment
August 1965	Installed first annular dissolver(3). Floor in cell rebuilt. New silver reactor (two beds) installed in A cell
January 1966	Second annular dissolver installed with modified vent in B cell; some concrete along one wall removed
April 1966	Installed new N6 and N7 vessels (Ta-lined and all Ti, respectively)
September 1966	C3 annular dissolver installed

TABLE B-7. Chronology of Major Equipment Changes, 1956 to 1972. (Sheet 2 of 2)

Time period	Major equipment changes
February 1967	UNH rework concentration and reflux system installed in 203 area (TK-P6)
March 1967	Installed: geometrically favorable 2AF tank (TK-J5), improved N6 demister, greater capacity J4 cartridge (in hot spare column)
May 1967	Two-bed silver reactor in C cell; Zirflex decladding waste treatment system in E cell
June 1967	Unidiameter HA column installed. Also, new specially designed tanks installed in F7 position
April 1968	First use of Cd as neutron poison during rework Pu transfers (L11 to E6) (in solvent extraction)
June 1968	Bypassed HS column, codecontamination cycle decontamination factor dropped by factor of two to three, but was acceptable
July 1968	Replaced N cell resin "pusher" with "puller" and was unsuccessful
June 1969	E-F6 leaked and was replaced. First sectionalized concentrator installation
July 1969	Replaced barometric condenser for the acid fractionator with shell-and-tube unit
November 1969	Installed 1UD recycle system
July 1970	Installed sectionalized concentrators in F11 and H4 positions for Th campaign
December 1970 to January 1971	Replaced L cell package with third Pu cycle
January 1971	All three dissolver coils leaked
March 1971	Replaced B3 dissolver
September 1971	Installed new C3 dissolver
December 1971	Installed dissolver with plate coil in A3 position

This basic concentrator was succeeded in the 1960s by the sectionalized concentrator which provided a common reboiler compatible with two differing towers: one tower designed for simple evaporation and acid boiloff service, the other for organic stripping (uranium) service. The first sectionalized concentrator to be installed replaced an acid concentrator.

The chronology cited covers most of the major equipment changes at PUREX. In general, the reasons for the changes were:

- Equipment failure with attendant modifications intended to preclude future failures
- Inadequate equipment performance and, generally, increased capacity desired
- Desired improvements in process performance.

SIGNIFICANT EVENTS, 1956 to 1972

The chronology shown in Table B-8 is a record of significant events occurring from 1956 to 1972.

PUREX PLANT PROJECTS

Table B-9 shows all past projects at PUREX resulting in actual equipment and facility changes.

The nature of the projects changed with time. Initially, most projects were directed toward process refinement. Gradually, emphasis shifted toward increased production. The third phase was directed toward increased plant versatility and safety. A fourth phase was directed toward upgrading the facility to meet more restrictive requirements for environmental discharges and conduct of operations.

FIRE PROTECTION SPRINKLER PROJECTS

Fire protection facilities were originally provided only in the process cells and the laboratory area. The process cells were provided with a manually operated, water-fog, fire protection system and Fireye photoelectric detectors, and the laboratory area was provided with a fire detection system. In 1967, an automatic sprinkler system was installed in the laboratory area and provided a laboratory storage area equipped with an automatic sprinkler system (Project IAP-605). In 1968, supervised automatic sprinkler systems were installed in the following areas (Project IAP-615): west end of first floor service area up to and including the main entrance lobby and airlock on the east; west transformer substation, dock storage

area; regulated and hot shops, including airlock; N cell airlock; and the east end of the storage gallery. This project also provided fire detectors in the west switchgear and cable rooms, and the existing paint storage area fire detectors in the 2714-A building were connected to the PUREX alarm circuit. In 1974, the light-water, aqueous, film-forming-foam sprinkler system was installed in process cells G, H, J, K, and R and TK-R1A under Projects HCP-678 and B-115. The dissolver drown tanks were seismically upgraded to assure structural survival in the event of an earthquake under Project B-336.

TABLE B-8. Chronology of Significant Events. (Sheet 1 of 3)

Time period	Event
February 20, 1956	Blowback of contamination from L package-pressurized stripper to force overflow with a manometer[7]
April 7, 1956	Partition failure due to NO_2^- recycle
June 2, 1956	First U product met specifications
February 13, 1958	Silver reactor explosion[8] (returned to service August 28, 1958)
February 23, 1958	Fire in hot shop (oil or acid soaked rags); minor loss of contamination control in the hot shop area
March 24, 1959	Seepage from A sump in F cell into storage gallery roped off and covered with blocks for shielding; rebuilt cell floor
January 10, 1960	PR can pressurization (lacked vent hole in gasket). One small loss of contamination control in the PR area
February 25, 1960	Fire in N cell (welding)
April 3, 1961	30,000 gal of 57% HNO_3 drained to chemical sewer due to error in valving
April 20, 1961	1,335 lb of depleted U drained to crib due to valve leak
January 1962	F11 tube bundle; changeout resulted in major loss of contamination control in the canyon area
March 3, 1962	13,600 gal of water on floor in K cell. Loss of contamination control in the PR room
June 3, 1963	Caustic added to uncovered Al-clad fuel produced H_2 explosion. No significant equipment damage
August 1963	Charge of insufficiently aged fuel to C3. Dissolver idled for 2 mo

TABLE B-8. Chronology of Significant Events. (Sheet 2 of 3)

Time period	Event
April 9 to 19, 1964	Main exhaust filter differential pressure increased rapidly to 14 in. WG due to pluggage by ammonium nitrate. New exhaust filter installed
June 14, 1964	TK-F15 coil leaked; approximately 10,000 Ci discharged to pond. Routings changed so that discharges of most coils exposed to high-activity solutions are to steam condensate crib
February 1966	A-36-A crib overloaded with radionuclides (new dissolver); switched to 216-A-36-B
September 23, 1966	PR can tipped over on PR elevator; minor loss of contamination control to the PR elevator area
May 10, 1968	UNH truck leaked from PUREX to UO_3; minor U contamination
May 15, 1968	Overflowed cask in 212-A; no loss of contamination control in the 212-A facility
December 1969	Dumped a bucket of Zircaloy-clad N Reactor fuel on floor; fuel elements retrieved
May 1970	Approximately 14,000 Ci discharged to 216-A-36-B crib due to leaking valve in scrubber drain to catch tank
August to December 1970	Stack emission during Th processing[9] primarily due to Ru volatilization
January 3, 1971	First dissolver coil leak (C3) discovered
March 1971	All three dissolver coils subsequently found to leak
April 8 to 22, 1971	Pu polymer found in third Pu cycle due to omission of HNO_3 to 3BP during startup operability testing
October 1971	Spilled a canister of N Reactor fuel on B cell floor; picked some up, covered rest with water (water leaked out expansion joint and contaminated the storage gallery)
December 4, 1971	KOH inadvertently added to C3 dissolver. As a result, Pu was precipitated as a Pu polymer. U feed solution reacidified with HNO_3, digested at an elevated temperature for an extended time, and processed as normal feed
January 1972	High PR stack Pu emissions (L9 sampler pressurized tank)

TABLE B-8. Chronology of Significant Events. (Sheet 3 of 3)

Time period	Event
February 23, 1972	Greater than 500 g Pu accumulated in F11[10]
April 3, 1972	Transferred excessive Pu to TK-D4[11] (exceeded total Pu limit specifications)
April 11, 1972	Sugar denitrated a waste batch with greater than 811 g of Pu[12]
June 26 to July 17, 1972	14 of 19 charges exceeded criticality prevention limits for spike fuel due to change in canister load size. One deliberate excessive charge also made[13]

TABLE B-9. PUREX Projects. (Sheet 1 of 5)

	Project	Description
CA-513-A	PUREX facility	Design and construction of PUREX separations plant with appurtenant tank farm and required outside facilities to process production metal fuel
CA-513-C	Three-column prototype with concentrator	Built in 300 Area to test large-size pulse columns and concentration step in the PUREX process
CA-513-E	PUREX Plant modifications	Addition of a spare 40-ton crane, and conversion to 2-cycle process
CG-598	Vacuum fractionator	Auxiliary structure to PUREX, enclosing vacuum acid fractionator and associated equipment
CG-647	Backup (radioiodine) removal	293-A facility
CG-683	Reroute PUREX cooling water to new pond	216-A-271 diversion box to pond 216-A-25 retention basin
CG-686	In-line monitoring instruments, REDOX and PUREX	Provide equipment for in-line monitoring. PUREX installation and modifictions of gamma and alpha monitors and an automatic air cutoff. Iodine--A, B, C, and F 293-A. Gamma--G5, H3, J5A, and K3. Alpha--L1, L8, and 2BP
CG-742	HA column replacement--PUREX	Provide an HA column of new design to replace the existing column. The new column to be designed for a 4.0 capacity. The project includes burial of the old column and additional instrumentation and piping
CG-766	Additional ventilation for PUREX P&O gallery	Provide additional ventilation facilities, including a new blower, new ductwork, associated controls, and other minor equipment
CAC-140	PUREX ventilation filter replacement	Provide replacement for PUREX ventilation exhaust filter
CAC-152	PUREX analytical laboratory additions	Provide alteration and an addition to existing facilities
CAC-895	Reliability improvements 3.6 capacity factor, PUREX	D3/D4, demineralizer anion column, formaldehyde (TK-40)

TABLE B-9. PUREX Projects. (Sheet 2 of 5)

	Project	Description
CAC-964	New burial tunnel	Construction of new tunnel for retrievable storage of failed equipment
CGC-124	Increased processing flexibility--provide facilities for processing of natural, E metal, D metal, N Reactor fuel elements, and PRTR fuel elements	New J5, F7/F26, sump modifications for nuclear safety
CGC-172	Pu concentration and storage facilities--L cell--PUREX	Provide modifications to the existing L cell package. New L11, safe for ^{233}U
CGC-773	Interim waste crib--PUREX	Provide a new crib with associated piping and equipment for 200 East Area for disposing of condensate from PUREX boiling wastes
CGC-821	Project birch--PUREX Np	Provide in-canyon and gallery facilities in the PUREX Plant for recovery and decontamination of Np as a nitrate salt in aqueous solution from the PUREX waste streams
CGC-854	Conversion of PUREX anion exchange prototype to a manufacturing unit--N cell	Provision of a control room enclosure, access air lock and concrete radiation shielding wall, new improved feed pump system, and associated work to convert the facility to a manufacturing unit
CGC-873	FP loadout facility--PUREX	Provide an FP loadout facility on the south side of the PUREX building for transferring material from existing in-canyon vessels to suitable shipping containers (212-A Building)
CGC-891	PUREX 216-A-6 replacement (process condensate)	216-A-10 crib
CGC-929	NPR fuels processing annular dissolvers	Provide separation facilities for processing fuels from the new production reactor
CA-930	Secondary containment of dissolver offgases	Provide backup filters for each dissolver system in PUREX and REDOX facilities

TABLE B-9. PUREX Projects. (Sheet 3 of 5)

	Project	Description
IAP-600	PUREX 203-A UNH rework storage facility	TK-P6 installation in 203-A
IAP-601	Coproduct demonstration processing facilities, 200 Area	Coproduct insert
IAP-606	PUREX process condensate crib, 216-A-38	Replace A-10
IAP-608	PUREX D cell in-line sample station	D5 cave and canyon recirculation system
IAP-610	PUREX steam condensate crib, 216-A-37-1	A-30 replacement
IAP-615	Fire protection facilities, PUREX	Hot shop, regulated shop, service, and storage gallery
ICE-628	Third plutonium solvent extraction cycle, PUREX	Replace existing stripper concentrator with a third SX cycle, stripper-concentrator, and associated tanks
HCP-677	PUREX condensate bypass and pump system, 200 East Area	A pump tank and new run of piping (including a section over the railroad tunnel)
HCP-678	Improved fire protection, PUREX	Upgraded in-plant protection system
HCP-685	PUREX NH_3 scrubber, Waste Concentration Facilities	F11 receives NH_3 scrubber wastes
B-107	PUREX condensate recycle	Recycle AAD and AFD with excess to TK-F10, 3WD combination with 1UD
B-112	Waste management effluent control	Second-stage filtration--PR stack; filtration of R cell and U cell exhaust; upgrade sampling capability, retention basin for cooling water. Install third PUREX filter
B-115	Additional fire protection, PUREX Plant	J, K, L, and R cells on fire-foam system. New sprinkler system in ventilation tunnel
B-128	PUREX waste routing to 214-A-102 and -103 tanks	New waste routing
B-129	Piping from PUREX 241-AX-151 Encasement to 241-A valve pits	Route alkalinized and dilute wastes to 242-A system

TABLE B-9. PUREX Projects. (Sheet 4 of 5)

