CP-60203
Revision 0

REDOX Complex FY17-FY19 Deactivation Plan

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

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

P.O. Box 1600
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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J. R. Stults
CH2M HILL Plateau Remediation Company

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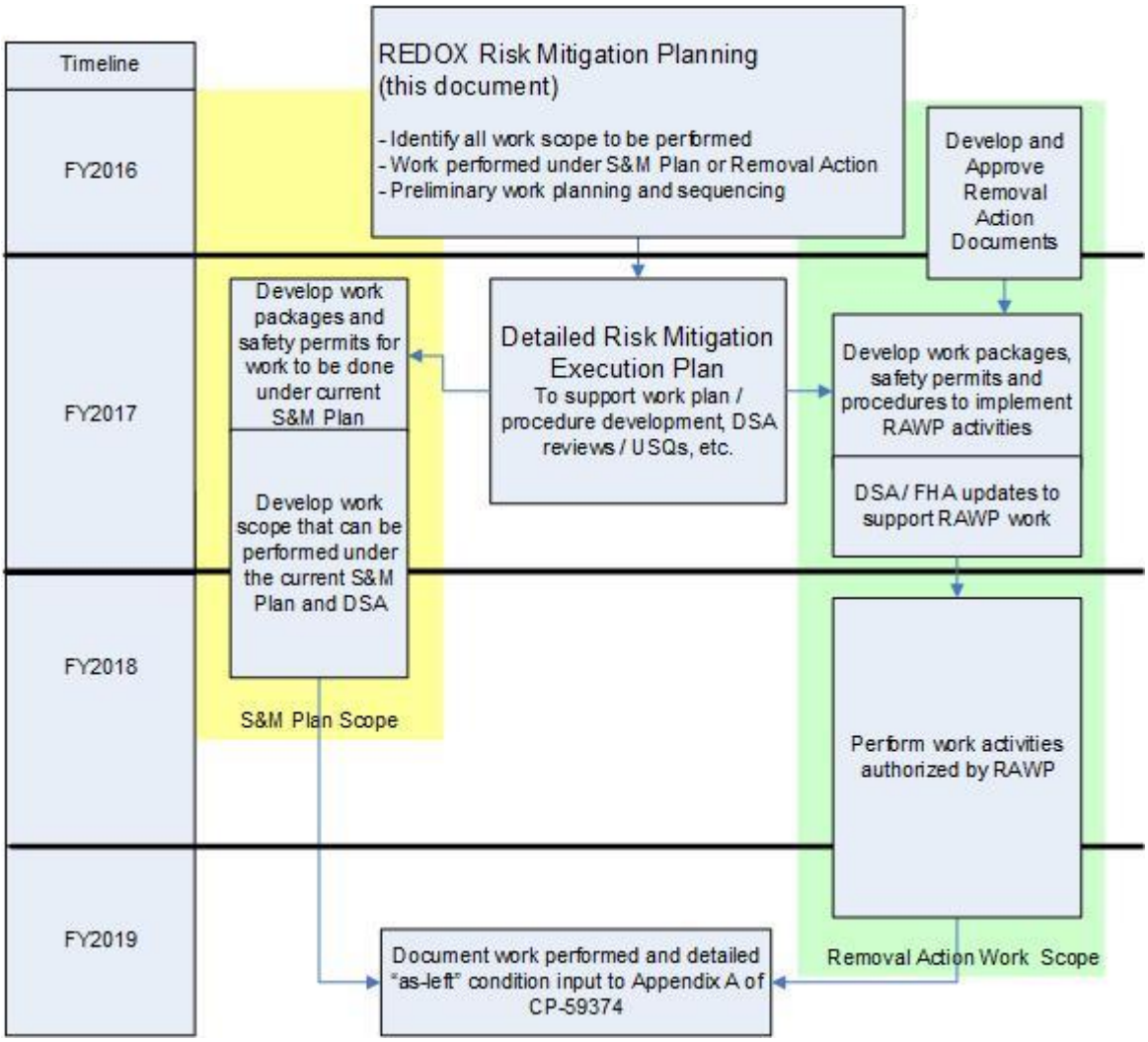
Terms

AM	action memorandum
AMU	aqueous makeup
CA	contamination area
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
COC	contaminant of concern
CMP	Crane Maintenance Platform
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DSA	documented safety analysis
Ecology	Washington State Department of Ecology
EE/CA	engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FY	fiscal year
HCA	high contamination area
HDR	header
MCC	motor control center
OU	operable unit
PPE	personal protective equipment
RAWP	removal action work plan
RBA	radiological buffer area
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	Reduction-Oxidation (S Plant)
S&M	surveillance and maintenance
SAP	sampling and analysis plan
SWP	special work permit
TRU	transuranic
USQ	unreviewed safety question
WDOH	Washington State Department of Health

1 Purpose and Scope

The purpose of this document is to plan the future risk mitigation activities for the Reduction-Oxidation (REDOX) Complex (202S) and ancillary structures not covered in other *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) decision documents (276S Hexone Storage Tanks, 293S Acid Recovery Building) (Figure 1-1). REDOX and ancillary structures are currently in a surveillance and maintenance (S&M) mode, awaiting a final decision document. To address current hazards in the building, an engineering evaluation/cost analysis (EE/CA) for REDOX (DOE/RL-2016-16, *Engineering Evaluation/Cost Analysis for the REDOX Complex*) has been developed to identify removal action alternatives for REDOX and analyze the effectiveness, ability to execute, and cost of the various alternatives. Once the EE/CA is approved (via issuance of an action memorandum (AM) (DOE/RL-2016-52, *Action Memorandum for the Reduction-Oxidation (REDOX) Complex*) by the U.S. Department of Energy (DOE) Richland Operations Office and concurred by the U.S. Environmental Protection Agency (EPA), a removal action work plan (RAWP) will be written to address how the work will proceed. A sampling and analysis plan (SAP) will also be generated to address how sampling will be performed to support work activities.

This document is intended to support CH2M HILL Plateau Remediation Company (CHPRC) initial S&M activities as well as the sampling, characterization, stabilization, demolition preparation, hazard mitigation, and demolition activities authorized by the EE/CA (DOE/RL-2016-16) and AM (DOE/RL-2016-52). The strategies and planning contained herein focus on the Silo, North Sample Gallery, Plutonium Load-Out Hood (in the North Sample Gallery), and Canyon Deck entry, based on near-term planned funded activities. This document is also intended to support future planning for risk mitigation activities when developing the RAWP, documented safety analysis (DSA) updates (REDOX is currently a Hazard Category 2 Building), fire hazard analysis updates, and SAP to ensure consistency among the planned project activities and the regulatory and safety documents. These changes may also require updates to various permits needed to support facility work efforts.



Reference: CP-59374, *Canyon Risk Mitigation Plan*.

Figure 1-1. Planned Fiscal Years 2017 through 2019 REDOX Activities

2 Facility History and Background

The REDOX Complex includes a main canyon facility and support structures. It is located approximately 36 km (22 mi) north-northwest of Richland, Washington, in an industrialized portion of the 200 West Area of the Hanford Site. Highway 240 is to the southwest of the REDOX Complex, and the Columbia River is north-northeast (Figure 2-1).

Public access to the Hanford Site is currently restricted and controlled at the Wye Barricade on Route 4 and the Yakima and Rattlesnake Barricades on State Highway 240. Unauthorized access to the REDOX Complex is prohibited. The complex buildings/structures are locked and a 1.8 m (6 ft) cyclone fence encloses the immediate areas, and entrance controlled by the Central Plateau S&M organization.

The REDOX Complex consists of the 202S Building (including the Canyon, Silo, and Annex), 293S Nitric Acid and Iodine Recovery Building, and *Resource Conservation and Recovery Act of 1976* (RCRA) 276S Hexone Storage Tanks (Figure 2-2). The closest operational building is the 222S Laboratory and associated support structures. The 222S Laboratory and its support facilities are not included in the scope of this document.

2.1 202S Canyon Building

The 202S Canyon Building (REDOX), also known as S Plant within the 200-CR-1 Operable Unit (OU), was constructed between 1950 and 1952 and began operations in 1952. It was the first large-scale, continuous-flow, solvent extraction process plant in the United States. REDOX operated for the recovery of plutonium from irradiated fuel rods. Shutdown activities began in 1967 and were completed in 1969, at which point the REDOX Complex was transferred to long-term S&M (HNF-13830, *Documented Safety Analysis for the Reduction-Oxidation Facility*).

The 202S Building and support buildings were designed to separate uranium, plutonium, and neptunium as individual product streams from fission products in the irradiated fuel. The building consists of three major substructures: Canyon, Silo, and Annex. The Canyon and Silo are large, heavily shielded metal and concrete structures. The Annex is a number of concrete structures made up of three subsections: North, Southwest, and East.

Figures 2-3 and 2-4 provide cross sectional views of the 202S Building along the west-east and north-south building axes. S&M activities are performed in accordance with the current S&M plan (DOE/RL-98-19, *Surveillance and Maintenance Plan for the 202-S Reduction Oxidation (REDOX) Facility*). Figures 2-5 through 2-9 are plan view illustrations of the building by gallery levels (one through five). In addition, the figures present the current general radiological conditions in the areas of the building that will be accessed during the performance of the work scope defined in this report. Water infiltration from the leaking canyon roof membrane has resulted in major contamination spreads in the galleries that historically have not been contaminated areas. Currently, a major project is underway to cover the existing REDOX Canyon roof, which will eliminate the water infiltration problems that have led to current contamination issues. Major areas of the 202S Building addressed in this document are described in the following subsections.

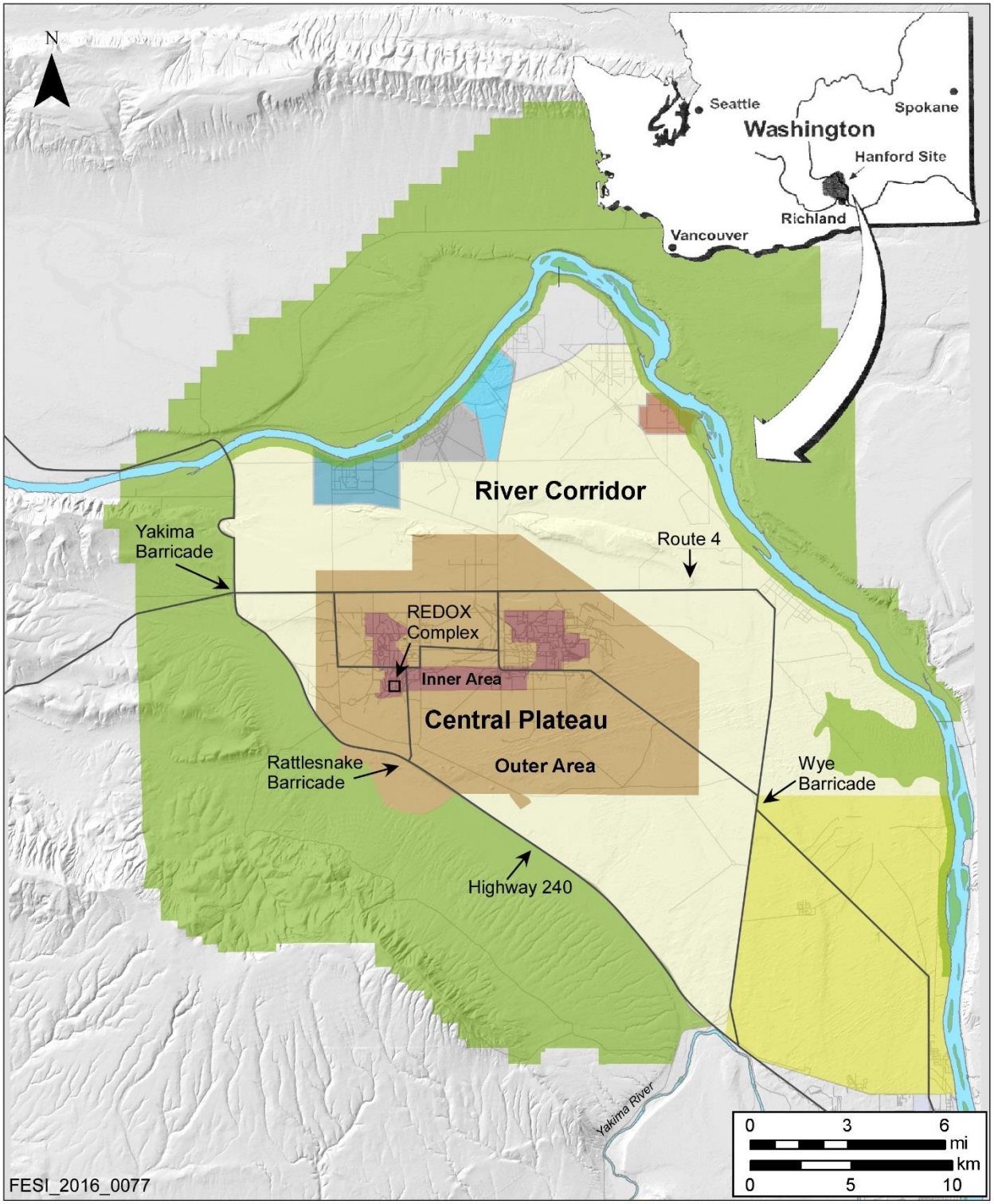


Figure 2-1. Hanford Site and REDOX Complex Location

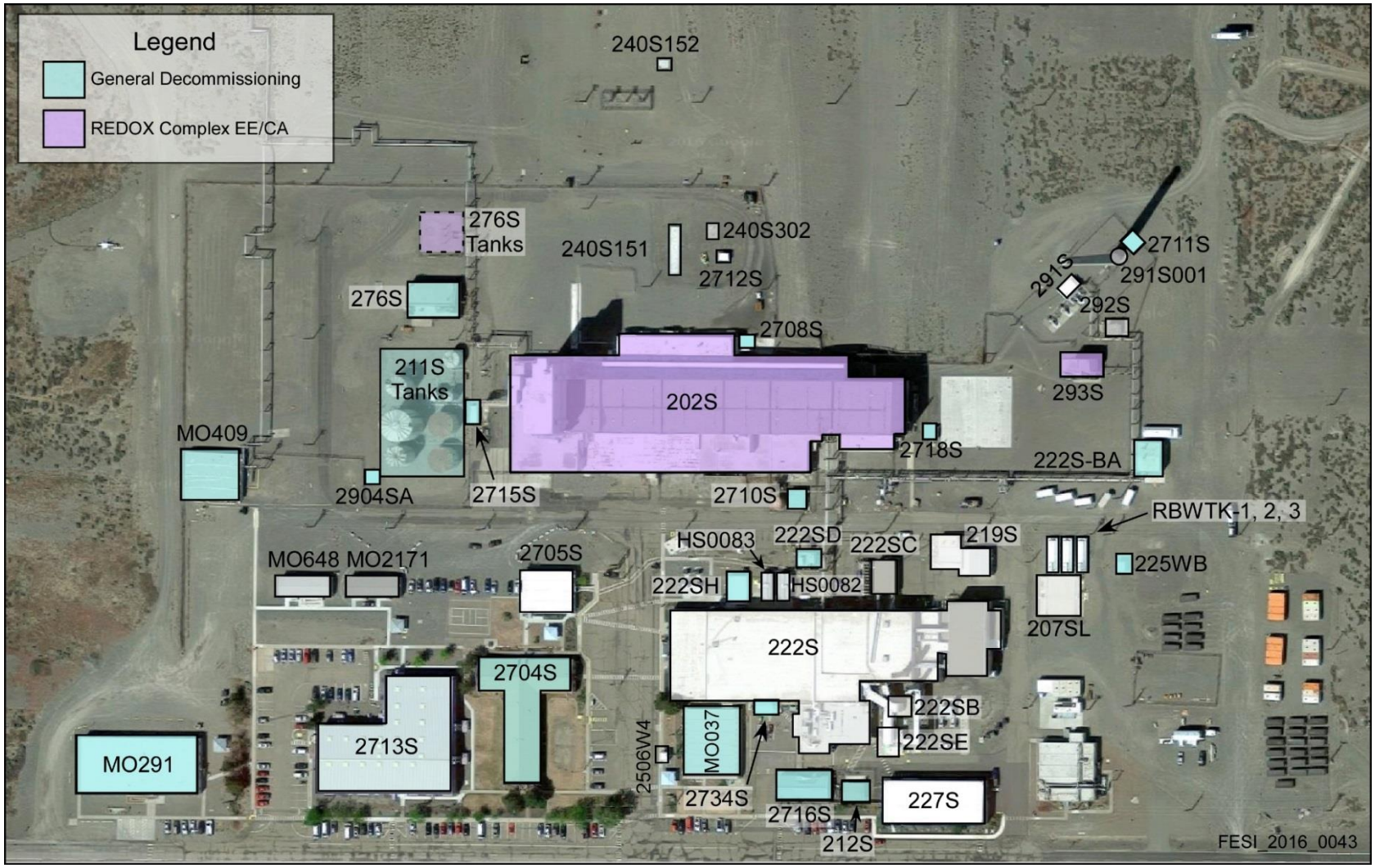


Figure 2-2. REDOX Complex Structures

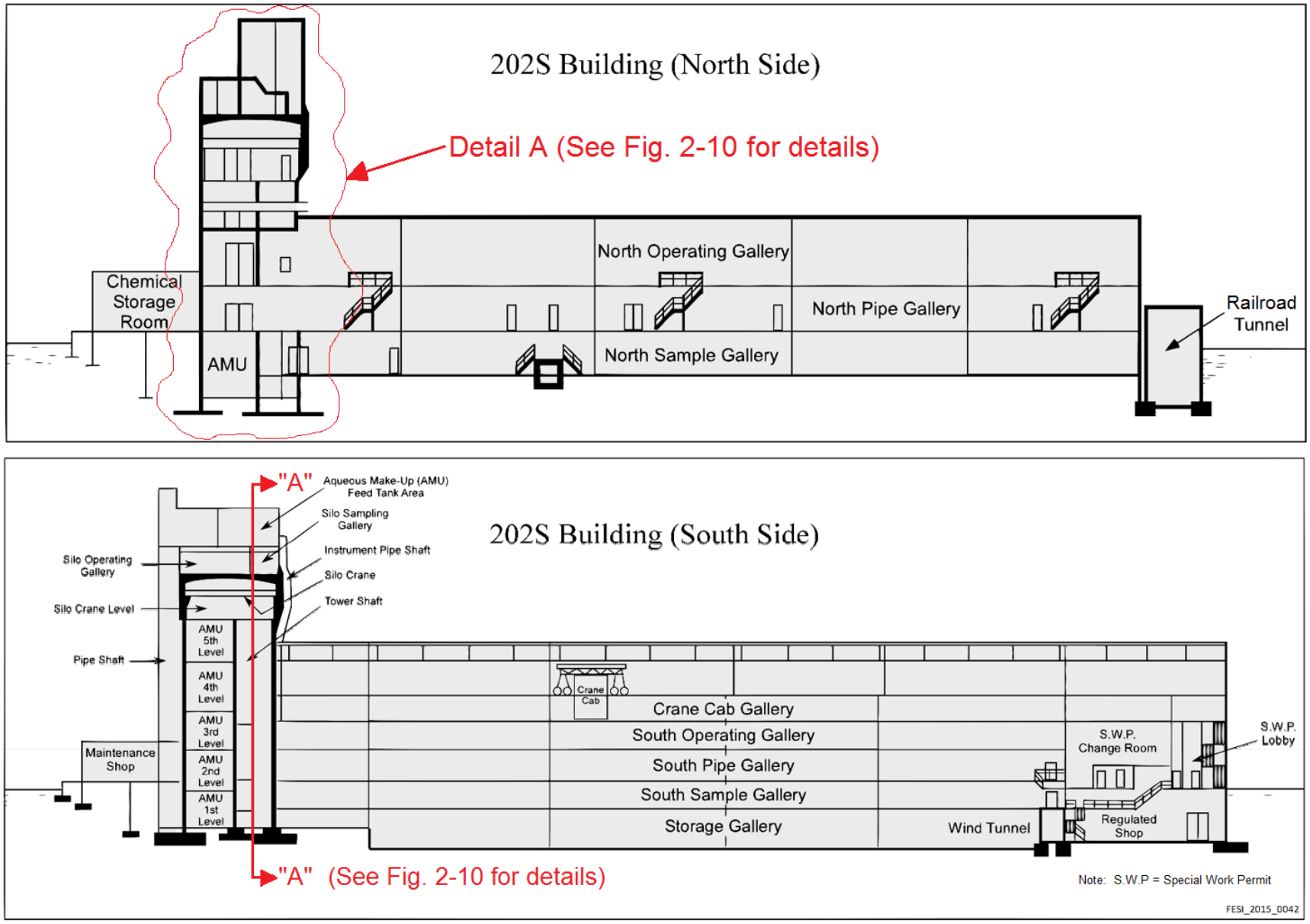


Figure 2-3. 202S Cross Section of Elevations

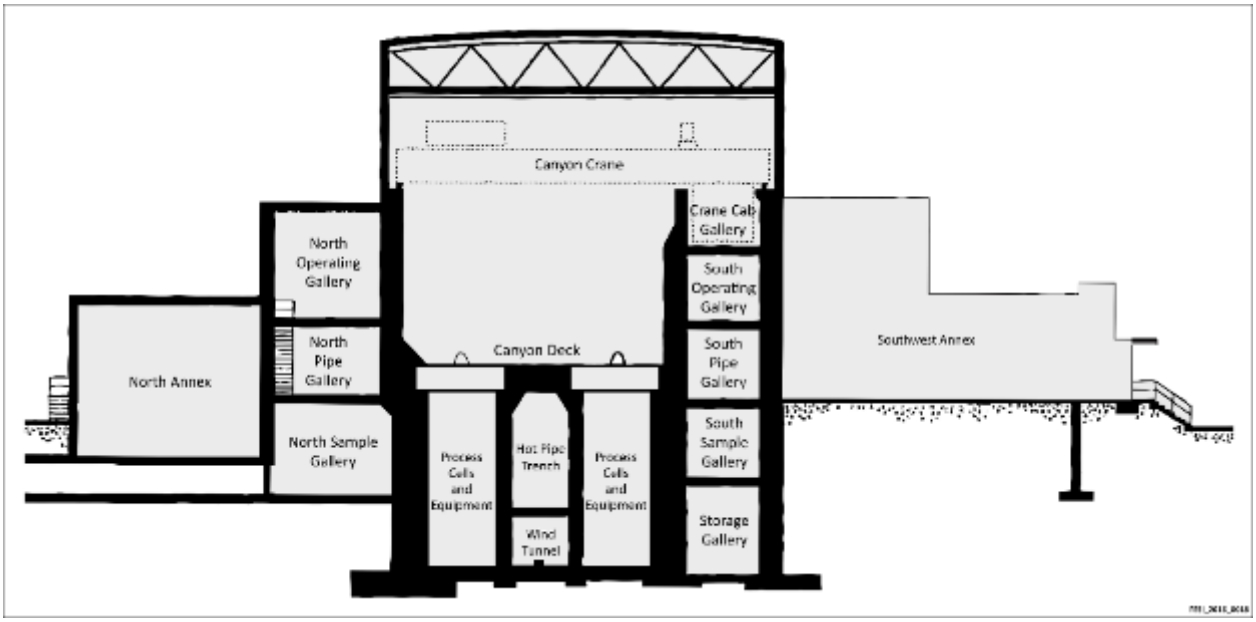


Figure 2-4. 202S Building Cross Section North to South (Facing East)

