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Characterization of Decontamination and Decommissioning Wastes Expected from the Major Processing Facilities in the 200 Areas

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Date Published
August 1994

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

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P.O. Box 1970
Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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Printed in the United States of America

DISCLM-1.CHP (1-91)

RELEASE AUTHORIZATION

Document Number: WHC-EP-0787

Document Title: Characterization of Decontamination and Decommissioning Wastes Expected from the Major Processing Facilities in the 200 Areas

Release Date: August 31, 1994

* * * * *

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ACKNOWLEDGEMENTS

The authors wish to recognize the efforts that went into the preparation of this document. Without the valuable expertise and responsive effort of the following key contributors, preparation of this document would not have been possible.

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EXECUTIVE SUMMARY

This study was intended to characterize and estimate the amounts of equipment and other materials that are candidates for removal and subsequent processing in a solid waste facility when the major processing and handling facilities in the 200 Areas of the Hanford Site are decontaminated and decommissioned. The facilities in this study were selected based on processing history and on the magnitude of the estimated decommissioning cost cited in the *Surplus Facilities Program Plan; Fiscal Year 1993* (Winship and Hughes 1992). The facilities chosen for this study include B Plant (221-B), T Plant (221-T), U Plant (221-U), the Uranium Trioxide (UO₃) Plant (224-U and 224-UA), the Reduction Oxidation (REDOX) or S Plant (202-S), the Plutonium Concentration Facility for B Plant (224-B), and the Concentration Facility for the Plutonium Finishing Plant (PFP) and REDOX (233-S). This information is required to support planning activities for current and future solid waste treatment, storage, and disposal operations and facilities.

Solid waste resulting from decontamination and decommissioning (D&D) of the facilities listed above was estimated based on a comparison of each facility with the Plutonium-Uranium Extraction (PUREX) Plant. A detailed study of the waste equipment and other materials expected to result from the D&D of the PUREX Plant was presented in the *Estimation of PUREX Equipment and Materials that are Candidates for Removal and Waste Processing During PUREX Plant Closure*.¹

¹ Valero, O. J., 1994, *Estimation of PUREX Equipment and Materials that are Candidates for Removal and Waste Processing During PUREX Plant Closure*, WHC-IP-0977, Westinghouse Hanford Company, Richland, Washington.

The waste volumes in this report are those expected to be generated by all D&D activities prior to actual building structural component disposal. The volumes are those expected to result from removal of all the process equipment, piping, and fixtures that are relatively easy to remove, such as by unbolting or cutting, leaving bare cell and canyon walls. The reason for this distinction is the greater certainty that such equipment will need to be actively managed by the Solid Waste Division with storage, treatment, or disposal facilities. Building structural components and demolition rubble may be sent directly to a disposal facility such as the Environmental Restoration Disposal Facility or perhaps be entombed in place.

The estimation of waste types, volumes, and weights for each facility was done in two ways. As a preliminary step, a rough order of magnitude estimation, based on the footprint (sheer square footage) of the facilities, was performed. A more refined estimation was then made based on volumes of similar structural features at each facility compared to the PUREX Plant. Further refinements to the estimates were made based on more specific knowledge of each facility's physical plant, process, and history.

The results of the solid waste characterization indicate a total of approximately 9,600 m³ of solid waste is expected to result from the D&D of the facilities included in this study. The volumes and percentages of waste by category are shown in Table ES-1.

Table ES-1. Total Solid Waste Volumes Expected to Result from D&D Activities for 200 Area Processing Facilities.

	Equipment and pipe volume expected (m ³)	Percentage of total solid waste expected
LLW-1	3,949	41%
LLW-3	2,738	28%
LLMW-1	1,889	20%
TRU	1,044	11%

Figure 1 graphically displays the volume of solid waste as well as the volume percentage of the different waste categories for the total estimated quantity of solid waste expected from the major processing facilities located in the 200 Areas.

Figure 1. Relative Volumes of Solid Waste Expected to be Generated During the Decontamination and Decommissioning of 200 Area Reprocessing Facilities.

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LIST OF TERMS

CAW	current acid waste
D&D	decontamination and decommissioning
DSW	dangerous solid waste
HEDTA	hydroxyethylenediaminetetraacetic acid
HEPA	high-efficiency particulate air
LLW	low-level waste
LLMW	low-level mixed waste
MW	mixed waste
PCF	Plutonium Concentration Facility
PFP	Plutonium Finishing Plant
PUREX	plutonium-uranium extraction
PWR	pressurized water reactor
REDOX	reduction oxidation
ROM	rough order of magnitude
TBP	tributylphosphate
TRU	transuranic
UNH	uranyl nitrate hexahydrate
UO ₃	uranium trioxide

LIST OF CONVERSIONS

FACTORS FOR UNIT CONVERSIONS

Quantity	Equivalent values
Mass	$1 \text{ kg} = 1,000 \text{ g} = 0.001 \text{ metric ton} = 2.20462 \text{ lb}_m = 35.27392 \text{ oz.}$ $1 \text{ lb}_m = 16 \text{ oz} = 5 \times 10^{-4} \text{ ton} = 453.593 \text{ g} = 0.453593 \text{ kg.}$
Length	$1 \text{ m} = 100 \text{ cm} = 1,000 \text{ mm} = 10^6 \text{ microns } (\mu\text{m}) = 10^{10} \text{ angstroms } (\text{\AA})$ $= 39.37 \text{ in.} = 3.2808 \text{ ft} = 1.0936 \text{ yd} = 0.0006214 \text{ mile.}$ $1 \text{ ft} = 12 \text{ in.} = 0.3333 \text{ yd} = 0.3048 \text{ m} = 30.48 \text{ cm.}$
Volume	$1 \text{ m}^3 = 1,000 \text{ L} = 10^6 \text{ cm}^3 = 10^6 \text{ ml} = 35.3145 \text{ ft}^3$ $= 220.83 \text{ imperial gallons} = 264.17 \text{ gal} = 1056.68 \text{ qt.}$ $1 \text{ ft}^3 = 1728 \text{ in.}^3 = 7.4805 \text{ gal} = 0.028317 \text{ m}^3 = 28,317 \text{ cm}^3.$
Force	$1 \text{ newton (N)} = 1 \text{ kg}\cdot\text{m/s}^2 = 10^5 \text{ dynes} = 10^5 \text{ g}\cdot\text{cm/s}^2 = 0.22481 \text{ lb}_f.$ $1 \text{ lb}_f = 32.174 \text{ lb}_m \cdot \text{ft/s}^2 = 4.4482 \text{ N} = 4.4482 \times 10^5 \text{ dynes.}$
Pressure	$1 \text{ atm} = 1.01325 \times 10^5 \text{ N/m}^2 (\text{Pa}) = 101.325 \text{ kPa} = 1.01325 \text{ bars}$ $= 1.01325 \times 10^6 \text{ dynes/cm}^2 = 760 \text{ mm Hg at } 0^\circ\text{C (torr)}$ $= 10.333 \text{ m H}_2\text{O at } 4^\circ\text{C} = 14.696 \text{ lb}_f/\text{in.}^2 (\text{psi})$ $= 33.9 \text{ ft H}_2\text{O at } 4^\circ\text{C} = 29.921 \text{ in. Hg at } 0^\circ\text{C.}$
Energy	$1 \text{ J} = 1 \text{ N}\cdot\text{m} = 10^7 \text{ ergs} = 10^7 \text{ dyne}\cdot\text{cm} = 2.778 \times 10^{-7} \text{ kW}\cdot\text{h}$ $= 0.23901 \text{ cal} = 0.7376 \text{ ft}\cdot\text{lb}_f = 9.486 \times 10^{-4} \text{ Btu.}$
Power	$1 \text{ W} = 1 \text{ J/s} = 0.23901 \text{ cal/s} = 0.7376 \text{ ft}\cdot\text{lb}_f/\text{s}$ $= 9.486 \times 10^{-4} \text{ Btu/s} = 1.341 \times 10^{-3} \text{ hp.}$

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1.0 INTRODUCTION

This study is intended to estimate the types and amounts of equipment and other materials that are candidates for removal and subsequent processing in a solid waste facility when the major processing and handling facilities in the 200 East and 200 West Areas of the Hanford Site are decontaminated and decommissioned.

The facilities in this study were selected based on processing history and on the magnitude of the estimated decommissioning cost cited in the *Surplus Facilities Program Plan; Fiscal Year 1993* (Winship and Hughes 1992). The selected facilities, along with their associated acronyms and building numbers, are given in Table 1-1.

Table 1-1. Major Processing and Handling Facilities
in the 200 Areas of the Hanford Site.

Facility name	Acronym	Building number
B Plant	B Plant	221-B
T Plant	T Plant	221-T
U Plant	U Plant	221-U
Reduction Oxidation Plant	REDOX or S Plant	202-S
Uranium Trioxide Plant	UO ₃ Plant	224-U and 224-UA
Plutonium Concentration Facility for B Plant	B Plant PCF	224-B
Concentration Facility for the Plutonium Finishing Plant and REDOX	---	233-S

1.1 PURPOSE

The objective of this study is to characterize and estimate the amount of solid waste that will be generated during the decontamination and decommissioning (D&D) of the major radioactive material processing and handling facilities in the 200 Areas of the Hanford Site. Estimates of the waste types and volumes that will result from the D&D of each facility are based on the facility's similarity to the Plutonium-Uranium Extraction (PUREX) Plant. A detailed study of the PUREX Plant D&D waste types and volumes was presented in *Estimation of PUREX Equipment and Materials that are Candidates for Removal and Waste Processing During PUREX Plant Closure* (Valero 1994).

The solid waste types used in this study are as follows:

- 1) Transuranic Waste. Without regard to source or form, transuranic (TRU) waste is waste that is contaminated with alpha-emitting transuranium radionuclides with half-lives greater than 20 years and concentrations greater than 100 nCi/g of waste matrix. Transuranium radionuclides are radionuclides having an atomic

number greater than 92. In addition to TRU radionuclides, radium sources and ^{233}U in concentrations greater than 100 nCi/g of the waste matrix are managed as TRU waste.

- 2) Transuranic Mixed Waste. Transuranic mixed waste (TRU MW) is waste that meets the definition above for TRU waste and contains dangerous waste in addition to the radioactive components. Dangerous wastes are defined in the *Washington Administrative Code* (WAC 173-303-040).
- 3) Low-Level Waste. Low-level waste (LLW), as defined in DOE Orders 5820.2A and 5400.3, is radioactive waste not defined as high-level waste, TRU waste, spent nuclear fuel, or byproduct material. All LLW is also classified according to Category 1, 3, and greater than Category 3 concentration limits. These limits are based on a similar waste classification system developed by the U.S. Nuclear Regulatory Commission in 10 CFR 61 and are explained in more detail in the *Hanford Site Solid Waste Acceptance Criteria* (Willis 1993).
- 4) Low-Level Mixed Waste. Low-level mixed waste (LLMW) is low-level waste that contains dangerous waste, as defined in the *Washington Administrative Code* (WAC 173-303-040).
- 5) Nonradioactive Dangerous Solid Waste. Nonradioactive dangerous solid waste (DSW) is any non-radioactive solid waste that has been contaminated by hazardous chemicals, as defined in WAC 173-303, and is regulated as dangerous waste.

The information generated by this study will support planning activities for current and future solid waste treatment, storage, and disposal facilities and operations.

1.2 BACKGROUND

In 1943, the Hanford Site, a 600-square-mile area in semi-arid southeastern Washington State, was selected by the U.S. Army Corps of Engineers for producing plutonium and other nuclear materials to support weapons production for World War II. This site was divided into three main operational areas: the 100 Areas for reactors; the 200 Areas for fuel reprocessing, plutonium and uranium recovery, and waste management; and the 300 Area for fuel fabrication. This study deals with the major facilities in the 200 Areas, which were built in the 1940s and 1950s (Ballinger and Hall 1991).

Three plants, B Plant, T Plant, and U Plant, are similar in design and were built to chemically extract plutonium from the fuel discharged by the first three reactors (B, D, and F Reactors). Due to the efficiency achieved at B and T Plants, the U Plant was not needed, and it was later converted for uranium recovery. Both the B and T plants used the bismuth-phosphate process to separate plutonium from uranium and fission products. The resulting plutonium product was concentrated in the 224-B Building.

The reduction oxidation (REDOX) and PUREX processes, developed later, improved the efficiency of the fuel reprocessing; the S Plant (REDOX) and A Plant (PUREX) were built to use these processes. The 233-S Facility was built to concentrate the plutonium products from REDOX and PUREX (Ballinger and Hall 1991). The UO_3 Plant was built to convert liquid uranium nitrate product from PUREX into solid uranium trioxide (UO_3) (WHC 1993).

1.3 SCOPE

The major sections of this document and the topics they cover are outlined briefly below. Because of the many figures included in this report, they appear at the end of each section.

Section 2.0 provides physical descriptions of the facilities and emphasizes the cell layouts and dimensions as well as the major pieces of equipment in each cell. The basic information presented in this section was used to determine the similarity of each section in a given facility to a cell in the PUREX Facility. These similarities are the basis for the estimated waste volumes found later in the document.

Section 3.0 describes the process or processes performed in each plant over its history. This process information forms the basis for the characterization of the waste types expected from the D&D of each facility.

Section 4.0 explains the methodology used to estimate the waste types and volumes expected to be processed by solid waste treatment, storage, and disposal facilities as a result of D&D activities. The assumptions and uncertainties implicit in the estimation methodology are also discussed.

Section 5.0 presents the results of the study and summarizes the types and amounts of solid wastes expected from each of the facilities studied as a result of their D&D.

Section 6.0 summarizes the information, compares the results of this study with previous studies, and discusses conclusions.

Section 7.0 lists the references used to compile the information found in this report.

During the course of this study, a number of sources that provide more detailed information on the solid wastes expected from the various facilities were discovered. This ancillary information forms the basis for the appendixes found at the end of this report.

Appendix A provides additional information about the PUREX Facility.

Appendix B provides additional information about B Plant.

Appendix C provides additional information about T Plant.

Appendix D provides additional information about U Plant.

Appendix E provides additional information about the REDOX Facility.

Appendix F provides additional information about the UO₃ Facility.

Appendix G provides additional information about the 224-B Facility.

Appendix H provides additional information about the 233-S Facility.

2.0 PHYSICAL DESCRIPTIONS OF THE FACILITIES

This section includes a description of the PUREX Plant as well as descriptions of the facilities included in the scope of this document: B Plant, T Plant, U Plant, the REDOX Facility, the UO_3 Plant, the B Plant Plutonium Concentration Facility (PCF), and the Plutonium Finishing Plant (PFP) and REDOX Concentrator. Similarities and/or differences to the PUREX Plant are noted. Maps detailing the locations of these facilities are shown in Figures 2-1, 2-2, 2-3, and 2-4, located at the end of this section.

2.1 PUREX PLANT (A PLANT) PHYSICAL DESCRIPTION

The following description of the PUREX Plant is provided so that similarities and/or differences to the facilities examined by this study can be identified more easily. For the most part, this discussion is taken from *Estimation of PUREX Equipment and Materials that are Candidates for Removal and Waste Processing During PUREX Plant Closure* (Valero 1994). A photograph of the PUREX Facility is shown in Figure 2-5. The PUREX Plant plot plan is shown in Figure 2-6.

Fuels reprocessing was conducted in the 202-A Building, the main structure of the PUREX Facility (see Figure 2-5). Built of reinforced concrete, its approximate dimensions are 306.3 m (length) by 36.3 m (width at its maximum) by 30.5 m (height), with approximately 12.2 m below the grade elevation of 222.8 m. It consists of three main structural components: (1) canyon, (2) galleries, and (3) service annex. A cutaway illustration of the 202-A Building is given in Figure 2-7.

2.1.1 PUREX Canyon

The canyon is a thick-walled, heavily shielded concrete structure that houses the equipment used for radioactive processing. The canyon area proper is 306.3 m (length) by 9.3 m (width) by 31.7 m (height). A single row of 12 process cells is contained within the canyon. The functions of these 12 cells, the equipment they contain, and their sizes (given as a volume) are provided in Table 2-1. A basin at the east end of the canyon stored irradiated fuel. A railroad tunnel, running north and south on the west side of the storage basin, brought casks containing fuel into the canyon (Valero 1994). Figure 2-8 displays the cells in a top view of the PUREX Plant.

The east crane maintenance platform is located in an extension added to the existing 202-A Building in 1957. The extension is 21.7 m (height) by 11.0 m (width) by 2.0 m (depth) and is a reinforced-concrete and steel-beamed structure. Three interior, 7.6-cm-thick, steel-plate shielding doors separate the canyon from the maintenance platform. Below the 223 m elevation, the maintenance platform is separated from the canyon by 25.4 cm of original building concrete. The roof consists of coal-tar pitch, roofing felt, mineral-surfaced roofing, plastic roofing, cement, and roofing gravel. This addition served as the containment vessel when the canyon shielding doors were opened (Valero 1994).

Table 2-1. PUREX Canyon Cell Functions, Equipment, and Volumes.

Cell	Function	Equipment	Cell volume (m ³)
A,B,C	Metal dissolution	Dissolvers, dissolver towers, scrubbers, heaters, silver reactors, process tanks, jets, filters	590
D	Metal solution storage	Metal solution storage tanks, metathesis solution storage, coating, waste receiver, pumps, jets, samples, agitators	1,095
E	Feed preparation and cladding waste treatment	Centrifuges, catch tank, coating waste tank, rework tank, feed makeup tank, recovered product tank, scrubber, pump, jets, agitators, samplers	1,196
F	Waste treatment and process ventilation	Nitric acid absorber, condensers, pumps, tanks, samplers, concentrators, jets, agitators	3,639
G	Solvent treatment system	Pulse column and generator, tanks, decanter, turbo-mixer, pumps, jet, agitators, samplers	1,836
H	First decontamination system	Tanks, concentrator, condenser, pumps, samplers, jets, pulse columns, pulse generators	927
J	Partition system, no recovery	Tanks, concentrator, condenser, pumps, samplers, jets, pulse columns, pulse generators	1,853
K	Uranium decontamination and concentration system	Pulse columns, tanks, pulse generators, concentrators, condensers, pumps, jets, agitators	1,432
L	Plutonium decontamination and concentration system	Pulse columns, tanks, pulse generators, concentrators, condensers, pumps, jets, agitators, stripper/condenser	758
M	Equipment decontamination and storage and plutonium nitrate storage	Tanks, pumps, hood, samplers	253

2.1.2 PUREX Gallery Levels

A 1.8-m-thick concrete wall separates the cells from the galleries. The storage, sample, pipe and operations, and crane cab galleries parallel to the north wall of the canyon are located at different levels, one above the other. The wall above the cells is 1.2 m thick and forms a shielded cabway (crane cab gallery) for the two 36-metric-ton master gantry cranes. Located on rails above the master crane level is a 36-metric-ton slave crane. Platforms for crane maintenance are located at the east and west ends of the crane cab level.

The pipe and operations gallery, located below the crane cab gallery, contains instrument transmitter racks, electrical motor controls, steam and cooling water supply lines, and the piping and associated valves used for transferring nonradioactive solutions. Because most of the valves were managed with control panels, only a few operators were required in the gallery. There are also several batch chemical addition tanks located on this level.

On the next level down, the sample gallery contains the remote samplers, which were used to obtain process solution sampled from the cell equipment. A shielded pipe case behind the remote-sampler boxes contains headers for recovered nitric acid, organic solvent, sampler drains, and sampler lines to and from cell equipment.

The storage gallery area, the level beneath the sample gallery, was used primarily for storage of dry chemicals and spare equipment. A 4.5-metric-ton capacity elevator serves the storage and pipe and operations galleries as well as the four floors of the aqueous makeup area.

At the west end of the storage gallery, there is a separate area containing the deactivated neptunium purification and load-out facility (in cell Q), the plutonium product handling and removal room, and the plutonium oxide production facility (in cell N) (Valero 1994).

2.1.3 PUREX Service Annex

The service annex is adjacent to and north of the gallery section. It consists of two separate areas. The larger, main area (the west annex), houses the maintenance shops, offices, lunchroom, locker room, radiation-zone entry lobby, ventilation air and supply room, a switch-gear room, compressor room, central control room, and the aqueous makeup facility. The smaller laboratory area (the east annex) contains the analytical laboratory, the head-end control room, and a switch-gear room (Valero 1994).

2.2 B PLANT PHYSICAL DESCRIPTION

The 221-B Facility is located in the center of the 200 East Area on the Hanford Site (Figure 2-3). A number of annexes and support facilities are associated with the main canyon building. A schematic of the 221-B Building is shown in Figure 2-9, and an aerial view of the B Plant complex is shown in Figure 2-10.

The B Plant was originally constructed to chemically separate irradiated uranium fuel using the bismuth-phosphate process. The plant commenced operation in April 1945 and continued until 1952 when the bismuth-phosphate process became obsolete with the development of the PUREX method. The plant shut down until the early 1960's when a series of renovations were made to support the extraction of various fission products from high-level liquid waste (Gehrke 1992).

The final renovation, completed in 1968, facilitated a high-capacity solvent-extraction and ion-exchange process. The campaign lasted from approximately 1968 until 1985 and resulted in the extraction of over 100 MCi of cesium and strontium.

A subsequent and final campaign involved 38,000 L of neutralized current acid waste (CAW) from double-shelled tank 101-AZ. Waste from this campaign still remains in the tanks in B Plant but will be removed prior to D&D.

Currently, B Plant stores chemicals used to treat LLW generated at the B Plant and the Waste Encapsulation and Storage Facility. It is used for the generation of demineralized water and for the conditioning of water used in heating, ventilating, and air-conditioning units (Gehrke 1992).

The B Plant is a lightly reinforced, concrete building, approximately 259 m (length) by 21 m (width) and 23 m tall, covering an area of about 5,370 m² and occupying a volume of approximately 121,100 m³. The canyon portion is about 247 m long. The building is divided into three main areas: galleries (electrical, piping, operating, and crane, listed from the bottom up), canyon deck, and cells. All interior and exterior walls, roof and floor slabs, and cell dividing walls are constructed of thick concrete to provide shielding from ionizing radiation. Figure 2-11 illustrates the canyon cell layout and ventilation, and Figure 2-12 shows a cutaway view of the 221-B Facility.

2.2.1 B Plant Gallery Levels

The B Plant galleries contain noncontaminated equipment such as electrical switchgear and motor controllers, air systems, and remote control equipment. The electrical and pipe galleries extend from cell 5 to cell 40, and the operating and crane galleries extend the length of the canyon. The dimensions of the galleries are as follows:

- Electrical 4.3 m X 4.3 m X 216 m (3,990 m³)
- Pipe 3.9 m X 4.3 m X 216 m (3,622 m³)
- Operating 3.7 m X 4.3 m X 247 m (3,930 m³)
- Crane 1.5 m X 4.3 m X 247 m (1,593 m³).

The volumes above are provided for information only and are not included in waste volume summaries elsewhere in the report as the report's focus is radioactive and hazardous waste.

The hot-pipe trench contains contaminated piping associated with intercell transfers and vessel ventilation piping. It provides containment and shielding while allowing access through removable, 1.4-m-thick covers. The hot-pipe trench is 2.4 m (width) by 3.2 m (depth), extends 216 m from cell 5 to cell 40, and occupies a volume of about 1,684 m³.

An air tunnel is located below the hot-pipe trench and provides exhaust ventilation from cells 5 through 40 to the external ventilation system. It is square in cross section (3.2 m X 3.2 m), 216 m long, and occupies a volume of 2,210 m³.

2.2.2 B Plant Canyon Cells

The B Plant contains 40 cells in a single row running the length of the canyon. Roughly 30% of the cell height is below grade. Cells 1 and 2 form a continuous space and are used for storage of spare parts. Cell 3 contains the railroad tunnel. Cell 4 is used for storage of contaminated waste. With the exception of cell 10, the standard operating cells, 5-14 and 17-39, are 5.4 m by 4.0 m by 6.7 m (143 m³). Cell 10 is 14.6 m deep and occupies a volume of 312 m³. The standard operating cells contain much of the original processing equipment, such as tanks, centrifuges, and columns. Entry to each cell is gained by removing the shielded plug that covers the top of the cell. Table 2-2 summarizes the use of each cell, the approximate sizes of the equipment within the cell, and the cell volume.

Table 2-2. Current B Plant Canyon Cell Functions, Equipment, and Volumes. (3 pages)

Cell	Function	Equipment (L x W x H or D x H in meters)	Cell volume (m ³)
1	Failed equipment storage	Radioactively contaminated equipment (dimensions unknown)	286
2	Failed equipment storage	Radioactively contaminated equipment (dimensions unknown)	Continuous with cell 1
3	Railroad tunnel	Rails, scaffolding (dimensions unknown)	640
4	Contaminated waste storage	Tank (dimensions unknown)	555
5	Strontium concentration and storage	Concentrate receiver (0.9 x 2.1 x 1.2) Concentrator (1.5 x 6.4) Condenser (1.2 x 4.0)	143
6	Strontium concentration and storage	Tanks (2) (2.4 x 4.3)	143
7	Strontium concentration and storage	Tanks (2) (2.4 x 4.3)	143
8	Strontium concentration and storage	Tanks (2) (2.4 x 4.3)	143
9	Waste collection	Tanks (2) (2.4 x 4.3)	143
10	Waste collection	Tank (5.5 x 3.4 x 2.1)	312
11	Treatment of current acid waste solids, purification of strontium for encapsulation	Tank (1.2 x 1.5) Tank (2.7 x 2.7)	143
12	Treatment of current acid waste solids, purification of strontium for encapsulation	Tank (2.7 x 2.9) Centrifuge (1.2)	143

Table 2-2. Current B Plant Canyon Cell Functions, Equipment, and Volumes. (3 pages)

Cell	Function	Equipment (L x W x H or D x H in meters)	Cell volume (m ³)
13	Treatment of current acid waste for cesium recovery, treatment of strontium purification waste for strontium recovery	Tank (2.7 x 2.7 x 2.1) Centrifuge (1.2)	143
14	Treatment of current acid waste for cesium recovery, treatment of strontium purification waste for strontium recovery	Tank (1.5 x 2.1) Tank (2.7 x 2.7)	143
15	Decontamination	Tank (dimensions unknown)	143
16	Decontamination	Tank (dimensions unknown)	143
17	Ion exchange cesium recovery	Tanks (2) (2.4 x 4.3)	143
18	Ion exchange cesium recovery	Tank (3.0 x 3.7) Tank (1.5 x 2.1) Ion exchange column (3.0 x 5.5)	143
19	Ion exchange cesium recovery	Tank (3.0 x 4.9 x 4.3)	143
20	Ion exchange cesium recovery	Tank (0.9 x 2.1 x 1.2) Concentrator (1.2 x 4.0) Condenser (1.5 x 3.0)	143
21	Ion exchange cesium recovery	Tank (3.0 x 4.9 x 4.3)	143
22	Vessel ventilation	Condensers (2) (0.6 x 3.7) Ammonia scrubber (0.6 x 4.9) Filters (3) (0.6 x 0.6 x 1.2) Heaters (2) (0.6 x 3.0) Tank (0.9 x 2.1 x 1.2)	143
23	Waste handling	Concentrator (1.5 x 6.4) Condenser (1.2 x 4.0) Tank (1.2 x 2.1 x 1.2) Tube bundles (1.5 x 3.0)	143
24	Waste handling	Tank (3.0 x 4.9 x 4.3)	143
25	Waste handling	Tanks (2) (2.4 x 4.3)	143
26	Solvent extraction	Tank (2.7 x 2.7) Tanks (2) (1.5 x 2.1 x 4.0)	143
27	Solvent extraction	Tank (1.8 x 3.7) Tank (2.1 x 4.3) Tank (0.9 x 1.5 x 1.2)	143

Table 2-2. Current B Plant Canyon Cell Functions, Equipment, and Volumes. (3 pages)

Cell	Function	Equipment (L x W x H or D x H in meters)	Cell volume (m ³)
28	Solvent extraction	Ion exchange column (0.6 x 5.5) Tanks (2) (1.8 x 3.7) Tank (0.9 x 1.5 x 4.3)	143
29	Solvent extraction	Ion exchange column (0.6 x 5.5) Tanks (2) (3.0 x 1.5 x 4.3) Tank (0.6 x 3.0)	143
30	Solvent extraction	Ion exchange column (0.6 x 5.5) Tanks (2) (3.0 x 1.5 x 4.3)	143
31	Acidified sludge treatment	Tanks (3) (1.8 x 2.7)	143
32	Acidified sludge treatment	Tank (3.0 x 2.7) Centrifuge (1.2)	143
33	Feed storage	Tank (3.0 x 4.9 x 4.3)	143
34	Storage of concentrated product	Tanks (3) (1.8 x 2.7 x 4.3)	143
35	Cask load out	Tank (1.5 x 2.1) Tank (2.7 x 3.0)	143
36	Storage of concentrated product	Tanks (3) (1.8 x 2.7 x 4.3)	143
37	Storage of concentrated product	Tanks (3) (1.8 x 2.7 x 4.3)	143
38	Cesium purification for encapsulation	Tank (0.9 x 0.9 x 2.1) Tanks (2) (1.5 x 2.1) Tank (0.9 x 1.2 x 2.1) Ion exchange column (0.6 x 4.3) Condenser (1.2 x 4.0)	143
39	Cesium purification for encapsulation	Tanks (3) (1.5 x 1.5 x 4.0) Tank (0.9 x 2.7)	143
40	Cesium purification for encapsulation	Loading ramp Sampler cave	143

2.2.3 Ventilation

The principal processes that took place in B Plant (separation of irradiated fuel and extraction of fission products from high-level liquid waste) were potential sources of airborne radioactivity. Building ventilation was accomplished by maintaining the process areas at a lower pressure than the occupied operating spaces and directing the ventilation exhaust through high-efficiency particulate air (HEPA) filters. Ventilation was also used to maintain cell temperatures within specified limits.

The exhaust ducting from the building occupies a volume of about 255 m³. The filter building (291-B) occupies about 340 m³. Both the ducting and the filter structures are large sources of radioactivity.

In addition to the building ventilation system, cell 22 houses two vessel ventilation systems used to maintain a negative pressure in vessels containing solutions with radioactivities greater than 0.38 Ci/m³ (100 Ci/gal) or that had temperatures greater than 70 °C. Vessel vent system No. 1 was used to vent systems in which ammonia was not present. The system is comprised of a steam heater, a high efficiency filter assembly, a steam- or air-operated jet, a condenser, a condensate receiver, and a recycle drain pump. Vessel vent system No. 2 is similar to No. 1 with the exception of an added ammonia scrubber. Some components are common to both systems.

2.3 T PLANT PHYSICAL DESCRIPTION

Much of the information in this section was provided by the *T Plant Safety Analysis Report* (Semmens 1993).

Located in the northern half of the 200 West Area (Figure 2-4), the T Plant was constructed in 1944 to extract plutonium and uranium from production reactor fuel using the bismuth-phosphate process. T Plant was deactivated in 1956, and most of the original process equipment has subsequently been removed. In 1957, T Plant acted as a beta-gamma decontamination facility and a support complex for experiments or other operations requiring containment or isolation. Currently, 221-T provides services in radioactive decontamination, reclamation, and decommissioning of process equipment contaminated with fission products.

The 221-T Building is made of reinforced concrete and is 260 m (length) by 20.7 m (width) by 22.6 m (height), covers an area of 5,370 m², and occupies a volume of 121,100 m³. The building consists of a canyon, three galleries (operating, pipe, and electrical), one craneway, and a "head-end" facility. Figures 2-13, 2-14, and 2-15 respectively show a canyon cell layout, a cutaway view, and the dimensional cross section of the 221-T Building.

The canyon area consists of 37 cells and one railroad tunnel entrance/exit. The cells are numbered and use "L" and "R" to indicate left and right. The cells are grouped into 12.2-m sections arranged in a single row running the length of the building. The canyon deck is about 12.2 m below a 7.6- to 10.2-cm-thick concrete roof. The head-end is divided from the 221-T canyon by a thin metal wall located at the beginning of section 2.

Shielding walls made of 2.7-m-thick reinforced concrete separate the cells from the electrical and pipe galleries. The operating gallery is separated from the canyon deck by a 2.1-m-thick reinforced-concrete wall and the crane cab is protected by a 1.5-m-thick concrete wall that extends part way (2.7 m) to the ceiling. Most of the cells are covered by four 0.6-m-thick reinforced-concrete blocks. Each block is stepped to eliminate a direct path for radiation streaming. Cover blocks for cells 11R, 13R and 15R are 0.6 m thick, and are covered with a 0.95-cm-thick stainless steel decontamination pad. Each cover block has a carbon steel lifting bail to allow access into

the cells. Cells 2R, 2L and 3L are not covered and are used for the railroad tunnel and storage of pressurized water reactor (PWR) core II blanket fuel.

The railroad tunnel used for transporting equipment into and out of the canyon enters the plant at cell 2L. A 4.9-m (width) by 6.7-m (height) opening, covered by a motor-driven rolling steel door, provides railroad canyon access.

The canyon deck is used for special decontamination services, repair, and storage. Section 2 is used as the PWR core II storage facility area. Cell 2R contains 72, 3.7-m-long, irradiated blanket fuel elements stored under water in a 4.0-m (width) by 8.4-m (length) by 8.5-m (depth) pool with a capacity of about 189 kL. A catwalk is placed 1.5 m above the pool to allow access to the pool for sampling and maintenance. An ion-exchange column recirculation system is used to limit the concentration of radioisotopes in the pool waters.

The canyon service areas, sections 4 through 10, are used as staging and storage areas for contaminated and decontaminated equipment. The major staging and storage areas for pumps and agitators are located in sections 4 and 6. All decontamination work is performed in sections 11 through 15. Contact maintenance work is performed in sections 16 through 20. The centrifuge run-in station is located on the deck in section 17.

Several entry and exit doors are located throughout the canyon area. The main canyon entry door is located in section 20. The rear canyon doors are normally used for emergency exit only, except for door R-19, which is used for access to the laundry storage area and a canyon viewing room or "bubble" at section 13.

The original building design provided for two electrical overhead bridge cranes with capacities of 68 metric tons and 9 metric tons, respectively. The cranes move parallel to the canyon, allowing easy access to the canyon deck area.

2.3.1 T Plant Cells

The standard canyon cells are 5.4 m (length) by 4.0 m (width) by 6.7 m (depth) (approximately 143 m³) and are normally covered by four 1.8-m-thick concrete cover blocks. The cells are separated from each other by 2.1-m-thick reinforced-concrete walls. All lines that service the cells are encased in concrete and terminate in a row of connector flanges on the cell wall 2.7 m below canyon deck level. Each cell slopes to a corner drain that drops into a 61-cm (diameter) tile sewer running the length of the building. The sewer is an integral part of the building structure. Cells are used for storage and for handling of radioactive waste resulting from decontamination efforts. Table 2-3 summarizes the function of each cell, the equipment located in each cell, and the volume of each cell.

Table 2-3. T Plant Canyon Cell Functions, Equipment, and Volumes. (2 pages)

Cell	Function	Equipment (L X W X H or D x H in meters)	Cell volume (m ³)
1	Head-end	Sodium storage	286
2L	Railroad tunnel	Rails, scaffolding, ladders	640
2R	Spent fuel storage	PWR spent fuel storage pool: 72 blanket fuel assemblies	555
3L	Storage	Miscellaneous equipment	143
3R	Storage	Pumps from PUREX and B Plant	143
4L	Storage	Pumps (12) (0.9 x 3.7) Tank farm sluicer assemblies (2)	143
4R	Storage	Miscellaneous jumper assembly (0.07 x 6.1) Pulser (1.2 x 0.9 x 2.1) Contaminated filter assemblies (2)	143
5L	Storage	Tanks (2) (2.1 x 2.1 x 2.1)	143
5R	Storage	Tank (2.7 x 2.7 x 2.7)	312
6L	Storage	Tank (3.0 x 3.0 x 3.0)	143
6R	Storage	Miscellaneous equipment	143
7L	Storage	PUREX tube bundles (2) PUREX tower vent line pulser stand	143
7R	Storage	Pulser agitators (2) (0.3 x 1.8) Jumpers (2) (0.07 x 6.1)	143
8L	Storage	Original equipment: Tanks (2.4 x 4.3) Jumpers (0.07 x 6.1)	143
8R	Storage	Original equipment: Jumpers (0.07 x 6.1) Centrifuges (1.2)	143
9L	Storage	Original equipment: Tanks (2) (2.4 x 4.3) Jumpers (0.07 x 6.1)	143
9R	Storage	Original equipment: Tank (3.0 x 3.7) Tank (1.5 x 2.1) Ion exchange column (3.0 x 5.5)	143
10L	Storage	Miscellaneous T Plant jumpers Drums of connector heads	143
10R	Decontamination	Tank (4.3 x 4.9 x 3.0)	143
11L	Decontamination	Tank (3.0 x 3.0 x 3.0)	143
11R	Decontamination	Tank (53,000 liters)	143

Table 2-3. T Plant Canyon Cell Functions, Equipment, and Volumes. (2 pages)

Cell	Function	Equipment (L X W X H or D x H in meters)	Cell volume (m ³)
12L	Decontamination	Empty	143
12R	Decontamination	Empty	143
13L	Storage	PUREX offgas silver reactor (3.7 x 2.7 x 5.2)	143
13R	Decontamination	Jumpers (0.07 x 6.1) Connector heads	143
14L	Storage	Centrifuges (12) (1.2) Centrifuge block	143
14R	Storage	Original equipment: Tanks (1.5 x 2.1) and (2.7 x 2.7)	143
15L	Storage	Waste tanks 15-6 and 15-9 (not in use)	143
15R	Storage	Tank (3.0 x 3.0 x 3.0)	143
16L	Storage	Original equipment: Tank (1.8 x 2.7) Jumpers (0.07 x 6.1)	143
16R	Storage	Original equipment: Tank (3.0 x 2.7) Jumpers (0.07 x 6.1) Centrifuges (1.2)	143
17L	Storage	Original equipment: Tank (3.0 x 4.9 x 4.3) Jumpers (0.07 x 6.1)	143
17R	Storage	Original equipment: Tank (1.8 x 2.7 x 4.3) Jumpers (0.07 x 6.1) Centrifuges (1.2)	143
18L	Storage	Original equipment: Jumpers (0.07 x 6.1)	143
18R	Storage	Original equipment: Tanks (3) (1.8 x 2.7 x 4.3) Jumpers (0.07 x 6.1) Centrifuge (1.2)	143
19L	Storage	Original equipment: Tanks (3) (1.8 x 2.7 x 4.3)	143
19R	Pump run-in	Pump run-in recirculation tank (2.1 x 2.1 x 2.1)	143
20L	Storage	Original equipment: Tank	143
20R	Storage	Miscellaneous centrifuge parts	143

2.3.2 T Plant Air Tunnel

A 3.2-m square concrete exhaust air tunnel runs parallel to the canyon and provides exhaust for the canyon cells. The tunnel exits Building 221-T at Section 3, 6.7 m below the deck level, where it narrows to a 1.2-m by 2.1-m duct. The duct then runs approximately 61 m underground to the HEPA filter system, which discharges to the 291-T stack exhaust system located just southeast of Building 221-T. The duct occupies a volume of approximately 255 m³. The filter building occupies a volume of approximately 340 m³.

2.3.3 T Plant Galleries

The electrical gallery is 232 m long and 4.3 m square, and it occupies a volume of 4,290 m³. A corridor extends along the full length of the gallery and can be entered through nine stairwells. The electrical gallery contains the main electrical lines, motor control centers, and the electrical distribution centers for the building. The main steam lines and water lines also enter the building through this gallery. Electrical and instrument shops are located in sections 17 through 20.

The pipe gallery is 232 m by 4.3 m by 3.9 m and occupies a volume of 3,890 m³. It also can be entered through nine stairwells. The pipe gallery contains most of the nonradioactive chemical, process, and utility piping, and is divided into four areas to meet requirements for present operations. Section 2 contains two compressor/condenser units for the PWR core II storage pool as well as the main power supply for the compressor/condenser units and the ion-exchange column. Sections 2 through 15 are used for chemical storage. The maintenance shop area is located in sections 11 through 18, and the change room, shower room, and locker rooms are located in sections 19 and 20. The laundry dock is located west of the building, off section 20, and a maintenance dock is located adjacent to the section 17 stairwell.

The operating gallery is approximately 232 m by 4.3 m by 3.7 m and occupies a volume of 3,690 m³. Nine stairwells provide access into the operating gallery. This gallery is the control center for remote operation of the canyon equipment. Section 2 is the PWR core II operating station. Various panel control boards are located in sections 5 through 15; however, only the control panels in sections 5, 11, and 15 are in use. Sections 16 through 19 contain the lunchroom and offices of the D&D operations personnel. The office adjacent to section 19 contains panel controls for canyon air, water, steam, and lights, along with power controls for the centrifuge run-in station.

Building 221-T stairwells also allow access to a 232 m (length) by 3.4 m (width) craneway. The craneway is a radiation area. Only the stairwells in sections 11 and 13 are used for access into the craneway. The other stairwell entrances are barricaded at the third floor to prevent unauthorized entry.

The 68-metric-ton capacity canyon crane is operated by use of periscopes from a crane cab that is shielded by a parapet and 10-cm-thick lead walls. A 9-metric-ton capacity crane and rotary hook provide adaptability for handling, positioning, and maneuvering functions. The 9-metric-ton capacity crane is

normally operated from the canyon deck by use of a suspended control box that hangs from the crane assembly. The crane gallery is 247 m by 4.3 m by 2.7 m and occupies a volume of 2,870 m³.

2.3.4 Ventilation

The process of separating irradiated fuel into its component parts is a potential source of high-level airborne radioactivity. Building ventilation was accomplished by maintaining the air pressure in the processing areas at a lower level than that in the occupied galleries and by directing the building exhaust through a series of HEPA filters. Ventilation was also used to maintain cell temperatures within specified limits.

The exhaust ducting from the building occupies a volume of about 255 m³. The filter building (291-T) occupies about 340 m³. Both the ducting and the filter structures are large sources of radioactivity.

2.4 U PLANT PHYSICAL DESCRIPTION

Originally built as a fuels separations facility to employ the bismuth-phosphate separation process, the U Plant actually was not used until 1952 after extensive modifications were made to equip it for the uranium metal recovery program. Modifications included new cell equipment in more than half of the 221-U Canyon Building cells.

The U Plant is built of reinforced concrete with outside dimensions of 247 m (length) by 20.1 m (width) by 23.5 m (depth), with 7.9 m below grade. It has a total floor area (on several levels) of 7,740 m² and is structurally separated into two sides: the galleries and the process canyon (Kiser 1988). A simplified plant layout is presented in Figure 2-16, and a cutaway illustration of U Plant is presented in Figure 2-17.

2.4.1 U Plant Canyon

The canyon contained the 40 process cells in which the actual uranium recovery was carried out. The canyon itself is 11.3 m wide, with most cells having standard dimensions of 5.4 m (length) by 4.0 m (width) by 6.7 m (depth). Cell 10 is the exception with a depth of 14.6 m. All cells are arranged in a single row and are grouped in sections with two per section. The cells still contain most of the uranium recovery process equipment. Since the shutdown of U Plant, the canyon has been used to store deactivated equipment. Table 2-4 details the function, equipment contained, and volume of each cell.

Table 2-4. U Plant Canyon Cell Functions, Equipment, and Volumes. (3 pages)

Cell	Function	Equipment (L X W X H or D X H in meters)	Cell Volume (m ³)
1	Storage	Empty	143
2	Storage	REDOX vessels D-13, G-13 tank, G-3 concentrator, H-4 coil	143
3	Access to railroad tunnel	Unknown	640
4	Storage	Fuel storage rack (0.4 x 3.0 x 4.3)	555
5	Storage	B Plant centrifuges (3) Pair of fuel canisters (19)	143
6	Feed receiving	U Plant tank (2.7 x 2.7)	143
7	Storage	PUREX Equipment: Pumps (3) B Plant Equipment: Pumps (2) Agitators (4)	143
8	Cell drainage	Waste tank 4-6	143
9	Cell drainage	Waste tanks 5-1 and 5-2	143
10	Cell drainage	Active waste handling tank 5-6	312
11	Waste evaporation and concentration	Evaporator dunnage from U Plant U Plant tank 6-4 B Plant F-22 filter	143
12	Storage	PUREX pot dissolver B Plant centrifuge	143
13	Waste evaporation and concentration	Evaporator Concentrator cooler Feed stripping tower Concentrator seal pot Concentrator condenser	143
14	Storage, waste concentration	Agitators (6) Pumps (8) U Plant tank	143
15	Waste evaporation and concentration	Evaporator Concentrator cooler Feed stripping tower Concentrator seal pot Concentrator condenser	143
16	Storage, waste concentration	B Plant tank PUREX thorium jumpers (17) Concentrator feed receiver	143

Table 2-4. U Plant Canyon Cell Functions, Equipment, and Volumes. (3 pages)

Cell	Function	Equipment (L X W X H or D X H in meters)	Cell Volume (m ³)
17	Waste evaporation and concentration	Evaporator Concentrator cooler Waste concentration tower Concentrator seal pot Concentrator condenser	143
18	Storage	PUREX F-8 tank	143
19	Waste evaporation and concentration	Evaporator Concentrator cooler Waste concentration tower Concentrator seal pot Concentrator condenser	143
20	Waste concentration	Concentrator for feed tank Concentrator feed receiver	143
21	Waste sampling	Waste sampler tank	143
22	Waste neutralization	Neutralizer tank	143
23	Waste sampling	Waste sampler tank	143
24	Waste sampling	U Plant tank (2.4 x 4.3) U Plant pump PUREX crane toolbox	143
25	Waste sampling	Waste sampler tank	143
26	Aqueous effluent, spent solvent stream receiving	Receiver tank	143
27	Feed preparation	Centrifuge catch tank	143
28	Feed preparation	Centrifuge catch tank	143
29	Storage	B Plant ti-tube bundles (2)	143
30	Storage	REDOX pots (2) REDOX towers (2)	143
31	Storage	B Plant centrifuges REDOX tube bundles (2)	143
32	Aqueous effluent receiving	Tank (2.7 x 2.7)	143
33	Spent solvent stream receiving, stripping and aqueous effluent processing	Spent solvent stream receiver tank Stripping column Aqueous effluent pumpout tank	143
34	Waste receiving and treatment	Uranium-containing stream feed tank Aqueous effluent receiver tank Decontamination column	143

Table 2-4. U Plant Canyon Cell Functions, Equipment, and Volumes. (3 pages)

Cell	Function	Equipment (L X W X H or D X H in meters)	Cell Volume (m ³)
35	Waste receiving and treatment	RIOW receiver tank RIO column RIOO receiver tanks	143
36	Hydrocarbon diluent feed	U Plant tank (2.1 x 4.3)	143
37	Spent solvent stream receiving, stripping, and aqueous effluent processing	Stripping column Pump-out and receiving tanks	143
38	Waste receiving and treatment	Uranium-containing stream feed tank Decontamination column Aqueous effluent receiver tank	143
39	RIIOO and RIIOW receiving, RIIO processing	RIIOO receiver tank RIOO column RIIOW receiver tank	143
40	Feed receiving	Hydrocarbon diluent feed tank	143

The information found in Table 2-4 was compiled from the *Canyon Equipment List for U Plant (221-U)* (Van Sickle 1990), *REDOX and U Plant Dangerous Waste Tank Identification and Sampling Ability* (Speer 1989), and cell photographs. These sources are included in Appendix D.

An air tunnel and hot-pipe trench complete the process canyon side. The pipe trench runs parallel to the cells from section 3 to section 20 and is 2.4 m wide by 3.0 m deep. It contains intercell process piping and waste transfer piping. The air tunnel, with a height of 3.3 m and a width of 3.2 m, is located directly beneath the pipe trench and provides exhaust ventilation for the cells and pipe trench (Kiser 1988).

Above the 1.8-m-thick concrete blocks that cover the cells and pipe trench is 12.2 m of open space containing the overhead traveling bridge crane equipped with 68-metric-ton and 9-metric-ton hoists. The final component of the canyon side is the vacant railroad tunnel that enters at section 2, cell 3, and runs the width of the building (Kiser 1988).

2.4.2 U Plant Gallery Levels

The galleries are separated from the canyon by a 1.5-m- to 2.7-m-thick concrete wall. The four galleries, ordered from top to bottom, consist of the crane gallery, operating gallery, pipe gallery, and electrical gallery. The gallery side is 4.3 m wide (Speer 1992).

The crane cab gallery, or cabway, is partitioned from the canyon by a 1.5-m-thick wall, but it has no ceiling and is open to the process side. Located immediately beneath the cabway, the operating gallery allows complete remote operation of the process equipment through instrument and operating boards at each section. Under the operating gallery, all chemical, electrical, steam, and instrument lines enter the cells from the pipe gallery. Remote maintenance was not required here, so all fixtures are standard. On the lowest level, the electrical gallery contains all electrical and steam lines that enter the building and pass through the pipe gallery (Ballinger and Hall 1991). The galleries contain most of the original process equipment.

2.4.3 Auxiliary Buildings

The U Plant canyon air, after passing through the ventilation duct, was vented to the atmosphere through the sand filter and stack facilities of the 291-U Building. Process tanks and condensers in the canyon cells were also vented to the 291-U stack. However, this air passed through separate headers and a blower pit before discharge to the ventilation duct leading to the sand filter (GEC 1951a). Both the ventilation duct and stack facilities are potential LLW because of airborne radioactivity. The ventilation duct occupies approximately 255 m³, while the 291-U Building has a volume of 340 m³.

The 276-U Building, the solvent storage and treatment area, is a potential source of LLMW. The organic solvents used within the 221-U Building, including tributylphosphate (TBP), were prepared and stored here. Also included in the 276-U Building were facilities to treat "off-standard" solvent from the 221-U Building. Although only fresh, noncontaminated TBP solution was stored here, some contamination of the TBP did occur. Through an interview with U Plant personnel, it was learned that surface contamination of the outside walls of the 276-U Building near the area of TBP storage had been found. Currently, only one TBP tank and one aqueous holding tank remain. The building has dimensions of 20.1 m (length) by 16.5 m (width) by 2.4 m (height) and an estimated radiological inventory of 8 Ci from fission products and 1 Ci from uranium (Bowers and Nolande 1980b).

2.4.4 Miscellaneous Waste

Since its shutdown, the U Plant canyon has been used to store deactivated equipment from other plants. After the final placement of the cell cover blocks, any deactivated equipment received was stored on the canyon deck. Although no volume estimates could be generated, a listing of the equipment on each cell deck is contained in Appendix D-3, *Canyon Equipment List For U Plant* (Van Sickel 1990). Another 85 m³ of equipment is on the walkway from section 3 to section 20 (Van Sickel 1990).

Approximately 5% of the jumpers in the cells had lead counterweights, with a typical volume of 1,232 cm³ per counterweight. This converts into nearly 14 kg of lead in each counterweight. A standard cell includes 32 jumpers, two of which contained lead counterweights; so 28 kg of lead are present in each cell, or about 1,000 total kg of lead in U Plant. This estimation has been supported in interviews with U Plant personnel.

There are several other potential sources of waste, all discovered through interviews with plant personnel. It is probable that residual heels of mercury are present in the U Plant instrumentation. Residuals of red oil (acetylene tetrabromide), used in manometers to measure small changes in differential pressure, are also likely to exist. This red oil was commercially manufactured and is not to be confused with the red oil produced as a byproduct of the PUREX process. Finally, it is virtually certain that the paint used throughout U Plant is leadbased.

2.5 REDOX (S PLANT) PHYSICAL DESCRIPTION

The REDOX Plant is located in the 200 West Area of the Hanford Site (see Figure 2-4). The REDOX Plant consists of a main processing facility (Building 202-S) and ancillary facilities, as shown in Figure 2-18. Building 202-S differs from the earlier B, U, and T Plant canyons in that it has two sets of process cells down the center of the building with an operating gallery on each side.

The 202-S Processing Facility is a multi-storied, reinforced-concrete structure with overall dimensions of approximately 144.8 m (length) by 42.7 m (height) by 48.8 m (wide). The building has two major portions: the process portion, which contains the contaminated process equipment, and the service portion, which housed personnel and equipment necessary for the remote operation of the facility. A simplified diagram of the 202-S Processing Building is shown in Figure 2-19.

The areas in the process portion that contain contaminated processing equipment are:

- Canyon cells
- Silo column enclosure
- Operating galleries.

The service portion includes rooms, shops, and equipment required for plant operation. Service rooms include an entrance lobby, offices, a lunch room, restrooms, regulated change rooms, and locker rooms. The shops provided are maintenance, instrument (industrial and electronic), and electrical. Control rooms include the operating galleries at the silo and at the north and south sides of the canyon. Equipment rooms to support operations include five blower rooms, a compressor room, a chemical storage room, five aqueous make-up levels, a silo feed gallery, an electrical substation, two 480-volt electrical distribution centers, an ozone generator room, and two pipe galleries (north and south).

2.5.1 REDOX Canyon Cells

The canyon cells contain dissolution equipment (cells A, B, and C), feed-solution preparation vessels (cell H), solution handling equipment (cells E and F), waste-solution neutralization and concentration equipment (cell D), equipment for decontaminating and purifying organic solvents used in extraction (cell G), and process offgas purification equipment (cell J). The product-removal cage houses the equipment that was used to concentrate

plutonium product solution prior to shipment. Table 2-5 summarizes the function of each cell, the equipment in each cell, and the volume of each cell.

The main canyon building is a massive concrete-walled structure approximately 130 m (length) by 25.6 m (width) by 25.6 m (height). One- and two-story wings are connected to the side of the main canyon on the south and west sides of the building. The main canyon building is divided into three structural segments: the canyon, the silo, and the east end.

Table 2-5. REDOX Canyon Cell Functions, Equipment, and Volumes. (2 pages)

Cell	Function	Equipment	Cell volume (m ³)
A	Fuel dissolution	Rinse tank Dissolver Offgas heater/silver reactor Offgas filter	239
B	Fuel dissolution	Rinse tank Dissolver Offgas heater/silver reactor Offgas filter	238
C	Fuel dissolution	Rinse tank Dissolver Offgas heater/silver reactor Offgas filter	255
D	Waste treatment	Sump drain collection tank Condensate receiver Condenser Condensate evaporator Condensate stripper Condenser Rework adjustment tank Waste neutralizer Waste sampler Concentrated waste receiver Condenser Waste concentrator Waste header receiver	1,080

Table 2-5. REDOX Canyon Cell Functions, Equipment, and Volumes. (2 pages)

Cell	Function	Equipment	Cell volume (m ³)
E	Extraction	3A feed tank 3BP receiver 3BP sampler 3BP rework 2A feed tank IBP receiver Crossover oxidizer Condenser Condenser 3EU concentrator 3EU concentrator receiver 3EU sampler Rework 2DF tank	743
F	Extraction	ICU concentrator Condenser 3D feed tank 3EU concentrator Condenser IA feed tank IS feed tank 2D feed tank	915
G	Organic recovery	Organic surge tank Condenser and phase separator Organic still Organic waste receiver	407
H	Metal solution (feed) preparation	IAF make-up tank Centrifuge Slurry waste receiver Oxidizer Ruthenium scrubber Condenser Metal solution storage (3) Dissolver waste tank	1,203
J	Off-gas filtration	Ruthenium filter Filter seal tank Vessel vent filter Condenser vent filter	575
Product-removal room	Product removal	Condenser Pu preconcentrator Pu concentrator Condenser Pu concentrator condenser Receiver Transfer trap condenser Pu transfer trap	24
Air tunnel	Air circulation	Empty	1,550
Pipe tunnel	Piping corridor	Inert gas vent header	1,550

2.5.2 REDOX Silo Column Enclosure

The silo structure houses the solvent-extraction columns and ancillary process facilities. There are eight levels in the operating area of the silo. The first five are aqueous make-up levels. The sixth level is occupied by the silo crane. The silo operating gallery and silo sample gallery make up the seventh level. Boiler room 4 and the feed tank area are on the eighth level. Two elevators are provided for the silo. Table 2-6 summarizes the functions, equipment, and volumes of the silo levels.

Table 2-6. REDOX Silo Enclosure Functions, Equipment, and Volumes.

Work Area	Function	Equipment	Work Area Volume
Silo Area			
Column shaft	Solvent extraction	Extraction columns (13)	1,930
Aqueous make-up level 1	Aqueous make-up addition	Make-up tanks	583
Aqueous make-up level 2	Aqueous make-up addition	Make-up tanks	663
Aqueous make-up level 3	Aqueous make-up addition	Make-up tanks	544
Aqueous make-up level 4	Aqueous make-up addition	Make-up tanks	544
Aqueous make-up level 5	Aqueous make-up addition	Make-up tanks	544
Silo operating gallery	Crane operation	36-metric-ton capacity crane	725
Silo sample gallery	Sampling extraction column streams	Unknown	299
Blower room 4/feed tank area	Ventilation and additions of cold (nonradioactive) feed streams to columns	Feed tank air-conditioning unit	929
Operating Galleries			
North operating gallery	Isolate operators from radioactive materials	Control panels, viewing windows	2,620
South operating gallery	Isolate operators from radioactive materials	Control panels, viewing windows	1,190
North pipe gallery	Process-pipe containment	Piping and jumpers	1,744
South pipe gallery	Process-pipe containment	Piping and jumpers	1,744
North sample gallery	Product sampling	Product removal case	1,700
South sample gallery	Product sampling	Unknown	1,250

2.6 UO₃ PLANT PHYSICAL DESCRIPTION

The UO₃ Plant, located in the 200 West Area of the Hanford Site (see Figure 2-4), consists of two primary buildings, 224-U and 224-UA, and several ancillaries, as shown in Figure 2-20. The floor layouts for 224-U and 224-UA are illustrated in Figures 2-21 and 2-22, respectively (Toebe et al. 1990). All processing operations are contained within these two main structures. The 224-U Building contains a wet process involving the uranyl nitrate hexahydrate (UNH) concentration. The 224-UA Building contains a dry process involving the conversion of UNH to UO₃ powder.

2.6.1 224-U Building Physical Description

The 224-U Building, originally named the Bulk Reduction Building, was completed on December 16, 1944. The structure is at a grade elevation of 214 m above mean sea level, is 60 m (length) by 18.3 m (width) by 18.6 m (height), and covers 1,110 m² (DuPont 1945a). The building is divided along its length by a 0.3-m-thick, concrete shield wall into a gallery side and a canyon side. At the time of construction, five general classes of permanent buildings were constructed: the 224-U Building was classed as a "reinforced concrete frame and concrete block construction" (DuPont 1945a). The gallery side is a three-story, reinforced-concrete frame structure with concrete floor and roof slabs. Exterior and interior infill walls are nonreinforced, 20.3-cm concrete blocks. The roof, supported by concrete beams, is a flat reinforced-concrete slab between 13 cm and 0.3 m thick.

The canyon side, constructed of 0.3-m-thick, reinforced-concrete walls, is also three stories high. The canyon is divided into six cells. Each cell is separated by a concrete wall that extends part way (4.6 m) toward the ceiling. A portion of C cell is the only part of the 224-U Building that extends below grade.

Figure 2-21 depicts the 224-U Building layout.

2.6.1.1 Process Cells and 224-U Canyon. The six process cells are located in line along the canyon side of the building. The functions of these cells, the equipment they contain, and their sizes (volume) are provided in Table 2-7.

The original building design provided for a maintenance crane. The crane, which has 7.3-metric-ton capacity, is operated by a chain and pulley system from the catwalk. Ten-inch steel "I" beam, suspended from the concrete roof beams and extending the full length of A through E cells, provides the crane beam supports.

Access for equipment moving in and out of the canyon via the crane is provided by a 3.7-m by 6.1-m bay door through E cell. However, movement of equipment along the length of the canyon is limited due to process equipment in D cell that extends nearly to the ceiling. Other access to the canyon and process cells for moving equipment is provided through various roof openings.

All cell floors, including the floor in the C cell pit area, are sloped to provide drainage. Cell drainage is routed via drains to tank C-7 by a steam jet (in the east corner of the C cell pit area).

Table 2-7. UO₂ Building 224-U Cell Functions, Equipment, and Volumes.

Cell	Function	Equipment (L x W x H or D x H in meters)	Cell Volume (m ³)
A	Nitric acid recovery	Off-gas cooler (0.93 x 0.12 x 1.4) Tower (2.1 x 0.6 x 2.4)	951
B	Equipment decontamination and feed pumps	Vessel vent condenser (4.6 x 0.91)	951
C	UNH receipt and inventory, and process condensate collection	Tanks (2) (2.7 x 2.7) Tanks (3) (2.7 x 1.4) Tank (3.8 x .84) Tank (1.5 x 0.9) Tank (0.6 x .46) Tank (0.3 x 0.3 x 0.9)	1,036
C pit	Recovered acid receiving and distribution, and scrap concentration	Tank (3.8 x .84 x 1.3) (Tank C-7)	161
D	UNH concentration	Tank (4.87 x 1.1) Tank (0.6 x 0.6) Tank (0.46 x 0.3) Tank (0.6 x 0.15) Tank (0.9 x 0.22) Tank (2.6 x 0.51) Concentrator (4.1 x 0.46) Condenser	951
E	Unused	Electric calciner pots	951
F	Unused	Electric calciner pots	867

UNH = Uranyl nitrate hexahydrate.

A shielded concrete catwalk extends around the perimeter of cells A through E except along the northwest wall. This catwalk is 3.7 m above the cell floor, 1.9 m tall and made of 0.2-m-thick concrete. Although seldom used, access to the catwalk is still provided through the second floor pipe gallery.

2.6.1.2 First Floor Gallery. The first floor of the gallery side of the 224-U Building is 159.4 m (length) by 9.9 m (width). A corridor extends almost the full length of the gallery and provides access to offices, the change room, shower rooms, locker room, and building ventilation room. Access to the canyon is provided through the change room via cell F.

2.6.1.3 Second Floor and Pipe Gallery. The second floor of the gallery side of 224-U is 59.4 m long and 9.9 m wide. The second floor contains the pipe gallery, the building lunch room, electric switch gear room, and a storage room. Cold piping and services originate in this gallery and are routed to the canyon. Some piping is routed through the third floor prior to entering the canyon.

2.6.1.4 Third Floor and Operating Gallery. The third floor gallery is 59.4 m (length) by 9.9 m (width). This floor contains the operating gallery, dispatcher's office, instrument shop, and various other offices and storage rooms. The operating gallery serves the function of control room for the UO_3 Plant process. Some cold piping originating on the second floor is routed through the shield wall to the canyon. A sulfuric acid storage tank is positioned in the floor at the north end of the building.

2.6.1.5 Lucky Pot Room. The Lucky Pot room was appended as part of F cell in the 224-U Building in 1953 under Project CA-513-B. This room, located at the southeast corner of the 224-U Building, is 11.4 m (long) by 8.8 m (wide) and is two stories high.

None of the pot calciners are presently used; however, one pot was reserved for use as a decontamination sink for the reclamation of uranium from used filter bags. Nitric acid for use as a solvent is routed from the acid recovery system to the pot. The uranium solution is jetted to tank X-20 in the 203-UX area and subsequently to the uranium recycle equipment.

2.6.2 224-UA Building Physical Description

The 224-UA Building was built in 1956 under Project CG-613, Metal Conversion Plant. The foundation, at 214 m above mean sea level, is 22.9 m (length) by 20.5 m (width). The floor slab and footing are reinforced concrete, 15 to 20 cm thick. Equipment footings and supports are reinforced-concrete pier columns with steel "I" beam framing. Outside walls consist of insulated, 18-gauge, metallic-coated steel panels. Figure 2-22 shows the 224-UA Building layout.

2.6.2.1 Ground Floor. The ground floor consists of the six calciner cells, each 2.4 m (length) by 3.7 m (width) by 7.6 m (height), a load-out room 6.1 m (width) by 14.6 m (length), the electrical switch gear room, and the bottom portion of the tower stairwell.

The six calciner cells are located along the northeast section of the building. The 7.4-m-tall cells are divided into two sections, with the calciners residing in the upper section. Powder pick-up bins and wet scrubbers are located on the ground floor. Each cell can be accessed from the outside by a roll-up bay door that extends the height of each cell or by doors in G and M cells that open into corridors along the front of the cells. These cells are characterized in Table 2-8.

Table 2-8. UO_3 Building 224-UA Cell Functions, Equipment, and Volumes.

Cell	Function	Equipment	Cell volume (m ³)
G, H, J, K, L, M	Conversion of concentrated UNH to UO_3 powder by calcination	Calciner, hot box, powder pick-up bin, wet scrubber, and monorail-mounted hoist	204

UNH = Uranyl nitrate hexahydrate.

UO_3 = Uranium trioxide.

The building also contains a permanent vacuum cleaner system to facilitate cleaning and decontamination work. Outlets are provided in each cell, the load-out room, and the powder-handling tower. The vacuum cleaner fan discharges into the powder-handling exhaust system and relies upon the system's filters (296-U-2) for dust removal from the air.

2.6.2.2 Second Floor. The continuous calciners are located on the second floor of the calciner cells. UNH feed is routed to the second floor and distributed through a hot box before entering the calciners. The hot box is a metal cabinet with steam coils to maintain elevated temperatures on the UNH feedline. A monorail is located in the center of each cell. The monorail contains a hoist that is suitable for moving process equipment and lifting the top of the calciner shell during maintenance.

Access to the second floor calciner cells is provided through doors to the motor room and by doors in G and M cells that connect to a corridor along the front of the cells.

The second floor also consists of the motor room, a room containing ventilation equipment, and portions of the acid tower. The motor room contains six 125-HP motors and one spare. A hoist, monorail, and outside door allow easy movement of the motors. The remaining room contains the blower, which supplies heating and cooling air to the building.

2.6.2.3 Tower and Roof. A section of the building located over the load-out room is five floors high. This tower is used to handle UO_3 powder. The tower contains two primary bag filters, two cyclones, and a storage bin. Construction of the tower is similar to the remainder of the building.

The 224-UA Building's roof consists of steel panels covered with insulation and built-up roofing material. Numerous pieces of process equipment, including the 296-U-2 and 296-U-14, exhausters are located on the roof.

2.7 B PLANT PLUTONIUM CONCENTRATION FACILITY (224-B) PHYSICAL DESCRIPTION

The 224-B Plutonium Concentration Facility is located in the 200 East Area (see Figure 2-3). The 224-B Building is shown, in both a photo and a schematic of B Plant and its surrounding buildings, in Figures 2-23 and 2-24 respectively. Used in conjunction with B Plant from 1944 to 1952, its main function was to further decontaminate recovered plutonium by replacing the bismuth-phosphate carrier with the more efficient lanthanum fluoride. The 224-B Facility was deactivated shortly after the B Plant bismuth-phosphate process was terminated in 1952. Since then, the facility has been modified several times to adapt it for temporary offices, shop use, lunchrooms, and storage.

The 224-B Building is a three-story structure constructed of reinforced concrete and concrete block. The first and second floors are 60 m (length) by 18.3 m (width), while the third floor is 60.9 m (length) by 18.3 m (width). The building is divided in half by a 0.3-m-thick concrete wall. On one side

are five interconnected cells (A through E cells) and one separate cell (F cell). The other side consists of a pipe gallery, an operating gallery, and offices, as shown in Figure 2-25 (Owens 1985; Prosk 1985).

2.7.1 A Through F Cells in 224-B

Cells A through F serve as the processing portion of the building. Five of the cells, A through E cells, are three stories high (12.2 m) and are separated from each other by 4.8-m-thick concrete walls. Each of these cells are approximately 7.6 m by 8.5 m. Four of these cells, A, B, D and E, are nearly alike in equipment and configuration. On the first floor of each are two tanks measuring 2.7 m in diameter and 2.7 m in height and one tank that is 1.4 m in diameter and 2.1 m tall. The B cell has an additional tank 1.4 m in diameter and 2.1 m tall. Some of these tanks are equipped with agitators and motors. At the second level, A, B, D, and E cells each have an operating deck, 3.0 m by 3.7 m. A 1-m centrifuge was installed on each of the four operating decks. However, after deactivation of the 224-B Facility, the centrifuge in E cell was moved from the operating deck to the floor of the cell, and a temporary plank and plywood deck was built 1.5 m above the second floor level of E cell.

Access to A, B, D, and E cells is through the sample rooms located on the second floor pipe gallery. Additionally, there is a ground level personnel access door into each of the five cells from outside. The E cell has an equipment access door in the top portion of the outside wall that measures 3.7 m (width) by 6.4 m (height). A manually operated, 8-ton bridge crane is installed over A through E cells. Its rails run the entire length from A cell to E cell and pass through the equipment access door to external rails. This arrangement allows the crane to access cells A through E and to move equipment in and out of the building.

The C cell is different from the other cells in both structure and arrangement. Approximately half of the cell's floor is sunk 5.8 m below the first-floor level to provide a deep cell. Vessels in the deep cell include two tanks measuring 1.4 m in diameter by 2.1 m high and one tank that measures 2.7 m in diameter by 2.7 m high. On the first floor level of C cell is another tank 2.7 m in diameter by 2.7 m high. A pipe tunnel (measuring 1.7 m wide by 3.3 m high) extends 10.3 m from the deep cell beneath the first floor offices to a pipe encasement. The piping in this tunnel and encasement was used to transfer solutions between 221-B (B Plant Separations Facility) and 224-B (Concentration Facility).

The F Cell measures 15.4 m by 7.6 m by 7.3 m high. It is completely separated from the other cells by a concrete wall, except that process and waste piping interconnect with the other four cells. Access to F cell is possible through doors from the load-out area, the outside, and from the second floor operating gallery. An elevated centrifuge deck, at 2.1 m above the rest of the floor, occupies approximately one quarter of the cell. There are two 0.66-m centrifuges on this deck and four vessels measuring 1.2 m in diameter by 1.5 m high on the ground floor. Additional equipment includes a small centrifuge (approximately 30 cm in diameter) and two small vessels (approximately 0.5 m by 0.6 m tall). A scale and an agitator motor from elsewhere in the facility have been placed in F cell for storage (Prosk 1985).

Table 2-9 summarizes the function, equipment, and volume of each cell in 224-B.

Table 2-9. 224-B Building Cell Functions, Equipment, and Volumes.

Cell	Function	Equipment (L x W x H or D x H)	Cell volume (m ³)
A	Cross-over process, by-product precipitation with BiPO_4	Tanks (2) (2.7 x 2.7) Tank (1.4 x 2.1) Agitators and motors (3.0 x 2.1) Operating deck, 1-m centrifuge	792
B	Initially a spare cell, fully equipped; later augmented D Cell	Tanks (2) (2.7 x 2.7) Tanks (2) (1.4 x 2.1) Agitators and motors (3.0 x 3.6) Operating deck, 1-m centrifuge	792
C	Receiving cell: product solutions from 221-B, wastes generated within 224-B, sewage disposal, waste treatment	Tanks (2) (1.4 x 2.1) Tall tanks (2) (2.7 x 2.7) Pipe tunnel	981
D	Cross-over process, by-product precipitation with LaF_3	Tanks (2) (2.7 x 2.7) Tanks (1.4 x 2.1) Agitators and motors (3.0 x 3.6) Operating deck, 1-m centrifuge	792
E	Cross-over process, by-product precipitation	Tanks (2) (2.7 x 2.7) Tanks (1.4 x 2.1) Agitators and motors (3.0 x 3.6) Operating deck, 1-m centrifuge Temporary plywood deck	792
F	Final concentration, metathesis and transfer out of building	0.6-m centrifuges (2) Tall vessels (4) (1.2 x 1.5) 0.3-m centrifuge Vessels scale and agitator motor (2) (0.46 x 0.6)	858

2.7.2 Gallery Half of 224-B

The first floor of the gallery and office half of the building is 4.2 m high and contains a mechanical room, offices, a change room, a lunchroom, and a rest room. The mechanical room houses the air supply equipment for the building and the motor control centers for the process equipment. An additional room at the west end of the building was used as a product (plutonium) load-out room. There is a stainless steel slab tank (measuring 0.1 m thick by 0.9 m wide by 0.84 m high) enclosed in a hood in this area. After 224-B was deactivated, this area was converted to a regulated workshop.

Part of this conversion involved isolating the load-out hood from the rest of the room with a wooden frame and plywood wall. In addition, a large roll-up door was installed in an outside wall of the load-out area.

The second floor of the gallery side of the building is 3.7 m high and contains the pipe gallery for A through E cells (10.1 m by 46.9 m) and the operating gallery for F cell (10.1 m by 15.5 m). Aqueous makeup, steam, and water piping; instrument and air tubing; and electrical conduit pass through the 0.3-m-thick concrete wall from the pipe gallery to A through E Cells. The piping passes through "windows" that were left in the wall when it was poured. Following the installation of the piping, these windows were cemented over to seal the cells from the gallery.

Also in the piping gallery, there is a sample room for each of A through E cells. These rooms double as air locks to operating decks in A, B, D, and E cells.

At the west end of the second floor is the operating area for F cell. There are panel boards in this area and viewing windows into the cell. Pumps and aqueous makeup tanks for F cell that were originally installed in this operating gallery have been removed. The piping into the cell has been blanked on the gallery side of the metal partitioning wall that isolates the cell.

When the first floor was converted to a regulated shop, the second floor was renovated for use as offices and lunchrooms. In the pipe gallery and the F-cell operating gallery, wooden frame and drywall walls define these rooms.

The third floor on the gallery side of the building is 4.4 m high and contains an operating gallery for A through E cells. Located in this area are aqueous makeup tanks, scales, pumps, and control panels for the five cells. Observation of the cells is possible through windows on this level. Shielded covers slide over these windows.

A 3.6-metric-ton elevator, on the gallery side of the building, provides access to all three floors from a concrete loading platform. It has a 2.1-m-wide by 2.4-m-high opening (Prosk 1985).

2.7.3 224-B Ventilation

The air balance in 224-B was achieved by air supply and building exhaust. Air was supplied through ducting to the first and third floors of the gallery and office side of the building (air leaked from here into A through E cells), to the F cell operating gallery, and to the load-out room. (Air leaked from the latter two areas into F cell.) Cell exhaust was provided by roof ventilators. Cells A through E are each equipped with one 105 m³/min ventilator, while F cell has two 170 m³/min to 226 m³/min ventilators. These roof ventilators were not filtered and are no longer running. A small amount of air leaks into the vessels, which are tied into the B Plant main exhaust system via stainless steel subheaders connected to 15-cm-diameter, below-grade, clay pipes. These in turn connect to the 0.61-m-diameter clay header, laid along the south and west sides of 224-B, that leads to the B Plant main exhaust tunnel at the east end of 221-B.

The 224-T Building was built the same as 224-B and served an identical purpose for T Plant. During a facility modification, the 0.61-m clay pipe along F-Cell at 224-T was excavated revealing plutonium contaminated soil. Apparently, moisture condensed in the tunnel and then seeped through the joints carrying with it plutonium contamination. An area about 15 m (length) by 3.7 m (width) by 3.7 m (depth) was excavated yielding 139 drums of soil contaminated with approximately 72 g of plutonium. According to the *Safety Analysis Report for the 224-B Plutonium Concentration Facility Decontamination and Decommissioning*, "It is quite possible that a similar condition exists at 224-B" (Prosk 1985).

2.7.4 224-B Steam Condensate System

The sanitary water originally provided as process water proved to contain too many dissolved materials (such as calcium and magnesium) to permit the isolation of satisfactorily pure product in the Isolation Building without extra processing. It was found that relatively pure water (approximately one part per million of calcium) could be obtained by condensing process steam.

The facilities provided for condensing process steam include a two-pass condenser operating on 103,420 N/m³ steam. A 75,700 L wooden storage tank is located on the roof of the building. The condensate was lifted to the storage tank by the steam pressure in the system and was fed to the scale tanks by gravity flow. Automatic control of the condenser by the liquid level in the storage tank was provided (Shoemaker 1979).

