8 BUILDING H2, H1 COOLING TOWER, AND H2 PIPE TUNNEL CURRENT CONDITIONS

The H2 waste processing building, H1 Evaporative Cooling Tower and Pump House, and the H2 Pipe Tunnel were used for processing liquid radioactive waste from Building G2, but also waste from the Hot Incinerator (located on the north side of Building F1), Building F2 drain lines, scrubber water, K4 laundry and laundry lines, and some laboratory wastes (R-001949). Most of the original equipment and tanks remain in H2, and some portions are still used for processing liquid waste.

H2 liquid waste handling and processing equipment and systems processed both highly radioactive liquid waste (0.05 microCuries or more per liter) and lower-level radioactive waste (less than 0.05 microCuries per liter) produced in Building G2. The site incinerator scrubber and chemistry laboratories also produced primarily low-level radioactive liquid waste. Waste categories designated as highly radioactive and lower-level were used to distinguish waste streams during the SPRU period and do not correspond to current definitions of high- and low-level radioactive waste (R-001949, p. 36).

Highly radioactive liquid waste sent to Building H2 was typically neutralized, concentrated, and transferred to the Tank Farm for storage and later solidification and off-site shipment for disposal. Lower-level liquid waste was collected in three 10,000-gallon storage tanks on the 309-foot level (A525-A, A525-B, and A525-C), processed in the evaporator system, and later drummed as solidified slurry for disposal. Evaporator distillate from which most of the radioactivity had been removed was discharged to the storm sewer system, sometimes after being diluted. The slurry was initially dried to a solid form in the drum dryer rooms, but this procedure was discontinued when it was discovered that the slurry solidified as it cooled (R-001949, p. 37).

During the SPRU period, approximately 9 million gallons of radioactive liquid waste were concentrated through evaporation into approximately 22,000 gallons of solid waste in 55-gallon drums. Approximately 25-40 percent of the lower level radioactive wastewater processed in Building H2 was generated by a radioactive laundry in the Lower Level Land Area (R-000485).

Liquid radioactive waste from SPRU was predominant, but the SPRU processes also generated waste containing chemicals plus radioactivity. The SPRU separations process used, at various times, hexone and tributyl phosphate, Gulf BT, AMSCO 123-15, and Ultrasene (R001949, pp. 7-35). Other chemicals that were used are listed in Table 6-3.

The current Building H2 physical condition and contamination descriptions in this section are based on information available at the time of document production. Located 90 feet north of G2, Building H2 contains approximately 27,900 square feet of floor space on three levels (309-, 319-, and 332-foot). Approximately 70 percent of H2 (309- and 319-foot levels) is located below ground level and is defined by concrete walls 2 feet thick on the north, south, and west sides and 6 feet thick between the Tank Farm and Pipe Tunnel on the east with a concrete foundation 2 feet thick. Above-grade, H2 is constructed of structural steel with corrugated transite siding. Building H2 is connected to G2 by the G2-H2 Tunnel (R-001949). Figure 8-1 is a view of H2 looking north from the roof of G2. Figure 8-2 is an H2 isometric view.

All areas of the H2 building except the 332-foot entryway are under radiological controls. Most H2 residual contamination is in below-grade areas, primarily in deactivated systems, equipment, and rooms previously used to process waste, and are inaccessible. Inaccessible areas cannot be entered without dosimetry, protective clothing, and in some cases, respirators or supplied air. All areas of H2 (except the main entry and all adjacent offices) are inaccessible.

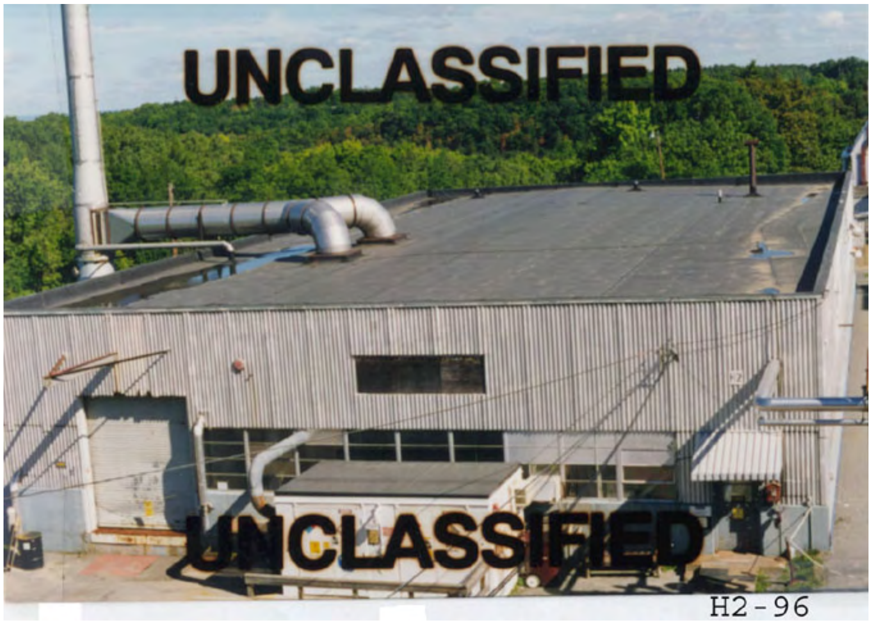


Figure 8-1. Photo H2-96, Looking North at Building H2 from G2 Roof, undated

The majority of below-grade systems are no longer used. However, parts of H2 are still being used for processing Radioactive Materials Laboratory reuse water and periodic cleanout of the Tank Farm vaults (I-000418). On the 332-foot level, most of the west bay area was converted in 1989 to collect and process water from the Hillside Drain System. A section of the west bay area also contains a solid waste baler for compacting low-level radioactive compressible solid waste. Water, steam, compressed air, and electrical services are still in service (R-001949).

The H1 Evaporative Cooling Tower and associated Pump House located north of H2 provided cooling water to the various H2 and G2 process condensers and coolers and tank jackets.

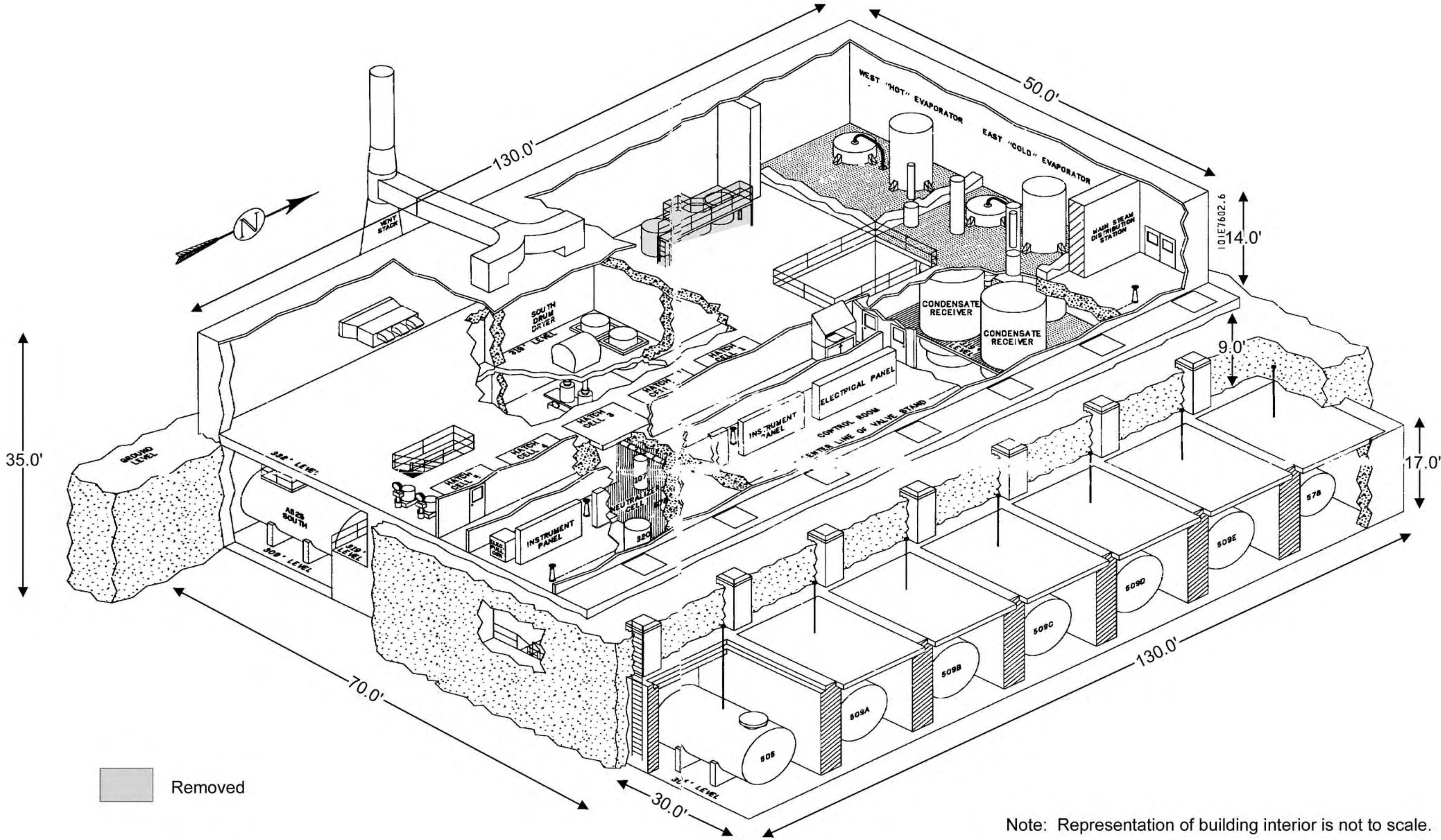
The H2 Pipe Tunnel is located on the east side of H2 between the Tank Farm and H2 neutralizer cells on the 309- and 319-foot levels. It connects to the G2-H2 Tunnel on the south side of H2. The H2 Pipe Tunnel contains radioactive process pipes from G2 and other KAPL laboratories and pipes connecting H2 waste processes to the Tank Farm (Drawing No. 2828-802-2).

Liquid waste was processed at the entrance to the H2 Pipe Tunnel by mixing diatomaceous earth with liquid waste in drums for solidification. The negative air pressure in the tunnel sucked particulate matter into the tunnel. As a result, considerable radioactive particulates remain on the floor and walls of the H2 Pipe Tunnel (I-000418).

8.1 Building H2 309-Foot Level

The Building H2 309-foot level is the lowest floor and contains waste processing equipment, storage tanks, and entries into the Pipe Tunnel, Hopper/Slurry rooms, Neutralizer Cell bases, and Evaporator Storage Tank bases. Figure 8-4 is the 309-foot level floor plan showing current equipment and room configurations. Specific H2 309-foot areas are illustrated and described in terms of current configurations and known contamination. Illustrations, descriptions, and contamination estimates are based on available surveys, photos, and visual inspections and are not a guarantee of accuracy.

Current 309-foot level radiological conditions are based on the 1989 or the 2004 survey and are depicted in Figure 8-5. Terms used in the figure are defined in Table 5-1.



(Source – R-001949)

Figure 8-2. H2 Isometric Drawing

8.1.1 NEUTRALIZER CELLS

Five waste stream neutralizer cells are arranged in a north-south row in the southeast corner of H2 (Figure 8.3). The concrete walled cells extend from the 309-foot level to the 332-foot level. They can be accessed through doors on the 309-foot level or concrete hatches at the 332-foot level. The cells are shielded by 4 feet of concrete (C-000142, Figure 14).

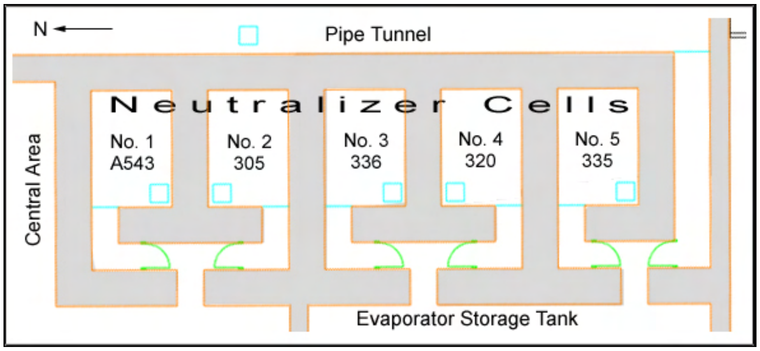


Figure 8-3. Building H2 Neutralizer Cells 309-Foot Level

Acidic or basic wastes were collected in the neutralizer cells and neutralized prior to further processing and/or storage. Live steam or steam heater jackets functioned to distill solvents for reuse or evaporate excess water to reduce waste volume prior to storage.