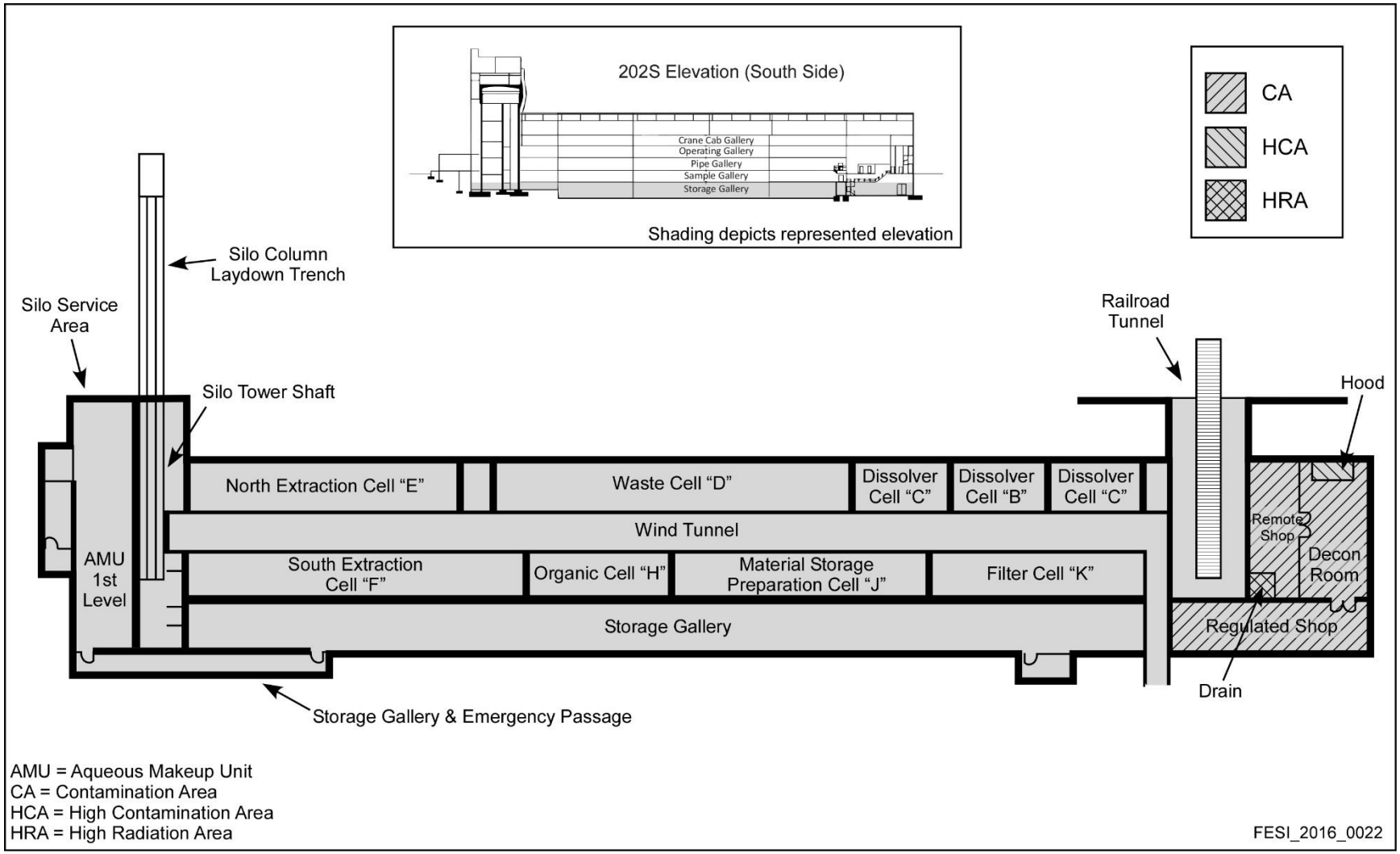


Figure 2-5. 202S Building Plan View Storage Gallery Floor Level

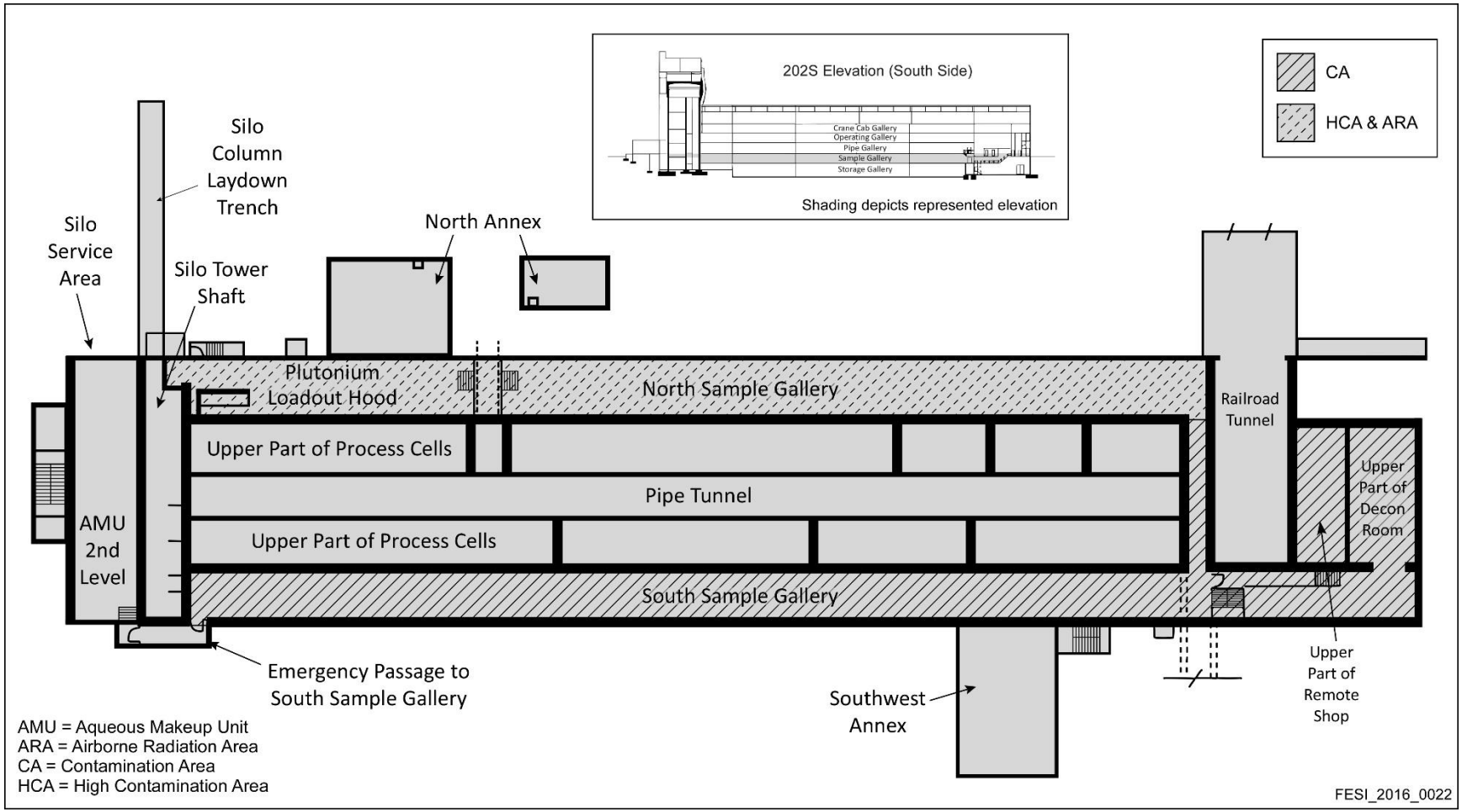


Figure 2-6. 202S Building Sample Gallery Floor Level

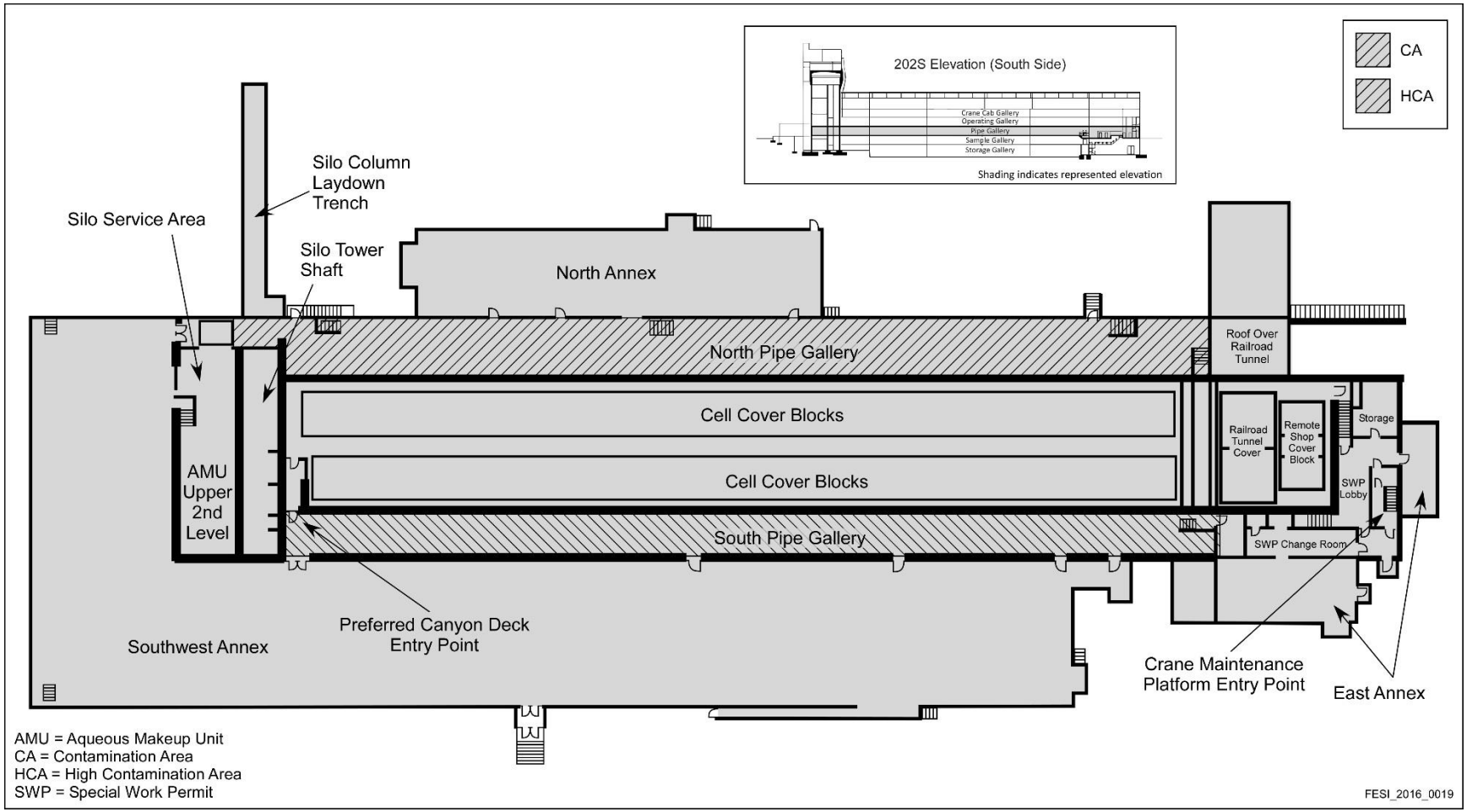


Figure 2-7. 202S Building Pipe Gallery Floor Level

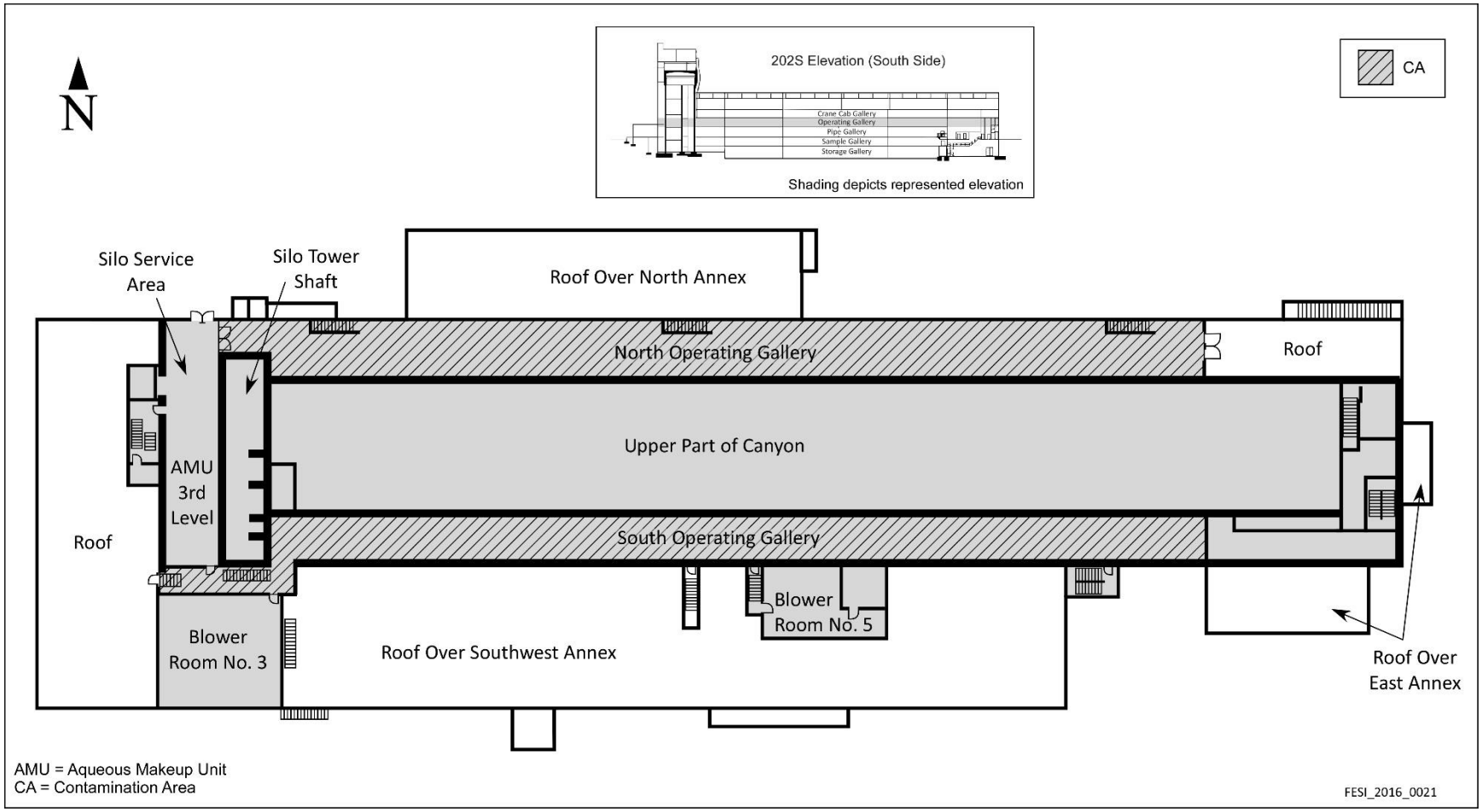


Figure 2-8. 202S Canyon Building Operating Gallery Floor Level

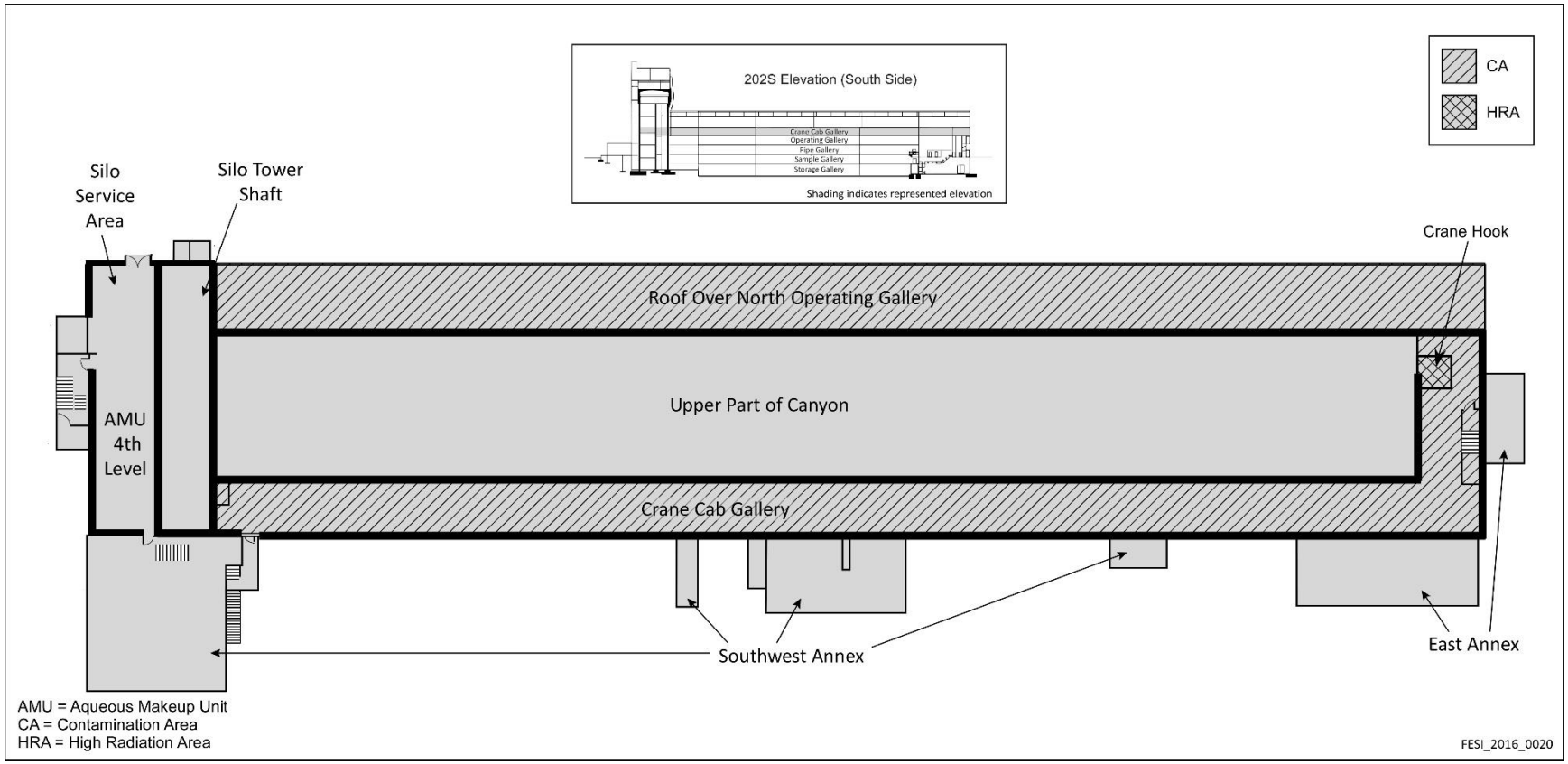


Figure 2-9. 202S Building Crane Cab Gallery Floor Level

2.1.1 202S Canyon

The 202S Canyon is a large, multistory, concrete structure with reinforced concrete walls. The building is 142 m (468 ft) long, 19.5 m (64 ft) wide, and 49 m (161 ft) high with 18.3 m (60 ft) abovegrade. The canyon, which lies on an east-west axis, contains all the equipment for dissolving fuel elements, preparing radioactive column feeds, distilling solvents, concentrating and neutralizing waste, and treating process gaseous wastes. Abovegrade areas include the Canyon Deck, North and South Pipe Galleries, North and South Operating Galleries, and the South Crane Cab Gallery. Approximately half of the building is constructed belowgrade, with processes performed below the Canyon Deck for shielding purposes (Figure 2-4). Belowgrade areas include the North and South Sample Galleries and the Storage Gallery (located on the south side of 202S). The process cells, Wind Tunnel, and Hot Pipe Trench are belowgrade and below the Canyon Deck.

2.1.1.1 Canyon Deck

One large room, referred to as the Canyon Deck, extends the entire length of the building with walls separating it from galleries on the east and west sides, and the floor separating it from the process cells and Hot Pipe Trench. The Canyon Deck floor consists of removable cell cover blocks measuring 1.2 m (4 ft) thick.

The cover blocks are stepped to eliminate the direct path of radiation streaming and skyshine. The cover blocks are removable by crane to access and install equipment in the process cells located below the Canyon Deck. Because the crane has been deactivated, the highly contaminated process cells are not currently accessible (Figure 2-4).

2.1.1.2 Crane Area

The canyon has two cranes. The largest is electrically driven and operates on tracks running lengthwise on both sides of the canyon. This crane has a 60-ton capacity main hoist, a 10-ton rotating auxiliary hook, and two dual-auxiliary hoists of 0.5 and 1-ton capacities, respectively. The 60-ton crane was operated via an attached crane cab that hung below the crane and was located behind a shielding wall. The area behind the shielding wall is referred to as the Crane Cab Gallery and is located on the south side of the canyon, directly above the South Operating Gallery. The crane was used to remove the cover blocks and move equipment between the Canyon Deck, process cells, and Railroad Tunnel. It was operated remotely from the Crane Cab Gallery. The second crane has a 2-ton capacity, is electrically operated, and is mounted on a monorail running cross-wise at the east end of the canyon. This crane is used for servicing the main crane.

2.1.1.3 Process Cells

The process cells contain deactivated processing equipment formerly used in spent fuel separations. Nine process cells are located in two parallel rows with a concrete Hot Pipe Trench and Wind Tunnel between the rows, separated by 0.6 m (2 ft) thick concrete walls for shielding.

The nine process cells are identified by letters, as follows:

- Cell A - Dissolver Cell
- Cell B - Dissolver Cell
- Cell C - Dissolver Cell
- Cell D - Waste Cell (treatment)
- Cell E - North Extraction Cell
- Cell F - South Extraction Cell
- Cell G - Organic Cell (recovery)

- Cell H - Metal Solution Preparation Cell
- Cell J - Filter Cell

Process cells A, B, and C were used for dissolving irradiated uranium fuel slugs received from the 100 Area reactor complexes. Cell D was a waste treatment cell that was used for neutralizing and concentrating waste solutions. Cells E and F were extraction cells that handled the solutions pumped to and from the solvent extraction columns. Cell G was used to decontaminate and purify organic solvent for reuse. Cell H was a metal solution preparation cell that prepared the dissolved fuel element feed solution. Cell J was a filter cell used to decontaminate process offgases prior to discharge through the 291S sand filter and stack.

While preparing for shutdown, all process equipment and piping were flushed to remove much of the chemical and radiological contamination; however, significant quantities of residual chemical and radiological materials from past processing remain. The process cells are estimated to contain the vast majority of the remaining chemical and radiological inventory in the 202S Canyon (Chapter 6).

2.1.1.4 Hot Pipe Trench

The Hot Pipe Trench contains a network of transfer piping used to convey product and waste streams between process cells during operations. The Hot Pipe Trench was flushed during shutdown activities to remove and reclaim any product; however, residual contamination is expected.

2.1.1.5 Wind Tunnel

During operations, the Wind Tunnel provided exhaust ventilation to all process cells and the Silo Tower Shaft. Process equipment discharged offgases directly into the Wind Tunnel, which was flushed during shutdown activities to remove and reclaim product; however, residual chemical and radiological contamination is expected (Appendix B [Table B-1] describes this activity, conducted in 1965).

2.1.2 Galleries

Sample, operating, and pipe galleries are located along the north and south sides of the canyon. A storage gallery is located below all other galleries on the south side of the canyon. The galleries contain instrumentation, tanks, and piping that supplied processing areas. Galleries contained water services and supplied air and gases for instrumentation and processes. Tanks and instruments in the sample and pipe galleries were connected to process cells by connectors mounted on the gallery walls of the cells. Figures 2-5 through 2-9 are plan view illustrations of the REDOX galleries.

2.1.2.1 Storage Gallery

The Storage Gallery was used to store support equipment and material. The gallery is located on the south side of the building and is the lowest gallery level (Figure 2-6).

2.1.2.2 Sample Galleries

The North and South Sample Galleries, located on the north and south sides of the canyon, respectively, were used to collect radioactive process samples from the process equipment through highly shielded sample boxes on the walls shared between the galleries and the canyon. Solutions and products were collected using vacuum jets from process streams. The sampling equipment remains in the galleries and the internal configuration is unknown. In addition to sample boxes, there are numerous chemical lines that run overhead and miscellaneous equipment such as carts, tanks, and lead bricks. The Sample Gallery elevation is depicted in Figure 2-6. The following subsections address areas of the galleries where contamination exists as well as past problem areas.

North Sample Gallery and Plutonium Loadout Hood

On the west end of the North Sample Gallery is a rise with steps known as the Waste Line Tunnel (called the Hump) that runs beneath the gallery. The Hump houses pipelines that diverted waste to the 240S151 Diversion Box north of the 202S Building. The area west of the Hump contains more sample boxes and chemical lines, as well as the Plutonium Loadout Hood.

The Plutonium Loadout Hood, also referred to as the Product Receiver Cage, is located at the west end of the North Sample Gallery (Figure 2-6). The Plutonium Loadout Hood is an L-shaped enclosure for housing equipment that was used for the concentration of the plutonium product solution prior to shipment. The Plutonium Loadout Hood is composed of a metal frame supporting a series of Lexan™ panels. This enclosure isolates the process vessels and piping inside the hood from the North Sample Gallery. The Lexan part of the hood is approximately 2.55 m (8 ft 6 in.) high and sits on a raised concrete curb (15.2 cm [6 in.] high). The topmost 0.6 m (2 ft) of the hood is enclosed by stainless steel panels. The hood is configured in an L shape, with the base leg 3.4 m (11 ft) long and 1.5 m (5 ft) wide, and the other leg 5.2 m (17 ft) long and 1.5 m (5 ft) wide (BHI-01299, *Alternative Evaluation for the REDOX (202-S) Plutonium Loadout Hood*). The room is equipped with a stainless steel lined floor to support spill recovery.

The Plutonium Loadout Hood operated from 1951 to 1955. During operations, plutonium solutions from separation activities within the 202S Building were piped to the hood for concentration and loadout of the liquid plutonium nitrate product. In 1955, operations in the hood ceased because improved capabilities were provided in the 233S Plutonium Concentration Facility. Upon cessation of operations in the Plutonium Loadout Hood, the system was deactivated. The Plutonium Loadout Hood was historically serviced by a dedicated ventilation system that is no longer active. Currently, this area is ventilated by the Canyon Air Tunnel and is maintained at a slight negative differential pressure with respect to the North Sample Gallery.

Records and process knowledge indicate that flushing of the piping and vessels in the Plutonium Loadout Hood was performed during the removal of loadout components that were relocated to the 233S Building. Flushing was accomplished using nitric acid to decontaminate the internals of the hood and ancillary equipment followed by water (BHI-01255, *Interim Characterization Report for the REDOX Plutonium Loadout Hood*; 0200W-US-N0156-02, *Pu Loadout Hood Stabilization*).

The Plutonium Loadout Hood is radiologically contaminated; it was stabilized in 1999 to prevent the spread of contamination during S&M activities (BHI-01255; 0200W-US-N0156-02). Planned stabilization activities initiated in 1999 consisted of stabilizing the Plutonium Loadout Hood, decontaminating a large area within the North Sample Gallery, stabilizing former process and waste lines, and isolating the EF-8 exhaust system. The Plutonium Loadout Hood stabilization was accomplished by placing absorbent material in the sump, sealing the Plutonium Loadout Hood, and isolating the sampler hoods in the North Sample Gallery from the EF-8 exhaust system.

Figure 7-2 shows the layout of tanks within the Plutonium Load-Out Hood.

L-16 to H-4 Transfer Line (2 in. Schedule 40)

The H-4 Transfer Line is constructed of 488 ft of 2 in. schedule 40 stainless steel pipe. Elbows and rolling offsets are welded to the pipe sections. The pipe originated in the 233S Building and came from the L-l6 Recycle Tank (three vertical pipes 6 in. in diameter by 56 in. tall) that received any recycle (off-standard) plutonium solutions that needed reworking. The pipe enters the 202S Building in the North Sample Gallery at the north wall. Immediately following a rolling offset is a 15 in. long north-to south horizontal section. The pipe then turns east for approximately 8 ft after a 90 degree elbow; then turns south for

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another 8 ft after a second 90 degree elbow. Immediately after a tee connecting a run of l in. tubing to the pipe is a 2 in. schedule 40 valve. The following subsections discuss this 1 in. pipe under the branch circuit to Samplers E-1 and E-3. The tee and valve are approximately 7 ft above the Gallery floor. Another valve is found approximately halfway down the North Sample Gallery. The pipe continues to the south wall of the North Sample Gallery, where it turns toward the east. The pipe continues down the length of the North Sample Gallery, then turns south, running along the west wall of the North-South Corridor connecting the North and South Sample Galleries. The pipe turns back toward the west and runs along the north wall of the South Sample Gallery, before terminating at a valve at the H-Cell. The valve is connected to a wall mounted flange that is connected to the H-4 Oxidizer Tank located in H Cell of the 202S Canyon.

233S Deactivation Process

The deactivation process for the 233S Building included the piping section known as L-16 to H-4 Transfer Line. As discussed in ISO-1108, *REDOX Deactivation Manual*, the 233S deactivation involved a solution containing 57 percent nitric acid and 1 percent boric acid that was used to flush the internal surfaces of pipes and vessels in the 233S greenhouse. This solution was then routed via the L-16 to H-4 line to H Cell for reprocessing. A second solution made of 10 percent nitric acid and 1 percent boric acid was used to clean the external surfaces of the pipes and vessels in 233S, which then followed the same route through L-16 and H-4 to D Cell.

Residuals of these decontamination solutions remain in the L-16 to H-4 line, as noted in BHI-01255.

Branch Line to Samplers off the L-16 to H-4 Line

Directly adjacent to the east end of the Plutonium Loadout Hood in the overhead of the North Sample Gallery is a 1 in. stainless steel line that branches off the L-16 to H-4 line. This line feeds the E-1 and E-3 Samplers. In 1995, a leak from the E-3 Sampler valve into the 146 Sample Box indicated high levels of alpha contamination. A cleanup of this area was initiated to reduce the potential for further contamination spread. Based on this characterization, the content of this line contains residual of the original plutonium nitrate solution or the decontamination solutions used in the deactivation of the 233S Facility. Odds of significant quantities of fission products are small since all the associated pipes are off product return lines from the 233S Building, whose feed materials (all alpha products) were end products of the REDOX process.

202S North Sample Gallery West Bag

A plastic bag was placed on a leaking flange on the pipe marked ‘Acid HDR from 204’ when the gallery was cleaned up as part of the activities conducted in 1999 to stabilize the North Sample Gallery (Appendix A, photographs A-3 through A-5). This bag was located approximately 180 ft from the east end of the North Sample Gallery and was installed to confine further leakage from a pipe flange. In 2016, the bag was removed from the pipe and the leaking flange was sealed in order to prepare the area for further hazard mitigation activities, as defined in this report. Historically, this pipe is depicted in drawing H-2-30603, *Nitric Acid Piping from 204-S to Recovered Acid Header*; its purpose was to transport nitric acid that was recovered from the UO_3 Plant. The acid in this line still contained small quantities of uranyl nitrate hexahydrate; this acid was not able to be used for process such as the third plutonium cycle. This line is not found on the original engineering drawings because it was later installed as part of project CG-722, and the details are in HW-44715, *Utilization of UO_3 Plant Recovered Acid Design Criteria*, and HW-51257, *Scope & Design Criteria Revision, Utilization of UO_3 Recovered Acid at REDOX and PUREX*. As part of these planned work activities, the line will be checked for liquids and drained, the flanges will be removed, the two ends of the pipes will be threaded, and pipe caps will be installed.