2.8 PFP AND REDOX CONCENTRATOR (233-S) PHYSICAL DESCRIPTION

The 233-S Plutonium Concentration Facility is located on the north side of the REDOX Plant in the 200 West Area (see Figure 2-4). Built in 1954 and 1955, the 233-S Building is a reinforced-concrete and corrugated-metal structure measuring 26.2 m by 11.2 m by 32.1 m (Crusselle and Romano 1982). The building contains two can storage rooms, a can load-out and decontamination room (which includes a load-out hood), a change room, a restroom, an equipment room, a control room, a pipe gallery, four air locks, and a four-story high-bay area (Cummings and Carter 1993). Figure 2-26 shows the floor plan for the 233-S Building, and Figure 2-27 presents an isometric view of the building.

The high-bay area is 9.4 m (length) by 4.6 m (width) by 10.0 m (height) (Cummings and Carter 1993). It is divided into two zones, a process area and a process viewing area, by a vertical partition of transparent plastic panels reinforced with structural steel. The viewing room is a maintenance and process-viewing area with four working levels, the top three of which have open-grate flooring. Access to these working levels is provided through a sheet metal enclosed stairwell adjoining the exterior high-bay walls.

While the 233-S Building does not have cells, it does have a single process area, the process hood. It was designed for contact maintenance and contains stainless steel, titanium, and glass process equipment (Crusselle and Romano 1982). A list of process equipment is given in Table 2-10 (Keele et al. 1990).

Table 2-10. Process Equipment in 233-S.

Vessel	Description
L-1	XAS feed tank
L-2	Np product concentrator
L-3	Pu product concentrator
L-4	Product receiver tank
L-6	Product sampler
L-8	Condenser
L-9	Condensate sampler
L-10F	XAF feed tank
L-10W	Receiver tank
L-11	Condenser
L-12	Final Pu product Concentrator
L-13	XAF condenser
L-14	Pu transfer trap
L-15	Jet condenser
L-16	Recycle tank
L-18	mon Anion exchange column
L-18	Anion exchange column

XAS = Nitric acid scrub stream.

XAF = Plutonium feed stream.

The 233-S Facility is partitioned into 11 major rooms plus air locks:

- Change room
- Equipment room
- Control room
- Pipe gallery
- Electrical cubical
- Can storage room
- Product removal can storage room
- Product removal can load-out room
- Stairwell
- Viewing room
- Process room.

2.8.1 Change Room

Before deactivation, the change room contained lockers for personal clothing, a stock of protective clothing, a drinking fountain, and radiation survey instruments. This room was used for changing clothing, making normal entries into and exits from the radiation area, and performing personal surveys.

2.8.2 Equipment Room

The equipment room houses the ventilation supply fans and heating and air-conditioning equipment.

2.8.3 Control Room

The control room contains the control panel board and associated instrumentation and controls that were used for remote operation of the process equipment.

The following were not deactivated during the facility layaway:

- Ventilation supply and exhaust instrumentation
- Electrical power and supply panels
- Electrical motor control center
- Fire detector and alarm instrumentation.

2.8.4 Pipe Gallery

The control panel board with metal and rigid plastic walls partition the "clean" control room from the radiologically posted pipe gallery. The pipe gallery is entered through an outside air lock located at the southwest corner of the building. Control and service piping penetrate the pipe gallery wall entering the process hood. Some of these lines are:

- Instrument sensing lines
- Water lines
- Control air lines
- Steam lines
- Chemical addition lines
- Air lines.

2.8.5 Electrical Cubical

The electrical cubical contained the switch gears for the L-16 contactor, neutron monitors, and alpha detectors located in the building. The room has been dismantled and now contains light panels and instrument air connections from the pipe gallery to the 233-SA Building.

2.8.6 Can Storage Air Lock

During the operation of 233-S, the can storage air lock, can storage room, and product-removal can storage room were maintained as areas free of smearable radioactive contamination.

The can storage air lock was used to maintain ventilation air balance during product-removal can shipment from, and recycle-can receipt into, the facility.

2.8.7 Can Storage Room

The can storage room was used to store canned recycle solutions received from the Plutonium Finishing Plant (also called Z Plant).

2.8.8 Product-removal Can Storage Room

The product-removal can storage room was used for storing canned product solutions awaiting shipment to other facilities. The can and product-removal can storage room is entered through the air lock located outside the can storage room.

2.8.9 Product-removal Can Load-out Room

The product-removal can load-out room was maintained at a low level of alpha contamination. The inside of the load-out hood was usually grossly contaminated with alpha. Empty product-removal cans were placed into the load-out hood, loaded with product solutions, removed from the hood, decontaminated, and weighed.

This room was also used for transferring recyclable solutions back into the process. The load-out hood contains the tanks, valves, and equipment used for transferring concentrated solutions into and out of the transport cans.

Entry to the load-out room was through the door from the change room. This door is presently used as an emergency door only. Entry to the load-out room is now through the product-removal can storage room.

2.8.10 Viewing Room

The viewing room is one of three rooms (along with the stairwell and process hood) that make up the four-story high-bay area. Alpha contamination levels in the viewing room run from low-level loose contamination to gross levels of fixed and loose contamination.

The first level of the viewing room has a concrete floor and the second, third, and fourth floors are made of steel grating. The viewing room is partitioned from the process hood with a metal framework and removable transparent plastic panels.

2.8.11 Process Hood

The majority of the plutonium and neptunium process equipment is located within an isolated area identified as the process hood, which was commonly called the greenhouse. The process hood is a grossly alpha-contaminated area that is made up of one room, four stories tall. It can be entered through a door in the viewing room/process hood partition on the first level.

When the building was operational, access to equipment on the first and second levels was provided by using portable stepladders. Access to levels above the second floor was made by removing partition panels on the respective viewing room level and installing scaffold planks on existing horizontal steel framework. A separate enclosure for the ion exchange unit (L-16 contactor) is located on the northeast corner of the process hood.

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Figure 2-1. Location of the Hanford Site in Washington State.

Figure 2-2. Map of the Hanford Site Area.

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Figure 2-3. Map of the 200 East Area.

H8308007.1

Figure 2-4. Map of the 200 West Area.

Figure 2-5. PUREX Plant - 200 East Area.

Photo No. 90030143-5CN

Figure 2-6. The PUREX Plant Plot Plan.

- 1 275-EA Workhouse
- 2 CCL PIT (Chem. Sewer Line)
- 3 285-AC CCL (Chem. Sewer Line)
- 4 285-AC Fractionator
- 5 Laboratory Sample Receiving Deck
- 6 202-A Unit Pump Head-Center Room
- 7 202-A Unit Pump Head-Center Room
- 8 202-A Unit Pump Head-Center Room
- 9 202-A Unit Pump Head-Center Room
- 10 202-A Unit Pump Head-Center Room
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Figure 2-7. The 202-A Building.

Figure 2-8. Top-down View of the PUREX Plant (1955).

Figure 2-9. B Plant and Ancillary Facilities.

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Figure 2-10. B Plant Complex - 200 East Area.

Photo No. 91060449-49CN

Figure 2-12. Cutaway View of 221-B Building.

Figure 2-13. Building 221-T, First Floor Layout.

WHC-EP-0787

Figure 2-14. Cutaway View of the 221-T Building.

39312050.2
T PLANT

Figure 2-15. Dimensional Cross Section of the 221-T Building.

39312050.1
T PLANT

Figure 2-16. Simplified U Plant Layout.

Figure 2-18. Simplified REDOX Area Layout.

Figure 2-19. 202-S Processing Building, Simplified Layout.

Figure 2-20. UO₃ Plant and Ancillary Facilities.

Figure 2-21. 224-U Building Floor Layouts.

Second Floor Level

Ground Floor Level

29008036.18

29008036.19

Figure 2-22. 224-UA Building Floor Layouts.

Second Floor Level

Section A-A

29008036.14

Figure 2-23. B Plant Complex Showing 224-B Facility.

Photo No. 91060449-49CN

Figure 2-24. Schematic of B Plant, 224-B, and Surrounding Facilities.

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Figure 2-25. Exploded View of 224-B Building.

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Figure 2-26. Floor Plan of the 233-S Building.

Figure 2-27. Isometric View of the 233-S Building.

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3.0 PROCESS DESCRIPTIONS

3.1 PUREX PLANT (A PLANT)

The PUREX process was designed for the individual separation of uranium, plutonium, neptunium, and fission products present in irradiated fuel elements. The constituents were separated and purified with a solvent-extraction process using an organic phase TBP dissolved in a normal paraffin hydrocarbon and nitric acid aqueous phase. The separation and purification were accomplished by controlling the relative phase distribution of the desired constituents between the organic and aqueous phases.

3.1.1 PUREX Products

During the operating life of the PUREX Plant, the following products were produced:

- Weapons-grade plutonium
- Fuel-grade plutonium
- Depleted uranium
- Slightly enriched uranium
- Neptunium
- Thorium.

3.1.1.1 Plutonium Products. The initial plutonium product was in the form of a plutonium nitrate-nitric acid solution containing approximately 350 g of plutonium per liter and approximately 7M of nitric acid per liter. The plutonium nitrate-nitric acid product was loaded into product-recovery cans and transported to PFP for conversion to metal or oxide. Between 1977 and 1981, a plutonium nitrate to oxide conversion process was installed in N cell. The conversion process was employed to produce plutonium oxide. The plutonium products were used in weapons production or in the breeder reactor program, based on the isotopic content of the plutonium involved.

3.1.1.2 Uranium Products. The uranium product was recovered in the form of a uranyl nitrate solution containing approximately 7.2 grams of uranium per cubic meter with a nitric acid concentration of <0.17 grams per cubic meter. The plutonium content was <10 parts per billion parts of uranium. The ^{235}U isotope ratio ranged from depleted to a slight enrichment of 2.1%. The uranium product solution was shipped to the 244-U Building, located in the 200 West Area, for calcination to UO_3 . The oxide product was subsequently shipped offsite for future use as nuclear fuel.

3.1.1.3 Neptunium Product. The ^{237}Np product was produced in the form of a nitrate-nitric acid solution with a neptunium concentration of approximately 40 g of neptunium per liter and a nitric acid concentration of <0.3M. Initially, neptunium nitrate solution was shipped to the Savannah River Plant for use in the production of ^{238}Pu oxide.

3.1.1.4 Thorium Product. Thorium product was produced from 1966 to 1970.

3.1.2 PUREX Processing Units

The overall PUREX Plant process consisted of seven fundamental interfacing processing units. The following is a list of those processing units:

- Feed preparation
- Solvent extraction, separation, and purification
- Solvent recovery and treatment for recycling
- Backcycle waste system
- Acid recovery
- Waste treatment
- Offgas treatment
- Conversion of plutonium nitrate to plutonium oxide.

An eighth processing unit was added to N cell to convert the plutonium nitrate product solution to a plutonium oxide product. The following section briefly describes the PUREX process as it was conducted in the 1970s and 1980s.

3.1.2.1 Feed Preparation. In the original feed preparation process for aluminum-clad fuel, the fuel elements were de-clad 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 of dissolution cuts depended 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 ensure reasonably uniform nitric acid and uranyl nitrate concentration and then was used as feed for the solvent-extraction system.

The PUREX Facility was later modified to handle the reprocessing of fuel elements from N Reactor, which consisted of uranium metal with a Zircaloy cladding. In this process, N Reactor fuel elements in their canisters were charged (dumped) to dissolvers. To remove the Zircaloy cladding from the fuel elements, the zirflex process was used. This process employed a boiling solution of ammonium fluoride and ammonium nitrate to dissolve the cladding. Potassium hydroxide was then used to convert uranium and plutonium fluoride compounds to hydrated oxides (metathesis). The cladding waste, metathesis waste, and rinse solutions were then centrifuged to remove solid uranium and plutonium compounds. These compounds underwent metathesis (if required) and/or were dissolved in nitric acid. The resulting acid solution was then blended with the reprocessing feed.

3.1.2.2 Solvent-Extraction Separation and Purification. Pulsed solvent-extraction columns were employed in the PUREX process to effect the decontamination necessary to produce acceptable products. A number of cycles made up the total solvent-extraction process.

Co-decontamination Cycle (No Neptunium Recovery). In this cycle, the uranium and plutonium were extracted into an organic solvent to separate them from the bulk of the fission products, the americium, the neptunium, and the curium that remained in the aqueous stream. The organic solvent used was a

30 vol% TBP extractant in hydrocarbon diluent. The aqueous waste stream was concentrated, partially de-nitrated, adjusted to an alkaline pH, and stored in underground storage tanks.

Partition Cycle (No Neptunium Recovery). The uranium-plutonium organic solvent stream was contacted in a partitioning column with an aqueous counter-current stream containing a chemical reducing agent. The bulk of the uranium remained in the organic solvent stream that flowed out the top of the partitioning column. Plutonium transferred into the aqueous phase stream leaving the bottom of the column. This aqueous product solution entered the scrub column where it was scrubbed with fresh organic solvent to remove residual uranium. It was then routed to the second plutonium cycle.

The organic solvent stream was fed to another column in which the uranium was stripped countercurrently from the organic phase into a dilute aqueous nitric acid stream. The stripped organic solvent was treated in the organic recovery system and was reused in the process.

The exiting aqueous uranium product stream was fed to the tower of a steam-heated concentrator, where it was concentrated by a factor of 7 to 8. Using a steam stripping process, the concentrator removed entrained organic solvent that might have entered with the product stream. This prevented accumulation of an organic phase in the concentrator and reduced the possibility of formation of potentially explosive "red oil," a complex of nitrated degraded solvent with uranium or other heavy metals. The process condensate stream was recycled as makeup water for various solvent-extraction streams.

Second and Third Plutonium Cycles. The plutonium stream was processed through a second extraction and stripping cycle for continued purification from uranium, fission products, and other metallic impurities. A third plutonium cycle further reduced the fission products and other metallic impurities to complete the purification of the plutonium product. The overhead process condensates from the stripper and concentrator were routed to the third plutonium cycle feed tank for rework and recovery of trace amounts of plutonium.

The product stream was also steam stripped to remove residual organic solvent and to reduce the probability of red oil formation. The product stream was concentrated and transferred to storage tanks where it was sampled, analyzed, and held. The product could then be converted into plutonium oxide or transported to the PFP for conversion to metal or oxide.

Plutonium Oxide Production. The plutonium nitrate solution was converted to plutonium oxide by precipitating the plutonium as oxalate, which was then calcined to produce oxide. Next, the plutonium oxide went to a blender, where it was thoroughly mixed and sampled. If the sample analyses indicated that the plutonium oxide met product specifications, it was transferred to the canning operation; if not, it was returned for recycling through the second stage calciner or the plutonium oxide rework (dissolution) facility. The final product was chemically and radiolytically stable.

Can filling operations were remotely controlled. The empty cans were weighed, and then filled; the slip-lid was placed on the can, and the filled can was weighed. The can lid was then tape-sealed. After tape-sealing, the can was "bagged" and placed into a second can, which was sealed by a commercial can-sealing machine. The can assembly was sent by conveyor to a final canning location where the assembly was loaded into a third can. The can assembly was then labeled, sealed, and placed into a shipping container for transfer to storage.

Final Uranium Cycle. The concentrated uranium product solution from the partition cycle was adjusted and became feed for the final uranium cycle. This cycle provided final decontamination from plutonium and fission products and consisted of extraction into the organic phase followed by stripping back into the aqueous phase. The uranium product solution was steam stripped to remove residual organic solution, concentrated, transferred to the 203-A Building for interim storage, and then shipped to the UO_3 Plant.

The final uranium concentration step included essentially the same elements as described previously for the partition cycle uranium stream, except that the relatively uncontaminated process condensate was sent to an underground crib for final disposal instead of being recycled within the process.

The aqueous waste contained a small percentage of the uranium, plus the residual plutonium and fission products. It was routed to the back-cycle waste concentrator and subsequently fed, along with the virgin feed metal solution, to the co-decontamination cycle.

Neptunium Recovery. The PUREX Plant could be modified to produce a neptunium product. When neptunium recovery was not employed, most of the neptunium remained in the co-decontamination cycle aqueous waste stream where it was rejected with the fission products and americium. If neptunium recovery was required, a portion of the concentrated back-cycle waste stream was used as feed for the neptunium recovery cycle. In the continuous extraction-stripping cycle, neptunium was removed and returned to the back-cycle waste system. This operation continued until the neptunium concentration reached the desired level, after which the neptunium cycle was isolated and operated on total neptunium recycle until the concentrations of plutonium, uranium, and fission products were low enough for neptunium product transfer to the final purification system.

In the final purification system, neptunium was loaded on an ion exchange resin that would then be washed to remove residual fission products and plutonium, and would then be eluted from the resin. The neptunium was then retained in a storage tank or packaged for eventual shipment offsite. The remaining effluent stream and the wash were either retained in tankage or routed to the back-cycle waste system.

3.1.2.3 Solvent Treatment. The organic solvent was washed after use to remove impurities, chemicals, and radiolytic degradation products that would interfere with proper process operation. Two separate solvent treatment systems were used. The first processed all the solvent except that from the final uranium cycle, which was processed separately in the second system.

3.1.2.4 Back-cycle Waste System. The back-cycle waste system accumulated product-bearing aqueous waste streams that were generated in the uranium and plutonium cycles. This material was concentrated and recycled for use in the solvent-extraction process. The back-cycle waste system provided recovery of products routed from the individual product purification cycles by re-extraction in the co-decontamination cycle. It also provided the nitric acid needed for the efficient extraction operation of this cycle.

The overhead condensate from the waste concentrator was routed to the first-cycle uranium concentrator, where the condensate was re-evaporated along with the principal uranium product stream.

3.1.2.5 Acid Recovery. Nitric acid was one of the principal chemicals used in the PUREX process. In addition to being used to dissolve irradiated fuels, it was also used as the "salting" agent in the solvent-extraction cycles to help force the transfer of plutonium and uranium from the aqueous phase into the organic extractant. Because of the large volume used, nitric acid was recovered and reused.

A major recovery source of nitric acid was the aqueous high-acid waste from the solvent-extraction cycles. Most of the acid was recovered by evaporation in the high-level waste concentrator. Further treatment of the concentrated waste by sugar de-nitration reduced acid levels and produced oxides of nitrogen. These oxides of nitrogen were partially converted to acid in the acid absorber, which treated the vapor from the high-level waste concentrator. The resulting dilute nitric acid stream was fed to the acid fractionator along with the acid streams that were returned from the dissolver offgas facility and from the UO_3 Plant.

3.1.2.6 Waste Treatment. Aqueous waste from the co-decontamination cycle contained essentially all of the fission products that entered the PUREX process except the radioactive gases, a fraction of the halogens, and part of the tritium. This acid waste was routed to the high-level waste feed tank, where it was diluted to enhance acid recovery before entering the waste concentrator.

The concentrated waste, partially de-acidified by boiling acid overhead, overflowed continuously from the concentrator to a waste receiver tank. After the concentrated waste had been sampled, analyzed, and confirmed for transfer, it was partially de-nitrated by the addition of a sugar solution. The gases produced, principally carbon dioxide and oxides of nitrogen, were routed back to the vapor tower of the concentrator and then to the acid absorber where the oxides of nitrogen were partially recovered as nitric acid.

The concentrated, de-nitrated waste was made alkaline and transferred from the PUREX Plant to underground storage in the tank farms.

3.1.2.7 Offgas Treatment. The offgas from the decladding step contained hydrogen and ammonia, both kept well below their lower explosive limit concentrations by water scrubbing or dilution with the large flow of process air through the system. The de-cladding offgas was water-vapor scrubbed to remove ammonia. It was then passed through steam and electric heaters, a silver reactor (for the removal of radioiodine), two fiberglass filters in

series, and out the main ventilation stack to the atmosphere. The ammonia-bearing offgas stream from the ammonia-removal system was scrubbed with water, filtered, and then discharged to the atmosphere via a separate stack.

The ammonia scrubber water, containing some radionuclides, was concentrated and sent to underground storage tanks. The concentrator condensate was sent to a crib.

The offgas from the dissolving step was passed through steam and electric heaters, a silver reactor (for the removal of radioiodine), the in-cell fiberglass filter, the secondary fiberglass filter, and into the backup facility. In the backup facility, much of the remaining iodine and oxides of nitrogen were removed from the offgas by two acid absorbers in series. The offgas was then discharged through the main ventilation stack to the atmosphere. The dilute nitric acid produced in the absorbers was recycled to the PUREX acid recovery system where it was concentrated and recycled to the process.

A fourth stage of HEPA filters was installed in the main exhaust plenum of the PUREX Plant. The HEPA filter banks were installed downstream from the fiberglass filters. Design, installation, and activation (placing in service) occurred between 1983 and 1986.

3.1.3 Process Flow Diagram

A simplified flow diagram of the PUREX process, employing a block diagram to illustrate processing unit interfaces, is shown in Figure 3-1, "PUREX Plant Simplified Flow Diagram." This flow diagram is reprinted from the PUREX FSAR (WHC 1990) and describes the PUREX process as it was conducted during the middle to late 1980s.

3.2 B PLANT

Both B Plant and T Plant were designed to separate plutonium from irradiated fuel using the bismuth-phosphate process. This original process is described in Section 3.3. The process was halted in 1952 when the PUREX plant began operations. After 1952, both B Plant and T Plant were renovated for processing of high-level liquid waste.

The bismuth-phosphate process was used to extract cesium and strontium from the liquid waste. A detailed flowsheet of the fission-product extraction process is shown in Figure 3-2. Initial centrifugation separated the strontium-bearing residual solids in the waste from the liquid, which contained both cesium and strontium. The solid phase was washed in sodium carbonate and sodium hydroxide, dissolved in nitric acid, and used as feed for ion-exchange processes. The liquid phase was further treated to separate cesium and strontium.

Phosphotungstic acid was added to the supernate from the initial centrifugation. Cesium phosphotungstate precipitated, leaving the strontium in the supernate. After a nitric acid wash and dissolution in sodium hydroxide, the cesium-bearing solution underwent two stages of ion-exchange in

which sodium, rubidium, and potassium impurities were removed. The cesium carbonate product was eluted from the column by ammonium hydroxide, concentrated, and used for encapsulation feed.

The strontium-bearing supernate from the phosphotungstate precipitation reaction and the nitric acid solution derived from the original centrifugation were treated with citric acid, then the pH was adjusted to 4.9 with sodium carbonate. The solution was sent through a series of ion exchangers that alternately transferred the strontium into an organic, then into an aqueous phase. At each step, some of the impurities were separated from the desired product. At the end of the ion-exchange process, the strontium-bearing solution was further purified by the sulfate precipitation and the caustic strike processes.

The sulfate precipitation process began with the addition of sodium sulfate and a nitric acid wash. The supernate was discarded, and the precipitate was dissolved in hydroxyethylenediaminetetraacetic acid (HEDTA), then treated with sodium hydroxide and sodium carbonate. After several batches were processed, the equipment was used for the caustic strike process.

The caustic strike process was a sodium hydroxide precipitation followed by acid treatment to recover interstitial strontium in the precipitate. The strontium solution was converted to a carbonate with sodium carbonate, then used as encapsulation feed.

3.3 T PLANT

T Plant was originally designed for the separation of irradiated fuel using the bismuth-phosphate process. Irradiated fuel was brought into the plant in rail cars and dumped into a dissolver, which initially contained sodium hydroxide. The highly caustic solution dissolved the cladding from the uranium slugs, and the cladding waste was jet pumped to the tank farm. The decladded uranium slugs were then dissolved in a solution of nitric acid and sodium nitrate. The acid dissolved the metal, and the sodium nitrate adjusted the valence of the plutonium to a +IV state. Upon addition of bismuth nitrate and phosphoric acid, plutonium was removed from solution by co-precipitation with solid bismuth phosphate.

After centrifugation, the supernate, which contained many of the fission products, was pumped to waste, and the precipitate was dissolved in nitric acid. A dichromate solution was added to the dissolved precipitate to adjust the valence of the plutonium to a +VI state. This time, when the bismuth nitrate and phosphoric acid were added, the plutonium remained in solution and the fission products were carried along with the precipitate. The supernate was pumped to storage, and the precipitate was dissolved and pumped to waste.

These steps were repeated in order to more completely decontaminate the plutonium-bearing solution. After the product had been through the cycle twice, it was sent to the 224 Concentration Building as a dilute plutonium solution.

T Plant is presently used for decontamination operations, using chemical methods, such as spraying and immersion, as well as abrasive methods, such as sandblasting, to remove radioactive contamination.

3.4 U PLANT

U Plant was used to recover uranium from the uranium-bearing effluents derived from bismuth-phosphate processing and REDOX Plants and to convert it into uranyl nitrate for processing through the UO_3 Plant. The U-Plant process used TBP to preferentially extract uranium from the plutonium and fission products also present in the waste. This process information, along with Figure 3-3, is taken from the *Uranium Recovery Technical Manual* (GEC 1951a).

The process began when the waste tanks that contained the liquid waste were sluiced with their own supernatant to produce a slurry. This slurry was dissolved in nitric acid and the resulting solution pumped to U Plant. The waste was concentrated by evaporation to approximately 70% of its original volume and centrifuged to remove any solids.

After centrifugation, the uranium-containing stream was transferred to the decontamination column. The decontamination column used TBP to selectively extract uranium from the plutonium, fission products, and other ions in the aqueous phase. An aqueous scrub stream of nitric acid was introduced at the top of the column to scrub residual traces of the fission products and plutonium from the uranium-containing TBP stream. A hydrocarbon diluent was added to the decontamination column to dilute the TBP for easier use. The plutonium and fission products were retained by the aqueous effluent while the uranium was left in the TBP stream.

The TBP stream, containing uranium and trace amounts of nitric acid, was run through the stripping column, which used water to strip uranium back into the aqueous phase. The aqueous effluent, containing approximately 6 wt% hydrated uranyl nitrate [$\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$], was the product stream sent from U Plant to the UO_3 Plant.

A second process occurred in which the spent solvent stream from the stripping column was treated and then reused. This stream contained traces of the fission products and plutonium and also solvent decomposition products. It was processed through the solvent-recovery column. Fission products, plutonium, and solvent impurities were removed from the spent solvent upon contacting the aqueous scrub solution in the solvent-recovery column. The pure organic stream was then returned to the process as a hydrocarbon diluent. The aqueous effluent from the solvent-recovery column had to be treated before final disposal in an underground storage tank.

The aqueous effluent from the solvent-recovery column was combined with the aqueous effluent from the decontamination column and neutralized with NaOH before concentration. Neutralization was needed to minimize corrosion in the waste evaporator and in the underground storage tanks. The neutralized waste was concentrated by evaporation and returned to the same waste tanks that contained the original bismuth-phosphate process waste. The volume of returned waste was approximately the same as the original uranium waste volume.

3.5 UO₃ PLANT

The UO₃ Plant received uranium product from the PUREX Plant. This product, a UNH solution, was concentrated and then calcined to UO₃ powder. The UO₃ process also provided for recovery and reuse of nitric acid, and for the handling and disposition of gaseous, liquid, and solid wastes. The major components of the UO₃ Plant are shown in Figure 3-4, and a detailed chemical flowsheet is contained in Figure 3-5 (Young 1990).

Uranium product, as 60% UNH, was transported from the PUREX Plant to the UO₃ Plant in batches. The UNH solution was pumped from the tank trailer to tank C-1 in cell C. The solution was sampled for accountability and observed for the presence of organics. If a separate organic phase was observed, it was removed using absorbent pads prior to further processing. UNH accepted for processing was pumped to one of two 378,500-L storage tanks (X-1 and X-2) located in the 203-U area for interim storage.

After sufficient UNH inventory had been accumulated in the storage facilities at the PUREX and UO₃ Plants, concentration of the UNH was started. UNH solution was pumped from the 203-U area to concentrators in cell D. The solution was concentrated from a normal uranium content of 2.1M (60% UNH) to 5.2M (100% UNH) by thermal boiling in the concentrators. The concentrated UNH, routed to the 203-UX area, was stored in a steam-heated tank (X-30).

Offgas from the concentrator knockout pot was routed through a catch tank to a fiber mist eliminator that captured UNH droplets entrained from the E-D-2, E-D-6, E-D-7 concentrators and the C-2 recycle unit concentrator. The captured UNH droplets coalesced and drained by gravity seal loop to tank C-7 for recycle to PUREX via tank C-2 and tank X-38. The offgas exiting the fiber mist eliminator contained water and a small amount of nitric acid vapor evolved during concentration, which were condensed and collected in a condensate tank. Part of the condensate was used as reflux water in the acid absorber tower; the balance was stored in tank X-37 and later neutralized before being pumped to the U-17 crib.

Concentrated UNH stored in the 203-UX area was usually fortified with 17M (93%) sulfuric acid. The quantity of acid added was specified by the customer. During the stabilization campaign, no sulfuric acid will be added during the final process run. Sulfuric acid was normally added because sulfur in the powder product aided further processing of the uranium.

Concentrated UNH was filtered and pumped to the 224-UA Building where the calcination process was conducted. Conversion of UNH to UO₃ powder occurred by calciners. The UNH feed was supplied to the calciners from a pressurized, electrically heat-traced recirculation loop.

Before operation, the calciners were filled with UO₃ bed powder and the electric furnaces were turned on. The furnaces were operated over a 30-hour period to bring the calciner shell temperature to 400 °C, and UNH was introduced into the calciners through four feed points per calciner. This initial feed introduction reduced the calciner temperature. The UNH feed to the calciner was temperature controlled so that the calciner bed operated at

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270 °C near the feed points. Shell temperature was maintained at about 500 °C for optimal efficiency.

When UNH reached the bed powder, the conversion to UO_3 was almost instantaneous, and UO_3 coated the bed powder forming large spherical particles. The resulting accumulation overflowed a weir at one end of the calciner.

The rapid decomposition of UNH liberated quantities of water vapor, oxygen, and oxides of nitrogen. This offgas was routed through a gas cooler and then to an acid-absorber tower. Suction for this system was provided by steam jets on the 224-U roof. As the offgas bubbles rose through bubble cap trays in the tower, nitric acid was formed. This acid was approximately 8.47M (42%). The remaining gas was passed through a condenser prior to discharge to the environment via the 296-U-4 stack.

UO_3 powder from the calciner fell into a pickup bin. This product was conveyed pneumatically to the powder-handling tower where the powder and air were separated by a cyclone separator. The exhaust air from this operation was routed through primary and secondary bag filters, a pre-filter, and HEPA filters before discharge to the environment via a roof exhauster. Powder from the cyclone and primary bag filter was collected in the powder hopper. Powder from the secondary bag filter was collected in 114-L drums. The cyclone and bag filters each contained two units for operation and standby.

UO_3 in the powder hopper discharged into shipping containers in the powder load out room. Filled containers, called T-hoppers, contained 5.4 metric tons of UO_3 . These T-hoppers are currently stored on a concrete pad in a fenced area north of the 2714-U Building until a future use is determined. The powder from the secondary bag filters, collected in 114-L drums, was put back into the powder-handling system.

Process condensates from the tank C-2 recycle concentrator, the UNH concentrators, and steam jets JA-1 and JA-3 were neutralized batchwise in tank C-5 with potassium hydroxide (KOH) using phosphoric acid (H_3PO_4) as a buffer. The neutralized solution, with a pH of about 7, was then discharged to the 216-U-17 crib.

Air from the hood in the load-out room was passed through a pre-filter and HEPA filter, sampled for radioactive particulates, and monitored before discharge to the environment via stack 296-U-13.

3.6 REDOX PLANT (S PLANT)

The function of the REDOX Plant was the recovery of plutonium and uranium from irradiated fuel slugs. The separation of plutonium and uranium from each other and from radioactive fission products was accomplished by a solvent-extraction process.

The solvent-extraction process enabled recovery of at least 98% to 99% of the plutonium and uranium in the irradiated slugs. The plant was designed for an average uranium production rate of 909 to 2,272 kg per day. The design basis for plutonium production is classified.

3.6.1 General Process Description

The REDOX process used the preferential extractability of uranium nitrate by hexone to separate uranium from plutonium and other fission products. The final uranium product of the REDOX Plant was a concentrated uranyl nitrate solution. The uranyl nitrate solution was fed to the Uranium Conversion Plant (224-U) Building where the uranyl nitrate was calcined to UO_3 .

The REDOX process utilized the preferential extractability of the plutonium (IV) and (VI) nitrates by hexone and the virtual non-extractability of plutonium (III) nitrate to separate plutonium from uranium and other fission products. The final plutonium product of the REDOX Plant was a plutonium nitrate solution. The plutonium nitrate solution was fed to the 233-S Building for final processing.

Ruthenium, zirconium, and niobium (columbium) limited the decontamination of uranium that could be realized by solvent extraction. In order to eliminate the need for additional solvent-extraction cycles, equipment for ruthenium distillation and zirconium-niobium scavenging were incorporated in the REDOX Plant feed preparation facilities.

Figure 3-6 is a simplified flowsheet of the REDOX Process. The individual parts of the process, feed preparation, solvent extraction, solvent treatment, and waste treatment, are discussed in the following subsections.

3.6.1.1 Feed Preparation. The purpose of the feed-preparation process was to prepare a solution from pile-irradiated uranium slugs for feed to the first solvent-extraction cycle.

The feed preparation process included the following steps:

- (a) The aluminum jackets were removed from the irradiated slugs by a solution containing 10% sodium hydroxide and 20% sodium nitrate, at boiling temperature. The resultant coating removal waste was sent to underground storage tanks.
- (b) The uranium slugs, containing plutonium and fission products, were then dissolved in 60% nitric acid at boiling temperature. The offgas formed in the dissolution was passed through a "silver reactor" where, by reaction with silver nitrate, the highly toxic radioactive iodine was removed.
- (c) The metal solution from the dissolving step was treated with sodium dichromate to oxidize plutonium to the VI valence state. The solutions were further treated with potassium permanganate to oxidize the ruthenium to the volatile tetroxide, which could be swept from the solution by sparging with air. The ruthenium was removed from the offgas in a caustic scrubbing column. Bottoms from this column were routed to underground storage tanks.

- (d) After oxidation, the metal solution was centrifuged to remove solid material detrimental to the performance of the solvent-extraction columns. Before centrifugation the solution was scavenged with a filtration aid or a manganese dioxide precipitate. Zirconium and niobium fission products adsorbed on these scavenging agents were removed during centrifugation. The filtration aid was added to the solution as a slurry; manganese dioxide was formed by reducing potassium permanganate (added during oxidation) with chromic nitrate or manganous nitrate. The cake from the centrifugation operation was either slurried or dissolved out of the centrifuge bowl and routed to underground storage tanks.
- (e) The final adjustment of the metal solution to a proper composition for a feed to the first solvent-extraction column (the IA Column) was made by the addition of a sodium hydroxide solution.

3.6.1.2 Solvent Extraction. The descriptions of the solvent-extraction cycles and the chemical flowsheet found in Figure 3-7 are based on the nominal design basis for the REDOX Plant (GEC 1951b). Flexibility was incorporated in the plant to enable it to operate under a comparatively wide range of process conditions. Processing variations would have affected flow rates, the nitric acid concentration in the entering streams, and the ammonium nitrate concentrations in the scrub streams to the uranium decontamination columns (the IA, 2D, and 3D columns). The types of chemicals used in the process would not have varied, however, and it is believed that these descriptions provide an accurate basis for evaluating residual inventory.

First Extraction Cycle. The first extraction cycle accomplished the primary separation of the metal solution into an aqueous plutonium stream, an aqueous uranium stream, and an aqueous stream containing the bulk of the fission-product elements.

The feed solution from the feed preparation section was continuously fed to the intermediate feed point of the IA column. A counter-current flow of acidified hexone extracted uranium and plutonium, both in the VI valence state, from the aqueous phase into the organic in the presence of a salting agent, aluminum nitrate, which was introduced in an aqueous solution at the top of the column. In this manner, uranium and plutonium in the organic phase were separated from the bulk of the fission-product elements, which were carried into the aqueous effluent.

The organic overhead containing uranium and plutonium was contacted in the IB column with a countercurrent flow of slightly acidified aqueous solution containing ferrous sulfamate ($\text{Fe}[\text{NH}_4\text{SO}_3]_2$) and aluminum nitrate. The ferrous sulfamate reduced plutonium to the III valence state, thus permitting it to be extracted into the aqueous phase while uranium continued to favor the organic phase. The aqueous phase was scrubbed of any uranium by slightly acidified hexone introduced at the bottom of the column. The aqueous plutonium stream was further decontaminated in the second and third plutonium cycles.

The uranium in the organic stream from the IB column was transferred into the aqueous phase in the IC column by countercurrent extraction with an aqueous stream. The aqueous effluent was then stripped of dissolved hexone, concentrated, and simultaneously adjusted to the required pH in the effluent concentrator. This concentrated uranium stream constituted the feed to the second and third uranium cycles.

Second and Third Uranium Cycles. The second and third uranium cycles further decontaminated the uranium of residual traces of radioactive fission products and plutonium that were carried over with the uranium from the first extraction cycle.

The aqueous uranium concentrate from the first extraction cycle was fed to the intermediate feed point of the 2D column. This unit was operated in the same manner as the IA column described above. The feed stream was contacted with a countercurrent flow of acidified hexone and scrubbed with an aqueous acid-deficient aluminum nitrate-ferrous sulfamate solution. The uranium transfers into the hexone phase were carried overhead while traces of fission-product elements and plutonium left the bottom of the column in an aqueous stream.

The uranium-bearing hexone stream flowed directly to the bottom of the 2E column, where, just as in the IC column described above, uranium was transferred back into the aqueous phase by countercurrent extraction with an aqueous stream. The 2E uranium stream was stripped, concentrated, and adjusted to the required pH in a similar manner as described for the effluent concentrator above. The concentrated solution was then fed to the third uranium cycle if further decontamination was required.

The third uranium cycle served to decontaminate the uranium solution, still further, of residual traces of the fission-product elements and plutonium and was identical to the second uranium cycle except that partial neutralization in the final concentrator was not required. The final concentrated uranyl nitrate solution was shipped to the Uranium Conversion Plant for calcination to UO_3 before shipment offsite. Ruthenium, zirconium, and niobium decontamination procedures in the feed preparation step discussed above may have made the third uranium cycle unnecessary in some circumstances.

Second and Third Plutonium Cycles. The function of the second and third plutonium cycles was to decontaminate the plutonium residual of traces of the fission-product elements that were carried over from the first extraction cycle.

The aqueous effluent from the IB column contained plutonium in the III valence state. The solution was oxidized by the addition of nitric acid and sodium dichromate to place plutonium in the IV or VI valence state so that it could be extracted with hexone and thus further decontaminated. The oxidized solution was fed to the center feed point of the 2A column.

The 2A and 2B columns as well as the 3A and 3B columns were operated in the same manner as the 2D, 2E, 3D, and 3E columns in the second and third uranium cycles, except that no ferrous sulfamate was added to the scrub streams. The aqueous plutonium stream from the 2B column was adjusted to the

3A column feed composition by adding aluminum nitrate solution. Because of its already low flow rate, the aqueous plutonium stream was not concentrated by boiling off water.

The aqueous plutonium stream from the 3B column was concentrated for shipment to the 231-Z or the 234-5Z Building.

3.6.1.3 Solvent Treatment. All spent hexone streams (from the IC, 2E, 3E, 2B, and 3B columns) were fed directly from a header to a scrubber column (IO) where water or a 2% sodium carbonate solution served to remove the bulk of the plutonium, uranium, and fission products that may have been present in the hexone. The overhead from this scrubber was fed to a distillation column in which, by distillation and contact with aqueous caustic reflux, the hexone was further decontaminated (removing uranium, plutonium, and fission products) and purified of any methyl isopropyl diketone and organic acids (formed by decomposition of hexone) that may have been present. Following this distillation the hexone may have been subjected to further chemical treatment if it was unsuitable for feed to the extraction columns because of impurities such as methyl isobutyl carbinol. Fresh hexone was also added to the process at this point. The combined fresh and recovered hexone was then recycled to the extraction columns. Acid additions to the hexone were made by continuous line blending just prior to feeding to the columns.

3.6.1.4 Waste Treatment and Disposal. The function of waste treatment was to treat and segregate the aqueous waste streams from the extraction and distillation columns and concentration vessels and to recover dissolved hexone from these aqueous wastes.

All fission-product wastes from the IA, 2A, 3A, 2D, 3D, IO, and organic distillation columns were fed to a waste concentrator. The high-radioactivity bottoms from the boil-up vessel, which were concentrated (for storage volume economy) to the highest practical aluminum nitrate content, were blended with the high-radioactivity wastes from the ruthenium scrubber and the 222-S Laboratory Building. The resultant solution was neutralized with caustic before disposal to the underground storage tanks. To avoid rapid corrosion of these tanks at the low pH of aluminum nitrate solutions, sufficient caustic was added to convert the aluminum nitrate to sodium aluminate.

The overhead from the waste concentrator joined the overheads from the uranium and plutonium concentrators and flowed to the condensate stripper where hexone was removed and sent to the organic recovery section. The bottoms of this column were then evaporated before being cribbed as low-radioactivity wastes. The tailings from this evaporation were recycled to the waste concentrator.

Waste offgas was routed to the exhaust plenum for treatment in sand-bed and fiberglass filtration units.

Jacket removal wastes were sent directly to underground storage tanks.

3.7 224-B FACILITY

The equipment in cell A was used to perform the bismuth-phosphate byproducts precipitation process. Cell B is a spare cell that was used only occasionally for either lanthanum fluoride byproduct or product precipitations. Cell C contained a waste neutralizing tank and an 3,000-L capacity drain receiving tank. The process lines from Building 221-B are pitched such that they drain freely into the receiving tank in Building 224-B. Cell D was the cell normally used for the lanthanum fluoride byproduct step and cell E for the subsequent lanthanum fluoride product precipitation. The lanthanum fluoride product cake was separated in the cell E centrifuge, slurried, and routed to a 3,000-L holdup tank in cell F. Cell F was used for the metathesis and solution steps of the concentration process.

Equipment in cells A, B, D, and E was identical; each contained a standard precipitator, centrifuge, catch tank, and solution tank grouping. Process piping in these cells was brought into and out of the cells through wall penetrations, and no pipe trenches were used (Shoemaker 1979).

The primary process equipment is described below (Shoemaker 1979).

Precipitators A-1, B-1, D-1, E-1

These precipitators are 2.7-m by 2.7-m, jacketed, agitated tanks with an overflow capacity of approximately 14,000 L. Associated equipment includes two thermometers, a liquid level and density recorder, circulation distribution, microphone, samples, sparger, and ionization chamber.

Centrifuges A-2, B-2, D-2, E-2

Centrifuges are 1-m units with 227-L capacity. Associated equipment includes a thermometer, tachometer, wobble indicator, microphone, liquid-level indicator, and ionization chamber.

Catch Tanks A-3, B-3, D-3, E-3

Design of the catch tanks is identical to that of the precipitators, except that agitators and distributors are omitted. Each tank is provided with a resistance thermometer, liquid-level and density recorder, sampler, sparger, microphone, and outside ionization chamber.

Solution Tanks A-4, B-4, B-6, C-4, D-4, and E-4

The solution tanks are 1.4-m by 2.1-m, jacketed, agitated tanks with an overflow capacity of approximately 2,744 L. Instrumentation and equipment include resistance thermometer, liquid-level and density recorder, sampler, sparger, microphone, and outside ionization chamber.

Metathesis Tanks F-1, F-27, F-8, and F-9

These four cell F vessels are 1.2-m by 1.5-m jacketed tanks with approximately 1,570-L overflow capacity. All are equipped with agitators, except F-9. Instrumentation on each includes resistance thermometer,

liquid-level and density recorder, sampler, and sparger. F-1 is the only tank equipped with an outside ionization chamber.

Centrifuges F-2 and F-22

These centrifuges are similar to those previously described, but are 0.66 m in size instead of the larger 1-m machines.

Product Storage Tank F-10

Final product solution from centrifuge F-2 was jetted to F-10, a process scale tank, 0.1 m (width) by 0.91 m (length) by 0.83 m (height), with a capacity of 76 L. The solution was drained out of this tank into containers for transfer to the Isolation Building. The tank is suspended inside a glass enclosure with a stainless steel drip-pan floor. Any spillage or drainage collected in a small sump in the drip-pan floor, from which it was jetted to F-8. The tank is equipped with an air sparger and a direct vent to the ventilation system. The enclosure surrounding the tank is also tied in directly to the ventilation system.

Final Product Containers

A number of special containers were provided to transfer the final product solution from the Concentration Building to the Isolation Building and to return recycle solutions to the Concentration Building. The container assembly consists of a removable, 57-L capacity, inner vessel possessing a spherically ground closure, and an outer vessel serving as a "carrier" container. The handling of the compound container in the Concentration Building was the same as that described for the Isolation Building.

Waste Tanks C-7 and C-8

These vessels are almost identical to the jacketed, agitated precipitators previously described, except that they have no distributors. Instrumentation is the same as that described for the precipitators.

Scale Tanks

Nitric, phosphoric, and hydrofluoric acid and caustic headers were supplied from Building 271 and were connected to scale tanks that metered these chemicals into the cell process vessels. All other chemical reagent solutions used in the process were made up on the control gallery in the Concentration Building.

Tank A-1A was used to add the large volume of dilution water to A-1 for the bismuth-phosphate byproduct precipitation and also to add the nitric acid for cake solution to A-1. B-1B was used to add phosphoric acid and the water wash to A-1.

Tank C-4B was used to prepare the 6.5% sodium bismuthate-2.5% sodium dichromate solution-slurry oxidation mixture that was added to C-4 for the primary oxidation in the concentration process. C-8A was used to meter 50% sodium hydroxide into the waste neutralization tank, C-8.

Tank D-1-B was used to prepare the 5% potassium permanganate solution, the 10% lanthanum salt-10% nitric acid solution, and the 6% nitric acid cake-wash solution, all of which were added to D-1 in the lanthanum fluoride byproduct step.

Tank B-1-D-1-E-1-Y was used as an anhydrous hydrofluoric acid storage tank, out of which were bled metered amounts of acid to B-1, D-1, and E-1 in the fluoride cycle.

Tank E-1-E was used to prepare the 9.6% oxalic acid and the 1.5% lanthanum salt-1% nitric acid solutions, which were added to E-1 in the lanthanum fluoride product step. Tank E-1 was used to prepare the 6% nitric acid cake-wash solution.

Tank E-A was used to make up the 50% potassium hydroxide solution supplied to the F-1 metathesis via E-2 or F-1C. D-1-B was used to make up the 17% potassium hydroxide solution, which was also routed to the F-1 metathesis wash via F-1C.

Tank F-2B was used to add the 60% nitric acid and water rinse to F-2 centrifuge for the final cake solution. Tank F-1C was used as an intermediate transfer tank for the potassium hydroxide solutions sent to metathesis from the main control gallery.

Centrifuge Spray Pumps A-2D, B-2D, D-2D, E-2D, F-2D, and F-2HPD

Except for F-2HPD, these pump systems consisted of a 72-L head tank and a centrifugal pump delivering water under at least 4.9 kg/cm² pressure to the centrifuge bowl and case sprays. The bowl sprays were used to cut the cake off the bowls in either the cake-wash or slurry-removal operations.

The F-2HPD consisted of a 208-L head tank and a high-pressure (21 kg/cm²), positive-displacement pump used to cut the lanthanum hydroxide cake from the two lower baffled sections from the metathesis centrifuges F-2 and F-22.

3.8 PFP AND REDOX CONCENTRATOR (233-S)

In 1954 and 1955, Project CA-535 (REDOX Phase II Expansion, 233-S Building) provided a new building (233-S) for the concentration of plutonium solutions for shipment to the metal fabrication area.

3.8.1 233-S Plutonium Nitrate Process

In March of 1955, concentration of plutonium nitrate solutions began. Figure 3-8 shows the 233-S plutonium schematic flow diagram.

The operating gallery (control room) contained the controls for the equipment in the process hood and the wash-solution makeup tank, L-1-A. The load-out room contained a load-out and decontamination hood for the "new system" product-recovery cans and a recycle hood for unloading the "old style"

product-recovery cans. The sample hoods for the sump, recycle tank (L-16), and product sampler tank (L-6) were also located in the load-out room. The sample hood for the condensate sampler (L-9) was in the instrument loft.

Plutonium solution was transferred to L-1 under batch control from E-3. The solution was fed by pump or jet to L-2 where the hexone was stripped and 5% to 35% of the concentration was achieved. The overflow from L-2 was concentrated in L-3 to obtain the desired plutonium content and nitric acid concentration. The concentrated solution was drained from L-3 to L-4 at a controlled rate and was cooled in L-4 for vacuum transfer to L-6. L-14 was the vacuum tank or transfer trap. L-5 was a micrometallic filter for removal of precipitated aluminum compounds or other solids. (At that time, the L5-filter was considered the strongest radioactive source in the building.) The product solution was then agitated in L-6 by recirculation, using the L-6 pump, and was then sampled. Based on the results of the sample, the volume to be loaded into each can was computed. L-7 was used to measure this volume.

The overhead vapor from L-3 was condensed in L-11 and the condensate flowed to L-12 for re-evaporation. Any entrained plutonium or nitric acid that was boiled off from L-3 was concentrated in L-12 and returned to L-3 for recovery of the plutonium. The vapors from L-2 were condensed in L-8 and those from L-12 were condensed in L-13. The steam used in the condenser vent jet and in the L-14 vacuum jet was condensed in L-15. The condensate from L-8, L-12, and L-15 was drained into a common header with a diversion loop to L-10. A valve controlled by a cycle timer permitted a portion of the condensate to flow from this header to L-9 where it could be sampled. A valve controlled by a valve switch permitted draining L-9 to L-10, and a valve controlled by a valve switch permitted draining L-10 to D-5.

3.8.2 233-S Neptunium Nitrate Process and Plutonium Nitrate Process Revision

In 1962, 233-S was converted to process neptunium nitrate and a contactor was added to process plutonium nitrate. See Figure 3-9, the "233-S Neptunium Schematic Flow Diagram."

Project CGC-913 provided the necessary facilities to permit the accumulation, decontamination, and concentration of neptunium nitrate (sometimes referred to as brandy) without interrupting the rest of the REDOX process. Two major process changes in the 233-S portion of the REDOX process resulted from Project CGC-913.

1. The concentration and load-out facilities for the neptunium nitrate solution were separated.
2. A new plutonium anion exchange contactor was installed for achieving the desired final plutonium product purification and decontamination. The additional decontamination was required because the 3A-3B columns had been withdrawn from plutonium purification service and were being used for neptunium nitrate purification.

As a result of process flow changes in the REDOX Facility (Project CGC-913), the plutonium nitrate and neptunium that were sent to the 233-S Facility were steam stripped and free of hexone. Thus, the L-2 concentrator was no longer required as a hexone stripper ahead of the plutonium concentrator and was converted to a neptunium nitrate product concentrator. A new neptunium load-out tank (L-21) was installed in a hood in the load-out room. The L-21 tank was equipped with a vacuum transfer jet, which discharged back to the L-2 concentrator. The concentrated nitrate solution was transferred from L-2 to L-21 and then loaded into a product receiving can. The processing of neptunium nitrate through the 233-S Facility was a batch operation and was done only a few times a year.

The addition of a pushed-bed anion exchange contactor, L-18, was the main change in the plutonium flowsheet in the 233-S Facility. The flowsheet for the final concentration, sampling, and load-out of the plutonium product solution remained unchanged.

Before the plutonium product solution from the 2B port in 202-S was sent to the 233-S Facility, it was stripped of hexone, treated with ozone for ruthenium removal, butted with nitric acid, and finally butted with sodium nitrite or ferrous sulfamate to adjust the plutonium to the (IV) valence state. The solution was then pumped to the XAF (plutonium feed stream) concentrator (L-12) in the 233-S Facility. There the plutonium solution was concentrated to the plutonium feed stream specifications (including a 7.0M nitric acid composition). At that concentration, plutonium (IV) existed largely in the form of a hexanitra complex divalent anion, which was readily absorbed by strong base-type anion exchange resins. The concentration step destroyed the remaining nitrite so that solutions recycled to the 202-S Building were safe from the hazard of catalyzing hexone-nitric acid reactions. The concentrated plutonium feed solution passed through a plutonium monitor pot and was then airlifted to the L-10-F feed tank. This tank was a portion of the existing criticality-safe L-10 tank. The other portion of this tank was the L-10-W tank.

From the L-10-F tank, the feed solution was pumped through a heater and a filter to the L-18 anion exchange contactor. The L-18 column was made up of an extraction section, a scrub section, a stripping section, a resin-receiver section, and a resin-reservoir section. A complete cycle of L-18 operation was made up of an operating period and a push period. During the operating period, the valves controlling process streams to and from the L-18 unit were open, and all of the valves separating the different sections of the contactor were closed except the valve between the resin receiver and resin reservoir. The plutonium feed stream was fed to the unit and the plutonium (IV) anion was extracted by the resin; the loaded resin was scrubbed with a hot (60 °C) stream of 7.0M nitric acid; and the plutonium was stripped from the loaded resin with dilute nitric acid and removed as a product solution. During the push period, the valves controlling the process streams were closed, and all of the valves separating the different sections of the contactor were open except the valve between the resin receiver and the resin reservoir. The resin was moved hydraulically for a distance of about 28 cm in the contactor by the addition of a controlled amount of pushwater. The process streams flowed clockwise, and the resin intermittently was pushed counterclockwise.

The L-1 tank served as a supply tank for the 7.0 M nitric acid scrub stream. This solution was pumped through a heater to the scrub entry nozzle on the L-18 contactor.

The former L-9 alpha monitor was installed on the waste stream. Based upon the data from this sampler, waste could be routed either directly to the mixing pot in the 2DW line or to the L-10-W tank. With this arrangement, waste solutions containing appreciable amounts of plutonium could be set aside in the L-10-W tank and later returned to the 202-S process at a controlled rate.

A proportioning pump was installed in the north pipe gallery in the 202-S Building in the waste-stream line enroute to the 2DW mixing manifold. This pump metered the acid waste (the type of acid was not specified) into the mixing manifold at a controlled rate and provided assurance that the 2DW solution (the ingredients in the 2DW solution were not identified) did not back up into the 233-S Facility. Ordinarily, the waste stream was routed from the contactor into the L-10-W tank and pumped continuously from the L-10-W tank to the 2DW mixing manifold.

A plutonium monitor was installed on the plutonium product line between the L-18 contactor and the L-3 concentrator. The operation of the L-3 concentrator and flow to the L-4 product receiver, L-6 product sampler, and load-out were the same as before.

Figure 3-1. PUREX Plant Simplified Flow Diagram.

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Figure 3-2. B Plant Fission Product Extraction Flowsheet.

Figure 3-3. U Plant General Process Flowsheet.

Uranium Oxide Plant

Uranium Oxide Plant Chemical Flowsheet - Concentration and Calcination

Basis: 36.4 Metric Tons U Per Day

Figure 3-5. UO₃ Plant Chemical Flowsheet. (2 pages)

Uranium Oxide Plant Flowsheet - Fume and Vessel Vent Systems Basis: 36.4 Metric Tons U Per Day

Figure 3-5. UO₃ Plant Chemical Flowsheet. (2 pages)

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Figure 3-6. REDOX Process Simplified Flowsheet.

REDOX PROCESS
SIMPLIFIED FLOWSHEETS

Figure 3-7. REDOX Solvent-Extraction Chemical Flowsheet.

REDOX SOLVENT-EXTRACTION
PROCESS FLOWSHEET

Figure 3-8. 233-S Plutonium Schematic Flow Diagram.

Figure 3-9. 233-S Neptunium Schematic Flow Diagram.

4.0 ESTIMATION METHODS AND RESULTS

Estimates of the waste types and volumes that will result from the D&D of each of the facilities studied are based on each facility's similarity to the PUREX Plant. A detailed study of the PUREX Plant D&D waste volumes was presented in *Estimation of PUREX Equipment and Materials that are Candidates for Removal and Waste Processing During PUREX Plant Closure* (Valero 1994).

This section details the approach, methodology, and assumptions considered in this study. The conclusions of the study are presented in Section 5.0.

4.1 GENERAL APPROACH

This study was designed to yield a rough estimate of the waste types and volumes that may result from the D&D of the main fuel reprocessing facilities in the 200 Areas. The following facilities were considered in this study:

- B Plant
- T Plant
- U Plant
- REDOX Facility
- UO_2 Facility
- 224-B Facility
- 233-S Facility.

These facilities were compared to PUREX, and the results of a previous study done for PUREX were used to estimate the amounts and categories of solid waste likely to result from D&D. Table 4-1 summarizes the PUREX study results (Valero 1994).

Perhaps the largest uncertainty in the current study is the accuracy of the data from the PUREX study upon which this study is based. It should be noted that the PUREX study was, in turn, based on a series of assumptions, which are implicit in this effort (see Valero 1994).

A rough order of magnitude (ROM) estimation, based on the footprint (square footage) of the facilities, was performed first. Then a more refined estimation was made for the reprocessing facilities, based on the volumes of similar structural features and using physical, process, and historical knowledge. Additional details that were uncovered during the study (radiological surveys, hazardous chemical surveys, and engineering reports detailing D&D work) specific to individual facilities are presented in the appendixes.

Table 4-1. Summary of PUREX D&D Solid Waste Estimation.* (2 pages)

PUREX location		Volume (m3)	Percent of equipment volume	Estimated weight (kg)	Percent of equipment weight
A cell	A cell volume	590			
	Total equipment for A cell	309		63,276	
	A cell total LLW-1	184	59%	37,195	59%
	A cell total TRUMW	78	25%	19,051	30%
	A cell total LLMW > 3	47	15%	7,031	11%
B cell	B cell volume	590			
	Total equipment for B cell	307		63,276	
	B cell total LLW-1	184	60%	37,195	59%
	B cell total TRUMW	78	25%	19,051	30%
	B cell total LLMW > 3	45	15%	7,031	11%
C cell	C cell volume	590			
	Total equipment for C cell	309		63,276	
	C cell total LLW-1	184	59%	37,195	59%
	C cell total TRUMW	78	25%	19,051	30%
	C cell total LLMW > 3	47	15%	7,031	11%
D cell	D cell volume	1,095			
	Total equipment for D cell	170		35,891	
	D cell total LLW-1	59	35%	12,134	34%
	D cell total TRU	110	66%	23,757	66%
E cell	E cell volume	1,196			
	Total equipment for E cell	140		32,221	
	E cell total LLW-1	44	31%	15,434	48%
	E cell total LLW-3	62	44%	9,700	30%
	E cell total TRU	35	25%	7,087	22%
F cell	F cell volume	3,639			
	Total equipment for F cell	738		127,131	
	F cell total LLW-1	561	76%	96,343	76%
	F cell total TRU	177	24%	25,742	20%

Table 4-1. Summary of PUREX D&D Solid Waste Estimation.* (2 pages)

PUREX location		Volume (m3)	Percent of equipment volume	Estimated weight (kg)	Percent of equipment weight
G cell	G cell volume	1,836			
	Total equipment for G cell	419		77,959	
	G cell total LLW-1	358	85%	64,449	83%
	G cell total LLW-3	62	15%	13,510	17%
H cell	H cell volume	927			
	Total equipment for H cell	213		40,857	
	H cell total LLW-1	174	82%	25,991	64%
	H cell total LLW-3	6	3%	8,165	20%
	H cell total TRU	33	16%	6,702	16%
J cell	J cell volume	1,853			
	Total equipment for J cell	354		47,378	
	J cell total LLW-1	126	36%	24,426	52%
	J cell total LLW-3	228	64%	22,952	48%
K cell	K cell volume	1,432			
	Total equipment for K cell	292		53,490	
	K cell total LLW-1	259	89%	46,788	87%
	K cell total LLW-3	33	11%	6,702	13%
L cell	L cell volume	758			
	Total equipment for L cell	267		26,799	
	L cell total LLW-1	267	100%	26,799	100%
M cell	M cell volume	253			
	Total equipment for M cell	63		7,121	
	M cell total LLW-1	61	96%	5,307	75%
	M cell total TRU	3	4%	1,814	25%
Total equipment for the PUREX Plant:		3,581		638,675	
Total for Pipe and Operating Gallery:		135		872	

NOTE: Weight data was available for some waste that was not classified by type, thus weight percentages may not add up to 100%.

* PUREX estimated inventory at deactivation, basis 180 day mark IA fuel (12% ²⁴⁰Pu).

4.2 ROUGH ORDER OF MAGNITUDE ESTIMATION METHODOLOGY

An initial ROM estimation was performed by calculating the ratio of the square footage of each facility to that of PUREX, which has a total area of 11,120 m². These ratios were then used to estimate the expected volumetric amount of solid waste by waste category based on totals from the PUREX study (Valero 1994).

$$\text{Waste type ROM} = \left(\frac{\text{square footage of the facility}}{\text{square footage of PUREX}} \right) \cdot (\text{PUREX waste type volume or weight})$$

Complete results of the ROM estimation are displayed in Table 4-2. It should be noted that the process and feed materials used by each of the facilities varies significantly from those used in PUREX; therefore, the relative percentages of wastes assigned to specific waste categories are only rough estimates. As expected, a comparison of simple square footage yields a higher estimate of solid waste for larger facilities.

4.3 VOLUMETRIC ESTIMATION METHODOLOGY AND ASSUMPTIONS

In order to get a more refined estimate of the waste volume, the cells or process areas in each facility were matched to the most similar cells or process areas in PUREX. Cells were correlated based on knowledge of the equipment present, physical layout, and process history. (Section 2.0 presents details of each facility's process functions, major equipment, and cell volumes.)

To develop the volumetric estimates of waste, similar cell processes were identified, and it was assumed that the density of equipment in the unknown cell was the same as in the matching PUREX cell. The volumetric ratios for similar cells were calculated then multiplied by the amounts of solid waste (volume and weight) reported by Valero (1994) for each of the PUREX cells to yield the estimates of solid waste for each unknown cell. These cell estimates were summed over the entire facility using the following equations:

$$\text{Estimated waste volume} = \sum \left(\frac{\text{volume of cell in } X}{\text{volume of similar PUREX cell}} \right) \cdot (\text{volume PUREX waste})$$

$$\text{Estimated waste weight} = \sum \left(\frac{\text{volume of cell in } X}{\text{volume of similar PUREX cell}} \right) \cdot (\text{weight PUREX waste})$$

where X represents the individual facility.

Table 4-2. Rough Order of Magnitude Estimates of the D&D Wastes from 200 Areas Facilities.

	PUREX (A Plant) 202-A	REDOX S Plant 202-S	U Plant 221-U	B Plant 221-B	T Plant 221-T	PCF 224-B	UO ₃ Plant 224-U and 224-UA	233-S
Scaling factor	1.00	0.32	0.45	0.45	0.45	0.75	0.15	0.03
Waste type	Equipment volume (m³)							
LLW-1	5,352.0	1,709.0	2,384.0	2,384.0	2,384.0	4,014.0	815.0	142.0
LLW-3	496.0	158.0	221.0	221.0	221.0	372.0	75.4	13.1
LLMW-3	156.0	49.8	69.5	69.5	69.5	117.0	23.7	4.14
LLMW > 3	139.0	44.5	62.1	62.1	62.1	104.0	21.2	3.69
TRU	676.0	216.0	301.0	301.0	301.0	507.0	103.0	17.9
TRUMW	78.2	25.0	34.8	34.8	34.8	58.6	11.9	2.07
Total	6,897.0	2,203.0	3,073.0	3,073.0	3,073.0	5,173.0	1,050.0	183.0
Waste type	Equipment weight (kg)							
LLW-1	630,494	201,344	280,885	280,885	280,885	472,871	95,956	16,719
LLW-3	73,936	23,611	32,938	32,938	32,938	55,452	11,252	1,961
LLMW-3	38,102	12,168	16,974	16,974	16,974	28,576	5,799	1,010
LLMW > 3	21,092	6,736	9,397	9,397	9,397	15,819	3,210	559
TRU	107,819	34,431	48,033	48,033	48,033	80,864	16,409	2,859
TRUMW	19,051	6,084	8,487	8,487	8,487	14,288	2,899	505
Total	890,494	284,374	396,715	396,715	396,715	667,870	135,526	23,613
	Piping							
Volume (m³)	111.0	35.3	49.3	49.3	49.3	83.0	16.8	2.9
Weight (kg)	126,415	40,370	56,318	56,318	56,318	94,811	19,239	3,352

The same calculations were made for the pipe galleries:

$$\text{Estimated volume of pipe} = \sum \left(\frac{\text{volume of pipe gallery in } X}{\text{volume of pipe gallery in PUREX}} \right) \cdot (\text{PUREX piping volume})$$

$$\text{Estimated weight of pipe} = \sum \left(\frac{\text{volume of pipe gallery in } X}{\text{volume of pipe gallery in PUREX}} \right) \cdot (\text{PUREX piping weight}).$$

Once the volumetric estimation was completed for each of the cells (or process areas) in a given facility, a waste class was assigned to the cell. The designation of waste classes was based solely on the best judgement of the authors and was grounded on knowledge of the processes and equipment present in a given cell. The piping in a facility was assumed to be in the same waste classes and proportions as the equipment in that facility.

The estimated waste types, volumes, and weights for each facility are discussed in the following sections along with the assumptions made in order to derive these estimates.

4.3.1 B Plant Volumetric Estimates and Assumptions

To estimate the volume, weight, and type of solid waste present in the B Plant, the following conditions were assumed.

- The original equipment used for bismuth-phosphate separations accounted for the bulk of the equipment described in the *B Plant Safety Analysis Report* (Sewell 1985). This allowed the use of the *Hanford Engineering Works Technical Manual* (DuPont 1945b) to corroborate information and supply missing information.
- All process chemicals from separations activities were removed from the plant, either by flushing or during use of the plant for the most recent cesium-strontium extraction process (the neutralized current acid waste campaign).
- The B Plant cells, which either performed the same general function or contained the same equipment as the cells in the PUREX facility, would produce the same D&D waste volumes. To estimate these volumes, B Plant cells were scaled to PUREX cells according to the volume of each processing cell and the volume of equipment that cell contained.

Considering the above assumptions, the B Plant was compared to PUREX. Using the calculated ratios between PUREX cells and similar B Plant cells, an estimate of the volume and weight of equipment considered candidates for D&D was developed for each cell in the B Plant, as indicated in Table 4-3.

Table 4-3. Volumetric Estimate of Solid Wastes from the D&D of B Plant. (2 pages)

B Plant cell	B Plant cell volume (m ³)	PUREX similar cell	PUREX similar cell volume (m ³)	B Plant/PUREX similar cell volumetric ratio	PUREX cell equipment volume (m ³)	PUREX cell equipment weight (kg)	B Plant estimated equipment volume (m ³)	B Plant estimated equipment weight (kg)
1	143	A	590	0.2427	309	63,276	75	15356
2	143	A	590	0.2427	309	63,276	75	15356
3	640	A	590	1.0852	309	63,276	335	68670
4	555	D	1,095	0.5068	170	35,891	86	18189
5	143	F	3,639	0.0393	738	127,131	29	4999
6	143	F	3,639	0.0393	738	127,131	29	4999
7	143	F	3,639	0.0393	738	127,131	29	4999
8	143	F	3,639	0.0393	738	127,131	29	4999
9	143	D	1,095	0.1307	170	35,891	22	4690
10	312	D	1,095	0.2851	170	35,891	48	10232
11	143	E	1,196	0.1196	140	32,221	17	3855
12	143	E	1,196	0.1196	140	32,221	17	3855
13	143	E	1,196	0.1196	140	32,221	17	3855
14	143	E	1,196	0.1196	140	32,221	17	3855
15	143	A	590	0.2427	309	63,276	75	15356
16	143	A	590	0.2427	309	63,276	75	15356
17	143	D	1,095	0.1307	170	35,891	22	4690
18	143	G	1,836	0.0779	419	77,959	33	6075
19	143	D	1,095	0.1307	170	35,891	22	4690
20	143	F	3,639	0.0393	738	127,321	29	4999
21	143	D	1,095	0.1307	170	35,891	22	4690

Table 4-3. Volumetric Estimate of Solid Wastes from the D&D of B Plant. (2 pages)

B Plant cell	B Plant cell volume (m ³)	PUREX similar cell	PUREX similar cell volume (m ³)	B Plant/PUREX similar cell volumetric ratio	PUREX cell equipment volume (m ³)	PUREX cell equipment weight (kg)	B Plant estimated equipment volume (m ³)	B Plant estimated equipment weight (kg)
22	143	F	3,639	0.0393	738	127,321	29	4999
23	143	F	3,639	0.0393	738	127,321	29	4999
24	143	D	1,095	0.1307	170	35,891	22	4690
25	143	D	1,095	0.1307	170	35,891	22	4690
26	143	D	1,095	0.1307	170	35,891	22	4690
27	143	D	1,095	0.1307	170	35,891	22	4690
28	143	G	1,836	0.0779	419	77,959	33	6075
29	143	G	1,836	0.0779	419	77,959	33	6075
30	143	G	1,836	0.0779	419	77,959	33	6075
31	143	D	1,095	0.1307	170	35,891	22	4690
32	143	E	1,196	0.1196	140	32,221	17	3855
33	143	D	1,095	0.1307	170	35,891	22	4690
34	143	D	1,095	0.1307	170	35,891	22	4690
35	143	D	1,095	0.1307	170	35,891	22	4690
36	143	D	1,095	0.1307	170	35,891	22	4690
37	143	D	1,095	0.1307	170	35,891	22	4690
38	143	K	1,432	0.0999	292	53,490	29	5345
39	143	D	1,095	0.1307	170	35,891	22	4690
40	143	M	253	0.5663	63	7,121	36	4033
Total equipment waste for B Plant:							1,585	316,816

Based on available information and personal interviews, the potential types of waste associated with each cell in the B Plant were identified. In addition to the chemicals used in the process, some cells may also be contaminated with lead. The lead originates from the jumpers used to connect the equipment in the process cells. Lead counterweights ensured that the jumpers were level when suspended from a crane. It was estimated that approximately 5% of the jumpers required counterweights. Assuming that a typical process cell used 30 to 35 jumpers, the number of jumpers that required counterbalancing in the B Plant is conservatively estimated to be 70. Each counterweight is approximately 1,232 cm³ and weighs about 14 kg, so this estimate accounts for approximately 980 kg of lead.

It should also be noted that some cells currently contain materials that are scheduled for removal prior to decommissioning. As indicated in the *B Plant Cleanout and Stabilization Program Plan*, tanks 26-1 and 27-3, in cells 26 and 27 respectively, are estimated to contain about 19,000 L of organic waste (Gehrke 1992).

Additionally, it is estimated that nine tanks in the low-level waste system (approximately 136,300 L total) contain sodium hydroxide and sodium nitrate. Because these chemicals are scheduled for removal prior to decommissioning, the values are not included in the estimates or totals.

The potential types of waste associated with the B Plant are summarized in Table 4-4.

Table 4-4. Potential Types of Waste in the B Plant.

B Plant cell number	Probable predominant waste category	Other possible waste categories	Potential dangerous/hazardous chemicals ^a
1-4	LLW-3	LLW > 3 LLMW-3	HNO ₃ , NaOH, phosphotungstic acid, group 1 ^b , NH ₄ OH, Fe, Al, and Zr
5-8	LLW-3	LLW > 3 LLMW-3	HNO ₃
9-10 ^c	LLW-3	LLMW-3	HNO ₃ , NaOH, phosphotungstic acid, group 1 ^b , and NH ₄ OH
11-12	LLW-3	LLMW-3	NaOH
13-14	LLW-3	LLMW-3	Phosphotungstic acid
15-16 ^d	LLW-3	LLW-1	HNO ₃ , NaOH, phosphotungstic acid, group 1 ^b , and NH ₄ OH
17-21	LLW-3	LLMW-3	NaOH
22 ^e	LLW-3	LLW-1	HNO ₃ , NaOH, phosphotungstic acid, group 1 ^b , and NH ₄ OH
23-25 ^f	LLW-3	LLW-1	HNO ₃ , NaOH, phosphotungstic acid, group 1 ^b , and NH ₄ OH
26-30	LLW-3	LLMW-3	HNO ₃ , phosphotungstic acid, and group 1 ^b
31-32 ^g	LLW-3	LLMW-3	HNO ₃ , NaOH, phosphotungstic acid, group 1 ^b , and NH ₄ OH
33-37 ^g	LLW-3	LLW > 3	HNO ₃ , NaOH, phosphotungstic acid, group 1 ^b , and NH ₄ OH
38-40	LLW-3	LLW > 3	NH ₄ OH, HNO ₃ , and NaOH

^aThis list will also include lead from pipe jumpers.

^bGroup 1 contains:

Di-ethylhexyl phthalate, tributylphosphate (TBP), normal paraffin hydrocarbon (NPH), hydroxyethylenediaminetetraacetic acid (HEDTA), citric acid, and Na citrate.

^cCell(s) used for waste collection.

^dCell(s) used for decontamination.

^eCell(s) used for vessel venting.

^fCell(s) used for waste handling.

^gCell(s) used for waste and/or product storage.

4.3.2 T Plant Volumetric Estimates and Assumptions

To estimate the volume, weight, and category of solid waste present in the T Plant, the following conditions were assumed.

- Equipment for T Plant designated as "original" in the *T Plant Safety Analysis Report* (Semmens 1993) was assumed to be consistent with the equipment in the corresponding B Plant cell, described in the *B Plant Safety Analysis Report* (Sewell 1985).
- Cells that were not designated for a specific use, such as decontamination or equipment run-in, and that contained original equipment according to the safety analysis report, were assumed to contain chemicals and radionuclides associated with the bismuth-phosphate separation process.
- Only hazardous or dangerous radioactive solid waste from the canyon cells and pipe galleries were to be considered.

Lead counterweights used on jumpers are expected to exist in the T Plant facility. As previously discussed, this could result in lead contamination for some of the cells in the T Plant. Because more detailed information was not available, it was assumed that the T Plant contained the same number of jumpers as the B Plant. Based on this assumption, 70 jumpers could result in approximately 980 kg of lead.

Based on the assumptions above, the T Plant was compared to the data generated in the PUREX study (Valero 1994). The estimated volumes and weights of equipment considered for decommissioning are contained in Table 4-5.

Based on the information available, the potential types of waste associated with each cell in the T Plant were identified and are presented in Table 4-6.