The neutralizer cells and equipment are currently intact. The stainless steel equipment consists primarily of jacketed neutralizer collection tanks, separator columns, condensers for distillate, and distillate receiver tanks. Originally, the neutralizer cells had separate dedicated pipes from sources in G2. However, the current state of piping is not known because the Pipe Tunnel is an inaccessible area.

From north to south the neutralizer designations and tank capacities are:

Neutralizer Cell	Tank Capacity	Waste Stream
No. 1: A543	100 gal	Plutonium
No. 2: 305	1,000 gal	Lower level waste
No. 3: 336	500 gal	1DW and 2AW lower level
No. 4: 320	500 gal	Uranium
No. 5: 335	300 gal	1AW highly radioactive

The 1989 survey of Neutralizer Cells 1-4 identified general area radiation readings ranging from 2 to 100 milliRem per hour closed window and 6 to 200 milliRem per hour open window with a maximum reading of 100 milliRem per hour closed window and 1,000 milliRem per hour open window on the side of Tank 320 in Cell No. 4. Loose surface contamination of the floor areas ranged from less than 50 to 2,000 picoCuries per 100 square centimeters (less than 111 to 4,440 disintegrations per minute) alpha and from 1,800 to greater than 225,000 picoCuries per 100 square centimeters (3,996 to greater than 499,500 disintegrations per minute) beta-gamma. Based on this survey, the neutralizer cells are a high radiation and high contamination area. Further characterization is required to assess any change in radiological conditions since the 1989 survey.

Neutralizer Cell No. 1 (Tank A543)

Neutralizer Cell No. 1 (Tank A543) was the plutonium-processing stream neutralizer. It is 13 feet long, 9 feet wide and 20 feet high, and enclosed by 4 foot thick concrete walls. The reinforced concrete cell structure and equipment remain intact (C-000164, enclosure, p. 3).

The plutonium neutralizer system included a drum feed tank for transferring distillate to drums for transport to other systems. Waste was discharged from the neutralizer to a waste storage tank or another neutralizer (R-000036, p. 7). The plutonium neutralizer collection tank was the only cell tank with a

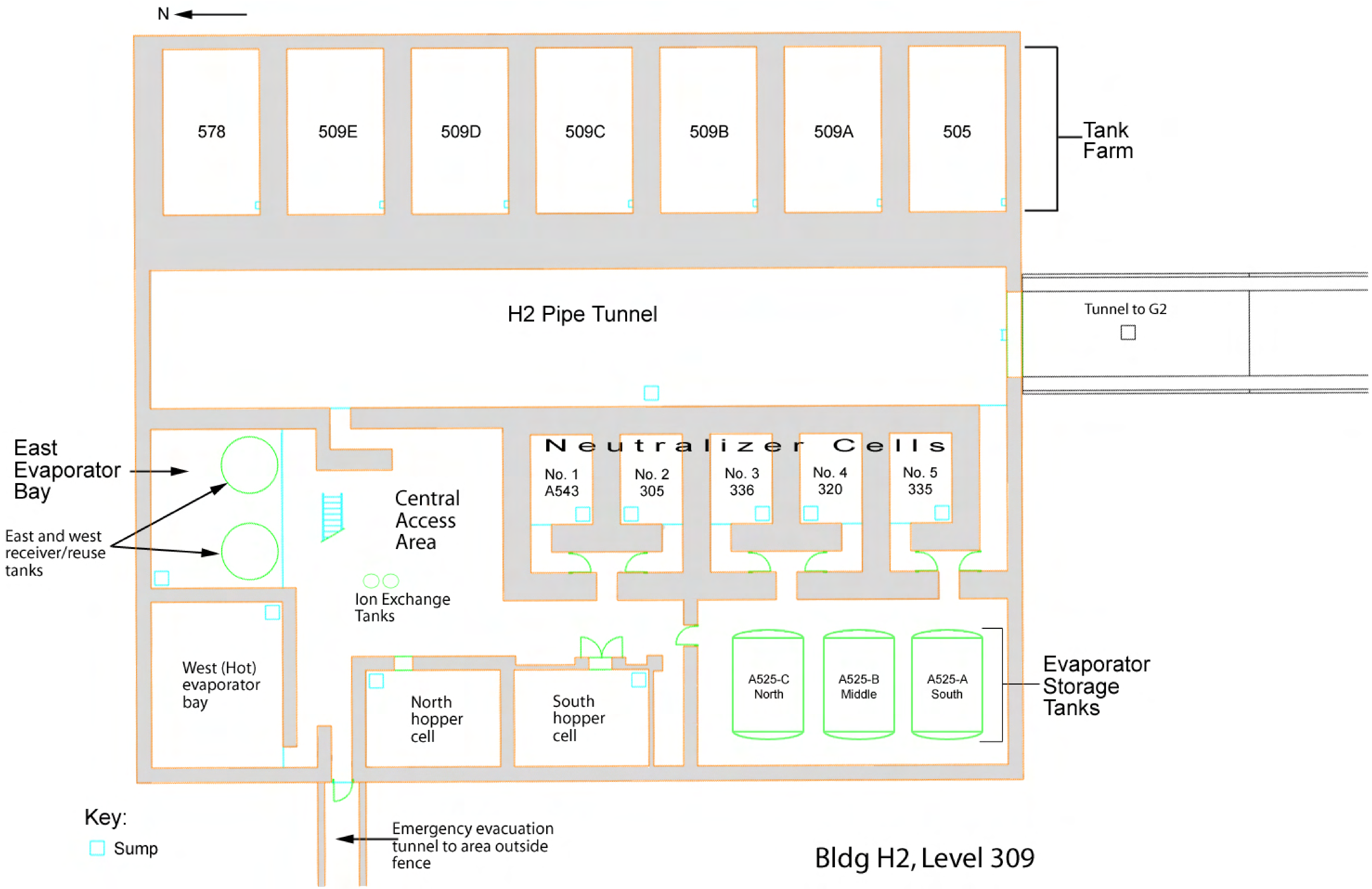


Figure 8-4. Building H2 309-Foot Level Plan

Figure 8-5. Current Radiological Conditions for the 309-Foot Level

re-circulating transfer pump to agitate tank contents. The other neutralizer collection tanks had agitators. The Neutralizer Cell 1 equipment is shown in Table 8-1.

Table 8-1. Neutralizer Cell No. 1 Equipment

Equipment	Quantity	Description/Use	Conditions	Reference
Neutralizing Tank A543 with transfer pump	1	100 gal; jacketed with transfer pump to neutralized plutonium containing streams; stripped solvent from aqueous streams	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 4
Scrubber Column	1		Still in cell as of April 1984	C-000164, encl., p. 4
Packed Column	1	16 in by 6 ft (4 ft packing)	Unknown	R-001932, H-Building section, p. 4
Condenser	1	36 sq ft	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 4
Receiver	2	50 gal	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 4
Sump Pump	1		Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 4
Steam Jet	2		Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 4
Electrical Equipment		Explosion-proof	Still in cell as of April 1984	C-000164, encl., p. 4
Flame Arrestor	1	Located in cell exhaust	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 4
Lights	3		Unknown	R-001932, H-Building section, p. 4
Piping Runs	~35	3/8 in to 2 in	Unknown	R-001932, H-Building section, p. 4
Conduit Runs	~15		Unknown	R-001932, H-Building section, p. 4
Shielding	1	4 ft concrete	Unknown	R-001932, H-Building section, p. 4

The Neutralizer Cell No. 1 collection tank and the floor were highly contaminated at the time of the 1966 survey (C-000428). The most recent neutralizer cell inspection was performed during the 1989 Building H2 inspection. At that time, the Neutralizer Cells No. 1 and 2 vestibule areas were congested with an empty 55-gallon drum, four cotton-wound filter units, and pieces of insulated wallboard material (R001949). Additionally, a piece of non-system piping traversed the entry to the Cell No. 1 and 2 access aisle and lead bricks were found in the entry. The pipe was connected to collars on the wall and was apparently used as a backstop for the plywood doorway cover, which was in place prior to the 1989 inspection (C-000198, p. 5).

Table 8-2 presents a summary of radiological survey data available for Neutralizer Cell No. 1.

Table 8-2. Neutralizer Cell No. 1 Radiological Survey History

Date	Visual Observations	Summary Findings	Reference
4/15/1966	Loose surface contamination Cell dry Items in cell consisted of two drums, ladder, mop, and pieces of wood	Dose rate at the step to the cell – 10 mR/hr gamma; 25 mRem/hr beta Dose rate around area of tank – 20 mR/hr gamma; 800 mRem/hr beta. Surface beta measurement on floor – 2.5 rad/hr Measurement at 3 ft off floor – 10 mR/hr gamma; 450 mRem/hr beta. Smear of surface of tank – 2 mR/hr gamma; 150 mRem/hr beta Shoe cover activity (for Cells No. 1-4) – 1 mR/hr gamma; 300 dpm/9.5 sq in alpha (130 pCi)	C-000120, pp. 1-2

Date	Visual Observations	Summary Findings	Reference
7/11/1966	None	Floor: 600 to 9,000 pCi/100 cm^2 loose alpha; 0.3 to 1.0 mrad/hr/100 cm^2 loose beta; <5 to 10 mR/hr direct gamma at 2 in 50 to 600 mrad/hr direct beta at contact Tank top: 1,500 pCi/100 cm^2 loose alpha; 0.3 mrad/hr/100 cm^2 loose beta; 80 direct gamma at 2 inches; >13,000 mrad/hr direct beta at contact	C-000428
12/1971	None	General radiation in area: <5 mRem/hr beta; 15 mRem/hr gamma Loose surface contamination: Floor – 200 dpm alpha; 0.4 mRem/hr beta-gamma Wall – 100 dpm alpha; 0.3 mRem/hr beta-gamma Surface of tank – 1,600 dpm alpha; 0.5 mRem/hr beta-gamma	R-000385, p. 1
12/15/1971	Loose surface contamination	Direct radiation: Access corridor – 250 mRem/hr beta; 10 mR/hr gamma General cell area – 15 mR/hr gamma Over top of tank – 250 mRem/hr beta; 10 mR/hr gamma Loose surface contamination swipes: Floor of cell – 200 dpm alpha; 0.4 mRem/hr beta-gamma Surface of tank – 1,600 dpm alpha; 0.5 mRem/hr beta-gamma South wall of cell – 100 dpm alpha; 0.3 mRem/hr beta-gamma	C-000133, p. 1
7/25/1989 – 8/31/1989	Clean, dry, and free of debris. Cell floor sumps dry Piping and tanks show no signs of damage or deterioration. No evidence of deterioration of piping insulation. Lighting not operational.	General area radiation readings (RO-2) – ranges from 2 to 100 mRem/hr closed window and 6 to 200 mRem/hr open window Loose surface contamination of floor areas – ranges from <50 to 2,000 pCi/100 cm^2 alpha and from 1,800 to >225,000 pCi/100 cm^2 beta-gamma (4,100 to 170,000 pCi/100 cm^2 due to Cs-137; 2,300 to 17,000 pCi/100 cm^2 due to Am-241)	C-000198, p. 5

Neutralizer Cell No. 2

Neutralizer Cell No. 2 is a 1,000-gallon lower-level waste neutralizer 13 feet long, 9 feet wide, 20 feet high, and enclosed by 4 foot thick concrete walls (C-000164, p. 3). Cell No. 2 normally discharged to Tank Farm Tank 509C, 509D, or 578, depending on the activity present (R-000036, p. 6).

There was decontamination work performed in Neutralizer Cell No. 2 prior to the April 15, 1966 inspection (C-000120). However, at the time of the 1966 survey, the Cell No. 2 collection tank and floor were reported as highly contaminated (C-000428). Table 8-3 shows Neutralizer Cell No. 2 equipment, and Table 8-4 presents a summary of radiological survey data available for Neutralizer Cell No. 2.