	Project	Description
B-132	PUREX NH_3 offgas system	Ties E cell scrubber offgas to F11
B-151	PUREX safeguards	Guardhouse and vehicle inspection equipment
B-153	PUREX Plant fire protection	Upgrades portions of facility to national fire safety codes
B-172 B-172A	Hanford plant security inspections, 200 Areas	Tie-in PUREX alarm systems with central computer, improve communications network. New perimeter fence
B-175	Plutonium oxide conversion facility	Provides facility in N cell to convert Pu nitrate to PuO_2 product
B-175A	PuO_2 rework	Provides batch equipment to dissolve off-specification PuO_2 and other recoverable material for rework in the PUREX process
B-188	NH_3 scrubber waste sampling system	Adds sampling system to NH_3 scrubber waste discharge for environmental monitoring
B-189	Primary stack systems	Adds sampler monitor and flow totalizing systems to the primary PUREX stack (216-A-1)
B-190	Chemical sewer systems	Adds monitor and flow diversion systems for effluent control
B-191	PR room stack systems	Adds sampling, monitoring, and flow totalizing systems for effluent monitoring
B-196	Pollution abatement	Adds H_2O_2 injection system to reduce NO_x emissions from the primary ventilation stack (291-A-1)
B-201	PUREX safeguards improvements	Building perimeter fencing, lighting, intrusion detection
B-203	Process condensate systems	Adds improved sampling, monitoring, and flow totalizing capability to the process condensate waste discharge
B-205	PUREX P&O gallery services upgrade	New cable trays and cable separation in P&O gallery
B-220	Waste transfer facilities, 200 Areas	Additional PUREX acid waste and neutralized high-level waste lines routed to PUREX

TABLE B-9. PUREX Projects. (Sheet 5 of 5)

	Project	Description
B-254	UNH storage area effluents	Adds collection, sampling, and selective disposal routing for environmental control
B-268	Pond 216-B-3 expansion	Expands pond 216-B-3 to receive increased flow of cooling water from PUREX
B-280	Additional waste lines 202-A to 244-AR	Install PUREX high-level waste lines
B-281	Additional waste lines 202-A to 241-AW	Install PUREX high-level waste lines
B-311	HVAC centralized control	Adds control room instruments for centralized control of ventilation systems 1 and 2
B-313	PUREX perimeter intrusion detection system addition	Provides a second intrusion detection and alarm system for PUREX
B-336	PUREX seismic upgrade	Reinforces dissolver drown tanks to assure structural survival in the event of an earthquake. Adds backup light water foam fire protection system for Cells H and J
B-346	HVAC pressure zone	Provides airlocks to segregate 202-A facility into four distinct pressure zones and provides the differential pressure sensors/alarms to monitor those pressure zones
B-379	White room filtration system	Adds HEPA filters and control instruments to divert airflow in the event of a leak in the P&O gallery
B-382	PUREX backup generators	Adds motor-generator sets and electrical switchgear to provide backup power
B-410	Lag storage tank	Adds additional tank for Pu nitrate storage

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11. ARHCO, Criticality Specification Violation - Exceeding 10,000 grams Plutonium Limit in TK-D4, ARH-2466, Atlantic Richfield Hanford Company, Richland, Washington (April 25, 1972).

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C1.5 (1968.09) Canyon Concentrator

Date: September 9, 1968

To: R. W. McCullugh

From: J. M. Blackburn ORIGINAL SIGNED BY J. M. BLACKBURN

Subject: CANYON CONCENTRATOR

The following information is submitted to acquaint you with concentrator failure history, the status of spare concentrators and to make recommendation concerning additional procurement of spares in FY 1969.

A. Concentrator Failure History

	Position	Installed	Failed	Life	Remarks
1.	F6 Original	Jan. 1956	Apr. 1961	5 yrs-4 mos.	
	F6 Spare #1	Apr. 1961	May 1964	3 yrs-1 mo.	
	F6 Spare #2	May 1964	June 1965	21 mos.	Prior to installation in F6 this spare was used in F11 position for 10 months. Total service life of #2 spare for both positions was 21 months.
	F6 Spare #6	June 1965			This spare is in service but is expected to fail within one year. To date it has been in service 3 yrs-2 mos.

R. W. McCullugh
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	Position	Installed	Failed	Life	Remarks
					Average life of concentrators in the F6 position is 3 yrs.-7 mos.; this assumes the unit now in service will last one more year.
2.	F11 Original	Jan. 1956	July 1960	4 yrs-7 mos.	
	F11 Spare #3	July 1960	Feb. 1962	1 yr-6 mos.	
	F11 Spare #2	Feb. 1962	Dec. 1962	10 mos.	Discontinued use of F11 concentrator due to improved methods for waste treatment. Spare #2 was moved to F6 position May 1964.
3.	F4 Original	Jan. 1956	Jan. 1961	5 yrs.	Concentrator was used for uranium service for 2 yrs-6 mos. during the 5 year period.

Position	Installed	Failed	Life	Remarks
14 Spare #1	Jan. 1961			Spare #1 was removed Feb. 1966 so a new, clean concentrator could be installed for the first thorium production run. At the time of removal service life was 5 yrs-1 mo.
14 Spare #5	Feb. 1966	Aug. 1968	2 yrs-6 mos.	
14 Spare #1	Sept. 1968			Since this spare has been in service previously for 5 years 1 month in this position, it is assumed it will fail within the next year. Average life of a concentrator used in this position is 4 yrs-6 mos.; this average life assumes Spare #1 just installed will last another year.

	Position	Installed	Failed	Life	Remarks
4.	J8 Original	Jan. 1956			For planning procurement of future spares it should be assumed this concentrator or the one in K4 will fail in the next 3 to 4 years.
5.	K4 Original	Jan. 1956			No failure.

B. Status of Spare Concentrator

1. All spares available are of the sectionalized type.
2. On hand - 3 reboiler sections
   1 top section for acid service
   2 top sections for uranium service
3. On order - 1 top section for uranium service; expect delivery November 1968.

C. Estimated Need for Spare Concentrators During Next Eighteen Months

1. 1 reboiler section and 1 top section will be needed for the F6 position. To date, the concentrator now in the F6 position has been in service 3 years 2 months. It is expected to fail within the next year based on failure rate of concentrators in this position. As pointed out above, average life for this position is 3 years 7 months.

2. 1 reboiler section and 1 top section for acid service will be needed for the F11 position. Under the present operating scheme, a concentrator will be needed in the F11 position for the thorium run. George Rabb has asked FES to investigate alternate schemes which would not require a standard sectionalized concentrator in this position; but, to date, such schemes have not been developed. For planning procurement of additional spares, I believe it should be assumed that a standard sectionalized concentrator will be required in the F11 position. At present an acid top section is not available and, therefore, one should be fabricated, using FY 1969 capital equipment funds. As pointed out above, it is expected that the one spare acid top available at this time will be required for the F6 position within the next year.

3. 1 reboiler section and 1 top section for uranium service will be needed for the H4 position. This assumes the used H4 concentrator just installed will fail within the next year or at least prior to the thorium run.

4. 1 reboiler section and 1 top section for uranium service will be needed for installation in the H4 position just prior to the start of the thorium run. This assumes the concentrator mentioned in the item 3 just above will be installed in the H4 position and that it could not be decontaminated to a level low enough to permit product specification to be met during the thorium run. A reboiler section would not be available for this installation if the three spares existing at the present time are used as predicted in items C1, C2, C3.

D. Recommendations for Procurement of Additional Spare Concentrator Sections

To meet spare concentrator needs noted under Item C above, one additional top section for acid service and one additional reboiler would be required. It is recommended that FY 1969 capital equipment funds in the amount of $300,000 ($100,000 for top - $200,000 for reboiler) be allocated for these two fabrications. Long delivery items required for fabrication of these two pieces are available in Spare Parts; these parts consist of demister pad, dished heads and other forgings. Additional material such as stainless steel plate needed for fabrication of vessel shells would have to be procured. It is believed this material could be procured by January 1, 1969. If funds could be allocated by that time, fabrication could commence.

Estimated time schedule for fabrication of the two sections working a normal schedule:

1. ARHCO shops - 16 months for reboiler - 12 months for top section. This includes time for mock up, insulation and sheathing. Both would be fabricated simultaneously.
2. J. A. Jones Shops - 7 months for reboiler and 6 months for the top section. An additional four months would be required for mock up, insulation and sheathing in ARHCO shops.

Information concerning fabrication in ARHCO shops is based on rough estimates provided by Paul Nussbaum; John Vinyard provided information concerning fabrication in J. A. Jones shops. Based on these estimates, it would appear that J. A. Jones should fabricate the reboiler and ARHCO shops should fabricate the top section.

Since the thorium run is scheduled to start in March or April of 1970, the two new sections should be ready for installation no later than February 15, 1970. To meet this schedule, working a normal schedule, funds would have to be made available in FY 1969.

If funds are not available for fabrication of additional sections this fiscal year, it might be possible to defer fabrication until FY 1970. Under this plan, fabrication would probably have to be done on a crash basis which would esculate costs; and it is possible that the equipment would not be ready for the start of the thorium run.

E. Concentrator Tube Bundles

1. Life Expectancy

Over the past three to four years the average life of tube bundles has been 20 months in F6 and 15 months in H4. Only one tube bundle failure has been experienced since plant start-up in J8 and K4 concentrators. The one failure occurred in J8.

2. Estimated Needs for Tube Bundles from Present to March 1970

Present to January 1, 1969	One failure F6
January 1, 1969 to July 1, 1969	One failure F6
July 1, 1969 to January 1, 1970	One failure H4
January 1, 1970 to March 1, 1970	One failure H4
	One bundle for the new F11 concentrator.
	Two bundles for installation in H4 just prior to the start of the thorium run
Total	7

3. Available Spare Tube Bundles

On hand - owned by Purex - 3 bundles, 1 1/4" tube
1 bundle, 1" tube

On hand - owned by Spare Parts - 1 tube bundle, 1 1/4" tube

4. Planned Procurement

Three additional tube bundles will be ordered within the next 60 days. On-site fabrication in either ARHCO shops or J. A. Jones shops will be requested. Tubing is available in Spare Parts for fabrication of these bundles. Additional tubing will be ordered to replace the tubing withdrawn from Spare Parts.

/ssa

cc: OF Beaulieu
RW McCullugh (2)
DW Morris
GC Oberg
File (2)

C1.6 PUREX Process Flow Diagrams

The PUREX process flow diagram has been revised multiple times over the operational life of the plant. The three most useful for a general understanding of the PUREX process are provided in order from most recent to oldest. The intent is to make the reader aware of their existence; it is recommended higher resolution copies be obtained if the PUREX Process Flow diagrams are required.