202S North Sample Gallery East Bag

Again, this plastic bag was replaced on a leaking valve that interconnects the ‘Steam Cond from L-2, L-3, L-12 to D-12’ line to the ‘L-16 to H-4’ line when the gallery was cleaned up as part of the activities

conducted in 1999 to stabilize the North Sample Gallery (Appendix A, photographs A-1 and A-2). This bag is approximately 130 ft from the east end of the North Sample Gallery. In 2016, the bag was removed from the valve and the valve was sealed with metal tape in order to prepare the area for further hazard mitigation activities, as defined in this report. Historically, to find the valve on an engineering drawing, the pipe labeled "Steam Cond from L-2, L-3, L-12 to D-12" was investigated, which is associated with Project CGC-913. The valve in question was found in the document *233S Information Manual* (referenced in CP-60059, *Bags in REDOX North Sample Gallery*). Clean steam entered the 233S condenser coils in L-2, L-3, and L-12. Condensate from these coils was then routed into 202S waste cell for disposition. In the event of a coil failure, provisions were added to allow the condensate to be routed into the L-16 to H-4 line for reclamation in H Cell. The leaking valve is the interconnection between the 'Steam Cond from L-2, L-3, L-12 to D-12' line and the 'L-16 to H-4' line. The assessment of the content of this bag (east end) most likely contains plutonium nitrate based on the historical use for the line it is attached to and the deactivation solution used to decontaminate the 233S Facility. Odds of the collected material containing neptunium nitrate are small, because no records of an L-2 condenser coil failure were found and neptunium runs only occurred a few times a year. Odds of significant quantities of fission products are small since all the associated pipes are return lines from the 233S Building, whose feed materials (all alpha products) were end products of the REDOX process. It should be noted that the piping is sloped so gravity pulls the liquids in an eastern direction. As part of the current planned work activities, the line will be checked for liquids and drained, the pipe will be removed and the line to the D-12 wall nozzle will be plugged at the isolation valve (Appendix A, photograph A-3, the upper black valve).

South Sample Gallery

The South Sample Gallery was used to collect samples from the process cells through highly shielded sample boxes on the walls shared between the galleries and the canyon. Solutions and products were collected using vacuum jets from process streams. This equipment remains and the internal configuration is unknown. In addition to sample boxes, numerous chemical lines run overhead, and miscellaneous unused equipment such as carts, tanks, and lead bricks are located in this gallery.

2.1.2.3 Pipe Galleries

There are two pipe galleries, the North Pipe Gallery and the South Pipe Gallery. The pipe galleries contain piping and junctions that were used to transfer nonradioactive chemicals and solutions during plant operations (Figure 2-7) via fixed wall mounted flanges.

2.1.2.4 Operating Galleries

The North Operating Gallery and South Operating Gallery are located on the north and south sides of the canyon and are the highest gallery level (Figure 2-8). The operating galleries include instrumentation panels, control valves, and tanks that were used during operations to remotely control and monitor activities that occurred in the canyon cells.

2.1.3 East End Rooms

During REDOX operations, tanks, piping, and other equipment from the canyon cells were removed by remote handling to a maintenance area located at the east end of the canyon. The Maintenance Shop area consists of a lobby used as a central staging area and the Hot Shop, Decontamination Room, and Regulated Shop.

2.1.3.1 Hot Shop

Also known as the Remote Shop, the Hot Shop is two-stories high, located to the east of the Storage Gallery and North and South Sample Galleries, directly east of the Railroad Tunnel. The Hot Shop includes a removable 1.2 m (4 ft) thick ceiling panel (cover block) that provides access into the canyon

process area. Equipment, tools, and other supplies could be transferred between the Canyon Deck and Hot Shop via the overhead crane. The Hot Shop is equipped with a stainless steel floor and a hot drain where contaminated equipment was flushed and rinsed with decontaminants. This drain is a radiation area. The Hot Shop is a 12.3 m (40.5 ft) by 4.6 m (15 ft) room with an 8 m (26.25 ft) high ceiling. Due to the nature of the work conducted in this room, surface contamination of mixed fission products is present in this space. The floor of the Hot Shop is known to be contaminated.

2.1.3.2 Decontamination Room

Equipment and tools delivered to the Hot Shop from the canyon process area were likely contaminated from processing activities. Equipment requiring repair or modification as well as any tools used in contaminated areas were moved to the Decontamination Room to undergo decontamination activities to reduce or remove contamination. The Decontamination Room contains two hooded sinks that were equipped with water, steam, and acid service for further decontamination of equipment. Decontamination activities were conducted under a ventilation hood and the area in and around these hoods have the potential for significant contamination. The Decontamination Room is a 12.3 m (40.5 ft) by 7.3 m (24 ft) room with a 6 m (19.67 ft) ceiling.

2.1.3.3 Regulated Shop

Following decontamination, equipment would undergo contact maintenance in the Regulated Shop, a 20 m (65.5 ft) by 3.9 m (12.75 ft) room with a 6 m (19.75 ft) high ceiling. Maintenance was performed under controlled conditions in the Regulated Shop.

2.1.3.4 Special Work Permit Lobby

The special work permit (SWP) lobby is a central staging area that is accessed through an air lock on the South Pipe Gallery level. The SWP lobby provides access to the Health Instrument Storage Room as well as a stairwell that leads to the Canyon Deck.

2.1.4 Silo

The silo is an eight-story structure located at the west end of the 202S Building. The silo is segregated into two parts: Silo Service Area and Silo Tower Shaft. The silo is 40 m (132 ft) high, with 35.7 m (117 ft) abovegrade. Figure 2-10 presents a cross section of the 202S Silo, including the Silo Service Area and Silo Tower Shaft. The exterior walls of the silo vary from 0.46 m (1.5 ft) to 0.91 m (3.5 ft) in thickness.

2.1.4.1 Silo Service Area

The Silo Service Area has eight levels, the first five of which are aqueous makeup (AMU) levels. The sixth level is occupied by the silo crane, and the Silo Operating Gallery and Sample Gallery are on the seventh level. The eighth level contains the blower room and feed tank area.

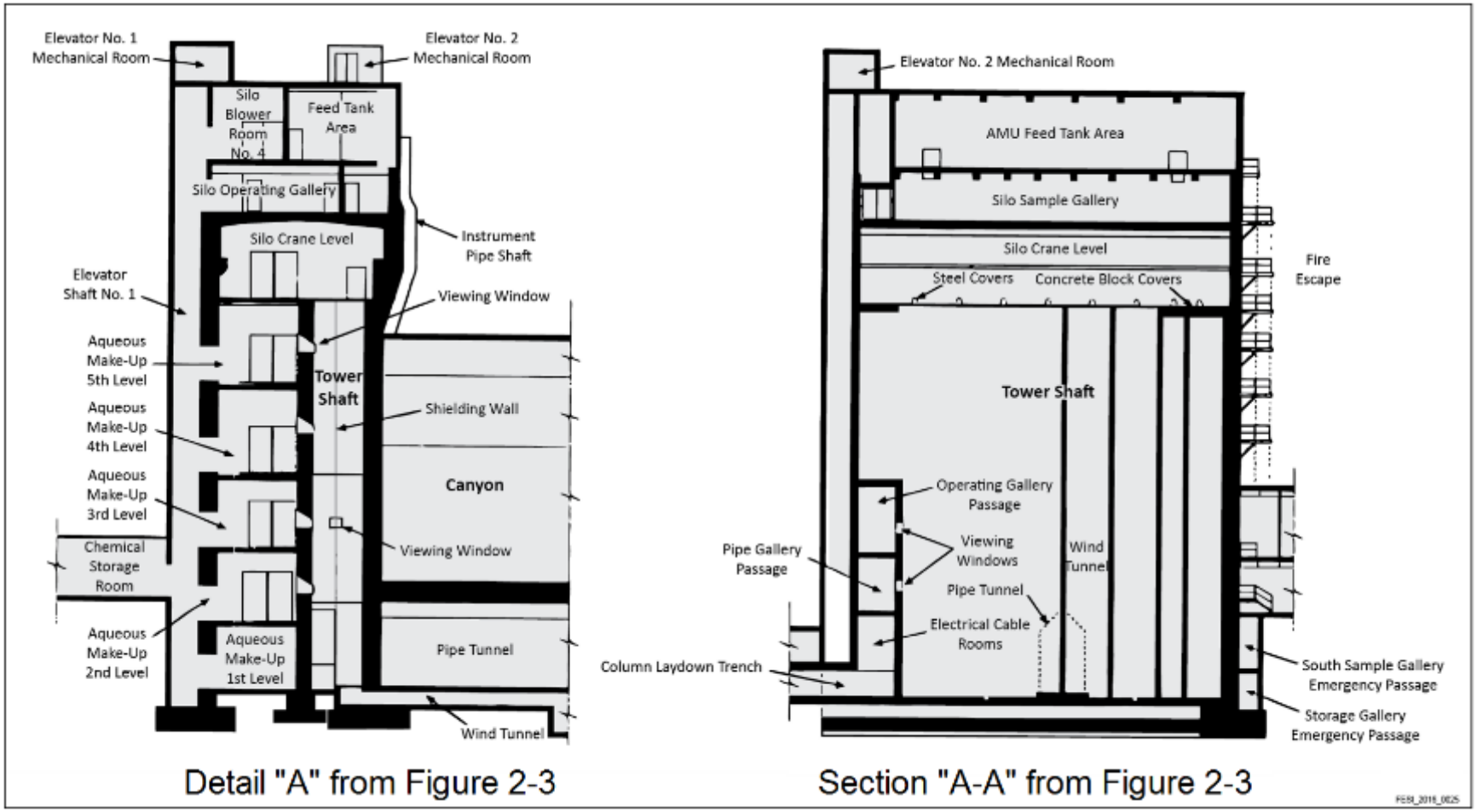

Figure 2-10. 202S Silo Cross Section Elevation View

2.1.4.2 Silo Tower Shaft

The Silo Tower Shaft area is separated from the Silo Service Area by concrete shielding. The tower shaft contains 13 solvent extraction columns and process jumpers. The columns were remotely operated from the Operating Gallery. Chemicals were gravity fed from the AMU feed tanks to the columns. The solvent extraction columns were removed and brought into the facility through the Column Laydown Trench, located on the north side of the silo. The tower shaft is 25.6 m (84 ft) high, 20.4 m (67 ft) long, and 3.3 m (11 ft) wide. The height of the solvent extraction columns varies between 9.7 m (32 ft) and 16.8 m (55 ft), depending on process function; column diameter varies between 7.62 cm (3 in.) and 25.4 cm (10 in.).

The tower shaft is highly contaminated due to the nature of the chemicals that were used and the radionuclides that were processed in this area. Operations within the tower shaft were viewed through lead glass, mineral oil filled viewing windows located at each of the remote station locations for operating the crane. Sixteen viewing windows are installed in the wall between the tower shaft and AMU levels. Another viewing window is located in the north wall of the tower shaft at the Operating Gallery level. These viewing windows are arranged in a pattern that provides a complete view of the equipment, connectors, and piping in the shaft. Process streams were sampled from the Silo Sampling Gallery, located above the Silo Crane Operating Area.

2.1.4.3 Column Laydown Trench

Columns were transferred into and out of the tower shaft through an underground tunnel known as the Column Laydown Trench (Figure 2-5). The Column Laydown Trench, located beneath the Silo Tower Shaft and extending underground to the north of the 202S Building, was designed to facilitate the replacement of failed columns during plant operations. The Column Laydown Trench is radioactively and chemically contaminated and is posted as a Radiation Area.

2.1.5 202S Annex

The 202S Annex is separated from the main Canyon structure by massive concrete shielding. Three sub-annexes comprise the REDOX Annex (Figures 2-6 through 2-9). These nonradiological processing areas contain offices, administrative support areas, and equipment rooms that are described in the following paragraphs. Historically, they are minimally contaminated due to cross contamination vectors. The annex buildings were included during the original construction of the 202S Building.

2.1.5.1 North Annex

The north service area contains a 2.4 kV switchgear room, a wet cell battery room, the north 480 V switchgear room, Blower Room #2, Cable Room #1, Cable Room #2, the former electric shop, and an office. Blower room #2 contains a deactivated supply fan for the north pipe and operating galleries. The electrical shop contains the motor control center (MCC) and the lighting panel for the operating equipment in the REDOX Complex.

2.1.5.2 Southwest Annex

The south and west service areas contain Blower Room #1, Blower Room #3, Blower Room #5, Cable Room #3, a compressor room, the south 480 V switchgear room, and the former chemical storage, equipment, shop, and offices. Blower Room #1 houses three deactivated supply fans for the REDOX Complex. The compressor room contains an air compressor and an instrument air dryer. The south 480 V switchgear room contains MCCs that have been deactivated. A beryllium contaminated area is located in the Administrative Room and adjacent Main Corridor of this section of the building; additional details are provided in CHPRC-202S-14-001, *Hanford Job Specific Beryllium Work Permit*.

2.1.5.3 East Annex

The east end segment of the Annex contains the former hot shops for the facility and the Railroad Tunnel access to the canyon processing area. This area is used for access to the 202S Canyon for ongoing S&M activities.

2.2 Ancillary Structures

In addition to the main process areas, the REDOX Complex includes multiple buildings that were formerly used to store chemicals, materials, and support systems (e.g., ventilation, exhaust stacks, and environmental monitoring systems). The majority of the ancillary structures are authorized for demolition in the General Decommissioning AM and RAWP and, therefore, are not covered in this document. This section describes the ancillary facilities/structures that are included in the scope of this document.

2.2.1 276S Hexone Storage Tanks (276S141 and 276S142)

Two hexone tanks (276S141 and 276S142) are buried north of the 276S Building. These single-shell, carbon steel storage tanks each have a capacity of 90,850 L (24,000 gal) and were formerly used to store virgin hexone solvent for the REDOX Complex during operations. From 1990 through 1992, 132,000 L (35,000 gal) of the solvent remaining in the tanks were recovered, distilled, and incinerated at an offsite location. The process used to drain and flush the waste solvent is discussed in WHC-EP-0570, *The Distillation and Incineration of 132,000 Liters (35,000 Gallons) of Mixed-Waste Hexone Solvents from Hanford's REDOX Plant*. Residual sludge in the tanks from the distillation process was grouted as an interim closure in 2002 (BHI-01142, *REDOX Facility Safety Analysis Report*; 0200W-US-N0217-02, *REDOX, Stabilization of Hexone Tanks*). The remaining void space in the tanks was subsequently grouted and left in place, pending final removal as specified in DOE/RL-2009-112, *Hexone Storage and Treatment Facility Closure Plan*. The closure plan proposes that the tanks will be clean closed by complete removal of the tanks and surrounding soil.

2.2.2 293S Nitric Acid and Iodine Recovery Building

The 293S Nitric Acid and Iodine Recovery Building is located to the east of the 202S REDOX Building, directly south of the 291S Ventilation System. The Building was in service from 1958 through 1967 to provide absorption of nitrogen oxides (nitric acid) and volatile fission products (primarily iodine) from REDOX dissolver offgas streams. The acid fumes were captured in a nitric acid absorber, and radioactive iodine was removed using a caustic scrubber system.

The concrete portion of the building (29 by 16 ft) extends from 12 ft belowgrade to 30 ft abovegrade. The main floor houses the absorption towers with a pipe valve pit in the basement.

The 293S Building housed the nitric acid and radioactive iodine recovery processes. The recovered nitric acid was stored in an underground, cylindrical, stainless steel nitric acid storage tank (3 m [10 ft] high by 3 m [10 ft] in diameter), located directly west of the 293S Building. The tank is currently empty.

2.2.3 291S Exhaust System

The 291S exhaust system provides active confinement and treatment of radiological particulate before the exhaust is released to the environment. The system operates to filter the release under normal operations and to minimize the spread of contamination from the canyon to gallery areas.

During hazard mitigation activities, the electrical power will be re-routed to the site to reduce potential electrical hazards throughout the building.

2.2.3.1 Wind Tunnel

The Wind Tunnel is a reinforced concrete, belowgrade structure that connects the 202S (e.g., silo shaft, canyon cells, and Remote Shop) to the 291S exhaust stack.

2.2.3.2 Exhaust Fans

Exhaust fans (EF-1 and EF-2) for 202S are located outside the 291S Building. Two stainless steel, direct-driven blowers are installed in parallel and are powered by 60 hp electric motors. The two fans are run alternately, as required. The 291S Building is not occupied but is entered routinely for surveillance.

2.2.3.3 291S Sand Filter

The 291S sand filter removes radioactive particles from exhaust air before the air is discharged to the atmosphere. The sand filter is a belowgrade structure, approximately 29.5 m (85 ft) by 29.5 m (85 ft) by 6.1 m (20 ft), consisting of approximately 3.9 m (12 ft) of sand and 2.4 m (8 ft) of air space in a concrete shell. The filter medium decreases in particle size from coarse gravel at the bottom to 30-mesh sand at the top. The roof over the sand filter was repaired and is in good condition.

2.2.3.4 291-S-1 Operating Stack

The 291-S-1 stack is included in AOP-00-05-006, *Hanford Site Air Operating Permit*, for 40 CFR 61, “National Emission Standards for Hazardous Air Pollutants,” and WAC 173-401, “Operating Permit Regulation.” Under AOP-00-05-006, Washington State Department of Ecology (Ecology) and Washington State Department of Health (WDOH) share responsibilities for oversight and compliance: Ecology is responsible for nonradioactive airborne emissions, and WDOH is responsible for radioactive airborne emissions.

2.3 Significant Operational Events

Table B-1 in Appendix B provides a summary of significant events throughout the REDOX Facility history.

3 Risk Drivers for Proposed Work

The objective of Risk Mitigation efforts is to place or return the facility into a safe and stable state that supports future cleanup missions. This chapter is provided to highlight the major identified risk items that require mitigation to support continued S&M and support placement of the 202S complex in a demolition-ready endstate. Performing these mitigation activities now will yield cost savings in the long-term, support ultimate decontamination and decommissioning (D&D) of the building by preserving critical confinement systems, reduce worker exposure to hazards now and in the future, reduce oversight from the regulatory agencies, and protect the environment from potential releases until the record of decision (ROD) is issued to address the final endstate of the facility (expected to be issued by 2032). The following sections address work that will be included in a work activity sequence element outlined in Chapter 6 and detailed in Appendix C of this document. These activities are a portion of the activities that will be authorized by the AM (DOE/RL-2016-52) and those currently addressed in the S&M Plan (DOE/RL-98-19).

3.1 General Housekeeping and Unused Materials Removal

The general housekeeping of the REDOX Facility is currently poor and needs improvement. Review of the previous 10 years of surveillance reports shows a degradation in housekeeping for all areas of the facility. Particularly noted is the increased accumulation of used consumable items, used protective clothing, spent light bulbs, and items used for minimization of water infiltration. Some areas of the building do not have the original equipment (e.g., no longer a working freight elevator) capability for removal of the larger excess equipment; therefore, these will need to be addressed in the ultimate D&D planning or mitigation activity. However, a large volume of the currently identified materials can be removed via the current egress routes. In addition, lift-assisted equipment can be used in accessible areas of the building to remove heavier items. These activities will enhance movement and emergency egress pathways throughout the building.

3.2 Water Infiltration from Leaking Roof Covers

As shown in CP-59374, *Canyon Risk Mitigation Plan*, water infiltration has occurred for many years. As facilities age, the protective roof covering that repels water degrades and water infiltration increases. This water infiltration causes two important secondary occurrences: structural degradation to the roof supporting structure and spread of water soluble contaminates to uncontaminated areas. The majority of roofs on the 202S Building have reached maximum life expectancy and need replacement or repair, especially the canyon roof.

Current work activities to cover the canyon roof and apply a fresh coat of sealant to other roof covers will eliminate water infiltration and arrest the structural degradation and radiological spread of contamination. This is a life expectancy improvement effort that will pay large dividends in the future by halting current structural degradation and contamination spread.

3.3 Decontamination and Source Term Reduction

Some very significant levels of radiological contamination are found throughout the REDOX Complex, due to operations, upset conditions during operations or S&M, and overt or slow migration over time. Mitigation approaches for each of these radiological contamination risks depend on source, location, and contamination level, will require individual work plans. The following paragraphs discuss a few higher visibility examples, but the driver is similar for each less-severe case that may be encountered: remove source or stabilize contamination in order to minimize the spread of contamination during subsequent

work and the following period of S&M, thus reducing costs for monitoring, reposting, and control of expansion areas.

1. **High contamination area (HCA) and contributing source:** Currently, many areas throughout the 202S Building have conservative radiological postings, given the infrequent entries throughout the building over the last 10 to 15 years. As a part of upcoming hazard mitigation work, radiological surveys and air monitoring will be performed to establish the correct postings. A number of posted HCAs are the result of loss of confinement over the years, with no real source of contamination in the immediate area. The existing HCAs in the Annexes, South Storage Gallery, and AMU areas are examples where rainwater washed through a high source term area (from operations era) and contaminated these historically lower posted areas. The baseline condition for the Annex and vast majority of the AMU spaces has been as a radiological buffer area (RBA). The South Storage Area has always been a contamination area (CA) since the only access to this space is through another CA—the South Sample Gallery. With the completion of the REDOX Canyon re-roofing, returning these areas to their respective historical posting status will provide future S&M efforts a baseline from which to monitor and maintain.
2. **Plutonium Loadout Hood:** The major source in the Plutonium Loadout Hood is from the operations era that contains a very high radiological source term (kg quantities of plutonium); contains 90 to 95 percent of the radiological source term outside the canyon cells and extraction columns; and along with the severed 233S pipes in the adjacent vicinity, is prime contributor to the large HCA in the west end of the North Sample Gallery. The initial work activities defined in Chapter 7 and Appendix C will isolate the leakage from the area of the Loadout Hood to control the spread of contamination with the increased activity in the area, followed by full removal of the hood and components. This action will significantly lower (by almost two orders of magnitude) the radiological source term outside the canyon cells and extraction column areas.
3. **South Sample Gallery:** Over the course of the past 30+ years, the South Sample Gallery has been an ad hoc sample storage area used by the 222S Labs. Two of these storage areas, currently wrapped in craft paper, offer the opportunity of containing unknown source or residual levels of contamination. Assessment of these “unknown” areas is critical to a full understanding of potential future sources of contamination. In addition, when the areas are decontaminated or fixed to a level that covering the space or items with craft paper is no longer needed, the potential danger is removed for future S&M teams.

3.4 Asbestos

Damaged asbestos, a widespread contaminant that was used for pipe covering and lagging throughout most areas of the facility, appears regularly in S&M reports. The efforts required to repair a single damaged location are rarely cost effective in the normal course of S&M. Rather, based on these findings, the current approach at REDOX has been to install caution tape and avoid entry into the area. This approach was acceptable in large part due to the low exposure risk by avoiding activities in that area.

With the increased work activities planned in many 202S areas, a concerted effort early in the work cycle should be undertaken to stabilize damaged asbestos (small abatements or patching) in order to remove this hazard from the list of hazards that workers may encounter. Ultimately, in order to proceed closer to “demolition ready,” a large scale abatement effort will be required.

For example, alpha contamination was the source of a CA or HCA getting larger and contaminating the asbestos lagging in the area or the room. A cost effective solution to removing the contamination may be to remove all the lagging, and then deal with the subsequently smaller surface area of contamination.

Early or late, the asbestos will need to be removed to get to a demolition ready point. The REDOX EE/CA (DOE/RL-2016-16) discusses the regulatory requirements for removal of asbestos to make it demolition ready for the future actions.

3.5 Electrical

Several items listed in CP-59374 surround some level of electrical safety. Many of the risk items deal with bare wires and open junction boxes and panels. However, when addressing the entire REDOX complex, significant risk items are major concerns for continued operations of the current distribution system. These include an oversized distribution system left over from the original plant operations era and hard to maintain, obsolete 2.4 kV switchgear equipment, located inside the building in difficult to access locations. From the information available, it appears that no 2.4 kV breaker maintenance has been accomplished recently and, therefore, the breakers would not be expected to operate within acceptable parameters.

The proposed action not only addresses all of the loose wire/open panel type risks, but also removes the obsolete complex-wide distribution system, providing the power that is needed, where it is needed, and in the capacities anticipated for the next 20+ years of facility S&M. This effort is a major life expectancy improvement for the overall building and mitigates all known electrical risks. The building lighting, convenience outlets, and limited 480V/3 phase system will be designed with the current and future needs in mind, meet the current National Electrical Code codes and standards, and allow completely de-energizing the 1950s equipment and systems. The new electrical distribution system would be operated or isolated outside the building and be similar to systems installed in B Plant and the cocooned reactors. In addition, a separate independent feed from the onsite distribution system is anticipated for the 291S Exhaust Fans, due to the load demand, and allow the fans to operate regardless of whether work is occurring in the 202S Building.

3.6 Chemicals

Like the previous asbestos discussion, chemical residue is ubiquitous and usually requires that the area be cordoned off. However, while most of the chemical residue in the building can be readily identified based on process knowledge of the location and equipment in the immediate area, that level of knowledge is not generally available to the worker in the field. Some of these residues can be hazardous under the right conditions, but it is the unknown that is reacted to in most cases. During hazard mitigation and demolition preparation activities, work should consider the chemicals that will be used during work processes (e.g., fixatives, grout, pipe void filling agents) and the existing chemicals that were used in the building. This will ensure that adverse reactions are avoided.

Like asbestos, the level of the current mitigation work will put more workers through a given area over time. In this case, the best mitigation effort is to remove this known material by wiping, scraping, and/or vacuuming in a concerted effort, thus removing the material and the slight risk it proposes from future discussion and concern from the workforce.

Particular areas of the REDOX Facility that potentially contain process chemical residuals are piping and vessels in the Silo AMU Section (Levels 1 through 5 and Level 8), the North and South Operating Galleries, the North and South Sample Galleries, the 276S Hexone Storage Tanks, and the 293S Nitric Acid Recovery Building. All other areas of the complex have a slight risk of harboring chemical residuals remaining from the operations and deactivation era. Therefore, attention to detail and upfront planning are required when breaking into these closed process equipment systems. In addition, several small containers are identified in the surveillance reports that potentially contain chemical residuals. Therefore, caution is required to ensure these materials are appropriately identified via historical information and, if required,

sample analysis for personnel protection and proper disposition. Sample analyses may be performed to confirm chemical constituents or to identify unknown materials.

4 Waste Disposition Pathway

Given the relatively low levels of contamination and radiological inventory of the majority of the waste being removed from the REDOX Complex in conjunction with this risk mitigation activity, the preferred disposition is the Environmental Restoration Disposal Facility (ERDF). This includes legacy wastes, S&M wastes, unused equipment, and project generated wastes. Chemical residuals removed for risk reduction activities may need to be pretreated prior to disposition at ERDF. The waste acceptance criteria documentation will define all acceptable waste streams and any pretreatment options needed for disposition of the wastes at ERDF.

Other wastes, such as the hexone tanks (276S141 and 276S142), will need a specific waste package authorization for disposition at ERDF. Project personnel and ERDF staff will cooperate on the documentation required to ensure overall success.