Table 8-3. Neutralizer Cell No. 2 Equipment

Equipment	Quantity	Description/Use	Condition	Reference
Neutralizing Tank 305, Agitator and Steam Jet Extractor	1	1,000 gal; steam jacketed Neutralized low-level waste; stripped solvent from aqueous; sump discharge holdup	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Scrubber Column	1		Still in cell as of April 1984	C-000164, encl., p. 4
Packed Column	1	32 in by 6 ft (4 ft packing)	Unknown	R-001932, H-Building section, p. 5
Condenser	1	150 sq ft	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Receiver	1	50 gal	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5

Equipment	Quantity	Description/Use	Condition	Reference
Sump Pump	1		Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Two Steam Jet	2		Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Electrical Equipment		Explosion proof	Still in cell as of April 1984	C-000164, encl., p. 4
Flame Arrestor	1	Located in cell exhaust	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Lights	3		Unknown	R-001932, H-Building section, p. 5
Piping Runs	~35	3/8 in to 4 in	Unknown	R-001932, H-Building section, p. 5
Conduit Runs	~15		Unknown	R-001932, H-Building section, p. 5
Shielding	1	4 ft concrete	Unknown	R-001932, H-Building section, p. 5

Table 8-4. Neutralizer Cell No. 2 Radiological Survey History

Date Area	Visual Observations	Summary Findings	Reference
4/15/1966	Loose surface contamination Cell dry	Dose rate at the step off to the cell – 10 mR/hr gamma Dose rate at floor surface: 5 mR/hr gamma; 1.2 Rem/hr beta Shoe cover activity (for Cells No. 1-4) – 1 mR/hr gamma; 300 dpm/9.5 sq in alpha (130 pCi)	C-000120, pp. 1-2
7/11/1966	Flooded	None	C-000428
12/1971	None	General radiation in area: <5 mRem/hr beta; 25 mRem/hr gamma. Loose surface contamination: Floor – 1,500 dpm alpha; 1.8 mRem/hr beta-gamma; Wall – 200 dpm alpha; 0.5 mRem/hr beta-gamma; Surface of tank – 100 dpm alpha; 0.1 mRem/hr beta-gamma	R-000385, p. 1
12/15/1971	Loose surface contamination	Direct radiation: At step off – 15 mR/hr gamma; General cell area – 25 mR/hr gamma. Loose surface contamination swipes: Floor by step off – 1,500 dpm alpha; 1.8 mRem/hr beta-gamma; Surface of tank – 100 dpm alpha; 1,000 c/m beta-gamma; North wall of cell – 200 dpm alpha; 0.5 mRem/hr beta-gamma	C-000133, p. 1
7/25/1989 – 8/31/1989 Cells 1-5	Cell No. 2 only – layer of dust on all surfaces Cell No. 2 only – sump pump found running and secured at time of entry. Piping and tanks show no signs of damage or deterioration with exception of surface corrosion noted on a transition piece of pipe behind tank in Cell No. 2. No evidence of deterioration of piping insulation. Lighting not operational	General area radiation readings (RO-2) – range from 2 to 100 mRem/hr closed window and 6 to 200 mRem/hr open window Loose surface contamination of floor areas range from <50 to 2,000 pCi/100 cm^2 alpha and from 1,800 to >225,000 pCi/100 cm^2 beta-gamma (4,100 to 170,000 pCi/100 cm^2 due to Cs-137; 2,300 to 17,000 pCi/100 cm^2 due to Am-241)	C-000198, p. 5

Neutralizer Cell No. 3

Neutralizer Cell No. 3 neutralized low-level waste streams. The 500-gallon capacity cell remains unchanged, with original structure and equipment intact. It is 13 feet long, 9 feet wide, and 20 feet high, and enclosed by 4 foot thick concrete walls (C-000164, enclosure, p. 3).

At the time of the 1966 survey, the Neutralizer Cell No. 3 collection tank and floor were reported as highly contaminated (C-000428). Table 8-5 shows Neutralizer Cell No. 3 equipment, and Table 8-6 presents a summary of radiological survey data available for Neutralizer Cell No. 3.

Table 8-5. Neutralizer Cell No. 3 Equipment

Equipment	Quantity	Description/Use	Conditions	Reference
Neutralizing Tank 336 with Agitator and Steam Jet Extractor	1	500 gallons; steam jacketed Neutralized low-level process streams	Still in cell as of April 1984	C-000164, encl., p. 4
Scrubber Column	1		Still in cell as of April 1984	C-000164, encl., p. 4
Packed Column	1	2 ft by 6 ft (4 ft packing)	Unknown	R-001932, H-Building section, p. 5
Condenser	1	140 sq ft	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Receiver	1	50 gal	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Sump Pump	1		Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Steam Jet	2		Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Electrical Equipment		Explosion proof	Still in cell as of April 1984	C-000164, encl., p. 4
Flame Arrestor		Located in cell exhaust	Still in cell as of April 1984	C-000164, encl., p. 4
Lights	3		Unknown	R-001932, H-Building section, p. 5
Piping Runs	~35	3/8 in to 4 in	Unknown	R-001932, H-Building section, p. 5
Conduit Runs	~15		Unknown	R-001932, H-Building section, p. 5
Shielding	1	4 ft concrete	Unknown	R-001932, H-Building section, p. 5

Table 8-6. Neutralizer Cell No. 3 Radiological Survey History

Date	Visual Observations	Summary Findings	Reference
4/15/1966	Dry material on floor	Dose rate at the step off to the cell – 5 mR/hr gamma; 250 mRem/hr beta. Floor contamination – 100 mR/hr gamma; 8 Rem/hr beta. Shoe cover activity (for Cells No. 1-4) – 1 mR/hr gamma; 300 dpm/9.5 sq in alpha (130 pCi)	C-000120, pp. 1-2
7/11/1966	None	Floor: 500 to 5,000 pCi/100 cm^2 loose alpha; 0.3 to 7.0 mrad/hr/100 cm^2 loose beta; 5 to 15 mR/hr direct gamma at 2 inches; 150 to 500 mrad/hr direct beta at contact.	C-000428
12/1971	None	General radiation in area: 700 mRem/hr beta; 20 mRem/hr gamma Loose surface contamination: Floor – 4,000 dpm alpha; 1.5 mRem/hr beta-gamma; Wall – 500 dpm alpha; 0.4 mRem/hr beta-gamma; Surface of tank – 400 dpm alpha; 0.3 mRem/hr beta-gamma	R-000385, p. 1

Date	Visual Observations	Summary Findings	Reference
12/15/1971	Loose surface contamination Various areas on floor show a caked sludge that measures high beta dose rates	Direct radiation at step off – 5 mR/hr gamma. General cell area – 5 mR/hr gamma. Caked sludge on floor – 6 Rem/hr beta; 5 mR/hr gamma. Loose surface contamination swipes: Surface of tank – 300 dpm alpha; 1,000 c/m beta-gamma; Cell wall – 600 dpm alpha; 0.5 mRem/hr beta-gamma; Cell floor – 4,000 dpm alpha; 1.5 mRem/hr beta-gamma	C-000133, p. 2
7/25/1989 – 8/31/1989 Cells 1-5	Clean, dry, and free of debris Cell floor sumps dry Piping and tanks show no signs of damage or deterioration No evidence of deterioration of piping insulation Lighting not operational	General area radiation readings (RO-2) – range from 2 to 100 mRem/hr closed window and 6 to 200 mRem/hr open window Loose surface contamination of floor areas – range from <50 to 2,000 pCi/100 cm^2 alpha and from 1,800 to >225,000 pCi/100 cm^2 beta-gamma (4,100 to 170,000 pCi/100 cm^2 due to Cs-137; 2,300 to 17,000 pCi/100 cm^2 due to Am-241) Maximum contamination measured was 15 mRem/hr/100 cm^2 beta-gamma by open window RO-2 measurement of swipe from access aisle to Cell No. 3	C-000198, p. 5

Neutralizer Cell No. 4

Neutralizer Cell No. 4 was used to neutralize uranium-containing liquids. The 500-gallon capacity cell is intact, including the original equipment. It is 13 feet long, 9 feet wide, and 20 feet high, and is enclosed by 4 foot thick concrete walls (C-000164, enclosure, p. 3).

At the time of the 1966 survey, the Neutralizer Cell No. 4 was highly contaminated. Yellow material was obtained on swipes from the tank and there was slimy material on the floor (C-000428). Table 8-7 shows Neutralizer Cell No. 4 equipment, and Table 8-8 presents a summary of radiological survey data available for Neutralizer Cell No. 4.

Table 8-7. Neutralizer Cell No. 4 Equipment

Equipment	Quantity	Description/Use	Conditions	Reference
Neutralizing Tank 320 with Agitator and Steam Jet Extractor	1	500 gal; steam jacketed Neutralized liquids containing Uranium; stripped solvents from aqueous solutions	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Scrubber Column	1		Still in cell as of April 1984	C-000164, encl., p. 4
Packed Column	1	2 ft by 6 ft (4 ft packing)	Unknown	R-001932, H-Building section, p. 5
Condenser	1	140 sq ft; heat surface	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Receiver	1	50 gal	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Sump Pump	1		Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Steam Jet	2		Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Electrical Equipment		Explosion proof	Still in cell as of April 1984	C-000164, encl., p. 4

Equipment	Quantity	Description/Use	Conditions	Reference
Flame Arrestor		Located in cell exhaust	Still in cell as of April 1984	C-000164, encl., p. 4
Lights	3		Unknown	R-001932, H-Building section, p. 5
Piping Runs	~35	3/8 in to 4 in	Unknown	R-001932, H-Building section, p. 5
Conduit Runs	~10		Unknown	R-001932, H-Building section, p. 5
Shielding	1	4 ft	Unknown	R-001932, H-Building section, p. 5

Table 8-8. Neutralizer Cell No. 4 Radiological Survey History

Date Area	Visual Observations	Summary Findings	Reference
6/1/63 Tank 320	Volume of waste = 550 gallons	Plutonium : 64 g ; Uranium : 111 kg ; Cesium 184 Ci, Strontium – 122 Ci	C-000118, Att. B, p. 2
4/1/65 Tank 320	Volume of waste = 275 gallons	Plutonium – 32 g, Uranium – 56 kg, Cesium– 92 Ci, Strontium – 61 Ci	C-000118, Att. B, p. 2
4/15/1966 Cell 4	Floor covered with slimy material Yellow, dry stain on tank	Dose rate at the step off to the cell – 150 mRem/hr gamma. Radiation reading at surface of Tank – 1 R/hr gamma; >14 Rem/hr beta; Surface readings on floor – 1 R/hr gamma; >14 Rem/hr beta; Smear of yellow stain on Tank – 25 mR/hr gamma; 7.5 Rem/hr beta; Shoe cover activity (for Cells No. 1-4) – 1 mR/hr gamma; 300 dpm/9.5 sq in alpha (130 pCi)	C-000120, pp. 1-2
7/11/1966 Cell 4	None	Floor: 1,000 to ~ 60,000 pCi/100 cm^2 loose alpha 3 to 240 mrad/hr/100 cm^2 loose beta, 50 to 200 mR/hr direct gamma at 2 inches; and 200 to 2,500 mrad/hr direct beta at contact. Walls: 500 to 20,000 pCi/100 cm^2 loose alpha; 0.7 to 20 mrad/hr/100 cm^2 loose beta. Drum: 75 mrad/hr/100 cm^2 loose beta. Tank: 100 to ~ 45,000 pCi/100 cm^2 loose alpha 0.1 to 90 mrad/hr/100 cm^2 loose beta	C-000428
12/1971 Tank 320	None	General radiation in area: <5 mRem/hr beta; 5 mRem/hr gamma Loose surface contamination: Floor – 4,000 dpm alpha; 1.5 mRem/hr beta-gamma; Wall – 500 dpm alpha; 0.5 mRem/hr beta-gamma; Surface of Tank – 300 dpm alpha; 0.1 mRem/hr beta-gamma	R-000385, p. 1
12/15/1971 Cell 4	Loose surface contamination Entire cell floor is covered with a dried caked gray material that measures high beta dose rates	Direct radiation: At step off – 30 mR/hr gamma General cell area – 700 mRem/hr beta; 20 mR/hr gamma; Side of tank – 7 Rem/hr beta; 50 mR/hr gamma; Loose surface contamination swipes: Surface of tank – 400 dpm alpha; 3 mRem/hr beta-gamma; Cell wall – 600 dpm alpha; 0.4 mRem/hr beta-gamma; Cell floor – 4,000 dpm alpha; 1.5 mRem/hr beta-gamma	C-000133, p. 2
7/25/1989 – 8/31/1989 Cells 1-5	Clean, dry, and free of debris; Cell floor sumps dry. Piping and tanks show no signs of	General area radiation readings (RO-2) – range from 2 to 100 mRem/hr closed window and 6 to 200 mRem/hr open window; maximum readings of 100 mRem/hr closed window and 1,000 mRem/hr open window found on side of Tank 320 in Cell No. 4	C-000198, p. 5

Date Area	Visual Observations	Summary Findings	Reference
	damage or deterioration. No evidence of deterioration of piping insulation Lighting not operational	Loose surface contamination of floor areas – range from <50 to 2,000 pCi/100 cm^2 alpha and from 1,800 to >225,000 pCi/100 cm^2 beta-gamma (4,100 to 170,000 pCi/100 cm^2 due to Cs-137; 2,300 to 17,000 pCi/100 cm^2 due to Am-241)	

Neutralizer Cell No. 5

Neutralizer Cell No. 5 neutralized highly radioactive waste. The 500-gallon capacity cell structure and equipment is original. It is 13 feet long, 9 feet wide, 20 feet high, and enclosed by 4 foot thick concrete walls (C-000164, encl., p. 3).