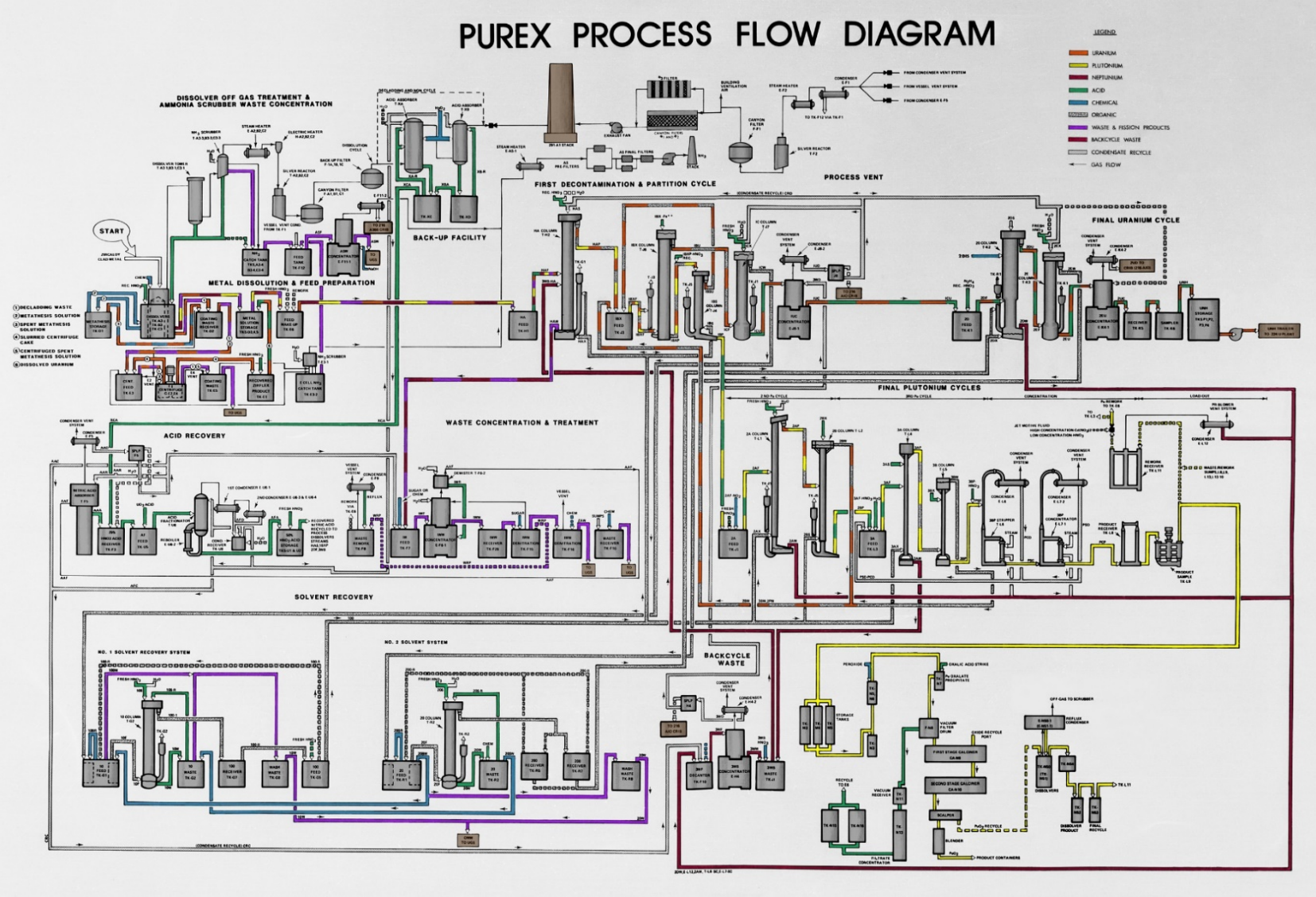

Figure C-1. 103127-1CN

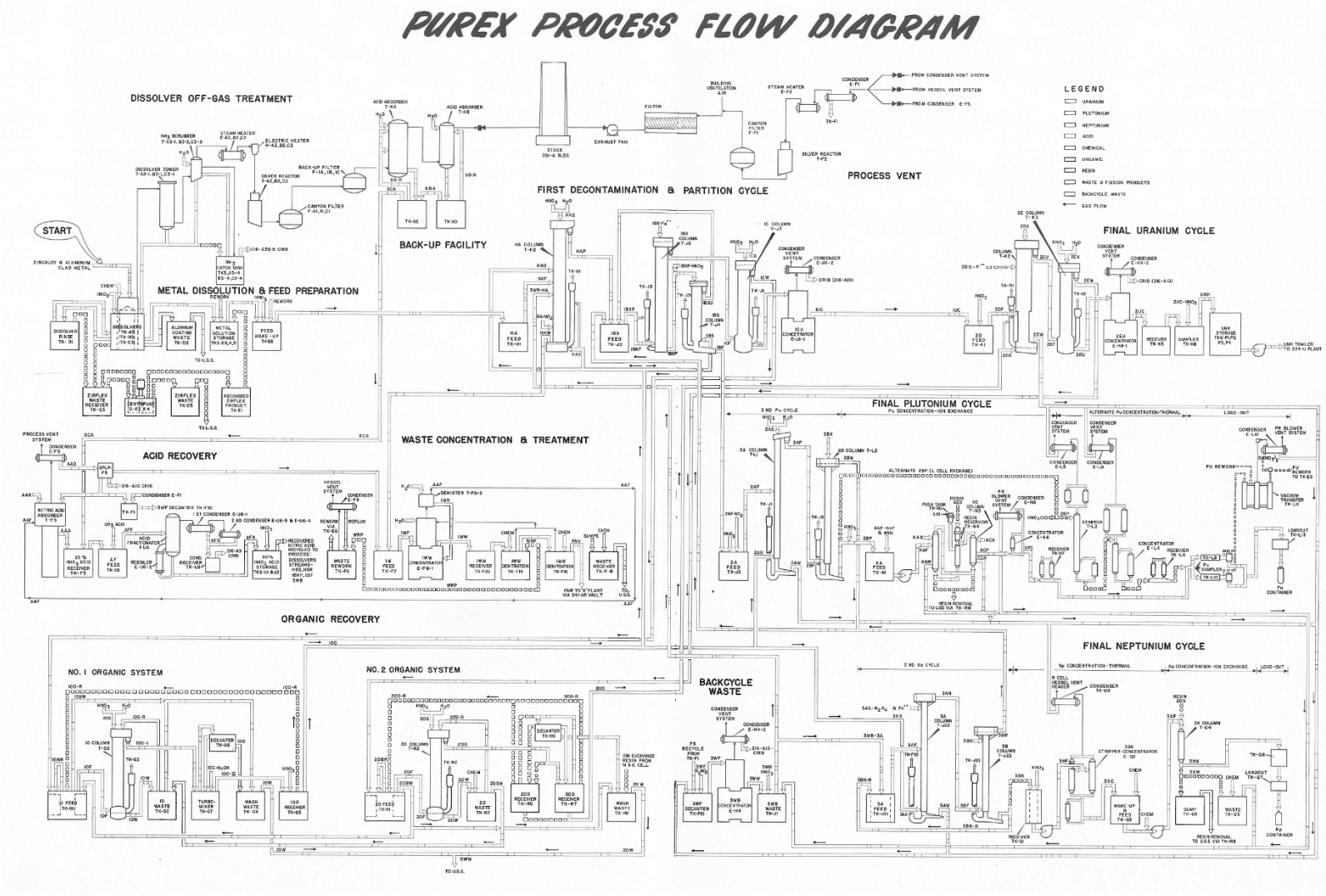

Figure C-2. WHC-SP-0474 Fig 1-2

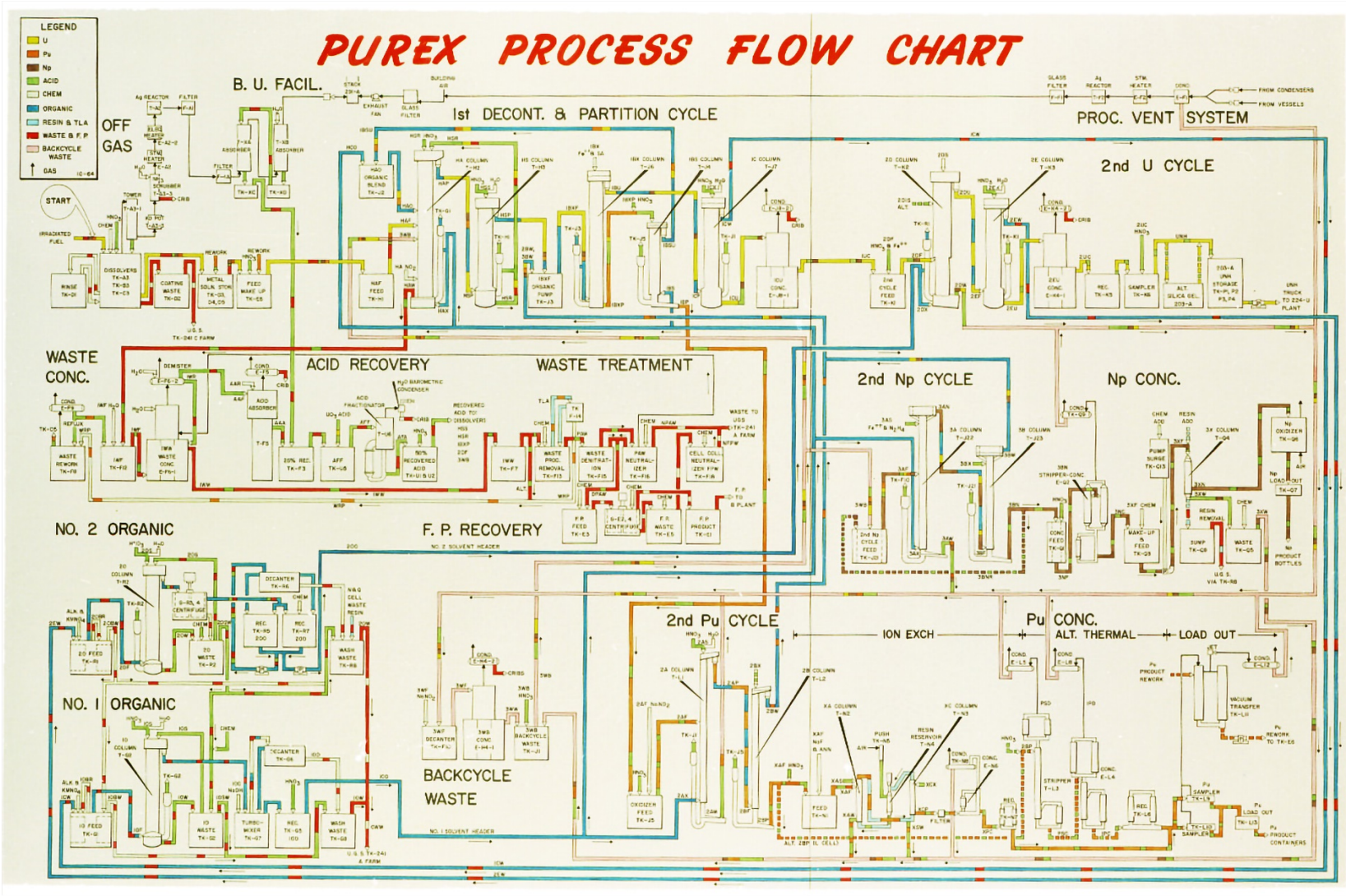

Figure C-3. 37919-1CN

C1.7 Tunnel Configuration Images

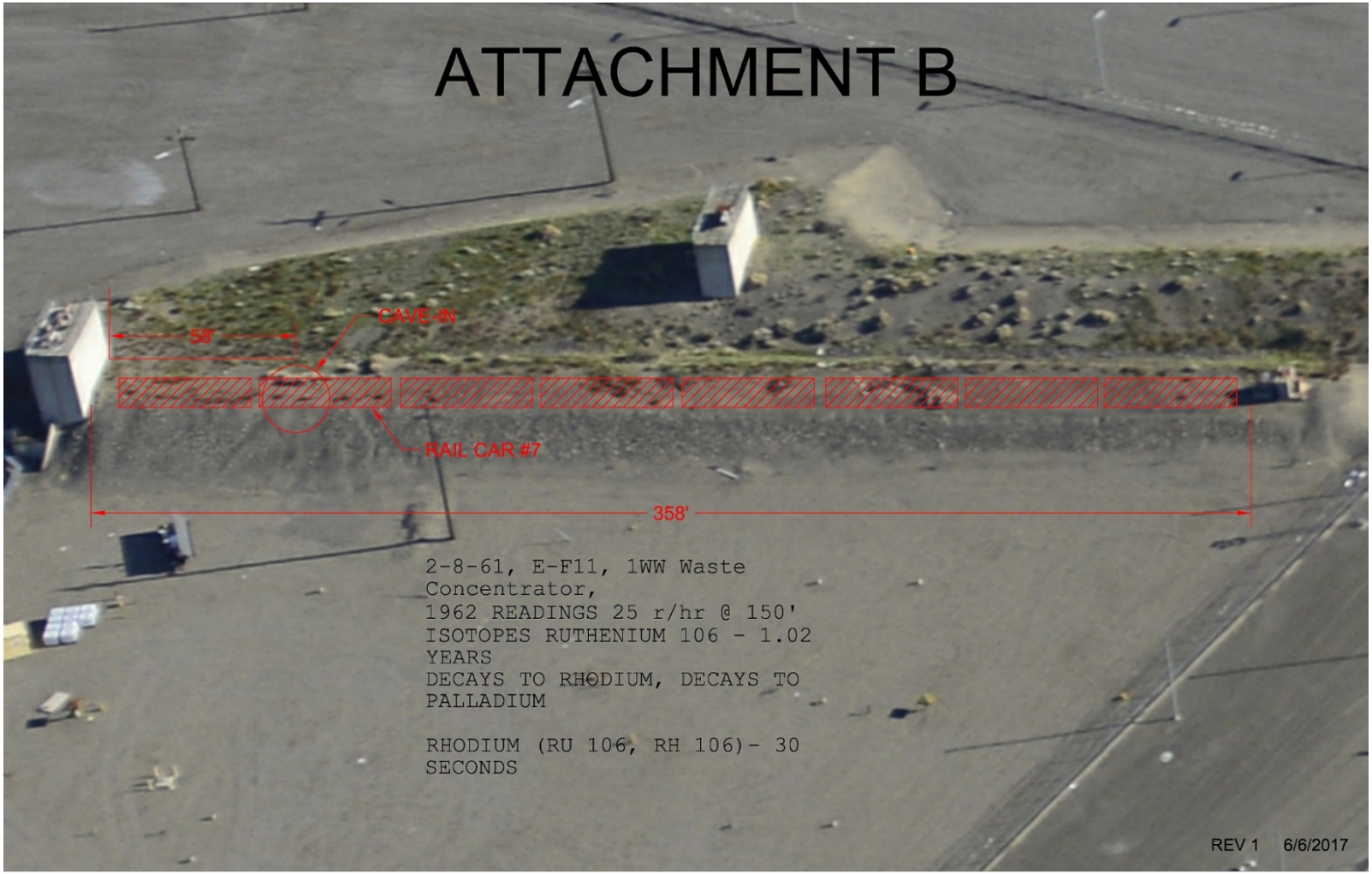

Figure C-4. Tunnel 1 Positions

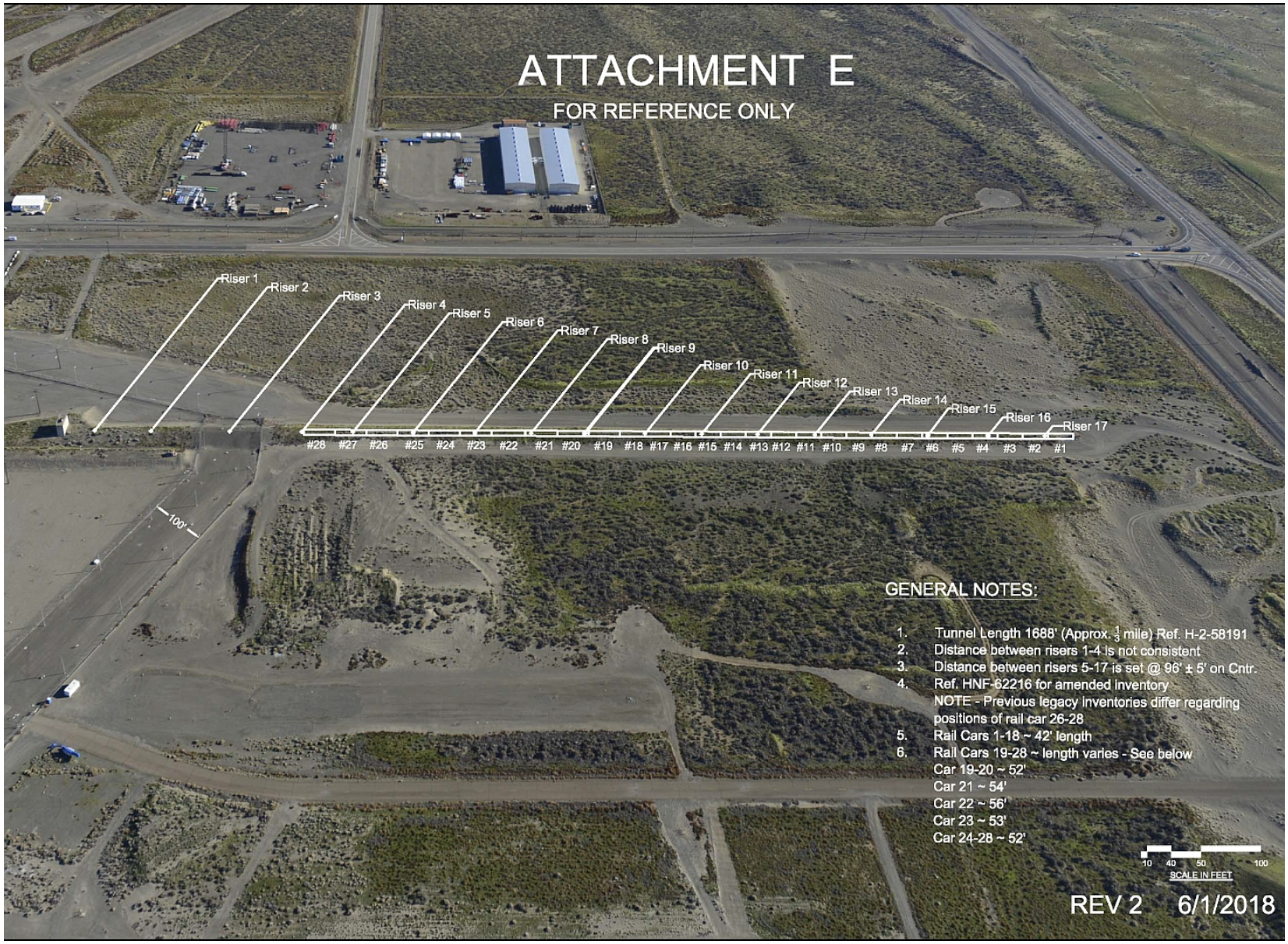

Figure C-5. Tunnel 2 Positions

C1.8 PUREX Equipment General Information

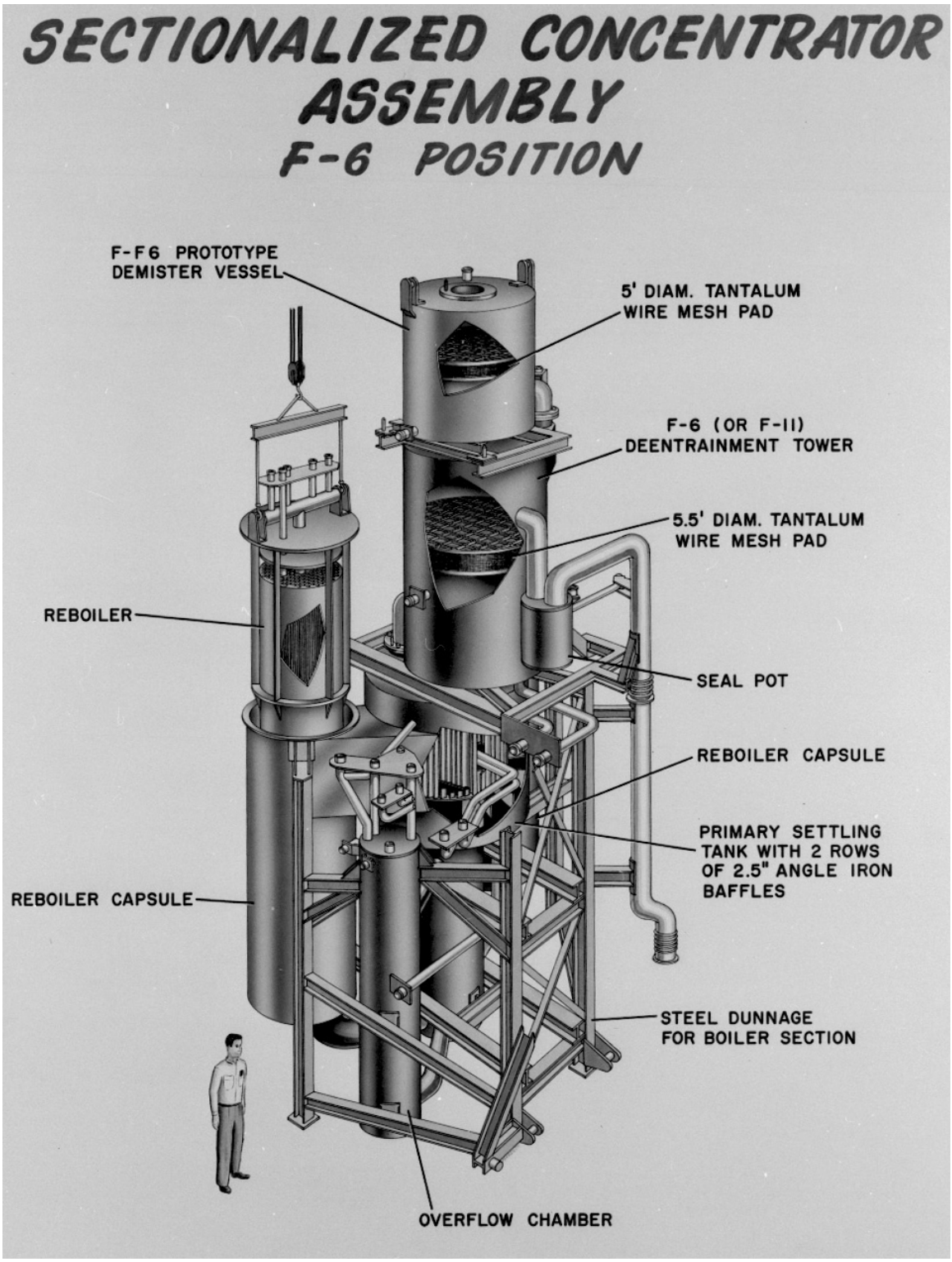

Figure C-6. F-6 Concentrator Diagram

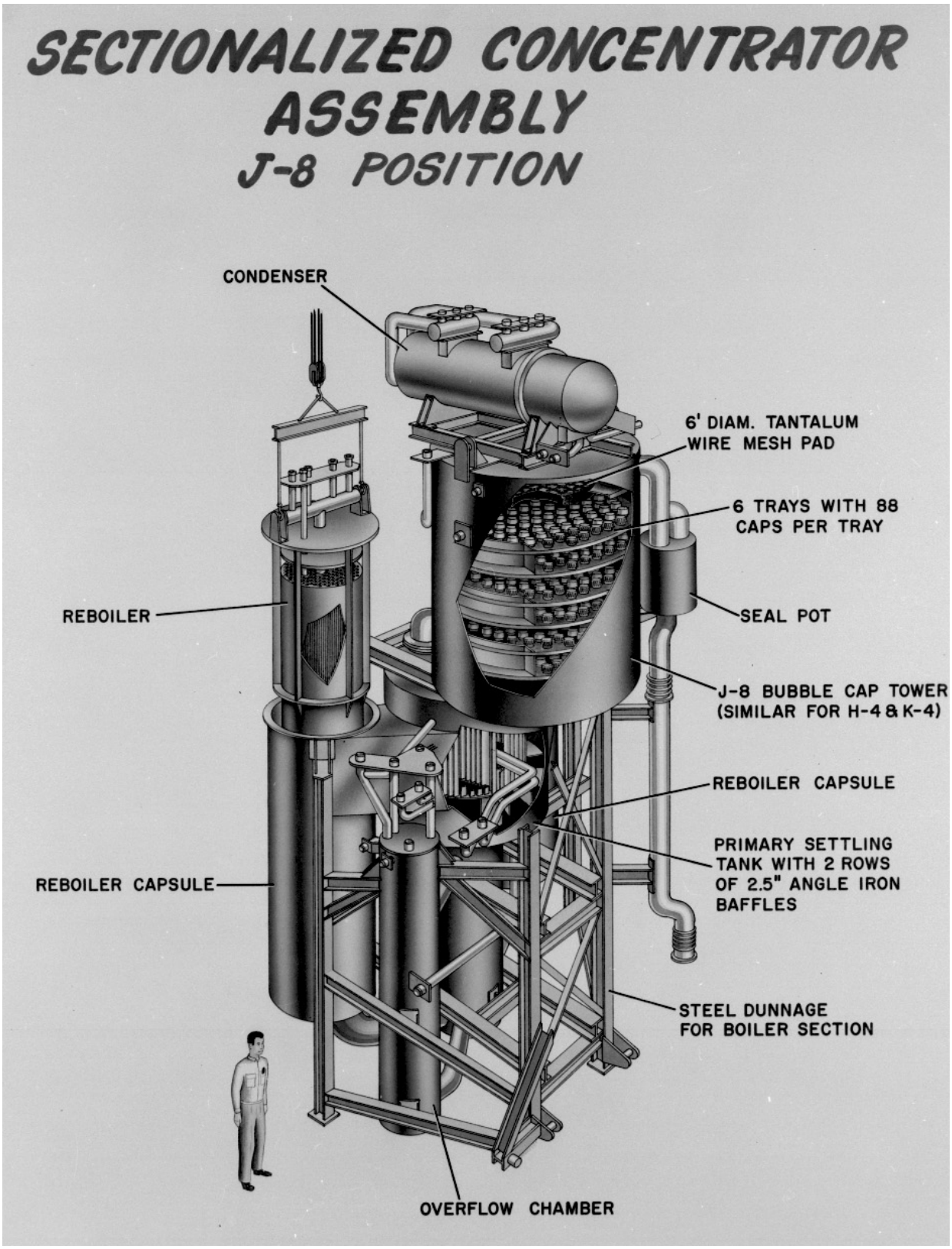

Figure C-7. J-8 Concentrator Diagram

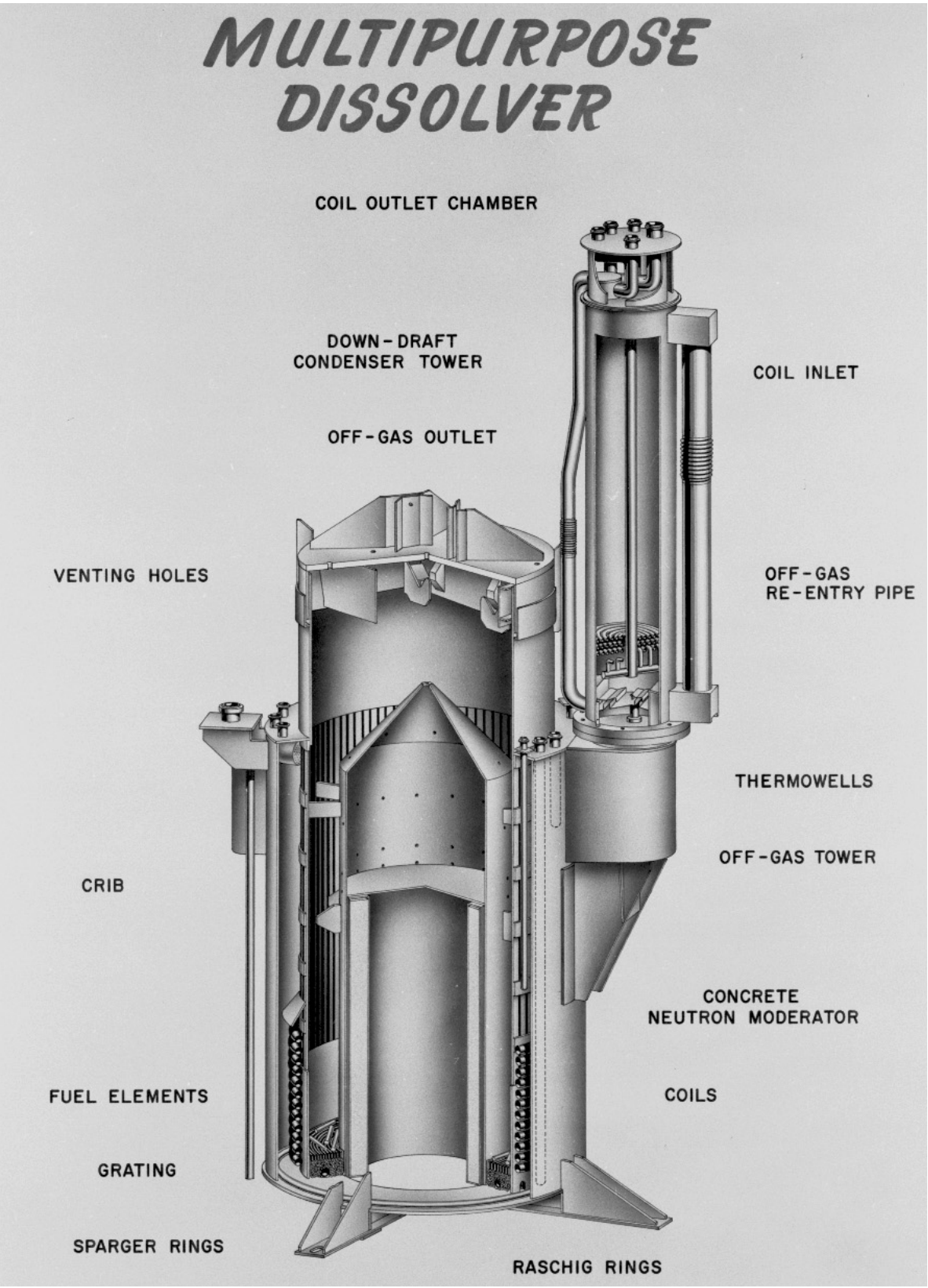