Table 4-5. Volumetric Estimate of Solid Wastes from the D&D of T Plant. (2 pages)

T Plant cell	T Plant cell volume (m ³)	PUREX similar cell	PUREX similar cell volume (m ³)	T Plant/PUREX similar cell volumetric ratio	PUREX cell equipment volume (m ³)	PUREX cell equipment weight (kg)	T Plant estimated equipment volume (m ³)	T Plant estimated equipment weight (kg)
Head end	143	A	590	0.2427	309	63,276	75	15,356
Head end	143	A	590	0.2427	309	63,276	75	15,356
2L	640	A	590	1.0852	309	63,276	335	68,670
2R	555	A	590	0.9412	309	63,276	291	59,554
3L	143	A	590	0.2427	309	63,276	75	15,356
3R	143	M	253	0.5663	63	7,121	36	4,033
4L	143	M	253	0.5663	63	7,121	36	4,033
4R	143	M	253	0.5663	63	7,121	36	4,033
5L	143	D	1,095	0.1307	170	35,891	22	4,690
5R	312	M	253	1.2354	63	7,121	78	8,798
6L	143	D	1,095	0.1307	170	35,891	22	4,690
6R	143	D	1,095	0.1307	170	35,891	22	4,690
7L	143	M	253	0.5663	63	7,121	36	4,033
7R	143	M	253	0.5663	63	7,121	36	4,033
8L	143	D	1,095	0.1307	170	35,891	22	4,690
8R	143	E	1,196	0.1196	140	32,221	17	3,855
9L	143	D	1,095	0.1307	170	35,891	22	4,690
9R	143	G	1,836	0.0779	419	77,959	33	6,075
10L	143	M	253	0.5663	63	7,121	36	4,033
10R	143	D	1,095	0.1307	170	35,891	22	4,690
11L	143	D	1,095	0.1307	170	35,891	22	4,690
11R	143	A	590	0.2427	309	63,276	75	15,356
12L	143	M	253	0.5663	63	7,121	36	4,033
12R	143	M	253	0.5663	63	7,121	36	4,033
13L	143	M	253	0.5663	63	7,121	36	4,033

Table 4-5. Volumetric Estimate of Solid Wastes from the D&D of T Plant. (2 pages)

T Plant cell	T Plant cell volume (m ³)	PUREX similar cell	PUREX similar cell volume (m ³)	T Plant/PUREX similar cell volumetric ratio	PUREX cell equipment volume (m ³)	PUREX cell equipment weight (kg)	T Plant estimated equipment volume (m ³)	T Plant estimated equipment weight (kg)
13R	143	M	253	0.5663	63	7,121	36	4,033
14L	143	E	1,196	0.1196	140	32,221	17	3,855
14R	143	D	1,095	0.1307	170	35,891	22	4,690
15L	143	D	1,095	0.1307	170	35,891	22	4,690
15R	143	D	1,095	0.1307	170	35,891	22	4,690
16L	143	D	1,095	0.1307	170	35,891	22	4,690
16R	143	E	1,196	0.1196	140	32,221	17	3,855
17L	143	D	1,095	0.1307	170	35,891	22	4,690
17R	143	E	1,196	0.1196	140	32,221	17	3,855
18L	143	M	253	0.5663	63	7,121	36	4,033
18R	143	E	1,196	0.1196	140	32,221	17	3,855
19L	143	D	1,095	0.1307	170	35,891	22	4,690
19R	143	D	1,095	0.1307	170	35,891	22	4,690
20L	143	D	1,095	0.1307	170	35,891	22	4,690
20R	143	M	253	0.5663	63	7,121	36	4,033
Total equipment waste for T Plant:							1,884	342,540

Table 4-6. Potential Types of Waste in the T Plant

T Plant section number	Probable predominant waste category	Other possible waste categories	Potential dangerous/hazardous chemicals
1 (head end)	LLW-1	--	Pb
2L	LLW-1	LLMW-1	Pb
2R	LLW-3	HLW - spent fuel	--
3L-7R	LLMW-1	LLW-1 LLMW-1	B Plant reagents, Pb, PUREX reagents, BiPO ₄ process reagents
8L-8R	TRU	LLW-1	H ₂ SO ₄ , HNO ₃ , H ₃ PO ₄ , BiPO ₄ , NaNO ₂ , Pb
9L-9R	LLW-1	LLW-3	NaOH, Pb, NaCO ₃
10L	LLMW-1	--	Pb
10R-12R	LLW-1	LLMW-1	NaOH, KMnO ₄ , HNO ₃
13L	LLMW-1	--	Ag salts, AgI
13R	LLMW-1	--	Pb
14L-14R	LLW-1	LLW > 3	H ₃ PO ₄ , NaBiO ₃ , Pb
15L-15R	LLW-1	--	NaOH, Pb, HNO ₃ , KMnO ₄
16L-16R	LLW-1	LLW-3	H ₃ PO ₄ , NaBiO ₃ , Pb
17L-17R	TRU	LLW-3	H ₃ PO ₄ , NaBiO ₃ , Pb
18L-18R	LLW-1	LLW-3, LLMW-1, LLMW-3	H ₃ PO ₄ , NaBiO ₃ , Pb
19L-19R	LLW-1	LLW-3, LLMW-1, LLMW-3	H ₃ PO ₄ , NaBiO ₃ , Pb
20L	LLW-1	--	Pb
20R	LLW-1	--	Pb

4.3.3 U Plant Volumetric Estimates and Assumptions

It is extremely difficult to determine the current contents of the U Plant cells. The major reason for this is the lack of information; exact records were not kept as to what deactivated equipment from other plants was transferred to U Plant and in which cells it was placed. Also, it has been quite difficult to resolve how the U Plant's cells were used in the uranium recovery process.

Existing information is often conflicting. Three sources, included in Appendix A, shed light on the contents of the cells: *Canyon Equipment List for U Plant* (Van Sickle 1990), *REDOX and U Plant Dangerous Waste Tank Identification and Sampling Ability* (Speer 1989), and photographs of most of the cells. It is not certain whether the cells were left unchanged after the photographs were taken. Unfortunately, the documents often list conflicting cell contents, and the pictures present a third possibility. In determining the cell contents, all three sources were compared, and when two sources agreed, that equipment was listed. If all sources differed, the photographs were taken as the definitive source. If a photograph was not available and the two memos disagreed, the information in the *Canyon Equipment List for U Plant* (Van Sickle 1990) was reported.

Another uncertainty was encountered in determining how the cells related to the uranium recovery process. It is not certain which cells were actually involved, and it is likely that there are cells that were never used and still contain the original U Plant equipment with jumpers in place. In cases such as this, the cell was considered to have been used and the total waste calculated accordingly.

Several assumptions were made when dividing the U Plant waste into the five waste categories discussed in Section 1.1. These assumptions follow.

- It was assumed that all tanks and process vessels still contained a residual heel of liquid waste because it is not known whether terminal cleanout activities were performed. Therefore, all cells with potential residual heels were designated LLMW.
- It was assumed that all non-mixed waste was Category I because 36 years have elapsed since the shutdown of U Plant. U Plant personnel supported this designation.
- It was assumed that very little TRU waste exists in U Plant. The plutonium and other fission products that entered the plant remained in solution and were passed through the system and back into underground storage tanks. The concentration of plutonium in the liquid waste entering the U Plant would have been minimal because most of it was removed by the bismuth-phosphate process. The plutonium content of the uranium waste processed in the U Plant was about 2 to 4 grams per ton of uranium (GEC 1951a). (It should be noted, however, that an unfinished study, begun in 1988, estimated 10% TRU and 90% LLW for the U Plant Facility.)
- It was assumed that the cells in which waste concentration occurred had a slight potential for TRU contamination; hence, several cells list TRU as a possible waste category. Stored equipment from the PUREX Plant is another possible source of TRU waste. Cell 12 contains a PUREX pot dissolver, a potential source of TRUMW. Cell 16 contains 17 PUREX thorium jumpers, a candidate source of TRU waste.

No definitive radiological inventory exists for U Plant. The *Canyon Equipment List for U Plant* (Van Sickle 1990), included in Appendix D-3, contains open cell readings for many of the canyon cells, but it is unclear whether this is a reliable source. The *Preliminary Characterization for*

Decontamination and Decommissioning of the U Plant Reprocessing Facilities (Bowers and Nolande 1980b) estimates a radiological inventory for the U Plant canyon of 800 Ci from fission products and 15 Ci from uranium. A value of 10,015 Ci of beta activity has been reported in several documents and was traced back to the *Rockwell Retired Contaminated Facility Listing and Description* (Crusselle and Romano 1982). However, no justification for this number has been discovered and its validity is questionable.

Considering the available information, the cell volumes for the U Plant were compared to the data in the PUREX study. The estimated volumes and weights of equipment considered for D&D in the U Plant are contained in Table 4-7.

Based on personal interviews, documents, and process information, the potential categories of waste associated with each cell in the U Plant are identified in Table 4-8.

Table 4-7. Volumetric Estimate of Solid Wastes from the D&D of U Plant. (2 pages)

U Plant cell	U Plant cell volume (m ³)	PUREX similar cell	PUREX similar cell volume (m ³)	U Plant/PUREX similar cell volumetric ratio	PUREX cell equipment volume (m ³)	PUREX cell equipment weight (kg)	U Plant estimated equipment volume (m ³)	U Plant estimated equipment weight (kg)
1	143	A	590	0.2427	309	63,276	75	15,356
2	143	M	253	0.5663	63	7,121	36	4,033
3	640	A	590	1.0852	309	63,276	335	68,670
4	555	M	253	2.1961	63	7,121	139	15,639
5	143	M	253	0.5663	63	7,121	36	4,033
6	143	E	3,639	0.1196	140	32,221	17	3,855
7	143	M	3,639	0.5663	63	7,121	36	4,033
8	143	F	3,639	0.0393	738	127,131	29	4,999
9	143	F	1,432	0.0393	738	127,131	29	4,999
10	312	F	253	0.0858	738	127,131	63	10,907
11	143	K	1,432	0.0999	292	53,490	29	5,345
12	143	M	253	0.5663	63	7,121	36	4,033
13	143	K	1,432	0.0999	292	53,490	29	5,345
14	143	M	253	0.5663	63	7,121	36	4,033
15	143	K	1,432	0.0999	292	53,490	29	5,345
16	143	M	253	0.5663	63	7,121	36	4,033
17	143	K	1,432	0.0999	292	53,490	29	5,345
18	143	M	253	0.5663	63	7,121	36	4,033
19	143	K	1,432	0.0999	292	53,490	29	5,345
20	143	K	1,432	0.0999	292	53,490	29	5,345
21	143	G	1,836	0.0779	419	77,959	33	6,075
22	143	G	1,836	0.0779	419	77,959	33	6,075

Table 4-7. Volumetric Estimate of Solid Wastes from the D&D of U Plant. (2 pages)

U Plant cell	U Plant cell volume (m ³)	PUREX similar cell	PUREX similar cell volume (m ³)	U Plant/PUREX similar cell volumetric ratio	PUREX cell equipment volume (m ³)	PUREX cell equipment weight (kg)	U Plant estimated equipment volume (m ³)	U Plant estimated equipment weight (kg)
23	143	G	1,836	0.0779	419	77,959	33	6,075
24	143	G	1,836	0.0779	419	77,959	33	6,075
25	143	E	1,196	0.1196	140	32,221	17	3,855
26	143	E	1,196	0.1196	140	32,221	17	3,855
27	143	E	1,196	0.1196	140	32,221	17	3,855
28	143	M	253	0.5663	63	7,121	36	4,033
29	143	M	253	0.5663	63	7,121	36	4,033
30	143	M	253	0.5663	63	7,121	36	4,033
31	143	M	253	0.5663	63	7,121	36	4,033
32	143	D	1,095	0.1307	170	32,221	17	3,855
33	143	F	3,639	0.0393	738	127,131	29	5,345
34	143	K	1,432	0.0999	292	53,490	29	5,345
35	143	G	1,836	0.0779	419	77,959	33	6,075
36	143	E	1,196	0.1196	140	32,221	17	3,855
37	143	K	1,432	0.0999	292	53,490	29	5,345
38	143	K	1,432	0.0999	292	53,490	29	5,345
39	143	K	1,432	0.0999	292	53,490	29	5,345
40	143	E	1,196	0.1196	140	32,221	17	3,855
Total equipment waste for U Plant:							1,673	281,097

Table 4-8. Potential Types of Waste in the U Plant. (2 pages)

U Plant cell number	Probable predominant waste category	Other possible waste categories	Potential dangerous/hazardous chemicals
1	LLW-1	--	--
2	LLMW-1	LLW-1	Hexone
3	Unknown (LLW-1)	--	--
4	LLW-1	--	--
5	LLW-1	--	--
6	LLMW-1	LLW-1	HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaHSO ₄ , uranyl nitrate hexahydrate (UNH)
7	LLW-1	TRU, LLMW-1	--
8	LLW-1	--	--
9	LLW-1	--	--
10	LLW-1	--	--
11	LLMW-1	TRU, LLW-1	HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaHSO ₄ , UNH
12	LLW-1	TRUMW	Zr heel, Hg
13	LLMW-1	TRU, LLW-1	HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaHSO ₄ , UNH
14	LLW-1	--	--
15	LLMW-1	TRU, LLW-1	Al(NO ₃) ₃ , HNO ₃ , TBP, UNH
16	LLW-1	TRU	--
17	LLMW-1	TRU, LLW-1	NH ₄ OH, Fe(OH) ₃ , NaCl, Na ₂ U ₂ O ₇ , NaNO ₃ , Na ₃ PO ₄ , Na ₂ SO ₄ , TBP
18	LLW-1	--	--
19	LLMW-1	TRU, LLW-1	HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaHSO ₄ , UNH
20	LLMW-1	TRU, LLW-1	HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaHSO ₄ , UNH
21	LLMW-1	LLW-1	NH ₂ SO ₃ H, Fe(NH ₄) ₂ (SO ₄) ₂ , FeCN, HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaHSO ₄ , TBP, UNH
22	LLMW-1	LLW-1	NH ₄ OH, Fe(OH) ₃ , NiSO ₄ , NaCl, Na ₂ U ₂ O ₇ , NaOH, NaNO ₃ , Na ₃ PO ₄ , TBP, Na ₂ SO ₄
23	LLMW-1	LLW-1	NH ₂ SO ₃ H, Fe(NH ₄) ₂ (SO ₄) ₂ , FeCN, HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaHSO ₄ , TBP, UNH
24	LLMW-1	LLW-1	NH ₂ SO ₃ H, Fe(NH ₄) ₂ (SO ₄) ₂ , FeCN, HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaHSO ₄ , TBP, UNH
25	LLMW-1	LLW-1	NH ₂ SO ₃ H, Fe(NH ₄) ₂ (SO ₄) ₂ , FeCN, HNO ₃ , H ₃ PO ₂ , NaNO ₃ , NaHSO ₄ , TBP, UNH
26	LLMW-1	LLW-1	NH ₂ SO ₃ H, Fe(NH ₄) ₂ (SO ₄) ₂ , FeCN, HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaHSO ₄ , TBP, UNH
27	LLMW-1	LLW-1	Al(NO ₃) ₃ , HNO ₃ , TBP, UNH
28	LLMW-1	LLW-1	HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaHSO ₄ , UNH

Table 4-8. Potential Types of Waste in the U Plant. (2 pages)

U Plant cell number	Probable predominant waste category	Other possible waste categories	Potential dangerous/hazardous chemicals
29	LLW-1	--	--
30	LLMW-1	LLW-1	Cr, sulfamate, hexone
31	LLW-1	--	--
32	LLMW-1	LLW-1	HNO ₃ , TBP, UNH
33	LLMW-1	LLW-1	DEOBASE ^a , HNO ₃ , TBP, UNH
34	LLMW-1	LLW-1	NH ₂ SO ₃ H, Fe(NH ₄) ₂ (SO ₄) ₂ , HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaHSO ₄ , TBP, UNH
35	LLMW-1	LLW-1	DEOBASE, HNO ₃ , H ₃ PO ₄ , Na ₂ SO ₄ , H ₂ SO ₄ , TBP, UN, UNH
36	LLMW-1	LLW-1	TBP, DEOBASE
37	LLMW-1	LLW-1	DEOBASE, HNO ₃ , TBP, UNH
38	LLMW-1	LLW-1	NH ₂ SO ₃ ⁴ , Fe(NH ₄) ₂ , HNO ₃ , H ₃ PO ₄ , NaNO ₃ , NaSHO ₄ , TBP, UNH
39	LLMW-1	LLW-1	DEOBASE, HNO ₃ , H ₃ PO ₄ , Na ₂ SO ₄ , H ₂ SO ₄ , TBP, UN, UNH
40	LLMW-1	LLW-1	TBP, DEOBASE

^a Representative diluent.

4.3.4 REDOX Facility Volumetric Estimates and Assumptions

To estimate the volumes, weights, and categories of solid waste present in the REDOX Facility, the following conditions were assumed.

- The *REDOX Technical Manual* (GEC 1951b) and engineering drawings accurately depict the as-built/current status of the facility.
- Deactivation operations have reduced radioactive inventory to levels that do not exceed LLW-1 or TRU criteria.
- Equipment dimensions increase or decrease linearly with comparative equipment at the PUREX Plant.
- The presence or association with hexone solvent constitutes a "mixed waste" condition.

Based on the assumptions above, the REDOX Facility was compared to the data generated by the PUREX study. The estimated volume and weight of equipment considered for decommissioning are contained in Table 4-9.

The potential categories of waste associated with the REDOX Facility are summarized in Table 4-10.

Table 4-9. Volumetric Estimate of Solid Waste from the D&D of the REDOX Facility.

REDOX cell	REDOX cell volume (m ³)	PUREX similar cell	PUREX similar cell volume (m ³)	REDOX/PUREX similar cell volumetric ratio	PUREX cell equipment volume (m ³)	PUREX equipment weight (kg)	REDOX estimated equipment volume (m ³)	REDOX estimated equipment weight (kg)
A,B,C	733	A,B,C	1,769	0.4140	924	189,829	383	78,605
D	1,079	F	3,639	0.2965	738	127,131	219	37,703
E	743	J,L	2,612	0.2845	621	74,177	177	21,109
F	915	H	927	0.9870	213	40,857	210	40,329
G	406	G	1,836	0.2213	419	77,959	93	17,255
H	1,203	E	1,196	1.0057	140	32,221	141	32,408
J	575	F	3,639	0.1579	738	127,131	117	20,076
Silo ^a	6,761	H,K,L	3,117	2.1690	771	121,200	1,672	262,891
Total Equipment for REDOX:							3,011	510,376

^a Volume only represents column extraction area, aqueous makeup, boiler/feed tank, sample gallery and crane operating gallery.

Table 4-10. Process Areas and Probable Associated Waste Categories.

REDOX cell	Probable predominant waste category	Other possible waste categories	Potential dangerous/hazardous chemicals
A	LLW-1	LLMW	Silver salts
B	LLW-1	LLMW	Silver salts
C	LLW-1	LLMW	Silver salts
D	LLMW	LLW-1	Hexone
E	LLMW	LLW-1	Cr sulfamate, hexone
F	LLMW	LLW-1	Cr sulfamate, hexone
G	LLMW	LLW-1	Hexone
H	LLW-1	--	None
J	LLW-1	--	None
Silo	LLMW	LLW-1	Hexone

4.3.5 UO_3 Plant Volumetric Estimates and Assumptions

To estimate the volumes, weights, and categories of solid waste present in the UO_3 Plant, the following conditions were assumed.

- Knowledge of the original process was used primarily when matching similar cells, and knowledge of the equipment was used to select between PUREX cells with the same function.
- The UO_3 Plant will be deactivated in the same manner as PUREX, as they are both included in the *PUREX/ UO_3 Deactivation Project Management Plan* (WHC 1993).
- Cell functions (during processing) and equipment were considered consistent with the equipment lists in the *Uranium Trioxide (UO_3) Plant Process Flowsheet* (Young 1990).

Considering the assumptions above, the UO_3 Plant was compared to the data generated by the PUREX study (Valero 1994). The estimated volumes and weights of equipment considered for decommissioning are contained in Table 4-11.

Two documents were used to determine the cell contents of the UO_3 Plant, the *Uranium Oxide (UO_3) Plant Process Flowsheet* (Young 1990) and the *PUREX/ UO_3 Deactivation Project Management Plan* (WHC 1993). Available information indicates that no TRU waste is expected to be present in the UO_3 Plant. A summary of the most probable waste types in the UO_3 Plant is contained in Table 4-12.

Table 4-11. Volumetric Estimate of Solid Waste from the D&D of the UO₃ Plant.

UO ₃ cell	UO ₃ cell volume (m ³)	PUREX similar cell	PUREX similar cell volume (m ³)	PUREX study data description	PUREX cell equipment volume (m ³)	PUREX cell equipment weight (kg)	UO ₃ estimated equipment volume (m ³)	UO ₃ estimated equipment weight (kg)
224-U Building								
A	951	L	758	Total equipment for L cell	267	26,799	335	33,630
B	951	M	253	Cell	63	7,121	239	26,810
C	1,198	D	1,095	Total equipment for D cell	170	35,891	186	39,255
D	951	L	758	Total equipment for L cell	267	26,799	335	33,630
E	951	A	590	Total equipment for A cell	309	63,276	498	102,093
F	850	A	590	Total equipment for A cell	309	63,276	445	91,154
Total equipment waste for the 224-U Building:							2,038	326,571
224-UA Building								
G	204	A	590	Total equipment for A cell	309	63,276	107	21,877
H	204	A	590	Total equipment for A cell	309	63,276	107	21,877
J	204	A	590	Total equipment for A cell	309	63,276	107	21,877
K	204	A	590	Total equipment for A cell	309	63,276	107	21,877
L	204	A	590	Total equipment for A cell	309	63,276	107	21,877
M	204	A	590	Total equipment from A cell	309	63,276	107	21,877
Total equipment waste for the 224-UA Building:							641	131,262
Total equipment for the UO₃ Plant:							2,678	457,833

Table 4-12. Potential Types of Waste in the UO₃ Plant.

UO ₃ Plant cell number	Probable predominant waste category	Other possible waste categories	Pctential dangerous/hazardous chemicals
A	LLW-1	--	HNO ₃
B	LLW-1	--	--
C	LLW-3	LLW-1	HNO ₃ , uranyl nitrate hexahydrate (UNH)
D	LLW-3	LLW-1	UNH
E	LLW-1	--	--
F	LLW-1	--	--
G, H, J, K, L, M	LLW-1	--	HNO ₃ , UO ₃

4.3.6 224-B Facility Volumetric Estimates and Assumptions

To estimate the volume, weight, and category of solid waste present in the 224-B Facility, the following conditions were assumed.

- Knowledge of the original process was used primarily when matching similar cells, and knowledge of the equipment was used to select between PUREX cells with the same function.
- Equipment in the 224-B canyon cells is consistent with the equipment lists contained in the *224-B Decontamination Project Plan* (Owens 1985).

Considering the assumptions above, the 224-B Facility was compared to the data generated by the PUREX study (Valero 1994). The estimated volumes and weights of equipment considered for decommissioning are contained in Table 4-13.

The potential categories of waste associated with the 224-B Facility are summarized in Table 4-14.

Table 4-13. Volumetric Estimate of Solid Waste from the D&D of the 224-B Facility.

224-B cell	224-B cell volume (m ³)	PUREX similar cell	PUREX similar cell volume (m ³)	224-B/PUREX similar cell volumetric ratio	PUREX cell equipment volume (m ³)	PUREX cell equipment weight (kg)	224-B estimated equipment volume (m ³)	224-B estimated equipment weight (kg)
A	793	E	1,196	0.6628	140	32,221	93	21,356
B	793	E	1,196	0.6628	140	32,221	93	21,356
C	793	D	1,095	0.7239	170	35,891	123	25,984
D	793	E	1,196	0.6628	140	32,221	93	21,356
E	793	E	1,196	0.6628	140	32,221	93	21,356
F	858	L	758	1.1316	267	26,799	302	30,327
Total equipment waste for 224-B:							796	141,735

Table 4-14. Potential Types of Waste in the 224-B Facility

224-B cell number	Probable predominant waste category	Other possible waste categories	Potential dangerous/hazardous chemicals
A	TRU	--	--
B	TRU	--	--
C	TRU	LLW-1	--
D	TRU	--	--
E	TRU	--	--
F	TRU	--	--

4.3.7 233-S Facility Volumetric Estimates and Assumptions

To estimate the volume, weight, and category of solid waste present in the 233-S Facility, the following conditions were assumed.

- Knowledge of the original process was used primarily when matching similar cells, and knowledge of the equipment was used to select between PUREX cells with the same function.
- This facility is unique, as it has only one processing area. According to process history, this area is a potential source of TRU waste. Therefore, it was compared to cell L in the PUREX Plant, which was estimated to contain 100% TRU waste.

Considering the assumptions above, the 233-S Facility was compared to the data generated by the PUREX study (Valero 1994). The estimated volume and weight of equipment considered for decommissioning are contained in Table 4-15.

The potential categories of waste associated with the 233-S Facility are summarized in Table 4-16.

Table 4-15. Volumetric Estimate of Solid Waste from the D&D of the 233-S Facility.

233-S high bay volume (m ³)	PUREX similar cell	PUREX similar cell volume (m ³)	233-S /PUREX similar cell volumetric ratio	PUREX cell equipment volume (m ³)	PUREX cell equipment weight (kg)	233-S estimated equipment volume (m ³)	233-S estimated equipment weight (kg)
435	L	758	0.58314	267	26,799	153	15,359
Total equipment waste for 233-S:						153	15,359

Table 4-16. Potential Types of Waste in the 233-S Facility.

233-S cell number	Probable predominant waste category	Other possible waste categories	Potential dangerous/hazardous chemicals
High bay	TRU	--	Ferrous sulfamate, Hexone, Nitric acid, Resin, sodium nitrate, asbestos, lead, mercury, PCB

4.3.8 Pipe Galleries Volumetric Estimates and Assumptions

By comparing the volume of the 200 Areas reprocessing facilities with the volume of the PUREX Facility, the volumes and weights of pipe used in the pipe galleries in those facilities were estimated. Those estimates are summarized in Table 4-17.

Table 4-17. Volumetric Estimate of Solid Waste from the D&D of the 200 Areas Facilities Pipe Galleries.

Facility	Pipe gallery volume (m ³)	Volume of pipe (m ³)	Weight of pipe (kg)
PUREX	11,468	135	872
B Plant	1,684	20	2,052
T Plant	1,684	20	2,052
U Plant	1,684	20	2,052
S Plant (REDOX)	3,489	41	4,251
UO ₃ Plant	897	11	1,093
224-B	1,355	16	1,651
233-S	59	1	71
Totals	23,320	263	14,094

4.4 SUMMARY OF ADDITIONAL INFORMATION

During the course of this study, a number of sources were discovered that provide more detailed information on the actual waste present in the various facilities. Related sections have been included in this report in appendixes. The following is a summary of what each appendix contains.

Appendix A PUREX Facility Additional Information

- A-1 Sections 2.0 through 2.2 and Table 2.2-1 from *PUREX/UO₃ Deactivation Project Management Plan*, WHC-SP-1011 (WHC 1993), describe the anticipated status of the PUREX Plant after deactivation.

Appendix B B Plant Additional Information

- B-1 Tables 5-12 and 5-13 from the *B Plant Safety Analysis Report*, SD-WM-SAR-013 (Sewell 1985), provide a description of the equipment present at the B Plant.
- B-2 The executive summary of the *B Plant Cleanout and Stabilization Program Plan*, WHC-SD-WM-AP-023 (Bowen 1993), describes the overall goals and cleanout activities planned for B Plant.

Appendix C T Plant Additional Information

- C-1 *Preliminary Characterization for Decontamination and Decommissioning of the T Plant Reprocessing Facilities*, DO105ER0002 (Bowers and Nolande 1980a), provides the physical and radiological characterizations necessary to decommission the T Plant Facility.
- C-2 The canyon layout for T Plant, from an estimated general area radiation survey compiled by T Plant health physics personnel, illustrates the location of the cells within the plant.

Appendix D U Plant Additional Information

- D-1 Cell pictures, taken in approximately 1964 before the cell blocks were finally put in place, visually describe each cell's contents.
- D-2 Attachment 2 and 3 of the *REDOX and U Plant Dangerous Waste Tank Identification and Sampling Ability*, WHC internal memo 80420-89-100 (Speer 1989), gives a cell by cell description of equipment.
- D-3 *Canyon Equipment List for U Plant*, WHC internal memo 80420-90-018 (Van Sickie 1990), lists equipment both in the cells and on the canyon deck and gives a cell reading of mR/h.

Appendix E REDOX Facility Additional Information

- E-1 Appendix A from the *Qualitative Structural Evaluations of U Plant and REDOX Buildings*, WHC-SD-DD-SA-001 (Baxter 1990), is a radiological inventory estimated for REDOX.
- E-2 The information included in *Process Modifications 202-S Buildings*, Engineering Document HW-27968 (Rohrmann and Ludlow 1953), describes process modifications proposed in 1953.

Appendix F UO₃ Facility Additional Information

- F-1 Section 7.0 from *Uranium Trioxide (UO₃) Plant Process Flowsheet*, PFD-U-020-00001 (Young 1990), provides a descriptive account of the equipment present at the UO₃ Plant in 1984.
- F-2 Sections 2.0 through 2.2 and Table 2.2-2, from *PUREX/UO₃ Deactivation Project Management Plan*, WHC-SP-1011 (WHC 1993), describes the anticipated status of the UO₃ Plant after deactivation.

Appendix G 224-B Facility Additional Information

- G-1 *Radiological Characterization of the 224-B Hot Cells*, SD-DD-TRP-002 (Gould and Troyer 1985), describes the work done in 1985 to radiologically characterize the 224-B Facility.
- G-2 Appendixes A, B, and D from *224-B Decontamination Project Plan*, SD-DD-PP-002 (Owens 1985), present an equipment list for 224-B,

radiological characterization data for 224-B, and a list of chemicals used in the 224-B process, respectively.

- G-3 Sections 4.3 and 4.4 from *Preliminary Study for Decontamination and Decommissioning of the 224-B Concentration Facility*, D0105ER0009 (Shoemaker 1979), give estimated costs for decommissioning and estimated volumes of solid waste produced during D&D of 224-B, respectively.

Appendix H 233-S Facility Additional Information

- H-1 Sections 3.0 through 6.0 from *Physical Status and Post Stabilization Activities Report for the 233-S Building*, WHC-SD-DD-TI-028 (Beckstrom 1992), present radiological survey data from before (1987) and after (1988) stabilization of 233-S, the steps taken during the stabilization effort, conclusions from the project, and a list of references.
- H-2 Sections 1.0 through 4.0 from *233-Facility Potential Chemical Hazards*, WHC-SD-DD-TI-056 (Cummings and Carter 1993), include a historical timeline and a listing of chemicals thought to be present at one time at 233-S.
- H-3 Sections 3.0 and 4.0 from *Radiological Characterization of 233-S Facility*, WHC-SD-CP-TI-163 (Keele et al. 1990), include results, discussion, and conclusions from a radiological survey performed in 1990.

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5.0 SUMMARY AND CONCLUSIONS

The results of this study, obtained using the methods described in Section 4.0, are presented in this section. Solid waste estimates for the D&D of major processing facilities in the 200 Areas of the Hanford Site were based on a detailed study of the PUREX Plant presented in *Estimation of PUREX Equipment and Materials that are Candidates for Removal and Waste Processing During PUREX Plant Closure* (Valero 1994).

5.1 SUMMARY OF ROUGH ORDER OF MAGNITUDE ESTIMATION RESULTS

An initial ROM estimation was performed by calculating the ratio of the square footage of each facility to that of PUREX (3,400 m²). Volumes and weights of solid waste by waste category from the PUREX study (Valero 1994) were then multiplied by these area ratios (see equation 4.2.1). The ROM volumetric estimates for each building considered in this study are summarized in Table 5-1.

5.2 SUMMARY OF VOLUMETRIC ESTIMATION RESULTS

As detailed in Section 4.0, a more refined volumetric equipment estimate for each of the major processing facilities in the 200 Areas was developed by comparing physical, process, and historical knowledge to the PUREX study (Valero 1994). In addition, based on process knowledge, interviews, and documented information, the most probable waste categories were estimated, cell by cell, for each processing facility included in this study. The most probable predominant waste category was assumed to account for 100% of the estimated equipment volume in each cell. Table 5-2 summarizes the estimated waste categories and volumes of cell equipment and piping.

To develop a waste category breakdown for the pipe recovered from the pipe galleries, it was assumed that the percentage of waste categorized in the facility would be identical to the percentage of waste categorized in the pipe galleries. Therefore, Table 5-2 uses the estimated waste category percentages to also estimate the volume and waste category of pipe likely to be removed during D&D.

As indicated in Tables 5-1 and 5-2, the ROM estimation method results in significantly greater values for predicted solid waste. Because ROM estimates in Table 5-1 are strictly based on building square footage, the estimates may not be as accurate as the more detailed comparison in Table 5-2. A strict square footage comparison does not take into account the size of the processing areas; therefore, the ROM results could represent inflated values.

Table 5-1. Volumetric Estimate Using the Rough Order of Magnitude Method.

Volume (m ³)									
	Factor	LLW-1	LLW-3	LLMW-3	LLMW > 3	TRU	TRUMW	Solid Waste	Total
PUREX Plant (A Plant) 202-A	1.00	5,350	496	156	139	676	78.2	2,780	9,670
B Plant 221-B	0.45	2,380	221	69.5	62.1	302	34.8	1,240	4,310
T Plant 221-T	0.45	2,380	221	69.5	62.1	302	34.8	1,240	4,310
U Plant 221-U	0.45	2,380	221	69.5	62.1	302	34.8	1,240	4,310
REDOX (S Plant) 202-S	0.32	1,710	158	49.8	44.5	216.1	25.0	886	3,090
UO ₃ Plant 224-U and 224-UA	0.15	815	75.4	23.7	21.2	102.9	11.9	422	1,470
PCF 224-B	0.75	4,010	372	117	104	507	58.6	2,080	7,250
233-S	0.03	142	13.1	4.14	3.69	17.92	2.07	73.6	256
Total		19,200	1,780	560	499	2,423	280	9,960	34,700

Table 5-2. Summary of the Volumetric Estimates of Equipment Items that are Candidates for Removal During D&D in the Major Processing Facilities in the 200 Areas.

Processing facility	Percentage of most probable estimated waste category	Estimated equipment volume (m ³)	Estimated pipe volume (m ³)	Total estimated volume (m ³)
B Plant 221-B	100% LLW-3	1,585	20	1,605
T Plant 221-T	51% LLW-1 6% LLMW-1 39% LLW-3 4% TRU	969 108 729 78	10 1 8 1	979 109 737 79
U Plant 221-U	37% LLW-1 63% LLMW-1	623 1,050	7 13	630 1,063
REDOX S Plant 202-S	48% LLW-1 52% LLMW-1	643 696	20 21	663 717
UO ₃ Plant 224-U 224-UA	81% LLW-1 19% LLW-3	1,670 394	9 2	1,679 396
224-B PCF	100% TRU	796	16	812
233-S	100% TRU	153	1	154
Total		9,494	129	9,623

5.3 COMPARISON OF RESULTS WITH OTHER STUDIES

An earlier attempt to document and estimate the breakdown of solid waste by type was performed in 1988, but the results of this modernization study were never published. Information developed in the study was consulted, but the estimation methods and criteria used in the study are not detailed. For comparison, the modernization study estimated that 10% of the solid waste in the PUREX Plant, B Plant, T Plant, U Plant, and REDOX was TRU while 90% of the solid waste in those facilities was LLW; it also estimated that 100% of the waste in the 233-S Facility was TRU and that 100% of the solid waste in the UO₃ Plant and the 224-B Facility was LLW. Because the methodology to estimate the values in the modernization study cannot be verified, the accuracy of the estimates is uncertain.

Other efforts to estimate and characterize the amount of solid wastes that will be generated during D&D include the estimates developed by the project team responsible for the D&D of contaminated buildings on the Hanford Site. Their approach establishes a series of calculations using estimates derived from past D&D activities to predict the amount and types of solid waste that will be generated. This information is accessed through the use of 25 cost-estimating templates or "models" developed by the group and approved by the U.S. Department of Energy, Richland Operations Office. The scope of

these D&D estimates is more inclusive than the current study and focuses primarily on the cost associated with D&D. Not only will their estimates include the entire facility, but the estimates will also include the soil surrounding the facility. The volumetric estimates in this study only consider the equipment and piping in the major processing facilities in the 200 Areas based on a comparison to the results of the PUREX study (Valero 1994).

5.4 CONCLUSIONS

This study was designed to achieve an initial rough estimate of solid waste that may be generated during D&D of the facilities included in this study. The estimates were not only based on historical data, available documents, and process knowledge, but also a structural or process area comparison of the facilities with the data presented in the PUREX study (Valero 1994).

Although a more detailed study would be required to maximize characterization accuracy, the information presented in this report provides a rough estimate that will help facilitate future planning and activities associated with solid waste treatment prior to disposal.

6.0 REFERENCES

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APPENDIX A
PUREX Facility Additional Information

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- A-1. Sections 2.0 Through 2.2 and Tables 2.2-1 and 2.2-2
PUREX/UO₂ Deactivation Project Management Plan,
WHC-SP-1011D (Westinghouse
Hanford Company, 1993).

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2.0 PROJECT OBJECTIVES

2.1 PROJECT OBJECTIVES

The PUREX/UF₆ Deactivation Project objectives support the DOE Office of Facility Transition and Management overall goal of developing swift, uniform methods for deactivating similar facilities. The Project objectives are as follows.

1. Establish a passively safe and environmentally secure configuration of the plant (no active internal functions or equipment within confinement), and retain that configuration for a 10-year horizon.
2. Achieve a total yearly cost target of \$2 to \$5 million/year at turnover.
3. Implement cost-effective, innovative approaches to ensure the required safety envelope is defined and maintained during deactivation.
4. Achieve compliance with Environmental, Safety, and Health codes and standards during deactivation.
5. Involve stakeholders in the development and execution of the PUREX/UF₆ Deactivation project management plan.
6. Transition the workforce out of PUREX and UF₆ Plant through redeployment or outplacement.
7. Apply lessons learned from commercial deactivation experience.
8. Establish the PUREX/UF₆ Deactivation Project as a model for canyon facilities.

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2.1-2

A-6

2.2 TECHNICAL CRITERIA

The mission of the PUREX/UO₂ Deactivation Project is to demonstrate a safe, cost-effective model for facility deactivation by deactivating PUREX and UO₂ Plant and completing turnover to the Hanford Surplus Facilities Program (HSFP). Technical criteria define project completion and the acceptable conditions for turnover to the HSFP.

2.2.1 General Technical Requirements

General technical requirements define the Project's overall approach to fulfilling the end-state condition required for turnover to the HSFP. Applicable requirements set forth in draft DOE Order 58XX.XX, *Transition of Facilities to the Office of Environmental Restoration and Waste Management*, will be met.

The Project shall ensure that imminent hazards to personnel or the environment are controlled through partial closure, removal, isolation, mitigation, or stabilization. The Project shall also ensure that structures can be maintained in a safe condition, with immediate threats to human health and safety removed or appropriate compensatory measures (barriers, access controls, administrative controls, etc.) implemented.

The Project end state shall result in the classification of PUREX and UO₂ Plant as non-occupied facilities. As such, compliance with DOE Order 6430.1A, *General Design Criteria*, is not required. Project activities shall ensure that access during the surveillance phase is not required at a greater frequency than necessary to maintain the non-occupied facility status. Conservatively, the access that should be allowed for a non-occupied facility status is not more frequent than once each quarter.

The Project will end with PUREX and UO₂ Plant turnover to the HSFP for post-deactivation surveillance and eventual D&D. Existing WHC Site systems shall be used for Project execution, except as provided in this PMP.

2.2.2 Configuration Requirements

The PUREX and UO₂ Plant configuration shall be modified and controlled sufficiently to enable safety and regulatory compliance during Project performance and post-project D&D activities. The minimum configuration control requirements are as follows.

- Records shall be established and archived for reactivating D&D essential systems and providing meaningful D&D characterization. As a minimum, the following records should be established and maintained:
 - Location, identification, and qualification of hazardous materials that are attached/contained and cannot be removed without going into a D&D mode
 - Final radiological status surveys

- Certified vendor information files, equipment operating procedures, records, drawings, photographs, etc., that reflect "As-Left" configuration
- Information required to reactivate elevator systems
- Zero energy check records for electrical circuits that were de-energized
- Installed piping system and equipment blank records
- Documentation that locations where irradiated fuel elements and/or other source and special materials were handled and/or stored were examined and material accounted for
- Radiological posting in compliance with applicable requirements set forth in WHC-CM-1-6, *Radiological Control Manual*
- Pending radiation occurrence reports, event fact sheets, unusual occurrence reports and/or any other out-of-standard condition reports finalized and closed out
- The PUREX and UO₂ Plant Safety Basis revised for the post-deactivation surveillance period in accordance with the Project-specific requirements of Appendix F
- Documentation demonstrating compliance with worker safety and health prepared in accordance with the Project-specific requirements of Appendix F
- Any required permits relating to the facility's current or anticipated use obtained. Activities shall not preclude subsequent closure options until permitting dictates final closure.
- Deactivation check sheets completed and approved by the responsible personnel performing the actual work, the overview organizations, and plant management.

2.2.3 Workforce Restructure Requirements

Project activities shall include provisions for redeployment or retraining of the PUREX and UO₂ Plant workforce to enable transition into other Site activities including the potential deactivation of other Hanford canyon buildings (i.e., B Plant, U Plant, and the Reduction-Oxidation (REDOX) Plant). Retraining activities should be initiated early in the Project to maximize education/skill enhancement and be integrated with existing Hanford Site retraining programs.

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**2.2.4 Hazardous and Radioactive Materials
Removal/Stabilization Requirements**

Hazardous and radioactive materials shall be removed from the plants or stabilized sufficiently to ensure long-term PUREX and UO₂ Plant safety and regulatory compliance, enable plant classification as a non-occupied facility, and enable subsequent successful D&D.

Materials shall be removed and/or stabilized sufficiently to ensure that the plant complies with WHC-CM-1-6, *Radiological Control Manual*, as applicable to a non-occupied facility after completion of deactivation. As a general guide, "as-left" contamination and radiation levels in plant areas should be no greater than the levels encountered during normal operation and occupancy of the plant.

To ensure long-term safety and regulatory compliance, the following requirements apply.

- Permanent radiation zones to be entered for surveillance shall be decontaminated and released or the surface contamination levels reduced or stabilized to minimize re-suspension and/or migration of loose contamination. Temporary radiation zones inside and outside of buildings shall be eliminated.
- Packaged radioactive and mixed waste with identified final disposition shall be removed and disposed of. Wastes that are not removed shall be identified and characterized, and documented.
- Accessible interior glovebox surfaces shall be decontaminated or the surface contamination stabilized. Openings to gloveboxes shall be sealed in a manner that ensures confinement of remaining contamination.
- Loose or damaged (friable) asbestos in areas expected to be entered during surveillance shall be removed or stabilized.
- Fissile materials shall be removed sufficiently to eliminate the potential for a nuclear criticality excursion and the need for a criticality alarm system.
- Tanks, vessels, and drums shall be drained using installed equipment and features. Heels shall not contain material classified as hazardous waste.
- Hazardous materials used for deactivation and cleanup work shall be collected and disposed of.
- Emergency lighting and associated batteries from the facilities shall be removed and disposed of.

To ensure minimum life-cycle cost, the following requirements apply.

- The remaining surplus materials, equipment, supplies, and spare parts should be inventoried, labeled, segregated, and evaluated for use at other sites or sold.
- Disposal of waste materials will be maximized during deactivation.
- Existing system and equipment capabilities will be used for material removal/stabilization to the maximum extent possible.
- Conditions that require implementation of operational safety requirements (OSRs) during the surveillance period will be eliminated.

2.2.5 Surveillance Requirements

Facility configuration shall ensure D&D options are not foreclosed, and facility safety and environmental protection can be maintained until D&D.

To ensure safety and environmental protection during surveillance, the following requirements apply.

- Consistent with the PUREX and UO₂ Plant Safety Basis, the operation of safety and utility systems shall be reduced to the extent possible, while maintaining ventilation, alarms and other capabilities necessary for a deactivated facility. Required vital safety systems and utility systems shall be fully functional and have operating procedures in place.
- To minimize points of ingress, doors to the plants shall be locked from the inside except those required for entrance by surveillance crews.
- Security systems and procedures shall be adequate to prevent unauthorized entry to plant structures.
- Liquid effluent sources from PUREX and UO₂ Plant shall be eliminated prior to the surveillance phase. Flow routes to disposal sites should be isolated. Isolation should be achieved by sealing or valving off at the facilities and screening off accessible outlets of the discharge pipes for varmint control.
- Facility penetrations (louvers, pipe openings, etc.) will be closed off to prevent bird and other animal intrusions.
- Elevator systems shall be deactivated in a manner that enables future reactivation.
- Systems that were opened to facilitate deactivation and could present a radiological and/or an industrial safety problem if left open shall be adequately closed off.

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- Known facility roof leaks and/or deteriorated roof panels shall be repaired.
- Radiation space monitoring and continuous air monitoring systems shall be reduced to a level commensurate with the surveillance requirements. As a general guide, "as-left" contamination and radiation levels in the plants should be low enough that only portable monitoring equipment is required during surveillance entries.

To achieve a non-occupied facility status, the following requirements apply.

- Ventilation and monitoring equipment shall be consolidated, relocated, housed, operated, and/or maintained such that facility entry frequency does not compromise the non-occupancy status.
- Fire protection systems shall be modified or eliminated to both achieve and reflect the non-occupied status and to minimize system testing and maintenance.
- Electrical and water supply services to the process buildings shall be isolated; electrical and water supply services in the surrounding yard areas shall be reduced to meet minimum surveillance support requirements. Centralized electrical services for surveillance purposes should be considered.
- The building steam system shall be deactivated. Building steam requirements shall be eliminated to enable steam system deactivation.

2.2.5.1 Deactivated PUREX Condition. Table 2.2-1 describes the expected PUREX condition, by plant area, when the technical requirements stated above have been satisfied.

2.2.5.2 Deactivated UO₂ Plant Condition. Table 2.2-2 describes the expected UO₂ Plant condition, by plant area, when the technical requirements stated above have been satisfied.

Table 2.2-1. PUREX Status After Deactivation. (2 sheets)

Facility area	Area status description
Canyon	<ul style="list-style-type: none"> - Mobile quantities of Special Nuclear Materials (SNM) removed - Fuels removed - Process vessels emptied and flushed - Some process equipment disassembled to remove inventory - SNM Material inventory reconciled - Process cells flushed - Failed equipment/jumpers removed from canyon deck as appropriate - Canyon piping to external facility interfaces (Tank Farms, 216-B-3/Pond, out of service cribs, etc.) isolated
Storage Gallery	<ul style="list-style-type: none"> - Supplies removed - Shop equipment de-energized - Fire foam system deactivated - High-radiation areas mitigated
Sample Gallery	<ul style="list-style-type: none"> - Samplers, including D5 Cave, flushed - Sample Gallery area flushed - Hoods containing significant SNM decontaminated - Hood exhaust ductwork removed - Floor drains plugged
Pipe and Operating Gallery	<ul style="list-style-type: none"> - Gallery flushed - Mobile equipment removed - White room repainted - White room floor resurfaced - Headers drained and flushed - Floor drains plugged.
Cranes	<ul style="list-style-type: none"> - Cranes parked on maintenance platforms and shut down as is.
Aqueous Make-up	<ul style="list-style-type: none"> - Chemical inventory removed - Tanks and supply headers flushed
Analytical Laboratory	<ul style="list-style-type: none"> - All Chemical inventory removed - Hoods decontaminated - Equipment de-energized
Shop Areas	<ul style="list-style-type: none"> - Supplies removed - Equipment de-energized
Control Rooms	<ul style="list-style-type: none"> - All instrument and equipment controls de-energized, except control of canyon exhaust. These functions will be consolidated at a single remote monitoring location
Office/Change Rooms, Mobile offices	<ul style="list-style-type: none"> - Personnel relocated - Furniture and files removed
211-A Area	<ul style="list-style-type: none"> - Chemical inventory removed - Demineralizers isolated with resin disposed - Vessels flushed - Utilities isolated - Surfaces decontaminated of hazardous materials and resurfaced as necessary
203-A Area	<ul style="list-style-type: none"> - Tanks emptied and flushed - Utilities isolated - Acid solutions removed - Surfaces decontaminated and resurfaced as necessary
U-Cell/ Fractionator	<ul style="list-style-type: none"> - Recovered acid removed - Vessels flushed - Coverblocks sealed

Table 2.2-1. PUREX Status After Deactivation. (2 sheets)

Facility area	Area status description
Heating, ventilation and air conditioning (HVAC)/Services	<ul style="list-style-type: none"> - HVAC systems consolidated to limit gaseous effluent discharge and monitoring points to 291-A-1 Canyon exhaust stack - Steam, water and compressed air service eliminated - Electrical systems consolidated - Emergency loads minimized or eliminated - Electrical service provided for selected lighting panels - Alternative source of backup power to canyon fans - Monitoring functions consolidated at a single monitoring location
Effluents	<ul style="list-style-type: none"> - Liquid and gaseous effluent streams eliminated, except 291-A-1 stack discharge - Buildings decontaminated and locked - Effluent piping isolated
H-Cell, PR Room and G-Cell	<ul style="list-style-type: none"> - Gloveboxes decontaminated and residual contamination fixed
R-Cell Vault	<ul style="list-style-type: none"> - Organic solvent removed - Vessels and vault flushed - Coverblocks sealed
Ancillary Buildings	<ul style="list-style-type: none"> - Portable and/or mobile equipment and materials removed - Piping with external interfaces isolated - Utilities and HVAC isolated - Surfaces and piping and vessels flushed - Asbestos stabilized

Table 2.2-2. UO₃ Plant Status After Deactivation.

Facility area	Area status description
Cells A, B, C, and D in 224-U	<ul style="list-style-type: none"> - All process vessels emptied and flushed - Material accountability reconciled - Process cells flushed - Piping to external facility interfaces (effluents, etc.) isolated.
224-U Pipe and Operating Gallery	<ul style="list-style-type: none"> - Mobile equipment removed - Headers drained and flushed - Floor drains plugged
224-UA Processing Areas	<ul style="list-style-type: none"> - UO₃ powder removed from calciners, powder handling equipment, and vacuum cleaning system - Bag filters left in place after air blow of system - Material accountability reconciled - Piping to external facility isolated - Process areas decontaminated
Lucky Pet Room, Cells E and F, Abandoned powder handling equipment	<ul style="list-style-type: none"> - Abandoned equipment left as is - Piping to external facilities isolated
2714-U & T-Hopper storage pad	<ul style="list-style-type: none"> - Full T-hoppers shipped to purchaser - Drums of depleted UO₃ removed - Surfaces decontaminated and resurfaced as necessary
Shop Areas	<ul style="list-style-type: none"> - Supplies removed - Equipment de-energized
Control Rooms	<ul style="list-style-type: none"> - All instrument and equipment controls deactivated
Office/Change Rooms/Mobile offices	<ul style="list-style-type: none"> - Personnel relocated - Furniture and files removed
211-U Area	<ul style="list-style-type: none"> - Acid inventory removed - Vessels flushed - Utilities isolated - Asbestos stabilized
203-U Area	<ul style="list-style-type: none"> - Storage tanks emptied and flushed - Utilities isolated - Surfaces decontaminated and resurfaced as necessary
Heating, ventilation and air conditioning (HVAC)/Services	<ul style="list-style-type: none"> - HVAC systems shutdown - Steam, water and compressed air service eliminated - Electrical service provided for selected lighting panels
Effluents	<ul style="list-style-type: none"> - Liquids and gaseous effluent streams eliminated - Effluent piping isolated
Ancillary Buildings	<ul style="list-style-type: none"> - Portable/mobile equipment and materials removed - Piping with external interfaces isolated - Utilities and HVAC isolated - Surfaces and piping flushed and decontaminated

APPENDIX B
B Plant Additional Information

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B-1. Table 5-12 and Table 5-13
R. G. Sewell, *B Plant Safety Analysis*
Report, SD-WM-SAR-013 (Rockwell
Hanford Company, 1985).

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TABLE 5-12. Canyon Tanks Information. (Sheet 1 of 5)

Tank no.	Function	Dimension (ft/dia.)	Capacity (gal)	Cooling coils		Cell range (gal)		Maximum concentration			Agitator or pump
				Surface (ft ²)	Duty Btu/h	From	To	Sr(MCl)	Cs(MCl)	Pu(kg/l)	
5-1	Strontium concentrate receiver	3.25 x 7 x 4	500	240	4.8 x 10 ⁵	65	416	3.2**	6.62**	1.5	A-5-1
6-1	Strontium storage	8 x 14	5,200	420	8.4 x 10 ⁵	227*	1,649	15.1	21.9	2.5	A-6-1
6-2	Strontium storage	8 x 14	5,200	420	8.4 x 10 ⁵	238*	1,698	15.1	21.9	2.5	A-6-2
7-1	Strontium storage	8 x 14	5,200	157	3.14 x 10 ⁵	494*	4,051	10.8	15.3	2.5	A-7-1
7-2	Strontium storage	8 x 14	5,200	157	3.14 x 10 ⁵	500*	4,000	15.1	21.9	2.5	A-7-2
8-1	Strontium storage	8 x 14	5,200	157	3.14 x 10 ⁵	499*	4,022	10.8	15.3	2.5	A-8-1
8-2	Strontium storage	8 x 14	5,200	157	3.14 x 10 ⁵	416	4,022	10.8	15.3	2.5	A-8-1
9-1	Waste receiver	8 x 14	5,200	157	3.14 x 10 ⁵	432	4,035	15.1	21.9	2.5	A-9-1
9-2	Supernatant storage	8 x 14	5,200	157	3.14 x 10 ⁵	505	4,065	12.6	18.2	2.5	Air Lift Circulator
10-1	Waste collection	18 x 11 x 7	10,000	908	18.16 x 10 ⁵	700	7,500	34.5	48.8	4.0	None
11-1	Slurry tank	4.5 x 7	800	78	1.56 x 10 ⁵	122	662	2.52	3.64	13.1	A-11-1
11-2	Decant and metalthesis	9 x 9	3,913	300	6.0 x 10 ⁵	100	1,500	15.1	21.9	2.5	A-11-2
12-1	Supernatant receiver	9 x 9	4,200	118	2.36 x 10 ⁵	551	2,964	15.1	21.9	2.5	A-12-1
13-1	Centrifuge supernatant receiver	9 x 9	3,972	30	0.6 x 10 ⁵	318	3,532	10.3	14.6	2.5	A-13-1
14-1	CAW cesium product receiver	4.5 x 7	656.7	78	1.56 x 10 ⁵	98	687	4.21	7.37	1.3	A-14-1

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TABLE 5-12. Canyon Tanks Information. (Sheet 2 of 5)

Tank no.	Function	Dimension (ft/dia.)	Capacity (gal)	Cooling coils		Coil range (gal)		Maximum concentration			Agitator or pump
				Surface (ft ²)	Duty Btu/h	From	To	Sr(MCl)	Cs(MCl)	Pu(kg/l)	
14-2	Cesium storage	9 x 9	3,899	118	2.36×10^5	491	2,939	12.6	18.2	2.5	A-14-2
17-1	Cesium storage	8 x 14	4,940.3	228	4.56×10^5	173	1,476	15.1	21.9	2.5	A-17-1
17-2	Cesium supernatant receiver	8 x 14	4,995.3	100	1.97×10^5	110	950	2.52	3.64	2.5	A-17-2
18-1	IXW receiver	9.5 x 12	1,848.3	52	1.04×10^5	100	507	0.52	0.731	1.5	A-18-1
18-3	IXF pump tank	4.5 x 7	737.6	40	0.80×10^5	25	324	2.52	3.64	1.3	A-18-3
19-1	IXP receiver tank	10 x 16 x 14	11,260	160	3.2×10^5	600	2,670	0.52	0.731	3.0	A-19-1-1 A-19-1-2 PA-19-1
20-1	IXP concentrate receiver	3.25 x 7 x 4	492.1	240	4.8×10^5	62	412	2.52	3.64	1.5	A-20-1
21-1	Cesium eluent storage	10 x 16 x 14	12,500	160	3.2×10^5	500	2,520	7.55	10.9	3.0	A-21-1-1 A-21-1-2 P-21-1-1 P-21-2-1
22-1	Condensate receiver	3.25 x 7 x 4	460.9	240	21.6×10^5 4.8×10^5	68	417	3.0	4.88	1.5	PA-22-1
23-1	Nonboiling waste concentrate	3.25 x 7 x 4	792.2	128	2.56×10^5	53	502	2.52	3.64	1.5	PA-23-1
24-1	Low level waste receiver	10 x 16 x 14	11,090	290	5.8×10^5	500	7,092	2.52	3.64	3.0	A-24-1-1 A-24-1-2
25-1	Cesium waste receiver	8 x 14	4,873.9	435	8.7×10^5	150	2,045	2.52	3.64	2.5	P-25-1 A-25-1
25-2	High level waste receiver	8 x 14	4,862	435	8.7×10^5	150	2,096	2.52	3.64	2.5	A-25-2 P-25-2

TABLE 5-12. Canyon Tanks Information. (Sheet 3 of 5)

Tank no.	Function	Dimension (ft/dia.)	Capacity (gal)	Cooling coils		Coil range (gal)		Maximum concentration			Agitator or pump
				Surface (ft ²)	Duty Btu/h	From	To	Sr(MCl)	Cs(MCl)	Pu(kg/l)	
26-1	Organic contractor	9 x 9	3,932.1	68	1.36×10^5	302	3,358	2.52	3.64	2.5	A-26-1 P-26-1
26-2	ICF contractor	5 x 7 x 12.5	2,636.3	48	0.96×10^5	150	610	2.52	3.64	1.5	A-26-2
26-3	ICP receiver	5 x 7 x 12.5	2,621.3	48	0.96×10^5	125	569	3.45	4.88	1.5	P-26-3
27-2	ICP receiver	5.5 x 12	2,002.4	52	1.04×10^5	60	460	2.52	3.64	1.5	A-27-2
27-3	ICM contractor	7 x 14	3,790	200	4.0×10^5	200	2,074	2.52	3.64	2.0	P-27-3 A-27-3
27-4	ICF pump tank	2.75 x 5 x 3.5	280.3	55	1.1×10^5	30	205	1.79	3.14	1.0	PA-27-4
28-2	IDP receiver	5.5 x 12	1,980	52	1.04×10^5	64	561	2.52	3.64	2.0	P-28-2 A-28-2
28-3	IAX makeup	7 x 14	3,757.4	200	4.0×10^5	189	1,934	2.52	3.64	2.0	P-28-3 A-28-3
28-4	IDF pump tank	2.75 x 6 x 14	284.9	55	4.95×10^5 1.1×10^5	30	202	3.45	4.88	1.0	PA-28-4
29-2	IAF makeup	9.5 x 5 x 14	3,982.7	200	4.0×10^5	237	1,636	2.52	3.64	2.0	A-29-2
29-3	IAF pump tank	9.5 x 5 x 14	4,149.3	200	4.0×10^5	240	1,651	2.52	3.64	0.5	A-29-3 P-29-3
29-4	ISF pump tank	1.66 x 8.66	140					0.745	1.31	0.5	P-29-4
30-2	IAH receiver	9.5 x 5 x 14	4,128.9	200	4.0×10^5	140	1,500	2.52	3.64	2.0	A-30-2
30-3	IAX pump tank	9.5 x 5 x 14	4,135.5	200	18×10^5	209	1,634	2.52	3.64	2.0	A-30-3 A-30-3
31-1	PAS metathesis tank	5.5 x 9	1,533	52	4.68×10^5 1.04×10^5	61	533	4.31	6.10	1.5	A-31-1
31-2	Dissolved cake storage	4.5 x 7	715	40	0.80×10^5	111	405	4.58	8.24	1.3	A-31-2

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TABLE 5-12. Canyon Tanks Information. (Sheet 4 of 5)

Tank no.	Function	Dimension (ft/dia.)	Capacity (gal)	Cooling coils		Coil range (gal)		Maximum concentration			Agitator or pump
				Surface (ft ²)	Duty Btu/h	From	To	Sr(MCl)	Cs(MCl)	Pu(kg/l)	
32-1	Waste receiver tank	9.5 x 9	3,969.1	115	2.30×10^5	852	3,011	5.04	7.28	2.5	A-32-1
33-1	Treated acidified sludge storage	10 x 16 x 14	14,056.9	160	3.20×10^5	562	2,55	1.72	2.44	3.0	A-33-1-1 A-33-1-2
34-1	Cesium product storage	5.5 x 9 x 14	4,139.3	382	8.0×10^5	240	1,634	7.57	10.9	2.0	A-34-1
34-2	Cesium product storage	5.5 x 9 x 14	4,100	382	8.0×10^5	160	1,660	21.4	30.9	2.0	A-34-2
34-3	Cesium product storage	5.5 x 9 x 14	4,100	382	8.0×10^5	180	1,640	21.4	30.9	20.0	A-34-3
35-1	Cask feed loadout tank	4.5 x 7	750	95	2.0×10^5	50	320	4.68	8.41	0.5	A-35-1
35-2	Cask waste receiver tank	9 x 9.83	3,963	30	4.26×10^5	303	1,454	25.2	45.4	2.5	A-35-2
36-1	Strontium product storage	5.5 x 9 x 14	4,400	385	8.0×10^5	192.8	1,683.8	15.1	21.9	2.0	A-36-1
36-2	Strontium product storage	5.5 x 9 x 14	4,400	385	8.0×10^5	187.1	1,684.9	15.1	21.9	2.0	A-36-2
36-3	Strontium product storage	5.5 x 9 x 14	4,400	385	8.0×10^5	245.9	1,666.8	15.1	21.9	2.0	A-36-3
37-1	Cesium product storage	5.5 x 9 x 14	4,400	382	8.0×10^5	225	1,700	15.1	21.9	2.0	A-37-1
37-2	Cesium product storage	5.5 x 9 x 14	4,400	382	8.0×10^5	214	1,651	15.1	21.9	2.0	A-37-2
37-3	Cesium emergency receiver	5.5 x 9 x 14	4,400	382	8.0×10^5	---	1,848	15.1	21.9	2.0	
38-1	Feed tank	3 x 4 x 7	500	26	0.32×10^5 0.33×10^5	39.3	263	1.14	1.61	0.5	P-38-1

TABLE 5-12. Canyon Tanks Information. (Sheet 5 of 5)

Tank no.	Function	Dimension (ft/dia.)	Capacity (gal)	Cooling coils		Coil range (gal)		Maximum concentration			Agitator or pump
				Surface (ft ²)	Duty Btu/h	From	To	Sr(MCl)	Cs(MCl)	Pu(kg/l)	
38-2	Cask feed loadout	4.5 x 7	500	15	0.08×10^5	41.9	388.6	1.14	1.61	0.5	Air Sparge
38-3	Recycle tank	2.66 x 4 x 7	500	26	0.33×10^5	39.8	305.9	0.276	0.390	0.5	Air Sparge
38-4	Eluent receiver	4.5 x 5.5	500		0.25×10^5	46.2	262.8	0.793	1.12	0.5	Air Sparge P-38-4
38-8	Cesium product receiver	2.33 x 2	125	20	0.33×10^5	4.3	24.07	0.196	1.61	0.5	Air Sparge
39-1	Low level waste from WESF	9.5 x 5 x 12	3,700	200	375	63.4	2,659.9	0.0130	0.018	0.5	A-39-1
39-2	Cesium waste to WESF	4.75 x 5 x 12.66	1,850	90	3.0×10^5	46.8	749.7	10.3	14.6	0.5	A-39-2
39-3	Cesium feed to WESF	3.0 x 9.0	325	115	2.6×10^5			0.74	1.05	0.5	Air Sparge
39-4	Strontium waste from WESF	4 x 5 x 12	1,500	26	2.25×10^5	36.7	938.3	7.76	11.0	0.5	A-39-4
39-5	Strontium feed to WESF	5.5 x 5 x 12	2,200	100	4.20×10^5	53.0	1,618.5	7.55	10.9	0.5	A-39-5

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TABLE 5-13. Concentrators and Condensers.

Number	Name	Capacity (gal)	Duty (Btu/h)	Area (ft ²)	Bundle description
E-5-2	Strontium concentrator	300	4,500,000	896	307 Vert. tubes 1-12 BWG x 14 ft 2-7/8 in.
E-20-2	Cesium concentrator	300	9,000,000	896	307 Vert. tubes 1-12 BWG x 14 ft 2 7/8 in.
E-23-3	Waste concentrator	3,000	27,000,000	1,850	West-687 Vert. tubes 1 1/4 OD-BWG x 10 ft
			24,000,000	1,290	East-630 Vert. tubes 1-12 1 OD 12 BWG x 10 ft
E-5-3	Strontium condenser	---	4,500,000	895	342 Hor. tubes 1-12 BWG x 10 ft
E-20-3	Cesium condenser	---	9,000,000	895	342 Hor. tubes 1-12 BWG x 10 ft
E-23-4	Waste condenser	---	30,000,000	1,340	568 Hor. tubes 1-12 BWG x 10 ft
E-22-3	Vessel vent heater	---	200,000	190	91 Hor. tubes 1-12 BWG x 9 ft
E-22-4	Vessel vent condenser	---	2,000,000	895	342 Hor. tubes 1-12 BWG x 10 ft
E-22-7	Scrubber vent heater	---	50,000	40	51 Hor. tubes 1-12 BWG x 3 ft
E-38-6	Purified cesium concentrate	100	1,000,000 H 10,500 C	140	53 Vert. tubes 1-12 BWG x 10 ft
E-38-7	Purified cesium condenser		6,000,000	140	55 Vert. tubes 1-12 BWG x 10 ft filled with pall rings

H = Heat.

C = Cool.

B-2. Executive Summary
W. W. Bowen, *B Plant Cleanout and Stabilization*
Program Plan, WHC-SD-WM-AP-023 (Westinghouse
Hanford Company, 1993).

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B PLANT CLEANOUT AND STABILIZATION PROGRAM PLAN**EXECUTIVE SUMMARY****PURPOSE OF PROGRAM PLAN/PROGRAM OBJECTIVE**

The purpose of the Cleanout and Stabilization Program (CSP) is to provide detailed guidance for all plant organizations to accomplish near- and long-term goals. Cleanout and stabilization are those activities necessary to convert the plant from the present high hazard classification to a low hazard facility. To accomplish the transition to low hazard, inventories or source terms are characterized, then removed from the plant or stabilized/isolated.

The program plan includes the definition of budget and resources for the 5-year period, a schedule of major tasks critical to the success of the CSP mission, and guidance for existing and new major projects. The CSP plan will be reviewed and updated annually to reflect the changing financial climate. Updating will include risk assessment and cost effective strategy to complete the CSP goals. Re-assignment of plant personnel and priorities are expected to accompany the initiation of the CSP Plan.

This document will provide the environmental and safety strategy for the plant and a matrix for reference to all applicable U.S. Department of Energy (DOE) orders and regulations.

The program has a level of detail suitable for first line management. First line managers will be expected to understand specific task requirements and schedules, including critical paths. Additional work plans, procedures, etc. will be generated after the program plan has been issued for approval.

DEFINITION OF PROGRAM COMPLETION/PROGRAM GOALS

The relatively high operating and maintenance costs of B Plant are a result of several historical factors:

- The long plant history of radiochemical separation process missions has left B Plant with significant radioactive inventory in the form of stored process liquids (including liquid organics), megacurie quantities of solid particulate strontium and cesium on underground high-efficiency particulate air (HEPA) filters, and a highly contaminated facility structure.
- The most recent strontium and cesium recovery mission provided these purified fission products to the Waste Encapsulation and Storage Facility (WESF) for encapsulation. WESF was configured to provide long-term storage of the finished capsule inventory in pool cells. B Plant was also configured to provide essential service/support for ongoing WESF operations.
- The main B Plant structure, 221-B, is a 47-year old canyon process facility that requires remote operations. Parts of the plant are totally inaccessible.

Completion of the CSP 5-year plan will result in the following modifications to B Plant:

- Reduced hazards—B Plant is currently classified as a high-hazard nuclear facility. A goal of the CSP is to reduce the hazard classification to low-hazard. Removal of organic inventory and stabilization of the HEPA filter inventory will eliminate these two source terms as the drivers to high hazard classification.
- Long-term stabilization—The final B Plant configuration needs to be relatively immune to the effects of additional aging. Contaminated areas of the plant must be cleaned, and loose contamination must be immobilized, or access to these areas must be restricted.
- Minimized WESF support—Until final disposition of the cesium and strontium capsules, WESF depends on B Plant for several essential support requirements for pool cell storage. The current CSP plan recommends three new WESF projects to reduce dependence of WESF on B Plant. Throughout the CSP plan period, and an undetermined time period beyond the 5 year plan, WESF will remain fully operational.
- B Plant projects—Project requirements include completion of five projects in the original scope and rescoping of six existing projects.
- Plant configuration for future programs—Future programs may include preparation for eventual decontamination and decommissioning (D&D).

PROGRAM CRITICAL PATH ITEMS/SHORT-TERM GOALS

The detailed CSP schedules will identify and highlight specific scheduled critical path items. The following tasks include near-term goals that are expected to be critical to the success of a 5-year program, and are prioritized toward the low hazard objective:

1. Transfer Radioactive Liquid Inventories

Continued storage of neutralized current acid waste (NCAW) and liquid organic inventory does not support the cleanout objective and contributes to the high-hazard classification, as well as to high operating costs. The approximately 10,000 gal of liquid NCAW and several tank heels of liquid cesium inventory (from capsule rework processing in the 1980's) will be transferred to tank farms. The organic inventory will be consolidated for eventual removal.

2. Establish Drag-Off Burials

Tanks and process equipment are highly contaminated but have not been fully assessed. This residual contamination may contribute to moderate or high hazard classification after more data is obtained. It is anticipated that physical removal and burial of process cell equipment will be necessary to gain access to other equipment and to the cell walls and floors to determine the magnitude of the radioactive source term. Equipment will be decontaminated only to the extent necessary to meet burial requirements. The drag-off method with existing burial boxes is required.

3. Isolation of 291B Filters

Project W-059, "HVAC Safety Class Upgrade" will be rescoped to permanently isolate the A, B, C and D Filters with positive physical barriers that prohibit migration of radiological inventory to the stack or the facility. Completion of this project is essential to achieving low hazard status.

4. Start the B Plant Concentrator

The CSP assumes significant volumes of low-level waste will be required to remove radioactive material from the cells and the equipment.. The cell cleanout plan will be based on use of either the B Plant concentrator or an increased allocation for liquid waste transfer from B Plant to tank farms to be concentrated in the 242-A Evaporator.

5. Upgrade of the Canyon Crane

Rail repairs, a video system, and additional crane repairs are needed to support the scheduled CSP activities. The cell cleanout schedule dictates that the crane projects be done by mid fiscal year (FY) 1993. West end rail beds need to be complete by the end of FY 1993. After that, unscheduled downtime must be infrequent and of short duration for the CSP schedule to be met.

Additional short-term program goals have been defined that are essential to the success of the cleanout mission. The previous process mission has resulted in a plant condition and work practices that must be modified in the following areas:

- The canyon deck and canyon environment must be prepared for more frequent routine entries by personnel. The canyon must be cleaned and maintained while keeping risk as low as reasonably achievable (ALARA) to expedite the CSP work.
- The operation of unnecessary plant systems and process cells must be terminated as soon as practical to reduce costs and better use available resources.
- Work control practices and documentation must be streamlined significantly and reflect the final configuration of the plant.

RESOURCE REQUIREMENTS

The CSP is scoped to be completed in FY 1997. To accomplish this, a very aggressive, schedule must be maintained. The summary resource requirements estimate for this are identified in the Summary Table.

PROGRAM SUMMARY**Methodology and Action Plan**

Cold Side Facilities. "Cold side facilities" are defined as any area of the B Plant complex outside the 221-B canyon. The cold side areas or facilities vary significantly with regard to the level of radiological contamination, nonradiological condition, and the intended future use during or after

the CSP. The CSP 5-year plan will, as a minimum, address all areas with serious radiological or hazardous waste contamination.

The cold side CSP will (1) remove or appropriately isolate abandoned systems and equipment and (2) decontaminate, immobilize, or isolate hazardous and radioactive contamination to ALARA levels.

The sequence of priority for cleanup of cold side areas has been established and is reflected in the schedules. The 221-B galleries, the 271-B aqueous makeup (AMU) areas, and the 221-BC SWP change house have been selected as the top priority candidates of 13 cold side areas needing cleanup.

The isolation of the A, B, C, and D filters will be accomplished by installing positive physical barriers to prevent the radioactive inventory from migrating to the stack or the facility.

Low-Level Liquid Waste Handling System. The B Plant liquid LLW handling system uses seven tanks in six canyon process cells. The startup and operation of the waste concentrator will facilitate an important reduction in the volume of LLW generated during the CSP activities in the canyon. It will also add a cell to the LLW operating system.

The startup and operation of the B Plant concentrator is required for emergency response to a failed capsule scenario in the WESF pool cell area. Resolution of regulatory concerns with DOE and the Washington Department of Ecology (Ecology) is required for this emergency function. The concerns relate to the two condensate effluent streams generated by B Plant concentrator operation. A strategy for resolution and a startup plan are included in this program plan.

Restart of the tank farms 242-A Evaporator is expected in the first quarter of FY 1993. The evaporator is estimated to be online for routine facility transfers in FY 1994. By third quarter FY 1993 the CSP cell cleanout activities will generate increasing volumes of LLW and require the B Plant concentrator until increased LLW monthly volumes will be allowed for tank farm transfers.

Organic Solvent Mixture. An organic solvent mixture formerly used for the solvent extraction strontium recovery process is currently stored in five process cells. The CSP plan includes consolidation of the mixture to two tanks using existing equipment as much as possible and maintaining the operational safety requirements (OSR) for contaminated organic storage.

Characterization of the organic and aqueous solutions in the organic tanks will be completed after consolidation. Process selection will then proceed for removal of the strontium from the organic phase and eventually final treatment/handling for disposal. The leading candidate for the final disposal process is onsite incineration.

Shutdown of Plant Systems. An orderly shutdown of plant "systems" must be accomplished in a timely manner to save costs and better use personnel for the CSP work activities. Specific process systems slated for shutdown are NCAW and cesium inventory storage, vessel ventilation, air dilution, organic inventory storage, and numerous process cells.

Sixteen process cells are available for immediate deactivation. Deactivation and NCAW inventory transfers to tank farms will proceed in the near term. Vessel ventilation and air dilution shutdown will be implemented after liquid inventory transfers. The inventory transfer are being coordinated with Tank Farms. Organic consolidation should be initiated in FY 1993 and requires new process routes and some new jumpers.

The 5-year CSP will include shutdown of additional systems. Major systems to follow those listed above are secondary containment, liquid effluents (starting with cooling water), and WESF solid waste handling. The shutdown of the canyon crane and canyon ventilation is beyond the CSP, but modification of these two systems may be within the 5-year program.

Solid Waste. The capability to process solid waste, particularly highly contaminated process equipment, for burial is critical to the CSP. The program plan addresses the drag-off burial process, from procurement through burial trench requirements.

Ten existing drag-off burial boxes will be modified [Modified Fuel Spacer Burial Boxes (MFSBB)]. The first burial is scheduled to take place in early FY 1993. Initial burials will be low-level radioactive waste from the canyon deck. Future burials will use MFSBBs that have been redesigned to allow higher weight capacity. The burial location is 218-E-10 burial trench # 9 in 200 East area until the trench is filled.

The cleanout of canyon process cells will require cutting hazardous components, such as lead weights from some jumpers, as well as a size reduction on some equipment to fit in the burial box. Dose rate, weight, and other criteria will be monitored as equipment is staged for burial. Weight is expected to be a limiting factor. The equipment will be "triple-rinsed" with water during the cell cleanout to control contamination spread during the solid waste handling process and to eliminate any hazardous waste component as a consideration.

Cell Cleanout Strategy. The overall cell cleanout strategy starts with the modification of a specific cell for decontamination of process equipment. The tanks, process vessels, and jumpers will be removed from the original cell and transported to the "cleaning cell" for flushing. Existing inactive tank agitators, jets, pumps, instrumentation, and piping are considered to be unreliable for flushing equipment in each original process cell. The centralized approach to flushing can also minimize liquid waste volume.

Cell 15 has been selected to be modified as the decontamination cell and to handle the equipment from the first group of process cells (Cells 11, 12, 13, 14). Movable containers commonly called jumper pans, a mobile shearing device (jumper cutter), commercially available pressure spraying equipment, and new jumpers will be used in Cell 15 to accomplish the flushing and handling of equipment for disposal. Cell disassembly, Cell 15 CSP activities, and loading of the burial boxes will be performed remotely by the crane operator.

Cell decontamination activities for this program will be limited to a washdown of the original cell with jumpers in place, and a second washdown after equipment removal is complete.

The CSP activities for the Hot Pipe Trench and selected very complex, highly contaminated process cell equipment will be delayed until later in the 5-year program to allow time to develop better remote techniques and methods.

Canyon Crane. The 221-B canyon crane performs all remote process cell work, starting with removal of cover blocks. In addition to the cell cleanout activities, future undefined remote tool handling and support of semi-remote operations (assisting personnel on the canyon deck for heavy lifts) can be anticipated. Given the magnitude of the CSP and the intensity of the planned use of this system, it can be concluded that the crane is an unreliable system in its current condition.