The final disposition for the piping and vessels removed from the Plutonium Loadout Hood in the North Sample Gallery needs to be defined. These are transuranic (TRU) contaminated materials and the disposition pathway and pretreatment requirements will likely be based on experience and documentation of similar items that were removed from the Plutonium Finishing Plant. If a generated waste stream does not meet ERDF acceptance criteria or if TRU waste is generated, it would be moved to an onsite facility for storage and managed according to applicable waste acceptance criteria (HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*).

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5 Initial Walk Downs and Canyon Entry/Inspection

Currently, the REDOX building entry requirements for personal protective equipment (PPE) and personnel training are extensive. In fiscal year (FY) 2016, entries into REDOX cost a substantial amount of money and involve most of the CHPRC S&M staff to be dedicated to the entry in support of the activities, including nuclear chemical operators, compliance officers, radiological control technicians, field work supervisors, industrial hygiene, safety, and management oversight.

Historically, the office, the annexes, the pipe galleries, operating galleries, silo AMU, SWP lobby, and change room were not posted and entry into these areas in 'street clothing' was permitted. This was accomplished by establishing clean walkways and work zones within all routinely accessible areas of the building and having surveillance routines for these areas to ensure that contamination was not spread. But if spread did occur, due to water infiltration or other vectors, it was cleaned up without incident and the area returned to its previous condition.

Prior to initiating the work activities identified in this report, the facility entry requirements should be evaluated and a plan established to mitigate the infiltration and vectors that have resulted in the current restrictive entry requirements. As an ongoing beneficial effort, a systematic approach should be established to return the facility to its historical condition.

5.1 202S Walkdown

Given that entries into the 202S Building are not performed often, it is recommended that a systematic walkdown of the 202S accessible locations be performed, with extensive photographs and documentation provided in a report. The report would document the location and interferences of tanks and piping, legacy equipment, and debris that would be removed during the risk mitigation activities. Used PPE and other consumables that have been allowed to accumulate during the current facility activity cycle should be photographed and then removed when access conditions are appropriate. Photographs would also facilitate work planning for the removal of tanks, piping, asbestos, debris, and equipment, as well as documenting lighting conditions, equipment degradation, proper signage, and other things necessary to enable routine access to areas of the building. Each photograph would document where (i.e., gallery, Maintenance Shop, or Canyon Deck) the picture was taken, the location where the photographer was standing when the picture was taken, the direction the photograph was taken, a description of what is shown in the photograph, and so forth. Specific attention to lighting conditions should be made to ensure photographs are clear, focused, and generally useful for planning purposes. It is recommended that one individual be responsible for taking photographs, while a second individual log a description of each photograph. From experience, indirect lighting or using the camera flash works better than direct lighting (such as shining a flashlight onto an object and taking a picture of that object). Personnel responsible for photographing the walkdowns and documenting the results should practice in a low light area prior to entry in order to optimized their time and ensure the photographs are of the highest quality. An alternative would be to use the services of an outside contractor specifically trained to ensure high quality photographs are obtained.

5.2 Canyon Entry

The Canyon entry is a specific scope of work that has been funded by DOE for FY 2017. This is only a scoping activity and its purpose is to gather information to assess the current condition of the canyon structures and equipment (e.g., canyon roof decking, roof truss supports, canyon crane, cell block configuration, legacy equipment, degradation from water infiltration). This information in conjunction

with information gathered from other areas of the building will be used to ensure the work activities detailed in this report provide a stable and safe configuration when complete.

5.2.1 Recommended Canyon Entry Point – Crane Maintenance Platform

The recommended option for canyon entry is the Crane Maintenance Platform (CMP) located at the elevated east end of the canyon. The canyon airlock entry stairway is located on the east end of the SWP Lobby. This airlock stairway allows access to the CMP. From this location, personnel can view the Canyon Deck from the shield wall cutout for the 60-ton canyon crane hook. In addition, the roof panels and trusses can be viewed by walking the length of the canyon in the Crane Cab Gallery. If viewing of the Canyon Deck is required from other points along the Crane Cab Gallery, a ladder would be required in order to extend above the 8 ft shield wall. This entry point is elevated (approximately 25 ft) above the Canyon Deck and does not allow direct interface unless long-handled tools or other robotics are employed. This area shares common air space with the canyon and surface contamination would be of the same constituents and representative magnitude as what would be expected on the Canyon Deck itself. In addition, access to the Crane Cab can be obtained from this entry point allowing the crane lights to be energized, providing illumination of the Canyon Deck. When the crane was refurbished in 1999 to support cover block replacement on D Cell, all the lights were replaced; thus, it is expected these bulbs are still operational. Used equipment and contaminated SWP clothing will be encountered at this access point due to the lack of a viable egress point that would make removal of these items practical. All the items used during the 1999 campaign to replace the cover blocks on D Cell were removed but legacy waste and equipment remain on the CMP. Of the three options for canyon entry, this provides the best access for performing remote tasks and is expected to be the lowest risk to personnel.

5.2.2 Secondary Canyon Entry Points

If the recommended entry point discussed in Section 5.2.1 cannot be performed, the following entry points are recommended.

5.2.2.1 SWP Lobby Access Point

The first access airlock is located in the northwest corner of the SWP Lobby. This canyon airlock stairway access location allows entry onto the walkway on the north side of the Remote Shop cover block. From the inside door of the airlock stairway, personnel can proceed west on the walkway to the stairs that lead onto the Canyon Deck directly adjacent to the Dissolver Cell A. Based on information from previous entries, the deck and walkway should be clear of debris and equipment. But the airlock section may contain used SWP clothing and spent supplies. This is potentially one of the highest dose areas on the Canyon Deck due to its proximity to the dissolver cells and the Railroad Tunnel where high dose gamma radiation was present. In addition, loading the dissolver created liquid effluent leakage along the entire track of the fuel basket removal from the railcar to the placement of fuel elements into the dissolver hatches. Thus, residual surface contamination exists and, therefore, it is not recommended as the point of initial entry unless all other access location are eliminated.

5.2.2.2 South Pipe Gallery Access Point

Another more viable access airlock is located in the northwest corner of the South Pipe Gallery. This canyon airlock access location allows entry to the center of the west end of the Canyon Deck directly adjacent to Cell E and Cell F. From previous entries, the deck is free of debris and equipment with the exception of a jumper box, which is located on the Canyon Deck at the head end of F Cell (approximately 90 ft from the inside airlock door). No appreciated dose is expected from the jumper box; therefore, this would be the lowest dose Canyon Deck entry point available for personnel. Alpha contamination could be expected at this entry point due to its location adjacent to the extraction column preparation and retrieval

cells. This is the recommended entry point for Canyon Deck access, if a situation determines that access onto the Canyon Deck is advantageous or necessary following an initial observation entry.

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6 Chemical and Radiological Contamination

6.1 Known Fixed Contamination and Hot Spots

There are a number of accessible areas within the galleries and silo spaces with known/fixed contamination from pre1999 stabilization efforts. These areas should be researched (from stabilization documents and radiological records) to collect/quantify and establish this information as a baseline knowledge element during planning. Currently, many areas throughout the 202S Building have conservative radiological postings, given infrequent entries throughout the building over the last 10 to 15 years. As a part of upcoming hazard mitigation work, radiological surveys and air monitoring will be performed to establish the correct postings. As discussed in Chapter 5, historically the office, the annexes, the pipe galleries, operating galleries, silo AMU, SWP lobby, and change room were not posted and entry into these areas was permitted in 'street clothing.' This was accomplished by establishing clean walkways and work zones within all routinely accessible areas of the building and having surveillance routines for these areas that contamination did not spread. But if spread did occur, due to water infiltration or other vectors, it was cleaned up without incident and the area returned to its previous condition. One of the goals of the risk mitigation activity defined in this report is to return a majority of these areas to their historical condition by eliminating hazards or decontaminating areas where necessary to be able to support down-posting entry requirements, as well as allowing for easier access in the future.

6.2 202S Silo

Risk mitigation activities for the Silo and especially the AMU section have been funded for FYs 2016 and 2017 to reduce risks and entry requirements to their respective historical conditions. The FY 2017 activities focus specifically on characterization and the following information is provided to support that development. After hazard mitigation activities for the AMU portion of the silo are completed, the area will be used for an emergency egress escape route from other areas of the 202S Building (e.g., South Sample Gallery, South Storage Gallery).

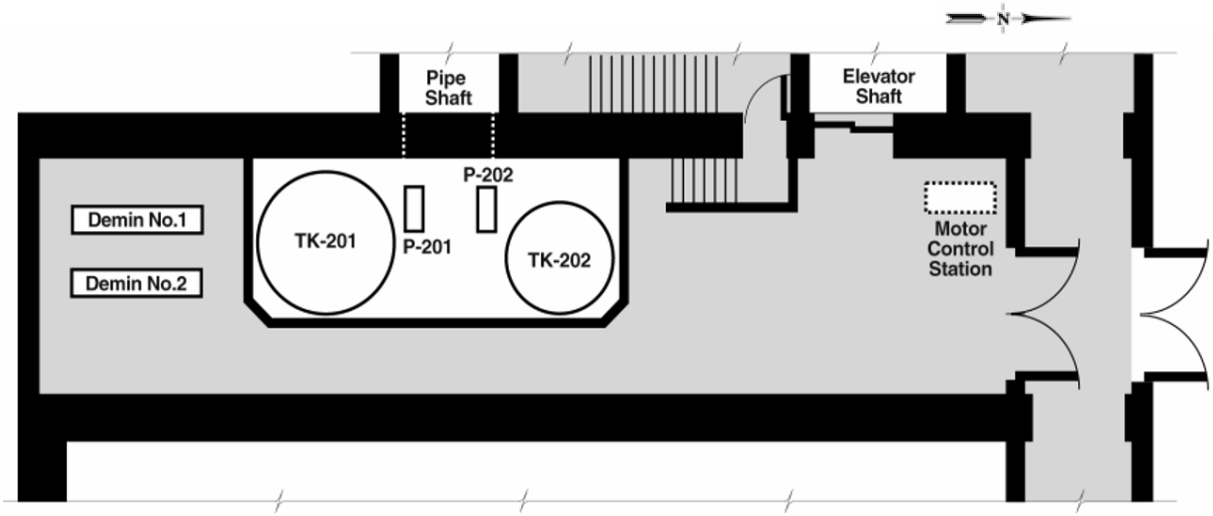
Figure 2-10 shows a cross section elevation view of the REDOX Silo. Figures 6-1 through 6-6 show the floor plan and tanks present on each level (starting at the bottom) of the AMU/service portion of the silo, which will all be removed, stabilized, and confirmed empty during the removal action. Following each figure is a table that provides the following detailed information about each tank:

- Tank capacity and dimensions
- Chemicals used during operation
- Deactivation procedures performed on tank/pump
- Expected chemical constituents of concern based on operational function and post-deactivation procedures

Levels 1 and 7 of the AMU side of the silo do not contain pumps or tanks associated with the original processes; therefore, figures and tables for these levels were not included. Hazards for these areas are similar to other areas of the AMU side of the silo.

The information was obtained from ISO-1108 and HW-18700, *REDOX Technical Manual*. The intent is to use this information to support the SAP development and process knowledge information to assist waste disposal efforts.

Although some radiological contamination may be encountered in the AMU areas, this was a nonradiological clean chemical addition area during operations. External surfaces of piping, tanks, and equipment may have had trace amounts of contamination introduced by biological and other vectors during the S&M period. Historical documents show no upsets that would have back-flowed column contaminants into these piping, tanks or equipment.

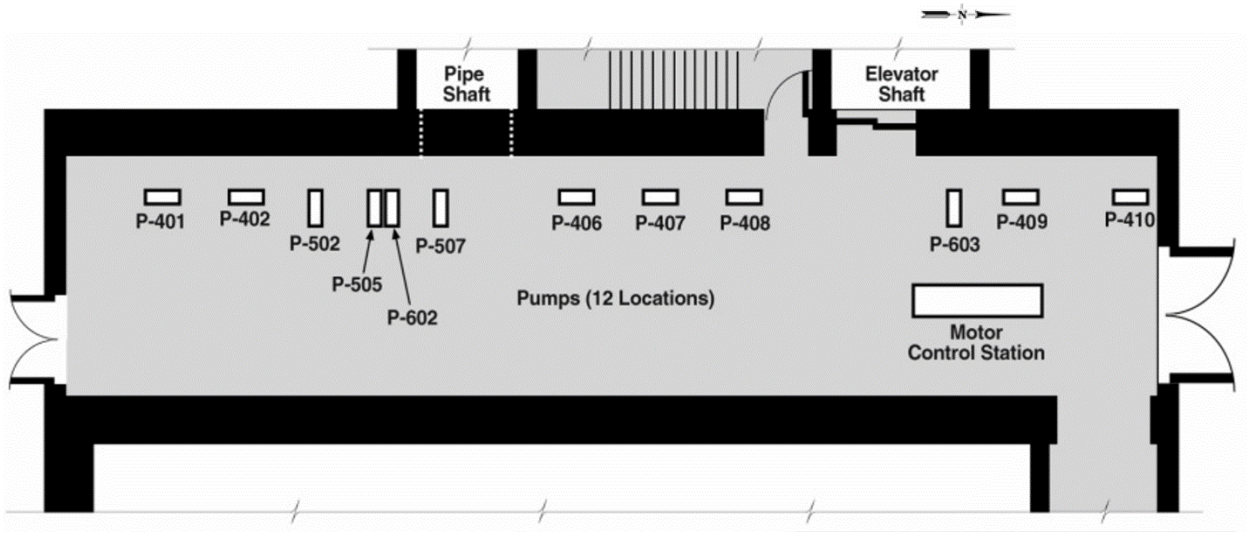


Reference: HW-18700, *REDOX Technical Manual*.

Figure 6-1. Silo, AMU/Service Side, Second Level Plan View

Table 6-1. Silo AMU/Service Side, Second Level Tank and Pump Details

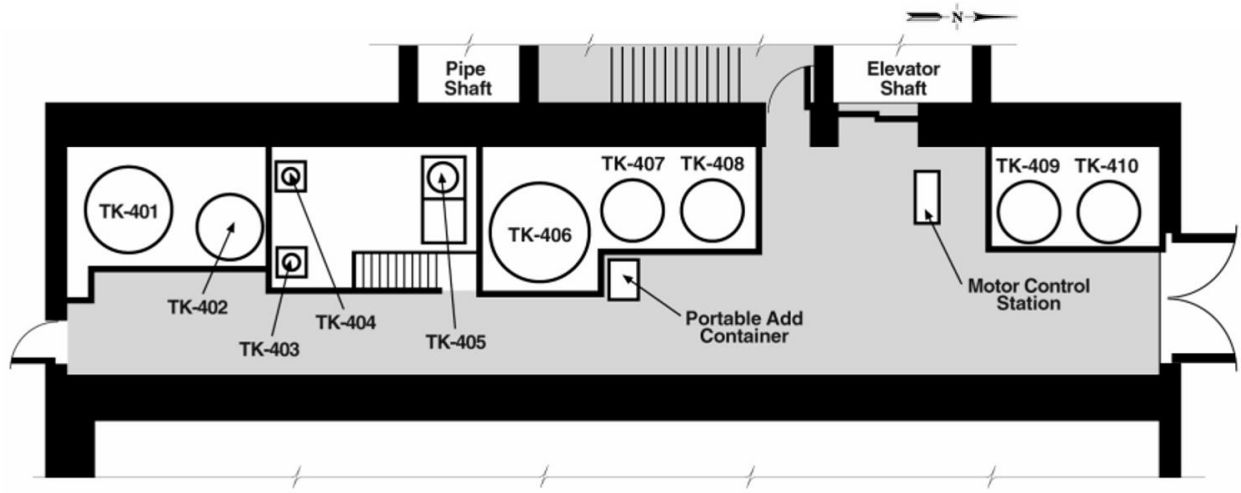
Item Number	Known Information
Tank 201 and P-201	Tank Name: 1CX, 2EX, 3EX Makeup Tank Tank Dimensions: 10 by 10 ft Tank Capacity: 6,000 gal
	Chemical COC: 0.04 M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 202 and P-202	Tank Name: Aluminum Nitrate Adjustment Tank Tank Dimensions: 8 by 10 ft Tank Capacity: 4,600 gal
	Chemical COC: $Al(NO_3)_3$
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals



Reference: HW-18700, *REDOX Technical Manual*.

Figure 6-2. Silo AMU/Service Side, Third Level Plan View

There are no tanks on the Third Level, pumps shown in Figure 6-2 are included with the tanks that they service. For example, P-401 is included with Tank 401, which is described with the Fourth Level tanks in Table 6-2.



Reference: HW-18700, *REDOX Technical Manual*.

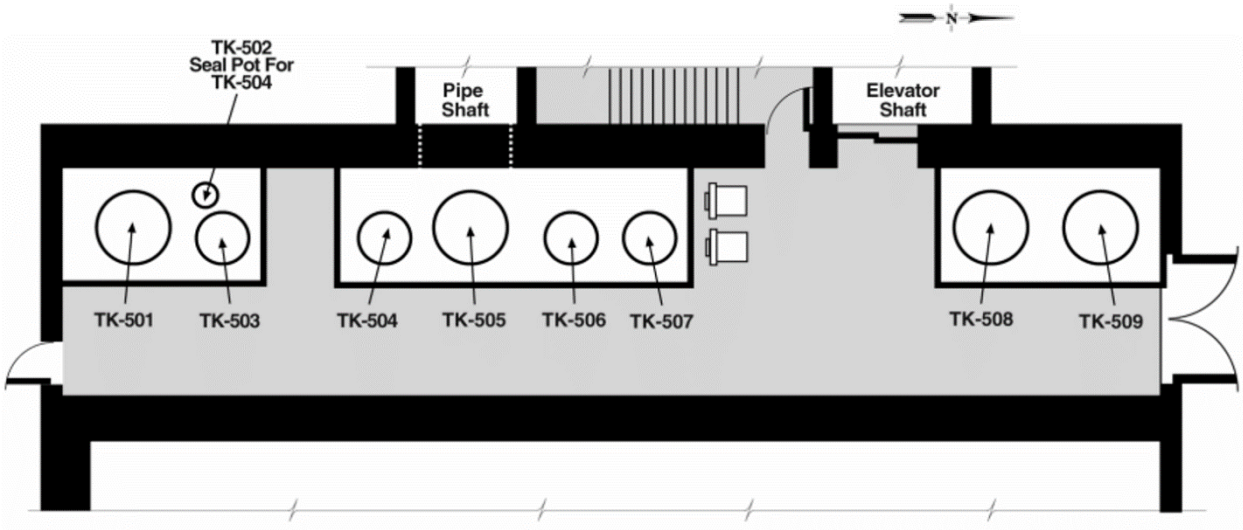
Figure 6-3. Silo AMU/Service Side, Fourth Level Plan View

Table 6-2. Silo AMU/Service Side, Third and Fourth Level, Tank and Pump Details

Item Number	Known Information
Tank 401 and P-401	Tank/Pump Name: 1AS Makeup Tank Tank Dimensions: 6.5 by 8 ft Tank Capacity: 2,100 gal Location: Tank on 4th AMU Level, Pump on 3rd AMU Level
	Chemical COC: 1.8 M Aluminum Nitrate, 0.2 M Sodium Hydroxide, 0.01 M Sodium Dichromate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 402 and P-402	Tank/Pump Name: 1SS Makeup Tank Tank Dimensions: 4.5 by 7 ft Tank Capacity: 1,070 gal Location: Tank on 4th AMU Level, Pump on 3rd AMU Level
	Chemical COC: 1.3 M Aluminum Nitrate, 0.2 M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 403	Tank Name: 60% Nitric Acid Head Tank Tank Dimensions: 1.5 by 4 ft Tank Capacity: 160 gal
	Chemical COC: Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 404	Tank Name: 50% Sodium Hydroxide Head Tank Tank Dimensions: 1½' by 4' Tank Capacity: 160 gal
	Chemical COC: Sodium Hydroxide
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 405 (P-405 is integral to assembly)	Tank Name: 30% Ferrous Sulfamate Head Tank Tank Dimensions: 3 by 3.5 ft Tank Capacity: 180 gal Location: Tank on 4th AMU Level, Pump on 3rd AMU Level
	Chemical COC: Ferrous Sulfamate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals

Table 6-2. Silo AMU/Service Side, Third and Fourth Level, Tank and Pump Details

Item Number	Known Information
Tank 406 and P-406	Tank/Pump Name: 2DS, 3DS Makeup Tank Tank Dimensions: 8 by 10 ft Tank Capacity: 5,350 gal Location: Tank on 4th AMU Level, Pump on 3rd AMU Level
	Chemical COC: 1.8 M Aluminum Nitrate, 0.2 M Sodium Hydroxide, or 0.05 M Ferrous Sulfamate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 407 and P-407	Tank/Pump Name: 1BX Makeup Tank Tank Dimensions: 4.5 by 7 ft Tank Capacity: 1,070 gal Location: Tank on 4th AMU Level, Pump on 3rd AMU Level
	Chemical COC: 1.3 M Aluminum Nitrate, 0.05 M Ferrous Sulfamate, or 0.05M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 408 and P-408	Tank/Pump Name: 2BX, 3BX Makeup Tank Tank Dimensions: 4.5 by 7 ft Tank Capacity: 1,070 gal Location: Tank on 4th AMU Level, Pump on 3rd AMU Level
	Chemical COC: 0.1 M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 409 and P-409	Tank/Pump Name: 2AS Makeup Tank Tank Dimensions: 4.5 by 7 ft Tank Capacity: 1,070 gal Location: Tank on 4th AMU Level, Pump on 3rd AMU Level
	Chemical COC: 1.3 M Aluminum Nitrate, 0.01 M Sodium Dichromate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 410 and P-410	Tank/Pump Name: 3AS Makeup Tank Tank Dimensions: 4.5 by 7 ft Tank Capacity: 1,070 gal Location: Tank on 4th AMU Level, Pump on 3rd AMU Level
	Chemical COC: 1.3M Aluminum Nitrate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals



Reference: HW-18700, *REDOX Technical Manual*.

Figure 6-4. Silo AMU/Service Side, Fifth Level (Lower Part), Plan View

Table 6-3. Silo AMU/Service Side, Fifth Level, Tank and Pump Details

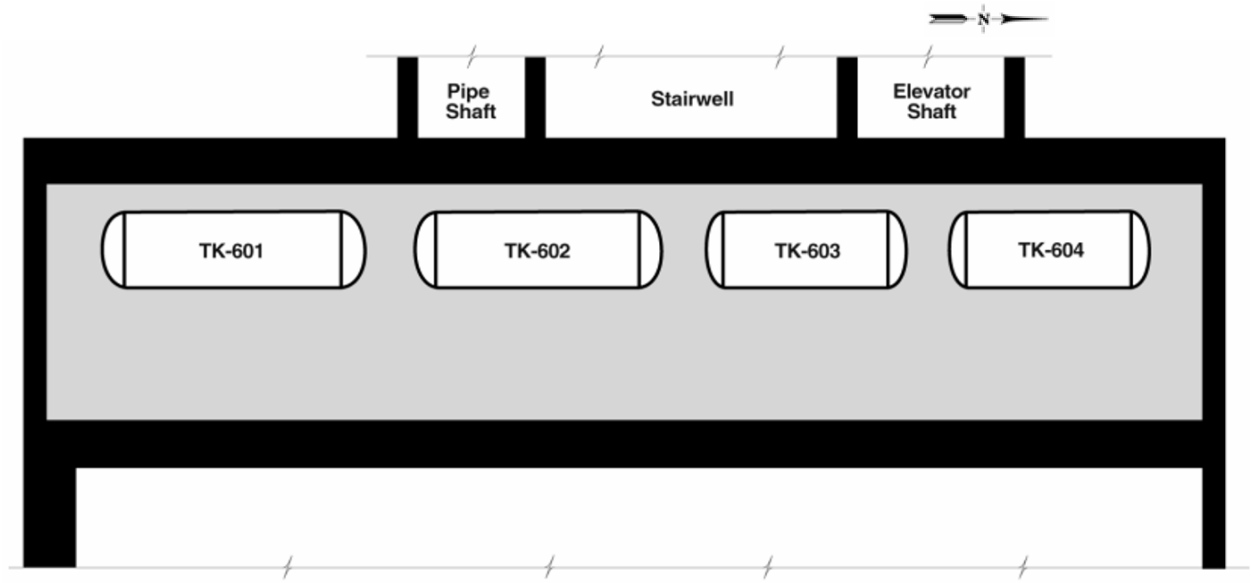
Item Number	Known Information
Tank 501	Tank Name: 2% Sodium Carbonate Makeup Tank Tank Dimensions: 5.5 by 8 ft Tank Capacity: 1,440 gal Location: Tank on 5th AMU Level, Pump on 3rd AMU Level
	Chemical COC: Sodium Carbonate
	Decontamination: See Note 1 – Used Processes 1, 2, 3, 4, 5, and probable demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 502 and P-502	Tank Name: Seal Pot for Tank 504 Tank Dimensions: 1.5 by 2 ft Tank Capacity: 80 gal
	Chemical COC: Ferrous Sulfamate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 503	Tank Name: Ferrous Sulfamate Adjustment and Supply Tank Tank Dimensions: 4 by 6 ft Tank Capacity: 600 gal
	Chemical COC: Ferrous Sulfamate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals

Table 6-3. Silo AMU/Service Side, Fifth Level, Tank and Pump Details

Item Number	Known Information
Tank 504	Tank/Pump Name: Ferrous Sulfamate Preparation Tank Tank Dimensions: 4 by 6 ft Tank Capacity: 600 gal Location: Tank on 5th AMU Level, Pump on 3rd AMU Level
	Chemical COC: Ferrous Sulfamate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 505 and P-505	Tank/Pump Name: Wash Solution Makeup Tank Tank Dimensions: 5.5 by 8 ft Tank Capacity: 1,440 gal Location: Tank on 5th AMU Level, Pump on 3rd AMU Level
	Chemical COC: Nitric Acid or Sodium Hydroxide
	Decontamination: See Note 1 – Used Processes 1, 2, 3, 4, 5, and probable demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 506	Tank Name: 50% Sodium Dichromate Makeup Tank Tank Dimensions: 4 by 6 ft Tank Capacity: 600 gal
	Chemical COC: Sodium Dichromate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 507 and P-507	Tank/Pump Name: 2% Sodium Hydroxide Makeup Tank Tank Dimensions: 4 by 6 ft Tank Capacity: 600 gal Location: Tank on 5th AMU Level, Pump on 3rd AMU Level
	Chemical COC: Sodium Hydroxide
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 508	Tank Name: 40% Sodium Hydroxide Makeup Tank Tank Dimensions: 5.5 by 8 ft Tank Capacity: 1,440 gal
	Chemical COC: Sodium Hydroxide
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals

Table 6-3. Silo AMU/Service Side, Fifth Level, Tank and Pump Details

Item Number	Known Information	
Tank 509	Tank Name: 26% Sodium Carbonate Makeup Tank Tank Dimensions: 5.5 by 8 ft Tank Capacity: 1,440 gal	
	Chemical COC: Sodium Carbonate	
	Decontamination: Demineralized water flush	
	Expected Condition: Empty/Drained with Trace Residuals	
Note 1:	Process 1	57% Nitric Acid and 1% Boric Acid, heated to 70ºC, 6,000 gal
	Process 2	20% Nitric Acid, 6% Ammonium Fluoride and 1% Boric Acid
	Process 3	10% Nitric Acid
	Process 4	1% Boric Acid
	Process 5	1% Potassium Permanganate and 25% Sodium Hydroxide, then Process 3 plus water

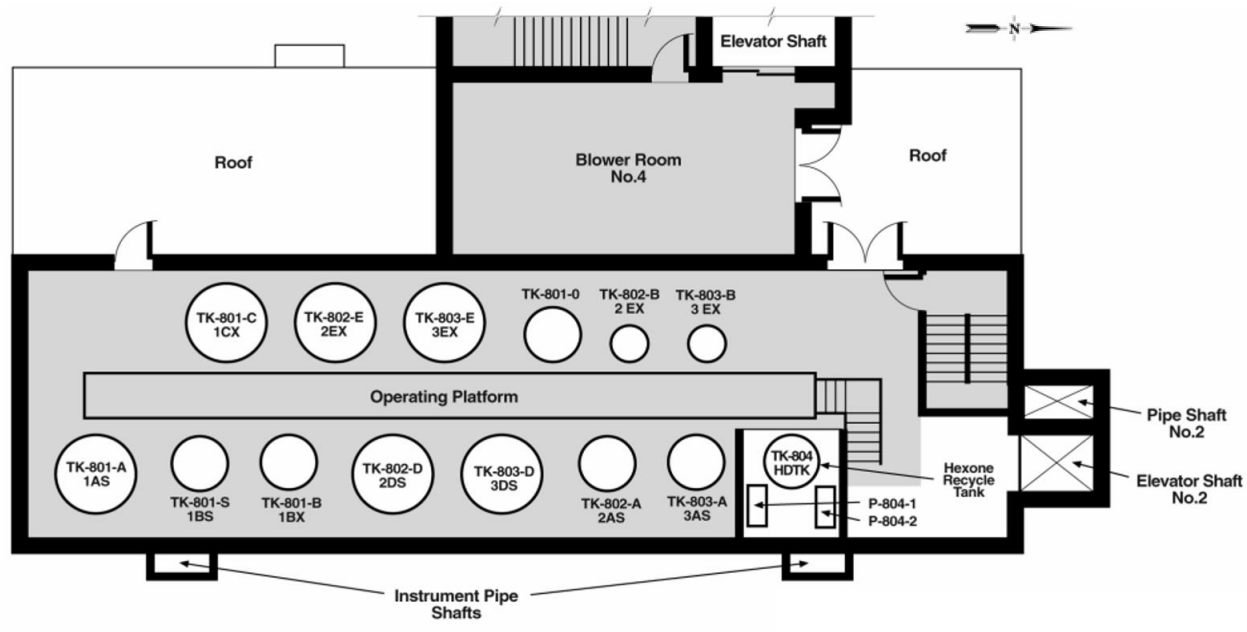


Reference: HW-18700, *REDOX Technical Manual*.