Figure C-8. Multipurpose Dissolver Diagram

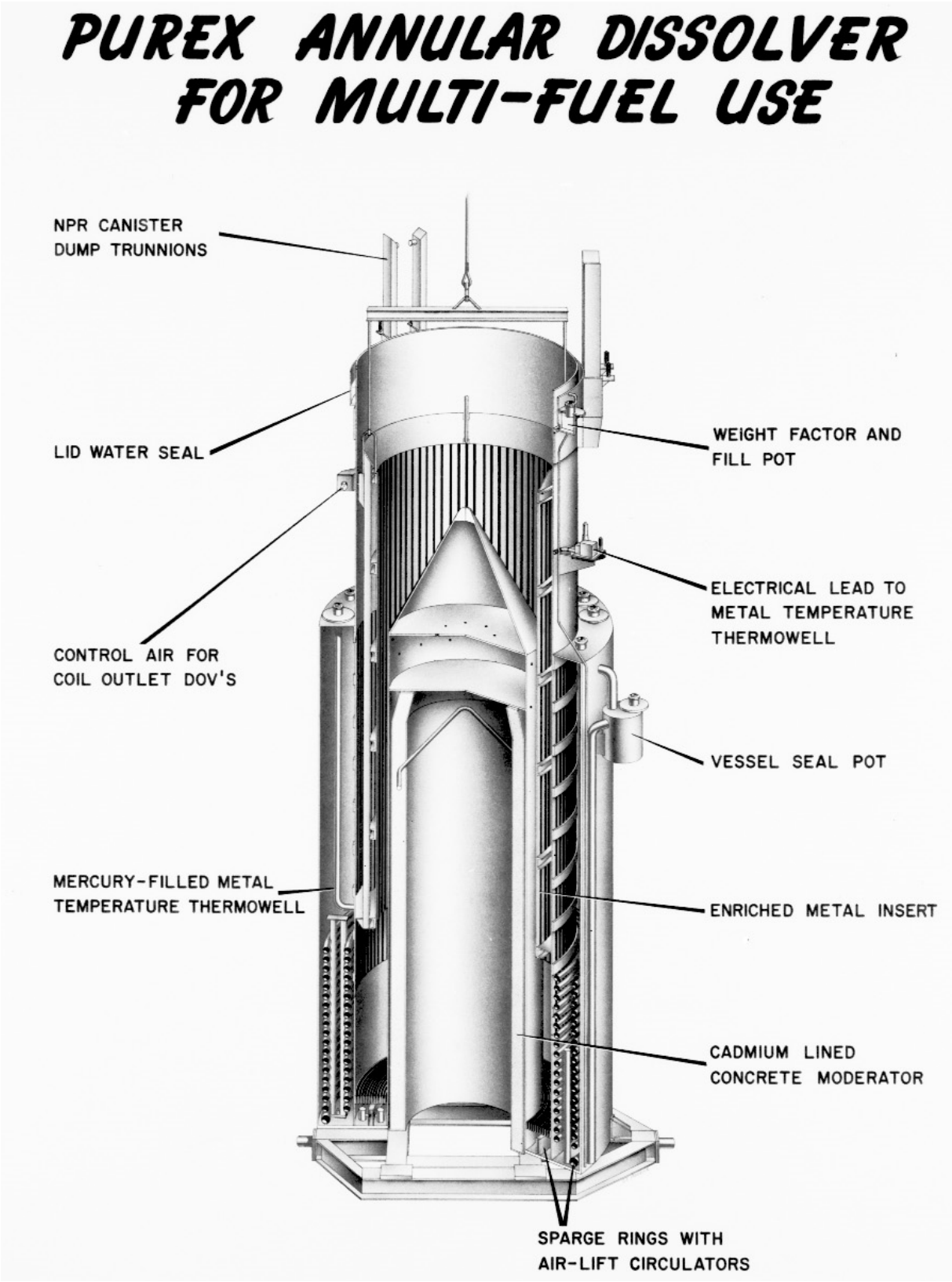

Figure C-9. Annular Dissolver Diagram

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Appendix D

Examples of Equipment in the Tunnels

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Figures

Figure D-1. Acid Absorber (89111018-2CN) D-1
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Figure D-4. Centrifuge (GE-3184-NEGA) D-4
Figure D-5. Extraction Column (89111018-10CN) D-5
Figure D-6. Extraction Column (GE-3055-NEGF) D-6
Figure D-7. Concentrator (GE-3195-NEG) D-7
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Figure D-11. Container - Grout Container (64662-4) D-11