The following major CSP tasks are scheduled to correct the deficiencies:

- Repair or replace the rails and rail beds
- Install a video system to supplement/replace optics
- Replace wheels and align truck.

Safety Analysis Report. The existing safety analysis report (SAR) for B Plant does not reflect the current plant configuration, the current minimum process operations, or the CSP. It also contains outdated OSRs. These deficiencies do not, however, imply that the strategy and work plans of the

CSP fall outside the safety envelope described by the current SAR. Minor SAR revisions will be made to address either the CSP work or resulting changes to operations, but no impacts to the program are anticipated, and no major efforts are needed to upgrade safety documentation .

Requirements Identification Document. Requirements (based on a graded approach) will be identified in a requirements identification document (RID) based on the existing facility specific SAR and current mission. Requirements for a facility in transition from an operational mission to a low-hazard, long-term surveillance and maintenance mission will have fewer requirements.

Permitting. The strategy for environmental compliance as it relates to hazardous waste activities is to minimize the treatment, storage, and disposal (TSD) activities. Reducing these activities will minimize the hazardous waste permitting requirements. After the CSP is complete and TSD activities are eliminated, environmental closure can be pursued.

Summary Table

YEAR	FTE	MATL	TTL	COMMENTS
FY 92				
B PLANT	280	8783	32786	Radiation zone reduction complete for routine canyon entries.
WESF	<u>49.5</u>	<u>410</u>	<u>4414</u> *	NCAW and Ca inventory transfer complete. Organics consolidated
TOTAL:	309.5	9193	37200	Gallery cleanup initiated. K3 changeout complete. Rotating shifts reduced to 4 personnel.
FY 93				
B PLANT	204	15650	33089	3 million expense dollars for canyon crane upgrades. Upgrade existing burial boxes. Routine waste transfer performed on day shift only. Procured jumper cutter. Decon cell established.
WESF	<u>40.4</u>	<u>530</u>	<u>4111</u> *	Part B management plan initiated. Removal of jumper/small equipment initiated. Revise technical basis for CSP operation to reduce requirements in SAR.
TOTAL:	244.4	16180	37200	
FY 94				
B PLANT	198	14144	32390	Part B permitting activities continue. Procurement of additional burial boxes. Organics removal/disposal complete. Addendums to the SAR. Tank integrity plan. IOTECH capsule receipt complete
WESF	<u>40.4</u>	<u>530</u>	<u>4111</u> *	
TOTAL:	238.4	14674	36501	
FY 95				
B PLANT	184	13936	29822	Part B permitting activities continue. Procurement of additional burial boxes. Cold side facility zone reduction for surveillance activities complete. Addendums to the SAR. Tank integrity assessment.
WESF	<u>40.4</u>	<u>530</u>	<u>4111</u>	
TOTAL:	224.4	14466	33933	
FY 96				
B PLANT	148	9592	23167	Part B permit submitted to the state for approval. Reduce Ops, Crafts, and Engineering by 25% of 1993. Concentrator shutdown. Addendums to the SAR. Complex equipment/large tanks removal initiated. Tank integrity report.
WESF	<u>40.4</u>	<u>530</u>	<u>4111</u>	
TOTAL:	188.4	10122	27278	
FY 97				
B PLANT	115	9090	19787	Steam system reduced 80% of 1992. Liquid effluents 90% of 1992. Gaseous effluents 40% of 1992, no raw water (WESF has CLCS). Completion of safety documentation. Reduced Crafts, Ops and Engineering by 50% of 1993.
WESF	<u>40.4</u>	<u>530</u>	<u>4111</u>	
TOTAL:	155.4	9620	23898	
FY 98				
B PLANT	81.1	3448	8318	Essential systems minimized to handling WESF and LLW. Canyon ventilation flow rates minimal. WESF radiological inventory/capsule management. HEPA exhaust filters have been isolated.
WESF	<u>40.1</u>	<u>505</u>	<u>4044</u>	
TOTAL:	101.2	3953	12362	

* Does not include incremental Cesium Capsule funding

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APPENDIX C
T Plant Additional Information

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AIM

Association for Information and Image Management

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Centimeter

Inches

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3 of 6

- C-1. D. E. Bowers and A. L. Nolande, *Preliminary Characterization for Decontamination and Decommissioning of the T Plant Reprocessing Facilities*, D0105ER0002 (Rockwell Hanford Operations, 1980).

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SUPPORTING DOCUMENT		Number	Rev. No.	Page
		D0105ER0002	0	2
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	3.1 PROCESS CANYON BUILDING (221-T)			4
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	3.3 EXHAUST FAN CONTROL HOUSE, SAND FILTER AND STACK (291-T)			5
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4.0	DECOMMISSIONING			5
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	4.2 DISPOSITION TASKS			6
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1.0 INTRODUCTION

T-Plant, located in the 200 West Area of the Hanford Site, was constructed between June 1943 and October 1944 as one of three original fuel separation facilities. Irradiated fuel, brought by rail from the Hanford 100 Area reactors to the 221-T processing building, was dissolved and the plutonium recovered by extraction with bismuth phosphate. The remaining waste from the dissolved fuel, including the uranium, was sent to underground high-level waste storage tanks. From 221-T, the plutonium was sent to the 224-T concentration building for final decontamination and concentration. T-Plant operated as a fuel separation facility from completion of construction until shutdown in 1956.

Retired T-Plant facilities applicable to this report include 221-T, Process Canyon Building; 271-T, Office and Service Building; 291-T, Exhaust Fan Control House, Sand Filter and Stack; and 296-T, Gaseous Effluent Release Points (-1, -2, & -4).

Since shutdown, various processing and support facilities have been converted to other uses, retired and/or new facilities added. Highlights of some major changes are:

- o 1957 to present - Portions of 221-T building were modified for use as a high-level equipment decontamination and repair facility.
- o 1964 to present - The headend portion of the 221-T building was walled-off for use as a research facility by various Hanford contractors.
- o 1977 to present - The fuel receiving and storage area of 221-T building was modified for receipt and storage of PWR Core II blanket fuel assemblies from the Shippingport Reactor.

2.0 OBJECTIVE

The objective of this Engineering Report is to present the physical description, radiological characterizations, and work scope necessary to decommission the T-Plant Reprocessing Facilities. This information will facilitate the development of a systematic approach for the planning effort and allocation of resources required for Hanford decommissioning projects.

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3.0 PROJECT DESCRIPTION

The following summarized the physical description and radiological condition of Project RLH2-16, in support of the Department of Energy Surplus Facility Management Plan, RLO/SFM-79-2, and Rockwell Hanford Operations (Rockwell) Long Range D&D Plan, D0105PP0001.

3.1 PROCESS CANYON BUILDING (221-T)

221-T Building is a reinforced concrete canyon building with outside dimensions of 875 x 66 x 77 ft. (26 ft. below grade) with approximately 97,700 ft.² of floor area. It is built in 21 sections, with expansion joints between each one. The first section, the headend, is 65 ft. long; the remaining section, numbered 1 through 20, are each approximately 40 ft. long. A wall divides the building lengthwise into the gallery side and the process canyon side. Typical wall thicknesses are; floor - 6 ft., roof - 3 to 4 ft., outside wall; process side - 5 ft., outside wall; gallery side - 3 ft., and the dividing wall - 5 ft. to 9 ft. See Figure 4.

The gallery side, 14 ft. wide, is 4 floors. From bottom to top these are: electrical gallery, pipe gallery, operating gallery, and the crane cabway which has no ceiling and is open to the process side. The galleries contain the electrical distribution centers, almost all cold piping and all instrumentation and controls for the cell processes.

Current radiological condition indicates high dose rates in some cells and parts of the building. Estimated inventory, excluding fuel assemblies:

Pu	-	15 Ci
U	-	10 Ci
Fp	-	800 Ci

3.2 OFFICE AND SERVICE BUILDING (271-T)

271-T Building is a 4 story structure (including basement) 160 x 48 x 68 ft., with approximately 30,720 ft.² area. It consists of a reinforced concrete foundation, floors, pillars, concrete block walls on 3 sides, and a built up asphalt and gravel roof. This building is physically attached to the outside gallery wall of the 221-T canyon building. The basement contains shops and air compressor. First floor is storage and

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change rooms. Second floor is office area, and the third floor has process chemical makeup facilities for 221-T. Currently most of the equipment remains, but almost all free space has been converted to storage and office space.

Used for compressed air supply, chemical makeup, storage, offices, and change rooms for 221-T. Currently retired but most free space is utilized for offices and storage. Still supplies compressed air to 221-T and 224-T.

Current radiological condition for most of the building is known to be clean, but low-level contamination may exist in the chemical makeup areas and in the ventilation equipment.

3.3 EXHAUST FAN CONTROL HOUSE, SAND FILTER, AND STACK (291-T)

The control house is an 18 x 19 x 14 ft., approximately 330 ft.² area building. It has reinforced concrete foundation and floor, concrete block walls and a flat concrete roof slab with a built up gravel covering. The building is equipped with two electrical exhaust fans outside and a backup steam turbine fan inside. The stack is built of reinforced concrete and lined with acid resistant brick. The base is 14 ft. in diameter and is 200 ft. high. The sand filter is a partially below grade reinforced concrete box structure with outside dimensions of 110 x 48 x 14.6 ft. The floor and walls are 12-inch-thick concrete and the roof is made of sixty 7-inch-thick concrete slabs. The structure is filled with a 8 1/2 ft. deep bed of varying grades of sand and gravel. There are also several hundred feet of underground concrete air tunnels to connect the facilities together, some smaller filter and blower pits, and various utilities and services. These facilities supply exhaust for 221-T. It is currently retired, but actively used for original purpose.

3.4 GASEOUS EFFLUENT RELEASE POINTS (296-T)

296-T-7 is unfiltered exhaust support for 2706-T Building and 296-T-13 filtered exhaust support for 221-T.

Current research for radiological inventory in these stacks is being done at present.

4.0 DECOMMISSION

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4.1 DISPOSITION MODE

The tentative disposition mode selected for T-Plant Reprocessing Facilities is complete decontamination and partial or total dismantlement as required, so that the site may be released for unrestricted use. This mode is subject to change, pending permanent establishment of a disposition mode based on detailed engineering studies.

4.2 DISPOSITION TASKS

The major activities associated with dismantling of these facilities include the following:

- Engineering development.
- Decontaminate all equipment, piping, etc., in the facility to lowest practical levels.
- Dismantle and section contaminated equipment, piping, etc., and package for disposal.
- Decontaminate building surfaces to facilitate dismantling of the facility.
- Dismantle the facility as required and package contaminated wastes for disposal.
- Remove any contaminated dirt adjacent to the facility and package it for disposal.
- Remove all contaminated wastes from the site.
- Remove all uncontaminated debris from the site.
- Fill all excavations with clean dirt.

4.3 COST AND SCHEDULE ESTIMATES

The estimated cost (from Ref. 5.7) for the D&D of the entire T-Plant complex and disposal sites is 35 to 45 million dollars. This is a preliminary order of magnitude value and should be used accordingly. This estimate is based on the recorded costs for the D&D of the P-11 lab, the removal of the Division of Military Application's (DMA) equipment from 234-5 Z and 231-Z, and the estimated cost of decommissioning the Redox fuel reprocessing plant prepared by the Pacific Northwest Laboratories.

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Assuming adequate manpower, money and equipment is available, it is estimated that decommissioning will take seven years. This can be divided into three main time blocks:

- o detailed characterization and engineering 1 year
- o structural and ground disposal site
decontamination and decommissioning activities;
including reactivation and upgrade 5 years
- o final site cleanup and release 1 year

More accurate cost and manpower estimates will require a conceptual design study or completion of the detailed characterization and preliminary engineering tasks which considers only the structural facilities covered by this report. Estimates for D&D of the ground disposal sites (no longer included in the SFMP Program, Ref. 5.3) are highly uncertain and should be separated from the above estimates.

4.4 WASTE VOLUME ESTIMATES

The amount of contaminated solid waste generated by dismantling operations is difficult to estimate because the levels, distribution, and penetration of contamination are not well known at this time. Assuming that most of the concrete, piping and equipment from the process facilities will require contaminated disposal, it is estimated that 40,000 to 50,000 cubic yards of contaminated solid waste will require disposal.

4.5 MANPOWER ESTIMATES

Manpower requirements can not be realistically estimated until the establishment of methods, processes, etc., that will be routinely used throughout all decommissioning operations.

4.6 OCCUPATIONAL EXPOSURE ESTIMATES

Exposure values are a direct function of processes and techniques used and can only be estimated through a more detailed engineering study.

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	D0105ER0002	0	8

5.0 REFERENCES

1. Final Environmental Statement,
Waste Management Operations,
Hanford Reservation	ERDA - 1538
2. DOE National D&D Planning
Program Survey for Contaminated
Facility Data	D0105FL0003
3. Department of Energy Surplus
Facility Management Plan	RLO/SFM-79-2
4. Rockwell Long Range D&D Plan	D0105PP0001
5. Preliminary Study for Decontamination
and Decommissioning of Miscellaneous
Facilities	D0105ER0012
6. Rockwell Active Contaminated Facilities
Listing	D010FL0002
7. Resource Book - Disposition (D&D)
of Retired Contaminated Facilities
at Hanford	BNWL-MA-88
8. Hanford Technical Manual Section	HW-10475-C
9. T-Plant Special Services
Training Manual, Introduction	SS-0
10. T-Plant Special Services
Training Manual on Decontamination
Operations	SS-1
11. RHO Drawing Files	

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C-2. T Plant General Area Radiation Survey.

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APPENDIX D
U Plant Additional Information

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D-1. Cell Pictures.

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Cell 6

Photo No. 36677-2

Cell 7

Photo No. 36677-26

Cell 8

Photo No. 36677-5

Cell 9

Photo No. 36677-22

Cell 13

Photo No. 36677-7

Cell 14

Photo No. 36677-10

Cell 15

Photo No. 36787-105

Cell 16

Photo No. 36787-108

Cell 17

Photo No. 36787-112

WHC-EP-0787

Cell 18, View 1

Photo No. 36787-114

WHC-EP-0787

Cell 18, View 2

Photo No. 36787-115

Photo No. 36677-14

Photo No. 36787-135

Cell 21

Photo No. 36787-140

WHC-EP-0787

Cell 22

Photo No. 36787-120

Photo No. 36787-143

MHC-EP-0787

Cell 24

Photo No. 36787-147

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Cell 25

Photo No. 36787-148

WHC-EP-0787

Cell 26

Photo No. 36787-153

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WHC-EP-0787

Cell 27, View 1

Photo No. 36787-155

Cell 27, View 2

Photo No. 36787-154

Cell 28

Photo No. 36787-123

MHC-EP-0787

Cell 29

Photo No. 36787-158

D-27

Cell 30

Photo No. 36787-161

Cell 32

Photo No. 36787-125

Cell 34

Photo No. 36787-167

Photo No. 36677-18

Cell 36

Photo No. 36787-129

Cell 37

Photo No. 36787-133

Cell 38

Photo No. 36787-170

Cell 39

Photo No. 36677-30

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D-2. Attachment 2 and Attachment 3
D. R. Speer, *REDOX and U Plant Dangerous Waste Tank
Identification and Sampling Ability*, WHC Internal
Memo 80420-89-100 (Westinghouse
Hanford Company, 19890.

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U-PLANT FACILITY DANGEROUS WASTE TANK EVALUATION

ITEM TYPE	EQUIP NO	LINE NO	BLDG NO	AREA	WASTE	DESCRIPTION
1 TANK	TK-3-1	WF 38	221-U	CELL 5	8,10,14,17,22	FEED RECEIVER
2 TANK	TK-3-6	WF 80	221-U	CELL 6	8,10,14,17,22	FEED RECEIVER
3 TANK	TK-4-1	WF 38	221-U	CELL 7	1,8,20,22	INTER CYCLE HOLDUP TANK
4 TANK	TK-4-6	WF 80	221-U	CELL 8	6,9,18,CELL DRAINAGE	MISCELLANEOUS WASTE TANK
5 TANK	TK-5-1	WF 38	221-U	CELL 9	CELL DRAINAGE	MISCELLANEOUS WASTE TANK
6 TANK	TK-5-2	WF 20	221-U	CELL 9	CELL DRAINAGE	MISCELLANEOUS WASTE TANK
7 TANK	TK-5-6	WF 47	221-U	CELL 10	CELL DRAINAGE	MISCELLANEOUS WASTE TANK
8 EVAPORATOR	E-6-1	NA	221-U	CELL 11	8,10,14,17,22	EVAPORATOR
9 TANK	TK-6-2	WF 23	221-U	CELL 11	8,10,14,17,22	CONCENTRATOR COOLER
10 TANK	T-6-4	NA	221-U	CELL 11	8,10,14,17,22	FEED STRIPPING TOWER
11 TANK	TK-6-4A	NA	221-U	CELL 11	8,10,14,17,22	CONCENTRATOR SEAL POT
12 CONDENSER	E-6-5	NA	221-U	CELL 11	8,10,14,17,22	CONCENTRATOR CONDENSER
13 TANK	TK-6-6	WF 80	221-U	CELL 12	8,10,14,17,22	CONCENTRATOR FOR FEED TANK
14 TANK	TK-6-7	WF 62	221-U	CELL 12	8,10,14,17,22	RECEIVER TANK
15 EVAPORATOR	E-7-1	NA	221-U	CELL 13	8,10,14,17,22	EVAPORATOR
16 TANK	TK-7-2	WF 23	221-U	CELL 13	8,10,14,17,22	CONCENTRATOR COOLER

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WMC-EP-0787

ITEM TYPE	EQUIP NO	LINE NO	BLDG NO	AREA	WASTE	DESCRIPTION
17 TANK	T-7-4	NA	221-U	CELL 13	8,10,14,17,22	FEED STRIPPING TOWER
18 TANK	TK-7-4A	NA	221-U	CELL 13	8,10,14,17,22	CONCENTRATOR SEAL POT
19 CONDENSER	E-7-5	NA	221-U	CELL 13	8,10,14,17,22	CONCENTRATOR CONDENSER
20 TANK	TK-7-6	WF 80	221-U	CELL 14	8,10,14,17,22	CONCENTRATOR FOR FEED TANK
21 TANK	TK-7-7	WF 62	221-U	CELL 14	8,10,14,17,22	CONCENTRATOR FEED RECEIVER
22 EVAPORATOR	E-8-1	NA	221-U	CELL 15	1,8,20,22	EVAPORATOR
23 TANK	TK-8-2	WF 23	221-U	CELL 15	1,8,20,22	CONCENTRATOR COOLER
24 TANK	T-8-4	NA	221-U	CELL 15	1,8,20,22	FEED STRIPPING TOWER
25 TANK	TK-8-4A	NA	221-U	CELL 15	1,8,20,22	CONCENTRATOR SEAL POT
26 CONDENSER	E-8-5	NA	221-U	CELL 15	1,8,20,22	CONCENTRATOR CONDENSER
27 TANK	TK-8-6	WF 80	221-U	CELL 16	1,8,20,22	CONCENTRATOR FOR FEED TANK
28 TANK	TK-8-7	WF 62	221-U	CELL 16	1,8,20,22	CONCENTRATOR FEED RECEIVER
29 EVAPORATOR	E-9-1	NA	221-U	CELL 17	2,7,11,12,14,15,16,20	EVAPORATOR
30 TANK	TK-9-2	WF 23	221-U	CELL 17	2,7,11,12,14,15,16,20	CONCENTRATOR COOLER
31 TANK	T-9-4	NA	221-U	CELL 17	2,7,11,12,14,15,16,20	WASTE CONCENTRATOR TOWER
32 TANK	TK-9-4A	NA	221-U	CELL 17	2,7,11,12,14,15,16,20	CONCENTRATOR SEAL POT
33 CONDENSER	E-9-5	NA	221-U	CELL 17	2,7,11,12,14,15,16,20	CONCENTRATOR CONDENSER

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WHC-EP-0787

ITEM TYPE	EQUIP NO	LINE NO	BLDG NO	AREA	WASTE	DESCRIPTION
34 TANK	TK-9-6	WF 80	221-U	CELL 18	2,7,11,12,14,15,16,20	CONCENTRATOR FOR FEED TANK
35 TANK	TK-9-7	WF 62	221-U	CELL 18	2,7,11,12,14,15,16,20	CONCENTRATOR FEED RECEIVER
36 EVAPORATOR	E-10-1	NA	221-U	CELL 19	8,10,14,17,22	EVAPORATOR
37 TANK	TK-10-2	WF 23	221-U	CELL 19	8,10,14,17,22	CONCENTRATOR COOLER
38 TANK	T-10-4	NA	221-U	CELL 19	8,10,14,17,22	FEED CONCENTRATOR TOWER
39 TANK	TK-10-4A	NA	221-U	CELL 19	8,10,14,17,22	CONCENTRATOR SEAL POT
40 CONDENSER	E-10-5	NA	221-U	CELL 19	8,10,14,17,22	CONCENTRATOR CONDENSER
41 TANK	TK-10-6	WF 80	221-U	CELL 20	8,10,14,17,22	CONCENTRATOR FOR FEED TANK
42 TANK	TK-10-7	WF 62	221-U	CELL 20	8,10,14,17,22	CONCENTRATOR FEED RECEIVER
43 TANK	TK-11-1	WF 38	221-U	CELL 21	3,5,6,8,10,14,17,20,22	WASTE SAMPLER
44 TANK	TK-11-6	WF 80	221-U	CELL 22	2,7,9,11,12,13,14,15,16,20	NEUTRALIZER TANK
45 TANK	TK-12-1	WF 38	221-U	CELL 23	3,5,6,8,10,14,17,20,22	WASTE SAMPLER
46 TANK	TK-12-6	WF 80	221-U	CELL 24	3,5,6,8,10,14,17,20,22	WASTE SAMPLER
47 TANK	TK-13-1	WF 38	221-U	CELL 25	3,5,6,8,10,14,17,20,22	WASTE SAMPLER
48 TANK	TK-13-6	WF 80	221-U	CELL 26	3,5,8,10,14,17,20,22	RAW-ROW RECEIVER
49 CENTRIFUGE	G-14-1	WF 7	221-U	CELL 27	1,8,20,22	CENTRIFUGE
50 TANK	TK-14-2	WF 20	221-U	CELL 27	1,8,20,22	CENTRIFUGE CATCH TANK

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WHC-EP-0787

ITEM TYPE	EQUIP NO	LINE NO	BLDG NO	AREA	WASTE	DESCRIPTION
51 CENTRIFUGE	G-14-6	WF 83	221-U	CELL 28	8,10,14,17,22	CENTRIFUGE
52 TANK	TK-14-7	WF 62	221-U	CELL 28	8,10,14,17,22	CENTRIFUGE CATCH TANK
53 TANK	TK-15-1	WF 38	221-U	CELL 29	1,8,21	REU SAMPLER
54 TANK	TK-15-6	WF 80	221-U	CELL 30	NA	NA
55 TANK	TK-16-1	WF 38	221-U	CELL 31	1,8,21	REU RECEIVER
56 TANK	TK-16-6	WF 80	221-U	CELL 32	8,20,22	ROU RECEIVER
57 TANK	TK-17-1	WF 38	221-U	CELL 33	4,8,20,21	ROW RECEIVER
58 COLUMN	ET-17-2	NA	221-U	CELL 33	4,8,20,21	RC COLUMN
59 TANK	TK-17-3	WF 5	221-U	CELL 33	8,20,22	ROU PUMPOUT TANK
60 TANK	TK-17-6	WF 47	221-U	CELL 34	8,10,14,17,22	RAF FEED TANK
61 TANK	TK-17-7	WF 76	221-U	CELL 34	3,5,8,10,14,17,20,22	RAW RECEIVER
62 COLUMN	ET-17-8	NA	221-U	CELL 34	3,4,5,8,10,14,17,20,22	RA COLUMN
63 TANK	TK-18-1	WF 38	221-U	CELL 35	4,20	RIOO RECEIVER
64 COLUMN	ET-18-2	NA	221-U	CELL 35	4,8,10,16,19,20,21	RIO COLUMN
65 TANK	TK-18-3	WF 20	221-U	CELL 35	8,16,20,22	RIOU RECEIVER
66 TANK	TK-18-6	WF 62	221-U	CELL 36	4,20	RAX FEED
67 TANK	TK-19-1	WF 38	221-U	CELL 37	1,8,21	REW RECEIVER

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ITEM TYPE	EQUIP NO	LINE NO	BLDG NO	AREA	WASTE	DESCRIPTION
68 COLUMN	ET-19-2	NA	221-U	CELL 37	1,8,21	RE COLUMN
69 TANK	TK-19-3	WF 5	221-U	CELL 37	1,8,21	REU PUMPOUT TANK
70 TANK	TK-19-6	WF 47	221-U	CELL 38	1,8,20,22	RDF FEED TANK
71 TANK	TK-19-7	WF 76	221-U	CELL 38	1,8,20,22	RDM RECEIVER
72 COLUMN	ET-19-8	NA	221-U	CELL 38	1,8,20,22	RD COLUMN
73 TANK	TK-20-1	WF 38	221-U	CELL 39	1,8,10,16,19,21	RIIO RECEIVER
74 COLUMN	ET-20-2	NA	221-U	CELL 39	1,8,10,16,19,21	RIIO COLUMN
75 TANK	TK-20-3	WF 20	221-U	CELL 39	1,8,10,16,19,21	RIIOH RECEIVER
76 TANK	TK-20-6	WF 62	221-U	CELL 40	1,8,10,16,19,21	RDX FEED TANK
77 TANK	TK-X-03	DIR ACS	221-U	OG CELL 6	NA	SCALE TANK
78 TANK	TK-X-04	DIR ACS	221-U	OG CELL 7	NA	SCALE TANK
79 TANK	TK-X-05	DIR ACS	221-U	OG CELL 9	NA	SCALE TANK
80 TANK	TK-X-07	DIR ACS	221-U	OG CELL 13	NA	SCALE TANK
81 TANK	TK-X-09	DIR ACS	221-U	OG CELL 17	NA	SCALE TANK
82 TANK	TK-X-11	DIR ACS	221-U	OG CELL 18	9	SCALE TANK
83 TANK	TK-X-12	DIR ACS	221-U	OG CELL 26	6,18	SCALE TANK
84 TANK	TK-X-13	DIR ACS	221-U	OG CELL 27	6,18	SCALE TANK

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ITEM TYPE	EQUIP NO	LINE NO	BLDG NO	AREA	WASTE	DESCRIPTION
85 TANK	TK-X-14A	DIR ACS	221-U	OG CELL 28	NA	SCALE TANK
86 TANK	TK-X-14B	DIR ACS	221-U	OG CELL 27	NA	SCALE TANK
87 TANK	TK-X-14C	DIR ACS	221-U	OG CELL 28	NA	SCALE TANK
88 TANK	TK-X-16	DIR ACS	221-U	OG CELL 31	NA	SCALE TANK
89 TANK	TK-X-18A	DIR ACS	221-U	OG CELL 35	NA	SCALE TANK
90 TANK	TK-X-18B	DIR ACS	221-U	OG CELL 34	NA	SCALE TANK
91 TANK	TK-X-20A	DIR ACS	221-U	OG CELL 39	NA	SCALE TANK
92 TANK	TK-X-20B	DIR ACS	221-U	OG CELL 38	NA	SCALE TANK
93 TANK	TK-276A	DIR ACS	221-U	OG CELL 40	NA	NA
94 TANK	TK-276B	DIR ACS	221-U	OG CELL 40	NA	NA
95 TANK	TK-WR-001	DIR ACS	241-WR	1ST FLOOR	7,11,12,14,15,16,20	RECEIVER
96 TANK	TK-WR-002	DIR ACS	241-WR	1ST FLOOR	8,10,14,17,22	FEED SAMPLER
97 TANK	TK-WR-003	DIR ACS	241-WR	1ST FLOOR	8,10,14,17,22	FEED RECEIVER
98 TANK	TK-WR-004	DIR ACS	241-WR	1ST FLOOR	8,10,14,17,22	FEED SAMPLER
99 TANK	TK-WR-005	DIR ACS	241-WR	1ST FLOOR	8,10,14,17,22	FEED RECEIVER
100 TANK	TK-WR-006	DIR ACS	241-WR	1ST FLOOR	NA	NA
101 TANK	TK-WR-007	DIR ACS	241-WR	1ST FLOOR	1,8,10,14,17,20,22	RECEIVES T-6-4,7-4,8-4

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LIST OF ABBREVIATIONS USED

DIR ACS	Direct Access via Flange
E	Evaporator or Condenser
ET	Column
FLUSHED	Verified Final Flush
FT	Feed Tank Area
G	Centrifuge
L (L5)	Level (Level 5)
LINE NO	Sample Line Number
NA	Not available (at this time)
NR	Not Required
OG	Operating Gallery
SG	Specific Gravity Line
T	Tower
TK	Tank
WF	Weight Factor Line

CHEMICALS

1	$\text{Al}(\text{NO}_3)_3$	Aluminum Nitrate
2	NH_4OH	Ammonium Hydroxide
3	$\text{NH}_2\text{SO}_3\text{H}$	
4	DEOBASE	Representative Diluent
5	$\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2$	
6	Ferrocyanide	
7	$\text{Fe}(\text{OH})_3$	Ferric Hydroxide
8	HNO_3	Nitric Acid
9	NiSO_4	Nickel Sulfate
10	H_3PO_4	Phosphoric Acid
11	NaCl	Sodium Chloride
12	$\text{Na}_2\text{U}_2\text{O}_7$	Sodium Diuranate

13	NaOH	Sodium Hydroxide
14	NaNO ₃	Sodium Nitrate
15	Na ₃ PO ₄	Sodium Phosphate
16	Na ₂ SO ₄	Sodium Sulfate
17	NaHSO ₄	Sodium Sulfate Hydrogen
18	Sr(NO ₃) ₂	Strontium Nitrate
19	H ₂ SO ₄	Sulfuric Acid
20	(C ₄ H ₉ O) ₃ PO	TBP, Tributyl Phosphate
21	UN	Uranium Mono-Nitride
22	UNH	Uranyl Nitrate Hexahydrate

- D-3. Van Sickle, *Canyon Equipment List for U Plant*,
WHC Internal Memo 80420-90-018
(Westinghouse Hanford Company, 1990).

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CANYON EQUIPMENT LIST
FOR
U-PLANT

SECTION: 1

<u>LEFT</u>	<u>RIGHT</u>
<u>On the Deck:</u> 1) 1 wheelbarrow. 2) 1 obsolete CMP ladder. <u>In the Cell:</u> Empty (under crane maintenance platform area).	<u>On the Deck:</u> 1) 1 cell cover block. 2) 1,10 ton power hook for canyon crane - discard. 3) 1 grabber tool for canyon crane. <u>In the Cell:</u> 100mR/Hr edge of cell 1) Redox vessels D-13, G-3 TK, G-3 concentrator, H-4 coil.

SECTION: 2

<u>LEFT</u>	<u>RIGHT</u>
Access to Railroad Tunnel	<u>On the Deck:</u> 1) 1 working platform for railcar waste tanker. 2) 1 decon sink. 3) 35' of miscellaneous piping. <u>In the Cell:</u> 10mR/Hr open cell rdng 1) 7-1 fuel storage rack, 16"X10'X14'

SECTION: 3

<u>LEFT</u>	<u>RIGHT</u>
<u>On the Deck:</u> 1) 1 working platform for railcar waste tanker. 2) 1 obsolete centrifuge from T plant. 3) 2,3"X10' flex waste tanker decon piping. 4) 1 instrument dip tube from waste <u>In the Cell:</u> ??mR/Hr open cell rdng 1) 3 B plant centrifuges. 2) 19 pair of fuel canisters.	<u>On the Deck:</u> 1) Manlift working platform with miscellaneous fittings, flanges and piping from waste tanker work at U-plant. 2) 2 B plant hot pipe wrench milling saws. 3) 8,6"X6"X6' timbers. <u>In the Cell:</u> 10mR/Hr open cell rdng 1) Obsolete U plant 9'X9' tank.

SECTION: 4LEFTOn the Deck:

- 1) Clear.

In the Cell: 10mR/Hr open cell rdng1) Purex Equipment:

- 2 repaired R-1 pumps.
- 1 repaired GS-1 pump.
- 1 JG4199 pump, no history.

B plant Equipment:

- P-27-3 repaired pump.
- P-28-3 repaired pump.
- 1A-12-1 repaired agitator.
- 2A-A19-1-1 repaired agitator.
- 2A-30-3 repaired agitator.
- 2A-A17-1 repaired agitator.

RIGHTOn the Deck:

- 1) 1 hanford type shipping cask, lid is stored on deck at cell 12.
- 2) 1 man basket.
- 3) 1,4 point lifting yoke 4'X9'X4'.
- 4) 1 electrical jumper for old 7-1 tk
- 5) 1,25',6"X8" I beam.

In the Cell: 150mR/Hr open cell rdng

- 1) 4-6 waste tank, original equipment for U plant, jumper installed.

SECTION: 5LEFTOn the Deck:

- 1) 35-1 repaired B plant tank.

In the Cell: 50mR/Hr open cell rdng

- 1) Waste tanks 5-1 & 5-2.
- 2) Original U plant equipment, jumper still in place.

RIGHTOn the Deck:

- 1) 3,5'X3 1/2' decon tank.
- 2) Yoke for handling Stanray cask lid.

In the cell: 15mR/Hr open cell rdng

- 1) Original 5-6 tank, active waste handling tank.

SECTION: 6LEFTOn the Deck:

- 1) Yoke storage area.
- 2) 1 jumper assembly, H-2-46384.
- 3) 1,7-1 tank electrical jumper.
- 4) 3 Stanray cask loading yokes.
- 5) 1,3'X12' divider for burial.

In the Cell: 10mR/Hr open cell rdng

- 1) Evaporator dunnage from U-plant.
- 2) 1,6-4 tank U-plant.
- 3) 1 B-plant F-22 filter, for burial

RIGHTOn the Deck:

- 1) 1 lid for hanford type cask, 100N.
- 2) 1 M-130 cask unloading shield.
- 3) 1 A-3 Purex dissolver shipping cradle (save for Purex).
- 4) 1,9'X6' Redox tank.
- 5) 3 hanford slug buckets (2 filled with lead bricks).

In the cell: 150mR/Hr open cell rdng

- 1) 1 Purex pot dissolver.
- 2) 1 B-plant centrifuge, 1G-13-2.

SECTION: 7

LEFT	RIGHT
<u>On the Deck:</u>	<u>On the Deck:</u>
1) Old U-plant condenser, not modified for B-plant.	1) 1 storage rack for pumps and agitators for B-plant. Majority of these pumps removed from U-plant but never modified for B-plant. Run-in station in cell.
<u>In the Cell: 150mR/Hr open cell rdng</u>	<u>In the Cell: 10mR/Hr open cell rdng</u>
1) 1 B-plant pulser, 1C-27-1.	1) A-11-1 agitator, needs work.
2) 1 old unmodified centrifuge from B-plant.	2) 2A-24-1-2 agitator, modified.
	3) 2A-A6-1 agitator, modified.
	4) Numerous pumps for burial: P-13-6-1, P-4-6-2, P-4-6-1, P-11-6-3 P-18-3, P10-7, P16-6-2 & P-14-7-2.
	5) Numerous agitators for burial: A-18-3, A-14-2 & A-17-3.

SECTION: 8

LEFT	RIGHT
<u>On the Deck:</u>	<u>On the Deck:</u>
1) 1 Purex F-14 tank deconned and repaired.	1) 1 Redox tube bundle capsule.
2) 1 cell cover block.	2) 1 open 9'X9' decon tank.
3) 1 storage rack for GE waste liner	3) 1 Purex condenser assy. old bolted flange type.
4) 1 Purex tube bundle shipping capsule, used with multi-purpose transfer box.	4) 1 jumper assy, J-J6-F-J7G (61867).
	5) 1 unidentified jet jumper assy. Belongs to Redox or Purex.
	6) 1 obsolete agitator, no motor.
	7) 2 obsolete pump columns.
<u>In the Cell: 20mR/Hr open cell rdng</u>	<u>In the Cell: 10mR/Hr open cell rdng</u>
1) 1 U-plant evaporator, E-8-1.	1) 1 B-plant tank, 31-1, for storage.
2) <u>Original equipment from cells.</u> All jumpers removed from cell.	2) 17 Purex thorium jumpers, to be buried.

SECTION: 9

LEFT	RIGHT
<u>On the Deck:</u>	<u>On the Deck:</u>
Deck is clear.	1) 1,7'X6'X12' metal waste box, full waste, at one time used for jumper transport to tank farms, not approved as a shipping or burial container.
	2) 1 waste skiff full of misc waste material.
	3) 1 B-plant 9'X9' tank for storage.
<u>In the Cell: 20mR/Hr open cell rdng</u>	<u>In the Cell: 200mR/Hr open cell rdng</u>
1) 1 old U-plant pulse column.	1) 1 Purex F-8 tank, needs to be deconned and repaired.
2) U-plant 7-4 concentration dunnage	

SECTION: 10

LEFT	RIGHT
<u>On the Deck:</u> 1) 1 old Shippingport fuel storage rack. 2) B-plant 13-1 tank, 9'X9', storage 3) 1 Redox pot dissolver. 4) 1,10'X3'X4' portable tool cabinet 5) 6,100N fuel shipping cask divider <u>In the Cell:</u> 120mR/Hr open cell rdng 1) 1 T-10-4 concentrator dunnage. 2) Original U-plant equipment.	<u>On the Deck:</u> 1) Redox pot tower. 2) U-plant 8'X14' tank spacer assy. for scrap shipping cask. 3) 1,3'X3'X2' lifting yoke, for burial. <u>In the Cell:</u> 180mR/Hr open cell rdng 1) Purex B-3 pot dissolver, to be buried.

SECTION: 11

LEFT	RIGHT
<u>On the Deck:</u> 1) 1 concentrator lifting yoke. 2) 1 jumper assembly #56-386. 3) 3 U-plant cell jumpers. 4) 5 exhaust ventilator assemblies removed from the roof at 224-T. Contaminated with low level Pu. Need containers for burial. 5) 1 obsolete B-plant dissolver. 6) 1 portable Lincoln welder. <u>In the Cell:</u> 50mR/Hr open cell rdng 1) 18 B-plant jumpers that need to deconned and buried.	<u>On the Deck:</u> 1) 1 open top decon tank 6'X14'. 2) 1 Purex dissolver catch tank/yoke. 3) 1 B-plant SP-5 tank, 5'X7'. Stored as a B-plant spare. <u>In the Cell:</u> 90mR/Hr open cell rdng 1) 1 Purex C-3 dissolver, to be buried 2) 1 B-plant centrifuge, 32-2.

SECTION: 12

LEFT	RIGHT
<u>On the Deck:</u> 1) 1 Redox pot dissolver. <u>In the Cell:</u> 50mR/Hr open cell rdng 1) 1 Purex C-3 dissolver, to be buried.	<u>On the Deck:</u> 1) 1 Purex F-5 condenser, deconned but needs to be leak tested. 2) 1 Redox centrifuge "A" frame 3) 1 Purex centrifuge G-G3-S0, cleaned but needs repair. 4) 1 U-plant concentrator column. <u>In the Cell:</u> 5mR/Hr open cell rdng 1) 1 Purex crane tool box, stored per Purex request. 2) 1 U-plant 8'X14' tank. 3) 1 U-plant pump 11-6-3.

SECTION: 13

LEFT	RIGHT
<p><u>On the Deck:</u></p> <p>1) 1 Redox silo leaded viewing glass window.</p> <p><u>In the Cell: 10mR/Hr open cell rdng</u></p> <p>1) Storage rack containing 17 misc. U-plant pumps and agitators.</p>	<p><u>On the Deck:</u></p> <p>1) 9 original U-plant pumps and agitators. Motors and baseplates removed from some units.</p> <p>2) 1 Redox F-2 pot.</p> <p><u>In the Cell: 50mR/Hr open cell rdng</u></p> <p>1) 1 Redox pot 11-V-D-12.</p>

SECTION: 14

LEFT	RIGHT
<p><u>On the Deck:</u></p> <p>1) Shipping capsule for pumps and agitators, for use with a multi-purpose tanks.</p> <p>2) 2 Hanford type shipping casks, for use in 100 area well cars.</p> <p>3) 1 U-plant philly gear agitator, no motor.</p> <p>4) 5 lifting bails for U-plant pumps and agitators.</p> <p>5) Lifting yoke for scrup cask.</p> <p>6) Unidentified agitator, no motor.</p> <p><u>In the Cell: 10mR/Hr open cell rdng</u></p> <p>1) 1 B-plant 9'X9' tank.</p> <p>2) Storage.</p>	<p><u>On the Deck:</u></p> <p>1) 2 cell cover blocks.</p> <p>2) 1,9' tall "A" frame.</p> <p><u>In the Cell: 1,000mR/Hr open cell rdng. (Taken in 1980).</u></p> <p>1) 1 Purex F-7 tank (HOT), save for Purex. Possible decon and repair.</p>

SECTION: 15

LEFT	RIGHT
<p><u>On the Deck:</u></p> <p>1) Damaged pump shipping stand, bury</p> <p>2) 1,4' wide cell storage rack.</p> <p>3) 3 Hanford type shipping casks, for 100 area type well cars.</p> <p>4) 1 Purex off-gas heater EA-2, to be repaired.</p> <p><u>In the Cell: ??mR/Hr open cell rdng</u></p> <p>1) 2 B-plant ti-tube bundles, need to be saved for B-plant.</p>	<p><u>On the Deck:</u></p> <p>1) 1 B-plant 31-1 tank, stored.</p> <p>2) Purex centrifuge 2-G-G-3, repairs completed.</p> <p>3) 1 T-plant centrifuge "A" frame with tank and bowl assy in place, for burial.</p> <p>4) 1 cell cover block.</p> <p><u>In the Cell: ??mR/Hr open cell rdng</u></p> <p>1) Following Redox equipment: D-10 and F-1 pots. D-14 and F-2 towers.</p>

SECTION: 16

LEFT	RIGHT
<u>On the Deck:</u> 1) 2 cell cover blocks. 2) 1,6'X31/2' tank coil made in error for a B-plant tank. 3) U-plant pump column, no motor or or base plate. 4) E-20-3 B-plant condenser, deconned, may need to be modified. 5) 1,8'X14' B-plant tank, save it. 6) 1 Purex H-4 condenser, deconned and repaired. <u>In the Cell: ??mR/Hr open cell rdng</u> 1) 1 B-plant centrifuge 32-2 to be deconned and repaired. 2) Unidentified B-plant centrifuges. 3) 2 Redox tube bundles, stored in capsules.	<u>On the Deck:</u> 1) 2 100N fuel shipping casks, for 1 well shipments. 2) 2 halves of old pump and agitator shipping container (save this). 3) 1 fuel storage rack, used with scrup cask shipments. 4) 1 Purex centrifuge 2-G-E2, SS764 has been repaired. <u>In the Cell: ??mR/Hr open cell rdng</u> 1) 1 U-plant tank 9'X9'.

SECTION: 17

LEFT	RIGHT
<u>On the Deck:</u> 1) 4 Hanford shipping casks, for 100N area type III well cars. 2) 2 old T-plant centrifuges "A" frame with tank and bowel. <u>In the Cell: ??mR/Hr open cell rdng</u> 1) 1 old U-plant 9-H tank.	<u>On the Deck:</u> 1) 1 B-plant centrifuge "A" frame. 2) 1 Purex J-8 condenser, deconned. 3) 1 Purex pulser, #10, 1-PG-G2, deconned and repaired. 4) 1 Purex off gas jumper (doughnut), deconned and repaired. 5) 7 various size HAPO shipping casks, stored for B-plant. <u>In the Cell: ??mR/Hr open cell rdng</u> 1) 1 old B-plant 9'X9' tank.

SECTION: 18

LEFT	RIGHT
<u>On the Deck:</u> 1) 1 B-plant 9'X9' tank for storage. <u>In the Cell: ??mR/Hr open cell rdng</u> 1) S/S jackets from 9'X9'tanks. 2) 9'X9' tank (8-1); B,T or U plant.	<u>On the Deck:</u> 1) 3 cell cover blocks. <u>In the Cell: ??mR/Hr open cell rdng</u> 1) 7'X14' tank (9-7) from U-plant. 2) 9'X9' tank (8-1) from B-plant.

SECTION: 19

LEFT	RIGHT
<u>On the Deck:</u> 1) 2 cell cover blocks. <u>In the Cell: ??mR/Hr open cell rdng</u> 1) 1 old TBP tower.	<u>On the Deck:</u> 1) 2 cell cover blocks. <u>In the Cell: ??mR/Hr open cell rdng</u> 1) B-plant tank 12-6 (6'X14") and 9-1 (9'X9').

SECTION: 20

LEFT	RIGHT
<u>On the Deck:</u> 1) 1 cell cover block. <u>In the Cell: ??mR/Hr open cell rdng</u> 1) Unknown.	<u>On the Deck:</u> This area is clear. <u>In the Cell: ??mR/Hr open cell rdng</u> 1) 20-6 bathtub. All original equipment intact. 2) Cover block on cell under 10 ton crane.

GENERAL NOTE:

Miscellaneous drums of unknown content (originally listed as chemicals), many rolls of various size hose, DOV valve, drum pallets, and odds/ends on the walkway from Section 3 through 20. Estimated at 3,000 cu./ft. of material.

SPECIAL NOTES:

- 1) **mR/Hr open cell rdng denotes open cell reading.
- 2) The information contained in this listing was obtained from a survey performed on 1-7-82 by unknown personnel. The listing was found in the possession of T-plant maintenance personnel by IFS&M.

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APPENDIX E

REDOX Facility Additional Information

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E-1. Appendix A

**J. T. Baxter, *Qualitative Structural Evaluations
of U Plant and REDOX Buildings*, WHC-SD-DD-SA-001
(Westinghouse Hanford Company, 1990).**

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APPENDIX A

RADIOLOGICAL INVENTORY ESTIMATE FOR REDOX (221-S)

CONTENTS:

- a. Letter report - REDOX radiological inventory ...Page A-2
assessment

DON'T SAY IT --- Write It!

DATE: April 5, 1990

WHC-SD-DD-SA-001
Rev. 0
Appendix ATO: ~~SECRET~~ Baxter HO-31FROM: R. G. Egge R2-77 *R. G. Egge*

Telephone: 3-2141

cc: D. R. Speer R2-77
RGE File/LB**SUBJECT: REDOX RADIOLOGICAL INVENTORY ASSESSMENT**

In response to your request for radiological inventory on the REDOX facility, the following information is provided:

202-S REDOX BUILDINGS**General**

The 202-S Canyon Building is a large, complex facility with different areas having very different physical and radiological characteristics. Due to the size and condition of the building, it is hard to formulate a "best guess" as to the actual condition of the radiological inventory but with the aid of operational records and the deactivation detailed procedures, this process will be attempted.

In general, the REDOX complex was operational from January 1952 to early 1967. The reinforced concrete structure was designed for processing highly radioactive materials on a large scale. This processing was performed in stainless steel vessels installed in deep, concrete cells in the canyon and in gravity flow solvent extraction columns in the silo section. Behind the concrete shielding walls along both sides of the canyon, the operations personnel controlled the entire process. Ventilation equipment rooms, a compressor room, offices, and other supporting facilities were located around perimeter of the processing area.

The attached REDOX Plant Deactivation Completion Report covers all the aspects of this facility with the exception of the sand filter at 291-S which remained in service and, therefore, did not meet the criteria for deactivation. The purpose of the sand filter is to remove radiological particulate material from the exhaust air. The filter consists of a graded gravel and sand bed designed to pass approximately 40,000 cfm of air at a face velocity of 5 fpm and 7 inches of water pressure drop across it. Air passes upward through the filter and re-enters the exhaust fan plenum on the northeast corner of the underground structure.

During the operational time period of the REDOX complex, the exhaust system was used to eliminate mitigation of radiological contamination by utilizing the sand filter at 291-S. It is therefore practical that this filter is radiologically contaminated but to what extent remains to be determined during the final deactivation of the REDOX complex.

If you require additional information, please call me at 3-2141.

cmj

A-2

54-3000-101(EF) GEF014
D.S.I.

REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. 5 DETAIL PROCEDURE NO.
SUBJECT: TERMINAL PROCESSING		PAGE 1 OF 2	
PREPARED BY J. R. Cartmell <i>JRC</i>		October 25, 1967	

Section 5 of the Redox Deactivation Manual gave instructions and detailed procedures for the period extending from the last scheduled charge of production-type fuel through final processing of products recovered in the extensive flushing of vessels, piping and equipment enclosures. In the original schedules it had been intended to continue normal processing through year-end, 1966. This schedule was revised to terminate regular production on 11-17-66, in favor of separate campaign processing of PRTR and PWR metals, the latter to include decontamination for cask loadout of the Am-Cm fractions. Separation of the various products, flushing of process vessels and sludge removal operations were conducted simultaneously where compatible with the end result desired, and to the extent permitted by equipment flexibility. The following is the schedule obtained through the product recovery period. Separate Completion Reports for the individual sections of Terminal Processing work are included under specific instruction numbers:

Completion Schedule

Final Production Charge	11-17-66
Final PRTR Charge	11-22-66
Final PWR Charge	12-01-66
U-Pu Inventory Depletion	12-29-66
First Neptunium Loadout	1-15-67
57% Nitric Acid Flush Completed	1-22-67
Vessel Sludge Removals Completed	1-29-67
U-Pu Terminal Processing Completed	3-05-67
Am-Cm Cask Loadout	3-15-67
Sec ond Neptunium Loadout	4-14-67
57% Nitric Acid Flush Completed	4-16-67

Product recoveries obtained in the final 57% nitric acid flush, in addition to the recovery data tabulated from all previous flushing operations, including vessel sludge dissolutions, were used as a basis for request to rescind provisions of Section 6 "Critical Mass Hazards Control Specifications" - RL-SEP-315. Formal concurrence by signatories of RL-SEP-315:

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REDOX PLANT DEACTIVATION COMPLETION REPORT		INSTRUCTION NO.
		5
		DETAIL PROCEDURE NO.
		5
SUBJECT: TERMINAL PROCESSING (Continued)		PAGE
		2 OF 2
PREPARED BY J. R. Cartmell <i>JRC</i>		October 25, 1967
<p>H. C. Rathvon G. R. Kiel R. E. Tomlinson R. W. McCullugh</p> <p>was given on 4-21-67 to permit start of the second phase of Terminal Processing - decontamination flushing - to proceed on that date.</p>		
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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0	INSTRUCTION NO.
		Appendix A	5.1.1
			DETAIL PROCEDURE NO.
			5.1.1.1D
SUBJECT:		PAGE	
FINAL 57% NITRIC ACID FLUSH THROUGH REDOX LINES AND VESSELS		1 of 2	
PREPARED BY		April 16, 1967	
J. R. Cartmell <i>gac</i>			

Detailed Procedure 5.1.1.1D represents the final acid flush of process vessels and piping following the termination of all processing including sludge removals from vessels listed in Procedure 5.1.1.3D. The flush was completed without the exceptions noted in the initial 57% nitric acid flush, conducted at the start of terminal processing and reported by M. C. Jacobs under the January 31, 1967 date.

Due to sampling and/or analytical problems that developed in connection with the 2D column, F-2 and F-1 vessel flushes, chemical assays received from F-1 samples were not corroborated by D-9 analysis. As a result the 2D column drain flush was repeated three times. The F-1 assays (subsequently) were determined to be in error.

Summary of plutonium accumulation data shown below was basis of the request to rescind provisions of RL-SEP-315:

Source	Grams Pu
1B, E-5, E-6, E-7	7
2D Overflow	5
1C, F-5, F-4	1
2D Drain, F-2, F-1	474*
2AW	0
3AW	0
2B, E-2, E-1	1
3B, E-4, E-3	0
Total Measured in D-14	(300)
Total Measured in D-9	378

*F-1 is obviously in error and should be about 350.

Repeat of 2D, F-2, F-1 Flush:

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REDOX PLANT DEACTIVATION
COMPLETION REPORT

INSTRUCTION NO.

5.1.1
DETAIL PROCEDURE NO.

SUBJECT:

FINAL 57% NITRIC ACID FLUSH THROUGH REDOX LINES AND VESSELS

5.1.1.1D

PAGE

2 OF 2

PREPARED BY

J. R. Cartmell

(Continued)

April 16, 1967

<u>Source</u>	<u>Grams Pu</u>
Measured in F-1	54
Measured in D-14	17
Measured in D-9	19
Previous in D-9	<u>378</u>
TOTAL in D-9	397*

*Material in D-9 discarded.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		INSTRUCTION NO. 511 DETAIL PROCEDURE NO.
SUBJECT: TERMINAL PROCESSING	PAGE 1 OF 1	
PREPARED BY J. R. Cartmell <i>gpc</i>	June 28, 1967	
<p>COMPLETION:</p> <p>A. <u>Silo</u></p> <p>The final water flush of the silo shaft was confined to use of the floor washdown spray system on February 9, 1967. It was decided to forego the use of a special wand shown on page 3 of Instruction 5.1.4. This flush water was processed through D-cell for combination with other flush solutions subsequently prepared for terminal processing of product to recovery.</p> <p>Decontamination flushing of the column carrier, silo shafts, and column exteriors were completed by use of a spray wand and high pressure pump at a later date. See Completion Report 5.2.1 for result of the flush.</p> <p>B. <u>Canyon Cells</u></p> <p>Cell flushes were completed as instructed except that D-1 samples were voided in the interest of expediting flushing operations.</p>		

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REDOX PLANT DEACTIVATION COMPLETION REPORT		WHC-SD-DD-SA-001 Rev. 0 Appendix A	INSTRUCTION NO. 5.2.1 through 5.2.4 DETAIL PROCEDURE NO. 5.2.1.1D PAGE 1 OF 12
SUBJECT: DECONTAMINATION FLUSHES FOR REDOX VESSELS AND PIPING, COLUMN CARRIER, CANYON DECK, CELLS AND EQUIPMENT.			
PREPARED BY J. R. Cartmell		June 5, 1967	

I. COMPLETION:

Detailed Procedure number 5.2.1.1D and Instruction numbers 5.2.2, 5.2.3, and 5.2.4 were completed on May 31, 1967, without exceptions.

II. OBSERVATIONS:

- A. The decontamination flushes consumed 7,423 pounds of potassium permanganate in a 1 1/2% solution and 8,000 pounds of oxalic acid in a 2 1/2% solution.
- B. Installed Beckman instruments failed to give internal or external radiation readings for the cells. Page 2 gives the results of canyon deck radiation surveys.

III. SUMMARY:

A summary of decontamination flush product pick-up is tabulated below:

A. Vessels and Piping

	<u>U(lbs)</u>	<u>Pu(gms)</u>	<u>Ho(gms)</u>
Alkaline Permanganate Flush No. 1	168	182	34
Alkaline Permanganate Flush No. 2	29	46	13
TOTAL PICKUP	197	228	47

B. Decks and Cells

	<u>U(lbs)</u>	<u>Pu(gms)</u>	<u>Ho(gms)</u>
TOTAL PICKUP	189	153	42

C. Column Carrier and Silo Shaft

	<u>U(lbs)</u>	<u>Pu(gms)</u>	<u>Ho(gms)</u>
TOTAL PICKUP*	40	22	7

*Included flush of A and B Cells.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. *See Below DETAIL PROCEDURE NO.
SUBJECT: TERMINAL PROCESSING - 233-S		PAGE 1 OF 1	
PREPARED BY J. R. Cartmell		June 5, 1966	
<p> *OPERATIONS - Instruction No's. 6.1.1 6.2.1 6.1.2 6.2.2 6.1.3 6.2.3 </p> <p> Following completion of the final 57% nitric acid flush through 233-S concentration and loadout equipment, which was routed to the waste section for subsequent discard in terminal waste batches, the decontamination flushes external to the vessels were completed as specified. Only very nominal product accumulation was experienced in the internal flush since it followed the second neptunium campaign which had been preceded by and followed with copious flushing associated with that loadout of neptunium. </p> <p> Decontamination flushes of greenhouse and loadout hood external to vessels and piping were completed as specified in the instruction without exception. These flushes were restricted to use of 10% nitric acid followed by water. </p> <p> The loadout hood was contact decontaminated to levels considered reasonable by R.M. Standards prior to sealing all cracks and openings and installing the high efficiency filter in one of the hood glove ports. </p> <p> Decontamination of Sections external to the greenhouse and hood were reduced to non-smearable status for painting. See other Section 6 - Completion Reports for areas recoated. </p>			
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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. See Below DETAIL PROCEDURE NO. See Below
SUBJECT: 233-S (VARIOUS SECTIONS)		PAGE 1 of 2	
PREPARED BY S. W. Douglas, R. L. Hibbard & J. R. Cartmell		June 9, 1967	
<p>In the interest of brevity and to consolidate the paper work involved the following Completion Reports have been combined. They represent the efforts of Mechanical, Instrument and Operations forces who certify that work specified in the procedures was completed without exception unless otherwise noted:</p> <p><u>Instruction</u></p> <p>6.2.4 Instruments deactivated as per 11.1.3.3 and 11.1.6.1. S. W. Douglas.</p> <p>6.2.4 Load out room walls spray painted with 33 Amercoat. Floors of room brush painted. R. L. Hibbard.</p> <p>6.2.4 Operations - Instruction completed without exception. J. R. Cartmell.</p> <p>6.2.5 Instrument deactivated as per Instruction 11.1.6. S. W. Douglas.</p> <p>6.2.5 Operations - Instruction completed without exception. J. R. Cartmell.</p> <p>6.2.6 Viewing room walls and grating painted with 133 Amercoat. Airless spray gun used. R. L. Hibbard.</p> <p>6.2.6 Operations - Instruction completed without exception. J. R. Cartmell.</p> <p>6.2.7 Stairwell spray painted with 33 Amercoat. R. L. Hibbard.</p> <p>6.2.7 Operations - Instruction completed without exception. J. R. Cartmell.</p> <p>6.2.8 Operations - Instruction completed without exception. J. R. Cartmell.</p> <p>6.2.9 Lower section of pipe gallery walls were spray painted with 33 Amercoat. The floor was brush coated. R. L. Hibbard.</p> <p>6.2.9 Instruction completed without exception. J. R. Cartmell.</p> <p>6.3 Heat and Vent Instruction for 233-S completed without exception. J. R. Cartmell.</p> <p style="text-align: center;">A-11</p>			

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTIONS See Below
			DETAIL PROCEDURE NO. See Below
SUBJECT: 233-S (VARIOUS SECTIONS) (Continued)			PAGE 2 of 2
PREPARED BY S. W. Douglas, R. L. Hibbard & J. R. Cartmell			June 9, 1967

- 6.4 Instrument Instruction for 233-S utilities completed without exception. S. W. Douglas.
- 6.4 Operations - Instruction for 233-S utilities completed without exception. J. R. Cartmell.
- 6.5 Instrument Instruction for 233-S equipment completed without exception. S. W. Douglas.
- 6.5 Operations Instruction for 233-S equipment completed without exception. J. R. Cartmell.
- 6.6 Instrument Instruction for 233-S Operating gallery completed without exception as per Instruction 11.1.6. S. W. Douglas.
- 6.6 Operations Instruction for 233-S Operating gallery completed without exception. J. R. Cartmell.
- 6.7 Operations Instruction for 233-S Change room completed without exception. J. R. Cartmell.
- 6.8 Operations Instruction for 233-S Storage building completed without exception. J. R. Cartmell.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. 7.1
			DETAIL PROCEDURE NO.
SUBJECT: GENERAL BULK STORAGE 211-S		PAGE 1 of 1	
PREPARED BY J. R. Cartmell <i>JRC</i>		June 9, 1967	
<p>Storage Vessels:</p> <p>TK 123 - Ammonium Fluoride 36, 125 lbs. 100%.</p> <p>TK 112 - Nitric Acid 957, 456 lbs. 100%.</p> <p>These two chemicals are being held in inventory for transfer to Purex at a later date.</p> <p>All remaining storage vessels for:</p> <p>Nitric Acid</p> <p>Caustic Soda</p> <p>ANN</p> <p>Sodium Dichromate</p> <p>Demineralized Water</p> <p>have been emptied and flushed clean. They are being held in stand-by condition as per procedure without exceptions.</p>			
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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. 7.1.1		
			DETAIL PROCEDURE NO.		
SUBJECT:	MAKE UP AND DISTRIBUTION - OPERATIONS - INSTRUMENTS		PAGE 1 of 1		
PREPARED BY	S. W. Douglas and J.R. Cartmell - <i>JRC</i>		June 9, 1967		
<p>All AMU and 8th level head tank vessels were deactivated as per the Instruction. Piping revisions to supply raw water for stand-by flushing operations were completed as prescribed in Section XIX.</p>					
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INSTRUCTION NO.

7.2
DETAIL PROCEDURE NO.REDOX PLANT DEACTIVATION
COMPLETION REPORTSUBJECT: ORGANIC SYSTEMS 276-S AND 202-S
ELECTRICAL, MECHANICAL, INSTRUMENTS, AND OPERATIONSPAGE
1 of 1PREPARED BY
R. L. Hibbard, S. W. Douglas & J. R. Cartmell

June 9, 1967

All provisions of procedure 7.2 were complied with except that storage of spent organic is being maintained in U.G.S. tanks 141-142, pending receipt of a method for disposal. The void space in each vessel has been filled with water to preclude vapor formation within the vessels.

See Appendix Section for radiation and contamination status of 276-S process section.

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<p style="text-align: center;">REDOX PLANT DEACTIVATION COMPLETION REPORT</p>		INSTRUCTION NO.
		7.3
<p>SUBJECT: 293-S NITRIC ACID RECOVERY AND STORAGE OPERATIONS - MECHANICAL - ELECTRICAL</p>		DETAIL PROCEDURE NO.
		7.3.D
<p>PREPARED BY M. C. Jacobs and R. L. Hibbard</p>		PAGE
		1 of 1
		March 7, 1967

I. COMPLETION

Operations work was completed without exception as per procedure 7.3.D.

Pump motor disconnects for Tk-3, T3-1, T3-2 were pulled at motor control center as per Instruction 11.2.3.2.

Item 12 of Instruction 7.3 was found impractical to follow. The alternate of drilling holes in two traps was done to provide drainage. The traps were tagged accordingly.

II. OBSERVATIONS

The C-Dissolver Absorber by-pass valve failed to close when operated from C-Section in the north operating gallery. Repairs were not made, but the information has been noted on the deactivation tag affixed to controller. The valve remains in open position.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. 7.4
			DETAIL PROCEDURE NO.
SUBJECT: TANK FARM SODIUM NITRATE		PAGE 1 OF 1	
PREPARED BY J. R. Cartmell <i>JRC</i>		June 20, 1967	

Provisions of Instruction 7.4 were completed as planned with the exception that the transfer lines from SX farm had plugged with salt several months prior to Redox shutdown, and as of the above date had not been cleared. Subsequent to this time Waste Management forces were successful in clearing the lines from 240-S-151 diversion box back to 105-SX.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		INSTRUCTION NO. 7.5
		DETAIL PROCEDURE NO.
SUBJECT: PROPANE STORAGE AND DISTRIBUTION		PAGE 1 of 1
PREPARED BY MECHANICAL - OPERATIONS R. L. Hibbard and J. R. Cartmell <i>JRH</i>		May 15, 1967

The Instruction was completed as specified and without exception.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. 8.1
			DETAIL PROCEDURE NO. 8.15 - 8.16
SUBJECT: UTILITIES - 222-S, 202-S (MECHANICAL - OPERATIONS)			PAGE 1 of 1
PREPARED BY R. L. Hibbard and J. R. Cartmell <i>JRC</i>			March 9, 1967

Supply of demineralized water to the Laboratory was discontinued as per Instruction 8.15. Raw water is now being fed to the 222-S Still.

After all hexone had been displaced and flushed from process vessels, 804 Head-Tank and the O-1, O-2, and O-3 tanks at 276-S, inert gas supply to the 100 and 25 psi header and distribution systems were converted to process air.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. 8.2.1 - 8.2.2
			DETAIL PROCEDURE NO. 11.2.2.2
SUBJECT:	CHEMICALS TO 222-S - NITRIC ACID, SODIUM HYDROXIDE		PAGE 1 OF 1
PREPARED BY	R. L. Hibbard and J. R. Cartmell <i>per</i>		May 25, 1967

Completed deactivation of nitric acid, and caustic lines to the 222-S building. Completed caustic and nitric cut-in of new installation from pumps that were installed by Construction Forces.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		INSTRUCTION NO. 8.3
SUBJECT: RADIOACTIVE WASTE DISPOSAL 222-S		DETAIL PROCEDURE NO.
PREPARED BY J. R. Cartmell <i>JRC</i>		PAGE 1 OF 1
		May 25, 1967

Revisions were completed to 219-S vault by J. A. Jones forces to permit direct neutralization of 222-S Laboratory waste.

The jumpers required for by-pass of D-8 Waste Neutralizer vessel in the Redox waste cell has been fabricated, but not installed since Waste Management is continuing to utilize waste concentration facilities for 202-S Building.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. 9.1.1 through 9.1.5 DETAIL PROCEDURE NO.
SUBJECT: UNH STORAGE - 205-205 BUILDINGS		PAGE 1 of 1	
PREPARED BY MECHANICAL, INSTRUMENTS, OPERATIONS R. L. Hibbard, S. W. Douglas, J. R. Cartmell <i>per</i>		June 20, 1967	
<p>All Instructions in Section 9 were completed without exception.</p> <p>The security fence has been erected and the 204-205 facilities transferred to Purex and Waste Management dual responsibility. The latter organization came into the picture on July 1 in connection with handling of aqueous wastes from Battelle Northwest.</p>			
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REDOX PLANT DEACTIVATION COMPLETION REPORT		INSTRUCTION NO. 10
		DETAIL PROCEDURE NO.
SUBJECT: EFFLUENT SYSTEMS		PAGE 1 of 1
PREPARED BY J. R. Cartmell <i>JRC</i>		June 30, 1967

The following Instructions were completed without exception:

- 10.1.1 Open Pond
- 10.1.2 Cribs
- 10.1.3 Diversion Boxes
- 10.1.4 Tank Farms
- 10.2.1 Canyon and Silo
- 10.2.2 233-S

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. 11 DETAIL PROCEDURE NO.
SUBJECT: EQUIPMENT		PAGE 1 of 1	
PREPARED BY J. R. Cartmell <i>JRC</i>		June 30, 1967	
<p>The Instructions covering equipment in:</p> <ul style="list-style-type: none"> 11.1.6.1 11.1.6.2 11.1.6.3 11.2.1 <p>were completed without exception. General instructions followed with respect to all equipment precluded D-Section where waste concentration operations are continuing. The waste cell functions previously conducted from K-Panel in the Silo Operating Gallery has been transferred back to D-Board. Instruments required for operation were moved from K-Panel.</p> <p>The canyon crane was decontaminated to the lowest levels measured in many years. Request to paint the crane for preservative purpose has been requested. See Appendix for radiation levels measured after completion of the decontamination effort.</p>			
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REDOX PLANT DEACTIVATION COMPLETION REPORT		INSTRUCTION NO.
		12
SUBJECT:		PAGE
UTILITIES		1 of 1
PREPARED BY		June 30, 1967
J. R. Cartmell, R. L. Hibbard, S. W. Douglas <i>Qpk</i>		

Services in 202-S and associated buildings were deactivated in accordance with the following Instructions with the few exceptions required for D-cell continued operation:

- 12.1.1 High Pressure Steam
- 12.1.2 Medium Pressure Steam
- 12.1.3 Low Pressure Steam
- 12.2.1 Process Air
- 12.2.2 Instrument Air
- 12.2.3 Breathing Air
- 12.3.1 Raw Water
- 12.3.2 Sanitary Water
- 12.3.3 Demineralized Water
- 12.5.1 Propane Receiving and Distribution
- *12.5.2 Inert Gas Generation and Distribution
- 12.6 Ozone
- 12.7.2 Public Telephones
- 12.7.3 Intercom
- **12.7.4 TV
- 12.7.5 Data Transmission

*The inert gas compressor low pressure tank cut off limit switches have been adjusted so that contacts are closed in order to permit stand-by operation of the generators. If the service is reactivated the contacts must be opened before the compressors are started up. The equipment has been tagged to call out this fact.

**The canyon TV camera and TV receivers have been retained for service.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. 14.0 DETAIL PROCEDURE NO.
SUBJECT: GALLERIES		PAGE 1 OF 1	
PREPARED BY S. W. Douglas, R. L. Hibbard, J. R. Cartmell		June 30, 1967	

Deactivation Instruction 14.0 was completed with the following exceptions:

1. All instrumentation and services associated with D-Board Operation including the vent systems.
2. Retention of D-9 sampling capability.
3. Retention of D-2 to crib route.
4. Did not install 222-S to 241 by-pass jumper.

REDOX PLANT DEACTIVATION COMPLETION REPORT		INSTRUCTION NO. 15
		DETAIL PROCEDURE NO.
SUBJECT:	REGULATED AREAS	PAGE 1 OF 1
PREPARED BY	J. R. Cartmell <i>JRC</i>	June 30, 1967

Instructions 15.1 through 15.4 were completed as specified. See Appendix for a review of final radiation and contamination status.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		INSTRUCTION NO. 16
		Rev. 0 Appendix A DETAIL PROCEDURE NO.
SUBJECT: SERVICE AREAS - OPERATIONS - ALL CRAFTS		PAGE 1 OF 1
PREPARED BY J. R. Cartmell <i>JRC</i>		June 30, 1967
<p>All Deactivation Instructions covered in Section 16.1 through 16.8 were completed except for the following:</p> <p>16.3 Ladies Lounge continues in service.</p> <p>16.4 All restrooms continue in service.</p> <p>16.7.1 -</p> <p>16.7.5 All maintenance facilities continue in service.</p> <p>The Shops are being used as a Waste Management tank farm maintenance crew base.</p>		
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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. DETAIL PROCEDURE NO.
SUBJECT: DEACTIVATION SURVEY		PAGE 1 OF 8	
PREPARED BY J. R. Cartmell and R. C. Herald			

<u>BLDG. OR AREA</u>	<u>SURVEY RESULTS</u> <u>RADIATION LEVELS - CONTAMINATION LEVELS</u>
<u>291-S Area</u>	
Exhaust Fan Housing	200 mR/hr at C (Internal Contamination)
Exhaust Fan Housing Base and Concrete Fan	35W.O. 8 W.C. at C 100,000 c/m smears
291-S Bldg. Lines and Floor	To continue in present status
291-S Stack - Side	To continue in present status
291-S Stack Shack	To continue in present status
291-S 50' Stack Sample Rm. and Stairway	Smears 6000 c/m $\angle$ 1 mR/hr at F
Sample Room	Smears 6000 c/m
Lines and Floor in Sample Room	Smears 500 c/m Direct 6000 c/m
<u>292-S Bldg.</u>	
Pipe and Lines (Ground Floor)	Direct 1000 c/m Smears 400 c/m
Entrance to Bottom Level	Direct $\angle$ 1 mR/hr Smears 400 c/m
<u>293-S Bldg.</u>	
Valve Pit Room (Walls)	Smears 200 c/m $\angle$ 500 d/m
Lines, Valves and Floor	Smears 600 c/m $\angle$ 500 d/m
Stairwell and Sampling Area	Smears 200 c/m $\angle$ 500 d/m
Absorber Room	
Absorber and Floor	Smears 200 c/m $\angle$ 500 d/m
Absorber	$\angle$ 6 mR/hr at C
Scrubber	$\angle$ 6 mR/hr
Scrubber and Floor	Smears 200 c/m $\angle$ 500 d/m
Sample Area and Instrument Area-Ground Level	$\angle$ 6 mR/hr at C Smears 500 c/m $\angle$ 500 d/m
<u>Underground Tanks Area 291-S</u>	$\angle$ 6 mR/hr through concrete covers
291-S Fallout Area	Low level B-G contamination over ground area (General) Washed into soil
Sand Filter (202-S)	To remain in active status
Sand Filter Shack	To remain in active status

<u>Symbol</u>	<u>Identification</u>
W.O.	Window open with a C.P. Survey Instrument - Beta-Gamma Reading.
W.C.	Window closed with a C.P. Survey Instrument - Gamma reading only in mR/hr.
At C	At contact
At F	At field
N.S.	Non-smearable
15/5	Means 15 W.O. 5 W.C. with a C.P.
SOP	Step-Off Pad
D.R.	Dose Rate
d/m	Counts per minute measured with a G.M. Instrument for Beta-Gamma,
d/m	Disintegrations per minute used 20 alpha contamination as measured with Poppy or Juno Instrument.