Figure 6-5. Silo AMU/Service Side, Sixth Level, Plan View

Table 6-4. Silo AMU/Service Side, Sixth Level, Tank and Pump Details

Item Number	Known Information
Tank 601	Tank Name: 62% Aluminum Nitrate Supply Tank Dimensions: 5.5 by 16 ft Tank Capacity: 3,000 gal
	Chemical COC: Aluminum Nitrate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 602 and P-602	Tank/Pump Name: Demineralized Water Head Supply Tank Dimensions: 5.5 by 16 ft Tank Capacity: 3,000 gal Location: Tank on 6th AMU Level, Pump on 3rd AMU Level
	Chemical COC: None
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 603 and P-603	Tank/Pump Name: Nitric Acid Supply Tank Dimensions: 5.5 by 12 ft Tank Capacity: 2,300 gal Location: Tank on 6th AMU Level, Pump on 3rd AMU Level
	Chemical COC: 60% Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 604	Tank Name: 50% Sodium Hydroxide Tank Dimensions: 5.5 by 12 ft Tank Capacity: 2,300 gal Location: 6th floor of AMU Level
	Chemical COC: 50% Sodium Hydroxide
	Decontamination: Demineralized Water Flush
	Expected Condition: Empty/Drained with Trace Residuals



Reference: HW-18700, *REDOX Technical Manual*.

Figure 6-6. Silo AMU/Service Side, Eighth Level, Plan View

Table 6-5. Silo AMU/Service Side, Eighth Level, Tank and Pump Details

Item Number	Known Information
Tank 801-A	Tank Name: Scrub Tank (1AS feed stream) Tank Dimensions: 8.5 by 8 ft Tank Capacity: 2,500 gal
	Chemical COC: 1.8M Aluminum Nitrate, 0.2M Sodium Hydroxide, 0.01M Sodium Dichromate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 801-B	Tank Name: Scrub Tank (1BX feed stream) Tank Dimensions: 4.5 by 9 ft Tank Capacity: 1,050 gal
	Chemical COC: 1.3 M Aluminum Nitrate, 0.05 M Ferrous Sulfamate, 0.05 M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 801-C	Tank Name: Scrub Tank (1CX feed stream) Tank Dimensions: 6.5 by 8 ft Tank Capacity: 2,500 gal
	Chemical COC: 0.04 M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals

Table 6-5. Silo AMU/Service Side, Eighth Level, Tank and Pump Details

Item Number	Known Information
Tank 801-O	Tank Name: Organic Wash Addition Tank Tank Dimensions: 4.5 by 7 ft Tank Capacity: 1,050 gal
	Chemical COC: Hexone
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 801-S	Tank Name: Scrub Tank (1BS feed stream) Tank Dimensions: 4.5 by 7 ft Tank Capacity: 1,050 gal
	Chemical COC: 1.3M Aluminum Nitrate, 0.2M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 802-A	Tank Name: Scrub Tank (2AS feed stream) Tank Dimensions: 4.5 by 7 ft Tank Capacity: 1,050 gal
	Chemical COC: 1.3 M Aluminum Nitrate, 0.01 M Sodium Dichromate
	Decontamination: See Note 1 – Used Processes 1, 2, 3, 4, 5, and probable demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 802-B	Tank Name: Scrub Tank (2EX feed stream) Tank Dimensions: 3 by 5.5 ft Tank Capacity: 500 gal
	Chemical COC: 0.1 M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 802-D	Tank Name: Scrub Tank (2DS feed stream) Tank Dimensions: 6.5 by 8 ft Tank Capacity: 2,500 gal
	Chemical COC: 1.8 M Aluminum Nitrate, 0.2 M Sodium Hydroxide, 0.05 M Ferrous Sulfamate
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals

Table 6-5. Silo AMU/Service Side, Eighth Level, Tank and Pump Details

Item Number	Known Information
Tank 802-E	Tank Name: Scrub Tank (2EX feed stream) Tank Dimensions: 6.5 by 8 ft Tank Capacity: 2,500 gal
	Chemical COC: 0.04 M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 803-A	Tank Name: Scrub Tank (3AS feed stream) Tank Dimensions: 3 by 5.5 ft Tank Capacity: 500 gal
	Chemical COC: 0.04 M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 803-B	Tank Name: Scrub Tank (3EX feed stream) Tank Dimensions: 3 by 5.5 ft Tank Capacity: 500 gal
	Chemical COC: 0.1 M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 803-D	Tank Name: Scrub Tank (3DS feed stream) Tank Dimensions: 6.5 by 8 ft Tank Capacity: 2,500 gal
	Chemical COC: 1.8M Aluminum Nitrate, 0.2M Sodium Hydroxide, 0.05M Ferrous Sulfamate
	Decontamination: See Note 1 – Used Processes 1, 2, 3, 4, 5, and probable demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals
Tank 803-E	Tank Name: Scrub Tank (3EX feed stream) Tank Dimensions: 6.5 by 8 ft Tank Capacity: 2,500 gal
	Chemical COC: 0.04 M Nitric Acid
	Decontamination: Demineralized water flush
	Expected Condition: Empty/Drained with Trace Residuals

Table 6-5. Silo AMU/Service Side, Eighth Level, Tank and Pump Details

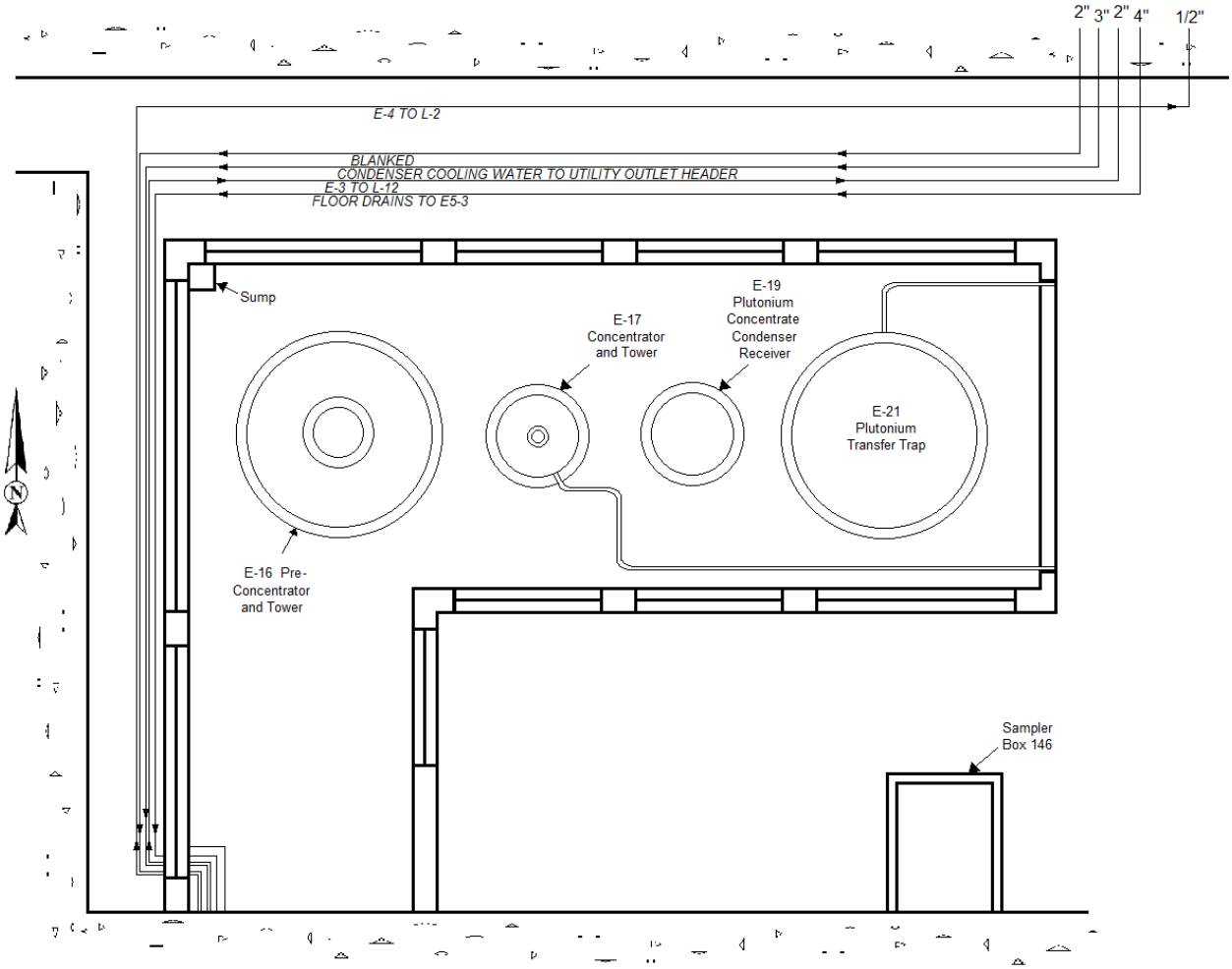
Item Number	Known Information	
Tank 804-2, P-804-1 and P-804	Tank/Pump Name: Hexone Recycle Tank Tank Dimensions: 3 by 5.5 ft Tank Capacity: 500 gal Location: Tank in Explosion Proof Enclosure on 8th AMU Level, Pumps on 7th AMU Level	
	Chemical COC: Hexone	
	Decontamination: Demineralized water flush	
	Expected Condition: Empty/Drained with Trace Residuals	
Note 1:	Process 1	57% Nitric Acid and 1% Boric Acid, heated to 70ºC, 6,000 gal batch
	Process 2	20% Nitric Acid, 6% Ammonium Fluoride and 1% Boric Acid
	Process 3	10% Nitric Acid
	Process 4	1% Boric Acid
	Process 5	1% Potassium Permanganate and 25% Sodium Hydroxide, then Process C plus water.

6.3 202S Sample Galleries

Risk mitigation activities include removal of the Plutonium Loadout Hood and L-16 to H-4 Transfer Line. Figure 7-2 shows the floor plan of the Plutonium Loadout Hood, which is located in the North Sample Gallery. The piping that originally interconnected the E Cell vessels with the 233S process equipment is also shown. Figure 6-8 shows the remaining area of the North Sample Gallery, the North-South Corridor, and the South Sample Gallery. This figure also includes the L-16 to H-4 Transfer Line; the Steam Condensate from L-2, L-3, L-12 to D-12 Line; and the Acid Header (HDR) from 204 Line. Following each figure is a table that provides the following detailed information about each piping system or vessel:

- Design information for vessels, pipes, and sump
- Chemical contaminants of concern (COCs) for each component
- Fissionable material inventory (obtained from BHI-00994, *In-Situ Non-Destructive Radiological Characterization of Selected 202-S Reduction Oxidation (REDOX) Facility Sample Gallery Pipes and Vessels*)
- Deactivation activities during plant shutdown
- Expected current conditions of each system

The information obtained from ISO-1108, BHI-01299, BHI-01142, BHI-00994, and HW-18700 is intended to support SAP development and process knowledge information in order to assist in waste disposal.



References: H-2-7957, *Piping - Gen. Arrangement Plans P.R. Room*.
H-2-8754, *Piping Gen'l. Arrg't, Elevations & Sections P.R. Room*.

Figure 6-7. Plutonium Loadout Hood, North Sample Gallery Plan View

Table 6-6. Plutonium Loadout Hood, North Sample Gallery Vessel, Piping, and Sump Details

Item Number	Known Information
E-16	Design Information: Name – Pre-Concentrator and Tower.
	Chemical COC: cadmium, nickel, mercury, nitrite, sulfate, chromium, lead, fluoride, nitrate oxalate, silver, arsenic, barium, iron, selenium, chloride, phosphate, aroclor 1016, aroclor 1221, aroclor 1232, aroclor 1242, aroclor 1248, aroclor 1254, aroclor 1260, and hexone.
	Fissionable Materials Inventory: 1,450 g (88.9 Ci) of plutonium-239.
	Deactivation: Demineralized water flush.
	Expected Condition: Majority of the inventory is adhered to heating coils with flush residuals located in the bottom of the vessel.

Table 6-6. Plutonium Loadout Hood, North Sample Gallery Vessel, Piping, and Sump Details

Item Number	Known Information
E-17	Design Information: Name – Concentrator and Tower.
	Chemical COC: cadmium, nickel, mercury, nitrite, sulfate, chromium, lead, fluoride, nitrate oxalate, silver, arsenic, barium, iron, selenium, chloride, phosphate, aroclor 1016, aroclor 1221, aroclor 1232, aroclor 1242, aroclor 1248, aroclor 1254, aroclor 1260, and hexone.
	Fissionable Materials Inventory: 650 g (40 Ci) of plutonium-239.
	Deactivation: Demineralized water flush.
	Expected Condition: Majority of the inventory is adhered to heating coils with flush residuals located in the bottom of the vessel.
E-19	Design Information: Name – Plutonium Concentrate Condenser Receiver.
	Chemical COC: cadmium, nickel, mercury, nitrite, sulfate, chromium, lead, fluoride, nitrate oxalate, silver, arsenic, barium, iron, selenium, chloride, phosphate, aroclor 1016, aroclor 1221, aroclor 1232, aroclor 1242, aroclor 1248, aroclor 1254, aroclor 1260, and hexone.
	Fissionable Materials Inventory: none.
	Deactivation: Demineralized water flush.
	Expected Condition: Dry with residual minimal radiological and chemical contamination.
E-21	Design Information: Name – Plutonium Transfer Trap.
	Chemical COC: cadmium, nickel, mercury, nitrite, sulfate, chromium, lead, fluoride, nitrate oxalate, silver, arsenic, barium, iron, selenium, chloride, phosphate, aroclor 1016, aroclor 1221, aroclor 1232, aroclor 1242, aroclor 1248, aroclor 1254, aroclor 1260, and hexone.
	Fissionable Materials Inventory: none.
	Deactivation: Demineralized water flush.
	Expected Condition: Dry with residual minimal radiological and chemical contamination.
ES-3 Sump	Design Information: Name – Plutonium Loadout Hood Sump (6 in. by 6 in. by 6 in.).
	Chemical COC: cadmium, nickel, mercury, nitrite, sulfate, chromium, lead, fluoride, nitrate oxalate, silver, arsenic, barium, iron, selenium, chloride, phosphate, aroclor 1016, aroclor 1221, aroclor 1232, aroclor 1242, aroclor 1248, aroclor 1254, aroclor 1260, and hexone.
	Fissionable Materials Inventory: 5.9 g (0.36 Ci) of plutonium-239.
	Deactivation: Flushed with demineralized water but further liquid infiltration occurred from the 233S floor drains and the 233S pipe trench during the 1969 through 2013 period.
	Expected Condition: Absorbent pads and fixative placed in sump during the stabilization activities in 1999. No free liquids noted at that time.

Table 6-6. Plutonium Loadout Hood, North Sample Gallery Vessel, Piping, and Sump Details

Item Number	Known Information
E-4 to L-2	Design Information: Name – E-4 to L-2 Transfer Line (29 ft long) 1/2 in. stainless steel pipe that contained plutonium nitrate product from E-4 vessel in E Cell to L-2 receiver in 233S.
	Chemical COC: plutonium nitrate, nitric acid, aluminum nitrate, methyl isobutyl ketone (hexone), potassium permanganate, sodium dichromate, uranium nitrate nonahydrate.
	Fissionable Materials Inventory: unknown.
	Deactivation: Demineralized water flush.
	Expected Condition: Residual liquids containing radiological and chemical contamination.
E-3 to L-12	Design Information: Name – E-3 to L-12 Transfer Line (29 ft long) 2 in. stainless steel pipe that contained plutonium nitrate recycled product from 233S back to E-3 vessel in E Cell.
	Chemical COC: plutonium nitrate, nitric acid, aluminum nitrate, methyl isobutyl ketone (hexone), potassium permanganate, sodium dichromate, uranium nitrate nonahydrate.
	Fissionable Materials Inventory: 0.8 g (0.05 Ci) of plutonium-239.
	Deactivation: Demineralized water flush.
	Expected Condition: Residual liquids containing radiological and chemical contamination.
Floor Drains	Design Information: Name – 233S Floor Drains to ES-3 Line (26 ft long) 4 in. stainless steel line from the 233S floor drains to the E5 vessel in E Cell.
	Chemical COC: cadmium, nickel, mercury, nitrite, sulfate, chromium, lead, fluoride, nitrate oxalate, silver, arsenic, barium, iron, selenium, chloride, phosphate, aroclor 1016, aroclor 1221, aroclor 1232, aroclor 1242, aroclor 1248, aroclor 1254, aroclor 1260, and hexone.
	Fissionable Materials Inventory: 0.8 g (0.05 Ci) of plutonium-239.
	Deactivation: Flushed with demineralized water but further liquid infiltration occurred from the 233S floor drains and 233S pipe trench during from 1969 through 2013.
	Expected Condition: Residual liquids containing radiological and chemical contamination.

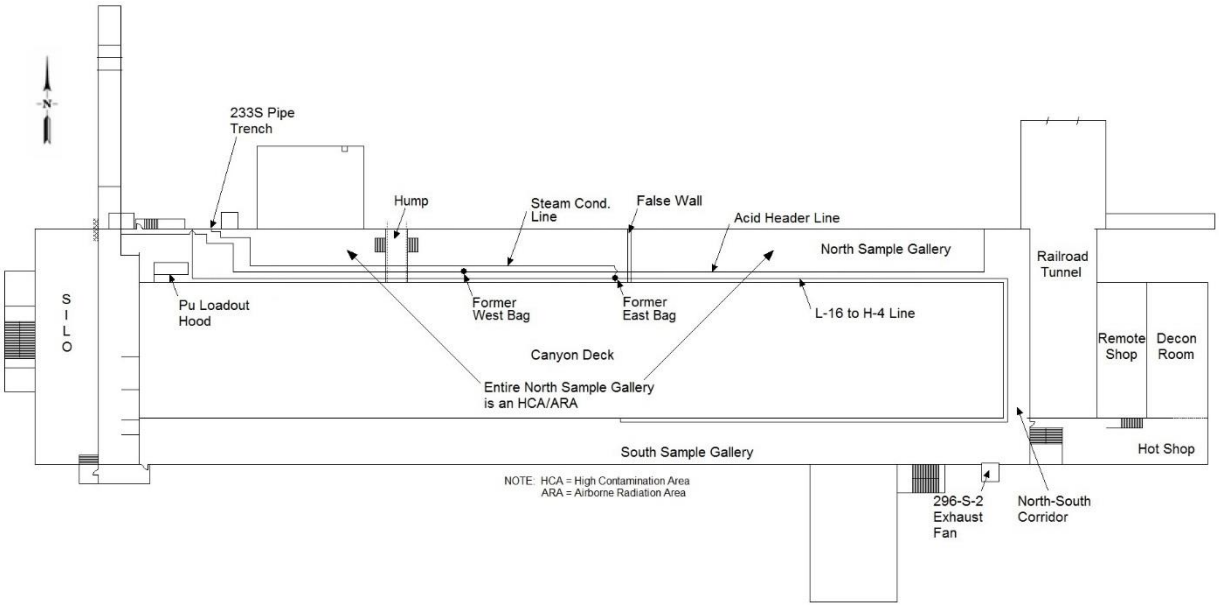


Figure 6-8. North and South Sample Galleries, Plan View

Table 6-7. North and South Sample Galleries, Piping Details

Item Number	Known Information
L-16 to H-4	Design Information: Name – L-16 to H-4 Transfer Line (488 ft long) 2 in. stainless steel pipe that contained off-standard plutonium nitrate solutions from 233S back to H-4 vessel in H Cell.
	Chemical COC: plutonium nitrate, nitric acid, aluminum nitrate, methyl isobutyl ketone (hexone), potassium permanganate, sodium dichromate, and uranium nitrate nonahydrate.
	Fissionable Materials Inventory: 52.8 g (3.25 Ci) of plutonium-239 (Table 6-8 provides additional details of quantities contained in each section of the pipe).
	Deactivation: Unknown.
	Expected Condition: The line is expected to contain flush solution from the 233S process vessel and piping performed during the deactivation process from 1967 to 1969. No known water flushes of this line are documented. The primary constituent is expected to be plutonium nitrate from information gathered during the stabilization activities completed in 1999.
Acid Header	Design Information: Name – Acid Header from 204S Line (approx. 315 ft long) 2 in. stainless steel pipe that was used to transport recovered nitric acid from the UO_3 plant back to the 202S dissolver cells.
	Chemical COC: trace amounts of uranyl nitrate hexahydrate, nitric acid and nitric acid decomposition products.
	Fissionable Materials Inventory: None.
	Deactivation: Unknown.
	Expected Condition: The line is expected to contain recovered nitric acid. No known water flushes of this line are documented. The primary constituent is expected to be nitric acid with trace amounts of uranyl nitrate hexahydrate.

Table 6-7. North and South Sample Galleries, Piping Details

Item Number	Known Information
Steam Condensate	Design Information: Name – Steam Condensate from L-2, L-3, L-12 to D-12 Line (approximately 190 ft long) 1 in. stainless steel pipe that contained steam condensate from the heating coils in the 233S concentration vessels (L-2, L-3, L-12) to the D-12 waste tank in D Cell.
	Chemical COC: corrosion products with a potential cross contamination of materials containing plutonium nitrate, nitric acid, aluminum nitrate, methyl isobutyl ketone (hexone), potassium permanganate, sodium dichromate, and uranium nitrate nonahydrate.
	Fissionable Materials Inventory: None expected from original use.
	Deactivation: Unknown.
	Expected Condition: Steam condensate liquids are anticipated to be contained in this line due to the elevation difference between the canyon wall nozzle flange in the North Pipe Gallery and the slope of the line in the North Sample Gallery. In addition, the isolation valve between this steam condensate line and the L-16 to H-4 transfer line has potentially failed, which would result in the plutonium nitrate solutions contained in the L-16 to H-4 Line to migrate into this line, as well. Information gathered during the stabilization activities completed in 1999 would suggest that minimal cross contamination has occurred.

Table 6-8. North and South Sample Galleries, Plutonium-239 Quantity in L-16 to H-4 Transfer Line

Component	Plutonium-239 (g)	1σ Error (%)	1σ Error (g)
Pipes			
South Sample Gallery	3	100	3
North-South Corridor	7	3	0.21
East End of North Sample Gallery	26	3.5	0.91
West End of North Sample Gallery	7	45	3.2
Valves			
South Gallery at H-Cell	0.2	1.8	0.003
Middle of North Sample Gallery	0.3	100	0.3
Near Plutonium Loadout Hood (2 in. Line)	1.5	1.8	0.03
Near Plutonium Loadout Hood (1 in. Line to Samplers)	0.06	1.9	0.001
Bends			
Southeast Corner	0.01	9.9	0.01
Northeast Corner	0.1	2.7	0.005

Table 6-8. North and South Sample Galleries, Plutonium-239 Quantity in L-16 to H-4 Transfer Line

Component	Plutonium-239 (g)	1σ Error (%)	1σ Error (g)
Corner over Sample Boxes (Box 146)	2.5	0.7	0.18
Near North Wall (233S Pipe Trench)	0.5	3	0.02
Across from Plutonium Loadout Hood	5	1.7	0.09
Total Plutonium-239 in Pipe	**52.8**	**14**	**7**

6.4 202S REDOX Complex – Radiological and Chemical Contaminants of Concern

A SAP for waste designation and work planning support will be written to address sampling of radiological and nonradiological hazardous substances in FY 2017 to support the RAWP activities. Table 6-9 provides process knowledge to support SAP document development and waste disposal of miscellaneous items that are present throughout the building, which will be removed as waste during S&M, hazard mitigation, and demolition preparation activities. Specific items that are not removed during this activity due to size, bulk, functionality, or accessibility can be characterized and stabilized for removal during future demolition activities. Appendix B details significant events that occurred during the operational life of the REDOX Complex. The location where items are present will most likely match the radiological COCs of that area. The chemical constituents of items are expected to be derived both from the product information or description of the items themselves as well as from the processes that occurred in that section of the complex.