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Figure D-13. Dissolver (40138-2) D-13
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Figure D-27. Crane Moving Tube Bundle (13418-1-PHOTO) D-27
Figure D-28. Tube Bundle (17426-8) D-28

Figure D-1. Acid Absorber (89111018-2CN)

Figure D-2. Acid Absorber (GE-3007-NEGO)

Figure D-3. Centrifuge (26223-1)

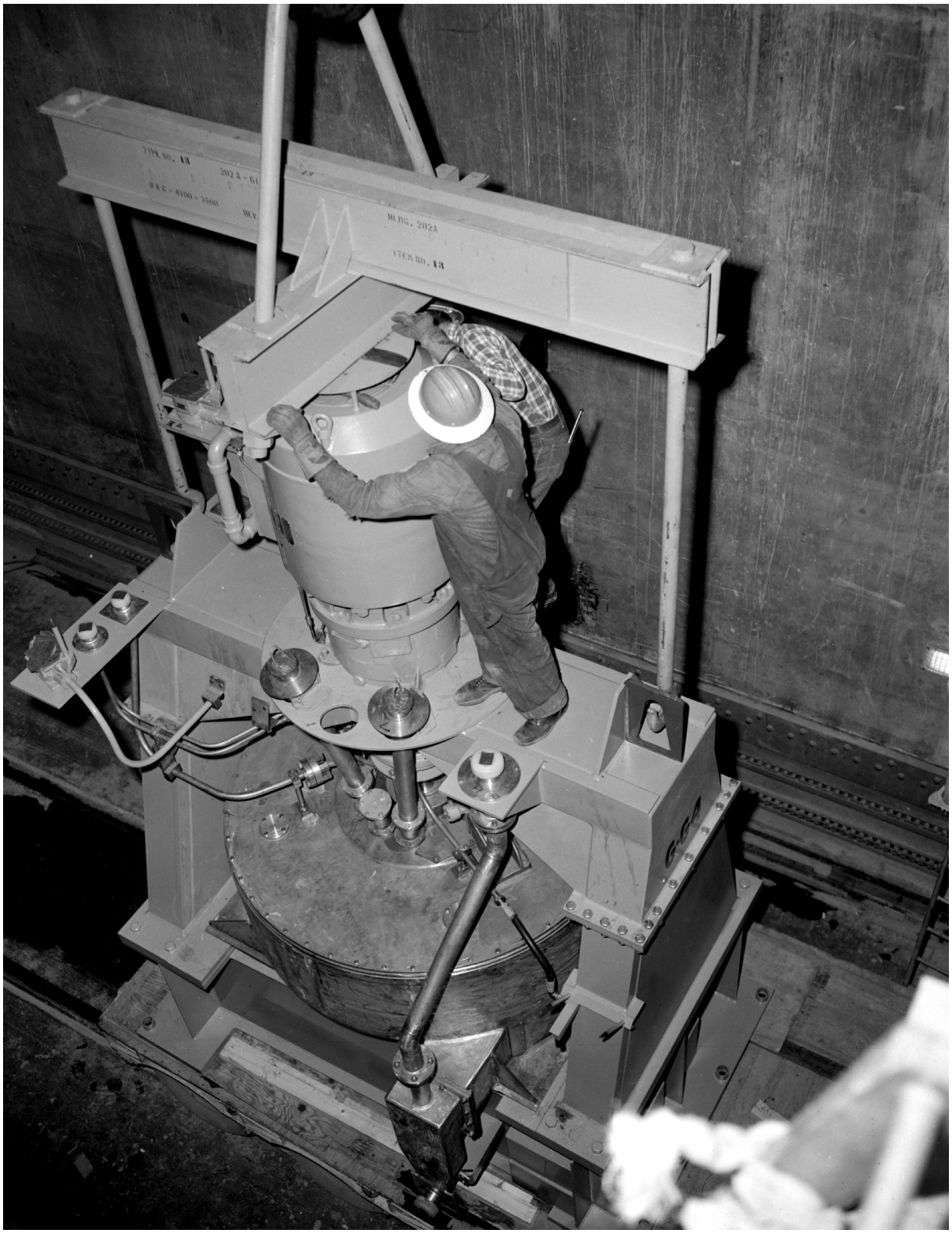

Figure D-4. Centrifuge (GE-3184-NEGA)

Figure D-5. Extraction Column (89111018-10CN)

Figure D-6. Extraction Column (GE-3055-NEGF)

Figure D-7. Concentrator (GE-3195-NEG)