The 1966 survey reported Neutralizer Cell No. 5 as highly contaminated (C-000428). Table 8-9 shows Neutralizer Cell No. 5 equipment, and Table 8-10 presents a summary of radiological survey data available for Neutralizer Cell No. 5.

Table 8-9. Neutralizer Cell No. 5 Equipment

Equipment	Quantity	Description/Use	Conditions	Reference
Neutralizing Tank 335 with Agitator and Steam Jet Extractor	1	Could be 500 gal steam jacketed; or 350 gal Neutralized highly radioactive waste; stripped solvent from aqueous	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Scrubber Column	1		Still in cell as of April 1984	C-000164, encl., p. 4
Packed Column	1	2 ft by 6 ft (4 ft packing)	Unknown	R-001932, H-Building section, p. 5
Condenser	1	140 sq ft, cooling surface	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Receiver	1	50 gal	Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Sump Pump	1		Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Steam Jet	2		Still in cell as of April 1984	C-000164, encl., p. 4; R-001932, H-Building section, p. 5
Electrical Equipment		Explosion-proof	Still in cell as of April 1984	C-000164, encl., p. 4
Flame Arrestor		Located in cell exhaust	Still in cell as of April 1984	C-000164, encl., p. 4
Lights	3		Unknown	R-001932, H-Building section, p. 5
Piping Runs	~45	3/8 in to 4 in	Unknown	R-001932, H-Building section, p. 5
Conduit Runs	~10		Unknown	R-001932, H-Building section, p. 5
Shielding	1	4 ft	Unknown	R-001932, H-Building section, p. 5
Centrifugal Pump	1	1 HP	Unknown	R-001932, H-Building section, p. 5

Table 8-10. Neutralizer Cell No. 5 Radiological Survey History

Date Area	Visual Observations	Summary Findings	Reference
4/20/1966 Cell 5	Approximately 1 to 2 in of water on floor	Dose rate at the step off to the cell – 40 mR/hr gamma Dose rate at surface of tank – 5 mR/hr gamma; 100 mRem/hr beta	C-000120, p. 2
7/11/1966 Cell 5	None	Floor: 750 to 15,000 pCi/100 cm^2 loose alpha; 0.3 to 3.5 mrad/hr/100 cm^2 loose beta; 10 mR/hr direct gamma at 2 inches 50 mrad/hr direct beta at contact.	C-000428
12/1971 Cell 5	None	General radiation in area: <5 mRem/hr beta; 20 mRem/hr gamma Loose surface contamination: Floor – 4,000 dpm alpha; 0.7 mRem/hr beta-gamma; Wall – 500 dpm alpha; 0.3 mRem/hr beta-gamma; Surface of tank – 400 dpm alpha; 0.5 mRem/hr beta-gamma	R-000385, p. 1
12/15/1971 Cell 5	Loose surface contamination	Direct radiation: At step off – 20 mR/hr gamma; Floor area – 50 mRem/hr beta; 5 mR/hr gamma; Loose surface contamination swipes: Cell wall – 600 dpm; 0.3 mRem/hr beta-gamma; Surface of tank – 400 dpm; 0.5 mRem/hr beta-gamma; Drum in cell – 1,600 dpm; 2 mRem/hr beta-gamma Cell floor – 4,000 dpm; 0.7 mRem/hr beta-gamma	C-000133, pp. 2-3
7/25/1989 – 8/31/1989 Cells 1-5	Clean, dry, and free of debris. Cell floor sumps dry Piping and tanks show no signs of damage or deterioration. No evidence of deterioration of piping insulation. Lighting not operational	General area radiation readings (RO-2) – range from 2 to 100 mRem/hr closed window and 6 to 200 mRem/hr open window Loose surface contamination of floor areas – range from <50 to 2,000 pCi/100 cm^2 alpha and from 1,800 to >225,000 pCi/100 cm^2 beta-gamma (4,100 to 170,000 pCi/100 cm^2 due to Cs-137; 2,300 to 17,000 pCi/100 cm^2 due to Am-241)	C-000198, p. 5

The area is unchanged, although the tanks (normally the South Tank) currently receive laboratory waste for processing through ion exchange systems and a filter train. The reuse water is piped back through the G2-H2 Tunnel to the Radioactive Materials Laboratory (R-001949). Figure 8-7 shows Evaporator Storage Tank A525-A.

8.1.2 EVAPORATOR STORAGE TANK AREA

The Evaporator Storage Tank Area (Figure 8-6.) consists of three 10,000-gallon storage tanks (Tanks A525-A South, A525-B Middle, and A525-C North) located in the southeast corner of the 309-foot level and extending to the 319-foot level. The tanks received liquid waste from Building G2 for processing in hot or cold evaporators and subsequent discharge (R-001949).

Figure 8-6. 10,000-Gallon Storage Tank Area, 309-Foot Level

Figure 8-7. Photo H2-45b, Evaporator Storage Tank A525-A, undated

On December 21, 1976, following removal of sludge from the south collection tank (A525-A), approximately 700 picoCuries of beta-gamma contamination was detected in the knee area of a worker's trousers. It was believed the contamination occurred through anti-c clothing when he kneeled against a highly contaminated Plexiglas (C-000860, Attachment 1, Radiological History for H2). Table 8-11 presents a summary of radiological survey data available for the Evaporator Storage Tank in Building H2.

During visual inspection in 2004, non-SPRU-related drums containing KAPL waste were stored near the north tank (A525-C). A plywood box approximately 14- to 15-feet long containing refueling equipment was observed on the floor area next to the north and middle tanks (A525-B and A525-C).

Table 8-11. Building H2 Evaporator Storage Tank Area Radiological Survey

Date Area	Visual Observations	Summary Findings	Reference
7/25/1989 – 8/31/1989 Tank Bay	Area contains tools, supplies, and equipment from previous work (i.e., pallets, drums, plastics, rods) Area is dry and dusty; heavy layer of dust on floor Floor under middle tank has lines that appear to be where floor tiles were installed – unclear if floor tiles still remain Tank supports, piping, pipe insulation, and ductwork show no evidence of damage or deterioration Lighting in area poor There are seven 55-gallon waste drums on the floor	General area radiation – 7 to 100 mRem/hr closed window and 10 to 140 mRem/hr open window with maximum localized reading of a floor area of 150 mRem/hr closed window and 450 mRem/hr open window Maximum gamma dose rate as measured by Teletector is 400 mRem/hr Air sample data indicated 2.7×10^{-12} μCi/ml gross alpha with 8.9×10^{-13} μCi/ml due to Pu-238/239 Air sample data indicated 2.3×10^{-10} μCi/ml gross beta from Cs-137 Loose surface alpha contamination of floor areas <50 pCi/100 cm^2; swipes of personnel protective clothing show trace amounts of Pu-238/239 and U-234 Loose surface beta-gamma contamination of floor areas from 675 to 45,000 pCi/100 cm^2 with 290 to 37,000 pCi/100 cm^2 due to Cs-137	C-000198, pp. 3-4

Date Area	Visual Observations	Summary Findings	Reference
	Drum No. 2 has surface corrosion, corrosion is also evident on floor around drum; unclear if corrosion is from leakage of contents	Yellow powder-like sample from floor near middle tank produced 38,462 pCi/gm Cs-137 Maximum contamination measured is 1 mRem/hr/100 cm^2 beta-gamma by open window RO-2 measurement of a swipe of the floor	

8.1.3 WASTE EVAPORATOR BAYS

Two evaporator bays extend from the 309-foot level to the 332-foot level and are located at the north end of H2. A 2 foot thick concrete wall shields the West Evaporator while the East Evaporator is open to the main area of the building (Figure 8-8). Evaporator system equipment is intact and includes:

- Horizontal 2-pass evaporator heater (steam heated) and flash-pan evaporator (6 foot diameter by 16 feet high)
- Separating column of similar size containing a 10 foot de-entrainment section and 4 bubble cap trays
- Tube and shell single pass vertical condenser
- Two 5,000-gallon stainless storage tanks, formerly used for evaporator condensate storage on East Bay 309-foot level, also used for reuse waste processing purposes (R-001949)
- 650 gallons per minute evaporator recirculation pump (431-104)
- Steam driven air ejector and associated condenser that maintained a vacuum in the system.

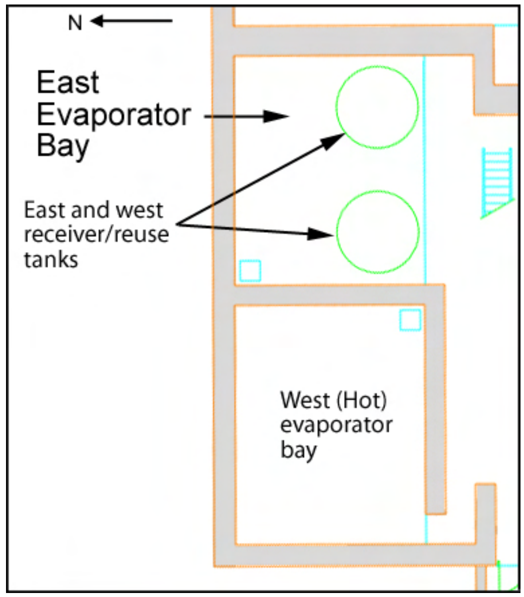


Figure 8-8. Plan View of the Evaporator Area

West Evaporator Bay

The West Evaporator Bay concrete structure and original configuration are intact (R-001949). No 309-foot level Waste Evaporator Cell photos exist; however, the 1989 inspection indicated that the area contains pumps and piping.

The West Evaporator Bay received low-level liquid waste for condensate and solid waste processing from the North and Middle 10,000 gallon Storage Tanks. The condensate was liquefied, tested, and discharged or diluted and discharged. Solid waste was stored in drums for off-site disposal. At the time of the 1989 inspection, the West Evaporator Bay had about 6 inches of water in the 1 foot deep stainless steel floor pan, or approximately 1,700 gallons. Initially, the area was inspected from the cell doorway because of the water, but was entered and inspected after the water had been pumped out and the floor flushed with clean water. No evidence of the water source was apparent, i.e., no pipe leakage, pipe insulation damage, wall cracks, or stains on the walls or ceiling were observed. The water surface contained dirt, dust, and mold/algae. A sump pump in the area was not operating at the time of inspection, nor was area lighting operational (R-001949). Table 8-12 presents a summary of radiological survey data available for 309-foot level West Evaporator Cell.