Table 6-9. REDOX Complex Chemical and Radionuclides of Concern

Building Location/Area	Process Description of Area	Reference Document	Chemical of Concern1	Primary Radionuclides of Concern	Expected Contamination Level
202S Building Overall	Canyon including process cells, equipment, Air Tunnel, Hot Pipe Trench, piping, Canyon Deck, and all surfaces	HNF-13830, Appendix A HW-18700	Group 1	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	Estimated 9,000 Ci beta and 1,500 Ci alpha
Silo AMU 1st Floor	Aqueous Makeup 1st Level	ISO-1108	See Note 1.	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	trace
Silo AMU 2nd Floor	Aqueous Makeup 2nd Level	ISO-1108	Table 6-1	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	trace
Silo AMU 3rd Floor	Aqueous Makeup 3rd Level	ISO-1108	Table 6-2 through 6-4	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	trace
Silo AMU 4thFloor	Aqueous Makeup 4th Level	ISO-1108	Table 6-2	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	trace
Silo AMU 5th Floor	Aqueous Makeup 5th Level	ISO-1108	Table 6-3	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	trace

Table 6-9. REDOX Complex Chemical and Radionuclides of Concern

Building Location/Area	Process Description of Area	Reference Document	Chemical of Concern1	Primary Radionuclides of Concern	Expected Contamination Level
Silo 6th Floor	Silo Crane Level	ISO-1108	Table 6-4	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor
Silo 7th Floor	Silo Operating Gallery	ISO-1108	Group 2 See Note 1	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor
Silo 7th Floor	Silo Sample Gallery	ISO-1108	Table 6-1 through Table 6-5	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	moderate
Silo Feed Tank 8th Floor	Aqueous Feed Tank Level	ISO-1108	Table 6-5	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	trace
Silo Tower Shaft	Thirteen extraction columns enclosure	HNF-13830, Appendix A	Table 6-1 through Table 6-5	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	high surface contamination, radiation area
Silo Column Laydown Trench	Trench used to remove failed columns from the Silo	HNF-13830, Appendix A	Table 6-1 through Table 6-5	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor surface contamination, radiation area due to shine from the Silo Tower Shaft

Table 6-9. REDOX Complex Chemical and Radionuclides of Concern

Building Location/Area	Process Description of Area	Reference Document	Chemical of Concern1	Primary Radionuclides of Concern	Expected Contamination Level
North Operating Gallery	Operating Gallery	HNF-13830, Appendix A	Group 2	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor, some contamination and RBAs
North Pipe Gallery	Pipe Gallery	HNF-13830, Appendix A	Group 2	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor, some contamination and RBAs
North Sample Gallery	Sample Gallery excluding the Plutonium Loadout Hood and HCA located west of the hump	HNF-13830, Appendix A	Group 1	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor, some contamination and RBAs
Plutonium Loadout Hood	Majority of inventory present in the E-16 and E-17 concentrators (97 percent)	HNF-13830, Appendix A	Group 3	Primarily plutonium with very minor amounts of mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, neptunium, and americium	840 Ci beta 140 Ci alpha
North Annex	Switchgear and Office area	HNF-13830, Appendix A	Group 2	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor
North Supply Fan Room	Maintenance Room and Supply Fan	HNF-13830, Appendix A	Group 2	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor

Table 6-9. REDOX Complex Chemical and Radionuclides of Concern

Building Location/Area	Process Description of Area	Reference Document	Chemical of Concern1	Primary Radionuclides of Concern	Expected Contamination Level
SWP Lobby and Change Room	East entry access point and CMP stairway entry point	SM-14-05727, *REDOX Annual Surveillance* (2014)	Group 2	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor
CMP and Cab Gallery	Crane Maintenance Platform and Crane Cab Gallery	ISO-1108	Group 1	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	moderate, 60-ton crane hook is a radiation area
South Operating Gallery	Operating Gallery	HNF-13830, Appendix A	Group 2	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor, some contamination and RBAs
South Pipe Gallery	Pipe Gallery	HNF-13830, Appendix A	Group 2	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor, some contamination and RBAs
South Sample Gallery	Sample Gallery excluding the sampler boxes	HNF-13830, Appendix A	Group 1	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor, some contamination and RBAs
South Storage Gallery	Same level as bottom of canyon cells, posting changed in 2014 to HCA	SM-14-05727	Group 1	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	moderate, unexpected spread of contamination due to water infiltration

Table 6-9. REDOX Complex Chemical and Radionuclides of Concern

Building Location/Area	Process Description of Area	Reference Document	Chemical of Concern1	Primary Radionuclides of Concern	Expected Contamination Level
Remote Shop	East end of canyon at the cell floor level, remotely work on failed equipment from the canyon cells. Sump located in southwest corner adjacent to Air Tunnel access	HNF-13830, Appendix A	Group 1	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	moderate, surface contamination, radiation area in sump
Decon Room	East end of canyon at the cell floor level, decontamination area for failed equipment from the canyon cells	HNF-13830, Appendix A	Group 1	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	moderate, significant contamination potential in decon hood
Regulated Shop	Southeast corner of the 202S Building at the cell floor level, shop area for cell equipment repair	HNF-13830, Appendix A	Group 1	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor
Southwest Annex	Switchgear, Supply Fan, and Office area	HNF-13830, Appendix A	Group 2	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor
D Cell Vessels and Sump 1	Tank D-10 approximately 1,420 gal. and D-13 approximately 5,560 gal of waste transferred from 222S Labs. Also 2,567 gal of misrouted low-level liquid waste from 219-S were inadvertently dropped in the Sump 1 of D Cell in February 1982.	HNF-13830, Appendix A Occurrence Report (82-08, *219-S Liquid Waste Transfer*)	Unknown	Uncharacterized low-level liquid waste from 222S Labs	High contamination and high radiation area expected due to process constituents and wastes
293S Nitric Acid Recovery and Iodine Backup Building	Upper level of the building contains fiber filter media (RBA), and lower area contains caustic columns (contamination area)	HNF-13830, Appendix A	Group 4	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	4 Ci beta 1 Ci alpha

Table 6-9. REDOX Complex Chemical and Radionuclides of Concern

Building Location/Area	Process Description of Area	Reference Document	Chemical of Concern1	Primary Radionuclides of Concern	Expected Contamination Level
276S Hexone Storage Tank	Residual in the tank, belowgrade and grouted	HNF-13830, Appendix A	Group 5	Mixed fission products (strontium-90 and cesium-137), activation products (cobalt-60), uranium, plutonium, and americium	minor

Chemical Group Definitions:

Group 1: Nitric Acid, Boric Acid, Citric Acid Decontamination Agent, Sodium Hydroxide, Ammonium Fluoride, Aluminum Nitrate, Ferrous Sulfamate, Sodium Dichromate, Sodium Carbonate, Potassium Permanganate, Polychlorinated Biphenyl, Asbestos, Lead Based Paint, Hexone

Group 2: Trace quantities of Group 1

Group 3: Nitric Acid, Asbestos, Lead Based Paints

Group 4: Nitric Acid, Sodium Hydroxide, Polychlorinated Biphenyl, Asbestos, Lead Based Paints

Group 5: Hexone sludge (per WHC-EP-0570, *The Distillation and Incineration of 132,000 Liters (35,000 Gallons) of Mixed-Waste Hexone Solvents from Hanford's REDOX Plant*), Asbestos, Lead Based Paints

Note 1: Levels 1 and 7 of the AMU side of the silo do not contain pumps or tanks associated with the original processes; therefore, figures and tables for these levels were not included. Radiological constituents for these areas are similar to other areas of the AMU side of the silo.

6.5 276S Hexone Tanks

A SAP for the 276S hexone tanks was issued in 2010 (DOE/RL-2009-116, *Sampling and Analysis Plan for the Hexone Storage and Treatment Facility Closure Plan*) to be used in conjunction with DOE/RL-2009-112. Given that the tanks have been solidified with grout, the SAP addresses verification soil sampling after the two tanks are removed. Per the SAP, no sampling of the abovegrade and belowgrade piping, tanks, pumps, or equipment will be required. Sampling of the soil below the tanks will only be required.

As documented in the REDOX Facility DSA (HNF-13830), which includes the 276S hexone tanks, the radiological constituents consist of mixed fission products, plutonium, and americium. These constituents are consistent with what may still be present at minor levels in the piping, pumps, and equipment that fed the tanks that may have not be stabilized with grout.

The treatment, storage, and disposal unit constituents that will require verification to meet clean closure standards are shown in Table 1-2 of DOE/RL-2009-116. According to Table 1-3 of DOE/RL-2009-116, the data quality objective process required for sample data states that "After equipment or contaminated soil has been removed, soil samples will be taken from the excavation area to verify that no residual soil contamination remains above clean closure standards established in accordance with WAC 173-303-610(2)(b)(i), "Dangerous Waste Regulations," "Closure and Post-Closure," requirements for unrestricted use. Soil samples will be analyzed for the suite of chemical constituents identified in Table 1-2." The milestone for complete closure of the hexone tanks is 9/30/2020 (M-037-10).

6.6 293S Nitric Acid Recovery Building

As discussed in CP-59461, *293-S, 2711-S, 2715-S, and 2718-S Hazard Categorization*, the hazard categorization for 293S is less than Hazard Category 3. Table 3-2 of CP-59461 states that the inventory consists of 1 Ci of plutonium-239 and 4 Ci of strontium-90, based on SD-DD-FL-001, *Rockwell Retired Contaminated Facility Listing and Description*. Given the time since the strontium-90 inventory was estimated in SD-DD-FL-001, strontium-90 would have decayed to below 2 Ci. This inventory is primarily present in the scrubber/absorption column and piping. The upper level of the building contains fiber filter media and is designated as an RBA; the lower area contains the exchange columns and is designated as a CA. CP-59461 states that, "Facility is deactivated and minor amounts of radiological contamination remain."

A SAP for waste designation and work planning support will be written to address sampling of radiological and nonradiological hazardous substances in FY 2017 to support the RAWP activities. In FY 2018, an entry will be performed to assess the condition of the building in preparation for removal action activities.

7 Work Sequencing

Since deactivation, S&M operations have been performed at REDOX (HNF-13830). The S&M program focuses on maintaining the structures in a safe and stable mode until their eventual disposition (e.g., demolition). The REDOX Complex structures are many decades old, and as a natural result of aging are degrading physically. Many contain radiological and/or chemical contamination.

CHPRC has undertaken work to identify, evaluate, and prioritize the physical and programmatic risks presented by these aging structures. CP-59374 was developed to identify, evaluate, and prioritize the physical and programmatic risks presented by hundreds of operating and deactivated structures across the DOE Hanford Site. This plan formed the basis for the hazards identified in the REDOX Complex and which are detailed in this report. Table 7-1 summarizes the logical approach to mitigate these hazards through a sequential listing of purposed work activities. Appendix C is provided to expand the level of detail of each work items from Table 7-1, arranged in a rudimentary work activity sequence.

Table 7-1. Work Activity Sequence Summary

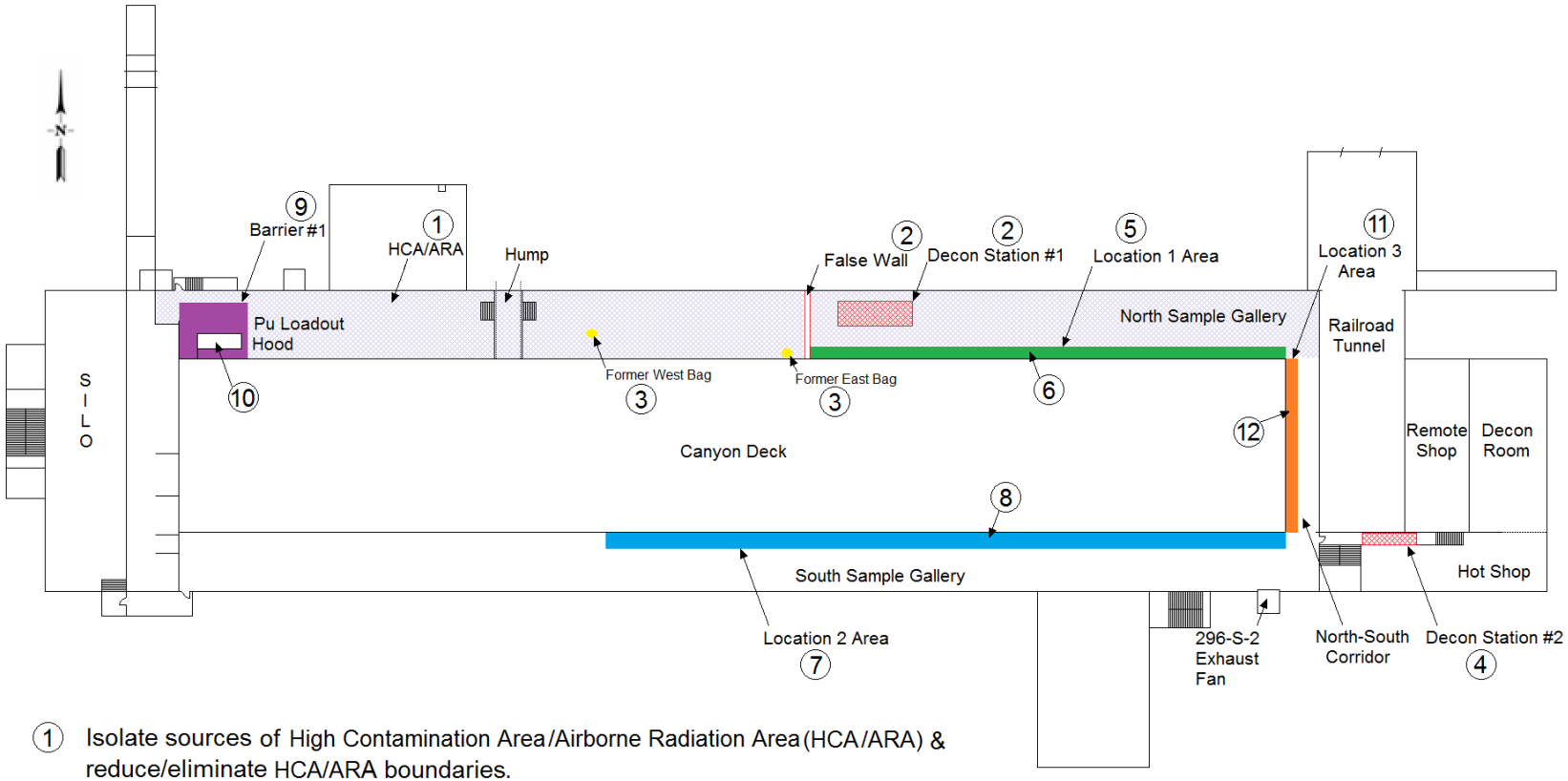
Work Activity Sequence	Description of Activity
1	Complete annual surveillances of the REDOX Complex, and initiate work planning and field execution package for housekeeping and hazard mitigation within the scope of the S&M Plan ((DOE/RL-98-19); Appendix A (photographs A-5 and A-6) provides examples. Update radiological posting throughout 202S Building. This work should be completed throughout the entire REDOX Complex. A list of activities is shown in Table C-1.
2	Plan and execute a CMP entry in the 202S Canyon in order to perform a canyon roof inspection prior to re-roofing activities and visual inspection of the Canyon Deck.
3&4	Initiate design and work activities that allow the REDOX Facility to be isolated from the current electrical power sources and installation of a new temporary lighting and distribution system. This will substantially reduce the potential for hazardous energy source impacts during upcoming hazard mitigation activities and future D&D operations. Confirm that water and steam systems have been isolated exterior to the building.
5	REDOX RAWP approved. Initiate removal action scope.
6	Per Item 1, ensure that general housekeeping has been performed in the North Sample Gallery. Remove North Sample Gallery portion of L-16 to H-3 process line (approximately 160 ft of 2 in. stainless steel schedule 40 piping). The work sequence for removal will be done in three phases to align with other risk reduction activities that are planned for these galleries. Figure 7-1 and Appendix A, photographs A-1 through A-5 provide details. This activity is a required predecessor to Plutonium Loadout Hood removal.
7	Remove the Plutonium Loadout Hood vessels, piping, and enclosure from the west end of the North Sample Gallery (Appendix A, photographs A-7 and Figure 7-2).
8	Remove H-4 to L-16 process line South Sample Gallery. Remove H-4 to L-16 process line from the north-south corridor. This work step was delayed to ensure personnel egress is maintained in the north-south corridor during the Plutonium Loadout Hood removal covered in Work Activity Sequence 7 (Figure 7-1). This is the last removal effort in the Sample Galleries prior to final cleanup and exiting.

Table 7-1. Work Activity Sequence Summary

Work Activity Sequence	Description of Activity
9	Mitigate chemical, biological, industrial safety, and asbestos hazards in the AMU/Silo section of the 202S Building (Appendix A, photograph A-8 provides an example). Removal of tanks and piping should be evaluated on a case-by-case basis. The benefit of removal for risk reduction should be balanced against the cost of removal now versus removal as part of debris during demolition.
10	Plan and execute a more detailed Canyon Deck entry if needed based on information gathered during the previous CMP entry as defined in Work Activity Sequence 2. Determine the gap information required and initiate work planning to accomplish the entry.
11	Initiate work planning and field execution package for the characterization and demolition of the 293S Nitric Acid and Iodine Recovery Building. This structure will be demolished to grade level and the belowgrade concrete structure will be left in place and backfilled.
12	Hazard Abatement, Demolition Preparation, and Demolition of 202S Annexes. Hazard Abatement and Select Demolition Preparation of Abovegrade Galleries (not addressed in the previous Work Activity Sequence steps). Work may include full-scale asbestos abatement; removing light ballasts; draining fluids from piping and equipment; isolating piping and/or stabilizing contaminates; removing asbestos flooring; and removing piping, tanks, and equipment.
13	Coordinate with ERDF for the disposal of the grouted underground 276S141 and 276S142 Hexone Storage Tanks. Remove abovegrade piping, pumps, and equipment. Excavate around tanks to facilitate one-piece disposal of each tank as a monolith to ERDF. Complete the RCRA Clean Closure verification sampling and administrative requirements once tanks and pipeline are removed and underlying soil is verified clean.
14	Future work planning activities will be required for the following buildings under the general decommissioning AM (DOE/RL-2010-22, *Action Memorandum for General Hanford Site Decommissioning Activities*): • 211S Tank Farm • 276S Solvent Preparation Facility • 202S Office and Maintenance Shops removal Remainder of work under REDOX AM (DOE/RL-2016-52) that was not addressed in the previous work activity sequence steps.

7.1 Work Sequence – Bar Graph Schedule

A simple bar graph schedule (Figure 7-3) shows a general flow of work, while specifically calling out the work items that may be started immediately (i.e., under the current S&M Plan [DOE/RL-98-19] and DSA [HNF-13830]).



1. Isolate sources of High Contamination Area/Airborne Radiation Area (HCA/ARA) & reduce/eliminate HCA/ARA boundaries.
2. Construct new false wall. Set up Decon Station #1.
3. Install glovebags and remove piping west of the new false wall.
4. Set up Decon Station #2.
5. Set up moveable barrier in Location 1 Area.
6. Install glovebags at low point and hot tap pipe on the east side of false wall in the North Sample Gallery.
7. Set up moveable barrier in Location 2 Area.
8. Install glovebags at low point and hot tap pipe in the South Sample Gallery.
9. Set up Barrier #1.
10. Remove Pu Loadout Hood.
11. Set up moveable barrier in Location 3 Area.
12. Install glovebags at low point and hot tap pipe in the North-South Corridor.
13. Clean up area and remove all unused/waste items.

Figure 7-1. Sample Gallery Work Sequence

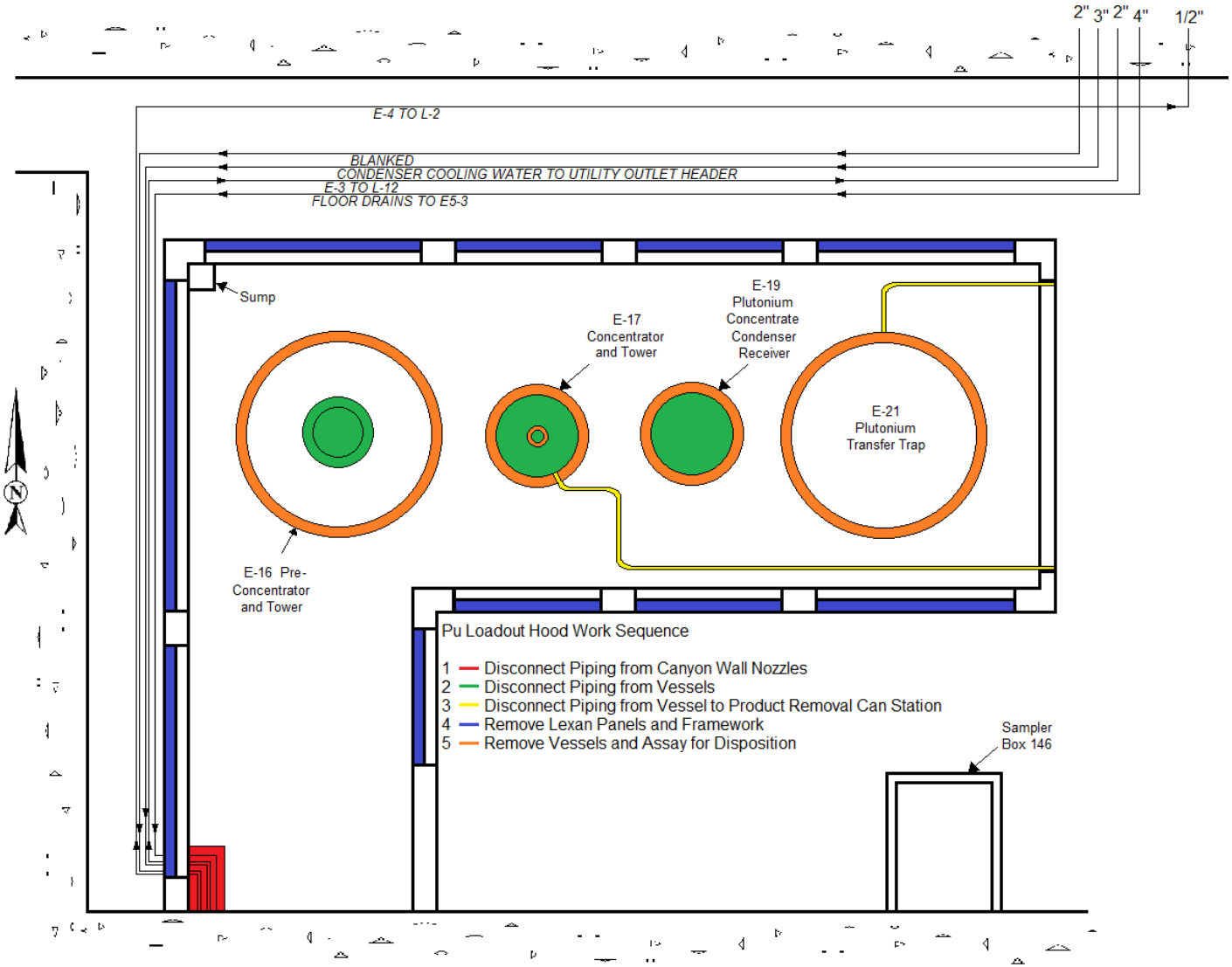


Figure 7-2. Plutonium Loadout Hood Work Sequence

RAWP Approved

Work Activity Sequence		FY17	FY18	FY19
1*	Complete annual surveillance of the REDOX Complex, housekeeping and hazard mitigation under the current S&M Plan			
2*	Plan and implement a CMP entry			
3*	Request Electrical Utilities to provide an independent feed for the 291-S Exhaust Fans			
4*	Remove 202-S Building from 2.4KV provided electrical power and implement temporary electrical power systems. Confirm that water and steam systems have been isolated exterior to the building. Evaluate and perform ventilation upgrades to support removal action scope.			
5*	RAWP Approved. Initiate removal action scope.			
6	Implement work documents and field activities for line isolation of Line L-16 to H-4 and removal of this pipe in the North and South Sample Galleries			
7	Pu Loadout Hood removal			
8	Removal of Line l-16 to H-4 from the north-south cooridor between the North and South Sample Galleries			
9*	AMU hazard mitigation and vessel/piping inspection			
10*	Canyon Deck entry (if additional information is required after CMP entry is accomplished in item 2 above).			
11	293-S Nitric Acid and Iodine Recovery Building - inspection entry and risk mitigation			
12	Hazard Abatement, Demolition Preparation and Demolition of 202-S Annexes. Hazard Abatement and Select Demolition Preparation of Above-Grade Galleries.			
13	276-S Hexone Tank - Planning, Removal and RCRA Closure			
14	Future scope - Planning and execution of hazards mitigation under General and REDOX AM documents.			

* Work items to be done under current S&M Plan and DSA

Figure 7-3. Work Activity Sequence Schedule for REDOX Risk Mitigation

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8 Path Forward

This document provides a recommended sequence of activities to implement the removal action documented in the AM and S&M activities discussed identified in CP-59374. In addition, this report provides CHPRC management, engineering, planning, work package development, and field work crews with the basic knowledge of how the REDOX Complex operated (1952 through 1967) and what risks were introduced by each phase of the fuel separations activities conducted during its operational lifespan. Also, the deactivation and long-term S&M activities that follow the operation phase are addressed to cover the period from 1967 through 2016.

The following three areas of the 202S Building are specifically addressed with respect to hazards and detailed work activities intended to reduce these hazards:

1. North and South Sample Galleries
    a. Plutonium Loadout Hood
    b. L-16 to H-4 Transfer Line
    c. Cell E to 233S Interconnecting Lines
    d. Leaking valves and flanges
        - Acid HDR from 204 Line
        - Steam Condensate from L-2, L-3, L-12 to D-12 Line
    e. Sample Storage Area (previously used by 222S Labs)
2. Silo
    a. Aqueous Makeup 1st Level
    b. Aqueous Makeup 2nd Level
    c. Aqueous Makeup 3rd Level
    d. Aqueous Makeup 4th Level
    e. Aqueous Makeup 5th Level
    f. Silo Crane Level (6th Floor)
    g. Silo Operating and Sample Gallery Level (7th Floor)
    h. Feed Tank Level (8th Floor)
3. Canyon Deck
    a. Visual observation from the CMP and Crane Cab Gallery
    b. Physical entry onto the Canyon Deck through the airlock in the South Pipe Gallery

This report addresses housekeeping and industrial hazard removal in other areas of the 202S Building (i.e., North and South Operating Galleries, North and South Pipe Galleries, South Sample Gallery, South Storage Gallery, Crane Cab Gallery, North Annex, Southeast Annex, CMP, SWP Lobby and Change Room, Remote Shop, Decon Shop, and Regulated Shop). Also included are demolition planning and

execution for two ancillary facilities: Hexone Storage Tanks (276S141 and 276S142) and 293S Nitric Acid Recovery and Iodine Backup Facility.

Chapter 7 and associated Appendix C provide a detailed work activity sequence of activities that are intended to accomplish the goal of risk reduction for the REDOX Complex by addressing specific mitigation activities that would eliminate the hazard. This listing is intended to provide a specific flow sequence that would be implemented through the CHPRC work control process.

9 References

0200W-US-N0156-02, 2000, *Pu Loadout Hood Stabilization*, Unreviewed Safety Question Evaluation Form, Rev. 2, Bechtel Hanford, Inc., Richland, Washington.

0200W-US-N0217-02, 2002, *REDOX, Stabilization of Hexone Tanks*, Unreviewed Safety Question Determination Form, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

40 CFR 61, "National Emissions Standards for Hazardous Air Pollutants," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol8/xml/CFR-2010-title40-vol8-part61.xml.

AOP-00-05-06, 2009, *Hanford Site Air Operating Permit*, Revision E Issuance, Washington State Department of Ecology, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1001140037.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1001140038.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1001140039.

BHI-00994, 1997, *In-Situ Non-Destructive Radiological Characterization of Selected 202-S Reduction Oxidation (REDOX) Facility Sample Gallery Pipes and Vessels*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI-01142, 2001, *REDOX Facility Safety Analysis Report*, Rev. 3, Bechtel Hanford, Inc., Richland, Washington.