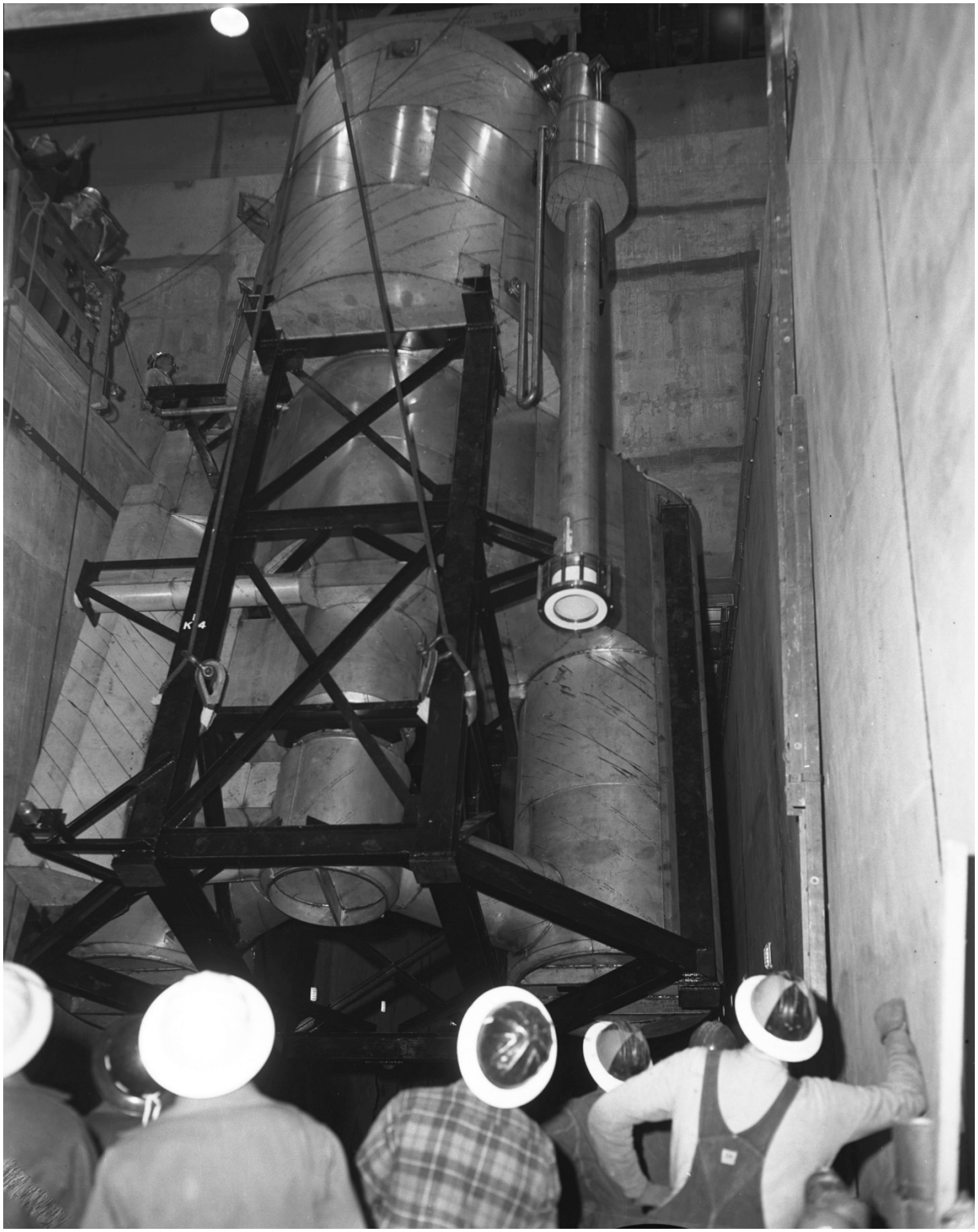

Figure D-8. Concentrator (GE-3202-NEG)

Figure D-9. Container – Concrete Burial Box (85H744-15CN)

Figure D-10. Container – Wooden Burial Box (13956-NEG-2)

Figure D-11. Container - Grout Container (64662-4)

Figure D-12. Dissolver (81E859-9CN)

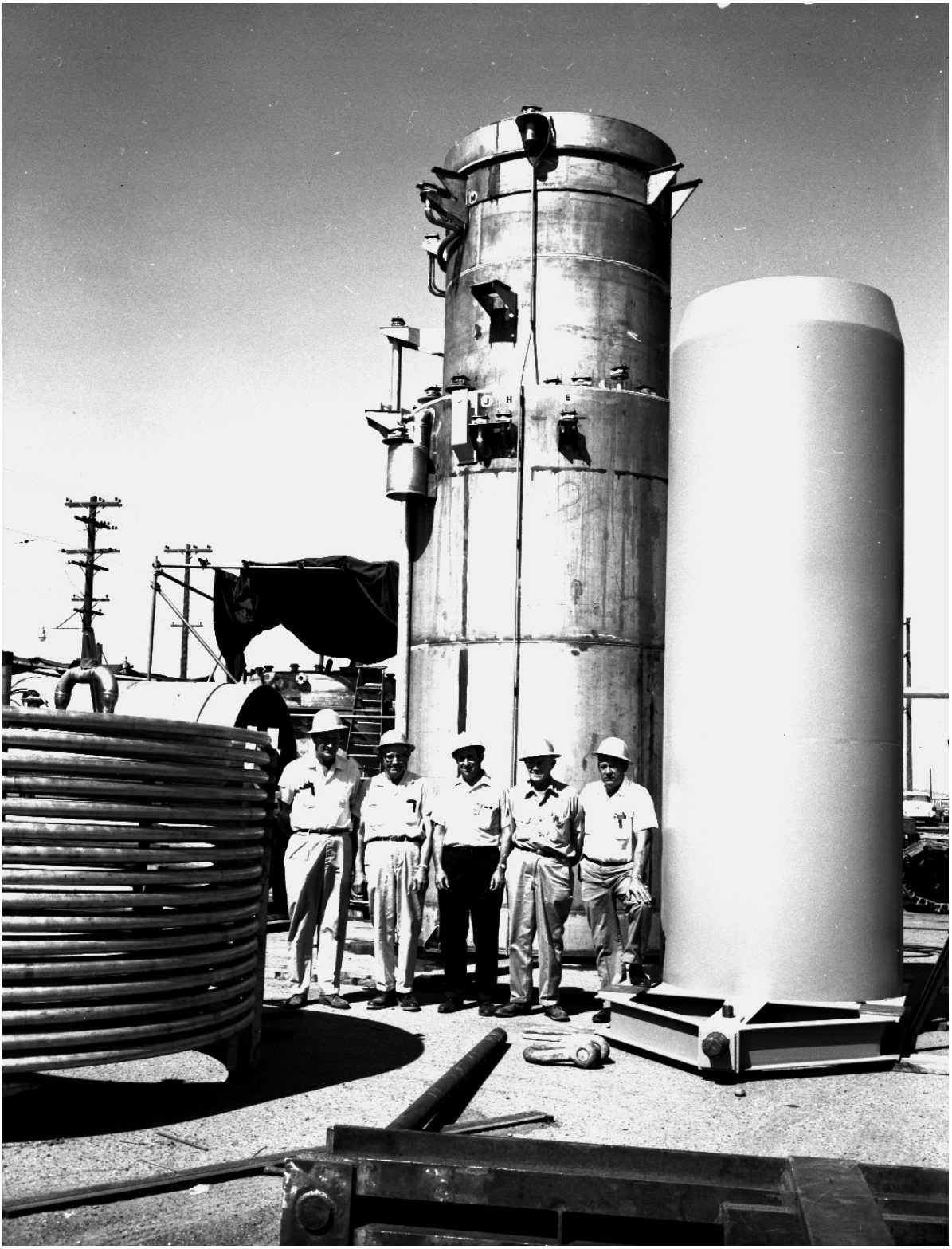

Figure D-13. Dissolver (40138-2)

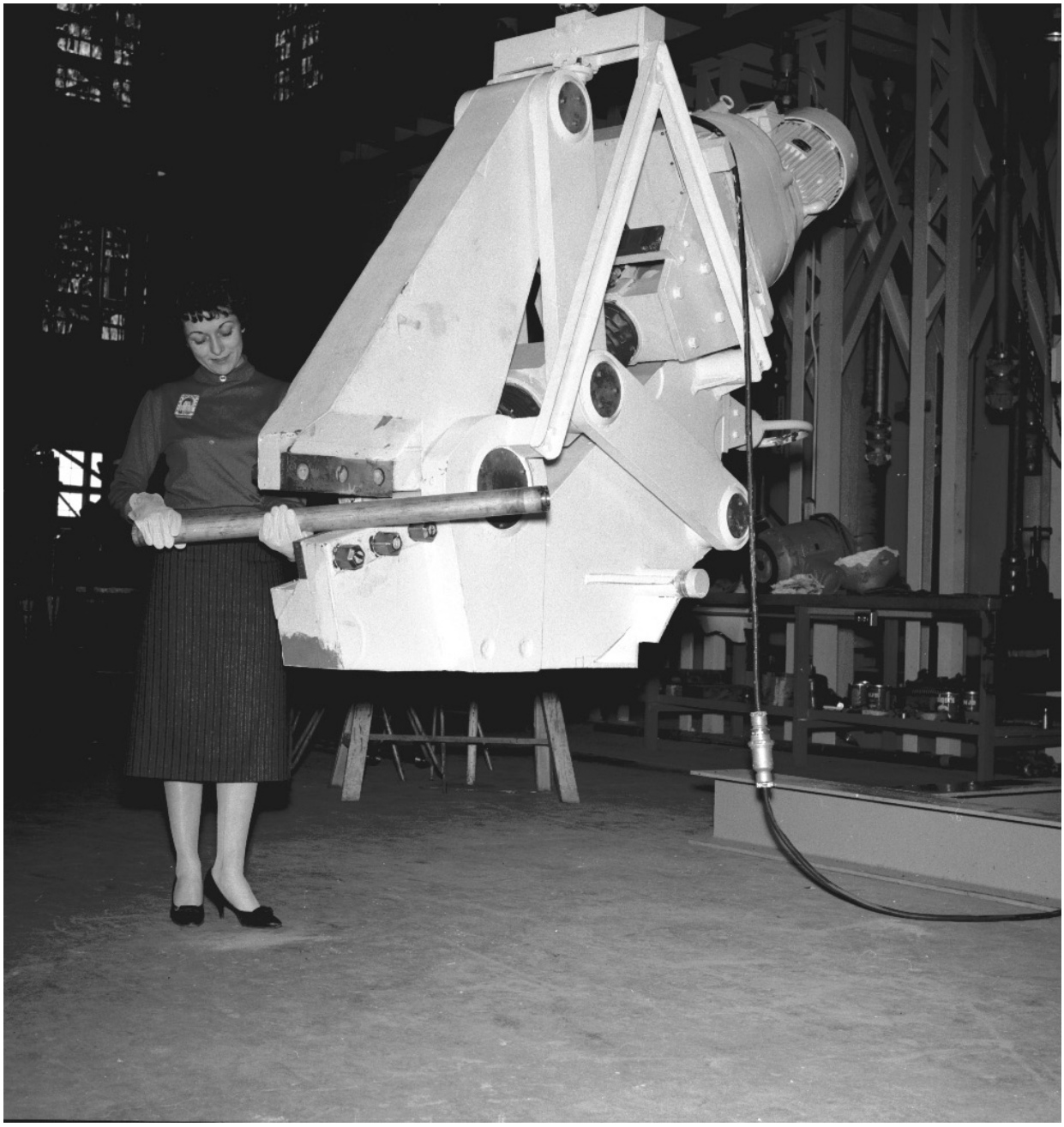

Figure D-14. Jumper Cutter (25289-4)