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0	INSTRUCTION NO.
		Appendix A	DETAIL PROCEDURE NO.
SUBJECT:		PAGE	
DEACTIVATION SURVEY		2 of 8	
PREPARED BY			
J. R. Cartmell and R. C. Herald			

<u>BLDG. OR AREA</u>	<u>SURVEY RESULTS</u> <u>RADIATION LEVELS - CONTAMINATION LEVELS</u>
<u>204-205 Area</u>	
204 Pit	≤ 6 mR/hr at C
Floor	To 3000 c/m smears - 500 d/m smears
Tops and Sides (Tanks)	To 40 mR/hr at C - Smears 35,000 c/m and 1,000 d/m
Catwalk	10 mR/hr at F
204 Pump Pit	
Floor, lines and pump	≤ 6 mR/hr at C - 2000 c/m smears 500 d/m smears
<u>205 Bldg.</u>	
Lines and Tanks	≤ 6 mR/hr at C ≤ 200 c/m smears ≤ 500 d/m smears
Sample Room	6 mR/hr at C ≤ 200 c/m smears ≤ 500 d/m smears
<u>151-152 Tanks</u>	
Tanks, piping floor	To 80 W.O. - 25 W.C. Smears 6,000 c/m ≤ 500 d/m
<u>276-S</u>	
(Outside) Wall Instrument	220 W.O. 40 W.C. Smears 3500 c/m
Lines and Pipe on East Side of Bldg.	
Operating Gallery	
Process Side	
Bottom Level	To 150 W.O. and 100 W.C. at F
All lines - Floor	≤ 1 mR/hr at C ≤ 100 c/m ≤ 500 d/m smears
Floor and Drain	1000 W.O. 500 W.C. at 1" Smears 50,000 c/m
Sides of Tanks and lines	To 500 mR/hr at C Smears 1500 c/m ≤ 500 d/m
Tops of tanks and pumps	25 mR/hr at C Smears 1500 c/m ≤ 500 d/m
<u>233-S</u>	
Entrance air lock, instrument Rm. Direct Smears	≤ 100 c/m ≤ 500 d/m
Change room, blower room, Rest room, and Operating Gallery	
Pipe Gallery	
Wall, floor pipes and Lines	6 mR/hr at C - General Smears 5,000 d/m after painting
Pipe Gallery airlock	500 d/m smears

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. DETAIL PROCEDURE NO.
SUBJECT: DEACTIVATION SURVEY		PAGE 3 OF 8	
PREPARED BY J. R. Cartmell and R. C. Herald			

<u>BLDG. OR AREA</u>	<u>SURVEY RESULTS</u> <u>RADIATION LEVELS - CONTAMINATION LEVELS</u>
Electrical switch gear station East of 233-S	Contaminated on external surfaces to 1000 d/m direct
All conduit and other lines outside and inside 233-S	Contaminated internally
<u>233-S</u>	
Can storage rooms and loading dock	≤ 1 mR/hr ≤ 500 d/m smears
Loadout room Hooks, scales, Hoods Side and Front - Walls, ceiling, top of hoods, monorail Ports of Loadhood	Smears ≤ 500 d/m
233-S Viewing Room Stairwell Stairs, floor, walls, ledges	Smears 5000 d/m - after painting
Viewing Room - 4th level Grating, Walls, Beams Window Ledges	Smears 5000 d/m - after painting
3rd Level Viewing Room Grating, Walls, Beams, Window ledges	10,000 d/m smearable - after painting
2nd Level - Grating, Walls Beams, Window Ledges	50,000 d/m smearable - after painting
1st Level - Grating, Walls, Beams, Window Ledges	5,000 d/m smearable - after painting
233-S Greenhouse	2400 W.O. 800 W.C. at Plastic Window
<u>202-S</u>	
S Sample Gallery - General Sample Port Ledges Floor Area	Max. 200 W.O. - 100 W.C. at 6" Generally ≤ 20,000 c/m smears - Max. ≤ 100,000 c/m Smears 10,000 c/m
F Sample Ports	To 40,000 d/m direct 5000 d/m smears
North Sample Gallery A thru D Sect. Sample Ports (Inside)	Max. 80 W.O. 20 W.C. at 6"

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REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO.
			DETAIL PROCEDURE NO.
SUBJECT: DEACTIVATION SURVEY		PAGE 4 OF 8	
PREPARED BY J. R. Cartmell and R. C. Herald			
<div style="display: flex; justify-content: space-between;"> <div style="width: 40%;"> <p><u>BLDG. OR AREA</u></p> <p>E Section - Ports (Inside Sample Boxes)</p> <p>Port Ledges</p> <p>Floor Area A through D E Section</p> <p>Remote Shop Walls Floor</p> <p>Decontamination Room Decontamination Hood</p> <p>Gloved Box and All Stored Equipment Floor</p> <p>Regulated Shop - All Tools, Equipment and Machinery</p> <p><u>202-S</u></p> <p>Pipe and Operating Galleries Including Offices in S.O.G. North Pipe Gallery</p> <p>Floors, Equipment, Tools, etc. of Lunch Room, Offices, H-vox Room, Compressor Room, Main Floor Corridor, Electric Shop, Instrument Shop, Maintenance Shop - Change Room</p> <p>Blower Rooms Area outside Blowers - Area inside Units</p> <p>Main Elevator Pit Area, Top of Elevator and cables Elevator Inside Sample Elevator</p> <p>Silo Operating and Pipe Gallery Panel Board, Instrument Lines Floor and Desk</p> <p>Silo Sample Gallery Outside Areas of Sample Ports</p> </div> <div style="width: 55%;"> <p><u>SURVEY RESULTS</u> <u>RADIATION LEVELS - CONTAMINATION LEVELS</u></p> <p>Max. 200 W.O. - 200 W.C. at 6"</p> <p>Smears to > 40,000 d/m</p> <p>300 c/m Smears 2000 d/m Smears</p> <p>Direct and Smear 500 W.O. - 100 W.C. at C 500 W.O. at 6" and 50 W.O. - 10 W.C. at C on smears</p> <p>30,000 c/m Smears 10,000 d/m Smears</p> <p>4,000 c/m 15000 c/m Smears</p> <p>≤ 6 mrad/hr ≤ 100 c/m ≤ 500 d/m Smears</p> <p>Walkway smearable ≤ 100 c/m ≤ 500 d/m D Section roped off. Smears 700 c/m to 1500 c/m</p> <p>Good - All ≤ 100 c/m ≤ 500 d/m Direct and Smearable</p> <p>Good</p> <p>Good - All ≤ 200 c/m ≤ 500 d/m Direct and Smears Direct and Smears To 10,000 c/m direct 400 c/m smears</p> <p>≤ 200 c/m ≤ 500 d/m Direct and Smears</p> <p>A-32</p> </div> </div>			
<p>Smear 1000 c/m - 1000 d/m - (300 W.C. at C direct)</p>			

REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO.																																								
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SUBJECT: DEACTIVATION SURVEY		PAGE 5 of 8																																									
PREPARED BY J. R. Cartmell and R. C. Herald																																											
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Appendix A

INSTRUCTION NO.

DETAIL PROCEDURE NO.

REDOX PLANT DEACTIVATION COMPLETION REPORT		INSTRUCTION NO. DETAIL PROCEDURE NO.
SUBJECT: DEACTIVATION SURVEY		PAGE 6 OF 8
PREPARED BY J. R. Cartmel and R. C. Herald		

BLDG. OR AREA	SURVEY RESULTS RADIATION LEVELS - CONTAMINATION LEVELS
AMU Levels - 1,2,3,4,5	1st level light ports to 60,000 c/m direct 6,000 c/m smears
Tools, Floors and Walls Silo lights - Ports	1st level floor near leak - 30,000 c/m Smears $\angle 100$ c/m $\angle 500$ d/m 2nd level window smears to 800 c/m 40,000 c/m direct 3rd level - OK 4th level near light port 15 W.O. 5 W.C. at C N.S. 5th level leak from 6th level through ceiling to 10,000 c/m - Tanks and floor smears 800 c/m
804 Enclosure Tank (top) Floor (sides) Pumps Lines 804 level in general Floor - lines and etc.	$\angle 5$ mR/hr at C 15/5 at C - Smears 1,000 c/m Smears 1000 c/m to 1000/200 at 1" Smears $> 100,000$ c/m 500 d/m Good shape - $\angle 200$ c/m $\angle 500$ d/m smearable
All exhaust fans and stacks From 202-S other than 291-S stack	$\angle 6$ mR/hr at C $\angle 200$ c/m $\angle 500$ d/m smearable
RR Tunnel Floor Walls Floor Drain	4000 W.O. 1000 W.C. at 2" near drain line Floor smears 35 W.O. 10 W.C. at C 100 W.O. 50 W.C. at 1" Smears 30/5 at C Rails smear 5 W.O. at C Smears floor drain 120/20 at C
RR Cut	Several spots in cut to 100,000 c/m
Cask car decontamination station	Several spots to 8,000 c/m
<u>CMP</u> Floors, Walls, Equipment	Smears 10 W.O. 5 W.C. 2000 d/m D.R. to cross CMP - 50 mRads/hr at F Readings 100 W.O. 30 W.C. at F Crane in Barn
Craneway <u>60 Ton Crane</u>	100 W.O. 800 W.C. at 22"
Auxiliary units other than hooks, cables and wrenches Hooks Cables - Wrenches	1500/1000 at 6" 5000/3000 at 1" 5000/3000 at 1"

REDOX PLANT DEACTIVATION COMPLETION REPORT		Rev. 0 Appendix A	INSTRUCTION NO. DETAIL PROCEDURE NO.
SUBJECT: DEACTIVATION SURVEY		PAGE 7 of 8	
PREPARED BY J. R. Cartmell and R. C. Herald			

BLDG. OR AREA	SURVEY RESULTS RADIATION LEVELS - CONTAMINATION LEVELS
Underside of Crane Rails, Beams, Optics Festoons-Cables	200/100 at C
Light Reflectors	1500/1000 at 6"
Light Shields	
Top of Catwalk	East 300/200 at 6" West 1000/500 at 6"
Rails	1500/1000 6"
Motors	1000/1000 6"
Wheel Areas	1500/1000 6"
Top of Trolley	
Flat Surfaces, Cables, Motors	1500/400 at 6" 1000/1000 at 6"
Crane Cab - Filter Units	No cleaning - still very hot
Air conditioner Filter	No cleaning - still very hot
Air conditioner condenser Fans	No cleaning - still very hot
Top of Penthouse	No survey at this time
Penthouse (inside) and Floor	No survey at this time
<u>60 Ton Crane (Cab)</u>	
Cab on Inside	Direct 300-800 c/m Smear = Background
Cab Airlock	
Floor and SOP	Smear 5,000 c/m
Walls	Smear 600 c/m
CMP	Smear of deck = 10/5 at C and 2000 d/m
Viewing Room	(Crane in Barn) 5/5/F Smear 500 c/m 800 d/m
Undressing airlock	Smear 500 c/m
Stairwell-Steps, landings, Rails	Smear = Background 200-300 c/m ≤500 d/m Smearable
<u>202-S</u>	
SWP Change Room	Through tile on floor @west end direct 9,000 c/m
Floor	Smear ≤100 c/m ≤500 c/m
Walls	Smear ≤100 c/m ≤500 c/m
Duct Work and Pipes	Background 200 - 1,000 c/m
Store Room	≤200 c/m ≤500 d/m
SWP Lobby	≤200 c/m ≤500 d/m
Floor	Background 400-600 c/m
Sample Gallery and Stepoff Area	Smear ≤200 c/m ≤500 d/m
SWP Decontamination Room - Floor	Smears ≤200 c/m A-35

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SUBJECT: DEACTIVATION SURVEY		PAGE 8 OF 8																		
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REDOX PLANT DEACTIVATION DETAIL PROCEDURE: EXTENSION		PROCEDURE NO. 14.8DM	
		INSTRUCTION NO. 14	
SUBJECT: GALLERIES - 7th LEVEL		Extension No. 1	PAGE 1 OF 1
APPROVED BY: C. E. McMahon	PREPARED BY: C. E. McMahon	DATE: August 14, 1969	

SCHEDULE: Work to be performed is not to be initiated until after cessation of the water runs and assurance is made that the 8th level head tanks and the silo columns are empty.

STATUS DESIRED:

1. Complete deactivation of the 8th level head tanks used during the water runs and all of the 7th level except for ventilation.
2. Completion Report properly made out indicating the status.

MECHANICAL - (Operations - Maintenance):

1. Drain the 1-0X, 3-DA and 3-EX rotometer piping. (Located behind "K" panel board)
2. Drain the 2-AS rotometer piping. (Located in the Silo Sample Gallery)

INSTRUMENTS:

1. Deactivate 8th level head tank instruments 801-0, 802-A and 803-DA according to Redox Deactivation Instruction for Equipment (Section 11).
2. Valve off the air supply to all panel boards.

ELECTRICAL:

1. Remove the electrical power supplying all panel boards at the breakers and affix a deactivation tag at the breakers.

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Appendix A

REDOX PLANT DEACTIVATION DETAIL PROCEDURE - EXTENSION

PROCEDURE NO.

14.5DM

INSTRUCTION NO.

14

SUBJECT:

GALLERIES "F" SECTION

Extension
No. 1PAGE
1 OF 1

APPROVED BY: C. E. McMahon

DATE: August 14, 1969

PREPARED BY: C. E. McMahon

DATE: August 14, 1969

SCHEDULE: The work to be performed is not to be initiated until after cessation of the water runs and assurance is made the cell vessels are empty.

STATUS DESIRED:

1. Complete deactivation of "F" section except for F-S-1 and F-S-2 cell sumps liquid level readouts, alarms and jet outs.
2. Completion Report properly made out indicating the status.

MECHANICAL - (Operations - Maintenance):

1. Install blanks in the flanges on gallery wall nozzles 57, 92 and 115.
2. Assure that the blanks installed as per Detail Procedure 14.5DM have not been removed.

INSTRUMENTS:

1. Deactivate weight factor instruments F-1, F-2, F-4, F-5, F-7 and F-8 by
 - a) valve off the purge and close the valves at the gallery wall on all dip tube (impulse) lines, b) deactivate associated equipment according to the Redox Deactivation Instruction for Equipment (Section 11).

ELECTRICAL:

1. Deactivate 2DF, F-1 recirculation (External Cooler), 3DF, 1AF (F-7), 1SF (F-8) and F-8 recirculation pumps and the F-4 agitator by disconnecting the motor lead wires at the Motor Control Center and affixing a deactivation tag indicating the method of deactivation to the Motor Control Unit.

E-2. C. A. Rohrmann and J. O. Ludlow, *Process
Modifications 202-S Buildings*, HW-27968
(General Electric Company, 1953).

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Classified by [redacted] and [redacted]

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By [redacted] WITH DELETIONS

C.A. Rohrmann

By [redacted] 10/1/53

Verified By [redacted] 11/1/53

1. A.B. Greninger
2. R.H. Beaton
3. J.S. McMahon
4. H.A. Carlberg
5. W.K. MacCready
6. W.K. Woods
7. W.M. Harty
8. V.D. Nixon
9. T.W. Hauff
10. R.S. Bell
11. C.P. Cabell
12. P.D. Lee
13. C.F. Hill

14. C.E. Reed
15. V.R. Chapman
16. J.L. Boyd/C.E. Kent
17. P.W. Woodfield/R.J. Scot
18. F.A. Hollenbach
19. W.H. Mobley/R.G. Barnes
20. R.E. Smith
21. G.C. Gabler/H.Z. Hanthorn
22. V.R. Cooper
23. R.E. Tomlinson
24. C.A. Rohrmann
25. Yellow
26. 700 File

WITH DELETIONS

This document consists of
 15 pages, [redacted]
 S. Series [redacted]

May 5, 1953

TO: V.D. Nixon

COPY 1 OF 1, SERIES MA

FROM: C.A. Rohrmann/J.C. Ludlow

PROCESS W DELETIONS 202-S BUILDING

Ref: HW-26030 "Program X" - Separations Cost", C.A. Rohrmann, 10/23/52.

HW-27010 "Back-Cycling of 2D4-3D4 to Earlier Cycles as Scrub - 202-S Building", R.G. Barnes/O.C. Schroeder, 2/9/53.

Introduction:

Document HW-26030 presented annual operating costs for a 200 TU/Mo Redox plant. Document HW-27010 proposed a scheme whereby the third and second uranium cycle salt wastes in the Redox plant are combined, stripped, evaporated, and then returned as scrub to the first (and possibly second) cycles as scrub, operating as a dual scrub column.

Purpose:

It is the purpose of this report to study this proposed method of back-cycling, and to investigate other methods of reducing chemical and waste storage costs. The method which appears most desirable will be recommended for inclusion in the Phase II Redox alterations.

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V.D. Nixon

- 2 -

May 5, 1953

Summary & Conclusions:COMPARISON OF ALTERNATES

<u>Alternates</u>	<u>Manufacturing Costs Per Year.</u>	<u>Dollar Value over Basic Redox of U and Pu Recovered</u>
Basic 200 TU/Mo Redox.	\$2,080,900	0
Basic Redox / 2 Stage Back-Cycle.	5,811,400	\$343,200
Basic Redox / Pre-Cycle / 2 Stage Back-Cycle.	5,275,100	404,400
Basic 200 TU/Mo Redox - Cribbable.	7,453,900	0
Basic Redox / 2 Stage Back-Cycle - Cribbable.	5,185,500	343,200
Basic Redox / Pre-Cycle / 2 Stage Back-Cycle - Cribbable.	4,615,500	392,200
Basic 200 TU/Mo Redox with Self Concentration.	7,017,900	0
Basic Redox / 2 Stage Back-Cycle with Self Concentration.	4,635,400	343,200
Basic Redox / Pre-Cycle / 2 Stage Back-Cycle with Self Concentration.	4,342,000	404,400
Basic 200 TU/Mo Redox - Cribbable with Self Concentration.	6,140,200	0
Basic Redox / 2 Stage Back-Cycle - Cribbable with Self Concentration.	4,426,400	343,200
Basic Redox / Pre-Cycle / 2 Stage Back-Cycle - Cribbable with Self Concentration	4,121,500	392,200

In view of the considerable savings and improved operation achieved by the use of pre-cycle, combined with two stage back-cycling of the uranium salt wastes and cribbing of coating wastes and final plutonium cycle wastes, it is proposed that Phase II Redox alterations be revised in accordance with Figure 4. Provisions should be provided for segregating coating wastes and final plutonium cycle waste for cribbing.

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Discussion:

After receiving HW-27010, consultations by the Separations Section and the Design Section resulted in a decision to modify the back-cycle proposal to provide for 2 stage back-cycling of uranium salt wastes - third cycle returned to second cycle and second cycle returned to the first cycle.

During the preliminary scope design of the Purex plant, the process consisted of one combined decontamination and partition cycle, followed by a separate decontamination cycle each for uranium and plutonium. Further study by the Technical Section resulted in the conclusion that sufficient decontamination to produce specification uranium and plutonium could not be assured using two cycles. As a result, the Technical Section requested that the scope be revised to include a third uranium decontamination cycle and a third plutonium cycle. Study and evaluation by the Design Section resulted in an alternative proposal to install a single complete decontamination cycle for uranium together with plutonium, at the start of the extraction battery, and thus as a result to provide the third cycle for both uranium and plutonium. This was the so-called pre-cycle flowsheet. This proposal accomplished the desires of the Technical Section using only two additional columns instead of the four necessary for separate third cycles. A further saving was realized in that chemicals and waste storage for only one additional cycle were required. This was true, since the chemicals and waste facilities necessary for 16,600# of metal are not increased by including the plutonium along with this mass of uranium in the pre-cycle.

Since it was realized that considerable piping and equipment revisions would have to be made in order to provide facilities for Phase II Redox and ANN back-cycling it was decided to investigate the possibility of making further piping changes in order to gain the benefits of pre-cycle operation.

Basic Redox layout consists of head-end treatment, feed tanks, concentrators, and auxiliaries located in cells in the canyon section of the building. The extraction columns are all located in the silo section of the building. Piping connecting these two sections of the building are via a hot pipe trench. Therefore, a given feed tank can be connected to a different column by making relatively minor changes in piping in the silo.

Investigation of silo lay-out, correlated with the desired process pattern led to the following revised flow pattern.

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The 1AF tank feeds the 1A-1S combination as at present. Organic from the 1A-1S column top is jumpered to the feed point of 2E column. The line from the 2E column is jumpered to the 1CU concentrator. Organic from the 2D column is jumpered to the 1B feed. Aqueous from the 1C column is jumpered to the 2EU concentrator. The 2BP is jumpered to the 3BP receiver with a diversion valve so it can be routed to the 3AF tank if desired. The existing third plutonium cycle thus will not be required for normal processing, but can be used for off-standard operation, thus giving four cycles available for plutonium.

Two stage back-cycling can be provided by routing the III DW to the 1CU concentrator, and routing the II DW and possibly the II AW via the proposed ANH concentrator to the feed to the 1A-1S units.

Figure 1 shows in brief outline form the Basic Redox flow pattern.

Figure II shows the changes in pattern to achieve 2 stage back-cycling.

Figure III shows the changes in pattern to achieve 2 stage back-cycling and operated with pre-cycle.

Figure IV is a rearrangement of Figure III, deleting lines not used, and regrouping the equipment to clarify the flow pattern.

Other than raw material and waste storage costs, advantages gained include:

- 1) Improved decontamination since two acid deficient cycles and one acid cycle are better than one acid deficient cycle followed by two acid cycles.
- 2) Improved recovery, since all fission products leave from one column. This column can be run for maximum recovery at slight expense of decontamination, and the other "A" type columns run for maximum decontamination at the expense of waste "loss", since these bottoms are recycle and the plutonium and uranium there-in thus automatically recovered.
- 3) Minimization of the effect of minor column upsets, since all except first "A" type column provide for automatic recovery of wastes.
- 4) Liberation of an existing Pu decontamination cycle which can be used in line to provide four cycles for processing off-standard (Pu containing) wastes. Plant practice has indicated that three cycles are not sufficient in some cases to produce specification product. This final cycle can also be available for receiving and processing off specification plutonium through an additional cycle without interruption of plant operation.
- 5) Since this method reduces the waste volume/TU processed, less interruption in plant capacity is occasioned by having to rework production of non-standard wastes.

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Table I, column I, lists manufacturing costs for the basic 200 TU/Mo Redox plant, wherein raw material costs and waste volumes are based on information secured from the Separations Section, labor costs are based on the best estimate available by consultation with Separations Section, and the balance of the costs as given in HW-26030. Values used for labor and other fixed charges are constant for all alternates studied, and thus do not effect the savings possible. They are included so that savings may be evaluated as per cent of basic Redox costs.

Column 2 lists the costs for the basic 200 TU/Mo Redox plant as revised for two stage back-cycle.

Column 3 lists the cost for the basic 200 TU/Mo Redox plant as revised for pre-cycle and two stage back-cycle.

Consultation with the Separations Section and with Radiological Sciences has indicated the possibility that coating waste can be cribbed, since it has negligible content of long lived fission products. Study by the Design Section has resulted in the conclusion that, if coating waste can be cribbed, final Plutonium Cycle salt waste can probably also be cribbed. Radiological Sciences is currently conducting tests to verify these possibilities. Final Plutonium Cycle wastes can be segregated and routed to crib by utilization of the spare sump drain header.

Table II lists costs of the three alternate methods of operation if the coating waste and the final Plutonium Cycle wastes are cribbed.

Experiences in operation of the Redox Plant and numerous calculations indicate that the waste storage tanks will boil for a considerable period of time. In order to provide storage for wastes at Phase II rates, 241-SX tank farm has been authorized and is in process of detailed design. The flow pattern as designed will allow the condensate collected from the boiling tanks to be cribbed, thus providing self concentration of the wastes.

Document HW-23477 "Heat Generation in Stored Redox Wastes" by J.S. Kane and R.E. Burns gives the heat liberation from fission product activity/TU as a function of time after discharge from the reactor.

These figures were used to provide plots of heat liberation versus time in a 750,000 Gal. tank for several methods of operation of the Redox Plant. These plots were then integrated to provide gallons evaporated. Test data indicating that Redox Wastes of present concentration can still be handled satisfactorily if reduced to $\frac{1}{4}$ volume are also given.

The tank heat evolution curves plotted in HW-23477 are not directly applicable to the costs now being studied in the following aspects:

- 1) Plant operation rate is different.
- 2) Quantity of waste/TU is different.
- 3) 241-SX tanks are 1,000,000 Gal. each, tanks used in document were 750,000 Gal. each.

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In view of the above it was decided to use the basic heat content for sixty day old wastes as given in HW-23477, and apply their method in determining heat evolution, but to use 1,000,000 Cal. storage tanks, 200 TU/Mo processing rate, and the waste volume/TU as calculated for the three alternates used in Table I, and as revised for use in Table II. As a limiting case in volume reduction, 1/3 the volume before concentration was used. This is conservative since test experiments quoted in HW-23477 indicate that a reduction to $\frac{1}{3}$ volume is feasible, if heat is available.

Table III lists the waste volume in gallons/TU processed used in Table I and II (without concentration) and also lists the volume following concentration. Those cases where more heat is available than is required to concentrated to 1/3 volume are marked with an asterisk and the volumes shown is 1/3 the original volume.

Table III also gives the time in months before the 15,000,000 Cal. of storage provided by 241-SX tank farm will be filled for each case.

Tables IV and V list the costs of the alternates shown in Tables I and II, but allow for self concentration of wastes to the degree shown in Table III.

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Table I

ANNUAL COSTS OF REDOX SEPARATIONS

	<u>Basic 200 TU/Mo Redox</u>	<u>Basic Redox / 2 Stage Back-Cycle</u>	<u>Basic Redox / Pre- Cycle / 2 Stage Back- Cycle</u>
Direct Material	\$1,797,400	\$1,065,400	\$ 893,000
Labor	890,000	890,000	890,000
IME	150,000	150,000	150,000
Waste Storage (@ 40¢/gal)	<u>3,302,000</u>	<u>1,764,500</u>	<u>1,400,600</u>
Total Within Division	6,139,400	3,869,900	3,333,600
Outside Division Costs	1,941,500	1,941,500	1,941,500
Manufacturing Costs for processing 200 TU/Mo	8,080,900	5,811,400	5,275,100
Reduction in Manuf. Cost below Basic Redox Cost for processing 200 TU/Mo	0	<u>8,080,900</u> <u>5,811,400</u> 2,269,500	<u>8,080,900</u> <u>5,275,100</u> 2,805,800
Dollar Value over Basic Redox Cost for processing 200 TU/Mo	0	<u>242,200</u>	<u>104,400</u>
Total Net Reduction		\$2,612,700	\$3,211,200

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Table V

ANNUAL COSTS OF REDOX SEPARATIONS

	Basic 200 TU/Mo Redox - Cribbable with Self Concentra- tion.	Basic Redox / 2 Stage Back-Cycle - Cribbable with Self Concentration	Basic Redox / Pre- Cycle / 2 Stage Back- Cycle - Cribbable with Self Concentration.
Direct Material	\$1,797,400	\$1,065,400	\$ 893,000
Labor	890,000	890,000	890,000
IME	150,000	150,000	150,000
Waste Storage (@ 40¢/gal)	<u>1,361,200</u>	<u>379,500</u>	<u>217,000</u>
Total Within Division	4,198,700	2,484,900	2,180,000
Outside Division Costs	1,941,500	1,941,500	1,941,500
Manufacturing Costs for processing 200 TU/Mo	6,140,200	4,426,400	4,121,500
Reduction in Manuf. Cost below Basic Redox Cost	8,080,900	8,080,900	8,080,900
for processing 200 TU/Mo	<u>6,140,200</u>	<u>4,426,400</u>	<u>4,121,500</u>
	1,940,700	3,654,500	3,959,400

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Table IV

ANNUAL COSTS OF REDOX SEPARATIONS

	Basic 200 TU/Mo Redox with Self Concentration	Basic Redox / 2 Stage Back-Cycle with Self Concn.	Basic Redox / Pre- Cycle / 2 Stage Back- Cycle with Self Concn.
Direct Material	\$1,797,400	\$1,065,400	\$ 893,000
Labor	890,000	890,000	890,000
IME	150,000	150,000	150,000
Waste Storage (@ 40¢/gal)	<u>2,239,000</u>	<u>588,500</u>	<u>167,500</u>
Total Within Division	5,075,400	2,693,900	2,391,500
Outside Division Costs	<u>1,941,500</u>	<u>1,941,500</u>	<u>1,941,500</u>
Manufacturing Costs for processing 200 TU/Mo	7,017,900	4,635,400	4,342,000
Reduction in Manuf. Cost below Basic Redox Cost for processing 200 TU/Mo	8,080,900 <u>7,017,900</u> 963,000	8,080,900 <u>4,635,400</u> 3,445,500	8,080,900 <u>4,342,000</u> 3,738,900

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Table II

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ANNUAL COSTS OF REDOX SEPARATIONS

	Basic 200 TU/Mo Redox - Cribbble	Basic Redox / 2 Stage Back-Cycle - Cribbble	Basic Redox / Pre- Cycle / 2 Stage Back- Cycle - Cribbble
Direct Material	\$1,797,400	\$1,065,400	\$ 893,000
Labor	890,000	890,000	890,000
IME	150,000	150,000	150,000
Waste Storage (@ 40¢/gal)	2,675,000	1,178,600	771,000
Total Within Division	\$5,512,400	3,244,000	2,574,000
Outside Division Costs	1,941,500	1,941,500	1,941,500
Manufacturing Costs for processing 200 TU/Mo	7,453,900	5,185,500	4,615,500
Reduction in Manuf. Cost below Basic Redox Cost for processing 200 TU/Mo	8,080,900 7,453,900 627,000	8,080,900 5,185,500 2,895,400	8,080,900 4,615,500 3,465,500

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PHASE II
REDOX

Flow Sheet

FIGURE 1

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TWO - STAGE
BACK CYCLE

FIGURE 2

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CODE
 — EXISTING LINES
 - - - REVISED PARALLEL LINES
 — REVISED MAIN LINES

PRE-CYCLE
 AND
 TWO-STAGE
 BACK-CYCLE

FIGURE 3

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APPENDIX F

UO₃ Facility Additional Information

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F-1. Section 7.0
M. A. Young, *Uranium Oxide (UO₃) Plant Process
Flowsheet*, PFD-U-020-00001 (Westinghouse
Hanford Company, 1990).

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7.0 EQUIPMENT DESCRIPTION

Tanks and process vessels are described in the vessel schedule in Table 2. Pumps, agitators, blowers and other common equipment are not described. Some of the more unique equipment is described below:

Fluidizing valve - A specialized, Hanford designed piece of equipment used in the powder handling system to control the powder level in the downcomer. When the powder level gets too high, the pressure transmitter opens an air valve, allowing air to move powder through the system. When the powder level gets too low, the transmitter shuts off the flow of air through the system.

Wet scrubbers (G, H, J, K, L, and M Cells) - Off-gas from the calciners is routed through wet scrubbers to the E-A-4 gas cooler. Nitric acid is sprayed within the scrubber to remove UO_3 particulates from the off-gas.

Powder Downcomers and Pickup Bins (G, H, J, K, L and M Cells) - Powder from the calciners is routed through a downcomer to a pickup bin. A snorkel tube in the pickup bin is used to transfer powder to the powder handling system.

UNH Tank Trailer - The UNH trailer is a twin-axle trailer with a 3100 gallon capacity tank. (A normal load is 2800 gallons.) The tank is 57 inches in diameter, 24 feet, 9 inches in length and is constructed on 3/8 inch type 304-L stainless steel plate.

C-2 Filter/Makeup Tank - Makeup tank is used to mix up a slurry of filter aid. Filter aid solution is pumped into the filter tank to coat the 17 filter screens. Water can be added to the tank via 54 spray nozzles at the top of the tank. Steam is added via nozzles at the bottom of the tank.

T hopper - Powder is loaded into T hoppers for off-site shipment. T hoppers are cone shaped, 6 feet tall, 5 feet in diameter at the base and 2 feet in diameter at the top. T hopper have a maximum capacity of 6000 lbs UO_3 .

Rail cars - Two types of rail cars are used. Flatbed cars are used for the movement of T hoppers. Tankcars are used for the movement of nitric acid.

Hot bot (G, H, J, K, L, and M Cells) - A cabinet containing diaphragm operated valves for the control of UNH to each feed point on the calciners. The term hot box is used because the cabinet is steam heated.

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TABLE 2 UO₃ PLANT VESSEL SCHEDULE

ITEM	FUNCTION	LOCATION	CAPACITY/GALS.	DIMENSIONS
T-A-3	NO _x Absorption	224-U	614	37 ft. 5 in. x 4 ft. 7 in. diameter
TK-C-1	60% UNH Accountability	224-U	3,600	9 ft. x 9 ft. diameter
TK-C-2	Uranium Waste Concentration	224-U	4,000	9 ft. x 9 ft. diameter
TK-C-3	Nitric Acid Receiving (spare)	224-U	600	7 ft. x 4 ft. 6 in. diameter
TK-C-4	Nitric Acid Receiving	224-U	600	7 ft. x 4 ft. 6 in. diameter
TK-C-5	Process Condensate Receiving	224-U	600	7 ft. x 4 ft. 6 in. diameter
TK-C-6	Nitric Acid Cooler	224-U	-	12 ft. 6 in. x 2 ft. 9 in. diameter
TK-C-7	C-Cell Sump Collection	224-U	1,000	12 ft. 6 in. x 2 ft. 9 in. x 4 ft. 4 in.
TK-D-5	Vessel Vent Seal Pot	224-U	30	2 ft. x 2 ft. diameter
TK-D-10	Sulfuric Acid Receiving	224-U	175	3 ft. 8 in. x 3 ft. diameter
TK-D-11	Sulfuric Acid Tank	224-U	175	3 ft. 8 in. x 3 ft. diameter
TK-D-12	Sulfuric Acid Tank	224-U	8	3 ft. x 8 in. diameter
TK-D-13	Concentrator Catch Tank	224-U	99	8 ft. 6 in. x 10 to 30 diameter*
TK-X-1	60% UNH Storage	203-U	96,000	30 ft. x 25 ft. diameter
TK-X-2	60% UNH Storage	203-U	96,000	30 ft. x 25 ft. diameter
TK-X-20	X-30 Filter Flush Receiving	203-UX	415	5 ft. x 4 ft. diameter
TK-X-30	100% UNH Feed Storage	203-UX	3,600	9 ft. x 9 ft. diameter
TK-X-37	Utility Tank	203-U	12,000	13 ft. 6 in. x (10 ft. x 6 in. Torus)

* VARIABLE DIAMETER

TABLE 2 (Continued)

ITEM	FUNCTION	LOCATION	CAPACITY/GALS.	DIMENSIONS
TK-X-38	PUREX Recycle Storage	203-U	6,500	14 ft. x 10 ft. diameter
TK-U-301	Nitric Acid Storage (Spare)	211-U	100,000	30 ft. x 25 ft. diameter
TK-U-306	Nitric Acid Storage	211-U	100,000	30 ft. x 25 ft. diameter
TK-U-307	Nitric Acid Storage	211-U	100,000	30 ft. x 25 ft. diameter
TK-U-308	Nitric Acid Storage	211-U	100,000	30 ft. x 25 ft. diameter
E-A-4	Off-Gas Cooler	244-U	-	7 ft. x 2 ft. 8 in. diameter
E-B-3	Vessel Vent Condenser	224-U	-	14 ft. 11 in. x 2 ft. 10 in. diameter
E-D-2	UNH Concentrator	224-U	15	13 ft. 4 in. x 1 ft. 5 in. diameter
E-D-3	Vessel Vent Condenser	224-U	-	14 ft. 11 in. x 2 ft. 10 in. diameter
E-D-6	UNH Concentrator	224-U	15	13 ft. 4 in. x 1 ft. 5 in. diameter
E-D-7	UNH Concentrator	224-U	15	13 ft. 4 in. x 1 ft. 5 in. diameter
X-22-1	Cyclone	224-UA	-	10 ft. x 21 in. diameter
X-22-2	Cyclone	224-UA	-	10 ft. x 21 in. diameter
X-26	Storage Hopper	224-UA	72,000 lb UO ₃	13 in. x 7 ft. diameter
X-28-1	Bag Filter	224-UA	4 bags	136 in. x 18 in. diameter
X-28-2	Bag Filter	224-UA	4 bags	136 in. x 18 in. diameter
X-29-1	Bag Filter	224-UA	8 bags	102 in. x 12 in. diameter
X-29-2	Bag Filter	224-UA	8 bags	102 in. x 12 in. diameter
296-U-2	Process Exhaust Stack	224-UA	2000 cfm	13 ft. x 14 in. x 12 in. rectangle

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TABLE 2 (Continued)

ITEM	FUNCTION	LOCATION	CAPACITY/GALS.	DIMENSIONS
296-U-4	Process Exhaust Stack	224-U	2000 cfm	80 ft. x 10 in. diameter
296-U-13	Process Exhaust Stack	224-UA	6000 cfm	27 ft. x 25 in. diameter

NOTES: Vessel item designation are alpha numeric characters composed of three parts. The first part is the equipment designation, the second part is a location code and the third part is an equipment number. These three components are described below.

Equipment Designation

T - Tower
 TK - Tank
 E - Concentrators, Cooler or Condensers
 296 - Exhaust Stack

Location Code

A - A-Cell, 224-U Building
 B - B-Cell, 224-U Building
 C - C-Cell, 224-U Building
 X - Outside Equipment and 224-UA Building
 U - 211-U Tanks and U Complex

Equipment Number

Sequential number system designating equipment. For example, TK-C-1 is the first equipment piece in C-Cell.

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F-2. Sections 2.0 through 2.2 and Table 2.2-2
PUREX/UO₃ Deactivation Project Management
Plan WHC-SP-1011D (Westinghouse
Hanford Company, 1993).

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2.0 PROJECT OBJECTIVES

2.1 PROJECT OBJECTIVES

The PUREX/UF₆ Deactivation Project objectives support the DOE Office of Facility Transition and Management overall goal of developing swift, uniform methods for deactivating similar facilities. The Project objectives are as follows.

1. Establish a passively safe and environmentally secure configuration of the plant (no active internal functions or equipment within confinement), and retain that configuration for a 10-year horizon.
2. Achieve a total yearly cost target of \$2 to \$5 million/year at turnover.
3. Implement cost-effective, innovative approaches to ensure the required safety envelope is defined and maintained during deactivation.
4. Achieve compliance with Environmental, Safety, and Health codes and standards during deactivation.
5. Involve stakeholders in the development and execution of the PUREX/UF₆ Deactivation project management plan.
6. Transition the workforce out of PUREX and UF₆ Plant through redeployment or outplacement.
7. Apply lessons learned from commercial deactivation experience.
8. Establish the PUREX/UF₆ Deactivation Project as a model for canyon facilities.

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WHC-SP-1011D

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2.2 TECHNICAL CRITERIA

The mission of the PUREX/UO₂ Deactivation Project is to demonstrate a safe, cost-effective model for facility deactivation by deactivating PUREX and UO₂ Plant and completing turnover to the Hanford Surplus Facilities Program (HSFP). Technical criteria define project completion and the acceptable conditions for turnover to the HSFP.

2.2.1 General Technical Requirements

General technical requirements define the Project's overall approach to fulfilling the end-state condition required for turnover to the HSFP. Applicable requirements set forth in draft DOE Order 58XX.XX, *Transition of Facilities to the Office of Environmental Restoration and Waste Management*, will be met.

The Project shall ensure that imminent hazards to personnel or the environment are controlled through partial closure, removal, isolation, mitigation, or stabilization. The Project shall also ensure that structures can be maintained in a safe condition, with immediate threats to human health and safety removed or appropriate compensatory measures (barriers, access controls, administrative controls, etc.) implemented.

The Project end state shall result in the classification of PUREX and UO₂ Plant as non-occupied facilities. As such, compliance with DOE Order 6430.1A, *General Design Criteria*, is not required. Project activities shall ensure that access during the surveillance phase is not required at a greater frequency than necessary to maintain the non-occupied facility status. Conservatively, the access that should be allowed for a non-occupied facility status is not more frequent than once each quarter.

The Project will end with PUREX and UO₂ Plant turnover to the HSFP for post-deactivation surveillance and eventual D&D. Existing WHC Site systems shall be used for Project execution, except as provided in this PMP.

2.2.2 Configuration Requirements

The PUREX and UO₂ Plant configuration shall be modified and controlled sufficiently to enable safety and regulatory compliance during Project performance and post-project D&D activities. The minimum configuration control requirements are as follows.

- Records shall be established and archived for reactivating D&D essential systems and providing meaningful D&D characterization. As a minimum, the following records should be established and maintained:
 - Location, identification, and qualification of hazardous materials that are attached/contained and cannot be removed without going into a D&D mode
 - Final radiological status surveys

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- Certified vendor information files, equipment operating procedures, records, drawings, photographs, etc., that reflect "As-Left" configuration
- Information required to reactivate elevator systems
- Zero energy check records for electrical circuits that were de-energized
- Installed piping system and equipment blank records
- Documentation that locations where irradiated fuel elements and/or other source and special materials were handled and/or stored were examined and material accounted for
- Radiological posting in compliance with applicable requirements set forth in WHC-CM-1-6, *Radiological Control Manual*
- Pending radiation occurrence reports, event fact sheets, unusual occurrence reports and/or any other out-of-standard condition reports finalized and closed out
- The PUREX and UO₂ Plant Safety Basis revised for the post-deactivation surveillance period in accordance with the Project-specific requirements of Appendix F
- Documentation demonstrating compliance with worker safety and health prepared in accordance with the Project-specific requirements of Appendix F
- Any required permits relating to the facility's current or anticipated use obtained. Activities shall not preclude subsequent closure options until permitting dictates final closure.
- Deactivation check sheets completed and approved by the responsible personnel performing the actual work, the overview organizations, and plant management.

2.2.3 Workforce Restructure Requirements

Project activities shall include provisions for redeployment or retraining of the PUREX and UO₂ Plant workforce to enable transition into other Site activities including the potential deactivation of other Hanford canyon buildings (i.e., B Plant, U Plant, and the Reduction-Oxidation (REDOX) Plant). Retraining activities should be initiated early in the Project to maximize education/skill enhancement and be integrated with existing Hanford Site retraining programs.

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**2.2.4 Hazardous and Radioactive Materials
Removal/Stabilization Requirements**

Hazardous and radioactive materials shall be removed from the plants or stabilized sufficiently to ensure long-term PUREX and UO₂ Plant safety and regulatory compliance, enable plant classification as a non-occupied facility, and enable subsequent successful D&D.

Materials shall be removed and/or stabilized sufficiently to ensure that the plant complies with WHC-CM-1-6, *Radiological Control Manual*, as applicable to a non-occupied facility after completion of deactivation. As a general guide, "as-left" contamination and radiation levels in plant areas should be no greater than the levels encountered during normal operation and occupancy of the plant.

To ensure long-term safety and regulatory compliance, the following requirements apply.

- Permanent radiation zones to be entered for surveillance shall be decontaminated and released or the surface contamination levels reduced or stabilized to minimize re-suspension and/or migration of loose contamination. Temporary radiation zones inside and outside of buildings shall be eliminated.
- Packaged radioactive and mixed waste with identified final disposition shall be removed and disposed of. Wastes that are not removed shall be identified and characterized, and documented.
- Accessible interior glovebox surfaces shall be decontaminated or the surface contamination stabilized. Openings to gloveboxes shall be sealed in a manner that ensures confinement of remaining contamination.
- Loose or damaged (friable) asbestos in areas expected to be entered during surveillance shall be removed or stabilized.
- Fissile materials shall be removed sufficiently to eliminate the potential for a nuclear criticality excursion and the need for a criticality alarm system.
- Tanks, vessels, and drums shall be drained using installed equipment and features. Heels shall not contain material classified as hazardous waste.
- Hazardous materials used for deactivation and cleanup work shall be collected and disposed of.
- Emergency lighting and associated batteries from the facilities shall be removed and disposed of.

To ensure minimum life-cycle cost, the following requirements apply.

- The remaining surplus materials, equipment, supplies, and spare parts should be inventoried, labeled, segregated, and evaluated for use at other sites or sold.
- Disposal of waste materials will be maximized during deactivation.
- Existing system and equipment capabilities will be used for material removal/stabilization to the maximum extent possible.
- Conditions that require implementation of operational safety requirements (OSRs) during the surveillance period will be eliminated.

2.2.5 Surveillance Requirements

Facility configuration shall ensure D&D options are not foreclosed, and facility safety and environmental protection can be maintained until D&D.

To ensure safety and environmental protection during surveillance, the following requirements apply.

- Consistent with the PUREX and UO₂ Plant Safety Basis, the operation of safety and utility systems shall be reduced to the extent possible, while maintaining ventilation, alarms and other capabilities necessary for a deactivated facility. Required vital safety systems and utility systems shall be fully functional and have operating procedures in place.
- To minimize points of ingress, doors to the plants shall be locked from the inside except those required for entrance by surveillance crews.
- Security systems and procedures shall be adequate to prevent unauthorized entry to plant structures.
- Liquid effluent sources from PUREX and UO₂ Plant shall be eliminated prior to the surveillance phase. Flow routes to disposal sites should be isolated. Isolation should be achieved by sealing or valving off at the facilities and screening off accessible outlets of the discharge pipes for varmint control.
- Facility penetrations (louvers, pipe openings, etc.) will be closed off to prevent bird and other animal intrusions.
- Elevator systems shall be deactivated in a manner that enables future reactivation.
- Systems that were opened to facilitate deactivation and could present a radiological and/or an industrial safety problem if left open shall be adequately closed off.

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- Known facility roof leaks and/or deteriorated roof panels shall be repaired.
- Radiation space monitoring and continuous air monitoring systems shall be reduced to a level commensurate with the surveillance requirements. As a general guide, "as-left" contamination and radiation levels in the plants should be low enough that only portable monitoring equipment is required during surveillance entries.

To achieve a non-occupied facility status, the following requirements apply.

- Ventilation and monitoring equipment shall be consolidated, relocated, housed, operated, and/or maintained such that facility entry frequency does not compromise the non-occupancy status.
- Fire protection systems shall be modified or eliminated to both achieve and reflect the non-occupied status and to minimize system testing and maintenance.
- Electrical and water supply services to the process buildings shall be isolated; electrical and water supply services in the surrounding yard areas shall be reduced to meet minimum surveillance support requirements. Centralized electrical services for surveillance purposes should be considered.
- The building steam system shall be deactivated. Building steam requirements shall be eliminated to enable steam system deactivation.

2.2.5.1 Deactivated PUREX Condition. Table 2.2-1 describes the expected PUREX condition, by plant area, when the technical requirements stated above have been satisfied.

2.2.5.2 Deactivated UO₂ Plant Condition. Table 2.2-2 describes the expected UO₂ Plant condition, by plant area, when the technical requirements stated above have been satisfied.

Table 2.2-1. PUREX Status After Deactivation. (2 sheets)

Facility area	Area status description
Canyon	<ul style="list-style-type: none"> • Mobile quantities of Special Nuclear Materials (SNM) removed • Fuels removed • Process vessels emptied and flushed • Some process equipment disassembled to remove inventory • SNM Material inventory reconciled • Process cells flushed • Failed equipment/jumpers removed from canyon deck as appropriate • Canyon piping to external facility interfaces (Tank Farms, 216-B-3/Pond, out of service cribs, etc.) isolated
Storage Gallery	<ul style="list-style-type: none"> • Supplies removed • Shop equipment de-energized • Fire foam system deactivated • High-radiation areas mitigated
Sample Gallery	<ul style="list-style-type: none"> • Samplers, including B5 Cave, flushed • Sample Gallery area flushed • Hoods containing significant SNM decontaminated • Hood exhaust ductwork removed • Floor drains plugged
Pipe and Operating Gallery	<ul style="list-style-type: none"> • Gallery flushed • Mobile equipment removed • White room repainted • White room floor resurfaced • Headers drained and flushed • Floor drains plugged.
Cranes	<ul style="list-style-type: none"> • Cranes parked on maintenance platforms and shut down as is.
Aqueous Make-up	<ul style="list-style-type: none"> • Chemical inventory removed • Tanks and supply headers flushed
Analytical Laboratory	<ul style="list-style-type: none"> • All Chemical inventory removed • Hoods decontaminated • Equipment de-energized
Shop Areas	<ul style="list-style-type: none"> • Supplies removed • Equipment de-energized
Control Rooms	<ul style="list-style-type: none"> • All instrument and equipment controls de-energized, except control of canyon exhaust. These functions will be consolidated at a single remote monitoring location
Office/Change Rooms, Mobile offices	<ul style="list-style-type: none"> • Personnel relocated • Furniture and files removed
211-A Area	<ul style="list-style-type: none"> • Chemical inventory removed • Demineralizers isolated with resin disposed • Vessels flushed • Utilities isolated • Surfaces decontaminated of hazardous materials and resurfaced as necessary
203-A Area	<ul style="list-style-type: none"> • Tanks emptied and flushed • Utilities isolated • Acid solutions removed • Surfaces decontaminated and resurfaced as necessary
U-Cell/ Fractionator	<ul style="list-style-type: none"> • Recovered acid removed • Vessels flushed • Coverblocks sealed

Table 2.2-1. PUREX Status After Deactivation. (2 sheets)

Facility area	Area status description
Heating, ventilation and air conditioning (HVAC)/Services	<ul style="list-style-type: none"> • HVAC systems consolidated to limit gaseous effluent discharge and monitoring points to 291-A-1 Canyon exhaust stack • Steam, water and compressed air service eliminated • Electrical systems consolidated • Emergency loads minimized or eliminated • Electrical service provided for selected lighting panels • Alternative source of backup power to canyon fans • Monitoring functions consolidated at a single monitoring location
Effluents	<ul style="list-style-type: none"> • Liquid and gaseous effluent streams eliminated, except 291-A-1 stack discharge • Buildings decontaminated and locked • Effluent piping isolated
H-Cell, PR Room and G-Cell	<ul style="list-style-type: none"> • Gloveboxes decontaminated and residual contamination fixed
R-Cell Vault	<ul style="list-style-type: none"> • Organic solvent removed • Vessels and vault flushed • Coverblocks sealed
Auxiliary Buildings	<ul style="list-style-type: none"> • Portable and/or mobile equipment and materials removed • Piping with external interfaces isolated • Utilities and HVAC isolated • Surfaces and piping and vessels flushed • Asbestos stabilized

Table 2.2-2. UO₂ Plant Status After Deactivation.

Facility area	Area status description
Cells A, B, C, and D in 224-U	<ul style="list-style-type: none"> - All process vessels emptied and flushed - Material accountability reconciled - Process cells flushed - Piping to external facility interfaces (effluents, etc.) isolated.
224-U Pipe and Operating Gallery	<ul style="list-style-type: none"> - Mobile equipment removed - Headers drained and flushed - Floor drains plugged
224-UA Processing Areas	<ul style="list-style-type: none"> - UO₂ powder removed from calciners, powder handling equipment, and vacuum cleaning system - Bag filters left in place after air blow of system - Material accountability reconciled - Piping to external facility isolated - Process areas decontaminated
Lucky Pot Room, Cells E and F, Abandoned powder handling equipment	<ul style="list-style-type: none"> - Abandoned equipment left as is - Piping to external facilities isolated
2714-U & T-Hopper storage pad	<ul style="list-style-type: none"> - Full T-hoppers shipped to purchaser - Drums of depleted UO₂ removed - Surfaces decontaminated and resurfaced as necessary
Shop Areas	<ul style="list-style-type: none"> - Supplies removed - Equipment de-energized
Control Rooms	<ul style="list-style-type: none"> - All instrument and equipment controls deactivated
Office/Change Rooms/Mobile offices	<ul style="list-style-type: none"> - Personnel relocated - Furniture and files removed
211-U Area	<ul style="list-style-type: none"> - Acid inventory removed - Vessels flushed - Utilities isolated - Asbestos stabilized
203-U Area	<ul style="list-style-type: none"> - Storage tanks emptied and flushed - Utilities isolated - Surfaces decontaminated and resurfaced as necessary
Heating, ventilation and air conditioning (HVAC)/Services	<ul style="list-style-type: none"> - HVAC systems shutdown - Steam, water and compressed air service eliminated - Electrical service provided for selected lighting panels
Effluents	<ul style="list-style-type: none"> - Liquids and gaseous effluent streams eliminated - Effluent piping isolated
Ancillary Buildings	<ul style="list-style-type: none"> - Portable/mobile equipment and materials removed - Piping with external interfaces isolated - Utilities and HVAC isolated - Surfaces and piping flushed and decontaminated

APPENDIX G

224-B Facility Additional Information

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- G-1. J. I. Gould and G. L. Troyer, *Radiological Characterization of the 224-B Hot Cells*, WHC-SD-DD-TRP-002, (Westinghouse Hanford Company, 1985).

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EXECUTIVE SUMMARY

The test plan, SD-DD-TP-002, described the objectives and methods to be used in gathering data for the radiological characterization of the 224-B hot cells. This report presents the data and develops inventory estimates based on the methodology described in the test plan.

The test plan described two phases of activity: a general survey which would identify areas of interest and a detailed series of measurements to develop the final characterization. The first survey was performed by the Radiological Protection Department (RPD). Those results are tabulated on facility sketches and included as an appendix.

Following the RPD survey, the Analytical Process Development Unit (APDU) directed the detailed characterization measurements. These consisted of analysis of selected smear samples from within the hot cells, general radiation dose readings of penetrating gamma and beta fluxes, and in-place analysis of gamma emitting radionuclides with the Mobile Radionuclide Analysis Laboratories.

An inventory of the hot cells was developed based on averages of the measurements. Conservative estimates were made based on the maximum values of the sample analyses and in-place measurements where no direct data were available. The nontransuranic radionuclide inventory is 26 curies, consisting of:

- 1.1 curies of cesium-137,
- 22 curies of strontium-90, and
- 3.7 curies of cobalt-60.

The transuranic (TRU) inventory of 38 curies is:

- 5 curies of americium-241,
- 31 curies of plutonium-239, and
- 2 curies of other plutonium isotopes.

These values have an approximate error of $\pm 200\%$ at the 99% confidence level. An upper limit estimate is made at the three standard deviation point based on this error estimate. Over 80 percent of the inventory is due to only four tanks. These should be further measured during the D&D, individually.

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TEST REPORT

**Radiological Characterization of the
224-B Hot Cells**

1.0 INTRODUCTION AND BACKGROUND

Rockwell Hanford Operations (Rockwell) as contractor for the Department of Energy (DOE) is engaged in a program of decontamination and decommissioning (D&D) of surplus facilities.

One such facility is the 224-B Building in the 200 East separations area at Hanford. The building was used to process transuranic (TRU) material resulting from the fuel separations carried out at the Hanford site. There are six hot cell areas within the 224-B building, which are the primary subject of this characterization report.

Cell C was the receiving cell for product solutions from the 221-B Building and wastes generated within 224-B. Chemical processing of the crude product was performed in Cells A, D and E. The B-cell was initially a standby cell, but was also used to augment operations in D-cell. The F-cell was the final concentration area. It now contains an area called G-cell and was also the load-out area. Each of the cells has sampling basins on the second level. With the exception of C and E-cells, there is a centrifuge on the second level. F-cell has two centrifuges on the second level.

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C-cell has a lower level pit, which has been flooded at some times in the past. This pit is now dry, as are all of the gutters and sumps in the cells. Entry into the cells is from the outside on the south side of the building at ground level. All cells except C-cell have a second level deck with access from the building's second floor (see figure 1).

This report presents results from data taken during an extensive sampling program to characterize the radionuclides and their locations within the facility.

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Figure 1. Exploded View of the 224-B Building, showing Hot Cells.

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2.0 OBJECTIVES AND SCOPE OF MEASUREMENTS**2.1 OBJECTIVES**

The objectives of this effort were outlined in the test plan (SD-UC-TP-002). Briefly stated, they were to characterize the radionuclide inventory and flux in the 224-B hot cells.

2.2 SCOPE OF MEASUREMENTS

The measurements were divided into a general survey and detailed characterization as follows:

2.2.1 General Survey

The Radiological Protection Department (RPD) made a general survey of the hot cells using standard portable monitoring equipment. This survey identified areas which were not considered radiological hazards from those which contribute significantly to the radionuclide inventory. These have contamination levels requiring D&D attention. The results were recorded on hand-drawn facility sketches (see Appendix B).

2.2.2 Detailed Characterization

Based on this general survey, the Analytical Process Development Unit (APDU) directed the taking of smear samples by the RPD and analyzed the samples for radionuclide content. The APDU also made in-place measurements within the hot cells in order

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to characterize the radiological environment. These data provided the basis for a radiological inventory estimate. The data will support a work safety analysis report plus waste segregation and disposal plans prior to actual D&D of the facility.

2.3 MEASUREMENT SEQUENCE

2.3.1 Worker Exposure Levels

Initial entry was made by the RPD technician using hand instruments to check general floor, tank, and environment conditions. The APDU followed with an ionization chamber to measure the gamma and penetrating beta dose levels within the cells. Locations were noted within the cell for sampling and in-place measurements.

2.3.2 Sample Location System

A grid system was established within each cell, with each grid sector approximately one meter square. The grids are identified fully on the facility sketches in Appendix B.

2.3.3 Detailed Sampling

At least two wet and two dry smear samples were taken of the dust in each sector on the floor. Smears were also taken from the exteriors of tanks, centrifuges, miscellaneous equipment, and piping. All smear samples were checked by the RPD technician to determine which areas inside the cell contained measurable radioactive contamination.

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This determined which areas would need detailed characterization for the inventory estimate. The criteria used was whether or not the sample exceeded 200 cpm with a pancake-type GM (beta-gamma) detector, or 220 dpm with a PAM (alpha) detector.* When no smear sample exceeded these limits, APDU selected one typical smear to include in the detailed analysis.

2.4 DETAILED SAMPLE ANALYSES

The APDU performed gamma energy analysis (GEA), L X-ray analysis for transuranic elements (TRU), and gross beta counting on the samples as part of the detailed characterization measurements. The analysis results are tabulated by location in Appendix A.

2.4.1 Gamma Energy Analysis

Gamma energy analysis for radionuclides was done with the Mobile Radionuclide Analysis Laboratory (MRAL-I). The measurements used a multi-channel analyzer (MCA) in pulse height analysis mode with an intrinsic germanium detector. This system is capable of determining picocurie amounts of most common radionuclides.

* Note:

The RPD used the following portable instruments, typically:
Eberline, Model BNW-1, Geiger-Mueller (beta-gamma) detector, and
Eberline, Model E-140, portable alpha monitor (PAM) detector.

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2.4.2 L X-ray Analysis

The MRAL-I analysis system was also used to assay for TRU isotopes by analysis of the low energy gamma rays and x-rays using the MCA and a lithium-drifted silicon (SiLi) detector. This system is capable of detecting picocurie amounts of most TRU elements.

2.4.3 Strontium-90 Sample Counting

Strontium-90 in the samples was determined by the use of a phoswich detector. The method is based on the detection of secondary beta decays from yttrium-90, the ^{90}Sr decay daughter. However, precision is not as great as other APDU systems utilizing GEA. The detection limit ($\pm 100\%$, at 95% confidence) for ^{90}Sr varies with presence of other gamma and beta emitters, but is typically about 10-20 pCi.

2.5 REDUCED SAMPLING PLAN

Following the initial sampling and smears of A-cell, the detailed plan was revised and simplified:

- o Fewer grid squares were sampled in detail.
- o Dust and floor debris from the square were collected first by sweeping.
- o A single dry smear and two wet smears of a swept floor area were taken. This is called a triple-smear sequence.

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- o Within selected grid squares an in-place measurement was made to relate the residual, nonsmearable contamination to the overall cell inventory.

2.5.1 Reduced Cell Sampling

The reduced method was followed for cells B through F. The APDU analyzed the dust and debris (primarily pigeon feces) and the first wet smear, under the assumption that the dry smear would have taken the majority of the loose smearable contamination from the floor. Where the first wet smear was very high in radio-nuclides, the second wet smear was also analyzed. This approach indicated that significant amounts of contamination could still remain after removal of the dust in the cells and on equipment.

2.5.2 Flange Smear Samples

Exterior smear samples were made on pipe and tank flanges in all of the cells. The RPD checked the flanges on each tank, plus major piping into and exiting the cell. Where no flanges on a tank had direct readings above background, two easily accessible flanges were selected, and the triple-smear sequence was made.

Whenever a flange reading was significantly above background (200 cpm for beta/gamma) on a hand-held GM instrument or (220 dpm alpha) on a portable alpha monitor (PAM) a smear series was

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taken. All tank flanges were monitored, even though not all flanges in the cells are identified in the sample data.

2.6 AIR MONITORING

During the survey a continuous air monitor (CAM) was used to collect samples of the airborne activity in each cell. The CAM was operated for 30 minutes (+/- 1 minute), with a collection rate of 6 cfm. The APDU analyzed the particulate filters for gamma-emitter radionuclide content on standard equipment in the 222-S counting laboratory.

2.7 IN-PLACE RADIONUCLIDE MEASUREMENTS

In-place measurements were made in approximately 10% of the grid locations, using high-resolution GEA systems operated by the Mobile Radionuclide Analysis Laboratories (MRAL-I and MRAL-II). Measurements were made with an area of view of about 14 inches on the floor (MRAL-I) and looking horizontally through the sidewalls of the tanks (MRAL-II).

2.8 MISCELLANEOUS MEASUREMENTS

2.8.1 F-10 Load-out Hood

The MRAL-II made one omnidirectional measurement in the sump of the F-cell load-out hood. Several smears were taken from the inside wall and inside the hood doors.

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2.8.2 Ventilation Intake

The MRAL-II was used to make one measurement in front of the general building ventilation system filter. However, the RPD found only a very low level of contamination in the filter media itself. A smear was made from the dust on the filter frame near the area of highest count rate identified by the RPD.

2.8.3 Penetrating Radiation Dose Levels

A portable ionization chamber (Reuter-Stokes, model RSS-111) was used to determine general penetrating exposure rates for the survey team. Measurements were made at a minimum of three locations within the cells. These results are tabulated by locations in the cells and are included in this miscellaneous category.

2.8.4 Neutron Dose Rates

The RPD made several neutron dose rate (Snoopy) measurements at locations around the cell tanks with higher ion-chamber readings. The neutron dose rates were used only for a qualitative check on the smear results, except for the D-3 tank. Here, the neutron dose was used to verify inventory, see Appendix C. A second set of direct measurements confirmed that an earlier result was apparently a "flier." Inventory for this tank was estimated separately, see Appendix D.

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3.0 RESULTS

3.1 GENERAL SURVEY

The RPD survey results, comments, and location sketches are included in the data package in the appendix.

3.2 DETAILED CHARACTERIZATION

Sequential tabulation of the detailed measurement data is given in the appendix. The smear data are subdivided into categories of increasing concentrations:

- o Smears of walls, floors, and exteriors of equipment.
- o Smears of tank and piping flanges.
- o Smears from gutters, sumps, and sampling boxes.
- o Smears of tank and piping interiors.

Three additional categories are used to develop the inventories:

- o Solids: dust and piping residue.
- o In-place measurements with the mobile laboratories.
- o Neutron dose measured near the tank exterior.

Data from each cell is presented and summarized according to these six categories. Each category is characterized by an average and a maximum value. The averages are used to estimate an overall inventory in Section 4. The maximum values are used to estimate distributions and error estimates for the inventory.

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A summary of the analyses is presented in Table 3.1. Cesium-137, cobalt-60 and strontium-90 were the principal non-TRU radionuclides contained in the dust. Americium-241, a decay daughter of plutonium-241, is the prime TRU component identified by GEA. The plutonium total is estimated from the ratio of ^{241}Am to ^{239}Pu on those samples containing sufficient amounts of both ^{241}Am and ^{239}Pu to quantify their ratio (1:13.14). Details are given in Chapter 4. In the following sections, descriptions of the A-cell apply to all cells except as noted.

3.2.1 A-cell TRU Measurements.

The A-cell was sampled very thoroughly to determine the levels of detail required in the other cells. After analysis of the first smear samples, APDU decided that both wet and dry smear data were unnecessary. Each looks primarily at the loose material on the floor. Gamma energy analysis of dry floor smears was largely eliminated after sample 20.

Data from A-cell are presented in Appendix Tables A.1.1 and A.1.2 for TRU and non-TRU components corrected only by subtraction of background. The dust and smear samples qualitatively agree with the MRAL-I down-looking in-place measurements. No significant additional radionuclides were identified. The category averages are also presented in the same tables. These averages are used to estimate inventories presented in Chapter 4.

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TABLE 3.1 224B DATA SUMMARY AVERAGES

	<u>AMERICIUM-241</u> (pCi)	<u>CESIUM-137</u> (pCi)	<u>Other Ratios</u> (⁹⁰ Sr: ¹³⁷ Cs: ⁶⁰ Co)
<u>A-cell</u>			
Dust solids	741/g	215/g	1.05: 1: 0.25
Pipe scrapings	42400/g + (1)	577/g	3.48: 1: 0.26
Inside smears	34400 +	129	NA
Flanges	2267	56	2.28: 1: 0.53
In place	236/sqcm	15/sqcm	NA : 1: 0.18 (2)
<u>B-cell</u>			
Dust solids	505/g	284/g	0.77: 1: 0.39
Smears	9000 +	NA	NA
In-place	1681/sqcm +	14/sqcm	NA: 1: 0.38
<u>C-cell</u>			
Dust solids	472/g	394/g	16.6: 1: 10.9
Scrapings	60/g	12/g	268: 1: 6.15
Flange smears	8890 +	90 +	NA
In-place	20/sqcm	117/sqcm	NA: 1: 19.7
<u>D-cell</u>			
Dust solids	171/g	143/g	1.28: 1: 0.20
Inside smears	30352	198 +	32.9: 1: 7.2
(reconfirm)	1940	627	(see Appendix D)
Flanges	885	593 +	5.78: 1: 0.28
<u>E-cell</u>			
Dust solids	89/g	75/g	1.24: 1: 0.13
Inside smears	34820	14100 +	1.27: 1: NA
Samplers	2177	<mdl	NA
Flanges	2018	NA	NA
<u>F-cell</u>			
Dust solids	2326/g	1098/g	2.03: 1: NA
Flanges	9232	839 +	NA
Inplace	328/sqcm	161/sqcm	NA
Loadout hood	680nCi	18.5 nCi	NA

Note 1: The + designates a maximum value out of a limited number of samples. Detailed averages by category are in the appendix.

Note 2: NA designates a category that has too many <mdl values to adequately designate a ratio.

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The maximum measurement in a sample group is also flagged. These are used to estimate distributions and errors in Chapter 4.

3.2.1.1 Walls, Floors and Equipment Exteriors

The smear samples with the least amount of radionuclide contamination are from the walls, floors, and equipment exteriors. The significance of the smear samples lies in being able to quantify the ^{241}Am to non-TRU ratios with enough data to assure adequacy of the extrapolations needed to make the inventory estimate.

o Dust Influence

This category is influenced the most by dust settling in various locations. The presence of the dust tends to obscure the fact that contamination may also be imbedded in the surface or cracks and irregularities in the surface. The average TRU content in the A-cell dust is represented by samples 33-38 inclusive, plus 119 and 120. Only one of the eight dust samples exceeded 1 nCi/g.

o MRAL-I Estimate of TRU in Floor Dust

The average concentration of ^{241}Am in the floor dust of A-cell is estimated to be 236 pCi/sq cm. This is based on the average MRAL-I in-place measurements with the swept area value subtracted.

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o TRU of Nonfloor Surfaces

The walls and tank exteriors are typified by samples 41, 46, 52, 54, 60, 65, 78, 313, 315, and 323. The average value of these samples is 419 pCi. This exceeds the average dry floor smear, at 281 pCi. Also unexpectedly, the wall smear, sample 78, had more TRU than the overall average.

o TRU in the Bulk Solids

Dust sample 35 had the most ^{241}Am content. It is nearly seven times more than the group average. This variation is significant only when compared to the A-cell concentrations. When compared to the entire building, individual variations are less extreme. Errors in the facility-wide average are smaller than any one measurement. This can be seen by looking at all the dust samples in Appendix A.

o Operating Deck Samples

The second level operating deck is covered by contaminated dust much like the general floor area. The 2nd level samples contained an average of 396 pCi of ^{241}Am . There is no significant difference between the ground floor and the 2nd level dust values.

3.2.1.2 Tank and Piping Flanges

The A-cell flange data are presented on page 3 of Table A.1.1 for the A-1, A-3, and A-4 tanks plus the centrifuge. The average of all 16 flange smears is 2267 pCi. Five samples had less than

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minimum detection limits of 241Am . The maximum value came from a flange on the A-1 tank, which exceeded the average by a factor of 13, probably an indication of a leaking flange gasket.

3.2.1.3 Gutters, Sumps and Sampling Boxes

o Gutter TRU Measurements

The "G" grid sectors and gutter contain the greatest amounts of radioactivity. The average 241Am content is 2518 pCi per smear. This is a factor of 5.3 times greater than the general floor average. The maximum smear is 219% higher than the average. This indicates that the gutter regions are not uniformly contaminated.

o Sampling Boxes

- The sampling boxes are accessible from the 2nd floor vestibule.
- The sampling boxes appear visually to be "clean", but have residues from past usage. The boxes have noticeably less of the general dust than the rest of A-cell. The smear data is a better sample of the actual contamination resident in the walls of the box rather than in the dust, as is the case with the floor below.

o Sump

Each cell has a sump to collect drainage from the gutter. No sample of solids was taken from the sump of A-cell. Data from the sumps in C-cell and F-cell will be used to characterize the sumps and provide an inventory estimate for this category.

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3.2.1.4 Interiors of Tanks and Piping

Those smears from either inside tanks or piping are called inside smears (see Table 3.1). Samples 241 and 242 represent potentially flushable material from inside the piping and tanks. They were taken after opening the A-1 tank side flange in the triple smear sequence. It is significant that the dry smear collected more than the wet one which followed. Either the residue is very loosely attached to the piping, or whatever is left after the first smear remains bound to the walls. Interior flange scrapings give the ratios of ^{241}Am : ^{137}Cs : ^{90}Sr : ^{60}Co which are the bases for extrapolations of the radionuclide inventory.

o In-place Tank Measurements

The A-cell tanks on the first floor did not have sufficient radioactive material inside to obtain a tank-by-tank inventory. All such tanks are estimated at "less-than" values based on the in-place measurements by the MRAL-II inside tank D-4.

3.2.1.5 Adequacy of the A-cell Data--

Analysis of the solids (dust, debris, and interior scrapings) did not reveal any different radionuclides in significant amounts compared to the MRAL-I in-place measurements. Therefore, the APDU feels that the general amount of data is sufficient to give both qualitative and quantitative estimates of the radionuclide inventory in the A-cell.

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3.2.2 A-cell Non-TRU Measurements

Data for the non-TRU measurements are presented in Table A.1.2 in the same format as that for the TRU. Cesium-137 and cobalt-60 values were found by gamma energy analysis (GEA) of samples by the APDU. The strontium-90 component was measured by differences in window counting using a phoswich detector. Trace amounts of other fission products were also found, such as ruthenium/rhodium-106 and europium-154, -155.

3.2.2.1 Non-TRU Sample Measurements

The average values of the ^{137}Cs , ^{90}Sr and ^{60}Co smear samples are summarized in Table A.1.2 for the same categories as the TRU data. Some items of particular interest are:

- o Cobalt-60 is the least abundant contaminant of the three in the A-cell samples.
- o Strontium-90 is most abundant in the scrapings from inside the tanks and dust solids. However, the variation in relative ^{90}Sr content in different locations is larger than for ^{60}Co .
- o Cesium-137 is the most consistent in comparing samples and smears from different locations. This is used as the basis of comparison to estimate non-TRU quantities.

3.2.2.2 A-cell Radionuclide Ratios

Enough data were collected from the A-cell to estimate the ratios of alpha/beta/gamma radiation components, using the floor smear

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values of ^{241}Am : ^{90}Sr : ^{137}Cs . These ratios are 475: 68.5: 452. ^{137}Cs will be used as an indicator in the analysis in chapter 4. The non-TRU components are designated as the ratios of ^{90}Sr : ^{137}Cs : ^{60}Co . The "Indicator", ^{137}Cs , will always have the value of unity in the second position; see Table 3.1.

3.2.2.3 Non-TRU in Solids

The eight dust samples are summarized on page 4 of Appendix Table A.1.2. The activity content of both ^{90}Sr and ^{137}Cs are comparable, while the ^{60}Co content is about one-fourth as large. The $^{90}\text{Sr}/^{137}\text{Cs}$ ratio is higher than in the general floor smears. The scrapings have even greater amounts of ^{90}Sr compared to ^{137}Cs . The relatively small variation in ^{137}Cs compared to the others confirms the decision to use it as the non-TRU indicator.

3.2.2.4 Other Non-TRU Measurements

Several other observations may be noted from the tabular data.

- o The second level deck is double the activity per smear in ^{90}Sr , but nearly equivalent in the other radionuclides. If this trend is also seen in each of the remaining hot cells, it may be an indication of the general source of at least the ^{90}Sr component of the dust.
- o The gutter smears are higher than the general floor area in TRU. Differences are less significant for the non-TRU.

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- o The flange data are similar to the scrapings from inside piping. ^{90}Sr contributes the most to the smear activity.
- o ^{60}Co has very little direct contribution to general radiation levels on the floor, as seen from the MRAL-I measurements.
- o Sweeping the floor removed a significant fraction of both ^{137}Cs and ^{241}Am , but it had no effect on the measurement of ^{60}Co by the MRAL-I.

3.2.3 TRU in Cells B, D & E

- 1 The data format for B, D, and E cells follows that used for the
- 2 A-cell. The reduced sampling method and triple smear sequence was followed. Data are in Appendix Tables A.2.1, A.4.1, and A.5.1.

3.2.3.1 Comparison with A-cell Data

- 3 o B-cell Smears

Several smears collected more TRU contamination than from corresponding locations in A-cell. Four of the flange smears are over 2000 pCi of ^{241}Am . The non-TRU values are negligible, however.

- o Other B-cell Measurements

The dust samples have about the same concentrations as in A-cell. This indicates that they may have had similar sources. The in-place measurements in the center of B-cell indicate a very high amount of ^{241}Am . When the collimating cone was removed, the ^{241}Am photopeak intensity increased markedly. It is probably

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^{241}Am photopeak intensity increased markedly. It is probably "shine" from one of the tanks. However, the MRAL-II horizontally collimated detector was not sensitive enough to measure the ^{241}Am tank residue in a directional mode to confirm any one tank as the source. We have to estimate the ^{241}Am content based on other tank averages, plus the ratios from the interior smears.

o D-cell Smears

Data from the floor smears in D-cell follow the general pattern for A-cell, but with reduced ^{60}Co values. The flange smears have high amounts of ^{241}Am , followed by significant amounts of ^{90}Sr . Cesium-137 concentrations are relatively uniform.

o D-cell dust

The dust samples are uniformly low in ^{241}Am concentration. All have values of less than 1 nCi/g. The floor inside of this cell was not measured with the MRAL-I down-looking detector because of the relatively low concentrations in the dust samples.

o Tank Interiors

The D-4 tank cover was removed, and several interior smears were taken by the RPD. Two smears, 140 and 144, are of interest. The dry smear collected only a modest amount of ^{241}Am , but the wet one had much more activity. This is an indication that the

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tank interior contamination is not particularly loose, but that it may be washed off easily.

o MRAL-II In-place Measurements

Activity in all of the large tanks was measured using the MRAL-II collimated borehole detector. This detector/collimator has a round window, with a maximum viewing angle of approximately 45 degrees. The omnidirectional ^{137}Cs concentration was converted to this field of view and assumed to originate wholly from the closest tank wall. The attenuation of 662 keV gamma rays due to the thickness of the tank wall plus steam jacket is used for estimating the final net concentrations. The first measurement into the D-3 tank seemed to be a "flier" and was reevaluated, see Appendix D.

o D-cell Gutter

The D-cell gutter was very low in smearable contamination.

o E-cell Dust

The dust from E-cell was the lowest in overall activity of any cell. No floor measurements with the MRAL-I were taken in the E-cell because of the low values.

o E-cell Smears

The E-cell tank flange smears had more ^{241}Am than those in A-cell and the same order of magnitude as those in D-cell. This agrees

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with the cell use order, in which the TRU product was processed. The smear from inside tank E-4 was much lower in value than the corresponding one in tank D-4. Significant amounts of both ^{90}Sr and ^{241}Am were found on smears from inside the E-cell centrifuge. In estimating the 224-B building inventory, the centrifuges will be treated just as if they were tanks.

3.2.4 Non-TRU in Cells B, D and E

Sample data are tabulated in Appendix Tables A.2.2, A.4.2 and A.5.2. The activity concentrations in dust from these cells were lumped together with those from A-cell for estimating inventory.

- o Cobalt-60 remains the least concentrated of the radionuclides in both the dust and smear data.
- o There were large amounts of ^{90}Sr inside the tanks and piping found by the wet smears.
- o With the exception of sample 246, the ^{137}Cs content in the smear samples remains less than 1 nCi. Even the inside of the centrifuge drain was very low in ^{137}Cs .

3.2.5 TRU Measurements in C-cell

The C-cell has the most unusual geometry and presented the greatest challenge of all the cells to make characterization measurements of the radionuclides. General radiation shine from the pit and tunnel area contribute to the upper level flux/dose background.

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3.2.5.1 C-cell Dust Samples

The dust samples from the C-cell are very high in both ^{90}Sr and ^{60}Co and only moderate in value for ^{137}Cs and ^{241}Am . The pit has evidence of having been flooded, since watermarks and residues cover the walls of the pit. Scrapings from the pit wall have very high ^{90}Sr , low ^{137}Cs and intermediate amounts of ^{60}Co and ^{241}Am .

3.2.5.2 In-place Measurements

In-place measurements of the floor and sump area with the MRAL-I show higher readings than in any of the other cells, except for the center of B-cell, where the ^{241}Am dominates. Measurements with the MRAL-II into the C-cell tanks indicated a majority of ^{60}Co , rather than the ^{137}Cs of the other cells. The ^{60}Co provides added background in the energy range of ^{137}Cs , making it more difficult to distinguish from the background radiation.

3.2.5.3 Smear Sample Data

Data from the flange smears followed the general trend of the other cells. There are moderate amounts of contamination in the first wet smears of the triple sequence. No flange had an excessive amount of activity. This indicates a minimum of gasket leakage.

3.2.5.4 Tunnel

Special attention was paid to the tunnel area. This region is a blind end and yet has some of the highest concentrations of radio-

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nuclides in the dust. This is possibly due to large quantities of residual radionuclides in the piping. The pipes are more continuous inside the tunnel and not amenable to opening of flanges so no interior samples were taken. This is a higher dose area, and therefore of concern to worker exposures for D&D planning.