BHI-01255, 1999, *Interim Characterization Report for the REDOX Plutonium Loadout Hood*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI-01299, 1999, *Alternative Evaluation for the REDOX (202-S) Plutonium Loadout Hood*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

CHPRC-202S-14-001, 2014, *Hanford Job Specific Beryllium Work Permit*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

CP-59374, 2015, *Canyon Risk Mitigation Plan*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

CP-59461, 2015, *293-S, 2711-S, 2715-S, and 2718-S Hazard Categorization*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

CP-60059, 2016, *Bags in REDOX North Sample Gallery*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

DOE/RL-98-19, 2008, *Surveillance and Maintenance Plan for the 202-S Reduction Oxidation (REDOX) Facility*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA06814175.

DOE/RL-2009-112, 2010, *Hexone Storage and Treatment Facility Closure Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084307.

DOE/RL-2009-116, 2010, *Sampling and Analysis Plan for the Hexone Storage and Treatment Facility Closure Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084307.

DOE/RL-2010-22, 2013, *Action Memorandum for General Hanford Site Decommissioning Activities*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087977.

DOE/RL-2016-16, 2016, *Engineering Evaluation/Cost Analysis for the REDOX Complex*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2016-52, 2016, *Action Memorandum for the Reduction-Oxidation (REDOX) Complex*, Draft, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

H-2-7957 (drawing), 1957, *Piping - Gen. Arrangement Plans P.R. Room*, Rev. 3, General Electrical Company, Richland, Washington.

H-2-8754 (drawing), 1951, *Piping Gen'l. Arrg't, Elevations & Sections P.R. Room*, Sheet 1, Rev. 3, General Electrical Company, Richland, Washington.

H-2-30603 (drawing), 1957, *Nitric Acid Piping from 204-S to Recovered Acid Header*, Rev. 1, General Electric Company, Richland, Washington.

HNF-13830, 2016, *Documented Safety Analysis for the Reduction-Oxidation Facility*, Rev. 5, CH2M HILL Plateau Remediation Company, Richland, Washington.

HNF-EP-0063, 2011, *Hanford Site Solid Waste Acceptance Criteria*, Rev. 16, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/HNF-EP-0063_Rev16_041111_Website.pdf.

HW-18700, 1951 (declassified 1974), *REDOX Technical Manual*, General Electric Company, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0076412H.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0076411H.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0076410H.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0076409H.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0076408H.

HW-44715, 1956, *Utilization of UO_3 Plant Recovered Acid Design Criteria*, General Electric Company, Richland, Washington.

HW-51257, 1957, *Scope & Design Criteria Revision, Utilization of UO_3 Recovered Acid at REDOX and PUREX*, General Electric Company, Richland, Washington.

ISO-1108, 1966, *Redox Deactivation Manual*, Isochem Inc., Richland, Washington.

OR 82-08, 1982, *219-S Liquid Waste Transfer*, Occurrence Report, Rockwell Hanford Operations, Richland, Washington.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/rcraonline/.

SD-DD-FL-001, 1982, *Rockwell Retired Contaminated Facility Listing and Description*, Rev. 0, Rockwell Hanford Operations, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0077155H.

SM-14-05727, 2014, *REDOX Annual Surveillance*, CH2M HILL Plateau Remediation Company, Richland, Washington.

WAC 173-303-610, "Dangerous Waste Regulations," "Closure and Post-Closure," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303-610.

WAC 173-401, "Operating Permit Regulation," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-401.

WHC-EP-0570, 1992, *The Distillation and Incineration of 132,000 Liters (35,000 Gallons) of Mixed-Waste Hexone Solvents from Hanford's REDOX Plant*, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196107914.

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Appendix A

Photographs

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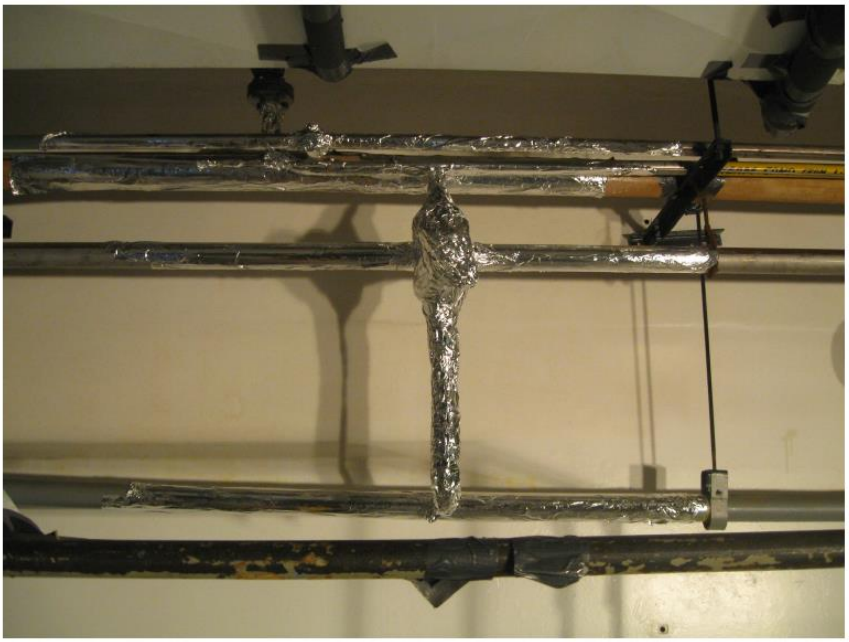
North Sample Gallery (East Bag)

A-1. East Bag Acid Header from 204S Line (North Sample Gallery)
Before Hazard Was Mitigated



A-2. East Bag Acid Header from 204S Line (North Sample Gallery)
After Hazard Was Mitigated

North Sample Gallery (West Bag)

A-3. West Bag Steam Condensate from L-2, L-3, L-12 to D-12 Line (North Sample Gallery) Before Hazard Was Mitigated

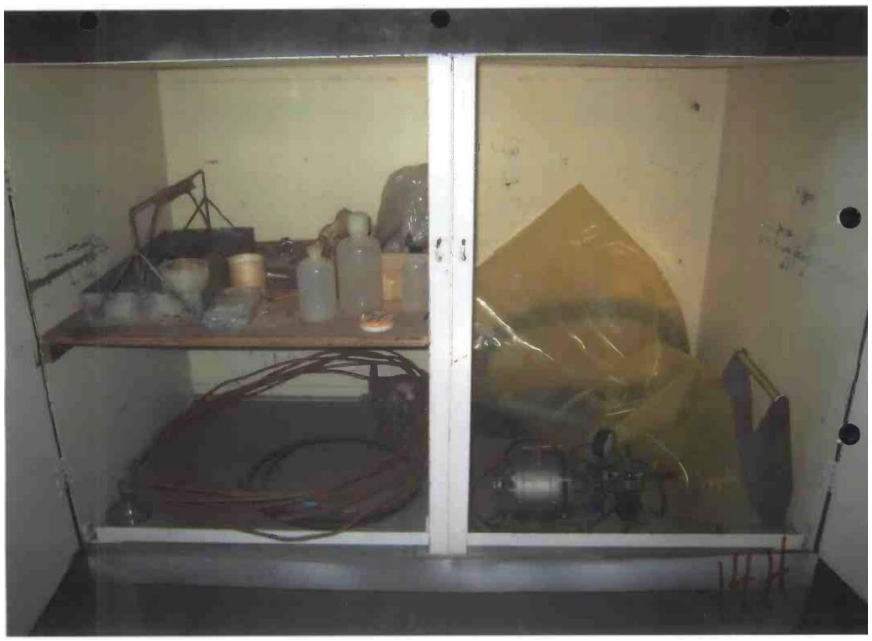
A-4. West Bag Steam Condensate Line to D-12 (Upper Left Valve) (North Sample Gallery) Before Hazard Was Mitigated

A-5. West Bag Steam Condensate Line to D-12 (North Sample Gallery) After Hazard Was Mitigated

Plutonium Loadout Hood

A-6. East End of the Plutonium Loadout Hood (North Sample Gallery)

North Sample Gallery

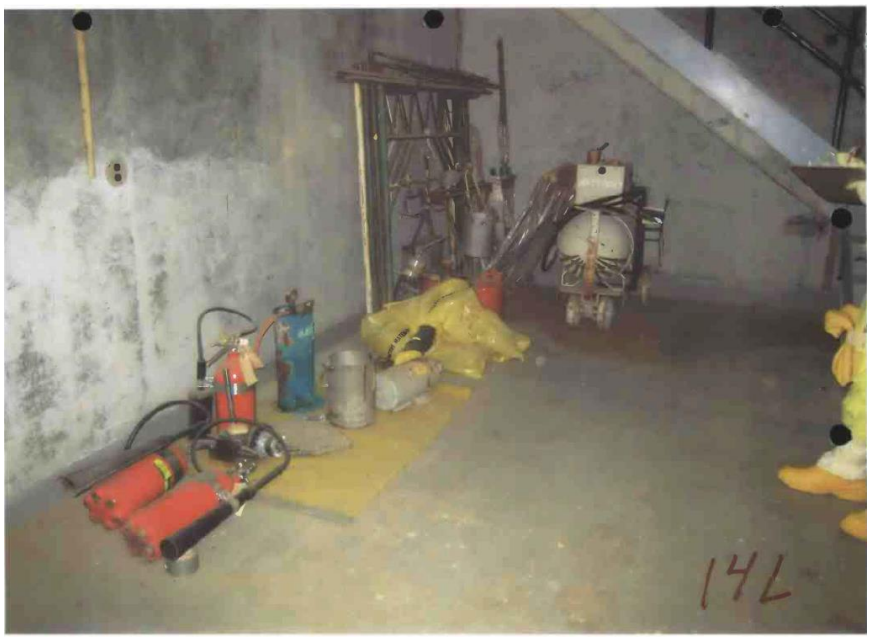


A-7. Accumulation of Unused Materials, Containers, and Debris (North Sample Gallery)

Silo

A-8. White Substance Forming on Equipment (202S Silo AMU 5th Level)

Hot Shop



A-9. Fire Extinguishers, Debris, and Unused Equipment (Hot Shop)

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Appendix B

Operating Events History

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Terms

AECL	Atomic Energy of Canada Limited
CMP	Crane Maintenance Platform
DOE	U.S. Department of Energy
PRTR	plutonium recycle test reactor
REDOX	Reduction-Oxidation (S Plant)

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Table B-1 provides a list of significant events in the Reduction-Oxidation (REDOX) Plant history; activities related to REDOX in other Hanford operating areas (e.g., S Tank Farms) are included for completeness.

Table B-1. REDOX (S Plant) Significant Events

Year	Area Affected	Description of Event	Document Number	Date
1951	211S Tank Farm and Sewer*	103,800 gal of aluminum nitrate was discharged to the sewer system after the hold-down studs on the cleanout flange failed.	HW-22875	21-Dec-51
1952	211S Tank Farm*	Aluminum nitrate storage tank SS-113 failed due to Tygon® liner failure. Two remaining tanks were under a watch condition and subsequently failed.	HW-23437	21-Feb-52
	202S and 222S Labs	Ruthenium scrubber failure caused a stack release that was ingested by the supply fans in the 202S and 222S Buildings causing internal building contamination.	HW-23982	18-Apr-52
	291S Stack	A significant number of radioactive particles were discharged from the REDOX stack. Radiological Sciences reported the presence of intensely radioactive particles in the REDOX area under conditions, which raised probably insoluble questions of possible overexposure.	HW-24337	20-May-52
	110S Waste Tank*	Waste in the 110S tank has started to boil. Air condensers are not adequate. Action to curb emission is required.	HW-25523	24-Sep-52
	107S Basin and 110S Waste Tank*	Emissions from 107 and 110S tanks are continuing. Air condensers are being modified to permit water cooling.	HW-25781	20-Oct-52
	202S D Cell	A steam coil failure in the REDOX D-12 Waste Concentrator caused gross contamination of process cooling water, 207S retention pond and swamp area outside 200 West Area. Swamp area dose rates are up to 2 R/hr including 35 mR/hr at 1 in. from the ground. The swamp has been diked to maintain a constant water level.	HW-26047	20-Nov-52
	202S H Cell	The H-4 oxidizer coil failure at REDOX caused further gross contamination of swamp and 207S Retention Basin. In a three-day period, the dose rate at the swamp inlet increased from 6 mR/hr to 700 mR/hr.	HW-26376	23-Dec-52

® Tygon is a registered trademark of Saint-Gobain Corporation, Malvern, Pennsylvania.

Table B-1. REDOX (S Plant) Significant Events

Year	Area Affected	Description of Event	Document Number	Date
1953	202S South Sample Gallery	On February 5, 1953, a violent chemical reaction involving hexone-nitric acid necessitated evacuation of personnel and extensive decontamination work at the REDOX Plant. Source of the incompatible mixture was either the salt waste header or a sample pot. Process solutions were blown from six ports in the South Sample Gallery. Surface dose rates up to 200 R/hr presented a difficult decontamination problem.	HW-27288	18-Mar-53
	202S D Cell	REDOX experienced the third D-12 Waste Concentrator failure since startup.	HW-28267	19-Jun-53
	202S South Operating and Pipe Galleries	A blowback occurred at the H-4 section contaminating both the REDOX operating and pipe galleries. This incident added to the already heavy decontamination load which includes crane, crane way, and South Sample Gallery.	HW-28756	22-Jul-53
	202S H Cell and 207S Basin	High radiation readings at the 207S Retention Basin were traced to a leaking H-4 Oxidizer pot coil at REDOX. Normal operation was continued by keeping the coil pressurized. Complete failure necessitated blanking the coil and adopting a cold oxidation step.	HW-29229	18-Sep-53
	291S Stack	A large number of ruthenium carrying crystals of ammonium nitrate again were discharged from the REDOX stack. Extensive decontamination of the REDOX crane and CMP has been ineffective because of prompt recontamination during process cell work. Until the cell ventilation system can be improved, crane contamination will be a problem.	HW-29279	18-Sep-53
	202S Canyon	Burial of a failed H-4 oxidizer at REDOX was the highest dose rate radiation work performed in the Separations Section to date. After 2 days of in-cell decontamination, the dose rate during burial was 250 mR/hr at 500 ft.	HW-29153	21-Oct-53

Table B-1. REDOX (S Plant) Significant Events

Year	Area Affected	Description of Event	Document Number	Date
1954	101S & 104S Waste Tanks and 291S Stack	Self-concentration in the 101S and 104S tanks is discharging steam vapor and liquid at frequent intervals. Metal shelters and glass wool filters have been installed on an emergency basis to confine contamination. There was a severe ruthenium emission from the 291S stack and high level contamination of a considerable expanse of surrounding area; 260 curies were discharged causing surface dose rates up to 7.5 R/hr and necessitating road resurfacing, access denial of extensive ground area, and cleanup of many vehicles.	HW-30724	25-Feb-54
	291S Stack	The REDOX head-end flowsheet has been revised in an effort to minimize ruthenium emissions. Reflux is being employed in the H-4 oxidizer tower.	HW-31006	23-Mar-54
	291S Stack	Total reflux in the REDOX H-4 oxidizer tower shows no appreciable improvement in ruthenium emission over the nonreflux type runs.	HW-31267	23-Apr-54
	202S Pipe Galleries	Five separate blowbacks into the REDOX Pipe Gallery instrument and chemical addition lines constituted a serious potential for personnel exposure.	HW-31734	21-May-54
	291S Stack	Offgases from both primary sources of REDOX stack emission, H-4 oxidizer, and vessel vent are now routed through the sand filter after receiving improved scrubbing or pre-filtering. Oxidizer offgas is routed through two caustic scrubbers in series, a fiberglass filter and the sand filter before stack discharge.	HW-32684	20-Aug-54
	Area East of the 291S Stack	A modified 200 West Area particle decontamination program resulted in a reduction in estimated expense from $235,000 to $106,000. The badly decontaminated 50 ac east of REDOX were plowed and seeded with rye grass. This action, coupled with backfill around the REDOX stack, greatly reduced a primary source of ground contamination within 200 West Area.	HW-33585	24-Nov-54
	291S Stack	Visible particulate contamination was released on several occasions from the REDOX stack. Activity ranged to 20 R/hr. Analyses of particles indicate ruthenium of an age related to the January 1954 emissions. More recent discharge shows predominance of ruthenium-103 indicating current material as the source. Verification is being vigorously pursued.	HW-33962	20-Dec-54

Table B-1. REDOX (S Plant) Significant Events

Year	Area Affected	Description of Event	Document Number	Date
1955	202S South Pipe Gallery	A process blowback from the H-4 oxidizer in REDOX produced radiation levels to 500 R/hr at 6 in. and 1 R/hr at the radiation zone boundary; 21 employees received some exposure but less than the daily control limit.	HW-38375	26-Aug-55
1956	233S Control Room	As a result of the control valve failure and plutonium backup to the 233S control rooms, three of eight employees received significant exposures. One of the three, based on bioassay, may be the highest deposition case experienced at the Hanford Atomic Products Operation. A control valve failure in the 233S Building caused plutonium solution to back up through an instrument line to the control room. Gross air and surface contamination resulted throughout the building and in the ground area outside.	HW-43938	23-Jul-56
1957	Noteworthy Item	The 293S Building was put into operation to effect more efficient iodine removal and acid recovery from the dissolving operation. A marked decrease in nitric acid consumption for the plant occurred.	Project No. CG-648	13-Sep-57
	Noteworthy Item	The year 1957 marked the first processing of irradiated fuel elements from foreign sources. Three shipments of fuel elements from the Chalk River Plant (AECL) were processed on a segregated basis.	N/A	N/A
	200W Area Railway*	A box used to transport failed equipment from REDOX to T Plant was pulled from the rail car en route when one of the box swing cables caught on a railroad tie or switch frog. The ground was contaminated to 2 R/hr.	N/A	24-Oct-57

Table B-1. REDOX (S Plant) Significant Events

Year	Area Affected	Description of Event	Document Number	Date
1958	Noteworthy Item	The processing of foreign (AECL) irradiated fuel elements was completed. Six shipments were received and processed without difficulty.	N/A	N/A
	Burial Grounds*	During an H-2 centrifuge burial from REDOX, fumes were observed coming from the centrifuge shortly after it was placed in the box. After four hours of this condition andunsuccessful attempts to control it, fumes escaped the tunnel and began circulating throughout the building via the vent system. Within eight hours, all personnel were on masks. Considerable contamination was deposited on all horizontal surfaces, including construction work areas outside the building. Controlled work conditions had to be set for the lump sum contractor. When the centrifuge was removed for burial, contamination was spread to 234-5 and 224-U areas.	HW-54319	21-Jan-58
	211S Tank Farm*	The bottom of the steel liner in storage tank 113-SX was found to be bulged about 4 ft upwards of its normal position. Liquid between the concrete support structure and the steel liner appears to be the most plausible explanation for the observed condition. During the month, the liner returned to its normal position.	HW-56602	22-Jul-58
	202S South Operating Gallery	On November 23, 1958, an H-4 oxidizer blowback occurred in REDOX resulting in 500 R/hr maximum readings from an instrument line at the panel board. A vapor phase reaction when hexone was recycled from F-8 tank to H-4 is suspected.	HW-58305	22-Dec-58
1959	Noteworthy Item	During September, the first program for recovery of neptunium was initiated at REDOX.	N/A	N/A
	200 West Area Burial Grounds*	On January 8, 1959, a fission product contamination spread occurred over 250 ac of 200 West Area when a burial box containing REDOX cell jumpers collapsed during backfill operations.	HW-59079	20-Feb-59
	106-TY Waste Tank*	Tank 106-TY is suspected to be leaking. Dry wells are being checked but no confirming results have been obtained.	HW-61736	21-Sep-59
	233S Building*	Building 233S at REDOX was operated on respiratory protection for two days due to alpha air contamination. Vessel pressurization and blowback through an instrument line and defective gauge at the panel board was the source.	HW-62179	21-Oct-59

Table B-1. REDOX (S Plant) Significant Events

Year	Area Affected	Description of Event	Document Number	Date
1960	200 West Area Burial Grounds*	A REDOX burial box collapsed during backfill, but no spread resulted since the collapse did not occur until work was almost complete. Box design and backfill techniques again are being studied in an effort to preclude further problems of this nature.	HW-67459	21-Dec-60
1961	Noteworthy Item	First tests of dissolution of zirconium-clad PRTR fuel elements were completed in December 1961.	N/A	N/A
1962	202S Silo Sample Gallery	Dose rates up to 5 R/hr were measured in the Silo Sample Gallery at REDOX as a result of a partial vacuum created when steam was allowed to condense in a line from the 1A column.	HW-74804	21-Sep-62
1963	Noteworthy Item	The dissolution and solvent extraction processing of the first production campaigns of PRTR, zirconium-clad, plutonium-aluminum alloy fuel elements were accomplished in February, March, and December.	N/A	N/A
	233S Building L-18 Ion Exchange Column*	A fire occurred in the 233S Building on November 6, 1963, which destroyed the ion exchange unit for final plutonium purification. The fire was caused by accidental loading of sodium dichromate onto the resin with consequent oxidation, exothermic reaction, pressurization and rupture of the ion exchange contactor. The fire burned plastic paneling, clothing, and wiring and damaged the L-18 contactor beyond repair. The viewing room, stairwells, and loadout room were grossly contaminated with gram quantities of plutonium, but contamination otherwise was relatively minor. Within 6 weeks, the 233S Building was cleaned, painted and returned to operation minus the L-18 ion exchange unit.	N/A	6-Nov-63
1964	107-SX Waste Tank*	There is a suspected leak from 107-SX tank. Radiation readings detected in underground laterals are increasing at an average daily rate of 2,000 counts/minute.	HW-82089	22-May-64
	107-SX Waste Tank*	Observation of 107-SX tank continues. One lateral probe reading has increased to 1,150,000 counts/minute. The other two laterals are static and no leak confirmation has been indicated from any of the seven dry wells.	HW-83508	21-Aug-64
	108-SX Waste Tank*	Tank 108-SX indicates some leakage as noted from increase in readings from two laterals from 150,000 to 720,000 counts/minute. One of the vertical test wells also has increased from 5,000 to 6,000 counts/minute.	RL-SEP-112	21-Dec-64

Table B-1. REDOX (S Plant) Significant Events

Year	Area Affected	Description of Event	Document Number	Date
1965	291S Stack	During a neptunium recovery campaign in September, 20 curies of ruthenium-103 and 46 curies of ruthenium-106 were emitted from the stack over a three-day period.	N/A	N/A
	202S Wind Tunnel	During October, a program for flushing the Wind Tunnel was initiated to recover plutonium lost from the E-2 pot ozonator operation. A total of 49,000 gal of 2.5 percent nitric acid; one percent boric acid was used to recover 6.5 kg of plutonium.	N/A	N/A
	108-SX Waste Tank*	REDOX waste storage tank 108-SX has shown some seepage as indicated by radiation readings on laterals under the tank and dry wells located around the tank perimeter. Two test holes were drilled near the tank through the seepage zones to determine the extent of seepage. Radioactivity has been found to terminate at depths 7 and 11 ft below the tank bottom. Maximum dose rates from the soil samples were about 2.5 R/hr.	RL-SEP-618	21-Jul-65
	115-SX Waste Tank*	Test wells are being drilled to depths of up to 70 ft around the 115-SX waste storage tank, which leaked approximately 16 in. of dissolved sodium nitrate solution to ground during March, 1965. Two wells drilled to date show deepest penetration of activity to be 9 ft below the tank bottom. Maximum beta-gamma activity in soil samples brought to the surface is 6,000 c/m.	RL-SEP-706	21-Sep-65
	291S Stack	During a neptunium run at REDOX, 66 curies of ruthenium were released to the atmosphere via the sand filter and ventilation stack. The activity was well dispersed in the environment, and ground activity was barely distinguishable above background. Cause of the unusual breakthrough was not determined, and the investigation is continuing.	RL-SEP-755	22-Oct-65

Table B-1. REDOX (S Plant) Significant Events

Year	Area Affected	Description of Event	Document Number	Date
1966	Noteworthy Item	The dissolution and solvent extraction processing of the first production campaign of Zircaloy-clad, 0.947 percent enriched, N Reactor fuels began on February 23, 1966.	N/A	N/A
	Noteworthy Item	Dissolution of the first production campaign of Zircaloy-clad N Reactor spike fuel (l.25 percent enriched outer tube, 0.947 percent enriched inner tube) began on April 19, 1966.	N/A	N/A
	Noteworthy Item	The first 13-ton lot of PWR-1 (Shippingport) was successfully dissolved (November 23) and processed through the solvent extraction battery in December 1966.	N/A	N/A
	Noteworthy Item	In December, the first americium-curium campaign was completed and preparation for a cask loadout was initiated.	N/A	N/A
	Noteworthy Item	In December, final processing began preliminary to deactivation of the REDOX process plant.	N/A	N/A
	115-SX Waste Tank*	Ten test wells were drilled around the 115-SX waste storage tank to determine the distribution of waste solution that leaked from the tank several months ago. The radioactivity, primarily radiocesium, appeared to have penetrated no more than 15 ft below the tank bottom.	RL-SEP-913	21-Jan-66
	291S Stack	A stack emission of short duration occurred on March 31, which spread contaminated particulate matter to the south and west of the REDOX stack. The particles appeared to be the usual ammonium nitrate crystals contaminated with radioruthenium. Contamination was contained within the exclusion area. Reason for the emissions is unknown.	IS0-210	22-Apr-66
1967	108-SX Waste Tank*	Persistent migration of radioactivity beneath waste storage tank 108-SX, which contains self-boiling REDOX wastes, led to a decision to remove the cesium-bearing supernatant solution. Calculations indicate that if the sludges were allowed to dry without supplementary cooling, peak temperatures of about 1,600°F would be reached in about 18 months. Since an air sweep could limit the peak temperature to acceptable values, an air cooling unit is being designed for installation and use if needed.	IS0-709	20-Apr-67
	108-SX Waste Tank*	Recent probing of waste storage tank 108-SX indicated that the bottom liner had bulged upwards about 2.5 ft in the northwest quadrant. Location of this deformation corresponds approximately with the site where contamination seepage was detected earlier.	ARH-59	25-Oct-67
	108-SX Waste Tank*	Color photographs obtained of the inside of waste storage tank 108-SX confirm the bulge in the bottom liner and the distortion of the recirculators and dip tubes.	ARH-60	22-Nov-67

Table B-1. REDOX (S Plant) Significant Events

Year	Area Affected	Description of Event	Document Number	Date
1969 to 1970	Noteworthy Item (202S Canyon Roof)	An ethylene propylene diene monomer roof membrane with 1 in. fiberboard underlayment was placed on the 202S Canyon Roof. This is an estimated of the timeframe when the current membrane was installed based on an expert option obtained during roof repair activities conducted in the late 1990s.	N/A	N/A
1982	219S Waste Transfer Routed to D Cell Sump	A routing error by 222S Building Operations personnel allowed low-level liquid waste to be transferred from the 219S Facility to the floor of D Cell within the 202S Building. At 102-SY in tank farms, 2,567 gal were transferred but never received. The sump level indicator for Sump 1 of D Cell was found to read 23 in. and previously read zero. The cover blocks were removed from D Cell, and the liquid was allowed to evaporate.	Occurrence Report OR 82-08	18-Feb-82
1995	202S North Sample Gallery Plutonium Loadout Hood	The 146 Sampler Box located directly behind the east end of the Plutonium Loadout Hood was discovered to be highly contaminated with loose alpha from an apparent leak from a valve on the L-16 to H-4 transfer line.	BHI-01255	20-Sep-95
2003	Noteworthy Item (233S Facility)*	The 233S Building was demolished (DOE/RL-2005-20, *233-S Plutonium Concentration Facility Removal Action Closeout Report*). This was the first open air demolition of an alpha contaminated facility in the DOE Complex.	N/A	N/A
1999	Noteworthy Item (D Cell Cover Blocks)	The cover blocks that were removed from D Cell in 1982 to allow the misrouted low-level liquid waste to evaporate over the 15+ year span were replaced. Now all cover blocks are properly installed on all canyon process cells in the 202S Building.	N/A	N/A
2015	REDOX Complex	CP-59374, Appendix A (REDOX). See referenced report for current listing of noteworthy hazards in each section of the buildings that were recorded on Surveillance Observations from 2006 through 2014.	CP-59374	1-Oct-15

* Events did not specifically occur at the REDOX Facility but at a related facility.