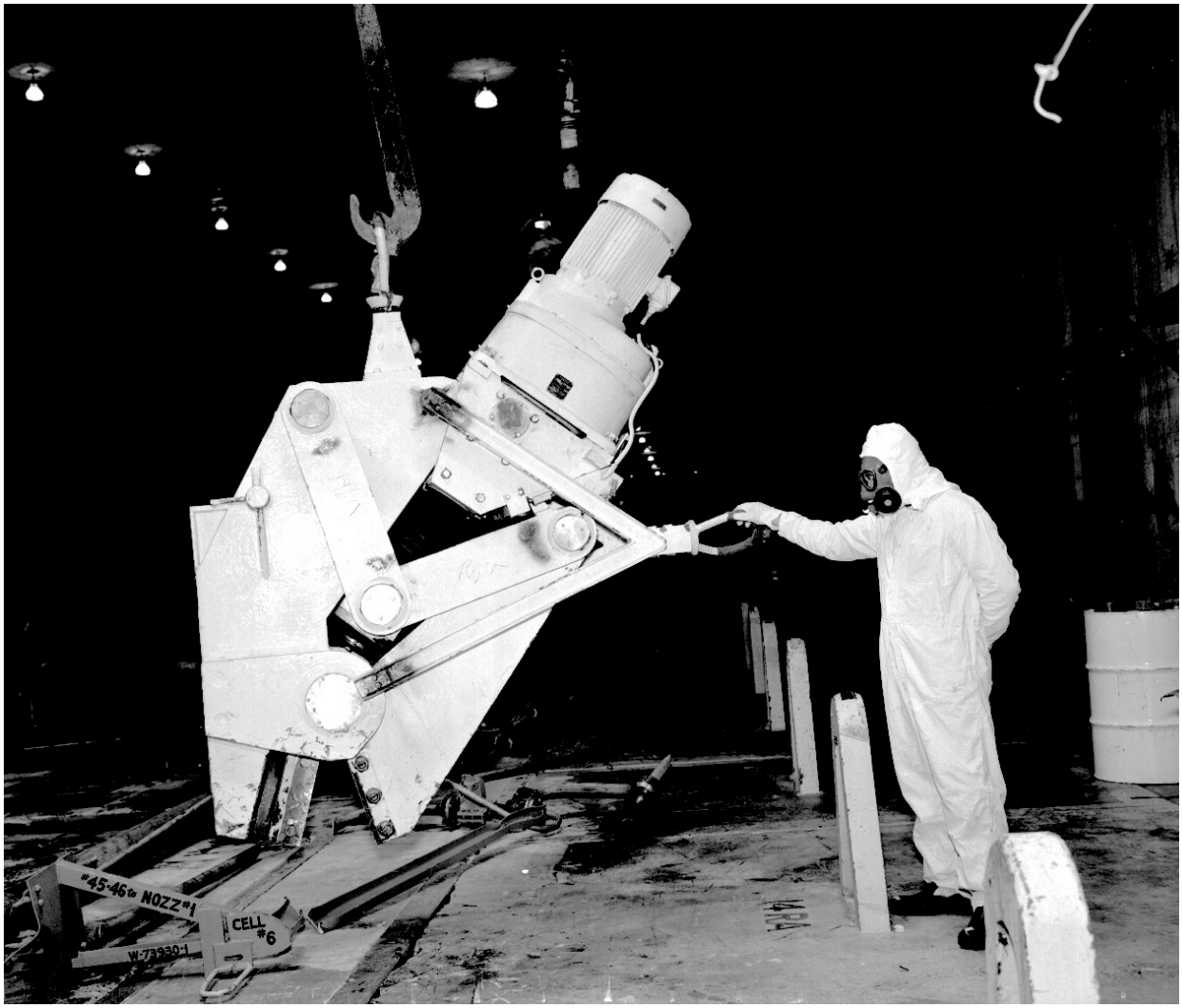

Figure D-15. Jumper Cutter (27532-5)

Figure D-16. Jumpers (3075-NEG)

Figure D-17. Jumpers (26138-6)

Figure D-18. L Cell Package (53775-3)

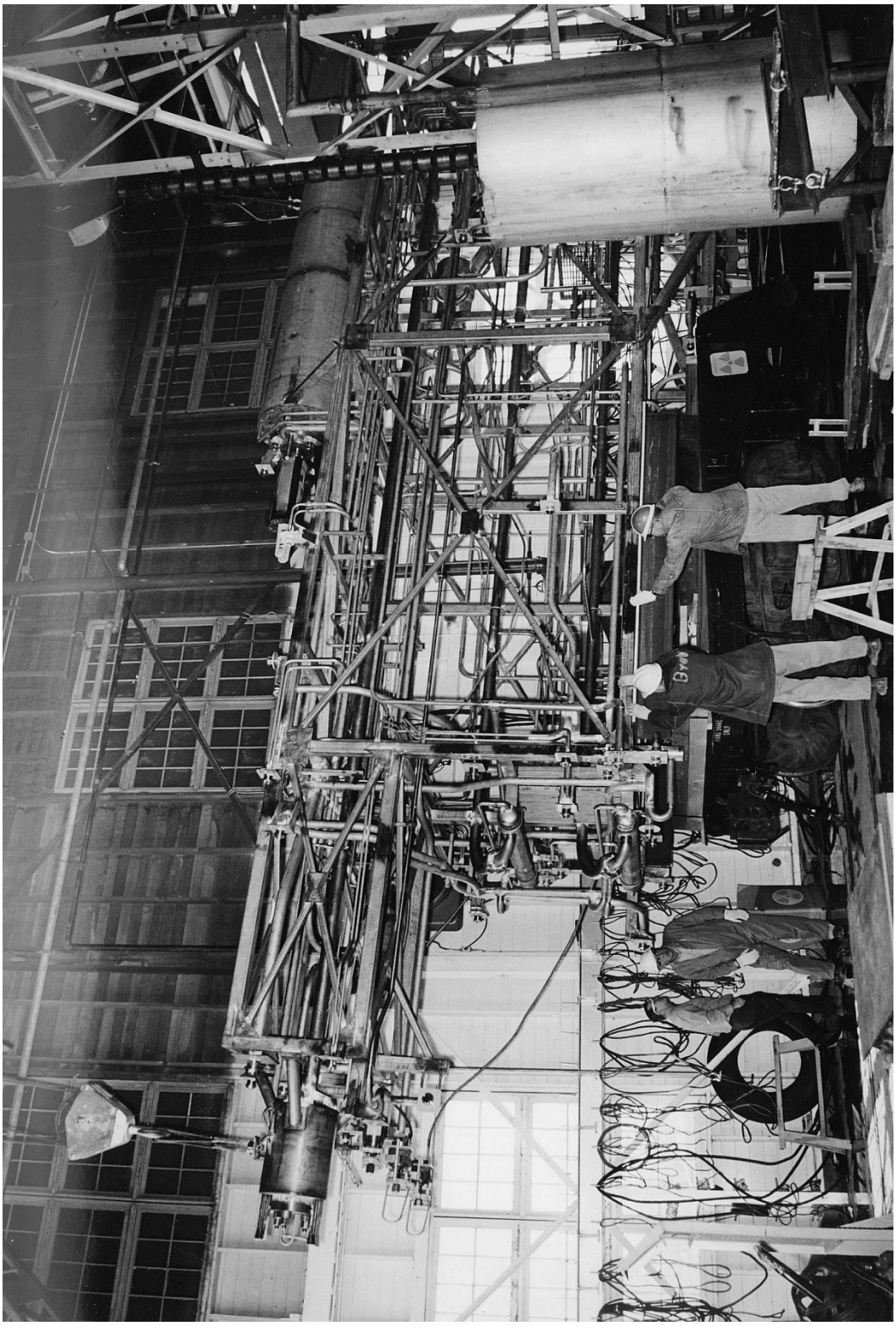

Figure D-19. L Cell Package (710775-7-PHOTO)

Figure D-20. Pulse Generator (25812-4)

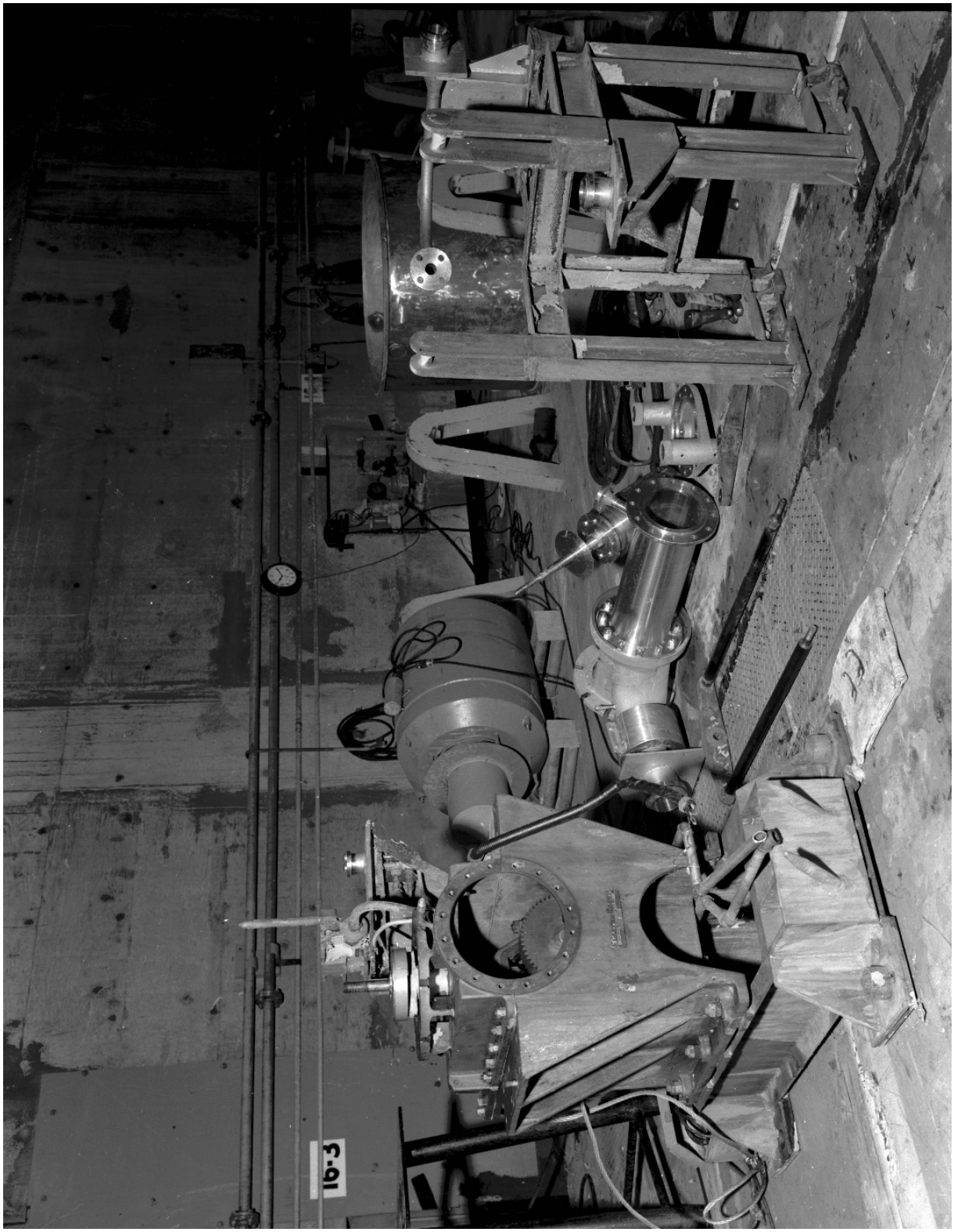

Figure D-21. Pulse Generator Components (26138-3)

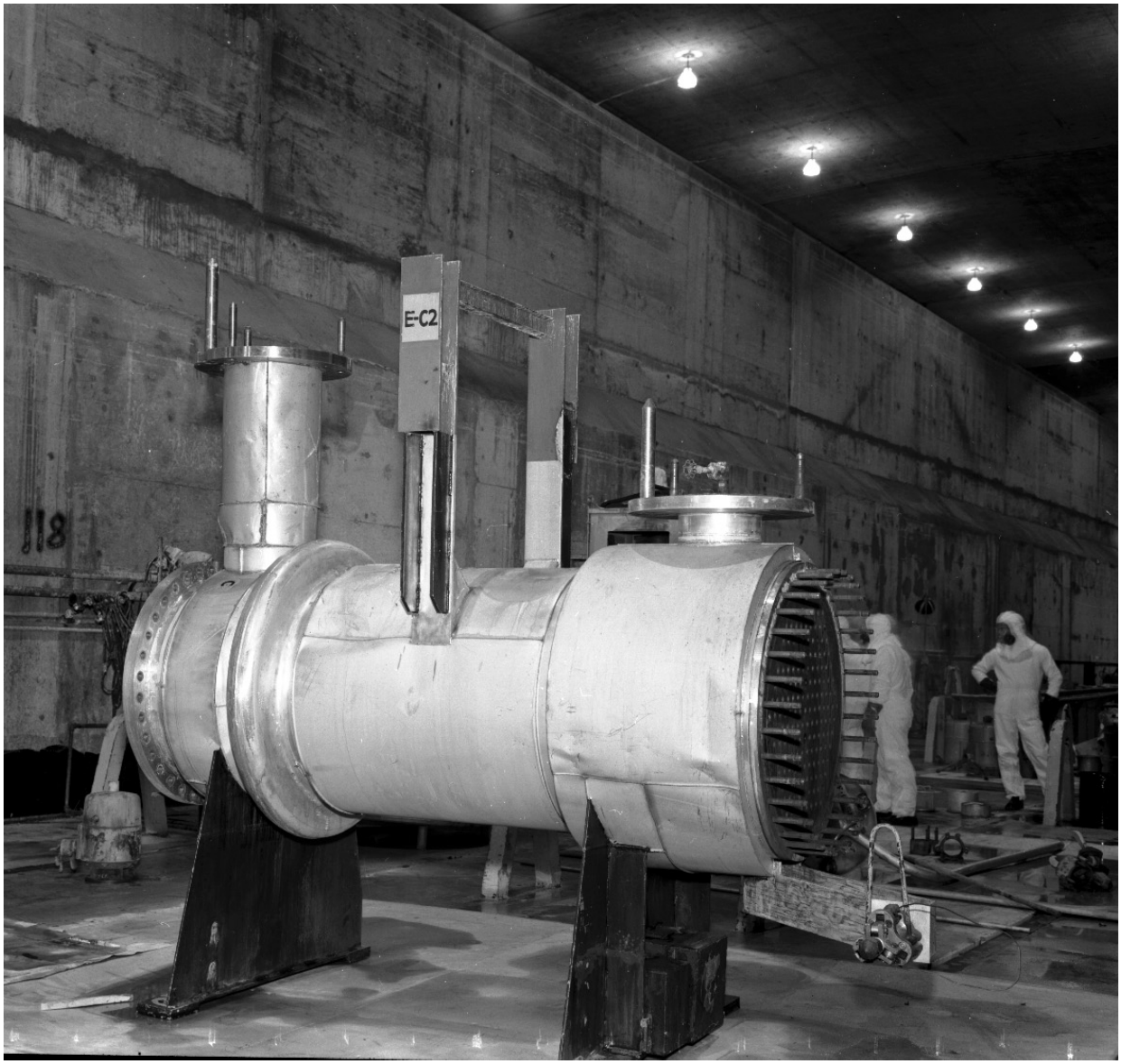

Figure D-22. Steam Heater (28158-1)