Table 8-12. 309-Foot Level West Evaporator Cell Radiological Survey

Date Area	Visual Observations	Summary Findings	Reference
7/25/1989 – 8/31/1989 Hot Evaporator Cell	About 6 inches of water in floor pan (approximately 1,700 gallons) No evidence of source of water (i.e., no piping leakage, no wall cracks, no stains on walls or overhead) Piping is intact No evidence of pipe insulation damage Surface of water contains dirt, dust, and mold Sump pump not operational at time of inspection Lighting not operational	Radiation readings in doorway - <0.2 mRem/hr closed window and 0.4 mRem/hr open window Loose surface contamination of doorway ledge - <50 pCi/100 cm^2 alpha and <450 pCi/100 cm^2 beta-gamma Radiochemical analysis – 22.2 pCi/100 cm^2 of Cs-137 and 0.26 pCi/100 cm^2 of Pu-238/239 Air sample taken at doorway indicated 6.6×10^{-13} µCi/ml gross alpha radioactivity; however, no alpha peaks observed on spectrum; positive alpha value due to sensitivity of alpha counter to beta activity Air sample taken at doorway indicated 2.3×10^{-12} µCi/ml gross beta radioactivity with 5.7×10^{-13} µCi/ml from Cs-137 Non-filterable portion of water sampled indicates $\leq 5.8 \times 10^{-6}$ µCi/ml MDA gross alpha and 7.8×10^{-4} µCi/ml gross beta, 1.9×10^{-4} µCi/ml due to Cs-137 and 2.6×10^{-4} µCi/ml due to Sr-90; tritium levels $\leq 2.7 \times 10^{-7}$ µCi/ml MDA Filterable suspension of water indicates $\leq 2.6 \times 10^{-9}$ µCi/ml MDA gross alpha and 9.5×10^{-6} µCi/ml gross beta, 6.5×10^{-6} µCi/ml due to Cs-137 and 5.7×10^{-7} µCi/ml due to Sr-90	C-000198, p. 2

East Evaporator Cell

The East Evaporator Cell, like the West Evaporator Cell, extends from the 309-foot level to the 332-foot level. Figure 8-9 is a photo showing the bottoms of the two 5,000 gallon receiver/reuse tanks in the cell. The 5,000-gallon tanks are used to store treated water from Tank Vault pump down events prior to discharge.

Figure 8-9. Photo H2-51b, East Evaporator Area 309-Foot Level, undated

On February 20, 1992, a 7-foot by 8-foot piece of plastic was placed over a contaminated section of concrete on the East Evaporator east wall at the 309-foot level. A swipe survey of the work area indicated that the highest level of beta-gamma loose surface contamination was 10,800 picoCuries per 100 cubic centimeters. Radiochemistry determined that the cesium-137 to strontium-90 ratio was approximately one to one. Total beta activity on an air sample patch was calculated to be 260 picoCuries with an airborne concentration of 8.2 x 10^{-11} microCuries per milliliter (C-000860, Attachment 1, and Radiological History for H2). Table 8-13 presents a summary of radiological survey data available for 309-foot level East Evaporator Cell.

Table 8-13. 309-Foot Level East Evaporator Cell Radiological Survey

Date Area	Visual Observations	Summary Findings	Reference
10/5/04 309' East Evaporator Bay	None	Contamination survey results: <450 pCi beta-gamma; one swipe measured 450 pCi/100 cm^2 and 100 cpm Radiation survey results of various readings around the bay: 1. 0.6 (mR or mRem)/hr open window/closed window 2. 20 (mR or mRem)/hr open window/1.2 (mR or mRem)/hr closed window 3. 5 (mR or mRem)/hr open window/1.4 (mR or mRem)/hr closed window 4. 1 (mR or mRem)/hr open window/closed window 5. 12 (mR or mRem)/hr open window/1.2 (mR or mRem)/hr closed window 6. 2 (mR or mRem)/hr open window/0.6 (mR or mRem)/hr closed window 7. 2.8 (mR or mRem)/hr open window/0.6 (mR or mRem)/hr closed window 8. 0.8 (mR or mRem)/hr open window/closed window	R-000525

8.1.4 Hopper/Drum Dryer Cells

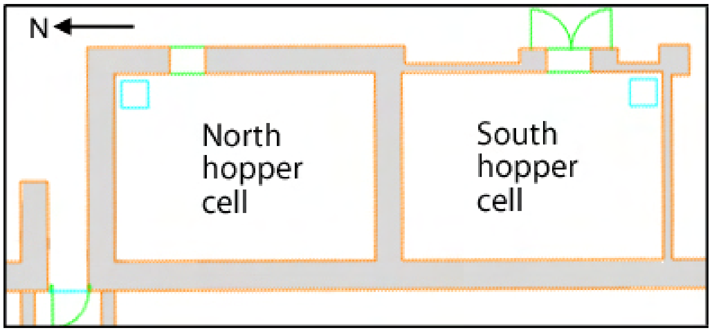


Figure 8-10. Hopper Cell Area, 309-Foot Level

Two Hopper/Drum Dryer cells (North and South) are centrally located in H2, to west side (Figure 8-10). They originally consisted of two Hopper Cells on the 309-foot level that extended to the 319-foot level, where the Drum Dryers were located. The North and South Hopper Cells on the 309-foot level and the South Drum Dryer Cell on the 319-foot level are still intact. The North Drum Dryer Cell on the 319-foot level was dismantled and converted to the RW Cell prior to 1966 (R-002108). The 319-foot level cells are addressed in Section 8.2. Since the 1965 and 1966 H2 waste removal and cleanup, the Hopper Cells have been designated as a high radiation control area with restricted access (I-000422).

South Hopper Cell

The South Hopper Cell contains equipment used to slurry evaporated liquid waste before conveyance to the Drum Dryer Cell on the 319-foot level (Figure 8-11). The equipment is reportedly still in the cell. Data from the 1989 inspection characterized the South Hopper Cell as a radiation and contamination area.

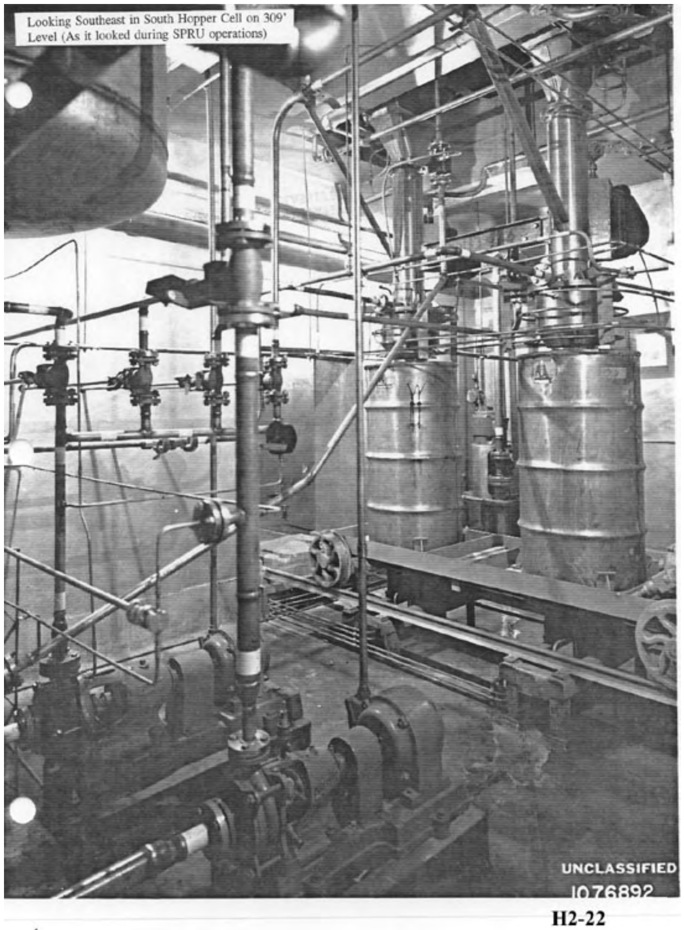


Figure 8-11. Photo H2-22, South Hopper Cell, Looking Southeast on 309-Foot Level, undated

Table 8-14 presents a summary of radiological survey data available for the South Hopper Cell in Building H2.

Table 8-14. Building H2 South Hopper Cell Radiological Survey History

Date	Area	Visual Observations	Summary Findings	Reference
7/25/1989 – 8/31/1989	South Hopper Cell	Area dry and free of debris Fine layer of dust on all surfaces Area contains RML water reuse system equipment (i.e., pumps, filters, hoses); equipment is intact RML pump was tested and is operational Floor sump dry Lighting not operational	General area radiation – 2 to 10 mRem /hr open/closed window with maximum reading of 20 mRem /hr open/closed window on full flow filter housing Loose surface alpha contamination of floor area <50 pCi/100 cm^2 Loose surface beta-gamma contamination of floor areas from 450 to 3,600 pCi/100 cm^2	C-000198, pp. 3-4

North Hopper Cell

The North Hopper Cell also contains equipment used to slurry evaporated liquid waste sent to the Drum Dryer Cell on the 319-foot level. The original equipment is still in the cell, although it is severely corroded. Data from the 1989 inspection indicates the North Hopper Cell is contaminated with slurry on the floor and equipment. Table 8-15 presents a summary of radiological survey data available for the North Hopper Cell in Building H2.

Table 8-15. Building H2 North Hopper Cell Radiological Survey History

Date	Area	Visual Observations	Summary Findings	Reference
7/25/1989 – 8/31/1989	North Hopper Cell	Heavy layer of corrosion on structural and other materials in contact with floor Nuts, bolts, hand tools, etc., remain in area and are severely rusted to point of disintegration Four I-beams supporting magnetite blocks used for tubing shielding show severe corrosion from the floor level to 6 inches above the floor Four foot high stainless steel revetment containing five tanks shows evidence of surface corrosion and pitting; revetment contains approximately 0.5 inches of liquid in bottom – source of liquid not identified Tanks and piping show no evidence of damage or deterioration Sump covered with stainless steel enclosure and not visible Entire floor covered with caked-on black powdery substance	General area radiation – 2 to 20 mRem /hr closed window and 6 to 200 mRem /hr open window with maximum reading of 600 mRem /hr closed window and 5,000 mRem /hr open window at 6 inches away from yellow crystal-like deposit on floor Air sample data indicated 1.8 x 10^{-12} μCi/ml gross alpha and 1.6 x 10^{-11} μCi/ml gross beta from Cs-137 Loose surface alpha contamination from 100 to 320 pCi/100 cm^2 Loose surface beta-gamma contamination from 18,000 to 112,500 pCi/100 cm^2 with 3,500 to 30,000 pCi/100 cm^2 due to Cs-137, 140 to 2,600 pCi/100 cm^2 due to Am-241, 55 to 10,000 pCi/100 cm^2 due to Eu-154, and 86 pCi/100 cm^2 due to Eu-155 Maximum contamination measured is 2.5 mRem /hr/100 cm^2 beta-gamma open window measured swipe of floor by RO-2 Sample of yellow crystal-like material produced 27,000 pCi/gm Cs-137 and 1,050 pCi/gm Am-241 Sample of black material found on floor produced 6,300 pCi/gm Cs-137	C-000198, p. 3

The 1989 survey of the North Hopper Cell indicated general area radiation readings of 2 to 20 milliRem per hour closed window and 6 to 200 milliRem per hour open window. There was a maximum reading of 600 milliRem per hour closed window and 5,000 milliRem per hour open window at 6 inches away from a yellow crystal-like deposit on the floor. Additionally, loose surface beta-gamma contamination from 18,000 to 112,500 picoCuries per 100 square centimeters was identified. Loose surface alpha contamination measured from 100 to 320 picoCuries per 100 square centimeters (C-000198, p. 3). This survey indicates a high radiation and a high contamination area. Further characterization is necessary to assess any change in radiological conditions since the 1989 survey.

8.1.5 H2 PIPE TUNNEL

The H2 Pipe Tunnel (Figure 8-12) contains liquid waste piping that carried process waste from D4, E1, G1, and G2 for processing in the H2 neutralizers or evaporators. It connects to the G2-H2 Tunnel. H2 Pipe Tunnel lines remain, but some E1, G1, and G2 pipes are capped.

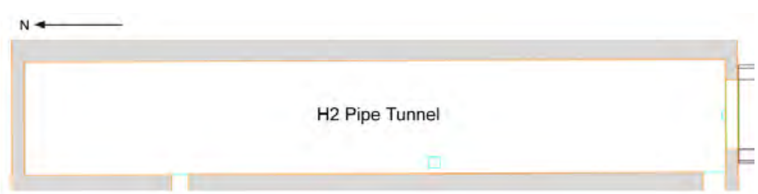


Figure 8-12. Pipe Tunnel, 309-Foot Level

The H2 Pipe Tunnel is entered at the 309-foot level through either of two stainless steel doors. One door is located near the north end of H2, the other near the south end. The tunnel can also be accessed from the outside of Building H2 (east outer wall) through an opening in a grade-level tunnel roof that is currently covered by five asphalt-sealed concrete blocks. The Tank Farm holding tank vaults are located on the east side of the H2 Pipe Tunnel, separated by 6 foot thick walls and a 2 foot thick ceiling. The north and south tunnel walls contain no penetrations, nor does the foundation slab. A lifting shaft and stairway penetrates all levels (309-foot through the 332-foot level). Negative building pressure and airflow down the lifting shaft and into exhaust ducts at the 309-foot level prevent migration of residual radioactivity to the upper levels.