3.2.5.5 Pit Wall

One sample was scraped off of the pit wall in C-cell. The sample was taken at approximately chest height. The contamination layer in the pit area was approximated by this sample, assuming it is representative of a uniform distribution everywhere along the wall.

3.2.6 Non-TRU Measurements in C-cell

The highest non-TRU contamination in C-cell is also in the pit area and tunnel. Cobalt-60 is the dominant radionuclide here, where the B-plant material came into the cell. Appendix Table A.3.2 shows that both ^{60}Co and ^{90}Sr have their highest values here. Samples 236 and 237 (solids) show this. Nowhere else in the cells do the solids have this much non-TRU per gram. The remaining measurements are not unusual except for the in-place measurement #B24W12, taken over the sump. Here the cobalt-60 value also dominates the measurement.

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3.2.7 TRU Measurements in F-cell

F-cell dust samples have the highest concentrations of TRU for all cells, but less total amount of dust covers floors and equipment. Many flanges had very low amounts of smearable contamination, but some still indicated small amounts of gasket leakage.

3.2.7.1 In-place Measurements

The MRAL-I measurements show moderate amounts of both ^{241}Am and ^{137}Cs . The measurement over the sump, #B24W15, shows greater than 2 nCi per square centimeter. This is the highest concentration of any location within the building. It suggests that the sumps may have been one source of the TRU in the cell dust.

3.2.7.2 F-10 Loadout Hood

Access into this hood was difficult. Only one measurement was attempted, that with the detector in the lowest part of the hood drain sump. The sump is approximately 6 inches square by 2 or 3 inches deep; the north wall extends upward behind the detector. Because of the odd geometry of the sump, detailed description of the measurement is not given here. Those desiring greater detail should look at the 224-B facility drawings.

In making the inventory estimates for the loadout hood, the ^{241}Am gamma rays were assumed to originate from an open, 6-inch sphere. This is about the size of the sump where the detector was placed.

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Because of their greater energy the ^{137}Cs gamma rays were assumed to originate from an open sphere 36 inches in diameter, which is about the interior width of the loadout hood.

3.2.8 Non-TRU Measurements in F-cell

The same exclusions and general comments made for the TRU measurements apply to the non-TRU. Cobalt-60 is nearly absent from this cell, and there is wide variation even in the amounts of ^{137}Cs . Therefore, non-TRU ratios are not given for the smear samples, but only as measured for the dust.

3.3 MISCELLANEOUS MEASUREMENTS

The miscellaneous measurements are summarized in Table 3.2.

3.3.1 Ion Chamber Radiation Measurements

The ion chamber exposure rates (gamma and penetrating beta) are shown in Table 3.2 for various locations both inside and outside of the cells. Neutron dose rates were measured by the RPD and are tabulated in Appendix B, by cells. Exposure rates are nearly at background levels except in C-cell. The rate in C-cell pit and tunnel rises a factor of 6 times above the average value in clean areas, and over 4 times the cellular average, not including these two areas. All exposure/dose rates represent approximately 90% of the maximum display rate over a 2 to 5-minute period.

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3.3.2 Air Samples

The air samples showed only ^{137}Cs at concentration above minimum detection limits. Of these, the air sample in A-cell stands out most conspicuously. The APDU believes that while this sample was being collected, the upper level doors to the cell were opened and closed. Larger than normal amounts of interior air were directed outward at the bottom entrance. This probably stirred up more of the floor dust and contributed to the higher sample activity.

3.3.3 Contributions to Dose/Exposure Rate.

A qualitative correlation may be made between the cobalt-60 in the C-cell, especially the pit and tunnel areas, and higher exposure rate readings from the Reuter-Stokes ion chamber. The in-place measurements show ^{60}Co is the primary radionuclide in the cell. Similarly, where the ^{60}Co is reduced, (e.g., F-cell) the ion chamber readings were correspondingly lower. The in-place measurements do not measure ^{90}Sr , but the scrapings from the pit wall indicate large amounts of this contaminant also. Therefore, higher exposure rates in C-cell are probably due to the larger amounts of ^{60}Co and ^{90}Sr in the tanks and in the pit wall residue.

The D-3 tank has been modeled by a cylindrical source of plutonium (weapons grade) whose strength was adjusted to match the measured neutron dose around it, see Appendix C. This was confirmed by the repeat measurements for D-3 tank, see Appendix D.

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Table 3.2 224-B MISCELLANEOUS MEASUREMENTS

LOCATION	RESULT
<u>Air Samples</u>	<u>$^{137}\text{Cs}^*$</u>
A-cell	75.3 E-12 uCi/milliliter
B-cell	4.9 E-12
C-cell	4.8 E-12
D-cell	<2.3 E-12
E-cell	<2.4 E-12
F-cell	3.1 E-12
 <u>MRAL-II In-place Measurement</u>	
Building Air Intake	1.51 nCi total, $^{137}\text{Cs}^*$
 <u>Ion Chamber Readings</u>	
	<u>micro-R/hr **</u>
A-cell	3 readings, between 10.2 - 11.5
B-cell	3 readings, between 10.0 - 11.8
	1 reading in center of cell, 13.3
C-cell	2 readings on main floor, less than 20
	2 readings in pit, less than 50
	1 reading in tunnel, 66***
D-cell	1 reading sector B-1, 15
	1 reading sector F-1, 18
(reconfirm)†	7 readings less than 25
E-cell	5 readings, all less than 12.9
F-cell	4 readings, all less than 18
	1 reading, 3 feet above sump, 24
1st floor, clean side	3 readings, all less than 11.4
2nd floor, clean side	6 readings, all less than 12.8
3rd floor, clean side	5 readings, all less than 12.8
[Outside the facility]	10 micro-R/hr**
 <u>Neutron Dose Reading</u>	
D-cell, around D-3 tank	<0.1 mrem/hr, average of several

Notes:

- * All other radionuclides were less than minimum detection level.
- ** Special effort was not taken to totally map the exposure rate readings; it is not appropriate to subtract a background from them. Probably 40-70% of the reading outside the facility truly represents "background" not produced by man.
- *** Highest exposure rate area.
- † Details of the reconfirmation measurement are in Appendix D.

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4.0 INVENTORY ANALYSIS AND CONCLUSIONS

The purpose of this chapter is to present a summary of the radiological environment in the 224-B hot cells. It is intended to provide estimates of inventory for the purpose of disposing of the tanks and other equipment as a part of the D&D activity for the facility.

- o The estimated total TRU inventory is 37.7 (113 maximum) curies, including ^{241}Am and all isotopes of plutonium.
- o The combined non-TRU inventory is 26.8 (80 maximum) curies of cobalt-60, cesium-137 and strontium-90.
- o The D-3, F-8 & F-9 tanks contain the most radioactive material, over 80% of the estimated inventory.

4.1 METHOD

The building inventory was estimated in the following manner:

- o Each of the several grouping categories was analyzed for averages and standard deviation of the four primary radionuclides (^{241}Am , ^{60}Co , ^{137}Cs and ^{90}Sr).
- o The ^{241}Am inventory was found from averages of each cell's group categories.
- o The plutonium-239 was estimated from those samples with enough activity to quantify both the ^{241}Am and ^{239}Pu gamma ray photopeaks by GEA. Averages of both were used to find the general ratio of $^{239}\text{Pu}/^{241}\text{Am}$ for final inventory estimates.

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- o The maximum estimates are given as 3 times the standard deviation above the average in the tables.

4.2 ESTIMATION OF A-CELL TRU INVENTORY

The following sections deal with the A-cell radionuclide characterization. For comparison purposes, the TRU ~~results~~ and non-TRU results are grouped together in tables 4.1 and 4.2, respectively.

4.2.1 Estimating the ^{241}Am in the Cellular Dust

The ^{241}Am per gram value was found by weight-averaging results of the dust samples. The average dust coverage was determined by comparing the in-place three-measurement average with the value after sweeping sector A-1 (measurement B24W04). This net value is 236 pCi/sq cm. The maximum value was nearly twice this average.

Then, a suitable check on the method had to be made. From the average value of ^{241}Am in the actual dust samples collected, the weight distribution of dust solids was found. This value is 0.4 g/sq cm (equivalent to a uniform thickness of 2.5 mm), which is a reasonable figure for the facility. The standard deviation (60%) among the in-place measurement results is smaller than that for the smear samples and dust solids. The APDU estimated a 75% weighted average for the entire facility.

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TABLE 4.1 SUMMARY OF TRU INVENTORY

CELL	A	B	C	D	E	F
CATEGORY	<u>Americium-241 (curies)</u>					
Dust: Floor, Walls & Equip.	6.4E-4 (191%)*	4.6E-4 (77%)	4.3E-4 (106%)	1.6E-4 (247%)	8.1E-5 (131%)	8.4E-5 (169%)
Gutter/sump Samplers	2.2E-5 (103%)	2.2E-5 (103%)	3.8E-5 (103%)	2.2E-5 (103%)	2.2E-5 (103%)	4.4E-5 (103%)
Tanks,** Centrifuges	<4.1E-2 (96%)	<7.0E-2 (96%)	<1.8E-1 (96%)	3.5E+0‡ (86%)	<5.0E-2 (96%)	1.3E+0 (96%)
Piping	1.7E-2 (99%)	1.7E-2 (99%)	2.1E-2 (99%)	1.7E-2 (99%)	1.7E-2 (99%)	2.1E-2 (99%)
Miscellaneous	C-pit walls: 2.9E-4		Loadout hood: 6.8E-4			
Totals	<5.9E-2	<8.8E-2	2.0E-1	3.5E+0	6.7E-2	1.3E+0
<u>GRAND TOTAL - 241Am</u>	<u>5.2 Ci (75%)*</u>					
<u>GRAND TOTAL - 239Pu</u>	<u>31.1 Ci [0.5 kg]‡‡</u>					
TOTAL: All Pu isotopes 32.6 Ci (99%)						
<u>The GRAND TOTAL of both 241Am and all plutonium is 37.8 curies. ‡‡‡</u>						

Notes:

- * The amount in parenthesis is the estimated standard deviation (SD) the sample (category) based on the measurement survey. One SD corresponds to a 68% level of confidence in accuracy of the value.
- ** The A-cell tanks did not have a positive net reading through the wall, therefore the average includes a minus error only. The same applies to all other tanks, which read "background" only.
- † The value for the D-cell is based on a second entry into the cell, reported by letter in the Appendix.
- ## The 239Pu/241Am ratio [13.14:1] was used to find all Pu except that in D-3, which was a direct measurement of 7.4 Ci of 239Pu.
- ### The maximum upper limit estimate (3-SD) of all TRU is 94 Ci.

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TABLE 4.2 SUMMARY OF NON-TRU INVENTORY

CELL	A	B	C	D	E	F
CATEGORY	<u>Cesium-137 (curies)</u>					
Dust on floor, Walls & Equip.	1.9E-4	2.6E-4	3.6E-4	1.3E-4	6.8E-5	4.0E-5
Gutter, sump Samplers	6.4E-6	7.4E-6	2.2E-4	1.8E-5	1.9E-5	2.1E-5
Tanks, ** Centrifuges	<1.1E-2	<3.0E-3	2.6E-1	<1.0E-1#	3.8E-2	6.5E-1
Piping	4.9E-3	4.9E-3	6.1E-3	4.9E-3	4.9E-3	7.0E-3
<u>Miscellaneous</u>						
				F-10 Loadout hood:		1.9E-8
C-pit walls:	(137Cs @ 3.4E-5), (90Sr @ 2.7E-3), (60Co @ 1.4E-4)					
Air filter:	1.5E-9					
Totals (curies)						
137Cs	1.6E-2	8.2E-3	2.7E-1	1.0E-1	4.3E-2	6.6E-1
90Sr*	3.6E-2	6.0E-3	1.9E+1	1.2E+0	5.4E-2	1.3E+0
60Co*	6.0E-3	3.0E-3	3.7E+0	1.4E-1	6.0E-3	<5.E-3
<u>GRAND TOTAL, all non-TRU: 26.5 Ci (75%)*#</u>						

Notes:

- * 90Sr and 60Co values are estimates from the ratios established during the sample analysis, summarized in Table 3.1.
- ** The same standard deviation for the facility is assumed as for the TRU.
- # The value for the D-cell is based on both modeling estimates and in-place measurements for the D-3 tank.
- ## The errors for the modeling are assumed to be equal to the rest of the measurements. The same SD is assumed as for the 241Am. Therefore, the non-TRU maximum (3-SD) upper limit is 59 Ci.

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o ²⁴¹Am Estimate in the Floor Dust

The unused floor area is estimated at 50 square meters, based on the facility sketches. The dust load is therefore 118 microcuries of ²⁴¹Am for the floor.

o ²⁴¹Am Estimate for Dust on Walls

The walls are assumed to have a linear gradient distribution of dust with the highest concentration at the bottom, zero at the top. The same concentration is assumed at the base of the walls, as for the floor average. The wall area is estimated at 240 square meters, including the gallery walkway. The ²⁴¹Am dust load for the walls is estimated at 281 microcuries of ²⁴¹Am.

o ²⁴¹Am in Equipment Dust

The equipment (including piping, but excluding the piping flanges) is included in this category, with an estimated approximate surface area of 100 square meters. The ²⁴¹Am dust load on the equipment exteriors is estimated at 236 microcuries of ²⁴¹Am.

o Total ²⁴¹Am Estimate in Cell Dust

The total contribution of the dust load to the A-cell inventory of ²⁴¹Am is 635 microcuries.

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4.2.2 Method of estimating tank inventory

The tank inventory is based on four measurement data sets:

1. MRAL-II in-place measurements,
2. Internal scrapings and smears, and
3. External flange smears.
4. Neutron dose rate (D-3 tank, only)

First, these were used to estimate the non-TRU surface density inside the tank, followed by conversion to the ^{241}Am total.

The $^{239}\text{Pu}/^{241}\text{Am}$ ratio was then used to estimate the fissile content and a final TRU tank inventory.

o Non-TRU Estimate

The MRAL-II through-the-wall measurements with the side-looking detector were used to estimate a concentration of either ^{137}Cs or ^{60}Co on the first inside tank wall. This calculation ignores radioactivity on the farther wall of the tank, due to the distance and the inverse-square law of gamma radiation dispersion.

o Estimate of ^{241}Am

The ratio of ^{241}Am to the non-TRU component was determined from scrapings inside flanges opened during the survey. If no scrapings existed for the tank, then the general average for the cell was used, adjusted by the ratio found on flange smears for the cell. Subjective judgement had to be used in some cases in the selection

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of an appropriate set of ratios for a particular cell, particularly when the data set was small or exhibited a large standard deviation.

o Estimating ^{239}Pu

The ^{239}Pu to ^{241}Am ratio was determined as an average for the entire facility based on several interior scrapings and smear samples which had the largest amounts of ^{241}Am by GEA. Again, this selection process was somewhat subjective. The larger values of ^{241}Am were selected; so that errors in the $^{239}\text{Pu}/^{241}\text{Am}$ ratio would be minimized. The facility average was 13.14:1 based on samples 118, 222, and 342 in A, B and F-cells.

o Total TRU Estimate

Quantities by weight of TRU were converted from the curie activity levels according to the laws of radioactive decay, with an assumed $^{239}\text{Pu}/\text{total-Pu}$ fraction of 95%. This is consistent with production grades at Hanford. If the material processed in 224-B was of a different ^{239}Pu fraction, then the total TRU inventory would change, but the total fissile part (^{239}Pu , essentially) remains unchanged.

4.2.3 Other ^{241}Am Calculations

The other categories shown in the summary provide far smaller input to the inventory. The general steps used were as follows:

AIIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

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o Piping

The piping inventory was determined as an average for the entire facility. This was because pipes that begin in one cell often go to another, such that the processed material was averaged as residue along the entire length of the pipe. Scrapings and smears from inside the piping flanges were used to estimate a surface density per foot. A value of 400 linear feet of 3-inch piping was assumed for the cells. Even if this length were increased to 1000 feet (factor of 2.5 increase), the inventory would be effected very little because the majority of the radio-nuclides are in the tanks.

o Gutters, Sumps and Samplers

A linear smearable density was determined by averaging the smear samples. This value was multiplied by an assumed average gutter length of 25 feet per cell, except in F-cell, which was assumed to be 50% longer. The MRAL-I downlooking measurements in C and F cells were used to determine the sump inventory, as an average for the entire building. The sampling-boxes were estimated by using the gutter smear data and the area of a sump.

o Other Cell Calculations

The inventory calculations for Cells B-F proceeded in the same manner as those in A-cell. Results are shown in Table 4.1 for the ^{241}Am component.

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4.2.4 C-cell Pit Walls

The C-cell pit has noticeable residues and watermarks from being flooded. The MRAL-II measurement into the C-9 tank showed that the primary radionuclide in this area is ^{60}Co . It was not appropriate to extend the in-place tank analysis for the MRAL-II detector to the pit walls, but APDU did make an inventory estimate based on the pit wall scrapings combined with several assumptions.

o Wall Residue Inventory Estimate

The wall residue was scraped from approximately a 25 square centimeter (2"x2") area. This was assumed to represent half of the contamination on the wall. The remainder was assumed to have penetrated farther into the concrete. The floor of the pit has already been included in the C-cell inventory using the MRAL-I in-place measurements. The walls were assumed to have a uniform distribution of activity, characterized by the scraping sample.

4.2.5 Adequacy of Smear Sample Data

It was mentioned in Section 2.5 that GEA of the dry floor smears was eliminated to a great degree beginning with sample 20. To test the veracity of this decision, a linear correlation was made of the ratio of ^{241}Am to ^{137}Cs in A-cell for both the wet and dry smears. In figure 4.2 smear sample data are plotted with total ^{241}Am on the Y-axis and total ^{137}Cs on the X-axis. A log-linear fit is made to both wet and dry samples. The slopes of the

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Figure 4.2 Correlation of ^{241}Am and ^{137}Cs in A-cell wet and dry smears.

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two lines are indicative of the ratio of ^{241}Am to ^{137}Cs . No extreme differences in the slopes are observed, beyond normal data scatter. Because of this, the APDU decided to only analyze the wet smears during the majority of the sampling.

4.3 TANK INVENTORY

Table 4.3 presents the ^{241}Am estimates for the individual tanks. Where no direct measurement into a tank with the MRAL-II side-looking detector was able to quantify the inside radionuclides, a "less-than" value was calculated based on the D-4 tank result. The D-4 tank was measured from the inside and gave a finite value, but was not distinguishable from background on the outside.

The curie levels of plutonium may be converted to mass by the relation: 1 Curie (Plutonium-239) = 16.1 grams.

o D-3 Tank Result

The D-3 tank in-place measurement was considered an outlier, so alternate methods were used to estimate an inventory in this tank. The Radiation Protection Engineering group modeled the dose rates for both neutron and gamma from a sheet cylinder of plutonium and cesium-137 inside the tank and extrapolated this result to the Snoopy and ion chamber measurements in the D-cell. Repeat in-place measurements verified the estimates. This reduced the D-3 tank estimate to 3.4 Ci of ^{241}Am plus 7.4 Ci of plutonium.

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TABLE 4.3 SUMMARY OF IN-TANK INVENTORY ESTIMATES

241Am (total Ci) ##					
A-CELL	A-1 <.003**	A-3 <.003	A-4 <.001	Centrifuge 0.034*	
B-CELL	B-1 <.012	B-3 <.012	B-4 <.006	B-6 <.006	Centrifuge 0.034*
C-CELL	C-4 <.029	C-7 0.038	C-8 <.083	C-9 <.029	
D-CELL	D-1 <.028	D-3 3.44#	D-4 <.010	Centrifuge 0.034*	
E-CELL	E-1 <.001	E-3 <.001	E-4 0.014	Centrifuge 0.034 (284%) ***	
F-CELL	F-1 <.061	F-7 0.061	F-8 0.608	F-9 0.468	
	F-2 Cent 0.034*	F-22 Cent 0.034*		2 Small Centrifuges 0.03 (total)	

Notes:

- * The centrifuges were inaccessible with the MRAL-II detector. Value is based on the E-cell measurement, as typical of all.
- ** Where no cesium-137 measurement was possible for the side-looking detector into the tank, a "less than value" is given based on the D-4 interior measurement, the equivalent E-4 profile, and modified by the Am/Cs ratio in that cell.
- *** The value in parentheses is that of one standard deviation relative to the single measurement value.
- # This a revised value based on a second entry into the D-cell on May 16, 1985. It reduces the inventory estimate by approximately a factor of 50, compared to an earlier estimate.
- ## The 239Pu inventory of each tank can be estimated by multiplying the 241Am estimate by 13.14, except for the D-3 tank. A direct measurement of the D-3 tank gave 7.4 Ci of 239Pu.

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4.4 NON-TRU CALCULATIONS

The calculations for cesium-137 are summarized in Table 4.2 for each of the cells and the several general categories. The results are based on the averages in Table 3.2 and the same area or volume estimates made for the ^{241}Am calculations. The ratios of $^{90}\text{Sr}/^{137}\text{Cs}$ and $^{60}\text{Co}/^{137}\text{Cs}$ are based on the dust and smear samples taken in each cell. The total non-TRU inventory is based on the ^{137}Cs result multiplied by these ratios.

4.5 ERRORS

4.5.1 Sources of Error in the Tank Estimates

In the analysis the intention has been to err on the high side of the estimate in order to provide a suitable margin of safety in planning. There are two major and one smaller contributions of error in the method:

- o The non-TRU in the large tanks is estimated from a low intensity reading taken horizontally into the side of the tank. Uncertainties associated with this measurement are smaller than the remaining two estimation steps.
- o The first major source of error lies in the estimation of ^{241}Am based on the ratio of ^{241}Am to ^{137}Cs . The ^{241}Am estimate must be based on smear samples where no scrapings were made.
- o Finally, the ^{239}Pu component of the TRU is also estimated based upon the already estimated ^{241}Am . These two estimates span six orders of magnitude from microcuries per square

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centimeter to as much as curies for the volume of the tank. Small uncertainties are greatly multiplied. This is exemplified by the difference in the RPE estimate vs the MRAL-II in-place result for the D-3 tank.

4.5.1.1 Individual Tank vs Facility Values — A Caveat

The errors associated with assigning a definite inventory to each tank are greater than that of assigning a total TRU inventory to the entire class of tanks. Averaging the individual measurements, builds added confidence in the result. The variance is reduced in proportion to the square root of the total number of measurements made. If only one measurement is made, the confidence is less. A facility-wide standard deviation estimate of 75% was made after the above analyses were completed. The maximum limits (Table 4.1 and 4.2 footnotes) represent three standard deviations above the inventory estimate which is based on the averages.

4.5.2 Other Inventory Estimates

o Strontium-90 Uncertainties

Because of the nonstandard geometry of the wadded smear material, the ^{90}Sr smear sample values can only be considered a general guide to relative amounts of this radionuclide. The APDU measured each sample twice, from each side, and averaged the results. The phoswich detector response was compared to both a uniform sand source and a flat filter paper source in developing the sensitivity.

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The phoswich detector has shown the potential for providing rapid analyses in both laboratory and field applications. Response, attenuation factors, and spectral interferences have not been completely characterized. This deficiency limits the realization of its full potential by inhibiting evaluation of collected data. These measurements could be biased low by an estimated 20%, this would cause the $^{90}\text{Sr}:\text{}^{137}\text{Cs}$ ratio to be low. Thus the total non-TRU inventory could be low. Additional characterization of the phoswich system is planned. If appropriate, a letter correcting the values will be issued in the future by APDU.

4.6 CONCLUSIONS

During the general survey, and later detailed characterization measurements, the scope of investigation was modified to assure adequacy of data and maximum usefulness of the results. After analysis of the samples and making the inventory calculations, the APDU offers the following conclusions:

- o Nearly all of the tanks have inventories of less than 1 curie of TRU. Because of extrapolation errors the tanks with the larger inventories are suspect as possible "fliers." Only a sampling program with extensive interior measurements can establish the veracity of these estimates. Error estimates at the 99% confidence level are used to estimate the greatest maximum probable value for the tanks with "less than" amounts.

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- o The dust in the building contains considerable inventory of both TRU and fission products. Respiratory protection will be needed for D&D workers.
- o Most flanges have a considerable amount of contamination which has leaked past the gaskets.
- o The errors for the in-tank inventory may seem greater than desired. To improve this, APDU made measurements directly within the D-4 and E-4 tanks using the MRAL-II and detector. Tank D-3 was remeasured extensively to remove ambiguity in its inventory value, see Appendix D. Tanks D-3, F-7, F-8 and F-9 plus the centrifuges should be treated individually during D&D, opening covers and remeasuring interior residue.
- o The inventory in the C-cell pit is predicated on assumptions concerning the wall scrapings and extending this information to the entire wall area. It is quite likely that the deposition of material is not uniform with location. It is also quite likely that the contamination penetrates the walls in an uneven pattern. This would quite likely require a large number of core samples with which to document the exact nature of the problem. However, the impact of the pit residue is small, and so this point is moot.

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- o Comparisons based on only the smear samples may not necessarily represent absolutes, but only variations in the amount of scrubbing involved in the taking of the sample. Therefore, in the inventory estimates, the APDU has tried to use nonsmear data in preference to smear sample data. However, the smear samples have been very useful in developing ratios of radio-nuclides.

- o The source of the contamination in the dust is believed to have been evaporation from the gutters and sumps, assisted by general air currents from the ventilation system and overhead openings. The building is far from airtight, as evidenced by the large amount of sand and debris on the floor.

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ACKNOWLEDGEMENT

The authors wish to express sincere thanks to those who assisted in the data gathering and interpretation for this report. In particular, Emery Rink and Ray Cram assisted in the operation of the Mobile Radionuclide Analysis Laboratories. Also Erv Marten and Walter Nelson of the B-Plant Radiation Monitoring Unit contributed greatly to the gathering of survey data and assuring safe practices while working in the facility hot cells. Thanks also to Dr. Vishnu Subrahmanyam for assistance in the mathematical analysis. Staff of the Radiation Protection Engineering group (Paul Rittmann and Les Sutton) performed the dose modeling calculations for the D-3 tank. Numerous others have contributed time and energy to review the report and make it useful to the goal of worker safety during the D&D of the facility.

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APPENDICES

A. SAMPLE IDENTIFICATION AND LOCATIONS IN 224-B

Table A.1.1 A-cell TRU measurements
Table A.1.2 A-cell non-TRU measurements
Table A.2.1 B-cell TRU measurements
Table A.2.2 B-cell non-TRU measurements
Table A.3.1 C-cell TRU measurements
Table A.3.2 C-cell non-TRU measurements
Table A.4.1 D-cell TRU measurements
Table A.4.2 D-cell non-TRU measurements
Table A.5.1 E-cell TRU measurements
Table A.5.2 E-cell non-TRU measurements
Table A.6.1 F-cell TRU measurements
Table A.6.2 F-cell non-TRU measurements

B. RESULTS OF GENERAL SURVEY (Facility Sketches)

C. LETTER ON DOSE MODELING

D. LETTER ON REPEAT IN-PLACE MEASUREMENTS

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TABLE A.1.1 A-CELL MEASUREMENTS - TRU (Page 1 OF 5)

SAMPLE	LOCATION/DESCRIPTION	TYPE	241Am pCi*
<u>Floor Smear samples</u>			
1	A-1 grid sector (1) smear	wet	776
2		dry	262
3	A-2 grid sector smear	wet	283
4		dry	344
5	A-3 grid sector smear	wet	275
6		dry	448
7	A-4 grid sector smear	wet	784
8		dry	125
9	A-5 grid sector smear	wet	223
10		dry	220
11	A-6 grid sector smear	wet	874
12		dry	315
13	B-1 grid sector smear	wet	294
14		dry	222
15	B-4 grid sector smear	wet	517
16		dry	389
17	B-5 grid sector smear	wet	370
18		dry	268
19	B-6 grid sector smear	wet	506
21	C-1 grid sector smear	wet (2)	332
23	C-2 grid sector smear	wet	760
25	C-3 grid sector smear	wet	659
27	C-4 grid sector smear	wet	471
29	C-5 grid sector smear	wet	328
31	C-6 grid sector smear	wet	1310
74	D-1 grid sector smear	wet	415
77	D-2 grid sector smear	wet	584
73	D-3 grid sector smear	wet	122
69	D-4 grid sector smear	wet	<mdl
67	D-5 grid sector smear	wet	179
85	D-6 grid sector smear	wet	219

Notes:

* Values given are total per smear, except as noted.

(1) Refer to text for description of grid numbering system.

(2) Beginning with #21, primarily only the wet samples were analyzed.

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TABLE A.1.1 (CONTINUED, Page 2 of 5)

SAMPLE	LOCATION/DESCRIPTION	TYPE	241Am pCi
76	E-1 grid sector smear	wet	112
82	E-2 grid sector smear	wet	262
327	E-3 grid sector smear	wet	271
329	E-4 grid sector smear	wet	152
83	E-4 grid sector smear	dry	217
87	E-5 grid sector smear	wet	298
106	E-6 grid sector smear	wet	596
330	F-1 grid sector smear	wet	320
326	F-5 grid sector smear	wet	2750 (+)
86	F-6 grid sector smear	wet	1310
108	F-6 grid sector smear	wet	269
AVERAGE: Wet floor smears (32 total)			519 (99%)**
AVERAGE: Dry floor smears (10 total)			281 (34%)
GENERAL AVERAGE:			475 pCi/smear

Gutter samples

93	G-1 wall/floor joint	wet	331
94	G-2 wall/floor joint	dry	485
109	G-3 wall/floor joint	dry	2410
90	G-4 wall/floor joint	dry	1090
40	G-5 wall/floor joint	dry	1660
89	G-6 wall/floor joint	dry	783
104	G-3 sector gutter	dry	1490
91	G-5 sector gutter	dry	6610
92	G-6 sector gutter	dry	4510
100	G-2 grid sector smear (typ)	wet	489
105	G-3 grid sector smear (typ)	wet	1340
101	G-4 grid sector smear (typ)	wet	251
110	G-5 grid sector smear	wet	8040
103	G-6 grid sector smear (typ)	wet	5760
AVERAGE: Gutter, all smears			2518 (103%)

Notes:

- (+) Indicates significant or highest value in a category.
 ** Value in parenthesis is 1 standard deviation (SD) for the sample category, this notation applies to entire table series.

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TABLE A.1.1 (CONTINUED, Page 3 of 5)

SAMPLE	LOCATION/DESCRIPTION	TYPE	241Am pCi	
44	2nd floor, vestibule smear	dry	362	
78	Op deck, wall smear	wet	540	
318	2nd floor, A-1 sector	wet	134	
320	2nd floor, A-2 sector	wet	562	
319	2nd floor, A-3 sector	wet	117	
59	2nd floor, A-4 sector	wet	218	
66	2nd floor, B-1 sector	wet	114	
321	2nd floor, B-2 sector	wet	1090	
317	2nd floor, B-4 sector	wet	1300	
314	2nd floor, C-1 sector	wet	294	
62	2nd floor, C-1 sector	dry	297	
322	2nd floor, C-2 sector	wet	171	
316	2nd floor, C-4 sector	wet	146	
61	2nd floor, C-4 sector	dry	194	
AVERAGE: All 2nd level smears			396 (94%)	
<u>Tank and Equipment samples</u>				
41	A-1 Tank, motor vent smear	wet	265	
48	A-1 Tank riser flange @3:00	wet	244 (3)	
49	A-1 Tank riser flange @2:00	wet	169	
102	A-1 Tank header flange @1:30	wet	31900	
241	A-1 Tank, side flange	dry	34400 (+)	inside pipe
52	A-1 Tank, motor sides	wet	1020	
53	A-3 Tank typical flange	wet	328	
54	A-3 Tank motor mounting ring	dry	1300	
42	A-3 Tank, cover	wet	1510	
39	A-3 Tank Flange @8:00	wet	599	
43	A-3 Tank flange @8:00	dry	1400	
45	A-3 Tank riser flange @2:00	dry	165	
46	A-3 Tank (typ) side smear	wet	<mdl (4)	
95	A-4 Tank, SE cover flange	dry	267	
97	A-4 Tank, riser flange (typ)	dry	<mdl	
107	A-4 Tank, side flange (typ)	dry	<mdl	
242	A-4 Tank, side flange	wet	14500	Second inside.

Notes:

- (3) Tank flangwes are referenced to a clock, with north = 12:00.
 (4) Ten smear samples were taken, none exceeding normal background.

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TABLE A.1.1 (CONTINUED, Page 4 of 5)

SAMPLE	LOCATION/DESCRIPTION	WEIGHT	241Am pCi/g
55	A-centfuge inlet flge @5:00	dry	400
57	A-centfuge inlet flge @12:00	dry	<mdl
58	A-centfuge inlet flge @1:00	dry	<mdl
60	A-centfuge frame, westside	dry	<mdl
63	A-centfuge drain flange	dry	402
64	A-centfuge inlet flge @6:00	dry	<mdl
65	A-centfuge, east side smear	dry	230
72	A-centfuge, motor shaft	dry	6640 Greasy shaft
313	Centfuge, west side A-frame	wet	766
315	Centfuge, east side A-frame	wet	<mdl
323	Centrifuge, sides	wet	67
331	Centfuge top pipe & Collector	wet	384
AVERAGE: Tank and piping flanges			2267 (349%)
AVERAGE: Equipment exteriors			1072 (180%)
328	Vestibule, sampler-A	wet	160
325	Vestibule, sampler-C	wet	<mdl
324	Vestibule, sampler-D	wet	122
AVERAGE: Sampler smears			94 (89%)
Solids			
33	Pigeon feces and dust	13.0g	160/g (5)
34	Floor dust sample #1	16.1g	75/g
35	Floor dust sample #2	40.9g	3290/g (+)
36	Floor dust sample #3	57.8g	127/g
37	Floor dust sample #4	46.2g	408/g
38	Floor dust sample #5	51.7g	381/g
119	Gallery walkway, dust #1	19.0g	184/g
120	Gallery walkway, dust #2	11.5g	230/g
WEIGHTED AVERAGE: All dust samples			741 pCi/g

118	A-3 Tank, flange @4:00, inside	2.6g	42400/g (+) Scrapings
121	A-1 Tank, side flange @3:00	3.9g	735/g Inside pipe
AVERAGE: Inside pipe scrapings			17401 pCi/g

Notes:

(5) No effort made to separate the dust from pigeon feces

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TABLE A.1.1 (CONTINUED, Page 5 of 5)

MRAL-I In-place measurements

MEASUREMENT(6)	LOCATION	TYPE	241Am
B24W01	Grid sector G-3	(7)	392 pCi/sqcm
B24W02	Grid sector G-6		210
B24W03	Grid sector G-5		119
		AVERAGE:	240 pCi/sqcm
B24W04	Grid sector A-1	(8)	4
	NET FLOOR AVERAGE:		236 pCi/sqcm

Notes:

- (6) This is the MRAL-I storage identification sequence for the GEA spectrum.
- (7) Using a downlooking detector, 6 inches above floor, within a shield that views a 14-inch diameter circle on the floor.
- (8) This area was swept, before the measurement.

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TABLE A.1.2 A-CELL MEASUREMENTS - NON TRU (Page 1 of 4)

SAMPLE	LOCATION/DESCRIPTION	90SrpCi	137CspCi	60CopCi*
<u>Floor Smear samples</u>				
1	A-1 floor sector smear wet	213	1726	343
2	dry	37	242	76
3	A-2 floor sector smear wet	30.3	373	100
4	dry	89	517	60
5	A-3 floor sector smear wet	97.6	229	140
6	dry	77	696	174
7	A-4 floor sector smear wet	121	1136	205
8	dry	20	96	34.5
9	A-5 floor sector smear wet	<mdl	126	2.5?? (1)
10	dry	87	109	5.5??
11	A-6 floor sector smear wet	6.7!?	886	70
12	dry	27	382	40
13	B-1 floor sector smear wet	101	389	125
14	dry	178	269	40
15	B-4 floor sector smear wet	77	225	39
16	dry	<mdl	469	85
17	B-5 floor sector smear wet	17?	458	112
18	dry	<mdl	495	111
19	B-6 floor sector smear wet	23	334	90
21	C-1 floor sector smear wet	54	390	38
23	C-2 floor sector smear wet	<mdl	775	63
25	C-3 floor sector smear wet	84	831	144
27	C-4 floor sector smear wet	84	654	145
29	C-5 floor sector smear wet	87	681	107
31	C-6 floor sector smear wet	292	1056	214
74	D-1 floor sector smear wet	87	318	35
77	D-2 floor sector smear wet	74	189	<mdl
73	D-3 floor sector smear wet	<mdl	145	18.5?
69	D-4 floor sector smear wet	87	174	36
67	D-5 floor sector smear wet	61	352	28
85	D-6 floor sector smear wet	<mdl	138	12.5!?

Notes:

* For general explanatory comments see Table A.1.1

(1) Symbol key:

?? = less than 1 standard deviation (SD) above background.

! ? = between 1 and 2 SD above background.

? = between 2 and 3 SD above background.

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TABLE A.1.2 (CONTINUED, Page 2 of 4)

SAMPLE	LOCATION/DESCRIPTION	90SrpCi	137CspCi	60CopCi
76	E-1 floor sector smear wet	77	202	15.5?
82	E-2 floor sector smear wet	<mdl	62	10.51?
84	E-2 floor sector smear dry	<mdl	--	--
327	E-3 floor sector smear wet	153	280	181
83	E-4 floor sector smear dry	--	581	107
329	E-4 floor sector smear wet	<mdl	327	22?
87	E-5 floor sector smear wet	111	556	125
106	E-6 floor sector smear wet	57	86	9.51?
330	F-1 floor sector smear wet	53	249	31
326	F-5 floor sector smear wet	241	359	50
86	F-6 floor sector smear wet	57	956	69
108	F-6 floor sector smear wet	17	377	70
AVERAGE: Wet floor smears		71.6(99%)	473(80%)	84.6(90%)
AVERAGE: Dry floor smears		57.2(100%)	386(52%)	73.3(66%)
GENERAL AVERAGE:		68.5pCi	452.3pCi	81.8pCi

Gutter samples

93	G-1 wall/floor joint	wet	34	156	32.5
94	G-2 wall/floor joint	dry	81	175	16?
109	G-3 wall/floor joint	dry	67	370	19.5?
90	G-4 wall/floor joint	dry	37	23?	29
40	G-5 wall/floor joint	dry	40	33	33
89	G-6 wall/floor joint	dry	84	226	74
104	G-3 sector gutter	dry	222	367	64
91	G-5 sector gutter	dry	202	799	37
92	G-6 sector gutter	dry	54	529	105
100	G-2 floor sector smear wet		124	50	<mdl
105	G-3 floor sector smear wet		60.5	330	5.5??
101	G-4 floor sector smear wet		74	109	26.5
110	G-5 floor sector smear wet		215	986	107
103	G-6 floor sector smear wet		155	725	140
AVERAGE: All gutter smears			103.5pCi	384.4pCi	49.2pCi

2nd level samples

44	Op Deck vestibule floor	dry	94	347	118
78	Op deck, wall smear	wet	140	544	176
318	2nd floor, A-1 sector	wet	126	714	66
320	2nd floor, A-2 sector	wet	39	244	13.51?
319	2nd floor, A-3 sector	wet	96	135	19.5?
59	2nd floor, A-4 sector	wet	111	177	6.5??

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TABLE A.1.2 (CONTINUED, Page 3 of 4)

SAMPLE	LOCATION/DESCRIPTION	⁹⁰ SrpCi	¹³⁷ CspCi	⁶⁰ CopCi
66	2nd floor, B-1 sector wet	98	285	71
56	2nd floor, B-1 sector dry	211	370	67
321	2nd floor, B-2 sector wet	39	675	71
317	2nd floor, B-4 sector wet	258	812	77
314	2nd floor, C-1 sector wet	218	497	96
62	2nd floor, C-1 sector dry	222	1336	129
322	2nd floor, C-2 sector wet	123	385	47
316	2nd floor, C-4 sector wet	144	304	9.51?
61	2nd floor, C-4 sector wet	111	169	83
AVERAGE: All 2nd level smears		129.4pCi	464.1pCi	68.1pCi
<u>Tank and Equipment samples</u>				
41	A-1 Tank, motor vent wet	27	<mdl	7.51?
52	A-1 Tank, motor sides wet	13	52	<mdl
48	A-1 Tk riser flge @3:00 wet	<mdl	56	<mdl
49	A-1 Tk riser flge @2:00 wet	<mdl	<mdl	<mdl
102	A-1 Tank header @1:30 wet	121	97	<mdl
241	A-1 Tank, side flange dry	107	<mdl	<mdl
53	A-3 Tank flange (typ) wet	51	<mdl	23
54	A-3 Tank motor mounting dry	43.7	332	93
42	A-3 Tank, cover wet	710	300	55
39	A-3 Tank Flange @8:00 wet	3.4??	101?	<mdl
43	A-3 Tank flange @8:00 dry	47	<mdl	2.5??
45	A-3 Tk riser flge @2:00 dry	111	25	33
46	A-3 Tank sides wet	<mdl	<mdl	4.5??
95	A-4 Tk, SE cover flge dry	<mdl	370	32.5
97	A-4 Tk, typ riser flge dry	<mdl	152	3.5
107	A-4 Tank, side flange dry	13	<mdl	<mdl
242	A-4 Tank, side flange wet	1296	161	<mdl
55	A-Cent inlet flge @5:00 dry	255	<mdl	1.5??
57	A-Cent inlet flge @12:00 dry	<mdl	8??	<mdl
58	A-Cent inlet flge @1:00 dry	<mdl	<mdl	24.5
60	A-Cent west frame dry	17	1106	30
63	A-Cent drain flange dry	128	77	3.5??
64	A-Cent inlet flge @6:00 dry	<mdl	<mdl	<mdl
65	A-centfuge, east side dry	71?	286	<mdl
72	A-centfuge, motor shaft dry	1736	68	14.5?
313	A-Cent, west A-frame wet	22	346	11.5!?
315	A-Cent, east A-frame wet	<mdl	<mdl	<mdl
323	Centrifuge, sides wet	22	<mdl	<mdl
AVERAGES: All flanges		128(235%)	56(169%)	29.7(310%)

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TABLE A.1.1 (CONTINUED, Page 4 of 4)

SAMPLE	LOCATION/DESCRIPTION		⁹⁰ SrpCi	¹³⁷ CspCi	⁶⁰ CopCi
324	Vestibule, sampler-D	wet	61	57	18.5?
325	Vestibule, sampler-C	wet	74	322	5.5??
328	Vestibule, sampler-A	wet	136	229	2.5??
331	A-Cent Top pipe/colltr	wet	43	168	48
Solids					
		Weight			
33	Pigeon feces and dust	13.0g	82/g	29.7/g	3.5/g
34	Floor dust sample #1	16.1g	69/g	62.5/g	<mdl
35	Floor dust sample #2	40.9g	570/g	357/g	66.8/g
36	Floor dust sample #3	57.8g	80/g	82.9/g	12.2/g
37	Floor dust sample #4	46.2g	277/g	348/g	91/g
38	Floor dust sample #5	51.7g	203/g	288/g	43/g
119	Gallery walk, dust #1	19.0g	157/g	150/g	52/g
120	Gallery walk, dust #2	11.5g	20.2/g	46/g	18/g

WEIGHTED AVERAGE: Dust samples 221/g(113%) 215/g(107%) 55/g(86%)

118	A-3 Tk flge @4:00	2.6g	3062/g	350/g	<mdl	Scrapings
121	A-1 Tk, side flge @3:00	3.9g	1306/g	728/g	250/g	Inside

AVERAGE: Inside pipe scrapings 2008/g 577/g 150/g

MRAL-I In-place measurements (2)

MEASUREMENT	LOCATION		¹³⁷ Cs	⁶⁰ Co
B24W01	Floor sector G-3		19 pCi/sqcm	2 pCi/sqcm
B24W02	Floor sector G-6		12	3
B24W03	Floor sector G-5		14	3
	AVERAGE:		15	2.67
B24W04	Floor sector A-1 (3)		9	3
NET FLOOR DUST AVERAGE:			4 pCi/sqcm	-0-

Notes:

- (2) Using a downlooking detector, 6 inches above the floor, inside a shield that views a 14 inch diameter circle on the floor.
- (3) This area was swept first before the measurement.

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TABLE A.2.1 B-CELL MEASUREMENTS - TRU

SAMPLE	LOCATION/DESCRIPTION	TYPE	Am241 pCi*
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Solids

233	A-1 sector, dust sample	45.6g	199/g
231	A-8 sector, dust sample	44.1g	354/g
232	G-1 sector, dust sample	41.2g	792/g
230	G-6 sector, dust sample	45.0g	913/g (+)
229	Op deck, C-4 sector, P-faces	23.5g	9/g (1)
234	2nd floor vestibule, sector C-1	32.9g	570/g

WEIGHTED AVERAGE:
505.2/g
Smear samples

283	B-6 Tank, riser flange @9:30	wet	311 (2)
284	2nd floor, Cent drain flange	wet	694
285	B-4 Tank, side flange @3:00	wet	2620
286	B-4 Tank, side flange @4:00	wet	5630
287	B-1 Tank, side flange @1:00	wet	9000 (+)
288	B-3 Tank, side flange @3:00	wet	270
289	B-1 Tank, riser flange @7:30	wet	<mdl
290	2nd floor, C-3 sector smear	wet	1330
291	Op deck, sampler-B, flange	wet	2060
292	B-3 Tank, riser flange @12:30	wet	422
293	B-6 Tank, riser flange @1:00	wet	530

MRAL-I In-place measurements
241Am
239pu

(3)

B24W05	A-6 Floor sector	50 pCi/sqcm	1200 pCi/sqcm
B24W06	D-4 Floor sector	1681	11740
B24W07	G-6 Floor sector	92	8536
B24W08	D-4 Repeat w/o cone	8054	78100 (4)

Notes:

* See Table 3.A.1 for general explanatory notes.

- (1) Since the access for pigeons has been cut off, no effort was made to separate the contamination in the dust from the feces.
- (2) These are the first wet smears in a triple-smear sequence.
- (3) The usual measurement is made with the detector 6 inches over the floor collimated to view a 14-inch diameter circle.
- (4) This measurement is one inch off the floor unshielded to obtain the estimate of overall shine in the cell.

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TABLE A.2.2 B-CELL MEASUREMENTS - NON TRU

SAMPLE	LOCATION/DESCRIPTION	TYPE	90Sr pCi	137Cs pCi	60Co pCi*
<u>Solids</u>					
229	Op deck C-4 sctr P-feces	23.5g	73.8/g	4/g	16/g
230	G-6 sector, dust sample	45.0g	347/g	148/g	124/g
231	A-8 sector, dust sample	44.1g	156/g	390/g	143/g
232	G-1 sector, dust sample	41.2g	173/g	193/g	53/g
233	A-1 sector, dust sample	45.6g	288/g	314/g	199/g
234	2nd floor, sector C-1	32.9g	655/g	770/g	308/g
AVERAGES:			284 (65%)	308 (75%)	145 (68%)
<u>Smear samples</u>					
283	B-6 Tank riser flge @9:30	wet	<mdl	<mdl	<mdl
284	2nd floor Cent drain flge	wet	65	23?(1)	<mdl
285	B-4 Tank side flge @3:00	wet	231	<mdl	25.5
286	B-4 Tank side flge @4:00	wet	43	<mdl	<mdl
287	B-1 Tank side flge @1:00	wet	158	<mdl	<mdl
288	B-3 Tank side flge @3:00	wet	<mdl	<mdl	<mdl
289	B-1 Tank riser flge @7:30	wet	<mdl	3??	10.51?
290	2nd floor C-3 sector	wet	<mdl	<mdl	13.51?
291	Op deck, sampler-B, flge	wet	<mdl	<mdl	<mdl
292	B-3 Tnk riser flge @12:30	wet	<mdl	<mdl	<mdl
293	B-6 Tank riser flge @1:00	wet	66	<mdl	28
<u>MRAL-I In-place measurements</u>			<u>137Cs</u>	<u>Co-670</u>	
B24W05	A-6 Floor sector	(1)	11pCi/sqcm	8pCi/sqcm	
B24W06	D-6 Floor sector		20	3	
B24W07	G-6 Floor sector		13	5	
B24W08	D-4 repeat w/o cone	(2)	74	9	

Notes:

* See Table A.1.1 for general explanatory comments.

- (1) The measurement is made with detector 6 inches above the floor, viewing a 14-inch diameter circle within a collimation cone.
- (2) This measurement made with detector unshielded, to estimate the overall shine in the cell.

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TABLE A.3.1 C-CELL MEASUREMENTS - TRU

SAMPLE	LOCATION	TYPE	241Am pCi*	
<u>Solids</u>				
235	A-1 sector, dust sample	29.2g	200/g	
236	A-6 sector, dust sample	40.1g	244/g	
237	D-3 gutter, dust sample	31.1g	832/g	
238	Tunnel floor, dust	22.7g	1910/g	
239	G-1 sector, dust sample	46.2g	124/g	
240	G-6 sector, dust sample	25.3g	50/g	
AVERAGE: Dust solids			472/g(106%)	
<u>Scraping samples</u>				
224	C-7 Tank bottom flange	32.0g	12/g	Inside flange
225	C-4 Tank, outside wall	46.5g	13/g	
226	C-4 Tank bottom flange	26.7g	18/g	Inside flange
227	Pit East wall scrapings	16.2g	505/g	(1)
228	C-7 Tank, outside wall	42.4g	2.9/g	
AVERAGE: Scrapings			59.7/g(178%)	
<u>Smear samples</u>				
249	C-4 Tk, riser flge @8:30	wet	308	
250	C-4 Tk, riser flge @8:30	wet#2	<mdl	
252	C-4 Tk, side flge @2:00	wet	123	
254	C-7 Tk, riser flge @6:30	wet	2250	
255	C-4 Tk, side flge @2:00	wet	117	
256	C-4 Tk, riser flge @8:30	dry	178	
257	C-7 Tk, riser flge @10:00	wet	<mdl	
258	C-7 Tk, riser flge @10:00	wet#2	<mdl	
259	C-9 Tk, riser flge @11:00	wet	<mdl	
260	Piping flange above floor	wet#	6290	
261	Piping flange above floor	wet	8890	
264	C-9 Tk, riser flge @2:30	wet	<mdl	
265	C-7 Tk, riser flge @6:30	wet#2	1530	
266	C-9 Tk, riser flge @2:30	wet#2	<mdl	
268	C-9 Tk, riser flge @11:00	wet	<mdl	
269	A-1 sector, floor smear	wet	<mdl	
270	G-1 sector, floor smear	wet#2	<mdl	

Notes:

* See Table A.1.1 for general explanatory comments.

(1) There is sufficient residue on the walls of the cell pit area to indicate that the pit has been flooded at some past time.

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TABLE A.3.1 (CONTINUED, PAGE 2 OF 2)

SAMPLE	LOCATION/DESCRIPTION	TYPE	241Am pCi
276	G-6 sector, floor smear	wet	<mdl
277	C-8 Tk, riser flge @8:00	wet	<mdl
278	A-6 sector, floor smear	wet	<mdl
279	D-3 sector, gutter smear	wet	184
280	G-1 sector, gutter smear	wet	164
281	C-8 Tk, riser flge @11:00	wet	<mdl
282	Tunnel floor under pipes	wet	590
AVERAGE:			1039 pCi/smear (226)

MRAL-I Measurements

MEASUREMENT LOCATION	241Am
B24W10* Floor sector G-1 (2)	6 pCi/sqcm
B24W11 Floor sector G-6	<mdl
B24W12 Floor sector C-3	55

Notes:

- * This is the identification number of the spectrum stored in MRAL-I memory.
- (2) Taken with a collimated detector 6 inches above the floor, viewing a 14-inch diameter circle.

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TABLE A.3.2 C-CELL MEASUREMENTS - NON TRU (Page 1 of 2)

SAMPLE LOCATION/DESCRIPTION	TYPE	90SrpCi	137CspCi	60CopCi*
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Floor smears

269	A-1 sector, floor smear	wet	219	<mdl	100
278	A-6 sector, floor smear	wet	393	141?	123
279	D-3 sector, gutter smear	wet	1400	74	7250
280	G-1 sector, gutter smear	wet	219	300	4790
270	G-1 sector, floor smear	wet#2	--	170	2550
276	G-6 sector, floor smear	wet	101	42	165
282	Tunnel floor under pipes	wet	131	108	161

AVERAGES:

410.5	101	2163
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Tank and equipment smears

249	C-4 Tnk riser flge @8:30	wet	148	???	5.5??
250	C-4 Tnk riser flge @8:30	wet#2	<mdl	<mdl	23.5
252	C-4 Tnk side flge @2:00	wet	273	90	85
255	C-4 Tnk side flge @2:00	wet	64	47	<mdl
236	C-4 Tnk riser flge @8:30	dry	57	<mdl	12.51?
254	C-7 Tnk riser flge @6:30	wet	<mdl	<mdl	10.5
257	C-7 Tnk riser flge @10:00	wet	<mdl	<mdl	44
258	C-7 Tnk riser flge @10:00	wet#2	7?	<mdl	44
265	C-7 Tnk riser flge @6:30	wet#2	<mdl	<mdl	<mdl
277	C-8 Tnk riser flge @8:00	wet	18	<mdl	6.5??
281	C-8 Tnk riser flge @11:00	wet	<mdl	<mdl	<mdl
259	C-9 Tnk riser flge @11:00	wet	91	17?	1.5??
264	C-9 Tnk riser flge @2:30	wet	84	<mdl	15?
266	C-9 Tnk riser flge @2:30	wet#2	47	<mdl	41
268	C-9 Tnk riser flge @11:00	wet	13	<mdl	22.5
260	Piping flange above floor	wet#2	87	<mdl	<mdl
261	Piping flange above floor	wet	64	1??	34

AVERAGES:

56	--	18
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Solids

235	A-1 sector, dust sample	29.2g	9155/g	410/g	978/g
236	A-6 sector, dust sample	40.1g	10480/g	370/g	2210/g
237	D-3 gutter, dust sample	31.1g	17386/g	517/g	20300/g (+)
238	Tunnel floor dust sample	22.7g	720/g	247/g	659/g
239	G-1 sector, dust sample	46.2g	596/g	535/g	1140/g
240	G-6 sector, dust sample	25.3g	143/g	137/g	707/g

AVERAGES:

6556/g(109%)	394/g(60%)	4286/g(175%)
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Note:

* See Table A.1.1 for general explanatory comments.

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TABLE A.3.2 (CONTINUED, Page 2 of 2)

SAMPLE LOCATION/DESCRIPTION	TYPE	90Sr pCi	137Cs pCi	60Co pCi
<u>Scraping samples</u>				
225 C-4 Tnk, outside wall	46.5g	2595/g	6.5/g	8/g
226 C-4 Tnk in bottom flge	26.7g	5204/g	19.6/g	223/g
227 Pit East wall scrapings	16.2g	4722/g	58/g	249/g
224 C-7 Tnk in bottom flge	32.0g	3127/g	<mdl	5.5/g
228 C-7 Tnk, outside wall	42.4g	2376/g	5.5/g	43/g
AVERAGES:		3275 (22%)	12.2 (89%)	75 (100%)

MRAL-I In-place measurements

ID	LOCATION/DESCRIPTION	137Cs	60Co
B24W10	Floor grid sector G-1 (1)	52 pCi/sqcm	425 pCi/sqcm
B24W11	Floor grid sector G-6	17	117
B24W12	Floor grid sector C-3	283	6399 (near sump)
AVERAGES:		117.3 pCi/sqcm	2313.7 pCi/sqcm

MRAL-II In-place measurements (2)

LOCATION/DESCRIPTION	ID	ISOTOPE/OMNI-CONCENTRATION (3)
Into C-4 tank	NA	Background only
Into C-7 tank (2)	(73,1)**	60Co @28.5 nCi/L
Away from C-7 tank	(73,2)	60Co @27.5 nCi/L
NET Tank wall concentration		1.06 uCi/sqcm
Into C-9 tank	(73,3)	60Co @0.5246 uCi/L
Away from C-9 tank	(73,4)	60Co @0.6862 uCi/L
NET:		Source is not inside C-9 tank.

Notes:

- ** Storage identification for MRAL-II (diskette, sequence tag).
 (1) Collimated detector viewing 14-inch diameter floor area.
 (2) Horizontally collimated, with approx 45-degree field of view.

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TABLE A.4.1 MEASUREMENTS IN D-CELL - TRU

SAMPLE LOCATION/DESCRIPTION	TYPE	Am241pCi*
<u>Solids</u>		
123 D-4 sector dust sample	49.1g	175/g
124 G-6 sector dust sample	37.1g	100/g
125 A-6 sector dust sample	46.6g	308/g
126 D-1 sector dust sample	44.1g	272/g
127 A-1 sector dust sample	47.2g	292/g
128 2nd flr vestibule dust	23.8g	70/g (and pigeon feces)
129 D-1 sector dust sample	23.8g	31/g
130 Op deck, dust sample	39.5g	27/g
AVERAGE:		171/g(247%)
<u>Smear samples</u>		
140 D-4 Tank, interior smear	dry	4180
144 D-4 Tank, interior smear	wet	113,000 (+)
300 D-3 Tnk, inside riser @8:30	wet	1940
301 D-3 Tnk, inside side flge	wet	2290
AVERAGE: Inside smears		30,352(181%)
<u>Floor smears</u>		
299 A-1 sector, floor smear	wet	119
295 A-6 sector, floor smear	wet	138
304 D-4 sector, floor smear	wet	183
297 D-1 sector, floor smear	wet	559
307 G-6 sector, floor smear	wet	<mdl
309 G-1 sector, floor smear	wet	129
311 East wall, gutter smear	wet	297
312 Op deck, general floor smear	wet	<mdl
296 2nd floor vestibule smear	wet	<mdl
308 2nd floor vestibule, A-sector	wet	15700 (+)
294 D-1 Tank, flange @6:00	wet	757
302 D-3 Tank, side flange @6:00	wet	<mdl 1 foot of
303 D-4 Tank, flange @6:00	wet	169
298 Centrifuge, flange @2:00	wet	106
305 Centrifuge motor air inlets	wet	476
306 D-1 Tank, flange @8:30	wet	2390
310 Centrifuge drain flange	wet	1890
AVERAGE: Flange smears		885pCi

Note:

* See Table A.1.1 for general explanatory comments.

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TABLE A.4.2 D-CELL MEASUREMENTS - NON TRU

SAMPLE LOCATION/DESCRIPTION	TYPE	90Sr ^p CI	137Cs ^p CI	60Co ^p CI*
Solids				
127 A-1 sector dust sample	47.2g	147/g	145/g	32/g
125 A-6 sector dust sample	46.6g	212/g	185/g	70/g
126 D-1 sector dust sample	44.1g	180/g	154/g	12/g
129 D-1 sector dust sample	23.8g	96/g	<mdl	31/g (1)
123 D-4 sector dust sample	49.1g	258/g	283/g	19/g
124 G-6 sector dust sample	37.1g	325/g	153/g	38/g
130 Op deck, dust sample	39.5g	19/g	7.5/g	27/g (1)
128 2nd flr vestibule dust	23.8g	--	96/g	41/g
AVERAGES:		183/g	143/g	29.3/g
Smear samples				
140 D-4 Tnk interior smear dry		1361	<mdl	41
144 D-4 Tnk interior smear wet		23984 (+)	198	<mdl
300 D-3 Tnk ins riser @8:30 wet		493	<mdl	1940
301 D-3 Tnk ins side flge wet		235	<mdl	2290
AVERAGE: Inside smears		6518	NA	1424
299 A-1 sector, floor smear wet		--	93	26
295 A-6 sector, floor smear wet		66	44	6.5??
297 D-1 sector, floor smear wet		--	260	4.5??
304 D-4 sector, floor smear wet		<mdl	81	<mdl
309 G-1 sector, floor smear wet		53	40	3.5??
307 G-6 sector, floor smear wet		26	48	6.5??
311 East wall, gutter smear wet		105	403	73
296 2nd flr, vestibule smear wet		<mdl	<mdl	<mdl
312 Op deck, general smear wet		105	15!?	10.5!?
308 2nd flr vestibule smear wet		1054	<mdl	<mdl
AVERAGE: Floor smears		176	98	13
294 D-1 Tank flange @6:00 wet		61	593	20.5?
306 D-1 Tank flange @8:30 wet		<mdl	<mdl	25
302 D-3 Tnk, side flge @6:00 wet		3425	<mdl	<mdl
303 D-4 Tank flange @6:00 wet		81	<mdl	169
298 Centrifuge flange @2:00 wet		<mdl	<mdl	106
305 Centrifuge motor vents wet		70	1??	<mdl
310 Centrifuge drain flange wet		66	<mdl	<mdl
AVERAGE: Flange smears		740 (1)	NA	45

Notes:

* See Table A.1.1 for general explanatory comments.

(1) Average excludes the <mdl-values.

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TABLE A.4.2 (CONTINUED, Page 2 of 2)

MRAL-II In-place measurements (2)

CELL LOCATION/DESCRIPTION	ID	ISOTOPE/OMNI-CONCENTRATION (3)
D-cell, into D-3 tank	(73,5)	^{137}Cs @1.5354 uCi/L
D-cell, away from D-3 tank	(73,6)	^{137}Cs @0.9771 uCi/L
NET tank wall concentration		0.0970 uCi/sqcm (
D-cell, into D-4 tank	NA	Background only
D-cell, into D-1 tank	NA	Background only

Notes:

- (2) Horizontally collimated detector, field of view approx 45 degrees.
- (3) Equivalent response from a uniform, infinite source in sand of density 1.38.
- (4) Measurement converted to concentration on inside wall of the tank.

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TABLE A.5.1 E-CELL MEASUREMENTS - TRU

SAMPLE	LOCATION/DESCRIPTION	TYPE	241Am pCi*
<u>Solids</u>			
114	A-1 sector dust sample	32.0g	167/g
115	A-6 sector dust sample	33.4g	254/g
117	D-4 sector dust sample	19.3g	14/g
122	D-1 sector dust sample	26.2g	17/g
113	G-1 sector dust sample	29.2g	119/g
111	G-6 sector dust sample	24.8g	42/g
112	2nd flr vestibule dust	26.9g	<mdl
116	Op Deck dust sample	21.9g	<mdl
	AVERAGE:		89.2/g
<u>Smear samples</u>			
131	E-4 Tnk riser flge @12:30	wet	2690
132	E-4 Tnk riser flge @12:30	wet#2	296
134	E-4 Tnk riser flge @11:30	wet#2	1670
135	E-4 Tnk riser flge @12:30	wet#2	406
271	E-1 Tnk outside wall smear	wet	425
272	E-3 Tnk, riser flge @6:30	wet	<mdl
273	E-1 Tnk, riser flge @7:00	wet	3260
274	E-1 Tnk, riser flge @2:00	wet	8850
275	E-3 Tnk, side flge @3:00	wet	569
	AVERAGE: Flange smears		2018
142	E-4 Tank interior smear-A	dry	3280
146	E-4 Tank interior smear-B	dry	314
244	Centrifuge drain, interior	wet	84600 (+)
246	E-1 Tnk inside riser @1:00	wet	78300
248	E-3 Tnk inside flge @3:00	wet	7610
	AVERAGE: Interior smears		34820
136	2nd flr vestibule samplr-C	dry	3500
138	2nd flr vestibule samplr-C	wet#2	1060
139	2nd flr vestibule samplr-C	wet	1970
	AVERAGE: Sampler smears		2177 pCi/smear

Note:

* See Table A.1.1 for general explanatory comments.

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TABLE A.5.2 E-CELL MEASUREMENTS - NON TRU

SAMPLE	LOCATION/DESCRIPTION	TYPE	90Sr pCi	137Cs pCi	Co60 pCi*
<u>Solids</u>					
114	A-1 sector dust sample	32.0g	225/g	194/g	15/g
115	A-6 sector dust sample	33.4g	152/g	180/g	12.5/g
122	D-1 sector dust sample	26.2g	25/g	8.5/g	0.2/g??
117	D-4 sector dust sample	19.3g	56/g	5/g??	<mdl
113	G-1 sector dust sample	29.2g	88/g	63/g	4.5/g
111	G-6 sector dust sample	24.8g	71/g	26/g	<mdl
112	2nd flr vestibule dust	26.9g	1.4/g?	7.5/g	<mdl
116	Op Deck dust sample	21.9g	68/g	43/g	<mdl
AVERAGES:			93/g	75.3/g	9.7/g
<u>Smear samples</u>					
131	E-4 Tnk riser flge @12:30	wet	--	<mdl	<mdl
132	E-4 Tnk riser flge @12:30	wet#2	--	106	<mdl
134	E-4 Tnk riser flge @11:30	wet#2	--	<mdl	4.5??
135	E-4 Tnk riser flge @12:30	wet#2	--	36	20.5
136	2nd flr vest sampler-C	dry	--	<mdl	12.51?
138	2nd flr vest sampler-C	wet#2	--	<mdl	<mdl
139	2nd flr vest sampler-C	wet	--	<mdl	<mdl
271	E-1 Tnk outer wall smear	wet	<mdl	3??	15.5?
272	E-3 Tnk riser flge @6:30	wet	<mdl	23?	<mdl
273	E-1 Tnk riser flge @7:00	wet	149	<mdl	<mdl
274	E-1 Tnk riser flge @2:00	wet	1015	<mdl	<mdl
275	E-3 Tnk side flge @3:00	wet	<mdl	<mdl	<mdl
142	E-4 tnk interior smear-A	dry	--	771	<mdl
146	E-4 Tnk interior smear-B	dry	--	689	<mdl
244	Centrifuge drain interior	wet	9607	84	<mdl
246	E-1 Tnk ins riser @1:00	wet	2110	14100	<mdl
248	E-3 Tnk inside flge @3:00	wet	326	133	<mdl
AVERAGES: Interior smears			4014	3155	--

Note:

* See Table A.1.1 for general explanatory comments.

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TABLE A.5.2 (CONTINUED, Page 2 of 2)

MRAL-II In-place measurements

Into E-Centrifuge (73,7)	137Cs @0.5816 uCi/L
(1)	
Away from E-Centrifuge (73,8)	137Cs @0.4653 uCi/L
NET tank wall concentration	0.0202 uCi/sqcm
(2)	
Into E-4 tank (73,9)	137Cs @0.4653 uCi/L
Away from E-4 tank (73,10)	137Cs @0.3954 uCi/L
NET tank wall concentration	0.012 uCi/sqcm
Into E-3 tank NA	Background only
Into E-1 tank NA	Background only

Notes:

- (1) Equivalent omni-directional concentration for infinite source in sand of density 1.38 g/mL.
- (2) Net concentration, estimated on first inner surface, 10 cm away from detector behind 7/16-inch steel.

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TABLE A.6.1 F-CELL MEASUREMENTS - TRU (Page 1 of 2)

SAMPLE LOCATION/DESCRIPTION		TYPE	241Am pCi*
<u>Floor smears</u>			
188	A-2 floor sector smear	wet	<mdl
191	E-1 floor sector smear	wet	245
176	E-4 floor sector smear	wet	102
173	G-4 floor sector smear	wet	157
182	H-5 floor sector smear	wet	567
185	J-1 floor sector smear	wet	137
AVERAGE:			201 pCi/smear
179	Main floor sump	wet	6250
<u>Flange smears</u>			
149	G-1 Centfge, riser flge	wet	<mdl
152	G-7 Centfge, riser flge	wet	<mdl
157	E-1 sector, lower flge	wet	96500 (+)
161	F-2 Centrifuge, cover	wet	648
164	F-22 Centrifuge, cover	wet	504
167	F-1 Tnk, cover smear	wet	1830
170	F-1 Tnk, riser @3:00	wet	346
194	F-1 Tnk side flge @2:30	wet	370
334	F-1 Tank, riser @3:00	wet	5760
335	F-1 Tank, riser @3:00	wet#2	7630
206	F-7 Tank, riser @3:30	wet	322
208	F-7 Tank, cover	wet	489
212	F-8 Tank, cover	wet	902
215	F-8 Tank, riser @3:00	wet	<mdl
197	F-8 Tnk side flge @6:00	wet	574
332	F-8 Tank, riser @3:00	wet#2	2410
333	F-8 Tank, side @6:00	wet	685
336	F-8 Tnk side flge @6:00	wet#2	2470
337	F-8 Tank, riser @3:00	wet	1130
200	F-9 Tank, riser @3:30	wet	<mdl
203	F-9 Tank, cover	wet	1580

Note:

* See Table A.1.1 for general explanatory comments.

SD-DD-TRP-002

TABLE A.6.1 (CONTINUED, Page 2 of 2)

SAMPLE LOCATION/DESCRIPTION	TYPE	241Am pCi	
158 Op deck, sampler flange	wet	7550	
339 Vestibule sampler flange	wet	14500	
340 Vestibule sampler flange	wet#2	10000	
338 A-4 sector, header flange	dry	432	
343 A-4 sector, header flange	wet	946	
344 A-4 sector, header flange	wet#2	941	
341 E-1 sector, flange smear	wet	64900	Pu=77nCi
342 E-1 sector, flange smear	wet#2	44400	Pu=888nCi

AVERAGE: Flange smears 9232(238%)

Solids

217 Main sump, dust sample	42.4g	8400/g
223 A-2 sector, dust sample	29.7g	582/g
220 A-4 sector, dust sample	42.6g	510/g
222 E-2 sector, dust sample	38.0g	2990/g
219 E-4 sector, dust sample	33.4g	559/g
218 H-5 sector, p-feces	20.6g	56/g
221 J-1 sector, dust sample	22.3g	260/g

AVERAGE: 2326/g(169%)

MRAL-I In-place measurements

B24W13 FLOOR SECTOR A-4	153pCi/sqcm (1)
B24W14 FLOOR SECTOR F-5	77
B24W15 SUMP, SECTOR F-5	2010
B24W16 FLOOR SECTOR J-5	9
B24W17 2ND LEVEL, SECTOR F-3	20
B24W18 2ND LEVEL, SECTOR A-1	11
B24W19 FLOOR SECTOR H-1	18

MRAL-II In-place measurement ID

F-cell, F-10 loadout hood	(100,1)	241Am @0.68mCi (2) (3)
---------------------------	---------	------------------------

Notes:

- (1) Measurements made using downlooking detector viewing 14-inch diameter floor area.
- (2) Measurement with borehole detector placed in sump of hood.
- (3) Equivalent total concentration based on a sphere of 1.5 foot radius.

SD-DD-TRP-002

TABLE A.6.2 F-CELL MEASUREMENTS - NON TRU

SAMPLE LOCATION/DESCRIPTION		TYPE	90Sr pCi	137Cs pCi	Co60 pCi*
<u>Floor smears</u>					
188	A-2 floor sector smear	wet	50	101	17.5?
191	E-1 floor sector smear	wet	50	28	9.51?
176	E-4 floor sector smear	wet	98	74	<mdl
173	G-4 floor sector smear	wet	<mdl	36	<mdl
182	H-5 floor sector smear	wet	111	258	<mdl
185	J-1 floor sector smear	wet	202	632	19.5?
AVERAGES:			85	188	7.8
179	Main floor sump	wet	895	6018	29.5
<u>Flange smears</u>					
149	G-1 Centfge riser flange	wet	54	<mdl	15.51?
152	G-7 Centfge riser flange	wet	57	<mdl	<mdl
157	E-1 sector, lower flange	wet	690	<mdl	11.51?
161	F-2 Centrifuge, cover	wet	97	24	<mdl
164	F-22 Centrifuge, cover	wet	34	<mdl	<mdl
167	F-1 Tank, cover smear	wet	831	298	<mdl
170	F-1 Tank, riser @3:00	wet	232	<mdl	<mdl
194	F-1 Tank side flge @2:30	wet	<mdl	<mdl	<mdl
206	F-7 Tank, riser @3:30	wet	67	<mdl	28.5
208	F-7 Tank, cover	wet	<mdl	86	<mdl
212	F-8 Tank, cover	wet	286	251	311
215	F-8 Tank, riser @3:00	wet	<mdl	<mdl	31.5
197	F-8 Tnk side flge @6:00	wet	138	141?	<mdl
200	F-9 Tank, riser @3:30	wet	100	<mdl	<mdl
203	F-9 Tank, cover	wet	255	209	<mdl
332	F-8 Tank, riser @3:00	wet#2	--	111?	7.51?
333	F-8 Tnk side flge @6:00	wet	--	131?	<mdl
334	F-1 Tank, riser @3:00	wet	--	<mdl	9.51?
335	F-1 Tank, riser @3:00	wet#2	--	5??	<mdl
336	F-8 Tnk side flge @6:00	wet#2	--	131?	<mdl
337	F-8 Tank, riser @3:00	wet	--	<mdl	17?

Note:

* See table A.1.1 for general explanatory comments.

SD-DD-TRP-002

TABLE A.6.2 (CONTINUED, Page 2 of 3)

SAMPLE LOCATION/DESCRIPTION	TYPE	90Sr pCi	137Cs pCi	60Co pCi
158 Op deck, sampler flange	wet	2123	839	<mdl
338 A-4 sector, header flge	dry	--	<mdl	<mdl
343 A-4 sector, header flge	wet	--	131?	<mdl
344 A-4 sector, header flge	wet#2	--	<mdl	<mdl
339 Vestibule sampler flange	wet	--	3??	<mdl
340 Vestibule sampler flange	wet#2	--	29	<mdl
341 E-1 sector, flange smear	wet	--	15+?	<mdl
342 E-1 sector, flange smear	wet#2	--	90	5??
AVERAGE: Flange smears		--	124	NA

Solids

217 Main sump, dust sample	42.4g	2327/g	3319/g	<mdl
223 A-2 sector, dust sample	29.7g	3338/g	564/g	<mdl
220 A-4 sector, dust sample	42.6g	708/g	518/g	<mdl
222 E-2 sector, dust sample	38.0g	5374/g	942/g	<mdl
219 E-4 sector, dust sample	33.4g	1609/g	666/g	<mdl
218 H-5 sector, p-feces	20.6g	148/g	53/g	<mdl
221 J-1 sector, dust sample	22.3g	898/g	549/g	<mdl

AVERAGES:

2227 (95%) 1098 (132%) --

MRAL-I In-place measurements

B24W13 FLOOR SECTOR A-4	(1)	--	17	<MDL
B24W14 FLOOR SECTOR F-5		--	60	<MDL
B24W15 SUMP, SECTOR F-5		--	950	<MDL
B24W16 FLOOR SECTOR J-5		--	31	<MDL
B24W17 2ND LEVEL, SECTOR F-3		--	31	<MDL
B24W18 2ND LEVEL, SECTOR A-1		--	27	<MDL
B24W19 FLOOR SECTOR H-1		--	17	<MDL

MRAL-II In-place measurements

Into F-1 tank	NA	Background only		
Into F-7 tank	(73,11)	137Cs @0.5583	uCi/L	
Away from F-7 tank	(73,12)	137Cs @0.2559	uCi/L	
NET tank wall concentration		0.053	uCi/sqcm	

WHC-EP-0787

SD-DD-TRP-002

APPENDIX B
GENERAL SURVEY RESULTS (Facility Sketches)

SD-DD-TRP-002

General Summary of Survey Conducted at 224-B:

Ervin C. Marten
RPT B-Plant
1/24/85

During the week of 11/26/84 we started surveying in the A-Cell of 224-B (Plutonium Processing Facility - shutdown since 1953) in preparation for future Decontamination and Decommissioning procedures. There are gross amounts of bird droppings and carcasses throughout the cell areas with heaviest concentrations in the E-Cell area. A great amount of dust has also accumulated over the 30 years since processing was halted. Relamping had to be conducted before surveying could begin. There are several ladders in various cells which were useful in climbing up onto tanks. A make-shift deck is in place over the E-Cell and is constructed from 2"x8" planks and plywood. A, B and D cells have a centrifuge located on the operating decks. The E-Cell centrifuge had been removed to the cell floor some time in the past. C-Cell has no operating deck. There is a Bridge Chain Hoist available and presently situated over the E-Cell area.