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Appendix C

Work Breakdown for Chapter 7 Work Sequencing

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Terms

AM	action memorandum
AMU	aqueous makeup
ARA	airborne radiation area
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CMP	Crane Maintenance Platform
D&D	decontamination and decommissioning
DSA	documented safety analysis
EE/CA	engineering evaluation/cost analysis
ERDF	Environmental Restoration Disposal Facility
HCA	high contamination area
HDR	header
NDA	nondestructive assay
PFWR	plant forces work review
RAWP	removal action work plan
REDOX	Reduction-Oxidation (S Plant)
S&M	surveillance and maintenance
SAP	sampling and analysis plan

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C1 Introduction

This appendix is provided as a supplement to the bar graph included in Chapter 7 (Figure 7-3) of the main text to define the work activities to be included within each line item in the bar graph. Table C-1 includes items that are identified in CP-59374, *Canyon Risk Mitigation Plan*, as hazards observed from past surveillances. The majority of the work on the list are activities that are authorized to be performed as surveillance and maintenance (S&M) activities per DOE/RL-98-19, *Surveillance and Maintenance Plan for the 202-S Reduction Oxidation (REDOX) Facility*, and also authorized activities discussed in Section 2.2 of the documented safety analysis (DSA) (HNF-13830, *Documented Safety Analysis for the Reduction-Oxidation Facility*). The following activities with references 1 to 5 can be addressed before *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) documents (engineering evaluation/cost analysis [EE/CA], action memorandum [AM], sampling and analysis plan [SAP], removal action work plan [RAWP], and air monitoring plan) are completed. The right column of Table C-1 includes a reference to those items that are called out in specific detail in this appendix.

Table C-1. Previous Surveillances at the REDOX Complex – Required Actions

Item Number	Activity	Section C2 Cross Reference
a	Clean up miscellaneous waste including (but not limited to) containers, drums, bags, personal protective equipment, trash, paper, miscellaneous combustibles, chairs, brooms, ladders, gas cans, asbestos, fire extinguishers, hoses, spray cans, bottles, laundry, benches, manometers, garbage cans, tools, wiring, plastic sheeting, light bulbs, removed piping, and small equipment.	1, 9
b	Clean up biological items (dead animals/birds and feces).	1, 9
c	Lighting – bulb replacement, running sting lights.	1, 4
d	Fix doors so they latch correctly.	1
e	Seal areas where dirt, animal, and birds are entering the building (spray foam and metal sheet metal plates).	1
f	Verify that exposed wiring is de-energized, and remove when possible.	1, 4
g	Verify confined space, asbestos, beryllium, and radiological postings.	1
h	Remove friable asbestos that is damaged.	1, 9
i	Conduct sampling analysis, radiological surveys/smears, and nondestructive assay.	1
j	Fix/stabilize localized areas of radiological and hazardous material contamination where leaks are present (surfaces, leaking valves, puddles, and pipes).	1, 5, 6
k	Tape/seal areas where high levels of contamination are present to ensure they do not spread.	1, 7
l	Spray areas of mold to prevent spread.	1
m	Remove/refasten loose ceiling and floor tiles and support roof repair work.	1, 2

C2 Work Activity Sequence and Approximate Sequence for Stabilization Project Work

1. Complete annual surveillance of the REDOX complex per requirement of the S&M Plan.

    1.1. Include personnel in the surveillance crew that can re-lamp areas or provide alternative lighting where inadequate lighting conditions exist.

    1.2. Include task to identify location where temporary lighting circuits can be established in surveillance locations and existing building penetrations where temporary distribution wiring can pass through barriers.

    1.3. Verify and repair/replace confined space, asbestos, beryllium, and radiological postings as required for compliance to various safety program requirements.

    1.4. Include supervisory personnel in the surveillance crew that can provide direction on activities required to complete the surveillance activity.

    1.5. Add new findings to CP-59374.

        1.5.1. Document risks with photos and narrative.

    1.6. Prioritize hazard mitigation of newly identified risks.

    1.7. Implement work planning documents for hazard mitigation activities.

    1.8. Implement field activities to mitigate identified hazards in surveillance areas if they are within the current S&M Plan and DSA scope. Identify hazards that go beyond the allowed scope of current documentation for later mitigation as part of the CERCLA work.

        1.8.1. Ensure waste disposition pathway is identified before generating wastes.

        1.8.2. Remove containers, drums, bags, personal protective equipment, trash, paper, miscellaneous combustibles, chairs, brooms, ladders, gas cans, asbestos, fire extinguishers, hoses, spray cans, bottles, laundry, benches, manometers, garbage cans, tools, wiring, plastic sheeting, light bulbs, removed piping, and small equipment whenever possible for ERDF disposal.

        1.8.3. Repair door latches as needed to ensure proper closure for all exterior doors and interior doors that isolate different air flow or contamination areas.

        1.8.4. Seal areas where dirt, animal, and birds are entering the building or locations to minimize spread of contamination – spray foam, metal sheet metal plates.

        1.8.5. Remove/mitigate industrial hazards as tripping hazards, mold, leading edge, fall warnings, egress paths, falling hazards, as may be possible. If removal is not feasible, warning boundaries and isolation techniques should be used to minimize personal exposure to the identified hazards.

        1.8.6. Using an approved bleach solution or similar, spray areas of observed mold to mitigate hazard and reduce/prevent its spread. Then cleanup treated area and dispose of materials.

        1.8.7. Perform biological cleanup (dead animals/bird, feces).

1.8.8. Verify exposed wiring is de-energized and remove hazard.

1.8.9. Abate discrete areas where friable asbestos that has been damaged. Large scale removal of asbestos in areas of the facility will be performed after CERCLA removal action is approved.

1.8.10. Fix/stabilize areas of radiological and nonradiological contamination. This does not include the fixing/stabilization within the North and South Sample Galleries, which will be performed under Work Activity Sequence 5 and 6.

2. Plan and implement a CMP entry.

2.1. Perform a roof evaluation per PRC-PRO-SH-10321, *Walking/Working Surfaces* (Page 5, Items 8 and 9).

2.1.1. Document evaluation with a formal report by a qualified engineer.

2.1.2. Support roof repair project work.

2.2. Add new finds to CP-59374.

2.3. Prioritize hazard mitigation of newly identified risks.

2.4. Update work planning documents for hazard mitigation activities in the CMP area.

2.4.1. Ensure waste disposition pathway is identified.

2.5. Implement field activities to mitigate identified hazards in CMP area.

3. Request Electrical Utilities to provide an independent electrical feed for the 291S Exhaust Fans, thus allowing the exhaust fans to be removed from the 202S electrical distribution system.

Note 1: Section 3.5 of the document discusses removal of the current 202S Building 2.4k permanent power supply. Work Activity Sequences 3 and 4 would add a D&D/temporary power system to supply the current 202S S&M and future D&D needs. The facility exhaust stack would have a separate power supply under this plan. An unreviewed safety question determination would need to address the change in facility conditions/description, but the design and installation of these systems could also be performed prior to CERCLA documentation being approved.

3.1. In addition, confirm that water and steam systems have been isolated exterior to the building. Also ensure the plant compressed air system is deactivated.

4. Remove 202S Building from 2.4 kV provided electrical power, and implement a D&D electrical power system.

4.1. Design the D&D/temporary electrical power distribution system that interfaces with the existing remote monitoring system.

4.1.1. Primary use of this system will be for illumination of surveillance routes and work areas. This requires a 115 to 230 VAC distribution system.

4.1.2. Secondary use of this system will be for heating and ventilation requirements for work areas. This requires a 480 VAC 3 phase system.

4.2. Perform a PFWR for this upgrade.

4.3. Based on PFWR determination, either procure equipment and implement changes or issue subcontract to perform work activity.

4.4. Procure necessary distribution equipment and lighting fixtures.

4.5. Request Electrical Utilities to provide an electrical feed to the D&D/temporary system and make plans to disconnect/deactivate the existing building feeder circuits outside the REDOX project footprint.

4.6. Install the D&D/temporary electrical distribution and lighting system in work areas of the 202S Building.

4.7. Disconnect/deactivate the existing building feeder circuits outside the REDOX project footprint.

4.8. Connect the remote monitoring system to the D&D/temporary distribution system.

4.9. Ensure all identified electrical hazards have been eliminated and remove those hazards from CP-59374.

5. REDOX RAWP approved. Initiate removal action scope.

6. North and South Sample Galleries L-16 to H-4 Line isolation and removal.

6.1. Before starting any risk reduction work activities in the North Sample Gallery, identify the source point for the existing alpha contamination that has resulted in the current HCA/ARA posting (see Figure 7-1 in main text).

6.2. Implement work documents and field work for cleanup and stabilization activities.

6.2.1. Isolate the source of alpha contamination.

6.2.2. Reduce or eliminate the HCA/ARA North Sample Gallery.

6.3. Implement work documents and field work for line isolation and removal to the D-12 cross connection point.

6.3.1. Increase ventilation at west end of North Sample Gallery via EF8 exhaust port.

6.3.2. Establish false wall to isolate the air spaces in the North Sample Gallery (Figure 7-1 in main text).

6.3.2.1. Ensure Fire Protection engineering is consulted for appropriate sheeting material for barrier construction.

6.3.2.2. Ensure HCA/ARA is eliminated on the east side of the false wall in the North Sample Gallery.

6.3.3. Establish a decontamination line for personnel exiting the HCA (Figure 7-1 in main text shows Decon 1 Station location).

6.3.4. Eliminate HCA on west side of the false wall if possible (Figure 7-1 in main text shows location).

6.3.5. Ensure the ‘Steam Cond from L-2, L-3, L-12 to D-12’ Line and the ‘Acid HDR from 204’ Line are contained and no evidence of leakage.

6.3.6. During line isolation/removal, if new leaks or contamination arise, perform the following:

6.3.6.1. Glove bag location at location of leak/contamination.

6.3.6.2. At all glove bag locations, hot tap the line at the low point to ensure lines are empty.

6.3.6.3. Temporarily repair leak source to support line isolation/removal.

6.3.7. Preform any additional NDA and sampling required for disposition of valve, flange or line when removed.

6.3.8. Glove bag leaking flange on the ‘Acid HDR from 204’ Line.

6.3.9. Hot tap the line at the low point to ensure the line is empty.

6.3.10. Remove the leaking flanges on the ‘Acid HDR from 204’ Line.

6.3.11. Fill internal void space in the line to ensure long-term stability.

6.3.12. Thread pipe ends and install pipe caps.

6.3.13. Glove bag all valve and flanges on the ‘Steam Cond from L-2, L-3, L-12 to D-12’ Line to the D-12 Isolation Valve.

6.3.14. Glove bag locations on the pipe where cuts will be required for size reductions.

6.3.15. At all glove bag locations, hot tap the line at the low point to ensure lines are empty.

6.3.16. Begin removal activities on the line starting at the 233S Trench (located on the north wall adjacent to the Plutonium Loadout Hood as shown in Figure 7-2 in the main text).

6.3.17. Systematically remove the ‘Steam Cond from L-2, L-3, L-12 to D-12’ Line to the cross-tie valve on the L-16 to H-4 Line (see Photographs A-1 through A-5).

6.3.18. Remove isolation valve on D-12 steam condensate line.

6.3.19. Remove flange and thread pipe.

6.3.20. Install pipe cap.

6.3.21. Decontaminate and stabilize work area; leave false wall and exhauster in place.

6.3.22. Ensure the L-16 to H-4 line is contained and no evidence of leakage.

6.3.23. During line removal, if new leaks or contamination arise, perform the following:

6.3.23.1. Glove bag area at location of leak/contamination.

6.3.23.2. At all glove bag locations, hot tap the line at the low point to ensure lines are empty.

6.3.23.3. Temporarily repair leak source to support line removal.

6.3.24. Preform any additional NDA and sampling required for disposition of line when removed.

6.3.25. Glove bag all valve and flanges on the L-16 to H-4 line west of the false wall.

6.3.26. Glove bag locations on the pipe where cuts will be required for size reductions.

6.3.27. At all glove bag locations, hot tap the line at the low point to ensure lines are empty.

6.3.28. Begin removal activities on the branch line that goes to the 146 Sampler and E-1/3 feeders.

6.3.29. Remove the 1 in. valves and pipes from this branch circuit.

6.3.30. Next begin line removal at the 233S Pipe Trench location (north wall of the gallery as shown in Figure 7-2 in the main text).

6.3.31. Systematically remove the L-16 to H-4 line to the tie point with the steam condensate header at the D-12 valve.

6.3.32. Remove isolation valve on D-12 steam condensate line.

6.3.33. Remove flange and thread pipe.

6.3.34. Install pipe cap.

6.3.35. Decontaminate and stabilize work area, and leave false wall and exhauster in place.

6.3.36. Establish a second decontamination line for personnel in the exit corridor above the Regulated Shop (this line would be used in case a loss of confinement occurred up stream) (see Figure 7-1 in the main text for Decon 2 Station location).

6.3.37. Package and dispose of removed pipe and valves.

6.4. Implement work documents and field activities for line isolation from south end of the north-south corridor to the H-4 wall nozzle in the South Sample Gallery.

6.4.1. Maintain increased ventilation at the center of South Sample Gallery via 296-S-2 exhaust port.

6.4.2. Establish physical barriers to isolate the L-16 to H-4 line from air spaces in the South Sample Gallery to H Cell (along the north wall of the gallery) (Figure 7-1 in the main text shows Location 2 Area).

6.4.3. Ensure the L-16 to H-4 line is contained and there are no liquids.

6.4.3.1. At all glove bag locations, hot tap the line at the low point to ensure lines are empty.

6.4.3.2. Fill internal void spaces in the line to ensure long-term stability.

6.4.4. Remove barrier structure and decontaminate and stabilize work area (Figure 7-1 in the main text shows Barrier 2 location).

6.4.5. Deactivate exhauster at the 296-S-2 exhaust port.

7. Plutonium Loadout Hood Removal.

7.1. Plutonium Loadout Hood decontamination and stabilization (external vessel surfaces only).

7.1.1. Maintain increased ventilation at west end of North Sample Gallery via EF8 exhaust port.

7.1.2. Maintain both previously established personnel decontamination lines (Figure 7-1 in main text shows Decon 1 and Decon 2 locations).

7.1.3. Establish a physical barrier around the Plutonium Loadout Hood that includes the 146 Sampler Box, overhead piping that originates on the north wall at the 233S Pipe Trench and the west wall of the North Sample Gallery. Exclude the Elevator #2 corridor (Figures 7-1 and 7-2 in the main text show Plutonium Loadout Hood Barrier 1).

7.1.4. Open Plutonium Loadout Hood by accessing the previously removing panel in the 1997 hood decontamination activity and characterization activities (BHI-01299).

7.1.5. Preform any additional NDA and sampling required for disposition of the removed items.

7.1.6. Remove absorbent pads from the sump.

7.1.7. Decontaminate external surfaces of vessels, pipes and internal panel surfaces of enclosure.

7.1.8. Package and remove material for disposition.

7.1.9. Remove remaining Lexan panels from the Plutonium Loadout Hood.

7.1.10. Remove panel support structure.

7.1.11. Glove bag wall nozzle locations on the south wall of the gallery that terminate in E Cell (Figure 7-2 in the main text shows glove bag locations at the wall nozzles):

7.1.11.1. Floor Drain to ES-3.

7.1.11.2. E-3 to L-12.

7.1.11.3. Condenser Cooling Water.

7.1.11.4. E-4 to L-2.

7.1.12. Glove bag each pipe connection on the vessels in the Plutonium Loadout Hood (Figure 7-2 in the main text shows locations):

7.1.12.1. E-16 Pre-Concentrator and Tower.

7.1.12.2. E-17 Concentrator and Tower.

7.1.12.3. E-19 Plutonium Concentrate Condenser Receiver.

7.1.12.4. E-21 Plutonium Transfer Trap.

7.1.13. Glove bag locations on the pipe where cuts will be required for size reduction.

7.1.14. At all glove bag locations, hot tap the line at the low point to ensure lines are empty.

7.1.15. Remove interconnecting pipes.

7.1.16. If wall nozzle piping is long enough, cut off flange, thread pipe, and install pipe cap. Otherwise, install blanks on wall nozzles and vessel flanges.

7.1.17. Decontaminate glove bag location and remove all bags.

7.1.18. Package and remove material for disposition.

7.1.19. Remove isolated vessels to a low dose counting area for further NDA and determine disposition pathway.

7.1.20. Pre-treat and package vessels in accordance with disposition facility requirements.

7.1.20.1. Preferred to use other onsite facilities/contractors that are available for pretreatment requirements.

7.1.21. Remove barrier structures in the North Sample Gallery, and decontaminate and stabilize work area (Figure 7-2 in the main text shows Plutonium Loadout Hood Barrier 1).

7.1.22. Remove personnel decontamination line in the North Sample Gallery (Figure 7-1 in main text shows Decon 1 location).

7.1.23. Deactivate exhauster at EF8 exhaust port.

8. Implement work documents and field activities for line isolation and removal from the north-south corridor between the North and South Sample Galleries.

8.1.1. Establish ventilation to the north-south corridor via a temporary exhauster located in the Remote Shop air tunnel access port.

8.1.2. Establish physical barriers to isolate the L-16 to H-4 line from air spaces in the South and North Sample Galleries from the north-south corridor (Figure 7-1 in the main text should Location 3 Area).

8.1.3. Ensure that L-16 to H-4 line is contained and there are no liquids.

8.1.3.1. Glove bag locations where the line will be hot tapped.

8.1.3.2. At all glove bag locations, hot tap the line at the low point to ensure lines are empty.

8.1.3.3. Fill internal void spaces in the line to ensure long-term stability.

8.1.4. Remove false wall and decontaminate and stabilize work area (Figure 7-1 in main text shows false wall location).

8.1.5. Remove temporary exhauster to Remote Shop air tunnel access.

8.1.6. Remove personnel decontamination line in the exit hallway above the Regulated Shop (Figure 7-1 in main text shows Decon 2 Station location).

8.1.7. Ensure galleries and work areas are cleaned and free of all debris and packaged waste.

8.1.8. Document removal activities in CP-59374, and close out Air Operating Permit and Regulatory Documents.

9. AMU hazard mitigation and vessel/piping inspection.

9.1. Refer to Chapter 6 of this report for characterization data on tanks, pumps, and piping in the AMU section of the Silo.

9.2. Refer to finding in CP-59374 for the REDOX Silo and AMU.

9.3. Prioritize hazard mitigation of identified risks (Appendix A, photograph A-8 shows an example)

9.4. Implement work planning documents for hazard mitigation activities.

9.4.1. Ensure waste disposition pathway is identified.

9.5. Implement field activities to mitigate identified hazards in Silo and AMU sections.

9.6. Inspect the tanks listed in Chapter 6 of this report.

9.6.1. Optimum access point to these tanks is either:

9.6.1.1. Solids addition hatch-way for the blend Tank 504 and 505.

9.6.1.2. Instrumentation line or access located on the upper surface of the tanks.

9.6.1.2.1. Use a self-illuminated, fiber optic inspection scope to inspect for tank content or residuals.

9.7. Add new finds to CP-59374.

9.8. Prioritize hazard mitigation of identified risks.

9.8.1. Implement work planning documents for hazard mitigation activities if required.

9.8.2. Ensure waste disposition pathway is identified.

9.9. Implement field activities to mitigate identified hazards in the AMU section of the Silo.

10. Canyon Deck entry (if additional information is required after CMP entry is accomplished).

10.1. Establish entry requirements for the Canyon Deck and develop work planning documents.

10.2. Airlock entry point is located in the northwest corner of the South Pipe Gallery (This is the lowest dose entry point to the Canyon Deck).

10.2.1. Canyon is not illuminated; therefore, ensure adequate lighting is available.

10.3. Ensure 291S Canyon Exhaust Fan is operating and the Canyon differential pressure is at least negative 0.1" H_2O with respect to atmosphere.

10.4. Establish personnel decontamination line at exit point in South Pipe Gallery.

10.5. Areas of concern for radiological dose concern are:

10.5.1. Dissolver Cells A, B, and C.

10.5.2. Waste Cell D.

10.5.3. Material Storage Preparation Cell H.

10.5.4. Hot Pipe Trench (in the middle of the canyon as shown in Figure 2-4 of the main text).

10.5.5. Jumper box and rack.

10.6. Ensure Health Physics personnel monitor for areas with a potential high dose.

10.6.1. Limit worker time in these areas.

10.7. Add new finds to CP-59374.

10.8. Prioritize hazard mitigation of identified risks.

10.9. Implement work planning documents for hazard mitigation activities if required.

10.10. Ensure waste disposition pathway is identified.

10.11. Implement field activities to mitigate identified hazards on the Canyon Deck.

11. 276S Solvent Handling Tanks.

11.1. Develop work planning documents.

11.2. EE/CA only addresses 276S141 and 276S142 Tanks within scope of removal action. Does not address the abovegrade 276S Hexone Solvent Handling structure.

11.3. Coordinate/communicate with ERDF transportation and disposal of the two grouted tanks as monoliths and stabilized piping, equipment, and pumps.

11.4. Develop excavation plan to address rigging and transportation issues with lifting/transporting of the tanks to ERDF.

11.5. Engaging waste management organization to ensure waste transportation is addressed adequately.

11.6. Develop, implement and verify the facility is cold, dark, and dry.

11.7. Stabilize piping, equipment, and pumps as needed to allow open air demolition. This stabilization may be required to control fugitive emissions for radiological control, nuclear safety, and environmental air regulations.

11.8. Use heavy demolition equipment to remove, process, and package for ERDF disposal all stabilized piping, equipment, and pumps that connect to the two underground tanks.

11.9. When the RAWP is approved, excavate to expose tanks.

11.10. Lift and transport tanks (each a separate shipment) to ERDF.

11.11. Perform verification sampling after two tanks have been removed per the SAP (DOE/RL-2009-116).

11.12. Complete *Resource Conservation and Recovery Act of 1976* Clean Closure administrative requirements once underlying soil is verified clean.

12. 293S Nitric Acid and Iodine Recovery Building.

12.1. Develop work planning documents.

12.2. The building inventory is expected to be primarily present in scrubber/absorption columns as discussed in Section 6.6 of this report, confirm with field screening radiological surveys as part of the initial entries and work planning.

12.3. Develop, implement and verify the facility is cold, dark, and dry. This effort shall include isolation of any drain or floor penetrations to control flow of any liquids after demolition.

12.4. After inspection, sampling (radiological and nonradiological constituents per the SAP), and detailed radiological surveys are performed, determine if grouting of tanks and/or piping/equipment/pumps is required. If full grouting is not needed, surface fixatives (e.g., paint, fogging, asbestos binding compound) can be applied to mitigate contamination spread. Note: Experience can be obtained from 100/300 Area D&D operations, which used a large number of surface fixatives.

12.5. Perform hazard abatement and demolition preparation activities.

12.6. Given relatively low levels of contamination and radiological inventory remaining, all waste is anticipated to be disposed at the ERDF.

12.7. Use heavy demolition equipment to remove, process, and package for ERDF disposal all abovegrade and belowgrade equipment, pumps, piping, and tanks from the building. Care should be taken to remove vessel intact when practical. Removal effort should include the 10 by 10 ft cylindrical storage tank (Recovered Nitric Acid Storage Tank) immediately west of the building.

12.8. Demolish structure. Basement walls, slab, and at grade slab to remain. Slab at belowgrade areas should be broken through at least once to minimize the collection of precipitation. Backfill the area with soil/grout.

13. Hazard Abatement, Demolition Preparation, and Demolition of 202S Annexes. Hazard Abatement and Demolition Preparation of Abovegrade Galleries (which were not addressed in the previous Work Activity Sequence steps).

13.1. 202S Annexes (Hazard Abatement, Demolition Preparation, and Demolition).

13.1.1. Develop work procedures.

13.1.2. Perform hazard abatement, demolition preparation, and demolition of three annexes. Work may include full scale asbestos abatement; removing light ballasts; draining fluids from piping and equipment; isolating piping and/or stabilizing contaminates; removing asbestos flooring; and removing piping, tanks, and equipment.

13.1.3. Develop, implement, and verify the facility is cold, dark, and dry. This effort will include isolation of any drain or floor penetrations to control flow of any liquids after demolition.

13.1.4. Radiological and nonradiological contamination in the Annexes are expected to be minimal and all material should be acceptable to ERDF.

13.1.5. Use heavy demolition equipment to remove, process, and package for ERDF disposal. Care should be taken not to damage the remaining 202S structure.

13.1.6. Document removal activities in CP-59374.

14. Future work planning activities under REDOX and general removal actions.

14.1. 211-S Tank Farms remediation and removal.

14.1.1. Asbestos abatement.

14.1.2. Tank removal.

14.1.3. Abovegrade pipe removal.

14.1.4. Tank pad and belowgrade piping removal.

14.1.5. Soil removal and stabilization.

14.2. 202S Office and Maintenance Shops removal.

14.3. 276S Solvent Preparation Facility.

14.4. Silo AMU tank and equipment removal.

14.5. Hazard Mitigation and Demolition Preparation of Abovegrade 202S Galleries (which were not addressed in the previous Work Activity Sequence steps but authorized in the REDOX AM [DOE/RL-2016-52]).

14.5.1. Develop work procedures.

14.5.2. Perform hazard abatement and demolition preparation work activities. Work may include full scale asbestos abatement; removing light ballasts; draining fluids from piping and equipment; isolating piping and/or stabilizing contaminates; removing asbestos flooring; and removing piping, tanks, and equipment.

14.5.3. Use tables in Chapter 6 of this document to facilitate waste disposal. Radiological and nonradiological contaminants of concern are discussed for various areas and systems within the building.

14.5.4. Document removal activities in CP-59374.

C3 References

BHI-01299, 1999, *Alternative Evaluation for the REDOX (202-S) Plutonium Loadout Hood*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

CP-59374, 2015, *Canyon Risk Mitigation Plan*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

DOE/RL-98-19, 2008, *Surveillance and Maintenance Plan for the 202-S Reduction Oxidation (REDOX) Facility*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA06814175.

DOE/RL-2009-116, 2010, *Sampling and Analysis Plan for the Hexone Storage and Treatment Facility Closure Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084307.

DOE/RL-2016-52, 2016, *Action Memorandum for the Reduction-Oxidation (REDOX) Complex*, Draft, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

HNF-13830, 2016, *Documented Safety Analysis for the Reduction-Oxidation Facility*, Rev. 5, CH2M HILL Plateau Remediation Company, Richland, Washington.

PRC-PRO-SH-10321, 2012, *Walking/Working Surfaces*, Revision 1, Change 1, CH2M HILL Plateau Remediation Company, Richland, Washington.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/rcraonline/.

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