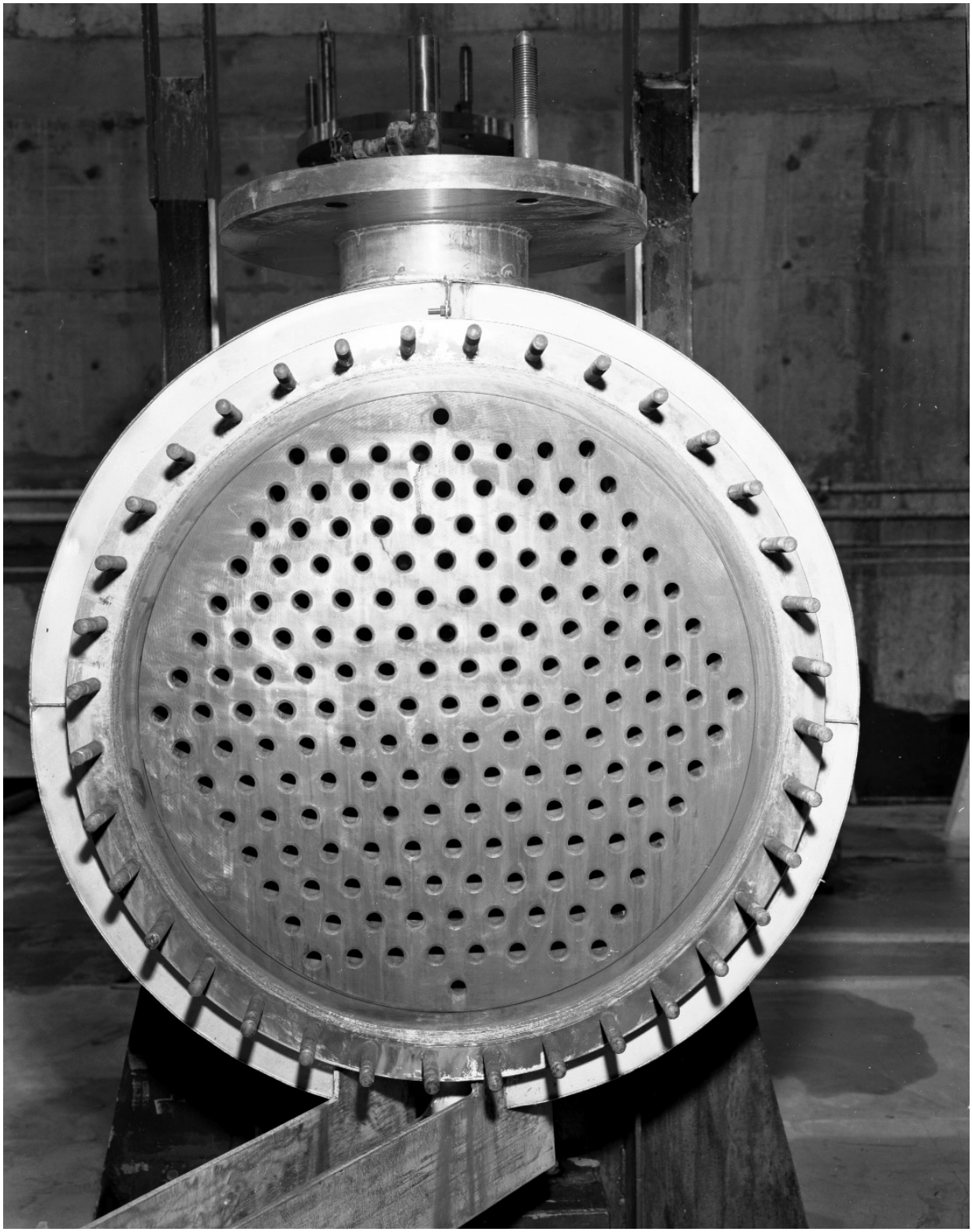

Figure D-23. Steam Heater (28158-3)

Figure D-24. Tank Car in Position 27 (49585-1)

Figure D-25. Tank Car in Position 28 (89501-1CN)

Figure D-26. Tube Bundle Wash Capsules (28158-5)

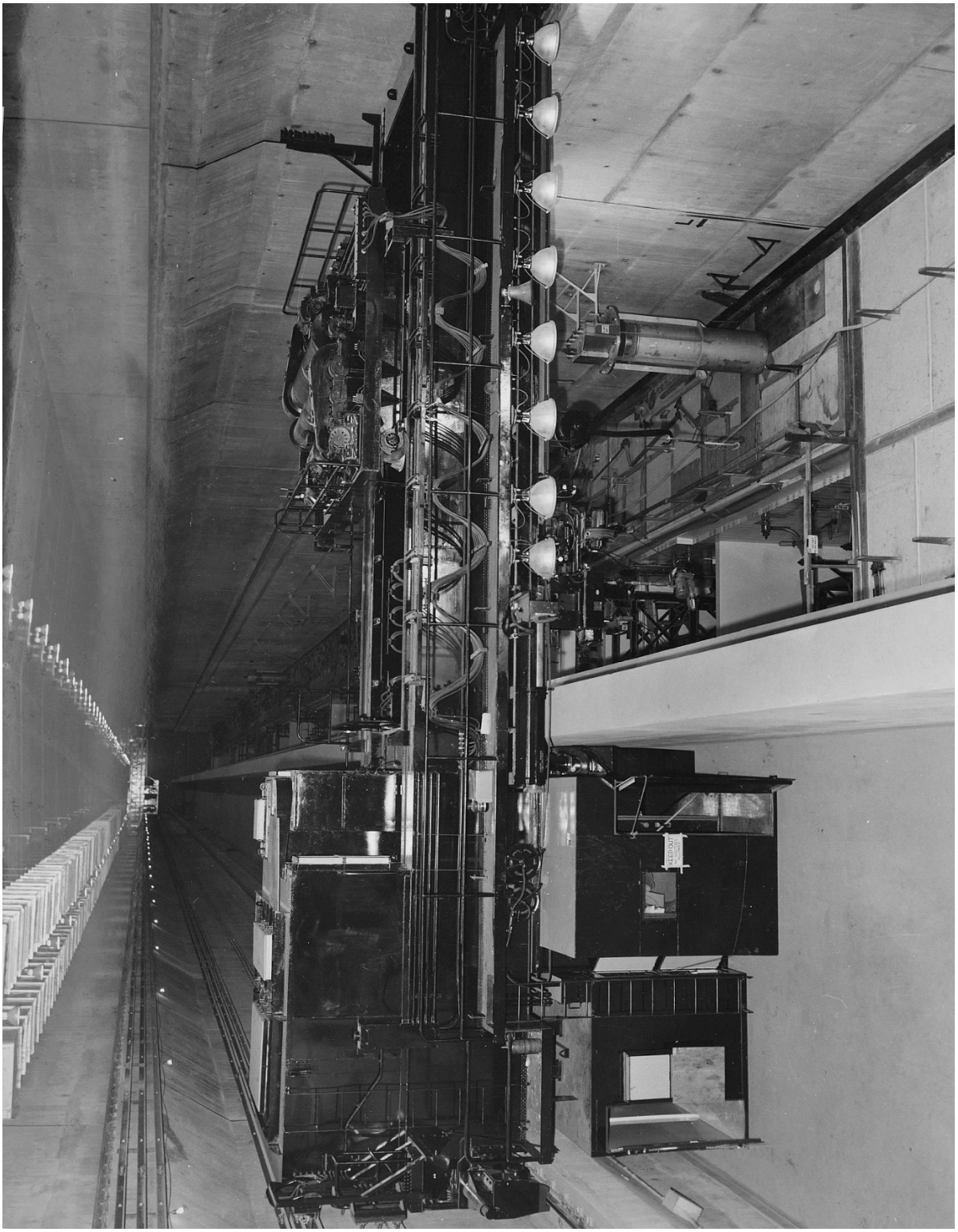

Figure D-27. Crane Moving Tube Bundle (13418-1-PHOTO)

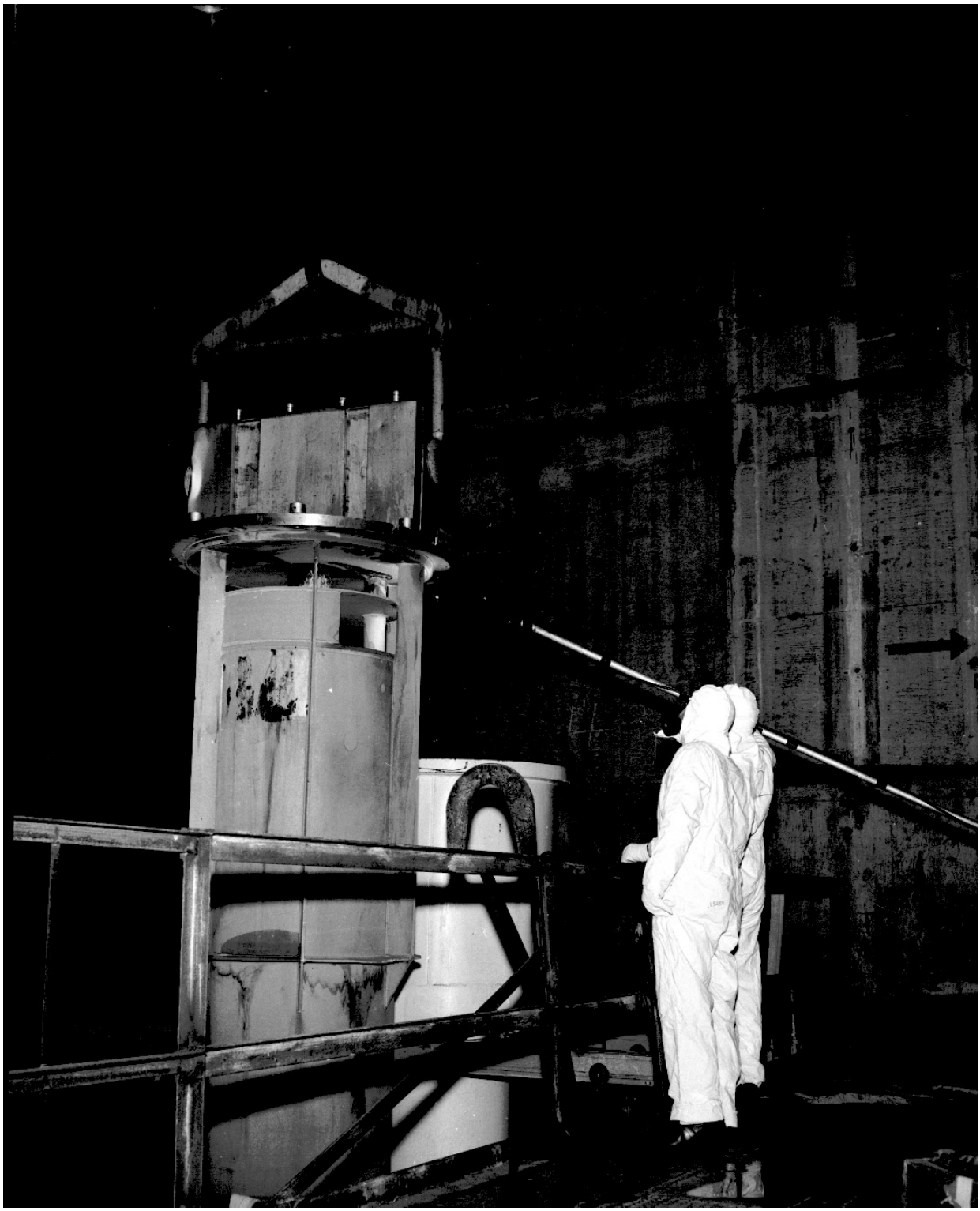

Figure D-28. Tube Bundle (17426-8)