CAUTION: When opening the operating deck doors a strong air flow exists into the cells from the gallery. A lesser negative air flow exists when opening the south wall doors that open into the cells proper. If both doors are open at the same time the stronger air flow from the gallery will overcome the lesser air flow from outside and air will escape into the outside atmosphere.

There is 110V electrical power supplied to the cells but an adaptor is required to allow present plugs to be connected to the outlets.

An extensive number of smears and direct readings were taken in each area as per the grid for A-Cell. These smears and direct readings were taken for Alpha, Beta and Gamma Radioactive Contamination and all smears were sent to the Radionuclide Analysis Laboratory (RAL) at REDOX for further analysis. Neutron surveys were taken in each cell with a Snoopy. Air samples were also taken in each cell along with dust scrapings and bird droppings which were also sent to RAL.

As a result of information collected in the A-Cell, surveying was limited in the remainder of the cells to only the areas indicated on each grid. An overall direct survey was taken with a GM with P-11 Probe and a PAM in all cells and then smears were taken at the highest areas of contamination. The major work was completed in about three weeks.

Generally contamination was minimal (see grids) and there has been no spread outside the cells as a result of the numerous entries and exits. All entries are being made in two sets of SWP clothing and filter mask. Smears and direct readings were taken randomly in the galleries, all of which were found to read less than background. Step-off Pads were smeared regularly and were shown to read less than background.

SD-DD-TRP-002

General Summary of Survey Conducted at 224-B (Continued):

Page Two

A pipefitter was called in and flanges were opened in A, D, E and F cells for smears and scrapings inside of piping and tanks as possible. Further data should be collected in the Ventillation Fan Room and the Product Load-out Room (located inside 225-B storage area on the north side of F-Cell). The Bridge-Chain Hoist has been load tested to 4000 pounds but cleaning needs to be conducted to allow movement up and down the canyon.

Refer to John Gould at RAL for isotopic results of samples collected. Amounts of Americium, Cobalt, Cesium and Strontium were detected in various areas. Refer to grids for location and definitive data as collected by RPT.

Future work is to include Photography by Battelle and excavation at the Southwest corner of the building to take data in the Vessel Vent Piping.

E.C. Marten

SD-DD-TRP-002

TABLE A.6.2 (CONTINUED, Page 3 of 3)

MRAL-II In-place measurements

Into F-8 tank	(73,13)	^{137}Cs @2.0007 uCi/L
Away from F-8 tank	(73,14)	^{137}Cs @1.6983 uCi/L
NET tank wall concentration		0.528 uCi/sqcm
Into F-9 tank	(73,15)	^{137}Cs @0.9538 uCi/L
Away from F-9 tank	(73,16)	^{137}Cs @0.7212 uCi/L
NET tank wall concentration		-0.407 uCi/sqcm
F-10 loadout hood	(100,1)	^{137}Cs @26.9 nCi/L
		18.56 nCi (total, ^{137}Cs)
Mech room, air intake	(100,2)	^{137}Cs @2.187 nCi/L
		1.51 nCi (total, ^{137}Cs)**

Notes:

- (1) Measurements view a 14-inch diameter circle of floor.
- (2) Detector was horizontally collimated with a viewing window of approx 45 degrees.
- (3) Equivalent omni-directional, uncollimated concentration of a uniform, infinite source.

** No other isotopes identified.

SD-DD-TRP-002

224-B A-CELL:

- ① DOSE RATES TO PERSONNEL: $< 1 \text{ mR/hr/mr}$
- ② ALL AREAS: $< 200 \text{ c/m (D) } \& \text{ (S)}$ UNLESS OTHERWISE
 $< 220 \text{ d/m (D) } \& \text{ (S)}$ UNLESS OTHERWISE
- ③ ON READINGS TAKEN IN AREAS A-3, D-4, D-6, F-1 & G-4;
ALL READINGS $< 1 \text{ mR/hr/mr}$ (THREE READINGS TAKEN ALONG
EACH WALL-FLUOR JOINT $< 1 \text{ mR/hr/mr}$)
- ④ DUST SAMPLES COLLECTED IN AREAS A-1, D-1, F-6 & G-1.
- ⑤ BIRD DROPPINGS COLLECTED IN AREA D-2.
- ⑥ AIR SAMPLE TAKEN 11-26-84, TAKEN IN AREA E-3
AT WASTE HIGH FROM 1:47 PM THROUGH AT LEAST 3:00 PM.
(FUSE IN SAMPLE BLOW OUT SO EXACT TIME OF SAMPLE
IS UNKNOWN.)
- ⑦ TANK A-1 RISER FLANGES: $< 200 \text{ c/m (D) } \& \text{ (S)}$ EXCEPT
 $< 220 \text{ d/m (S)}$ AS FOLLOWS
2:00 - 2800 d/m (S)
3:00 - 2800 d/m (S)
700 d/m - 1100 d/m (D) ALL FLANGES
- ⑧ TANK A-3 RISER FLANGES: $< 200 \text{ c/m (D) } \& \text{ (S)}$
 $< 220 \text{ d/m (S)}$
700 d/m - 1100 d/m (D) } ALL
FLANGES
- ⑨ TANK A-4 RISER FLANGES: $< 200 \text{ c/m (D) } \& \text{ (S)}$
 $< 220 \text{ d/m (S)}$
700 d/m - 2800 d/m (D) } ALL
FLANGES

11-26-84 THROUGH 11-30-84
E.C. MARTEN
RPT
INSTRUMENTATION:
C.A. GRIFFIN, P.M. & SALVAGE

SD-DD-TRP-002

SD-DD-TRP-002

224-B A-CELL VESTIBULE & OPERATING DECK:

- ① ALL AREAS: ≤ 200 c/m DIRECT^(b) & SCATTER^(s)
 ≤ 220 d/m DIRECT^(b) & SCATTER^(s)
 UNLESS OTHERWISE INDICATED
- ② 'N READING TAKEN WITH SNOOPY AT 11:30 ON
 CENTRIFUGE LID = ≤ 1 mRem/hr
- ③ CENTRIFUGE RISER FLANGES:
 5:00 - 1400 d/m(s) & 63 K d/m(D)
 6:00 - 700 d/m(s) & 42 K d/m(D)
 ALL OTHERS: ≤ 220 d/m(s) & 700 d/m(D)
- ④ CENTRIFUGE COVER GASKET:
 ≤ 220 d/m(s) & 56 K d/m(D)
- ⑤ DOSE RATES TO PERSONNEL: ≤ 1 mRem/hr

11-26-84 THROUGH 11-30-84

E.C. NIKITEN

RPT

INSTRUMENTATION:

CP, GM & P-11, Pam & SNOOPY

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224-B
B-CELL

F = FLOOR
U = WASTE (~3.5' AF)
H = HEAD (~6' PF)
(H) = DIRECT
(S) = SILENCE

Also: SEE REVERSE SIDE FOR OVERALL DATA.

SD-DD-TRP-002

SD-DD-TRP-002

224-B G-CELL:

- ① DOSE RATE TO PERSONNEL < 1 mR/hr.
- ② ONLY SELECTED AREA, SURVEYED.
- ③ AIR READINGS TAKEN IN AREAS A-2, B-4, E-3 & E-4, F-2 (UNRECOMMENDED) & F-6. ALL READINGS < 0.3 mR/hr.
- ④ GUST & DIRECTION LIMITED IN AREAS A-1, A-6, G-1 & G-6.

12-10-84 THROUGH 12-14-84
E.C. NIMICK
RPT
INSTRUMENTATION:
CP, GM & H-11, PMU & SNOOPY

- ⑤ AIR SAMPLE TAKEN IN AREA D-3.

F

SD-DD-TRP-002

SD-DD-TRP-002

224.0 E-CELL, VESTIBULE & OPERATING DECK:

- (1) Dose rate to personnel < 1 mR/hr.
- (2) Only selected areas surveyed.
- (3) Readings taken in areas 12-2 & 12-4.
Results: 0.1 mR/hr.
- (4) Time & exposure recorded in log.
12-1 & 12-4.

12-10-84 THROUGH 12-14-84
E.C. HARTEN
RPT
INSTRUMENTATION:
G-1, G-2 & P-11, FAN & SMOKE

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SD-DD-TRP-002

SD-DD-TRP-002

224-B C-CELL:

- ① DOSE RATE TO PERSONNEL:
 - ② EAST HALF (D, E, F & G AREAS) $< 1 \text{ mR/hr}$.
 - ③ WEST HALF (PIT-A, B & C AREAS) 3 mR/hr .
 - ④ TUNNEL (FIELD) 3 mR/hr .

20 mR/hr CONTACT WITH PIPING IN PIPE RUN.
- ② ONLY SELECTED AREAS SURVEYED.
- ③ NO READINGS TAKEN IN AREAS A-4, B-1, B-4, TUNNEL, F-3 & F-5. ALL READINGS $< 1 \text{ mR/hr}$.
- ④ C-CELL SAMPLER: SAMPLER "C" RIGHT FLANGE - 320 K d/m (D) , 64 K d/m (S) , 300 c/m (D) & $< 200 \text{ c/m (S)}$.
- ⑤ AREA SURVEYS:

<p>A-1 $< 220 \text{ d/m (D&S)}$ $< 200 \text{ c/m (D&S)}$</p> <p>A-6 $< 220 \text{ d/m (D&S)}$ $< 200 \text{ c/m (D&S)}$</p> <p>PIT AREA GUTTER 1400 d/m (D) $< 220 \text{ d/m (S)}$ $< 200 \text{ c/m (D&S)}$</p>	<p>TUNNEL 6200 d/m (D) 2500 d/m (S) 500 c/m (D) 300 c/m (S)</p> <p>G-1 700 d/m (D) $< 200 \text{ d/m (S)}$ 400 c/m (D) $< 200 \text{ c/m (S)}$</p> <p>G-6 1400 d/m (D) $< 220 \text{ d/m (S)}$ $< 200 \text{ c/m (D&S)}$</p>
---	---
- ⑥ AIR SAMPLES TAKEN IN AREAS E-3 AND MOUTH OF TUNNEL.
- ⑦ DUST & DROPPINGS COLLECTED IN AREAS A-1, A-6, TUNNEL, PIT AREA GUTTER, G-1 & G-6.
- ⑧ SCRAPINGS TAKEN ON TANKS C-4, C-7, EAST PIT WALL, BOTTOM FLANGE ON TANKS C-4 & C-7.

12-10-84 THROUGH 12-14-84
 E.C. MATHEN
 R.D.
 INSTRUMENTATION:
 10 cm & C-11 Dose & SURVEY

12

SD-DD-TRP-002

224-B D-CELL:

1. D/R TO PERSONNEL < 1 AIR/HR.
2. ONLY SELECTED AREAS SURVEILLED.
3. IN READINGS TAKEN IN AREAS A-2, C-3, E-6, F-1, AND G-2.
4. DUST & DROPPINGS COLLECTED IN AREAS A-1, A-6, D-1, D-4, G-1 AND G-6.
5. SWIPES TAKEN IN D-4 TANK ABOUT HALF WAY DOWN INSIDE.

E.C. MARTEN

RPT

12-3-84 THROUGH 12-7-84

INSTRUMENTATION:

CP, GM & P-11, PAM & SNOTP,

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SD-DD-TRP-002

(D) = DIRECT
(S) = STRAIGHT

CELL A, B, or (D) VESTIBULE & OPERATING DECK
E = ELEVATION "1" - "1" (NOTE: ~ 3.5' A.E.) H = HEIGHT (~ 6' A.E.)

↓
N

SD-DD-TRP-002

224-B D-CELL VESTIBULE & OPERATING DECK:

1. D/R TO PERSONNEL 2.1 mR/hr/hr.
2. ONLY SELECTED LOCATIONS SURVEYED & HIGHEST
FLUENCE SAMPLED AS INDICATED ON
GRID ON REVERSE SIDE.
3. IN READINGS TAKEN AT FLOOR LEVEL AT 12:00 AND
6:00 (BASE OF CENTRIFUGE) - 2.1 mR/hr/hr.
4. DUST SAMPLES COLLECTED AREAS C-1 & C-4.

E.C. KATZEN

RPT

12-3-84 THROUGH 12-7-84

INSITUATION:

CP, GM & R11, PM & SMOOBY

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SD-DD-TRP-002

234-B E-CELL:

1. D/R TO PERSONNEL < 1 mRad/Hr.
2. ONLY SELECTED LOCATIONS SURVEYED.
3. IN READINGS TAKEN IN AREAS A-1, E-4, BOTH SIDES OF CENTRIFUGE, F-1, F-3 AND F-5.
RESULTS: < 0.1 mRad/Hr.
4. DUST & DROPPINGS COLLECTED IN AREAS A-1, A-6, D-1, D-4, G-1 & G-6.

E. C. WILKINSON
RPT

12-3-84 THROUGH 12-7-84
INSTRUMENTATION:
CP, GM & P-11, PAN & SILOOPY

5. SWIPES TAKEN IN E-4 TANK ABOUT HALF
DOWN INSIDE.

18

SD-DD-TRP-002

90

234-B E-CELL VESTIBULE & OPERATING DECK:
 1. D/R TO PERSONNEL & 1 m. Rad/hr.
 2. ONLY SELECTED LOCATIONS SURVEYED
 I.E. SAMPLES AND DRIPPINGS.
 3. DRIPPINGS COLLECTED IN AREAS B-1 & B-4.
 E.C. MARTEL
 RPT
 12-3-84 THROUGH 12-7-84
 JUSTIFICATION:
 OF, GM & P-11 & P-11

SD-DD-TRP-002

SD-DD-TRP-002

224-K F-CELL :

- ① DOSE RATE TO PERSONNEL < 1 mkr/hr
- ② ONLY SELECTED AREAS SURVEILLED.
- ③ IN READINGS TAKEN IN AREAS: A-4, C-2, E-4, F-4, & J-2. ALL READINGS < 1 mkr/hr
- ④ IN READINGS TAKEN IN AREAS: A-2, A-4, E-2, E-4, E-5 & J-1.
- ⑤ SAMPLES & DIRECT READINGS TAKEN IN FLOOR WITH FOLLOWING RESULTS:

A-2	< 200 c/m (0.5)	< 220 d/m (0.5)
A-4	500 c/m (0)	< 200 c/m (5) < 220 d/m (0.5)
E-2	< 200 c/m (0.5)	1400 d/m (0) < 220 d/m (5)
E-4	< 200 c/m (0.5)	< 220 d/m (0.5)
SUMP	1000 c/m (0)	500 c/m (5) 6300 d/m (0) 6300 d/m
H-5	< 200 c/m (0.5)	700 d/m (0) 700 d/m (5)
J-1	< 200 c/m (0.5)	< 220 d/m (5)

- ⑥ H.R. SAMPLE TAKEN IN AREA E-3.

12-10-84 THROUGH 12-14-84
E.C. LIMITATION
RPT
INSTRUMENTATION:
CBP, GM-6011, FAN-1, SNO-104

2.2

SD-DD-TRP-002

10-00000-0110-000

DONT SAY IT --- Write It!

DATE 1-7-85TO ROGER A. HULTGENFROM E.C. MARTENB-PLANT
RADIATION PROTECTION UNIT

ATTACHED IS INFORMATION ON 224-B THAT YOU
 REQUESTED. IF THERE IS ANYMORE INFORMATION
 OR DATA I CAN PROVIDE FOR PLEASE DO NOT
 HESITATE TO LET ME KNOW. ANALYTICAL SURVEYING
 WILL CONTINUE DURING THIS WEEK

NOTE

NOTICE DIFFERENCE IN D-CAL ~~1-7-85~~ FROM ORIGINAL.

APPARENTLY ORIGINAL SAMPLES ALSO DECONTAMINATED.

+

TO MAKE LIFE LAST, PUT SAFETY FIRST

+

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SD-DD-TRP-002

RADIATION SURVEY									
DATE		TIME		LOCATION		SURVEYOR		INSTRUMENT	
1000		12 HOURS		GEN 12-11, FIVE-1		None		2.5000 A	
324-6									
INSPECTION OF CENTRIFUGAL MOTORS IN A, B & D CELLS									
Data Rate Measurements									
Item	WG	WC	Q-1	Q-2	Q-3	Q-4	Q-5	Q-6	Q-7
1. D/R TO PERSONNEL	41	41	F						
Consumption Correction Log									
Item	WG	WC	Q-1	Q-2	Q-3	Q-4	Q-5	Q-6	Q-7
1. PERSONNEL SURVEYS	4200	4220							
2. A-CELL MOTOR	4200	4220	4200	4220					
UNDER CAP			4200	6K					
3. B-CELL MOTOR	4200	4220	4200	4220					
UNDER CAP			4200	6K					
4. D-CELL MOTOR									
GENERAL INSPECTION OF CENTRIFUGAL MOTORS									
CARRIED OUT WITH DIRECT READINGS AND SAMPLES									
TAKEN ON EXTERIOR ASPECTS. MOTORS GENERALLY									
DUSTY BUT OTHERWISE CLEAN RADIOLOGICALLY WITH									
THE EXCEPTIONS AS LISTED (UNDER CAPS). SEE									
ATTACHED SURVEY INSTRUMENTATION FOLDER									
INSPECTION FOR GENERAL ASPECTS.									

WHC-EP-0787

SD-DD-TRP-002

APPENDIX C
DOSE MODELING RESULTS (Letter Report)

SD-DD-TRP-002

Internal Letter

Rockwell International

Date May 14, 1985

72310-85-WG-163

TO: K. W. Owens

FROM: L. N. Sutton

3-3287

Subject: Estimation of Plutonium Content in 224-B Tank D-3

The computer code BMC-MG was used to estimate the amount of plutonium inside the tank necessary to give a 0.1 mrem/hr dose rate near the tank at floor level. In order to maximize the estimated amount, it was assumed that the plutonium was evenly plated out on the inside surface of the tank wall.

The BMC-MG results indicate that the tank will contain about two kilograms of plutonium when the dose rate near it is 0.1 mrem/hr.

Since a previous estimation of the plutonium content was based on gamma exposure rates from associated Cs 137 contamination an ISOSHL case was run to determine the exposure rate to Cs 137 content relationship. The ISOSHL results show that 25 Ci of Cs 137 evenly plated out on the tank walls would give an exposure rate of about 500 mR/hr at five feet from the tank. Since exposure rates of this magnitude were not detected in the cell, I would have to conclude that considerably less than 25 Ci of Cs 137 is in the tank.

If you have any questions, please call me at the above number.

L. N. Sutton
L. N. Sutton
Radiological Engineering
and Effluent Controls

LNS/tjj

Att: DD-RE-LNS-045-85

cc: D. A. Dodd
J. I. Gould
D. B. Howe
P. D. Rittmann
G. J. Sliger

SD-DD-TRP-002

DD-RE-LNS-045-85

L. N. SUTTON

TITLE: 224-B PLUTONIUM ESTIMATION

PROBLEM:

Using the computer codes BMC-MG and ISOSHLD, estimate the amount of plutonium (6% Pu 240 content) and Cs137 required to be plated out on the inside of the tank walls to give a neutron dose rate of 0.1 mrem/hr and a gamma exposure rate of 1 mR/hr near the tank.

INPUT/ASSUMPTIONS:BMC-MG

The tank is nine feet in diameter, the total wall thickness was 9/16 of an inch which was also assumed to be the thickness of the lid.

By using reflecting boundaries, it was possible to model the problem using only 1/4 of the tank. The sketch on the following page shows the physical layout. You will note that the modelled configuration is not truly representative of the actual physical configuration, but it is close enough to provide the estimate required. By modelling only the lower right hand quadrant of the tank, computer running time was reduced, accuracy was increased and conservatism was incorporated into the calculation.

The source was assumed to be a uniform coating .1 cm thick on the walls of the tank. It was modelled as a salt cake consisting of 1 g/cc plutonium, .2 g/cc oxygen, .1 g/cc calcium and .1g/cc sodium. The isotopic weight percent of the plutonium was as follows:

Pu 238	.025%
Pu 239	93.44%
Pu 240	5.87%
Pu 241	.644%
Pu 242	.021%

In addition, the plutonium was aged by BMC-MG for 10 years. A total of 25860 grams of plutonium was assumed to be in the tank.

As the sketch shows, the doses were calculated at three points. These points were 15 cm above the floor.

ISOSHLD

IGEOM 12 was used to model the tank, the walls were 1.2 cm thick iron, the source was modelled as water with a SpG of .9 g/cc and the buildup factor was based on iron. The exposure rates were calculated at distances of 2 and 3 feet from the tank assuming that there was .5 Ci Cs137 plus .474 Ci Ba137m in the tank.

RESULTS:

The BMC-MG results were 1.7, 1.6 and 1.4 mrem/hr for dose points 1, 2 and 3 respectively. The ISOSHLD results were 22 and 10 mR/hr at 2 and 3 feet respectively.

PAGE :

Created by

SD-DD-TRP-002

DD-RE-LNS-043-85

L. N. SUTTON

PAGE 2

Checked By *Kevin L. L.*

SD-DD-TRP-002

DD-RE-LNS-045-83

L. N. SUTTON

CONCLUSIONS:

Before making any conclusions, it would be useful to give some more background information on the problem. It had been previously estimated that tank D-3 contained approximately 25 Ci of Cs137. A plutonium content of 33 kg was extrapolated from the Cs137 estimate using relationships between Cs and Pu concentrations developed from sample analysis. Actual dose and exposure rate measurements were taken in cell D of 224-B. They indicated neutron dose rates of about .1 mrem/hr near the tank and exposure rates of 1 mR/hr at about 5 feet from the tank.

The BMC-MG results would seem to indicate that a neutron dose rate of .1 mrem/hr near the tank equates to a plutonium content of 1.8 kg. On the other hand, if the tank contained 25 Ci of Cs137 then the ISOSELD results would indicate an expected exposure rate of 500mR/hr at 5 feet from the tank.

Based on the computer results, it appears that the estimation of the plutonium content in tank D-3 is high by a factor anywhere between 20 and 500.

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Checked By: *Handwritten signature*

SD-DD-TRP-002

APPENDIX D

D-3 TANK REPEAT MEASUREMENTS (Letter Report)

SD-DD-TRP-002

Internal Letter

Rockwell International

Date: June 7, 1985

No. : 65452-85-102

TO: (Name, Organization, Attention Address)

• K. W. Owens
 • Waste Management Systems Engineering
 • 2750E/0268/200 East Area

FROM: (Name, Organization, Attention Address, Phone)

• J. I. Gould
 • Analytical Process Development
 • 202S/200 West Area
 • 3-2125

Subject: Tank D-3 Reevaluation Measurements

Ref. Letter, 65452-85-085, May 15, 1985, J. I. Gould to K. W. Owens, "Work Plan for Additional D-3 Tank Measurements"

SUMMARY

Several measurements were made in the D cell following the general guidelines in the referenced test plan. The purpose of the measurements was to reevaluate the earlier estimates of the D-3 tank radionuclide inventory. These estimates had exceptionally high quantities in both TRU and non-TRU components. The Analytical Process Development Unit (APDU) and the Radiological Protection Department (RPD) performed the repeat measurements in the D cell.

The latest measurements demonstrated that the radioactive residue inside the D-3 tank is neither uniform in isotopic ratio nor uniform in its distribution. Measurements with a neutron-dose instrument (SNUOPY) confirm that the upper limit of 1.7 kg of TRU estimated by the Radiation Protection Engineering (RPE) Group is reasonable.

Measurements by pressurized ion-chamber for (gamma) exposure rate confirm that locations within the D cell are all less than 20 micro-R/hr. Measurements with the Mobile Radionuclide Analysis Laboratory (MRAL-II) indicate wide variations in the three primary radionuclides, cesium-137, americium-241, and plutonium-239. New smear samples were taken from the D-3 tank flanges. Ratios of TRU to cesium-137 based on these samples were nearer the general facility-wide averages first used to estimate the tank inventory. Ratios from the in-place measurements, however, indicate a higher TRU to cesium-137 ratio.

Based on this most recent set of measurements, the D-3 tank inventory is estimated at:

- Cesium-137 = 1.1 mCi (upper limit of 2.7 mCi)
- Americium-241 = 3.4 Ci (upper limit of 6 Ci)
- Plutonium-239 = 7.4 Ci (upper limit of 23 Ci).

The APDU suggests that individual insertion measurements be made into the D-3 tank, as well as the F-7, F-8, and F-9 tanks when O&U begins.

SD-DD-TRP-002

K. W. Owens
Page 2
June 7, 1985

DISCUSSION

Measurements

We reentered the D cell on May 16, 1985. The RPD technician, Walter Nelson, first made 16 measurements with a neutron dose meter (SNOOPY) at eight locations around the D-3 tank. For each positional location, measurements were made at both waist and floor heights. Measurements were also made at two locations around the D-4 tank and at four positions around the D-1 tank. The smallest marked increment on the readout dial of the SNOOPY was 0.1 mrem/hr. All of the SNOOPY readings were less than this smallest increment. The instrument was later taken to the 200 East Area tank farms operations office and its operation verified using a neutron source. The instrument was in current calibration and was not due for calibrational service for at least one more month. This series of measurement provided confirmation for the modeling calculations performed by the RPE.

The APDU made ion-chamber measurements of the exposure rate at four locations around the D-3 tank, two locations around the D-1 tank, and one location near the D-4 tank. The ion chamber was arranged on a tripod with the center of the chamber at approximately 30 inches above the floor. None of the rates exceeded 25 micro-R/hr. This was slightly higher than results from the earlier entry by APDU in which exposure rate was measured in this cell. The locations at which SNOOPY and ion chamber readings were taken are shown in figure 1. Cell references to tank location are made with respect to a clock, with twelve o'clock at due north.

The APDU used the HRAL-II borehole detector I6781010 to make four in-place measurements of the radionuclides present in the D-3 tank. The first was made outside the tank at the three o'clock position about 1.5 feet above the floor. This measurement was made with the detector uncollimated in order to maximize identification of as many photopeaks as possible in the gamma energy spectrum with a minimum of counting time. After this, three more spectra were taken with the detector outside the tank, collimated inward toward the D-3 tank.

Three smear samples were taken. Two were from a flange opened during the first characterization survey. The third was from the outside of a flange that appeared to have a white residue left from earlier operations. Analyses from the HRAL-I are shown in Table 2.

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International

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Results

Table 1 shows the results for the three radionuclides of primary interest in the D-3 tank. Count rates were corrected for field of view, for attenuation by the tank wall, and for various distributions of residue inside the tank.

Variations

There are wide variations in the results. The APDU examined the entire measurement method for inconsistencies in detector operation. The data variations appear to be real. The standard deviation (SD) of the D-3 tank reevaluation measurements is not much better than the SD previously determined for the entire 224-8 facility.

In calculating the inventories for the radionuclides, the unshielded measurement (table 1, column 1) was assumed to be from a uniform flat source with a solid angle of 2π steradian.

The three collimated measurement results were based on an assumed flat source with two sheets (equivalent to the front and far walls of the tank). The results at eight and twelve o'clock assumed a linear gradient to zero (at the top of the tank wall) with a uniform distribution across the tank floor. The three o'clock result assumed a linear gradient to zero at the top of the tank wall, plus a second gradient to 125% of the measured concentration at the bottom of the wall and across the floor. No distribution was assumed for the ceiling of the tank. Because the assumptions differed, the inventory calculations are not exactly linear; and the count rates do not scale exactly with the inventory estimate for the three locations.

Conservative Limits

A conservative upper limit for all three radionuclides is given, by assuming:

1. From the four measurements of surface concentration, a standard deviation (SD) for the group can be estimated.

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2. The experimental errors add to this in quadrature:

- 5% SD for the traceability of the calibration facility
- 7% SD for the calibration measurement statistical error
- 20% SD for the conversion from the 4-pi enclosed media to an open, nonattenuating spherical geometry
- The eccentricity of the detector response is not a factor in the americium-241 collimated measurement, but contributes a 10% error in the cesium-137 collimated measurement.

3. Since the range of measurement results is quite large, we used only two standard deviations upward from the calculated value to establish an upper limit on the inventory.

Ratios

The variation in ratios of the radionuclides with location is consistent with a facility in which several processes have been active. The ratios of americium-241/cesium-137 found from the in-place measurement are large and indicative of the general problems found in extrapolating the tank inventory initially. The in-place measurement result is consistent with the dose and exposure data from which RPE predicted only a small amount of total TRU and fission product in the tank.

CONCLUSION

These results are consistent with the predictions of inventory made by the Radiation Protection Engineering Group. The 23 Ci maximum estimate of plutonium-239 in the D-3 tank should not pose any hazard to O&D workers if reasonable safety precautions are followed.

The large general variation of the inventory suggests that future characterization efforts should plan for a larger number of measurements into the tanks of a process facility in order to develop a precise picture of the facility inventory. It shows that activity on the outside of flanges and tanks is not necessarily representative of the concentrations inside the vessels.

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Because there have been large variations in the results for the tank inventory as a result of using several data sets to make the inventory estimate, APOU requests the opportunity to make comparison measurements in each of the tanks with the HRAL-II insertion detector when it becomes convenient to remove the top cover plate of any tank.

These results will be incorporated into the 224-8 radiological characterization report as soon as possible. If you have questions, please contact me.

G. I. Gould
G. I. Gould
Scientist

JIG/pdk

Att.

cc: D. A. Dodd *[Signature]* G. J. Sliger L. N. Sutton
J. F. Mincey J. P. Slougher G. L. Troyer
P. D. Rittmann D. K. Speer

SD-DD-TRP-002

Table 1. D-3 Tank Reevaluation Measurements

Species (energy)	3 O'clock (unshielded)	3 O'clock (into tank)	12 O'clock (into tank)	8 O'clock (into tank)
²⁴¹ Am (59.5keV) Total	.428 cps 11.7uCi/sqcm 3.44 CI	.038 cps 3.51uCi/sqcm 535 mCi	.007 cps 2.59uCi/sqcm 560 mCi	-0-
²³⁹ Pu (129keV) Total	.076 cps 2.27uCi/sqcm 670 mCi	.026 cps 124 nCi/sqcm 26.9 mCi	not meas.	.310 cps 1.05uCi/sqcm 186 mCi
²³⁹ Pu (414keV) Total	.080 cps 2.36uCi/sqcm 697 mCi	.018 cps 2.12uCi/sqcm 384 mCi	.014 cps 4.09uCi/sqcm 726 mCi	.143 cps 41.8uCi/sqcm 7.41 CI
¹³⁷ Cs (662keV) Total	.543 cps .286nCi/sqcm 84 uCi	.133 cps .264nCi/sqcm 78 uCi	.347 cps 1.73nCi/sqcm 306 uCi	1.05 cps 5.99nCi/sqcm 1.06 mCi

Notes:

Data are uncorrected for interior geometry, but has been smoothed with a 5-point filter in order to get the best estimate of net count rates.

Variation in the three collimated measurements demonstrates the variable nature of deposition within the tank.

Standard deviations of the measurements are ²⁴¹Am, 86%; ²³⁹Pu, 156%; and ¹³⁷Cs, 126%.

Upper limits (at 2 SD) are ²⁴¹Am, 5.98 CI; ²³⁹Pu, 23.1 CI; and ¹³⁷Cs, 2.7 mCi.

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Table 2. Analysis of Smear Samples

ID	LOCATION	Americium-241	Cesium-137	Cobalt-60
353	D-3 Tank Interior Side Flg	1940 pCi	519 pCi	<mdl #
359	D-3 Tank Interior Side Flg	1630 pCi	627 pCi	18 pCi
354	D-3 Tank Riser @ 3:00	<mdl *	34 pCi	29 pCi

Ratios of Radionuclides

Location	$^{239}\text{Pu}/^{241}\text{Am}$	$^{241}\text{Am}/^{137}\text{Cs}$
Interior Smears	NA	3.11: 1
3:30 (unshielded)	0.2: 1	4.09E+4:1
3:00 (collimated)	0.6: 1	1.33E+4:1
12:00(collimated)	1.6: 1	1.50E+3:1
8:00 (collimated)	NA	NA

NOTES:

- * The minimum detection limit for americium-241 in these circumstances is about 8 pCi for the entire smear.
- # The measured value here was less than the nominal background usually subtracted from each of the sample measurements.

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G-2. Appendixes A, B, and D
K. W. Owens, *224-B Decontamination Project
Plan*, SD-DD-PP-002 (Rockwell
Hanford Operations, 1985).

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SD-DD-PP-002
REV 0APPENDIX A
224-B EQUIPMENT LIST

Item	Qty.	Description	Property no.
1. Tank	10	9 ft dia by 9 ft high; stainless steel; steam jacket	F185137-144-169, -170, -193, -194, -222, -229, -254, -255
2. Tank	7	4 ft-6 in. dia by 7 ft high; 0.188 in. mild steel; steam jacket; 12 top nozzles; 745 gal; 2,685 lb empty	F185136, -167, -168, -195, -198, -221, -253
3. Tank	4	4 ft dia by 5 ft high; 0.25-in. stainless steel; steam jacket; 2 ft dia manhole; 12 top nozzles; 415 gal; 1,750 lb empty	F1852181, -282, -283, -284
4. Tank	2	Small approximately 1 ft-6 in. dia by 2 ft high; stainless steel	F185298, -299
5. Tank	1	3 ft-6 in. dia by 5 ft-11 in. high; 0.188 stainless steel; 400 gal; 1,000 lb empty; 75 psi; dished bottom	F185142
6. Tank	4	2 ft-6 in. dia by 2 ft-8 in. high; 0.188 stainless steel; 75 gal; 450 lb empty	F185140, -226, -258, -263
7. Tank	4	Approximately 30 gal	F185136, -165, -220, -251
8. Tank	1	Approximately 3 ft-6 in. dia by 5 ft high; 0.25 in. carbon steel; 380 gal; 1,025 lb empty; 75-psi pressure vessel; dished top and bottom	Unknown

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REV 0

Item	Qty.	Description	Property no.
9. Agitator	6	15 HP at 1,750 RPM; output; 68 RPM; currently configured with item 1; the motor is missing from one of the agitators	F185118, -178, -179, 204, 230, UNK
10. Agitator	4	5 HP at 1,150 RPM; output-146 RPM; currently configured with item 2; motors are missing from three of the agitators	F185117, -145, UNK, UNK
11. Agitator	3	1 HP at 1,750 RPM; output-188 RPM; currently configured with item 3	F185264, -265, -266
12. Agitator	2	Currently configured with item 4	F185291, -292
13. Centrifuge	4	40-in. bowl; stainless steel	F185120, -150, -205, -236
14. Centrifuge	2	26-in. bowl; stainless steel	F185267, -268
15. Centrifuge	1	Small; estimate 8 in. to 12 in. bowl	F185293
16. Scale	6	Two scales still have tanks (items 5 and 8) associated with the scales; 6,000 lb capacity	F185143, -224
17. Pump	4	Pumps are configured with tanks (item 7) 7.5 HP, 60 cycle, 3 phase; General Electric Model 5KF254C25	F185135, -166, -219, -250
18. Microammeter	6	Beckman Instrument, Model RXG	F185124, -153, -184, -208, -238, -270

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REV 0

Item	Qty.	Description	Property no.
19. Multiswitch	6	Range Switches; Beckman Instruments, Model RSG	F185132, -163, -191, -248, -277, UNK
20. Recorder	21	Circular Chart; made by Ring Balance Instrument & Co.	F185125 through -131, F185154 through -159, -161 -162, F185185 through -190
	18	Strip Chart; made by Leeds & Northrup Co.; (face has been removed from one)	F185209, -210, -212 -213, -216, -217, F185241, -242, -243 -245, -247, F185271 through -276, F185295, -296, -297 UNK, UNK
21. Vibration meter	4	Made by Islip Radio Mfg. Corp.	F185286
22. Tank	1	4 in. by 3 ft by 2 ft 8-in. high stainless steel	F185287
23. Scale	1	Associated with tank in item 22	

SD-DD-PP-002
REV 0

APPENDIX B

RADIOLOGICAL CHARACTERIZATION DATA

The 224-B facility has been characterized to determine the radiological conditions that will be encountered during the D&O project and to establish a radiological inventory. Measurements were made with portable field instruments and mobile radioanalysis equipment.

The following portable field instruments were used in the characterization:

- Snoopy for neutron exposure rates
- Cutie Pie for beta-gamma dose rate
- Reuter-Stokes ion chamber for beta-gamma dose rate
- Geiger-Mueller (G-M) detector with a P-11 probe for beta-gamma surveying
- Portable alpha monitor (PAM) for alpha surveying.

The mobile radioanalysis equipment was used for taking in-place measurements in the cell and for isotopic analyses of smears and samples. The instrumentation included the following:

- Intrinsic germanium (IG) detector with a multichannel analyzer (MCA) for gamma energy analysis
- Lithium-drifted silicon (SiLi) detector with a multichannel analyzer (MCA) for gamma energy analysis
- Phoswich detector for strontium analysis.

A detailed description of the radiological characterization techniques and results is reported in the radiological characterization (Gould and Troyer 1985). Summary information by cell is reported in the following pages.

Direct and smear surveys were conducted in the gallery during the radiological characterization. No detectable radiation was found during these gallery surveys.

SD-DD-PP-002
REV 0

B.1.0 A CELL DATA

B.1.1 DOSE/EXPOSURE RATES

B.1.1.1 Snoopy Measurements

Measurements were taken at six locations adjacent to the tanks and centrifuge: all <0.1 mrem/h.

B.1.1.2 Cutie Pie Measurements

Measurements were made throughout the cell: all <1 mrad/h.

B.1.1.3 Reuter-Stokes Ion Chamber Measurements

Measurements were made at three locations in the cell: range from 10.2 to 11.5 μ R/h.

B.1.2 DIRECT AND SMEAR MEASUREMENTS

B.1.2.1 G-M with P-11 Probe

Measurements:

- <200 to 2,000 cpm direct
- <200 to 300 cpm smears.

B.1.2.2 PAM

Measurements:

- <220 to 245,000 d/m direct
- <220 to 49,000 d/m smear.

SD-DN-PP-002
REV 0**B.1.3 ESTIMATED INVENTORIES**

Estimated inventories for the primary radioisotopes detected in A cell are listed in table B-1.

Table B-1. A Cell Inventory Estimate.

Category	Radionuclide ^a				
	²³⁹ Pu	²⁴¹ Am	¹³⁷ Cs	⁹⁰ Sr	⁶⁰ Co
Dust	8.4 E-03	6.4 E-04	1.7 E-04	3.8 E-04	6.4 E-05
Gutter/sump sampler box	2.9 E-04	2.2 E-05	6.0 E-06	1.4 E-05	2.3 E-06
Equipment					
Tank A-1	3.9 E-02	3.0 E-03	8.1 E-04	1.8 E-03	3.0 E-04
Tank A-3	3.9 E-02	3.0 E-03	8.1 E-04	1.8 E-03	3.0 E-04
Tank A-4	1.3 E-02	1.0 E-03	2.7 E-04	6.1 E-04	1.0 E-04
Centrifuge -2	4.5 E-01	3.4 E-02	9.2 E-03	2.1 E-02	3.5 E-03
Piping	<u>2.2 E-01</u>	<u>1.7 E-02</u>	<u>4.6 E-03</u>	<u>1.0 E-02</u>	<u>1.7 E-03</u>
Totals	7.7 E-01 (13 g)	5.9 E-02	1.6 E-02	3.6 E-02	6.0 E-03

^aIn curies unless noted.

SD-DD-PP-002
REV 0

B.2.0 B CELL DATA

B.2.1 DOSE/EXPOSURE RATES

B.2.1.1 Snoopy Measurements

Measurements were taken at six locations adjacent on the ground floor: all <0.3 mrem/h.

Measurements were taken in two locations on the centrifuge deck: both measurements <0.1 mrem/h.

B.2.1.2 Cutie Pie Measurements

Measurements were made throughout the cell: all <1 mrad/h.

B.2.1.3 Reuter-Stokes Ion Chamber Measurements

Measurements were made at four locations in the cell: range from 10.0 to 13.3 μ R/h.

B.2.2 DIRECT AND SMEAR MEASUREMENTS

B.2.2.1 G-M with P-11 Probe

Measurements:

- <200 to 1,000 cpm direct
- <200 cpm smear.

B.2.2.2 PAM

Measurements:

- <220 to 200,000 d/m direct
- <220 to 21,000 d/m smear.

SD-DD-PP-002
REV 0**B.2.3 ESTIMATED INVENTORIES**

Estimated inventories for the primary radioisotopes detected in B cell are listed in table B-2.

Table B-2. B Cell Inventory Estimate.

Category	Radionuclide ^a				
	²³⁹ Pu	²⁴¹ Am	¹³⁷ Cs	⁹⁰ Sr	⁶⁰ Co
Dust	6.0 E-03	4.6 E-04	2.6 E-04	1.9 E-04	9.5 E-05
Gutter/sump sampler box	2.9 E-04	2.2 E-05	7.4 E-06	5.4 E-06	2.7 E-06
Piping	2.2 E-01	1.7 E-02	4.9 E-03	3.6 E-03	1.8 E-03
Equipment					
Tank B-1	1.9 E-01	1.2 E-02	5.1 E-04	3.8 E-04	1.9 E-04
Tank B-3	1.9 E-01	1.2 E-02	5.1 E-04	3.8 E-04	1.9 E-04
Tank B-4	7.9 E-02	6.0 E-03	2.6 E-04	1.9 E-04	9.4 E-05
Tank B-6	7.9 E-02	6.0 E-03	2.6 E-04	1.9 E-04	9.4 E-05
Centrifuge B-2	<u>4.5 E-01</u>	<u>3.4 E-02</u>	<u>1.5 E-03</u>	<u>1.1 E-03</u>	<u>5.3 E-04</u>
Totals	1.2 E+00 (20 g)	8.8 E-02	8.2 E-03	6.0 E-03	3.0 E-03

^aIn curies unless noted.

B.3.0 C CELL DATA

B.3.1 DOSE/EXPOSURE RATES

B.3.1.1 Snoopy Measurements

Measurements were taken at five locations in the cell: all
<0.1 mrem/h.

B.3.1.2 Cutie Pie Measurements

Measurements were made throughout cell: <1 mrad/h on ground level
<3 mrad/h in pit and tunnel.

B.3.1.3 Reuter-Stokes Ion Chamber Measurements

Measurements were made at two locations on the main floor: both
<20 μ R/h.

Measurements were made at three locations in the pit and tunnel: range
from <50 to 66 μ R/h.

B.3.2 DIRECT AND SMEAR MEASUREMENTS

B.3.2.1 G-M with P-11 Probe

Measurements:

- <200 to 500 cpm direct
- <200 to 300 cpm smear.

B.3.2.2 PAM

Measurements:

- <220 to 315,000 d/m direct
- <220 to 7,000 d/m smear.

SD-DD-PP-002
REV 0**B.3.3 ESTIMATED INVENTORIES**

Estimated inventories for the primary radioisotopes detected in C cell are listed in table B-3.

Table B-3. C Cell Inventory Estimate.

Category	Radionuclide ^a				
	²³⁹ Pu	²⁴¹ Am	¹³⁷ Cs	⁹⁰ Sr	⁶⁰ Co
Dust	5.7 E-03	4.3 E-04	3.6 E-04	2.5 E-02	4.9 E-03
Gutter/sump sampler box	5.0 E-04	3.8 E-05	2.2 E-04	1.6 E-02	3.0 E-03
Piping	2.8 E-01	2.1 E-02	6.1 E-03	4.3 E-01	8.4 E-02
Equipment					
Tank C-4	3.8 E-01	2.9 E-02	4.2 E-02	3.0 E+00	5.7 E-01
Tank C-7	5.0 E-01	3.8 E-02	5.5 E-02	3.9 E+00	7.5 E-01
Tank C-8	1.1 E+00	8.3 E-02	1.2 E-01	8.4 E+00	1.6 E+00
Tank C-9	3.8 E-01	2.9 E-02	4.2 E-02	3.0 E+00	5.7 E-01
Pit walls	<u>3.8 E-01</u>	<u>2.9 E-04</u>	<u>3.4 E-05</u>	<u>2.7 E-03</u>	<u>1.4 E-04</u>
Totals	2.7 E+00 (44 g)	2.0 E-01	2.7 E-01	1.9 E+01	3.6 E+00

^aIn curies unless noted.

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B.4.0 D CELL DATA

B.4.1 DOSE/EXPOSURE RATES

B.4.1.1 Snoopy Measurements

Measurements were taken at seven locations adjacent to the tanks and centrifuge: all <0.1 mrem/h.

B.4.1.2 Cutie Pie Measurements

Measurements were made throughout the cell: all <1 mrad/h.

B.4.1.3 Reuter-Stokes Ion Chamber Measurements

Measurements were made at two locations in the cell: range from 15 to 18 μ R/h.

B.4.2 DIRECT AND SMEAR MEASUREMENTS

B.4.2.1 G-M with P-11 Probe

Measurements:

- <200 to 100,000 cpm direct
- <200 to 9,000 cpm smear.

B.4.2.2 PAM

Measurements:

- <220 to 280,000 d/m direct
- <220 to 140,000 d/m smear.

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Estimated inventories for the primary radioisotopes detected in D cell are listed in table B-4.

Table B-4. D Cell Inventory Estimate.

Category	Radionuclide ^a				
	²³⁹ Pu	²⁴¹ Am	¹³⁷ Cs	⁹⁰ Sr	⁶⁰ Co
Dust	2.1 E-03	1.6 E-04	1.3 E-04	1.6 E-03	1.8 E-04
Gutter/sump sampler box	2.9 E-03	2.2 E-04	1.8 E-05	2.2 E-04	2.5 E-05
Piping	2.2 E-01	1.7 E-02	4.9 E-03	5.9 E-02	6.9 E-03
Equipment					
Tank D-1	3.7 E-01	2.8 E-02	1.6 E-03	2.0 E-02	2.3 E-03
Tank D-3	7.4 E+00	3.4 E+00	1.1 E-03	1.3 E-02	1.5 E-03
Tank D-4	1.3 E-01	1.0 E-02	5.8 E-04	7.0 E-03	8.1 E-04
Centrifuge D-2	<u>4.5 E-01</u>	<u>3.4 E-02</u>	<u>2.0 E-03</u>	<u>2.4 E-02</u>	<u>2.8 E-03</u>
Totals	8.6 E+00 (140 g)	3.5 E+00	1.0 E-02	1.2 E-01	1.5 E-02

^aIn curies unless noted.

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REV 0

B.5.0 E CELL DATA

B.5.1 DOSE/EXPOSURE RATES

B.5.1.1 Snoopy Measurements

Measurements were taken at seven locations adjacent to the tanks and centrifuge: all measurements were <0.1 mrem/h.

B.5.1.2 Cutie Pie Measurements

Measurements were made throughout the cell: all <1 mrad/h.

B.5.1.3 Reuter-Stokes Ion Chamber Measurements

Measurements were made at five locations in the cell: all <12.9 .

B.5.2 DIRECT AND SMEAR MEASUREMENTS

B.5.2.1 G-M with P-11 Probe

Measurements:

- <200 to $20,000$ cpm direct
- <200 to 800 cpm smear.

B.5.2.2 PAM

Measurements:

- <220 to $700,000$ d/m direct
- <220 to $140,000$ d/m smear.

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B.5.3 ESTIMATED INVENTORIES

Estimated inventories for the primary radioisotopes detected in E cell are listed in table B-5.

Table B-5. E Cell Inventory Estimate.

Category	Radionuclide ^a				
	²³⁹ Pu	²⁴¹ Am	¹³⁷ Cs	⁹⁰ Sr	⁶⁰ Co
Dust	1.1 E-03	8.1 E-05	6.8 E-05	8.5 E-05	9.5 E-06
Gutter, Sump, Sample Box	2.9 E-04	2.2 E-05	1.9 E-05	2.4 E-05	2.7 E-06
Piping	2.2 E-01	1.7 E-02	4.9 E-03	6.2 E-03	6.8 E-04
Equipment					
Tank E-1	1.3 E-02	1.0 E-03	7.6 E-04	9.5 E-04	1.1 E-04
Tank E-3	1.3 E-02	1.0 E-03	7.6 E-04	9.5 E-04	1.1 E-04
Tank E-4	1.8 E-01	1.4 E-02	1.1 E-02	1.3 E-02	1.5 E-03
Centrifuge E-2	<u>4.5 E-01</u>	<u>3.4 E-02</u>	<u>2.6 E-02</u>	<u>3.3 E-02</u>	<u>3.6 E-03</u>
Total	8.8 E-01 (14 g)	6.7 E-02	4.4 E-02	5.4 E-02	6.0 E-03

^aIn curies unless noted.

B.6.0 F CELL DATA

B.6.1 DOSE/EXPOSURE RATES

B.6.1.1 Snoopy Measurements

Measurements were taken at five locations around F cell: all <0.1 mrem/h.

B.6.1.2 Cutie Pie Measurements

Measurements were made throughout F cell: all <1 mrad/h.

B.6.1.3 Reuter-Stokes Ion Chamber Measurements

Measurements were taken at five locations in the cell: range from 18 to 24 μ R/h.

B.6.2 DIRECT AND SMEAR MEASUREMENTS

B.6.2.1 G-M with P-11 Probe

Measurements:

- 200 to 20,000 cpm direct
- 200 to 900 d/m smear

B.6.2.2 PAM

Measurements:

- 200 to 700,000 d/m direct
- 200 to 600,000 smear

AIM

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Centimeter

Inches

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Estimated inventories for the primary radioisotopes detected in F cell are listed in table B-6.

Table B-6. F Cell Inventory Estimate.

Category	Radionuclide ^a				
	²³⁹ Pu	²⁴¹ Am	¹³⁷ Cs	⁹⁰ Sr	⁶⁰ Co
Dust	1.1 E-03	8.4 E-05	4.0 E-05	7.9 E-05	3.0 E-07
Gutter, Sump Sample Box	5.8 E-04	4.4 E-05	2.1 E-05	4.1 E-05	1.6 E-07
Piping	2.8 E-01	2.1 E-02	7.0 E-03	1.4 E-02	5.3 E-05
Equipment					
Tank F-1	8.0 E-01	6.1 E-02	3.1 E-02	6.0 E-02	2.3 E-04
Tank F-7	8.0 E-01	6.1 E-02	3.1 E-02	6.0 E-02	2.3 E-04
Tank F-8	8.0 E+00	6.1 E-01	3.1 E-01	6.0 E-01	2.3 E-03
Tank F-9	6.2 E+00	4.7 E-01	2.4 E-01	4.6 E-01	1.8 E-03
Loadout hood	8.9 E-03	6.8 E-04	1.9 E-08	--	--
Centrifuge F-2	4.5 E-01	3.4 E-02	1.7 E-02	3.4 E-02	1.3 E-04
Centrifuge F-22	<u>4.5 E-01</u>	<u>3.4 E-02</u>	<u>1.7 E-02</u>	<u>3.4 E-02</u>	<u>1.3 E-04</u>
Total	1.7 E+01 (277 g)	1.3 E+00	6.5 E-01	1.3 E+00	<5.0 E-03

^aIn curies unless noted.

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CHEMICALS USED DURING 224-B OPERATION

INPUT CHEMICAL

BiPO_4	Bismuth Phosphate
NaBiO_3	Sodium metabismuthate
$\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$	Sodium chromate
H_3PO_4	Phosphoric acid
HNO_3	Nitric acid
$\text{La}(\text{NO}_3)_5 \cdot 2\text{NH}_4\text{NO}_3 \cdot 4\text{H}_2\text{O}$	Lanthanum ammonium nitrate
$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	Oxalic acid
HF	Hydrogen fluoride
KOH	Potassium hydroxide
KMnO_4	Potassium permanganate

WASTE SOLUTIONS

BiPO_4	Bismuth phosphate
HNO_3	Nitric acid
LaF_3	Lanthanum fluoride
KOH	Potassium hydroxide
H_3PO_4	Phosphoric acid
NaNO_3	Sodium nitrate
KNO_3	Potassium nitrate
$\text{Cr}(\text{NO}_3)_3$	Chromium nitrate
HF	Hydrogen fluoride
$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	Oxalic acid
$\text{Mn}(\text{NO}_3)_2$	Magnesium nitrate
NH_4NO_3	Ammonium nitrate
KF	Potassium nitrate
Fission products	

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G-3. Section 4.3 and Section 4.4

D. C. Shoemaker, *Preliminary Study for Decontamination and Decommissioning of the 224-B Concentration Facility*, D0105ER0009 (Rockwell Hanford Operations, 1979).

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Rockwell Hanford Operations

SUPPORTING DOCUMENT	Number D0105ER0009	Rev. No. 00	Page 14				
<p>4.3 <u>Cost and Schedule Estimates</u></p> <p>The cost estimate for decommissioning building 224-B is a preliminary order of magnitude and should be used accordingly. Estimated cost for decommissioning 224-B is \$15 - \$20 million (1979 dollars).</p> <p>Estimated time to complete this project is approximately 4 years.</p> <p>4.4 <u>Waste Volume Estimates</u></p> <p>The estimated volume of radioactive waste produced during D&D of building 224-B is as follows:</p> <table><thead><tr><th><u>Estimated Radioactive Waste Volume</u></th></tr></thead><tbody><tr><td>TRU-3,000 ft³</td></tr><tr><td>NON-TRU-15,000 ft³</td></tr><tr><td>Soil - 2,000 ft³ (Potentially TRU)</td></tr></tbody></table> <p>4.5 <u>Manpower Estimates</u></p> <p>Manpower requirements can not be realistically estimated until the establishment of methods, processes, etc., that will be routinely used throughout all decommissioning operations.</p> <p>4.6 <u>Occupational Exposure Estimates</u></p> <p>Exposure values are a direct function of processes and techniques used and can only be estimated through a more detailed engineering study.</p>				<u>Estimated Radioactive Waste Volume</u>	TRU-3,000 ft ³	NON-TRU-15,000 ft ³	Soil - 2,000 ft ³ (Potentially TRU)
<u>Estimated Radioactive Waste Volume</u>							
TRU-3,000 ft ³							
NON-TRU-15,000 ft ³							
Soil - 2,000 ft ³ (Potentially TRU)							

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APPENDIX H

233-S Facility Additional Information

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H-1. Sections 3.0 through 6.0
J. F. Beckstron, *Physical Status and Post Stabilization Activities*
Report for the 233-S Building, WHC-SD-DD-TI-028
(Westinghouse Hanford Company, 1992).

WHC-EP-0787

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3.0 IDENTIFICATION AND QUANTIFICATION OF RADIONUCLIDES

3.1 Administrative Controls

Decontamination work within the 233-S Building required the use of an industrial-type vacuum cleaner. The only vacuum cleaner authorized at the time was the "Minuteman X-100" utilizing a 55-gallon drum. Additional limitations specified that a vacuum could not be used in areas known to contain greater than 400 grams of fissile material, as established by nondestructive assay estimates prior to start of work. However, no limitations govern the use of vacuum cleaners if it could be determined that the quantity of fissile material in the designated work area was less than 10 grams, determined by the same nondestructive methods. Therefore, a nondestructive assay was performed in the Viewing Room and Stairwell to determine vacuum cleaner requirements and whether or not fissile inventory had changed since the last assay that was performed in the late 1970's.

3.2 Transuranic Isotope Inventory

Previous analyses of the contaminated areas in the 233-S Building (primarily Process and Loadout hoods), indicated total plutonium inventory to be about 2.0 kilograms $\pm$ 50%. (Reference 2). Table 2 lists the estimated quantities of plutonium in the 233-S Building based on previous Non-Destructive Analyses surveys performed in 1978.

Table 2. 1978 Estimated Plutonium Inventory - 233-S Building

Locations	Grams of Plutonium
SWP Change Room	Decontaminated (1)
Control Room	Decontaminated (1)
Can Storage Room	Decontaminated (1)
PR Can Storage Room	Decontaminated (1)
PR Can Loadout and Decontamination Room	Trace
Loadout Hood	20 $\pm$ 50% (2)
Stairwell Air Lock	Trace
Stairwell	Trace
Viewing Room	$\approx$ 3
Process Hood	2,000 $\pm$ 50% (2)
233-SA Building	} <30
Ventilation Ducts	
Pipe Trench	Not Determined
Pipe Gallery	Not Determined

(1) Decontaminated previous to 1980

(2) NDA performed in November 1978

3.0 IDENTIFICATION AND QUANTIFICATION OF RADIONUCLIDES (Cont.)

3.3 Non-Destructive Analysis (NDA)

The NDA was performed in November of 1987. The analytical method for determining total fissile inventory was based on gross alpha measurements of removable and fixed contamination levels at sample locations on each major surface area. Total inventory values were obtained by assuming that Pu-239 was the principal contaminating radionuclide in the areas adjacent to the Process Hood, and was due to the fire and explosion in the plutonium ion column in 1963. The approximate isotopic composition of plutonium in the 233-S Building, based on earlier findings (Reference 2), was $\approx 93.5\%$ Pu-239, $\approx 6\%$ Pu-240, $\approx 0.2\%$ Pu-241, and $\approx 0.3\%$ Am-241.

3.4 D&D Stabilization Project

The purpose of the D&D stabilization activities was to remove loose surface contamination from the rooms and spaces adjacent to the Process Hood (excluding the Process Hood and Pipe Gallery). One of the planned decontamination methods was to use vacuum cleaners to remove the large quantity of dust and dirt that had accumulated in the Stairwell and Viewing Room. In order to verify that the plutonium inventory in the building had not changed, and to determine that criticality standards would not be required during vacuum operations, the Stairwell and Viewing Room were again surveyed to establish plutonium inventories in November of 1987. The results of the analysis and the inventory status of the 233-S Building are listed in Table 3.

Table 3. 1987 Status and Plutonium Inventory - 233-S Building

Locations	Grams of Plutonium
SWP Change Room	Decontaminated (1)
Control Room	Decontaminated (1)
Can Storage Room	Decontaminated (1)
PR Can Storage Room	Decontaminated (1)
PR Can Loadout and Decontamination Room	Trace (2)
Loadout Hood	Trace (3)
Stairwell Air Lock	Trace
Stairwell	≈ 0.1 (4)
Viewing Room	≈ 3.3 (4)
Process Hood	$2,000 \pm 50\%$ (5)
233-SA Building	} <30
Ventilation Ducts	
Pipe Trench	Not Determined
Pipe Gallery	Not Determined

(1) Decontaminated previous to 1980.

(2) Decontaminated, 1979-1980, to low detectable levels of alpha contamination.

(3) Loadout Hood was decontaminated to remove gross levels of alpha contamination. The remaining contamination within the hood was fixed with paint.

(4) NDA performed in 1987.

(5) 1978 NDA results.

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3.0 IDENTIFICATION AND QUANTIFICATION OF NUCLIDES (Cont.)**3.5 Analytical Results**

Initial NDA results indicated that the Pu-239 inventory was less than 10 grams within the Viewing Room and Stairwell. Therefore, no administrative controls were required to operate the vacuum cleaner. Final NDA results, documented in Reference 3, estimated the total Pu-239 inventory in the Viewing Room and Stairwell to be 3.4 grams. Table 4 summarizes the final NDA results for the designated areas in the 233-S Building.

Table 4. Pu-239 Levels (Micrograms) in the 233-S Building.

LEVEL	VIEWING ROOM			STAIRWELL
	SOUTH	MIDDLE	NORTH	
4	2,000	2,100	12,000	5,000
3	1,600	2,600	21,000	9,500
2	3,000	2,500	200,000	85,000
1	5,500	22,000	3,000,000	6,000

TOTAL: 3.38 G Pu-239

Note: Numbers include best estimates of Pu-239 in dust on all horizontal surfaces in areas indicated.

4.0 STABILIZATION WORK SEQUENCE

In general, the 233-S stabilization project consisted of four major tasks. These tasks were pre-job preparation, outside area cleanup, decontamination and stabilization of designated interior areas and completion of the final radiological survey to establish the effectiveness of the decontamination activities.

4.1 Pre-Job Preparation**4.1.1 Contamination Control**

Stabilization of the 233-S Building required that preliminary tasks be completed prior to initiation of the interior decontamination activities. These tasks were: ventilation system repair and modification; installation of access containment; installation of continuous air monitors in the designated work areas, and completion of the Non-Destructive Analysis (NDA). The NDA was performed in November of 1987 and is discussed in detail in Section 3.0 above. The results of the NDA estimated the Pu-239 inventory to be approximately 3.4 grams in the areas designated.

4.0 STABILIZATION WORK SEQUENCE (Cont.)

4.1 Pre-Job Preparation (Cont.)

4.1.1 Contamination Control (cont.)

A prefabricated metal containment structure (greenhouse) was installed in the PR Can Storage Room at the entrance to the PR Can Loadout Room. The "greenhouse" was installed primarily for contamination control due to increased traffic in and out of the highly contaminated areas. In addition, the "greenhouse" also served to maintain proper air balance in the building.

Continuous Air Monitor (CAM) units were installed in the Loadout Room, PR Can Storage Room, Stairwell and Viewing Room.

4.1.2 Ventilation System Repair and Modification

The 233-S ventilation system consists of one supply fan, two exhaust fans, HEPA filters and associated supply and exhaust ducts. Fresh air is drawn in from outside the building by the supply fan and directed to clean (noncontaminated) rooms and spaces. The exhaust system draws a vacuum only on the Process Hood and the Loadout Hood in the PR Can and Decontamination Room. Therefore, air flow is from "clean" areas into progressively more contaminated areas before it is directed to the 233-SA filter building.

From the beginning, two items relating to the stabilization activities inside the building were of critical concern. First, the damper for the east exhaust fan required repair before personnel could begin work on a continuous daily basis. Secondly, the Process Cell, which contains the highest inventory of Pu-239 in the building, did not have containment isolation. Therefore, there was nothing to prevent contamination from escaping from the cell through the inlet openings should an air reversal occur.

The damper for the east exhaust fan, which would not close properly, was repaired prior to the start of decontamination activities inside the building. HEPA filters were installed over the four inlet openings (See Figure 8) to the Process Cell at the completion of decontamination activities. The reason for installing the HEPA filters after completing the contamination stabilization activities was to prevent the filters from getting clogged during the application of paint. The purpose of placing HEPA filters over the Process Cell inlet opening is to prevent contamination from escaping should an air reversal occur.

4.2 Outside Area Decontamination and Stabilization

Radiation surveys conducted prior to the start of the stabilization project identified several areas around the perimeter of the 233-S Building where alpha contamination averaged 2,000 dpm (average) and 20,000 dpm (max.) per probe area (50 cm²), using the standard Hanford portable alpha meter (PAM). These areas included: the ground surface east and adjacent to the 233-S Building; the ground area between the 233-S Building and the 202-S Building; and the concrete curbs and diamond plate covers over the 202-S column transfer tunnel located to the west of the 233-S Building. (See Figure 9).

Figure 8. 233-S Process Cell Showing HEPA Filter Locations

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Figure 9. Boundaries of Contamination - 233-S Perimeter

4.0 STABILIZATION WORK SEQUENCE (Cont.)

4.2 Outside Area Decontamination and Stabilization (cont.)

The ground surface around the 233-S Building was covered with a layer of asphalt during the 1965 post-accident decontamination activities. The surface contamination along the east side of the 233-S Building was found primarily in the deposits of dirt and sand that collected where the prevailing winds created eddies next to the building. No contamination was found in the asphalt surface with direct reading survey instruments. Contamination levels along the east side of the 233-S Building ranged between zero and 20,000 dpm alpha per PAM probe area.

Decontamination activities consisted of picking up the loose dirt, sand and rock with shovels and placing the material in 55-gal. waste drums for disposal.

The source of contamination around the 233-S Building most probably originated from the north wall of the 202-S Building. The north wall surface of the 202-S Building, in the vicinity of the 233-S Building, had been left heavily stained from previous operational activities. The contamination levels on the north wall of the 202-S Building ranged between 20,000 and 50,000 dpm alpha per PAM probe area surveyed.

Decontamination activities in the area between the 202-S and 233-S Buildings consisted of removing the deteriorated protective covering over the connecting tunnel between the two buildings and applying a new protective barrier over the tunnel consisting of a thick layer of ALARA Coat. The original protective covering over the tunnel along with all the loose dirt and gravel in the area were placed in 55-gal. waste drums. The ground surface between the two buildings and the north wall of 202-S was then sprayed with asphalt emulsion to fix the remaining contamination.

The 202-S Column Transfer Trench, though not associated with the 233-S Building, is located on the west side of the building. The trench is a deep underground structure that was used to transfer large ion exchange columns in and out of the 202-S Building. The top of the trench is covered with diamond plate panels. The inside to the trench is contaminated, and radiation surveys had identified loose surface contamination along the concrete curbs which hold the steel panels.

The joints between the steel cover panels and along the concrete curbs were sealed with cloth tape and coated with asphalt emulsion to prevent further release of contamination.

4.3 Interior Decontamination and Stabilization

The purpose of the stabilization activities in the 233-S Building was to decontaminate the rooms and spaces adjacent to the Process Cell and to provide containment isolation for the Process Cell and building proper. The rooms and spaces identified for decontamination activities were the PR Can Loadout Room, Stairwell, the two air locks adjacent to the stairwell and Process Cell Viewing Room.

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4.0 STABILIZATION WORK SEQUENCE (Cont.)

4.3 Interior Decontamination and Stabilization (Cont.)

The original decontamination plan was to vacuum and wipe down with damp rags all surfaces in the contaminated areas. In the early stages of the decontamination process, it was discovered that wiping down the surfaces was ineffective. Decontaminated areas were soon recontaminated due to the high degree of air turbulence from the ventilation system. Therefore, the practice of wiping surfaces with damp rags was discontinued on the ground floor, except in the PR Can Loadout Room, where air turbulence was most significant, and emphasis was placed on fixing the contamination with paint.

4.3.1 PR Can Loadout Room

Entry into the contaminated areas from the access/containment structure was made via the PR Can Loadout Room. This room contained low levels of alpha contamination and was maintained as an additional buffer zone between the access/containment structure and the more contaminated rooms and spaces.

The only significant source of contamination in the Loadout Room was located inside the Loadout hood, which was not within the scope of the stabilization activities.

A total of five 55-gal. drums of waste were removed from the Loadout Room. Most of this waste was generated from housekeeping and decontamination activities. The Loadout Room was the last room to be decontaminated and was accomplished by wiping down all accessible surfaces with damp rags until no significant change in detectable alpha activity was observed with standard Hanford portable survey instruments.

The emergency door between the Loadout Room and the SWP Change Room was sealed to prevent contamination from escaping into clean areas of the building. This was accomplished by taping a strip of cheesecloth over the space between the floor and door, and around the door jambs, then fixing the strip of cloth in place with ALARA Coat. This method provides an effective barrier without preventing the door from being opened in case of an emergency.

4.3.2 Stairwell and Air Locks

The ground floor level of the Stairwell and the two Air Locks to the south contained excessive quantities of miscellaneous trash, debris and old SWP clothing. This contaminated material was placed in twelve 55-gal. waste drums along with the waste associated with decontamination activities. The upper three levels of the Stairwell were totally free of trash and debris.

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4.0 STABILIZATION WORK SEQUENCE (Cont.)

4.3 Interior Decontamination and Stabilization (Cont.)

4.3.2 Stairwell and Air Locks (cont.)

The Stairwell and Air Locks were vacuumed to remove the large buildup of dust and spider webs that had accumulated over time. The upper levels of the Stairwell were wiped down with damp rags, however, a great deal of time was not expended on this task. The main emphasis was to remove the bulk of the loose surface material. After decontamination activities, the Stairwell and Air Locks were ~~spray~~-painted to fix the remaining contamination.

The exit doors located in each Air Lock were sealed in the same manner as the emergency door in the Loadout Room. The purpose of this action was to prevent dust and dirt from being drawn into the Air Locks through the cracks around the doors and prevent contamination from leaking out around the doors in the event of a release inside the building.

4.3.3 Viewing Room

The Viewing Room was the most highly contaminated area subject to the stabilization activities. Only two 55-gal. drums of waste were removed from this room. One drum was filled with waste material from the ground floor area and one drum from the upper three levels. The waste consisted primarily of paper, plastic, wood, cloth, tape and metal (scrap metal, nuts, bolts and old hand tools). A vacuum cleaner was used to remove spider webs and the dust and dirt that had accumulated on the horizontal surfaces. No attempt was made to vacuum 100% of the surface area in this room.

All glove port openings in the Process Hood were recapped and resealed. All observable holes and openings in the hood were also sealed. Upon completion of debris removal, vacuuming operations and sealing of the Process Hood, the entire room was sprayed with several coats of latex paint to fix the remaining contamination. After painting operations were completed, HEPA filters were installed over each of the four inlet openings in the Process Hood.

4.3.4 Final Radiological Survey

Post stabilization surveys were conducted in the Loadout Room, Stairwell and Air Locks, and the Viewing Room to establish effectiveness of the decontamination activities. Table 5 compares the results of the radiological surveys taken before and after the stabilization project.

4.0 STABILIZATION WORK SEQUENCE (Cont.)

4.3 Interior Decontamination and Stabilization (Cont.)4.3.4 Final Radiological Survey (cont.)

Table 5. Comparison of 1987 and 1988 Direct Radiological Surveys

LOCATION	Jan.87 Survey	Feb.88 Survey
	DPM ALPHA/Probe Area	
1. Loadout Room		
Dust on Criticality Detector	42,000	14,000
Floor near SOP to Stairwell	49,000	2,100
Floor near door to Process Area	49,000	700
Floor near door to Process Area	49,000	1,400
Dust on pipe - South Wall	175,000	700
Top of Loadout Hood	700	700
Top of Loadout Hood	1,000	1,400
Top of Loadout Hood	1,000	1,400
Floor, N.E. corner of Loadout Hood *	7,000	1,400
Floor near North Wall	<Detectable	1,050
North Wall	<Detectable	<Detectable
* Dose rate 10 mr/hr		
2. Air Lock (southeast)		
Floor	2,500	600
Floor	1,500	600
Floor	2,000	900
3. Stairwell		
Rails	17,500	2,700
Floor, bottom of Landing	35,000	1,200
Stairs	31,500	3,900
4. Viewing Room		
Vent Opening #1	17,000,000	3,380
Vent Opening #1	3,000,000	48,000
Floor - front of Vent #1	350,000	12,000
East Wall	364,000	1,400
North doors - to Loadout Room	210,000	900
Panel Ledge - center (west)	3,000,000	1,500
East Wall	70,000	600
Panel Ledge above Vent #2	42,000	1,500
Panel Ledge above Vent #3	35,000	9,000
Panel south of Vent #3	560,000	1,200
Floor near door to Air Lock	28,000	1,200
Wall near door to Air Lock	24,500	1,200
Ceiling - center	63,000	1,500
Panel - south of Vent #1	3,000,000	600
Door Handle to Air Lock	56,000	1,200
Light fixture	35,000	1,200

General Area dose rate - 20 mr/hr

Dose rate in contact with panel near Vent #1 - 180 mr/hr

SD-DD-TI-028 REV. 0

5.0 CONCLUSION

The 233-S stabilization project was completed on December 30, 1987, with the installation of the HEPA filters on the Process Hood. The HEPA filters were installed so as to allow maximum air flow into the hood and prevent contamination from leaking out of the hood should a reverse flow in the ventilation system occur. Using extreme caution and emphasizing the principles of ALARA, personnel were able to complete the project with no radiological incidents. Based on the final radiological survey, the decontamination activities were effective measures in stabilizing the 233-S Building.

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H-2. Sections 1.0 through 4.0
J. W. Cummings and G. J. Carter, Jr., *233-S Facility*
Potential Chemical Hazards, WHC-SD-DD-TI-056
(Westinghouse Hanford Company, 1993).

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ABBREVIATIONS, ACRONYMS, AND INITIALISMS

CAM	continuous air monitor
D&D	decontamination and decommissioning
FY	fiscal year
HEHF	Hanford Environmental Health Foundation
HEPA	high efficiency particulate air
MSDS	Material Safety Data Sheet
PCB	polychlorinated biphenols
ppm	parts per million
PR	product removal
REDOX	reduction oxidation
RM	radiation monitor
SWP	special work permit
TSP	trisodium phosphate
UNH	uranyl nitrate hexahydrate or uranyl nitrate in hexone

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233-S FACILITY POTENTIAL CHEMICAL HAZARDS

1. INTRODUCTION

The purpose of this report is to review the history of the 233-S facility for any chemical constituents that may potentially remain in the facility. A timeline for this facility was developed to provide an orderly sequence of events, equipment history, and chemicals used. A historical review of the types of chemicals and equipment used in the facility provided the basis for this report. This information will be used to support future decommissioning of this facility.

2. DESCRIPTION

The 233-S Plutonium Concentration Facility is located on the north side of the Reduction Oxidation (REDOX) Plant in the 200 West Area. Sketches of the facility are shown on Figures 1 and 2.

3. HISTORICAL TIMELINE

A timeline of the sequences of events for this facility was generated and is provided in this section. The timeline provides historical information regarding the sequence for events that occurred, the history of the equipment, and the chemicals that were used.

Some of the information presented in the timeline does not directly relate to the chemicals used in this facility; however, all information for the timeline has been included because a historical sequence of events for this facility can be an extremely valuable source of information.

3.1. 233-S FACILITY BUILT (1954-55) (Leach 1955)

Project CA-535 (REDOX Phase II Expansion - 233-S Building) provided a new building (233-S) for the concentration of plutonium solutions for shipment to the metal fabrication area.

3.2. PLUTONIUM NITRATE PROCESS INITIATED (March 1955) (Leach 1955)

Initiation of concentration of plutonium nitrate solutions started. See Figure 3, 233-S Plutonium Schematic Flow Diagram.

Figure 1. Floor Plan of 233-S Building.

Figure 2. Isometric View of 233-S.

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Figure 3. 233-S Plutonium Schematic Flow Diagram.

The operating gallery (control room) contained the controls for the equipment in the process hood and the wash solution makeup tank, L-1-A. The loadout room contained a loadout and decontamination hood for the "new system" product removal (PR) cans and a recycle hood for unloading the "old style" PR cans. The sample hoods for the sump, recycle tank (L-16), and product sampler tank (L-6) were also located in the loadout room. The sample hood for the condensate sampler (L-9) was in the instrument loft.

Plutonium solution was transferred to L-1 under batch control from E-3. The constituents in the plutonium solution were not stated in the records. The solution was fed to L-2 by pump or jet where the hexone was stripped and 5 to 35 percent of the concentration was achieved. The overflow from L-2 was concentrated in L-3 to obtain the desired plutonium content and nitric acid concentration. The concentrated solution was drained from L-3 to L-4 at a controlled rate and was cooled in L-4 for vacuum transfer to L-6. L-14 was the vacuum tank or transfer trap. L-5 was a micrometallic filter for removal of precipitated aluminum compounds or other solids. At that time, the L-5 filter was considered the strongest radioactive source in the building. The product solution was then agitated in L-6 by recirculation using the L-6 pump and was then sampled. Based on the results of the sample, the volume to be loaded into each can was then computed. L-7 was used to measure this volume.

The overhead vapor from L-3 was condensed in L-11 and the condensate then flowed to L-12 for re-evaporation. Any entrained plutonium or nitric acid which was boiled off from L-3 was concentrated in L-12 and returned to L-3 for recovery of the plutonium. The vapors from L-2 were condensed in L-8 and those from L-12 were condensed in L-13. The steam used in the condenser vent jet and the L-14 vacuum jet was condensed in L-15. The condensate from L-8, L-12, and L-15 were drained into a common header with a diversion loop to L-10. A valve controlled by a cycle timer permitted a portion of the condensate to flow from this header to L-9 where it could be sampled. A valve controlled by a valve switch permitted draining L-9 to L-10, and a valve controlled by a valve switch permitted draining L-10 to D-5. L-16 received recycle from the recycle hood for delivery to H-4.

3.3. METAL STORAGE FACILITY BUILT (1957)

An 800-ft² metal storage and service area was added to the north end of the original concrete building.

3.4. 233-S CONVERTED TO PROCESS NEPTUNIUM NITRATE AND CONTACTOR ADDED TO PROCESS PLUTONIUM NITRATE (1962) (Yoder 1962)

See Figure 4, 233-S Neptunium Schematic Flow Diagram.