In the mid-1970s, a liquid reuse system was installed in the H2 and G2-H2 Tunnels, which involved modifying tunnel piping to include laboratory waste-receiving lines and reuse water lines for transporting processed water back to laboratory areas. In 1989, four active lines remained. Two stainless steel lines provided pumped, but non-pressurized, drainage of radioactive water from the Radioactive Materials Laboratory, Chemistry, and D4 Complex to the H2 liquid waste collection tanks. Clean, processed reuse water was pumped to the same laboratories at 60 pounds per square inch gauge through two plastic supply lines. Currently, only the Radioactive Materials Laboratory feeds the system (I-000418).

The reuse water is not gravity fed and its transfer pump is secured during non-working hours. A break in these lines could contaminate tunnel floors. A similar situation would exist if leaks occurred in the three 10,000-gallon and two 5,000-gallon reuse water tanks or the three 950-gallon Hillside Drain processing tanks located in H2. Cooling Tower pipes in the H2 Pipe Tunnel were capped outside the building and now present no flooding threat. Figure 8-13 shows the H2 Pipe Tunnel during SPRU time.

The 1989 survey of the pipe tunnel identified general area radiation of 4 to 80 milliRem per hour closed window and 12 to 300 milliRem per hour open window with localized readings of floor areas up to 200 milliRem per hour closed window and 600 milliRem per hour open window. Maximum readings obtained were 400 milliRem per hour closed window and 2,400 milliRem per hour open window over 509C sump and 600 milliRem per hour closed window and 1,200 milliRem per hour open window over the 509A sump. Loose surface alpha contamination of the floor area measured from less than 50 to 5,200 picoCuries per 100 square centimeters (less than 111 to 11,544 disintegrations per minute). Loose surface beta-gamma contamination of floor areas measured from 27,000 to greater than 225,000 picoCuries per 100 square centimeters (59,940 to greater than 499,500 disintegrations per minute) (C-000198, pp. 4-5). Based on these survey results, the pipe tunnel is a high radiation and high contamination area. Further characterization is necessary to assess any change in radiological conditions since the 1989 survey.

Table 8-16 presents a summary of radiological survey data available for the H2 Pipe Tunnel.

Table 8-16. H2 Pipe Tunnel Radiological Survey

Date	Visual Observations	Summary Findings
7/25/1989 – 8/31/1989	Medium to heavy layer of white dust on all surfaces with heaviest concentration of 2 to 3 inches deep near north door; same solidifying agent, Micro-Cell E, found in G2 tunnels; Tools and supplies from previous work remain in area (i.e., tubing, air sample pump, water pumps, and open bag of Micro-Cell E); Piping is intact No evidence of pipe insulation deterioration 578 sump dry with mud on bottom 509E sump contained about 24 inches of water initially and 14 inches after pumping 509D sump contained less than 12 inches of water initially and was dry after pumping	General area radiation – 4 to 80 mRem /hr closed window and 12 to 300 mRem /hr open window with localized readings of floor areas up to 200 mRem /hr closed window and 600 mRem /hr open window Maximum readings obtained were 400 mRem /hr closed window and 2,400 mRem /hr open window over 509C sump and 600 mRem /hr closed window and 1,200 mRem /hr open window over the 509A sump Air sample data indicated 3.5 to 6.2 x 10^{-11} µCi/ml gross alpha from Pu-238/239 and 1.6 x10^{-10} to 1.7 x 10^{-9} µCi/ml gross beta from Cs-137 Loose surface alpha contamination of floor area from <50 to 5,200 pCi/100 cm^2

Date	Visual Observations	Summary Findings
	509C sump contained 12 inches of water 509B sump contained about 11 inches of water initially and after pumping 509A and 505 sumps contained about 8 inches of water each Lighting nearly completely operational Floor on east side around sumps damp to point of saturation but no free standing water Remainder of tunnel floor is dry	Loose surface beta-gamma contamination of floor areas from 27,000 to >225,000 pCi/100 cm2, with 24,000 to 1,300,000 pCi/100 cm2 due to Cs-137 and 1,700 pCi/100 cm^2 from one swipe due to Am-241 Maximum contamination measured is 50 mRem /hr/100 cm^2 beta-gamma by open window RO-2 measurement of swipe of floor Debris sample from floor produced 50,000 pCi/gm Cs-137 Debris sample from 509A sump ledge produced 4,667 pCi/gm Cs-137

Reference: C-000198, pp. 4-5

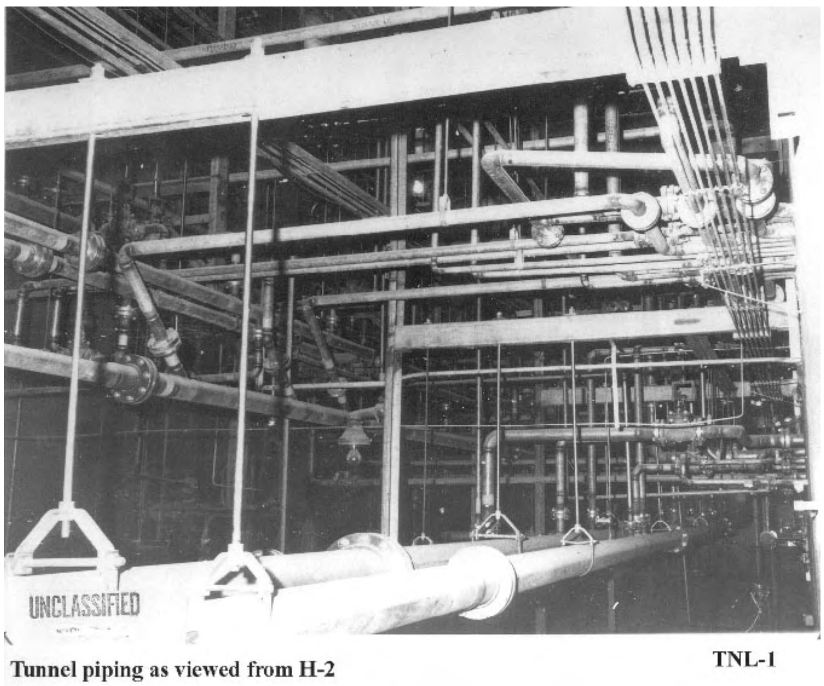


Figure 8-13. Photo TNL-1, View of H2 Pipe Tunnel, undated

8.2 H2 Building 319-Foot Level

The 319-foot level contains most of the operating instruments for the radioactive liquid waste reuse system, the former North Drum Dryer Cell/RW Cell, South Drum Dryer Room, and Galley over the Evaporator Storage Tanks. Figure 8-14 is a view of the 319-foot level floor plan showing configuration of the rooms and equipment. Current conditions are represented by radiological surveys conducted in 1989 and 2004.

Current 319-foot level radiological conditions are based on the 1989 or the 2004 survey and are depicted in Figure 8-15. Terms used in the figure are defined in Table 5-1.

The 1989 survey of the west evaporator bay identified general area radiation of 0.6 to 4 milliRem per hour closed window and 0.8 to 4 milliRem per hour open window. There was a maximum reading on the sight glass isolation valve on the side of the west evaporator of 12 milliRem per hour closed window and 150 milliRem per hour open window. Loose surface contamination of floor areas indicated less than 450 to 450 picoCuries per 100 square centimeters (less than 999 to 999 disintegrations per minute) beta-

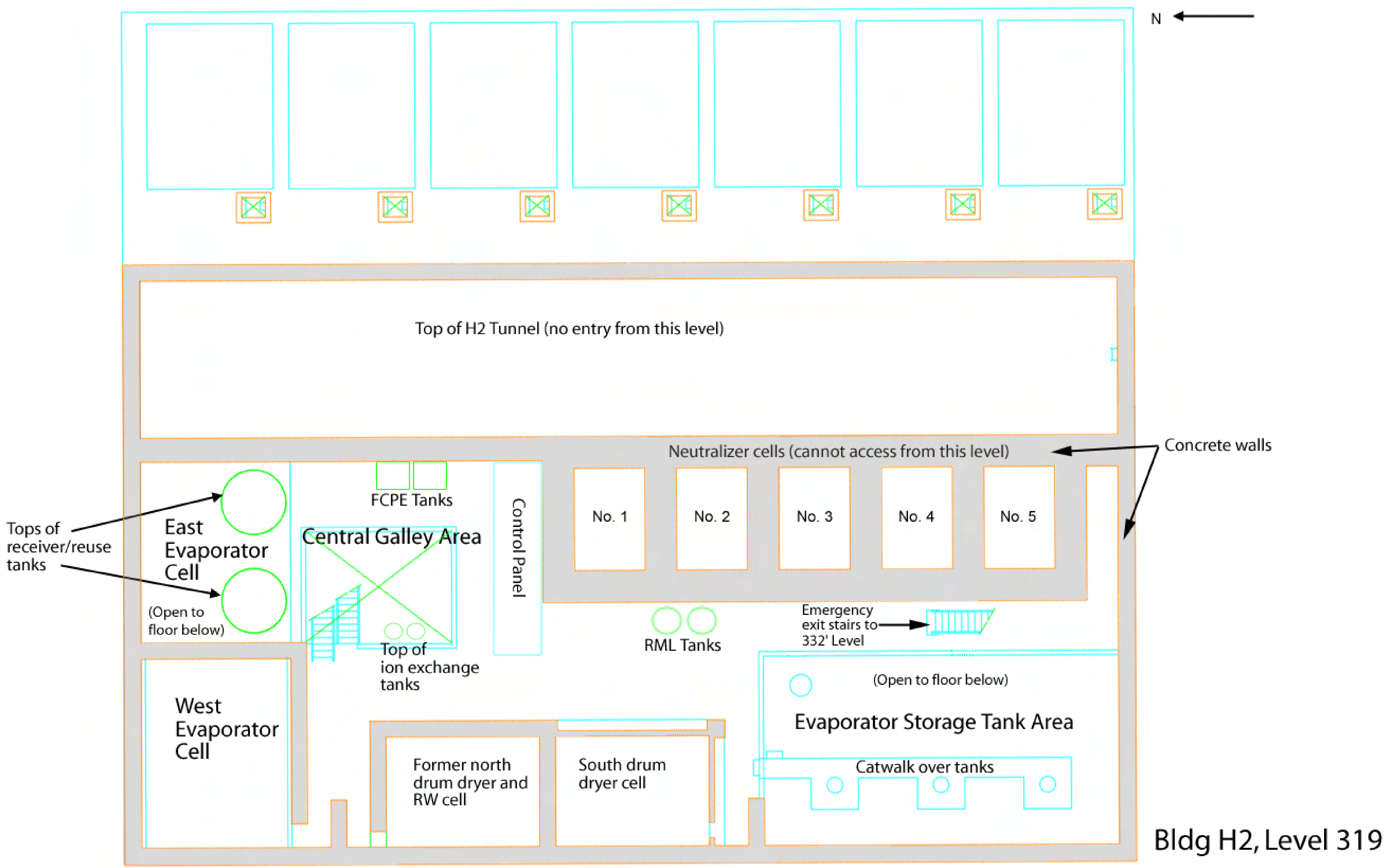


Figure 8-14. Building H2, 319-Foot Level Floor Plan

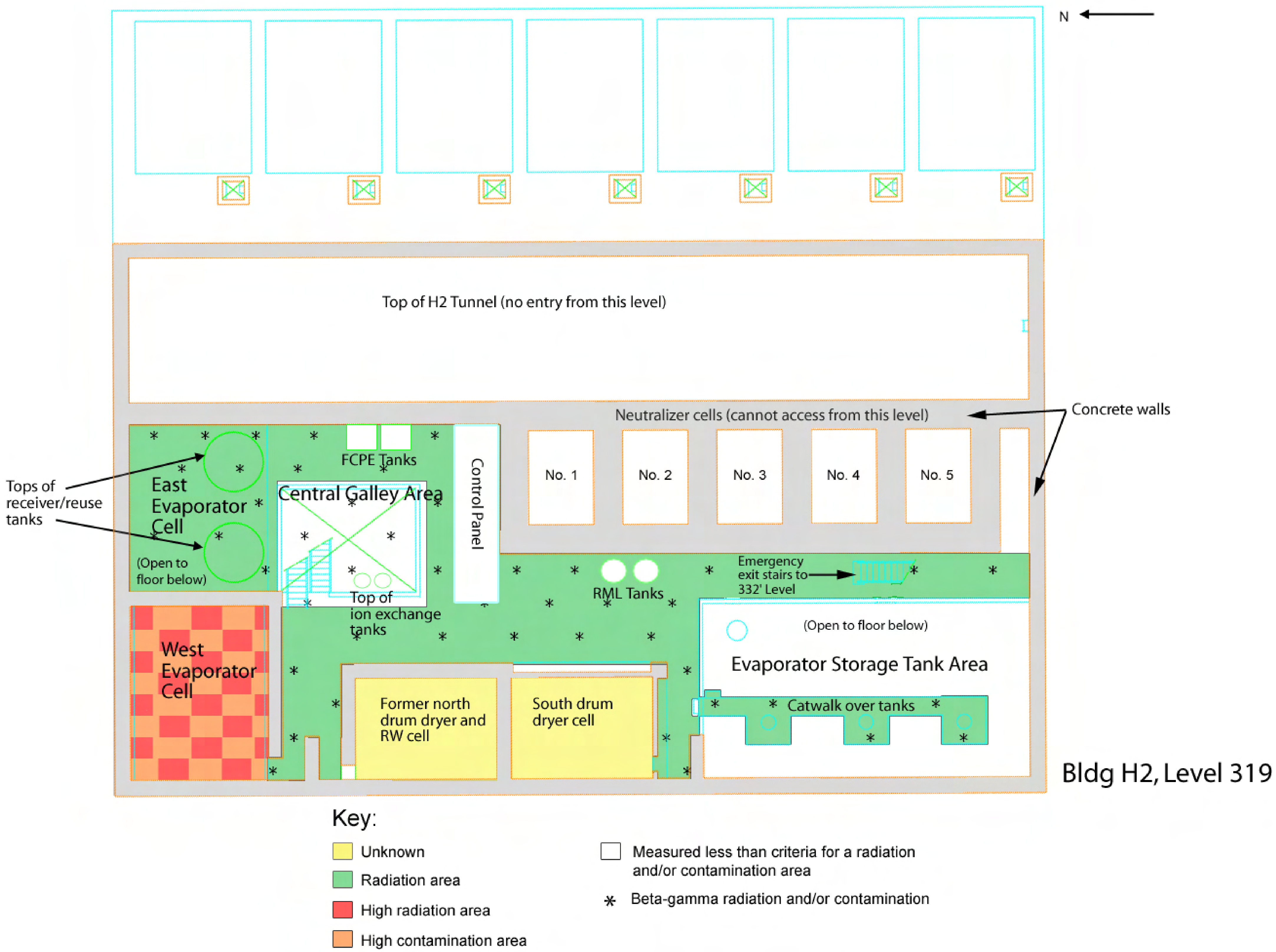


Figure 8-15. Current Radiological Conditions for the 319-Foot Level

gamma. Loose surface contamination on the sight glass isolation valve indicated less than 50 picoCuries per 100 square centimeters (less than 111 disintegrations per minute) alpha and 54,000 picoCuries per 100 square centimeters (119,880 disintegrations per minute) beta-gamma (C-000198, pp. 2-3). Based on this survey, the west evaporator bay is a high radiation area and a high contamination area. Further characterization is required to assess any change in radiological conditions since the 1989 survey.

In the 2004 survey of the east evaporator bay, radiation survey results ranged from 0.2 to 6 milliRem per hour. Contamination surveys identified less than 450 picoCuries (less than 999 disintegrations per minute) beta-gamma. Based on this survey, the east evaporator bay is a radiation area.

In the 2004 survey of the evaporator storage tank area, radiation survey results ranged from less than 0.2 to 30 milliRem per hour with the greatest readings near the south tank. Contamination surveys identified less than 450 picoCuries (less than 999 disintegrations per minute) beta-gamma. Based on this survey, the evaporator storage tank area at the 319-foot level is a radiation area.

In the 2004 survey of the dryer floor area (general area), radiation survey results ranged from less than 0.2 to 6 milliRem per hour. Contamination surveys identified less than 450 picoCuries (less than 999 disintegrations per minute) beta-gamma. Based on this survey, the dryer floor area (general area) is a radiation area.

No current survey information was identified for the north or South Drum Dryer Cells. Further characterization is necessary to assess the radiological condition of these areas.

8.2.1 FORMER NORTH DRUM DRYER AND RW CELL

The former North Drum Dryer Cell is smaller and more heavily shielded than the South Dryer Cell, as it was designed to handle highly radioactive material (Figure 8-16). Drum drying was discontinued in 1950, but slurry functions on the 309-foot level continued until an unknown time (I-000422).

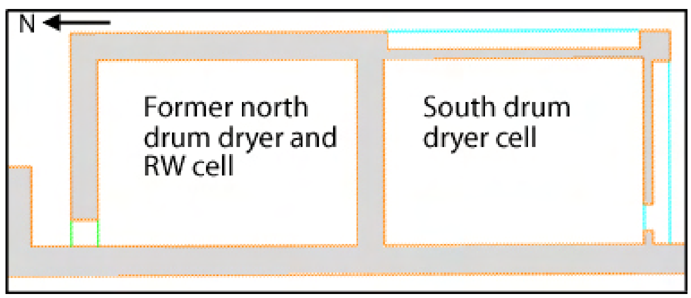


Figure 8-16. Former North Drum Dryer Cell and South Drum Dryer Cell, 319-Foot Level

After SPRU decommissioning, the North Drum Dryer Cell was converted to the RW Cell. It is described as an abandoned facility approximately 14 feet wide by 20 feet deep by 9 feet high (R-002108). It is located along the east wall of H2 on the 319-foot level (Figure 8-17). The RW Cell is partitioned into two approximately 7 feet wide by 20 feet deep areas. The floor and walls of the area toward the east wall were covered with stainless steel to a height of about 4 feet. The surface area is unpainted concrete. The cell partition is constructed of wooden panels bolted to a 3-inch by 3-inch by one-quarter-inch iron angle framework secured to the stainless steel floor of the eastern half of the cell by five welded joints and to the ceiling by bolts. The eastern half of the cell contained two pits, each 25 inches by 48 inches surrounded by 1/8-inch steel lips about 4 inches high, while the other half of the cell contained one pit about 37 inches by 37 inches. All three pits contained 30 to 40 ¼-inch by 3/8-inch and three to five ¾-inch and 1-inch steel tubes extending slightly above its top. Additionally, two pipe trenches, 18 inches by 7 inches by 6 inches deep and containing six ¾-inch tubes, were located in the concrete floor of the western half of the cell (R-002108, p. 13).

The RW Cell was not accessed during the 1989 inspection. A lead glass portal is located on the north wall, but electrical service and lighting necessary to view the interior of the cell were not operational. Lead bricks were stacked up along the base of the outside wall.

Figure 8-17. Photo H2-32b, Outside East Wall of the Former Drum Dryer Cell looking south, 319-Foot Level, undated

RW Cell cleanup in 1966 included removing loose debris; piping, ductwork, partition framework, and other equipment; and hood ductwork up to the wall penetration. Checkered carbon steel plates were installed over floor pits and pipe trenches; the accessible floor, ceiling, and wall surfaces were vacuumed; accessible surfaces were mopped twice; and the supply air duct was sealed at the flange joint where the duct enters the outer face of the cell north wall. The general dose rate prior to cleanup was less than 2 milliRem per hour with localized dose rates up to 75 milliRem per hour on some equipment. Loose surface contamination levels ranged from less than 50 picoCuries per 100 square centimeters to 12,000 picoCuries per 100 square centimeters beta-gamma. Contamination was primarily from plutonium-239, strontium-90, and cesium-137 (R-002108, pp. 13-14).

The RW Cell is above the North Hopper/Slurry Room. During a tour of H2 on May 11, 2004, it was noted that the outside wall of the cell was covered with magnetite brick to provide additional radiological shielding (primarily from gamma radiation).

8.2.2 SOUTH DRUM DRYER CELL

The drum dryers processed liquid waste into condensate and solid waste for discharge or storage and disposal. The system was used for a short period and abandoned in December 1950, but the structure and equipment remain intact (R-001949, p. 45). The South Drum Dryer Cell is approximately 14 feet wide by 20 feet deep by 11 feet high. The walls, floors, and ceilings are unpainted concrete (R-002108, p. 16).

The 1966 South Drum Dryer Cell cleanup included removing loose debris, condensers and piping; sealing wall, floor, and ceiling pipe penetrations and open pipe connections to the drum dryer and feed and condensate tanks; vacuuming accessible floor, wall, ceiling, and equipment surfaces; and mopping the accessible surfaces twice. Dose rates prior to clean up were generally less than 1 to 2 milliRem per hour. General loose surface contamination levels in the room ranged from less than 450 picoCuries per 100 cubic centimeters to 5,000 picoCuries per 100 cubic centimeters beta-gamma and less than 50 picoCuries per 100 cubic centimeters alpha. Contaminants were primarily strontium-90 and cesium-137 (R-002108, p. 16). The Figure 8-18 photograph of the South Drum Dryer Cell closely depicts current conditions.

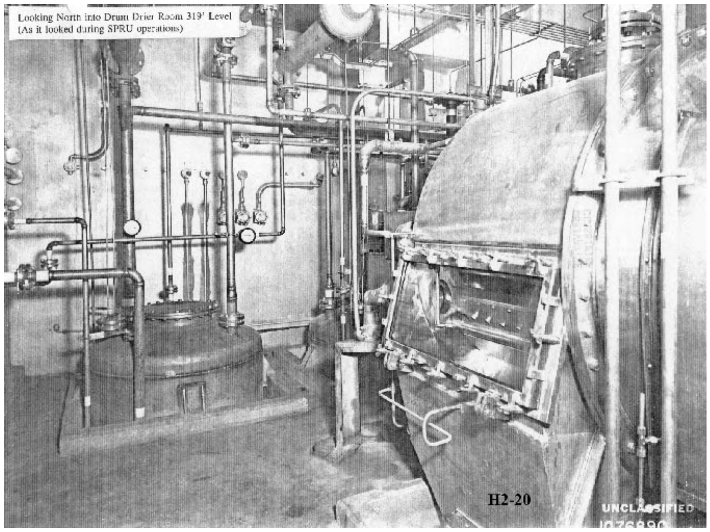


Figure 8-18. Photo H2-20, South Drum Dryer Cell 319-Foot Level, undated

8.2.3 EVAPORATOR STORAGE TANK AREA

The Evaporator Storage Tank bases are at the 309-foot level. A metal galley pipe rail surrounds the pit at the 319-foot level and a catwalk extends over the tanks (Figure 8-19). No evaporator tank modifications were made at the 319-foot level. Figure 8-20 is a photo of the Evaporator Storage Tank Area on the 319-foot level looking south. The catwalk is seen at the left side of the photograph.

A radiological survey of the Evaporator Storage Tank Area was conducted in 2004. The results are shown in Table 8-17.