Project CGC-913 provided the necessary facilities to permit the accumulation, decontamination, and concentration of neptunium nitrate (sometimes referred to as brandy) without interrupting the rest of the REDOX process. The two major process changes in the 233-S portion of the REDOX process resulting from Project CGC-913 were:

Figure 4. 233-S Neptunium Schematic Flow Diagram.

1. Separate concentration and loadout facilities for the neptunium nitrate solution were provided.
2. A new plutonium anion exchange contactor was installed for achieving the desired final plutonium product purification and decontamination. The additional decontamination was required because the 3A-3B Columns had been withdrawn from plutonium purification service and were being used for neptunium nitrate purification.

3.4.1. Neptunium Nitrate (Brandy) Flowsheet

As a result of flowsheet changes in the 202-S Facility due to Project CGC-913, the plutonium nitrate and neptunium nitrate which were sent to the 233-S Facility were steam stripped and free of hexone. Thus, the L-2 concentrator was no longer required as a hexone stripper ahead of the plutonium concentrator and was converted to a neptunium nitrate product concentrator. A new neptunium loadout tank (L-21) was installed in a hood in the loadout room. The L-21 tank was equipped with a vacuum transfer jet, which discharged back to the L-2 concentrator. The concentrated nitrate solution was transferred from L-2 to L-21 and then loaded into a product receiving can. The processing of neptunium nitrate through the 233-S Facility was a batch operation and was done only a few times a year.

3.4.2. Plutonium Flowsheet

The addition of a pushed bed anion exchange contactor, L-18, was the main change in the plutonium flowsheet in the 233-S Facility. The flowsheet for the final concentration, sampling, and loadout out of the plutonium product solution remained unchanged.

Before the plutonium product solution from the 2B port in 202-S was sent to the 233-S Facility, it was stripped of hexone, treated with ozone for ruthenium removal, butted with nitric acid, and finally butted with sodium nitrite or ferrous sulfamate to adjust the plutonium to the four valence state. The solution was then pumped to the XAF Concentrator (L-12) in the 233-S Facility. There the plutonium solution was concentrated to the XAF feed specifications (including a 7.0 molar nitric acid composition). At that concentration, plutonium (IV) existed largely in the form of hexanitratodivalent complex anion, which was readily absorbed by strong base type anion exchange resins. The concentration step destroyed the remaining nitrite ion so that recycle to 202-S Building was safe from the hazard of catalyzing hexone-nitric acid reactions. The concentrated plutonium feed solution passed through a plutonium monitor pot and was then airlifted to the L-10-F feed tank. This tank was a portion of the existing critically safe L-10 tank. The other portion of this tank was the L-10-W tank.

From the L-10-F tank, the feed solution was pumped through a heater and a filter to the feed point on the L-18 anion exchange contactor. The L-18 column was made up of an extraction section, a scrub section, a stripping section, a resin receiver section, and a resin reservoir section. A complete cycle of L-18 operation was made up of an operating period and a push period. During the operating period, the valves controlling process streams to and

from the L-18 unit (XAF, XAS, XAW, XCX, and XCP) were open and all of the valves separating the different sections of the contactor were closed except the valve between the resin receiver and resin reservoir. The plutonium feed stream, XAF, was fed to the unit and the plutonium (IV) anion was extracted by the resin; the loaded resin was scrubbed with a hot (60°C) stream of 7.0 molar nitric acid, XAS; the plutonium was stripped from the loaded resin with dilute nitric acid, XCX, and removed as a product solution, XCP. During the push period, the valves controlling the process stream were closed and all of the valves separating the different sections of the contactor were open except the valve between the resin receiver and the resin reservoir section. The resin was moved hydraulically for a distance of about 11 inches in the contactor by the addition of a controlled amount of pushwater. The process streams flowed clockwise and the resin was intermittently pushed counter-clockwise.

The L-1 tank served as a supply tank for the 7.0 molar nitric acid scrub stream, XAS. This solution was pumped through a heater to the scrub entry nozzle on the L-18 Contactor.

The former L-9 alpha monitor was installed on the waste stream, XAW. Based upon the data from this sampler, waste could be routed either directly to the mixing pot in the 2DW line or to the L-10-W tank. The L-10-W tank in turn drained to the mixing pot in the 2DW line. With this arrangement, waste solution containing appreciable amounts of plutonium could be set aside in the L-10-W tank and later returned to the 202-S process at a controlled rate.

A proportioning pump was installed in the north pipe gallery in the 202-S Building in the XAW line enroute to the 2DW mixing manifold. This pump metered the acid waste (the type of acid was not specified) into the mixing manifold at a controlled rate and provided assurance that the 2DW solution (the ingredients in the 2DW solution were not identified) did not back up into the 233-S facility. Ordinarily, the XAW stream was routed from the contactor into the L-10-W tank and pumped continuously from the L-10-W tank to the 2DW mixing manifold.

A plutonium monitor was installed on the plutonium product line, XCP, between the L-18 contactor and the L-3 concentrator. The operation of the L-3 concentrator and flow to the L-4 product receiver, L-6 product sampler, and loadout were the same as before.

CHEMICAL SAFETY:

The elimination of all hexone-bearing streams from the 233-S portion of the process eliminated the hazard of hexone-nitric acid reactions in the 233-S Facility.

The addition of sodium nitrite to the E-3 tank in the 202-S Building could have presented a hazard of catalyzing hexone-nitric acid reactions, if the nitrite ion was to contact a hexone-bearing stream. To prevent this from occurring, sodium nitrite which was made up in the E-2-A tank on the fourth level was piped only to E-3 tank which handled only hexone-free solution. (The hexone was stripped from the 3BP product solution in the E-2 vessel before being transferred to the E-3 vessel. From the E-3 tank, solution could be transferred only to the L-12 concentrator which was operated at a boiling

temperature and a 7.0 molar nitric acid composition. At these conditions, any remaining nitrite ions were killed, thereby assuring that waste and recycle from the 233-S process was free from nitrite ion.

3.5. FIRE AS RESULT OF CHEMICAL REACTION (1963)

A chemical reaction within the ion exchange unit caused a fire which resulted in extensive damage to the process equipment, gross alpha contamination within the process area, and general contamination spread to other portions of the facility.

Parts of the building were cleaned of gross contamination, and nonsmearable alpha contamination was fixed by covering with a special paint. The type of special paint used was not specified in the records.

3.6. OPERATIONS RESUMED (6 weeks later) (DOE 1978)

Operations resumed without the ion exchange process. The facility was then used for concentration (by evaporation) of plutonium and neptunium nitrate solutions from the REDOX 202-S Building.

3.7. 233-SA FILTER BUILDING CONSTRUCTED (1964)

The 233-SA was built adjacent to the 233-S in 1964 to handle ventilation for 233-S.

3.8. FACILITY PARTIALLY DECONTAMINATED FOR PLANT DEACTIVATION (June 1966) (DOE 1978)

The facility was partially decontaminated for plant deactivation.

The REDOX Plant Deactivation Instructions written for this purpose and the completion reports are given below. Both are included in this section because not all of the instructions were completed as originally expected. In addition, some of the Completion Reports merely state that the work was completed per a particular procedure.

3.8.1. Vessels and Piping - Process (i.e., Internal Flushing)

Instruction 6.2.1:

- Internal decontamination of 233-S process vessels and piping was to have been accomplished by the terminal 57 percent nitric acid flushes which were specified for product recovery by Terminal Processing 6.1.1, "Vessels and Piping." No further internal flushing was to be required.
- External flushing plans were included in Instructions 6.1.2, "Greenhouse," and 6.1.3 and 6.2.3, "Loadout Hood."

Completion Report:

- The final 57 percent nitric acid flush through 233-S concentration and loadout equipment, which was routed to the waste section for subsequent discard in terminal waste batches, was completed. Only very nominal product accumulation was experienced in the internal flush since it followed the second neptunium campaign which had been preceded by and followed with copious flushing associated with the loadout of neptunium.

3.8.2. Vessels and Piping - Terminal Processing (i.e., External Flushing of Vessels and Piping for Product Recovery within the Greenhouse)

Instruction 6.1.1:

- After the 57 percent nitric acid flushes had cleared the 233-S vessels and the L-16 tank was no longer required for recycle of product solution to H-4, the external surfaces of all vessels and piping within the greenhouse were to be flushed with a dilute solution of nitric acid. The purpose of this flush was to remove dust and to bring down any product held on the process pipes as a result of leaks.
- Starting at the fourth level of the viewing room, from points of vantage that provide access with a wand to all equipment within a given area, the spray was to be applied to the tops of vessels and piping. The flush solution, made up of 10 percent nitric acid was to be fed from L-1-A tank under pump pressure via the most direct route. As the solution was collected in the sump, transfer was to be continuous to L-16 until the vessel was full, at which time flushing was to be interrupted pending sample results. Flushing batchwise was to continue, contacting the equipment at each viewing room level in turn. After a reasonable number of sample assays had been reported, the supervisor was to exercise his judgment to decide on continuous rather than batch operation through L-16; interrupting the flush for sampling but not waiting for results. When the acid flush was completed, the operation was to be repeated using demineralized water.
- This instruction was supplemented by a detailed procedure which defined in more specific terms the equipment to be used, techniques to follow, and points of access and supply for the flush.

Completion Report:

- The decontamination flushes external to the vessels were completed as specified.

3.8.3. Greenhouse - Terminal Processing (i.e., Product Recovery - Flushing of Greenhouse Floor and Sump Area)

Instruction 6.1.2:

- Following the external flush of vessels and piping within the greenhouse, a similar flush of the floor and sump area was in order. The same solution and technique employed in Instruction 6.1.1 were to be used.

- Every portion of the floor was to be contacted by manipulating the flushing wand from the first level of the viewing room. Sampling was to be done batchwise as required in Instruction 6.1.1 until the supervisor determined that continuous operation through L-16 was in order.
- See the detailed procedure supplement to Instruction 6.1.1 for application to this instruction.

3.8.4. Greenhouse

Instruction 6.2.2:

- The 233-S greenhouse decontamination flushing was to be accomplished by product recovery flushes specified by Instruction 6.1.2, "Greenhouse." In addition to recovery of products, the flushes were to remove dust and lint and thus create more favorable conditions for future maintenance work and/or ventilation revisions. Combustibles and uninstalled foreign objects were to be removed.

Completion Report:

- The decontamination flushes of the greenhouse external to vessels and piping were completed as specified without exception.

3.8.5. Loadout Hood - Terminal Processing (i.e., Product Removal)

Instruction 6.1.3:

- Introduction: The final effort to flush deposition was to be made in the container loadout section of 233-S loadout hood. It was to be done at the same time the greenhouse floor section was to be flushed since the hood drained to the same sump. The enclosure was not expected to yield more than nominal amounts of plutonium. When this flush was completed, the loadout section and the two sections housing the L-7 and L-22 vessels were to be decontaminated according to instructions contained in 6.2.3.
- A 55-gallon drum or some other satisfactory source defined in the detailed procedure was to be used to supply 10 percent nitric acid for the loadout section flush. The drum was to be pressurized sufficiently to maintain a steady flow of flush solution from the tip of a wand which was to be manipulated to cover all sections of the hood. A water flush was to follow. When this phase was completed, instructions contained in 6.2.3 were to be followed for removal of dust, lint, and gross contamination from the three sections of the hood.

Completion Report:

- Decontamination flushes of the loadout hood external to vessels and piping were completed as specified without exception. These flushes were restricted to use of 10 percent nitric acid followed by water.

3.8.6. Loadout Hood (Decontamination of Surfaces Inside Loadout Hood)

Instruction 6.2.3:

- **Schedule:** Decontamination of the 233-S loadout hood was to follow product removal accomplished by Instruction 6.1.3.
- Surfaces inside the loadout hood were to be swabbed with a 5 percent aqueous of Turco W0-2, Wedac, or approved substitute to remove dust, lint, and gross contamination.
- Maintenance tools and supplies from loadout hood were to be removed and discarded to contaminated waste container.
- The exterior of the hood was to be cleaned to less than 1,000 disintegrations per minute alpha and less than 500 counts per minute beta and gamma smearable.
- A small filter was to be installed to vent the hood.
- Hood openings were to be sealed with plastic and pressure sensitive tape.

Completion Report:

- The loadout hood was contact decontaminated to levels considered reasonable by Radiation Monitor (RM) Standards prior to sealing all cracks and openings and installing the high efficiency filter in one of the hood glove parts.

3.8.7. Loadout Room

Instruction 6.2.4:

- Loose paint was to be removed from floors and walls, then dust and lint vacuumed.
- Five percent aqueous solution of Turco W0-2, Wedac or approved substitute was to be used to decontaminate floors and walls.
- Bare spots of floors and walls were to be brush painted with No. 88 semi-gloss Amercoat¹⁵ or equal.
- Doors were to be resealed to the viewing room if necessary.
- The scale was to be deactivated.
- Clothes hampers were to be removed.

¹⁵88 semi-gloss Amercoat is a trade name of Ameron Protective Coatings.

- Portable radiation survey instruments were to be removed and the alpha burst monitor was to be disconnected.
- The valves on the air samplers were to be closed.
- A radiation survey was to be performed.
- Shop supplies were to be removed.

Completion Report:

- Instruments were deactivated.
- Loadout room walls were spray painted with 33 Amercoat. The floors were brush painted.
- Operations: Instructions completed.

3.8.8. Can Storage Room

Instruction 6.2.5:

- The PR and reactor coolant cans were to be shipped.
- Decontaminated, regulated tools were to be transferred to 202-S Special Work Permit (SWP) lobby regulated tool room.
- The door to the loadout room was to be closed and sealed with pressure sensitive tape.
- Shop supplies and combustibles were to be removed.
- The air sampler valves were to be closed.
- The CIA unit was to be disconnected.
- The can storage room doors were to be closed and locked.

Completion Report:

- Instructions were completed without exception.

3.8.9. Viewing Room

Instruction 6.2.6:

- Loose paint was to be removed, then dust vacuumed from grating and floor.
- The L-6 sampler box was to be flushed with a small quantity of 10 percent nitric acid. The surrounding area was to be swabbed with a 5 percent aqueous solution of Turco WO-2, Wedac, or approved equivalent. The box was to be sealed with plastic and pressure sensitive tape.

- The greenhouse ledges were to be swabbed to remove gross contamination.
- Strip coat was to be removed from the floor.
- Bare spots on the walls and floor were to be brush painted with No. 88 semi-gloss Amercoat or equal.
- The viewing room windows were to be masked with paper and the grating spray painted with No. 88 semi-gloss paint or equal to fix residual contamination.
- The air sampler valves were to be closed.
- The CIA unit was to be disconnected.
- All combustibles and other supplies were to be removed, then the doors closed.

Completion Report:

- The viewing room walls and grating were painted with 133 Amercoat¹⁶.
- Operations: Instructions were completed without exception.

3.8.10. Viewing Room Stairwell

Instruction 6.2.7:

- The doors to the viewing room were to be sealed with pressure sensitive tape.
- Loose paint was to be removed, then the dust vacuumed.
- Voids on stairwell side of the outside wall were to be caulked.
- Bare spots on the walls and floor were to be brush painted with No. 88 semi-gloss Amercoat or equal.
- The stairs and floors were to be spray painted with No. 88 semi-gloss Amercoat or equal to fix contamination.
- All combustibles and supplies were to be removed.
- A radiation survey was to be performed.
- Doors leading to airlocks were to be closed.

¹⁶133 Amercoat is a trade name of Ameron Protective Coatings.

Completion Report

- The stairwell was spray painted with 33 Amercoat.
- Operations: Instruction were completed without exception.

3.8.11. Airlocks

Instruction 6.2.8:

- Heaters were to be switched to the OFF position.
- Laundry bags were to be removed.
- Area was to be decontaminated with 5 percent aqueous solution of Turco WO-2 or Medac.
- Combustibles and supplies were to be removed.
- Electrical service to poppys was to be disconnected and left in airlock.
- Doors were to be closed and locked.

Completion Report:

- Operations: Instructions were completed without exception.

3.8.12. Pipe Gallery

Instruction 6.2.9:

- Liquid from the L-1A tank was to be emptied, then the tank water flushed, and drained.
- Free board above boron rachig rings was to be measured and recorded.
- The ventilation filter between the pipe gallery and viewing room was to be changed out.
- Deactivation Instructions 6.4 and 6.5 were to be completed.
- Loose paint was to be removed and bare spots were to be brush painted with No. 88 semi-gloss Amercoat paint or equal. Paint was to be sprayed if necessary to reduce contamination.
- Combustibles, tools, and shop supplies were to be removed from the pipe gallery and airlocks.
- Laundry hampers were to be removed.
- RM portable instruments were to be removed.
- Portable electric devices were to be disconnected.

- The air sampler valves were to be closed.
- Doors were to be closed and locked.

Completion Report:

- The lower section of the pipe gallery walls was spray painted with 33 Amercoat. The floor was brush coated.
- Instruction were completed without exception.

3.8.13. Heating and Ventilation

Instruction 6.3:

- Normal heating and ventilation was to be maintained in the 233-S Facility.
- Pipe gallery filters were to be changed out as noted in Instruction 6.2.9 and the No. 1 and No. 2 inlet filters of the 233-S exhaust facility were to be replaced.

Completion Report:

- Heat and Vent Instructions were completed without exception.

3.8.14. Utilities

Instruction 6.4:

- Sanitary water to the ventilation units was to remain in service. All other water systems were to be deactivated according to Instructions 11.22, 11.26, and 12.3.
- Process and breathing air service was to be deactivated according to Instructions 11.22 and 12.2.
- Instrument air servicing the heat and supply ventilation and exhaust units and associated controls was to remain active.
- Instrument air associated with sump weight factor instrumentation was to remain in service.
- Instrument air not required for item 3 and 4 of this Instruction was to be deactivated according to Instructions 11 and 12.2.
- Steam servicing the heat and supply ventilation units were to remain active. All other steam services were to be deactivated according to Instructions 11.2 and 12.1.
- Deactivation of steam, water, air, and chemical services to the 233-S greenhouse was to include physical isolation by blanking or capping inlets to the greenhouse.

Completion Report:

- Instrument and operations instructions for 233-S utilities were completed without exception.

3.8.15. Equipment

Instruction 6.5:

- Equipment associated with the following was not to be deactivated:
 - (1) Ventilation Supply and Exhaust Systems
 - (2) Greenhouse Sump Weight Factor Indication and Alarm
 - (3) Fire Detection and Alarms.
- Lighting deactivation was to be consistent with Instruction 11.2.10.
- All other equipment was to be deactivated consistent with Instructions 6.2, 6.4, and 6.7.
- All equipment deactivation was to be according to Instructions 11.1, "Instrument," and 11.2, "Mechanical-Electrical."
- Deactivation of equipment associated with utilities was to be according to Instructions 12.1.2, 12.1, 12.3, and 12.7.

Completion Report:

- Instrument and operations instructions were completed without exception.

3.8.16. Operating Gallery

Instruction 6.6:

- Deactivation of the operating gallery was to follow completion of Instructions 6.1, 6.2, and 6.5.
- Deactivation Instructions 4.17 and 16.5 were to be completed.
- Portable electrical devices were to be disconnected.
- The air sampler valves were to be closed.
- The alpha burst monitor was to be disconnected.
- Combustibles and shop supplies were to be removed.

Completion Report:

- Instrument and operations instructions were completed without exceptions.

3.8.17. Change Room

Instruction 6.7:

- The restroom was to be deactivated per Instruction 16.4.
- All materials were to be removed from lockers.
- Electric service to the water fountain was to be removed and water drained from the unit. The water inlet and top of the fountain were to be covered with plastic and pressure sensitive tape.
- The wood bench and other combustibles were to be removed and discarded.
- Shop supplies were to be transferred to 202-S store room.
- Used laundry hampers were to be removed and sent to laundry.
- SWP apparel was to be removed and shipped to laundry.
- The floor was to be swept and mopped.
- Janitorial equipment and supplies were to be removed and discarded since they were potentially contaminated.
- Any masks that were used were to be left in the storage rack.
- A radiation survey was to be performed and if necessary, decontaminated.
- The door to the loadout room was to be closed and locked.

Completion Report:

- Operations instruction were completed without exception.

3.8.18. Storage Building

Instruction 6.8:

- SWP apparel was to be shipped to laundry.
- Shop supplies from the operations section of building was to be transferred to the 202-S storeroom.
- All combustibles were to be removed from the building.
- Electrical power to the building was to be de-energized.
- The area was to be swept, then doors closed and locked.

Completion Report:

- Operations instructions were completed without exception. However, verbal information indicates that the electric power to the entire facility was not de-energized. The process circuits were de-energized only.

3.9. FACILITY TAKEN OUT OF SERVICE (June 1967)

Both the REDOX and the 233-S facilities were taken out of service and placed in layaway status.

3.10. FACILITY CHANGED TO LAYAWAY STATUS (August 1969)

The layaway status was changed to layaway condition (retired).

3.11. FACILITY SELECTED AS DEMONSTRATION PROJECT (1978)

The 233-S Facility was selected as a demonstration project for dismantlement of retired contaminated facilities.

3.12. CUSTODY OF FACILITY CHANGED (April 24, 1978)

Custody of the 233-S and 233-SA facilities was changed from Product Handling and Special Services to Tank Farm Operations, D&D Program (Plant and Equipment Transfer No. Rockwell 78-128).

**3.13. INDICATION THAT FILTER PIT STILL IN SERVICE (September 1, 1978)
(Kover 1978).**

A remark in a memo (Kover 1978) relayed the information that the filters in the filter pit between 202-S and 233-S had failed dioctyl phthalate testing and must be replaced. This indicates that these filters were not removed and decontamination efforts for the filter pit area were not performed, at least as of this date.

3.14. DECONTAMINATION AND DECOMMISSIONING ACTIVITIES (1979)

**3.14.1. Can Storage and Product Removal Can Storage Rooms
(RHO 1979b).**

Completion:

- Continuous air monitors (CAM) were installed in both rooms.
- Specified fluids and electrical circuits were isolated from the work area.

- Loose dust and debris were removed by sweeping and wiping down with water dampened rags.
- Miscellaneous equipment and supplies (lockers, shelves, etc) were removed.
- Two lockers and a hanger for plastic sheeting were identified as items with potential future use. These were surveyed and released for uncontrolled use in the can storage room.
- The 75-gal resin storage tank was disconnected from its associated piping, and subsequently transported to land burial.
- Most of the equipment in the two rooms was dispositioned to land burial.
- Prior to entering the two rooms, a cleaning solution of trisodium phosphate (TSP) and water was prepared in the SWP Change Room. At the time, methods and procedures did not exist to dispose of plutonium contaminated liquid waste from 233-S. The TSP cleaning solution was prepared in a radiologically clean portion of the building to assure that the unused solution could be disposed of without the possibility of being contaminated. Only rags dampened with cleaning solution were allowed in the two rooms.
- Decontamination began on the rooms' ceilings, then proceeded down the walls to the floors. The TSP cleaning solution successfully removed the accumulated dirt, grease, and whatever slight contamination that may have been present on the surface, with one exception. A hot spot of approximately one square foot in area was found in the location where the resin tank was bolted to the floor prior to removal. The level of contamination was 1,500 dpm per swipe. Three successive attempts to decontaminate this area with TSP proved to be totally ineffective as the contamination was ingrained into the paint. Eventually the contaminated paint was removed with a commercial gel type paint stripper containing methylene chloride, methanol, and mineral spirits.
- Following decontamination of the rooms, a radiation survey was performed.
- Prior to applying the strippable coating, all floors, ceilings, and walls were subdivided with tape into squares approximately two feet on a side. The purpose of the taped grid was to facilitate lifting an edge of the strippable coating when removed.
- Turco 5931 (white) was the strippable coating used. Two coats of strippable coating were applied to the surfaces of the can storage room initially. Measurements indicated that two coats exceeded the required 0.005-inch dry film thickness. A test patch was then designated to determine if the strippable coating could be satisfactorily stripped without the necessity of applying additional coatings.

While attempting to remove the strippable coating, it was discovered that the Turco 5931 adhered so tightly to the underlying original paint that it did not strip.

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Contact with the vendor resulted in a suggestion that a layer of mineral oil be applied to the room surfaces prior to applying the strippable coating in an attempt to reduce the adhesion. A test patch was designated in the PR can storage room for this purpose. Meanwhile, strippable coating continued to be applied throughout the can storage and PR can storage rooms.

Mineral oil in various amounts was applied to the test patch. Five coats of Turco 5931 were applied over the test patch and the remaining surfaces of the can storage and PR can storage rooms. Removal of the strippable coating over the mineral oil test patch was again very difficult. There was no detectable difference in the adhesion to the underlying paint using mineral oil. In addition, the added thickness of five coats resulted in very little additional strength over two coats. It still bonded to the underlying paint and could only be removed in very small pieces.

The Turco 5931 would not strip on either painted concrete or painted sheet metal surfaces. Another produce (DuPont D-1000) was tested. It proved to be easier to remove than Turco 5931 but still too difficult for use in large areas.

Five coats of Turco 5931 were applied to all exposed surfaces in the airlock, can storage and PR can storage rooms.

3.14.2. Loadout Hood (RHO 1980a)

Completion:

- Sampling of the air within the hood for hexone, iodine-129, and airborne contamination was conducted. Analysis of the air samples showed no detectable hexone or iodine-129 present.
- Liquid samples were drawn from tanks L-7, L-21, and L-22 to characterize the contents of each tank. The L-7 tank was empty, tank L-21 sample arm contained approximately 2 tablespoons of liquid, and tank L-22 contained about 1 liter of a liquid that was light green in color. The liquid was sent to the analytical laboratory at Building 234-S. Analysis showed the sample to contain 0.525 grams plutonium per liter of solution. No mention is made of a chemical analysis being performed.
- A containment airlock tent at the doorway between the PR can storage room and the loadout room was installed.
- CAMs were installed in the loadout room.
- High efficiency particulate air (HEPA) filters were installed over two large open slots located on top of the hood.
- The monorail hoist was load tested.
- The loadout hood doors were removed and special containments over the openings were installed.

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- All visible accumulations of loose dust and debris were vacuumed using a HEPA filtered vacuum cleaner.
- Chemical decontamination and fixation efforts continued within the hood:

Decon Chem:	None
Fixative:	Butvar Strippable Coating
Decon Chem:	Radiacwash (A spray mist with ethylenedrametetracetic acid sequestrant)
Fixative:	Clear Coat
Decon Chem:	Kleno Bowl (dilute hydrochloric acid and detergents)
Fixative:	Turco Contam-Affix, removable
Decon Chem:	Turco 4306-C (sulfamic acid)
Fixative:	Water-based Latex Enamel Paint
Decon Chem:	Turco 4306-D (sodium bisulfate)
Fixative:	Aqualoid* 15-93 Strippable Coating*

* May be Acryloid

- Survey results indicated that the chemicals and fixatives were removing/fixing surface contamination but that the surfaces within the hood were constantly recontaminated due to the internal air exhaust turbulence. When decontamination/fixation efforts had reduced surface contamination levels as low as reasonably practicable, dismantling of the hood components commenced.
- Extensive dismantling efforts removed all internal components within the hood, including the L-7 tank and shielding, the PR can positioner, the L-21 tank and shielding, the L-22 tank and shielding, associated piping, hood doors and panels, and the overhead monorail. Heavy items such as the lead shielding were handled with the monorail's hoist. All items were decontaminated and fixed to minimize surface contamination levels, then wrapped in plastic prior to placement in 55-gallon drums. Large items were removed through an open door in the hood.
- Towards the end of fiscal year (FY) 1979, it was recognized that dismantling of the hood would not be completed by the scheduled date. Therefore, to stabilize the hood for the scheduled shutdown of decontamination and decommissioning (D&D) operations during the entire FY 1980, plexiglass panels with integral HEPA filters were cut to size and installed to replace the hood doors and cover other openings. The panels serve to maintain the air balance through the hood and to isolate remaining internal hood surface contamination from the loadout room.

Loadout hood tanks and associated pipes contained appreciable amounts of highly contaminated acid.

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3.14.3. Processing of Hood Waste through the 231-Z Sectioning/Pretreatment Facility and the Electropolishing Facility (RHO 1980b).

- Some waste resulting from decontamination and dismantling of the 233-S loadout hood was transferred to the 231-Z Facility. The purpose was to perform vibratory finishing and in situ electropolishing techniques on the waste to evaluate the effectiveness in reducing solid radioactive waste from transuranic to nontransuranic status. Radiological analyses were performed but no mention is made of any chemical analyses being performed.

3.15. PIPE GALLERY AND CONTROL ROOM - CHARACTERIZATION (April 18, 1980) (RHO 1980c)

- No mention of any chemical analyses was located; however, some lines in the pipe gallery were disassembled to determine the presence of liquid. Some of the lines selected for characterization were found to contain contaminated liquid.

3.16. SAFETY ASSESSMENT DOCUMENT, Rev. 1, ISSUED (July 22, 1980)

RHO-CD-658, Rev. 1, "233-S Building Decontamination and Decommissioning Safety Assessment Document," (RHO 1979a) was issued.

3.17. DECONTAMINATION AND DECOMMISSIONING OPERATIONS SAFETY REQUIREMENTS, Rev. A, ISSUED (April 20, 1981)

DO104AR0001 Rev. A, "233-S D&D Operations Safety Requirements," (RHO 1981a) issued. Supersedes and replaced the former Appendix A of RHO-MA-658.

3.18. ROOF OF FACILITY FOAMED (1984)

Verbal communications indicate that the roof of this facility was foamed in 1984. Urethane PSI-5200-30¹⁷ was used, followed by Silicone Rubber Dispersion 3-5000¹⁸.

3.19. NONDESTRUCTIVE ANALYSIS PERFORMED (1987)

Nondestructive Analysis was performed in November 1987.

¹⁷Urethane PSI-5200-30 is a trade name of Polythane Systems Incorporated.

¹⁸Silicone Rubber Dispersion 3-5000 is a trade name of Dow Corning Corporation.

3.20. STABILIZATION ACTIVITIES (Mid-1987 through December 1987) (Beckstrom 1988).

Work Completed:

- The damper for the east exhaust fan, which would not close properly, was repaired prior to start of decontamination activities inside the building.
- Decontamination activities in the outside area between the 202-S and 233-S Buildings consisted of removing the deteriorated protective covering over the connecting tunnel between the two buildings and applying a new protective barrier over the tunnel consisting of a thick layer of ALARA Coat. The original protective covering over the tunnel along with all the loose dirt and gravel in the area were placed in 55-gal waste drums. The ground surface between the two buildings and the north wall of 202-S was then sprayed with asphalt emulsion to fix the remaining contamination.
- The 202-S column transfer trench, although not associated with the 233-S Building, is located on the west side of the building. The trench is a deep, underground structure that was used to transfer large ion exchange columns in and out of the 202-S Building. The top of the trench is covered with diamond plate panels. The inside of the trench is contaminated, and radiation surveys have identified loose surface contamination along the concrete curbs which hold the steel panels.

The joints between the steel cover panels and along the concrete curbs of the lay-down (ion exchange column) trench were sealed with cloth tape and coated with asphalt emulsion to prevent further release of contamination. The lay-down trench is not part of the 233-S Facility.

- Interior Decontamination and Stabilization: The original decontamination plan was to vacuum and wipe down with damp rags all surfaces in the contaminated areas. It was discovered that wiping down the surfaces was ineffective because decontaminated areas were soon recontaminated due to the high degree of air turbulence from the ventilation system. Wiping the surfaces was therefore discontinued on the ground floor, except in the PR can loadout room, where air turbulence was most significant, and emphasis was placed on fixing the contamination with paint.
- PR Can Loadout Room: A total of five 55-gal drums of waste were removed from the loadout room. Most of this waste was generated from housekeeping and decon activities. The loadout room was the last room to be decontaminated and was accomplished by wiping down all accessible surfaces with damp rags until no significant change in detectable alpha activity was observed with standard Hanford portable survey instruments.

The emergency door between the loadout room and the SWP change room was sealed to prevent contamination from escaping into clean areas of the building. This was accomplished by taping a strip of cheesecloth over the space between the floor and door, and around the door jams, then

fixing the strip of cloth in place with ALARA Coat. This method provides an effective barrier without preventing the door from being opened in case of an emergency.

- Stairwell and Airlocks: The ground floor level of the stairwell and the two airlocks to the south contained excessive quantities of miscellaneous trash, debris, and old SWP clothing. This contaminated material was placed in twelve 55-gal waste drums along with the waste associated with decontamination activities. The upper three levels of the stairwell were totally free of trash and debris.

The stairwell and airlocks were vacuumed to remove the large buildup of dust and spider webs that had accumulated over time. The upper levels of the stairwell were wiped down with damp rags; however, a great deal of time was not expended on the task. The main emphasis was to remove the bulk of the loose surface material. After decontamination activities, the stairwell and airlocks were spray painted to fix the remaining contamination. The type of spray paint was not identified in the records.

The exit doors located in each airlock were sealed in the same manner as the emergency door in the loadout room. The purpose of this action was to prevent dust and dirt from being drawn into the airlocks through the cracks around the doors and prevent contamination from leaking out around the doors in the event of a release inside the building.

- Viewing Room and Process Hood: The viewing room was the most highly contaminated area subject to the stabilization activities. Only two 55-gal drums of waste were removed from this room. One drum was filled with waste material from the ground floor area and one drum from the upper three levels. The waste consisted primarily of paper, plastic, wood, cloth, tape and metal (scrap metal, nuts, bolts, and old hand tools). A vacuum cleaner was used to remove spider webs and the dust and dirt that had accumulated on the horizontal surfaces. No attempt was made to vacuum 100 percent of the surface area in this room.

All glove port openings in the process hood were recapped and resealed. All observable holes and openings in the hood were also sealed. Upon completion of debris removal, vacuuming operations and sealing of the process hood, the entire room was sprayed with several coats of latex paint to fix the remaining contamination. The type of latex paint was not identified in the records. After painting operations were completed, HEPA filters were installed over each of the four inlet openings in the process hood.

3.21. CHARACTERIZATION PLAN (February 16, 1990)

WHC-SD-CP-TP-055 Rev 0, "Characterization of 233-S Facility, Measurements Plan," (WHC 1990) by V. B. Subrahmanyam was issued.

3.22. ROOF AND EXHAUST DUCTS ON ROOF PAINTED WITH AMERCOAT AND FIXED WITH AEROSPRAY 70-A (August 1990)

The roof and exhaust ducts on the roof were painted with Amercoat 33 and two coats of Aerospray 70-A Binder were applied to fix loose contamination.

3.23. ADDITIONAL HAZARDOUS MATERIALS INFORMATION (September 1990)

- Several engineering drawings indicate that this facility contains lead (examples are the L-21 loadout tank and enclosure and the L-7 tank and shield).
- Drawings and visual inspection of some of the piping in the facility indicates that this facility may contain asbestos.
- Mercury is normally utilized in instrument/electrical equipment and may have been used in the 233-S Facility.
- Acetylene tetrabromide is a manometer fluid and may have been used in the 233-S Facility.
- Polychlorinated biphenols (PCB) were often added to many oils to enhance their fire resistive and electrical properties. High concentrations of PCBs can be found mainly in transformer and hydraulic oils which were used in elevators, larger transformers, floor hoists, vacuum pumps, and hydraulic operated process equipment. PCBs may have been used in the 233-S Facility.
- In the near future, it is expected to foam the area between the 202-S and 233-S facilities to fix contamination. It is also expected to foam the laydown trench located to the west of the 233-S Facility. The type of foam to be used is URETHANE PSI-S200-30 by Polythane Systems Inc. After the foam application, SILICONE RUBBER DISPERSION 3-5000 will be applied.
- A search was conducted by Ms. JoAnn Brehm for chemical flow from the 202-S to the 233-S Facility during the process years. The following three lines were located:
 1. Tank 503 - Ferrous Sulfamate Solution Adjustment Tank. Ferrous sulfamate was diluted with demineralized water to a 30 weight percent ferrous sulfamate solution.
 2. 3BP Sampler (E-3) - Third Plutonium Cycle. From the 3BP and the 1BP streams, the following chemicals were identified:
 - Plutonium
 - Neptunium
 - Ruthenium
 - Nitric acid
 - Silica (SiO₂)
 - Hexone
 - UNH (uranyl nitrate hexahydrate or uranyl nitrate in hexone)

- Aqueous aluminum nitrate solution
- Sulfamic acid (NH_2SO_3)
- Ions of:
 - Aluminum
 - Iron
 - Chromium
 - Sodium
 - Sulfuric
 - Calcium
 - Magnesium
 - Chlorine

3. 3BP Rework Tank (E-4) - Third Plutonium Cycle. The following chemicals were identified:

- Same as the 3 BP Sampler
- Ozone

4. LIST OF IDENTIFIED CHEMICALS

- **ACETYLENE TETRABROMIDE**

Material Safety Data Sheet (MSDS) 2112: 1,1,2,2-TETRABROMOETHANE

This manometer fluid contains 100 percent ACETYLENE TETRABROMIDE with a trace of red dye. The recommended exposure level for an 8-hour average exposure is 1.0 parts per million (ppm). For short-term exposures (less than 15 minutes), the recommended exposure level is 1.5 ppm. Potential effects of elevated short term exposures to ACETYLENE TETRABROMIDE may include eye, skin, and respiratory irritation. Absorption through the intact skin is also possible.

MSDS 2112 describes ACETYLENE TETRABROMIDE has analphatic halogen. It is a pale yellow, nonflammable liquid with a sweet, chloroform-like odor. The manometer fluid is hazardous and requires handling wiht nitrite protective gloves.

It is unknown if ACETYLENE TETRABROMIDE was used in this facility. Sampling is recommended to verify the absence of this product.

- **AEROSPRAY-70A BINDER**

MSDS 20319: AEROSPRAY-70A BINDER

In 1990, the exhaust ducts and the roof of the facility were painted with Amercoat, then two coats of AEROSPRAY-70A BINDER were applied to fix loose contamination.

AEROSPRAY-70A BINDER is a polyvinyl acetate emulsion. It is not regulated by state or federal waste regulations and use of this product will not produce a mixed waste. Therefore, sampling for chemical analysis is not required.

- **ALARA COAT**

MSDS 20758: **ALARA 1146 CAVITY DECON**¹⁹
MSDS 14254: **ALARA 1146 DECON**²⁰

During stabilization activities in 1987, the deteriorated protective covering over the pipe tunnel between 233-S and 202-S was removed and a thick layer of **ALARA COAT** was applied.

During the same timeframe, **ALARA COAT** was used to fix the strips of cheesecloth which were placed around the emergency door between the Loadout Room and the SWP Change room. The door was sealed in this manner to prevent contamination from escaping into clean areas of the building.

Although this product does not appear to be Occupational Safety and Health Act-regulated, there is a statement in the MSDS that it does contain a chemical known by the state of California to cause cancer and/or birth defects or other reproductive harm. The chemical is not identified.

- **ALPHA BURST MONITOR**

MSDS: Not Applicable.

No MSDS is available for the **ALPHA BURST MONITOR**. However, some detectors are known to contain hazardous materials. Visual inspection during future decommissioning activities will establish the existence of this product.

- **AMERCOAT 33**

MSDS 10288: **AMERCOAT 33**

During the 1966 partial decontamination for plant deactivation, **AMERCOAT 33** was either brushed or spray painted on the loadout room walls and floor, the viewing room walls and grating, the stairwell, the lower section of the pipe gallery walls and the pipe gallery floor.

Drawing H-2-17947 also states that all carbon steel material in the process area shall be painted in accordance with **AMERCOAT 33**.

In 1990, the exhaust ducts and the roof of the facility were painted with **AMERCOAT 33**, then two coats of **Aerospray-70A** binder were applied to fix loose contamination.

¹⁹Alara Coat 1146 Cavity Decon is a trade name of Carboline Company.

²⁰Alara Coast 1146 Decon is a trade name of Carboline Company.

The MSDS lists the hazardous ingredients as follows:

- Methyl isobutyl ketone
- Toluene
- Xylene
- Chlorinated paraffin
- Vinyl chloride resin
- Polyvinyl chloride resin
- VM and P naphtha
- Cycloparaffin
- Methyl ethyl ketone
- Mica
- Acrylic resin
- Pigments:
 - . Titanium dioxide
 - . Chromium oxide
 - . Iron oxide
 - . Carbon black

Visual inspection during future decommissioning activities will establish the existence of this product.

• **AMERCOAT 88 SEMIGLOSS**

MSDS: N/A. AMERCOAT 88 was not used.

In the referenced cases where use of AMERCOAT 88 SEMIGLOSS or equal was specified, Amercoat 33 was used instead.

• **AQUALOID (or ACRYLOID) 15-93 STRIPPABLE COATING**

MSDS: Not available

During the 1979 D&D activities, chemical decontamination and fixative efforts were performed inside of the Loadout Hood. AQUALOID 15-93 STRIPPABLE COATING was one of the fixatives used.

Although the internal components of the loadout hood have been removed, it is possible that AQUALOID 15-93 STRIPPABLE COATING is present on the external and internal walls of the loadout hood, as well as the area surrounding the hood.

Visual inspection during future decommissioning activities will establish the existence of this product.

• **ASBESTOS**

MSDS 12839: ASBESTOS

It is possible that ASBESTOS was used in construction of the roof and walls of the facility although drawings only indicate that some type of insulation was used.

According to MSDS 12839, long-term exposure to high concentrations of asbestos fiber may cause pulmonary disease. No hazardous ingredients are listed; although hazardous mixtures of other liquids, solids, or gases lists CHRYSOTILE ASBESTOS FIBER.

Visual inspection during future decommissioning activities will establish the existence of this product.

- **ASPHALT EMULSION**

MSDS 15402: ASPHALT EMULSION COATING.

During the 1979 stabilization activities, the ground surface between the 202-S and the 233-S buildings was sprayed with ASPHALT EMULSION to fix the remaining contamination. Current onsite inspection of this area indicates that the ASPHALT EMULSION was sprayed on the northern wall of the 202-S Facility but does not appear on the 233-S south wall. The ground area between the buildings appears to be primarily concrete although the ground area directly above the pipe tunnel has the coloration of ASPHALT EMULSION.

In addition, the joints between the steel cover panels and along the concrete curbs of the lay-down trench (ion exchange column trench) were sealed with ASPHALT EMULSION to prevent further release of contamination.

MSDS 15402 indicates that there are no applicable hazardous ingredients; however, recent literature indicates that ASPHALT EMULSION does contain hazardous substances.

Visual inspection during future decommissioning activities will establish the existence of this product.

- **BUTVAR STRIPPABLE COATING**

MSDS 10518: BUTVAR AQUEOUS DISPERSION BR.²¹
MSDS 12763: BUTVAR DISPERSION BR RESIN²²

During the 1979 D&D activities, chemical decontamination and fixative efforts were performed inside of the Loadout Hood. BUTVAR STRIPPABLE COATING was one of the fixatives used.

Although the internal components of the Loadout Hood has been removed, it is possible that BUTVAR STRIPPABLE COATING is present on the external and internal walls of the loadout hood, as well as the area surrounding the hood.

²¹Butvar Aqueous Dispersion Br. is a trade name of the Monsanto Company.

²²Butvar Dispersion Br Resin is a trade name of the Monsanto Company.

U.S. Department of Transportation, Superfund Amendment and Reauthorization Act, Comprehensive Environmental Response, Compensation, and Liability Act, and OSHA hazard notifications are listed as Not Applicable. Because BUTVAR STRIPPABLE COATING does not appear to contain hazardous substances, sampling for its presence is not recommended.

- **CAULK**

MSDS 18764: CAULK LATEX

During the 1966 partial decontamination activities for plant deactivation, reference is made to using CAULK in the voids on the stairwell side of the outside wall.

No mention is made of the type of CAULK used. The CAULK could be considered hazardous if it is lead based. MSDS 18764 also lists hazardous ingredients as follows:

- Mineral spirits
- Ethylene glycol
- Titanium dioxide.

Visual inspection during future decommissioning activities will establish the existence of this product.

- **CLEAR COAT**

MSDS 15584: CLEAR URETHANE SEAL COAT (AEROSOL) #2049

MSDS 18384: KLEAR KOTE²³

During the 1979 D&D activities, chemical decontamination and fixative efforts were performed inside of the loadout hood. CLEAR COAT was one of the fixatives used.

Although the internal components of the loadout hood were removed, it is possible that CLEAR COAT is present on the external and internal walls of the loadout hood, as well as the area surrounding the loadout hood.

It is difficult to assess the hazardous components of CLEAR COAT because the reference to this fixative did not give the exact name or an indication of the manufacturer.

MSDS 15584 lists the ingredients as follows:

- American Society for Testing and Materials Type I Polyurethane (resin contains no free isocyanate).
- Xylene (hazardous)
- Mineral spirits (hazardous)
- Methylene chloride (hazardous)

²³KlearKote is a trade name of Dynacco.

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- 1,1,1 Trichloromethane (hazardous)
- Propane (propellant function only).
- Isobutane (propellant function only).

Thermal hazardous decomposition products are listed as follows:

- Hydrogen chloride
- Carbon monoxide
- Chlorine
- Possibly phosgene

MSDS 18384 lists the hazardous ingredients as follows:

- Xylene
- Ethyl benzene
- Methoxyl propanol acetate
- Isophorone diisocyanate
- Prepolymer resin

Hazardous decomposition products are not listed.

Visual inspection during future decommissioning activities will establish the existence of this product.

• **DUPONT D-1000**

MSDS: Not available.

During the 1979 D&D activities, DUPONT D-1000 was used on a small test patch in either the can storage room or the PR can storage room. It was used as a test to find out if it was easier to remove than Turco 5931.

Sampling to confirm the presence of DUPONT D-1000 is considered unnecessary because only a small patch was used and apparently much of it was removed during the test.

• **FERROUS SULFAMATE**

MSDS 1228: FERROUS SULFAMATE (50 percent aqueous by Thatcher Co.)

In 1962, 233-S was converted to process neptunium nitrate and a contactor was added to process plutonium nitrate. During the plutonium nitrate process, before the 2BP was sent to the 233-S Facility, it was stripped of hexone, treated with ozone for ruthenium removal, butted with nitric acid, and finally butted with sodium nitrite or FERROUS SULFAMATE to adjust the plutonium to the four valence state. The solution was then pumped to the L-12 concentrator in the 233-S Facility.

During the 1966 partial decontamination for plant deactivation, internal decontamination of the 233-S process vessels and piping was accomplished by using 57 percent nitric acid flushes.

FERROUS SULFAMATE is a dark green, odorless, liquid. It is a salt of metal and acid and is listed in MSDS 1228 as hazardous.

Because of the flushing that was performed, **FERROUS SULFAMATE** would not be expected to be found in appreciable quantities in the process equipment; however, it is recommended that sampling be performed in the process equipment, process lines, process hood, and sumps and traps for chemical analyses to confirm the absence of **FERROUS SULFAMATE**.

- **HEXONE AND HEXONE-NITRIC ACID REACTIONS**

MSDS 1343: HEXONE (METHYL ISOBUTYL KETONE)

During the 1955 initial plutonium nitrate process, the plutonium solution (3BP) was transferred to L-1 under batch control from E-3. The solution was fed to L-2 by pump or jet where the **HEXONE** was stripped and 5 to 35 percent concentration was achieved.

In 1962, 233-S was converted to process neptunium nitrate and a contactor was added to process plutonium nitrate. As a result of flowsheet changes in the 202-S Facility due to Project CGC-913, the plutonium nitrate and the neptunium nitrate solutions which were sent to the 233-S were steam stripped and free of **HEXONE**. Thus, the L-2 concentrator was no longer required as a **HEXONE** stripper ahead of the plutonium concentrator and was converted to a neptunium nitrate product concentrator.

The elimination of all **HEXONE**-bearing streams from the 233-S portion of the process eliminated the hazard of **HEXONE-NITRIC ACID** reactions in the 233-S Facility.

The addition of sodium nitrite to the E-3 tank in the 202-S Building would have presented a hazard of catalyzing **HEXONE-NITRIC ACID** reactions if the Nitrite ion was to contact a **HEXONE**-bearing stream. To prevent this from occurring, sodium nitrite (which was made up in the E-2-A tank on the fourth level) was piped only to E-3 tank which handled only **HEXONE**-free solution. The **HEXONE** was stripped from the 3BP product solution in the E-2 vessel before being transferred to the E-3 vessel. From the E-3 tank, solution could be transferred only to the L-12 concentrator which was operated at a boiling temperature and a 7.0 molar nitric acid composition.

During the 1966 partial decontamination for plant deactivation, internal decontamination of the 233-S process vessels and piping was accomplished by using 57 percent nitric acid flushes.

During the 1979 D&D activities, sampling of the air within the hood for **HEXONE**, Iodine-129, and airborne contamination was conducted. Analysis of the air samples showed no detectable **HEXONE** or iodine-129 present.

According to MSDS 1343, **HEXONE** is an aliphatic ketone. It is a colorless liquid with a faint pleasant ketonic and camphor odor, and is listed as toxic.

Because of flushing, HEXONE or HEXONE-NITRIC ACID reactions would not be expected to be found in appreciable quantities in the process equipment; however, it is recommended that sampling be performed in the process equipment, process lines, process hood, and sumps and traps for chemical analyses to confirm the absence of HEXONE or HEXONE-NITRIC ACID reactions.

- **IODINE-129**

MSDS: Not Applicable (radiologically hazardous).

During the 1979 D&D activities, sampling of the air within the hood for hexone, IODINE-129, and airborne contamination was conducted. Analysis of the air samples showed no detectable hexone or IODINE-129 present.

A radiological characterization of this facility is currently being conducted by Analytical Systems Laboratories.

- **KLENOBOWL (dilute hydrochloric acid and detergents)**

MSDS 13069: KLENOBOWL

During the 1979 D&D activities, chemical decontamination and fixative efforts were performed inside of the loadout hood. KLENOBOWL was one of the decontamination chemicals used.

Although the internal components of the Loadout Hood have been removed, it is possible that KLENOBOWL is present on the external and internal walls of the loadout hood, as well as the area surrounding the loadout hood.

MSDS 13069 lists the hazardous ingredient as follows:

- Hydrochloric acid.

There are no known hazardous decomposition products listed.

Sampling for chemical analyses is not recommended. KLENOBOWL would have evaporated over the years and is unlikely to pose any current health hazards.

- **LEAD**

MSDS 1288: LEAD, sheet

During 1979, extensive dismantling efforts in the loadout hood resulted in removal of the internal components, including removal of the LEAD shielding. No indication as to the type of shielding was found; however, it could also have been LEAD GLASS.

The above MSDS lists LEAD SHEET as hazardous. Lead and its inorganic compounds are neurotoxins which may produce peripheral neuropathy.

Visual inspection during future decommissioning activities will establish the existence of this product.

- **MERCURY**

MSDS 1323: MERCURY (by Fisher Scientific)

MSDS 1323 states that **MERCURY** is a metal and is hazardous. Thermal decomposition products include highly toxic vapors of **MERCURY** and **MERCURY OXIDE**.

MERCURY is utilized in instrument/electrical equipment. It is not known if **MERCURY** was used in 233-S. Visual inspection during future decommissioning activities will establish the existence of this product.

- **MINERAL OIL**

MSDS 2629: MINERAL OIL

The actual type and manufacturer of the mineral oil used are not known.

During the 1979 D&D activities, it was suggested that a layer of **MINERAL OIL** be applied to the room surfaces prior to applying strippable coating in an attempt to reduce the adhesion of the strippable coating to the underlying original paint. A test patch of various amounts of **MINERAL OIL** was applied in the PR can storage room. There was no detectable difference in the adhesion to the underlying paint using the **MINERAL OIL**. The overlaying coats of Turco 5931 still bonded to the underlying paint and could only be removed in very small pieces.

MINERAL OIL is not hazardous. Sampling is not recommended.

- **NITRIC ACID**

MSDS 1384: NITRIC ACID (by Fisher Scientific)

NITRIC ACID was used extensively and in various concentrations both as a part of the plutonium nitrate and the neptunium nitrate process and as flushes after completion of the process.

During the 1966 partial decontamination for plant deactivation:

- Internal flushing of the vessels and piping in the facility was accomplished using **57 PERCENT NITRIC ACID**. The instructions did not call for a follow-up water flush and no mention is made in the completion report of a follow-up water flush.
- External flushing of the vessels and piping for product recovery within the greenhouse (process area) was accomplished using **10 PERCENT NITRIC ACID** followed by demineralized water.

- Flushing of the greenhouse floor and sump area for product recovery was accomplished using 10 percent NITRIC ACID followed by demineralized water.
- Flushing of the container loadout section of the loadout hood for product recovery was accomplished using 10 PERCENT NITRIC ACID and demineralized water.

The actual type and manufacturer of the NITRIC ACID used are not known. MSDS 1384 states that it is hazardous and thermal decomposition products may include toxic oxides or nitrogen.

Sampling is recommended to confirm the absence of this product.

- **NEPTUNIUM NITRATE**

MSDS: Not Applicable (radiologically hazardous)

In 1962, separate concentration and loadout facilities for NEPTUNIUM NITRATE solution were provided, as well as a new plutonium anion exchange contactor installed for achieving the desired final plutonium product purification and decontamination.

A radiological characterization of this facility is currently being conducted by Analytical Systems Laboratories.

- **OZONE**

MSDS: Not available.

In 1962, a contactor was added to process plutonium nitrate. Before the 2BP plutonium product solution was sent to the 233-S Facility from the 202-S Facility, it was stripped of hexone, treated with OZONE for ruthenium removal, butted with nitric acid, and finally butted with sodium nitrite or ferrous sulfamate to adjust the plutonium to the four valence. The solution was then pumped to the XAF concentrator (L-12) in the 233-S Facility.

OZONE is a hazardous substance. However, sampling for chemical analysis for OZONE is not recommended because the usage would be expected to absorb the majority of the OZONE. In addition, any residual OZONE should have reacted or decomposed over the years.

- **PAINT (LOOSE OR FIXED)**

MSDS 15365: LATEX BASE FIRE RETARDANT PAINT
 MSDS 11439: LATEX BLACK TRAFFIC PAINT
 MSDS 18060: LATEX CONCRETE SEALANT
 MSDS 16196: LATEX EGGSHELL ENAMEL-WHITE and LIGHT TINT
 MSDS 11441: LATEX FLOOR PAINT
 MSDS 15599: LATEX GLOSS and TRIM ENAMEL 74-03,04,07,08
 MSDS 15601: LATEX HOUSE PAINT 17-3,5,7,8,9,20,21,24
 MSDS 15387: LATEX INTERIOR SPEED PRIMER, WHITE 72-01
 MSDS 14468: LATEX PAINTS (MULTI)

Prior to 1979, a number of references in the historical records refer to completion of the task to remove **LOOSE PAINT** from floors and walls (loadout room, viewing room, viewing room stairwell). In each case, the area was then painted with Amercoat 33.

During the 1979 D&D activities in the can storage room and the PR can storage room, the ceilings, walls, and floors of these two rooms were cleaned of accumulated dirt, grease, and whatever slight contamination that may have been present on the surface. The only place where the original paint was removed was a hot spot of approximately one square foot in the location where the resin tank was bolted to the floor prior to removal. Eventually, the contaminated spot was removed with a commercial gel type paint stripper containing methylene chloride, methanol, and mineral spirits (no MSDS for this gel type could be located). Five coats of Turco 5931 were applied to all exposed surfaces in the airlock, the can storage room, and the PR can storage room.

During the 1979 D&D activities, chemical decontamination and fixative efforts were performed inside of the loadout hood. **WATER-BASED LATEX ENAMEL PAINT** was one of the fixatives used.

Although the internal components of the loadout hood have been removed, it is possible that **WATER-BASED LATEX ENAMEL PAINT** is present on the external and internal walls of the loadout hood, as well as the area surrounding the loadout hood. Sampling for chemical analyses is recommended.

In 1987, during stabilization activities, the bulk of the loose surface material in the stairwell and airlocks were removed. The stairwell and airlocks were then **SPRAY PAINTED** to fix the remaining contamination.

The type and manufacturer of the **LATEX** used are not known; however, numerous **LATEX** water emulsion paints are listed in MSDS 14468. These products were noncombustible water emulsion paints formulated without lead or mercury and are not hazardous.

No information as to the type of **ORIGINAL PAINT** that was used in the rooms of this facility was located so a hazardous evaluation based on historical data is not possible. Even though it was known that **LOOSE PAINT** was removed prior to 1979, sampling of the ceiling, walls, and floors is recommended. Neither the type nor manufacturer of the **ORIGINAL PAINT** used were specified and the **ORIGINAL PAINT** may be hazardous if it contained hazardous pigments or if it were lead based.

Sampling is recommended to confirm the presence of these products.

- **PAINT STRIPPER** (Commercial gel type paint stripper containing methylene chloride, methanol, and mineral spirits - Not MSDS #12362, Stripper 77A)

MSDS: Not available.

During the 1979 D&D activities, the can storage room and the PR can storage room were cleaned with TSP. A hot spot of approximately 1 ft² in area was found in the location where the resin tank was bolted to the floor prior to its removal. TSP proved to be ineffective as the contamination was ingrained into the paint. Eventually, the contaminated paint was removed with a **COMMERCIAL GEL TYPE PAINT STRIPPER** containing methylene chloride, methanol, and mineral spirits.

Although an MSDS containing the above substances could not be located, paint strippers are usually hazardous. However, the chemicals in paint strippers are volatile and therefore is not expected to present any current health hazards. Sampling is not recommended.

- **PLUTONIUM NITRATE
PLUTONIUM HEXANITRATODIVALENT COMPLEX ANION**

MSDS: Not Applicable. Radiologically hazardous.

PLUTONIUM NITRATE was concentrated as part of the process of this facility.

A radiological characterization of the facility is currently being performed by Analytical Systems Laboratories.

- **POLYCHLORINATED BIPHENOLS**

MSDS: 19093

PCBs were initially regulated because of their detriment to the environment. Recently, they have been determined to be a suspect carcinogen which targets the liver. Because of this, it is important to keep the workplace and personnel exposure to PCBs "as low as reasonably achievable."

PCBs are used in light ballasts, transformers, etc. It is not known if PCBs were used in the 233-S Facility. Visual inspection during future decommissioning activities will establish the existence of this product.

- **RADIACWASH**

MSDS 18081: **RADIACWASH**

During the 1979 D&D activities, chemical decontamination and fixative efforts were performed inside of the Loadout Hood. **RADIACWASH** was one of the decontamination chemicals used.

The above MSDS lists the hazardous ingredients as follows:

- Citric acid
- Octyl phenol condensed
- Tetrasodium ethylenediamine triacetate
- Benzyldimethyl ammonium chloride, hyamine 1622

The internal components of the loadout hood were removed.

Sampling is not recommended.

- **RESIN**

MSDS: Not available. The actual type of resin used is not known, except that it was a strong base type anion exchange resin.

In 1962, the addition of a pushed bed plutonium anion exchange contactor (L-18) was the main change in the plutonium flowsheet as a result of Project CGC-913. The contactor was installed to achieve the desired final plutonium product purification and decontamination. The L-18 column was made up of an extraction section, a scrub section, a stripping section, a RESIN receiver section, and a reservoir section. See timeline for year 1962 for a full description of the process involving the contactor.

In 1963, a chemical reaction within the ion exchange unit caused a fire which resulted in extensive damage to the process equipment, gross alpha contamination within the process area, and general contamination spread to other portions of the facility.

Parts of the building were cleaned of gross contamination and nonsmearable alpha contamination was fixed by covering with a special paint. Six weeks later operations resumed without the ion exchange process.

During the 1979 D&D activities, the 75-gal RESIN storage tank located in the (can storage room or the PR can storage room???) was disconnected from its associated piping and subsequently transported to land burial.

Although the laydown trench (ion exchange trench) located parallel at the west side of 233-S Facility is not a part of the 233-S Facility, it has been included in the current radiological characterization being performed for the 233-S Facility. During the 1987 stabilization activities, the joints between the steel cover panels and along the concrete curbs were sealed with cloth tape and coated with asphalt emulsion to prevent further release of contamination from this area. It is not known if the ion exchange columns are still in the trench. The type of RESIN used in the columns is also not known.

RESIN is usually an organic compound based material in bead form. If RESIN dries out, it can become airborne very easily. RESIN beads are extremely small (about the size of sand particles) and can easily fall into cracks and crevices. After the cleanup as a result of the fire in 1963, operations resumed without the contactor. However, it is not known if the contactor was removed from the process area.

Sampling is recommended to verify the existence of RESIN in this facility.

- **RUTHENIUM**

MSDS: N/A. Radiologically hazardous.

In 1962, the plutonium anion exchange contactor was installed for achieving the desired final plutonium product purification. Before the 2BP plutonium product solution was sent to the 233-S Facility, it was stripped of hexone, treated with ozone for RUTHENIUM removal, butted with nitric acid, and finally butted with sodium nitrite or ferrous sulfamate to adjust the plutonium to the four valence state.

It is possible that RUTHENIUM exists in the process vessels and piping as well as in the process area itself. As a result of the fire in 1963, RUTHENIUM may exist in a number of locations within the facility. A radiological characterization of the facility is currently being performed by Analytical Systems Laboratories.

- **SILICONE RUBBER DISPERSION by Dow Corning Corp.**

MSDS: Hanford Environmental Health Foundation (HEHF) is searching.

In 1984, the roof of the facility was foamed using Urethane PSI-S200-30 followed by SILICONE RUBBER DISPERSION 3-5000. It is intended to use the same combination over the area between the 202-S and 233-S facilities, and the area over the laydown trench.

Manufacturers literature indicates SILICONE RUBBER DISPERSION 3-5000 to be a one component product of two contrasting colors. It is considered to be hazardous.

Sampling is not deemed necessary. The material should be properly dispositioned when the facility is decommissioned.

- **SODIUM NITRITE**

MSDS 1495: **SODIUM NITRITE**

In 1962, the plutonium anion exchange contactor was installed for achieving the desired final plutonium product purification. Before the 2BP plutonium product solution was sent to the 233-S Facility, it was stripped of hexone, treated with ozone for ruthenium removal, butted with nitric acid, and finally butted with SODIUM NITRITE or ferrous sulfamate to adjust the plutonium to the four valence.

According to MSDS 1495, SODIUM NITRITE is an organic salt and is hazardous. Thermal decomposition may yield toxic oxides of nitrogen and toxic sodium oxide.

Sampling is recommended to verify the absence of this product.

- **STRIP COAT**

MSDS 13294: STRIPPABLE PROTECTIVE COATING.

During the 1966 partial decontamination for plant deactivation activities, STRIP COAT was removed from the viewing room floor.

It is unknown if STRIP COAT was used in other parts of the facility.

References in the files refer to STRIP COAT. No MSDS could be located for STRIP COAT. It is possible that the material used was STRIPPABLE PROTECTIVE COATING.

MSDS 13294 lists the hazardous ingredients as follows:

- Toluene
- Methyl ethyl ketone
- Acetone
- Dichlorodifluoromethane (Freon 12) - Propellant

The ingredients listed above are all volatile and should not pose a current health hazard; therefore, sampling is not considered necessary.

- **TRISODIUM PHOSPHATE**

MSDS 1509: TRISODIUM PHOSPHATE CRYSTALS

During the 1979 D&D activities, the can storage room and the PR can storage room were cleaned with TSP. Decontamination began on the room's ceilings, then proceeded down the walls to the floors. The TSP cleaning solution successfully removed the accumulated dirt, grease, and whatever slight contamination that may have been present on the surface.

MSDS 1509 lists TSP as a hazardous phosphate salt. There are no hazardous decomposition products.

TSP was used as a cleaning solution. The residual concentration remaining on the walls is considered negligible and should not currently pose a health hazard. Sampling is not recommended.

- **TURCO W0-2 (5 percent aqueous solution)**

MSDS 20424: TURCO W.O. 2

During the 1966 partial decontamination for plant deactivation activities, the following was accomplished:

- Surfaces inside the Loadout Hood were swabbed with a 5 percent AQUEOUS SOLUTION OF TURCO W02, Wedac, or approved substitute to remove dust, lint, and gross contamination.
- The L-6 sampler box was flushed with a small quantity of 10 percent nitric acid. The surrounding area was then swabbed with a 5 percent AQUEOUS SOLUTION OF TURCO W0-2, Wedac, or approved equivalent.

- The airlocks were decontaminated with 5 percent AQUEOUS SOLUTION OF TURCO WO-2 or Wedac.

MSDS 20424 lists TURCO WO-2 as a hazardous substance containing phosphoric acid. It is in the corrosive classification. There are no hazardous decomposition products.

The residual concentration remaining in the facility is considered negligible and should not currently pose a health hazard. Therefore, sampling for chemical analyses is not recommended.

- **TURCO DECON 4306-C**

MSDS 21977: TURCO DECON 4306-C

During the 1979 D&D activities, chemical decontamination and fixative efforts were performed inside of the loadout hood. TURCO DECON 4306-C was one of the decontamination chemicals used.

MSDS 21977 lists two ingredients in the hazardous information section. Both are listed because of irritation properties only:

- Sulfamic acid
- Sodium disulfate

It is an off-white granular powder and is listed as corrosive in the hazardous classification. It has no hazardous decomposition products.

Although the internal components of the loadout hood have been removed, it is possible that TURCO DECON 4306-C is present on the external and internal walls of the loadout hood as well as the area surrounding the hood. However, the residual concentration remaining in the facility is considered negligible and should not currently pose a health hazard. Sampling for chemical analysis is not recommended.

- **TURCO DECON 4306-D**

MSDS 12556: TURCO DECON 4306-D

TURCO DECON 4306-D was also used as one of the decontamination chemicals on the internal components of the loadout hood.

MSDS 12556 lists two ingredients in the hazardous information section. Both are listed because of irritation properties only:

- Sulfamic acid
- Sodium bisulfate

It is an off-white granular powder and is listed as corrosive in the hazardous classification. It has no hazardous decomposition products.

Even though some of the TURCO DECON 4306-D may remain inside the hood, the residual concentration remaining is considered negligible and should not currently pose a health hazard. Sampling for chemical analysis is not recommended.

- **TURCO CONTAM-AFFIX**

MSDS 13335: TURCO CONTAM-AFFIX

During the 1979 D&D activities, chemical decontamination and fixative efforts were performed inside of the loadout hood. **TURCO CONTAM-AFFIX** was one of the decontamination chemicals used.

MSDS 13335 lists the hazardous ingredients as follows:

- Toluene
- n-Butyl alcohol
- Isopropyl alcohol
- Acetone

Hazardous decomposition products are toxic oxides of carbon and nitrogen, carbon monoxide.

Some **TURCO CONTAM-AFFIX** may remain inside the hood; however, the residual concentration remaining is considered negligible and should not currently pose a health hazard.

- **TURCO 5931 (WHITE) - A strippable coating.**

MSDS 12553: TURCO 5931-C (same as Turco 5931).

During the 1979 D&D activities, five coats of **TURCO 5931** were applied to all exposed surfaces in the airlock, the can storage room and the PR can storage room.

MSDS 12553 lists the hazardous ingredients as follows:

- 2-Butoxy ethanol
- Dioctyl phthalate
- Morpholine
- Mineral oil

The hazardous decomposition products portion of the MSDS is not filled out. A respirator with a mechanical filter for mist for dust conditions is required for respiratory protection.

Visual inspection during future decommissioning activities will establish the existence of this product.

WHC-SD-DD-TI-056 Rev. 1

- **URETHANE PSI-S200-30** by Polythane Systems Inc.

MSDS: (HEHF searching.)

Verbal communications indicate that, in 1984, the exhaust ducts and the facility roof were foamed with **URETHANE PSI-S200-30**. The type of material used was not specified but it was likely a **URETHANE** product.

Manufacturer's information indicates that **URETHANE PSI-S200-30** is a two component system composed of a polymeric isocyanate "A" component and a fluorocarbon-blown "B" component. It is a hazardous product.

Visual inspection during future decommissioning activities will establish the existence of this product.

- **WEDAC**

MSDS 13365: **WEDAC**

During the 1966 partial decontamination for plant deactivation activities, the following was accomplished:

- Surfaces inside the Loadout Hood were swabbed with a 5 percent aqueous solution of Turco WO-2, **WEDAC**, or approved substitute to remove dust, lint, and gross contamination.
- The L-6 sampler box was flushed with a small quantity of 10 percent nitric acid. The surrounding area was then swabbed with a 5 percent aqueous solution of Turco WO-2, **WEDAC**, or approved equivalent.
- The airlocks were decontaminated with 5 percent aqueous solution of Turco WO-2 or **WEDAC**.

MSDS 13365 lists hazardous mixtures of other liquids, solids, or gases as follows:

- Phosphoric acid

WEDAC is a light amber liquid with a mild odor. There are no hazardous decomposition products. It is noted that the material in contact with active metals can liberate hydrogen.

Any residual concentration remaining is considered negligible and would have reacted or decomposed. It is therefore considered that **WEDAC** would not currently pose a health hazard and sampling is recommended.

H-3. Section 3.0 and Section 4.0
B. D. Keele, C. R. Neff, and V. B. Subrahmanyam, *Radiological
Characterization of 233-S Facility*, WHC-SD-CP-TI-163
(Westinghouse Hanford Company, 1990).

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3.0 RESULTS AND DISCUSSION

The characteristic gamma rays of ^{241}Am (59.5 keV), ^{239}Pu (129, 375 and 414 keV) and $^{237}\text{Np}/^{233}\text{Pa}$ (312 keV) in a WGEA spectrum, were used to identify these isotopes. The gamma ray peak areas of ^{241}Am and ^{239}Pu were used to calculate their respective amounts. However, in instances where the ^{239}Pu peaks could not be identified above the background, its activity was calculated based on the observed peak area of ^{241}Am . The relative activities of these two isotopes in 233-S was determined by two different methods. The wt% of ^{241}Am based on the AEA of a composite spectrum of all analyzed smear samples and an assumed 6.1 wt% of ^{240}Pu resulted in a value of 0.51. A value of 0.65 wt% was evaluated from gamma spectra where gamma peaks of both isotopes were detected. A value of 0.6 wt% for ^{241}Am was assigned to the transuranic material of 233-S Facility by taking into consideration the errors associated with each of the experimental quantities used in its evaluation. This selected value is also consistent with results of detailed analyses of smears with higher levels of radioactivity (see Appendix J).

The estimates of material holdup, evaluated by the methodology described here from all WGEA gamma spectra, results of other analyses and other details are given in the Appendices. Material holdup in various areas of 233-S Facility are summarized in Tables I and II. The rather large propagated error estimates are due to unavoidable multiple sources within the view of the detector and the inability to make measurements on individual sources by tighter collimation of the gamma detector. Additional determinate sources of error include peak area statistics, surface area subtractions, external radiation, collimation, detector orientation and shielding calculations.

Plutonium contents of process vessels reported in Table II were based on WGEA gamma spectra. When a gamma spectrum was accumulated using a wide angle collimator the detector response was due to the radioactivity present in more than one vessel. Thus it was not often possible to determine the activity in each individual process tank. In instances where more than one process vessel contributed to a gamma spectrum, the detector response, corrected for any surface activities, was attributed to each of the sources that were in the view of the detector. An example is the gamma spectrum obtained with the detector in front of process vessels L-1, L-2 and L-3. The activity level, hence the material content, corresponding to the detector response was reported as though the radiation originated in L-1 alone, L-2 alone or L-3 alone. The plutonium content of the various process vessels given in Table II represents an over-estimate of material present in any one of the vessels.

Furthermore, all non-surface activity was assumed to be contained within the process vessels even though the possibility exists that some of the radioactivity is present in inter-connecting pipes, pumps and other apparatus. This effect, therefore, further augments the over-estimates.

A major part of the plutonium appears to be present in process vessel L-16 located on the first floor of the process area. The high uncertainty reported for this determination arises from the extensive surface activity in the vicinity, and the presence of a high efficiency particulate (HEPA) filter in

TABLE I

Estimates of Plutonium in 233-S Facility

Location	Material (239,240-Pu) Content (g)	
	Total	Smearable/surface
1 PR Can Storage Room	7.3 E -4	2.3 E -6
2 PR Can Loadout Hood	2.4	NM
2a PR Can Loadout Room	NM	1.7 E -4
3 Viewing Room (less Hood face)	8.2	2.6 E -2
4 Process Area	1100	230 ²
5 Stairwell	0.4	1.4 E -3
6 North Air Lock ³	7.2 E -3	3.5 E -5
7 South Air Lock ³	3.9 E -2	1.6 E -4
8 Pipe Gallery	5.5 E -3	NM
9 Roof/Duct Work	1.4	NM
10 Pipe Trench/Underground Equipment	< 350	NM

1. Relative error +/- 20% except for 60% at locations 1, 8 and 9.
 2. Surface activity, smearability unknown.
 3. Located south of stairwell.
- NM Not measured.

Table II

Estimates of Plutonium Holdup in Process Vessels

Vessel ID	Material (239,240-Pu) Content,	
	Total (g)	+/-Error (%)*
L-1 XAS Feed Tank	50	40
L-2 Np Product Concentrator	37	40
L-3 Pu Product Concentrator	50	40
L-4 Product Receiver Tank	<50	50
L-6 Product Sampler	30	40
L-8 Condenser	6	30
L-9 Condensate Sampler	7	30
L-10F XAF Feed Tank	7	70
L-10W Receiver Tank	9	80
L-11 Condenser	50	30
L-12 Final Pu Product Concentrator	85	50
L-13 XAF Condenser	50	30
L-14 Pu Transfer Trap	130	40
L-15 Jet Condenser	7	30
L-16 Recycle Tank	< 600	50
L-18 mon Anion Exchange Column	20	30
L-18 Anion Exchange Column	30	60
Total		<1218 60

* Relative standard deviation.

front of the vessel. Due to the close proximity of the HEPA filter to the gamma detector any plutonium content of the filter provides a false detector response. Finally, better precision for the plutonium content of L-16 requires dismantling some of the hardware around the vessel so as to provide better access to and improved collimation of the gamma detector.

The activity of ^{237}Np when detected was quantified assuming it to be present on the outer surfaces. In the event that this isotope activity is present on the inside surfaces of pipes, the reported values are to be corrected for attenuation due to the wall thickness of the pipe and for the transformation to a line source.

Gamma rays of some fission products (e.g. ^{137}Cs) and chain members sustained by the major isotopes were also found but at much lower intensities.

The chemical analysis of smears with higher levels of radioactivity for inorganic hazardous elements indicated the presence of barium, cadmium, chromium and lead. Smears taken with wet a paper appear to contain higher amounts of these elements compared to dry smears from the same locations (see Appendix K). Hazard classification of the waste, however, requires additional investigations.

4.0 CONCLUSIONS

The radiological characterization of 233-S Facility using various in-situ measurement methods resulted in a conservative estimate of < 1218 g of plutonium with an estimated 60% relative standard deviation.

The high uncertainty in the estimates arose from high surface activity in the vicinity of some process vessels and poor counting statistics. The response of the gamma detector with more than one source in its view was attributed to each one of the sources. The conservative nature of the holdup material, hence, is in most part due to the multiple accounting of radioactivity.

All material inventory, except for a few grams in the viewing room and the PR can loadout hood, was to be found on the first floor of the process area and in the various process vessels. The activity was found to be present both on the inside of the process vessels and interconnecting pipes as well on the external surfaces of the equipment and the room.

The plutonium content within the pipe trench connecting 233-S Facility and 202-S (REDOX) Building was conservatively estimated at <350 g.

All other regions of the 233-S Facility, different rooms and the duct work on the roof, contain, at each location, only milligram quantities of plutonium.

Activities of ^{241}Am and ^{237}Np were also be detected in amounts quantified (see appendices).

Hazardous inorganic elements, barium, cadmium, chromium and lead, were found to be present in smears from some of the locations in 233-S Facility. Additional evaluations are necessary to determine their impact on hazard designation and waste disposal.

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