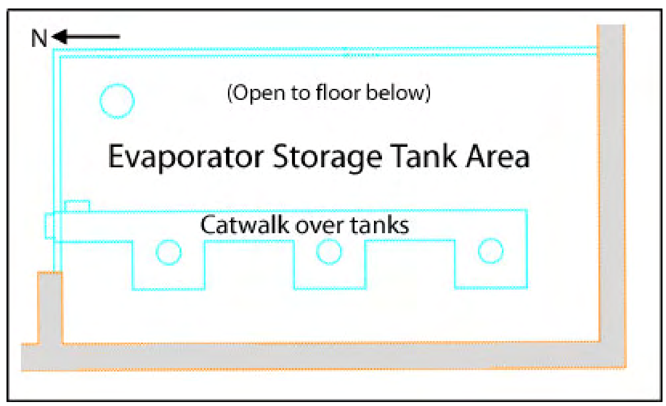


Figure 8-19. Evaporator Storage Tank Area, 319-Foot Level

Table 8-17. H2 319-Foot Level Evaporator Storage Tank Area Radiological Survey

Date/Area	Visual Impressions	Summary Findings	Reference
10/5/04 319' South Tank Bay	None	Contamination survey results: <450 pCi beta-gamma Radiation survey results of various readings around the tops of the tanks (moving from the north tank to the south tank): <0.2 mRem/hr, 0.4 mRem /hr, 1.2 mRem /hr, 1.4 mRem /hr, 1.5 mRem /hr, 3.5 mRem /hr, 6.0 mRem /hr, 12 mRem /hr, 13 mRem /hr, 14 mRem /hr, 28 mRem /hr, and 30 mRem /hr	R-000525

Figure 8-20. Photo H2-73, Evaporator Storage Tank Area, 319-Foot Level Looking South, 1997

8.2.4 CENTRAL GALLEY AREA

The 319-foot level Central Galley Area includes a general work area, the instrument panel, and radioactive liquid waste tank area outside of the former North Drum Dryer Cell (Figure 8-21). The entire area is a radiological control area, primarily due to loose surface contamination. The area is currently used by KAPL for the radioactive liquid waste reuse system. On the right side of the Figure 8-22 photo, one of the radioactive liquid waste resin tanks is visible in front of the instrument panel on the 319-foot level. The backside of the panel is blocked off and a mercury hazard sign posted; reportedly, mercury from instruments in the panel leaked onto the floor. The yellow tanks on the left of the photograph stored waste collected from the Full Core Physics Experiment (FCPE) in Building F2.

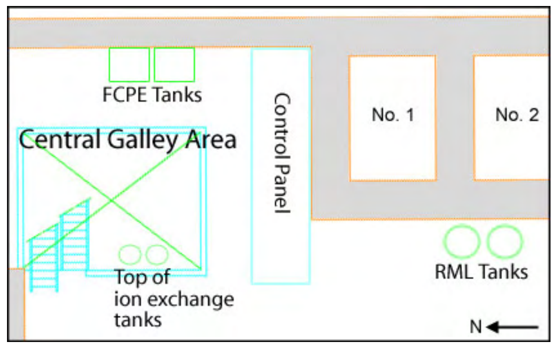


Figure 8-21. Central Galley Area, 319-Foot Level

Figure 8-22. Photo H2-35b, 319-Foot Level Instrument Panel, undated

8.2.5 WEST EVAPORATOR CELL

On the 319-foot level, the West Evaporator Cell (Figure 8-23) has 2 foot thick concrete walls that are not altered from the original configuration. However, the 319-foot level area around the West Evaporator is in a high radiation control area and inaccessible. It was inspected and videotaped during the 1989 inspection (V-002009) indicating that the equipment shown in Figure 8-24 is still present and intact.

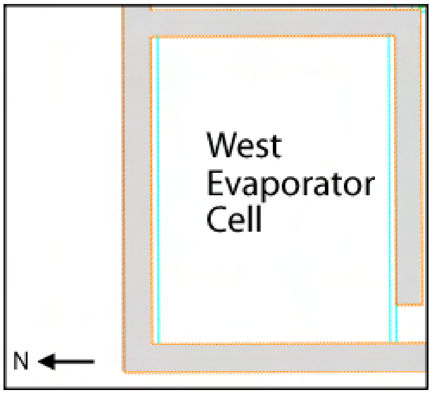


Figure 8-23. West Evaporator Cell, 319-Foot Level

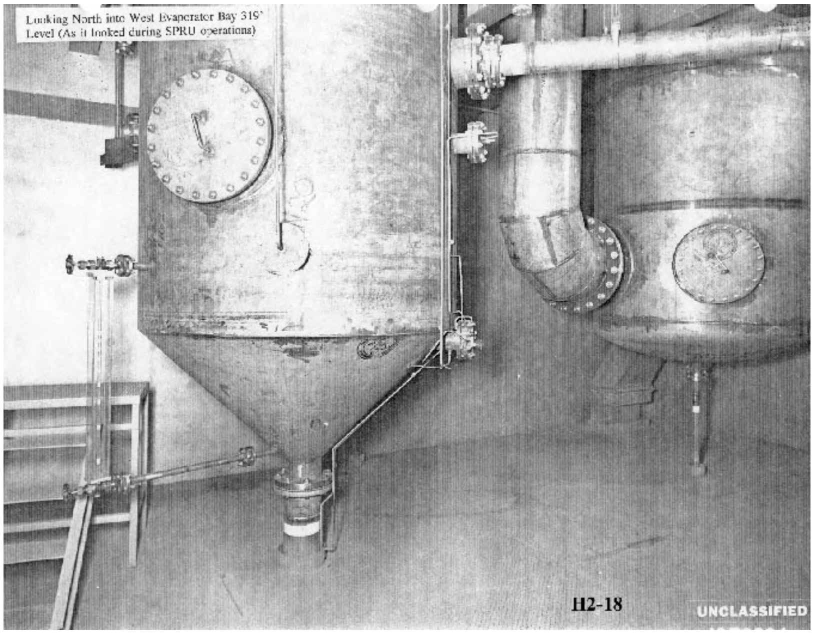


Figure 8-24. Photo H2-18, West Evaporator Cell, 319-Foot Level, undated

Table 8-18 presents a summary of radiological survey data available for the H2 319-foot level West Evaporator Cell.

Table 8-18. H2 319-Foot Level West Evaporator Cell Radiological Survey History

Date/Area	Visual Impressions	Summary Findings	Reference
7/25/1989 – 8/31/1989 Hot Evaporator Bay	Clean and dry with exception of oil-like stain on diamond plate floor under the west evaporator No evidence of pipe or pipe insulation damage Lighting not operational Duct work intact	General area radiation – 0.6 to 4 mRem /hr closed window and 0.8 to 4 mRem /hr open window, with maximum reading on sight glass isolation valve on side of west evaporator of 12 mRem /hr closed window and 150 mRem /hr open window Air sample taken indicated 3.2 x 10^{-13} µCi/ml gross alpha radioactivity; however, no alpha peaks observed on spectrum Air sample taken indicated 8.6 x 10^{-13} µCi/ml gross beta radioactivity with 4.6 x 10^{-13} µCi/ml from Cs-137	C-000198, pp. 2-3

Date/Area	Visual Impressions	Summary Findings	Reference
	No evidence of damage or deterioration of the tanks, with the exception of the sight glass isolation valve on the west evaporator tank – crystal-like deposit indicates evidence of corrosion and previous leakage	Loose surface contamination of floor area indicates <450 to 450 pCi/100 cm^2 beta-gamma, with 15 to 189 pCi/100 cm^2 due to Cs-137 Loose surface contamination of floor area measured by radiochemical analysis of swipes shows trace amounts of Pu-238/239 Loose surface contamination on sight glass isolation valve indicates <50 pCi/100 cm^2 alpha and 54,000 pCi/100 cm^2 beta-gamma with 24,100 pCi/100 cm^2 due to Cs-137	

8.2.6 EAST EVAPORATOR CELL

The East Evaporator Cell extends from the 309-foot level to the 332-foot level (Figure 8-25). Figure 8-26 shows the top of the two 5,000 gallon receiver/reuse tanks. The bottom of the evaporator that extends to the 332-foot level is behind the tanks.

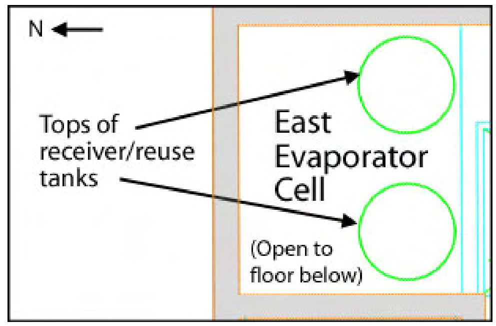


Figure 8-25. East Evaporator Cell, 319-Foot Level

Figure 8-26. Photo H2-34b, 319-Foot Level East and West Receiver Tanks, undated

Table 8-19 presents a summary of radiological survey data available for the H2 319-foot level East Evaporator Cell.

Table 8-19. H2 319-Foot Level East Evaporator Cell Radiological Survey

Date/Area	Visual Impressions	Summary Findings	Reference
10/5/04 319' East Evaporator Area	None	Contamination survey results: <450 pCi beta-gamma Radiation survey results of various readings around the area: <0.2 mRem /hr, 0.3 mRem)/hr, 1.8 mRem /hr, 0.5 mRem /hr, and 6 mRem /hr	R-000525

8.2.7 RADIOACTIVE LIQUID WASTE REUSE SYSTEM

The Demineralization Process System in Building H2 became operational in 1977 (R-000255) and is in current use for processing radioactive liquid waste from the Radioactive Materials Laboratory. In the past, it also processed liquid waste from non-SPRU KAPL laboratories including E1, D3, D4, and G1 until 2002, when the waste was rerouted to a new system in Building E11. The radioactive liquid waste reuse system is a "closed" process. Radioactive liquid waste collected in the 10,000-gallon former evaporator storage tanks (normally the South Tank) on the 309-foot level is processed through ion exchange beds and returned to the Radioactive Materials Laboratory.

The two evaporators were used to reduce radioactive liquid waste volume prior to solidification for disposal. Currently, two 5,000-gallon stainless storage tanks formerly used for evaporator condensate storage on the 309- and 319-foot levels are also used for waste processing purposes. Ion exchange resin beds are periodically disposed as low-level solid waste (I-000418). Figure 8-27 is a photo of the ion exchange resin tanks extending from the 309- to the 319-foot level.

Figure 8-27. Photo H2-58b, Radioactive Materials Laboratory Reuse System Ion Exchange Tanks, 309- and 319-Foot Levels, undated

8.3 H2 Building 332-Foot Level

The H2 332-foot level has east and west building areas. The east side of H2 contains the main building access, Control Room, Change Rooms, Former Sampling Corridor, Radiological Entry Control Room, and East Evaporator Cell. The west side contains the building Ventilation System, Hillside Drain Treatment System, Neutralizer Cell hatch covers, and the West Evaporator Cell. The Slurry Drum Facility is located on the 332-foot level outside of the East Evaporator Cell. The H1 Cooling Tower and Pump House are outside of H2 to the north of the Slurry Drum Facility. Figure 8-28 represents the 332-foot level floor plan.

Current radiological conditions for 332-foot level are based on the 1989 or the 2004 survey and are presented in Figure 8-29. Terms used in the figure are defined in Table 5-1.

In the 2004 survey of the restrooms and clothing change area, the contamination survey identified less than 450 picoCuries (less than 999 disintegrations per minute) beta-gamma and less than 50 picoCuries (less than 111 disintegrations per minute) alpha. Additionally, less than 0.2 milliRem per hour identified in the radiation survey (R-000525). Based on this survey, the restrooms and clothing change area do not meet the criteria for a radiation or contamination area.

In the 2004 survey of the west evaporator bay, radiation survey results ranged from less than 0.2 to 10 milliRem per hour. Contamination surveys identified less than 450 picoCuries (less than 999 disintegrations per minute) beta-gamma and less than 50 picoCuries (less than 111 disintegrations per minute) alpha (R-000525). Based on this survey, the west evaporator bay is characterized as a radiation area.

A 2004 survey of the general area identified less than 450 picoCuries (less than 999 disintegrations per minute) beta-gamma contamination and less than 50 picoCuries (less than 111 disintegrations per minute) alpha contamination. Radiation survey results ranged from less than 0.2 to 8 milliRem per hour in the area (R-000525). Based on the 2004 survey, the general area is characterized as a radiation area.

A 2004 survey of the 332-foot level corridor identified less than 450 picoCuries (less than 999 disintegrations per minute) beta-gamma contamination and less than 50 picoCuries (less than 111 disintegrations per minute) alpha contamination (R-000525). Based on the results of this survey, the 332-foot level corridor is not a contamination area. The extent of radiation (dose to individuals recorded in Rem per hour) could not be assessed as the 2004 survey included measurements for contamination only. Further characterization is recommended for this area to assess the extent of radiation.

No current survey information was identified for the east evaporator bay, standby laundry, or office/classroom areas. Characterization is necessary to assess the radiological condition of these areas.

8.3.1 CONTROL ROOM

Building H2 is entered from the southeast corner onto the 332-foot level, directly into a Control Room extending the entire north-south length of the building. The Control Room contains instruments and electrical panels (Figure 8-30). The Change Rooms are accessed from the Control Room corridor. They were modified to include an office, Contaminated Change Room, Clean Change Room, restrooms, and standby laundry facilities. Figure 8-31 is a 2004 photo of the Control Room looking north from the Building Access Door.

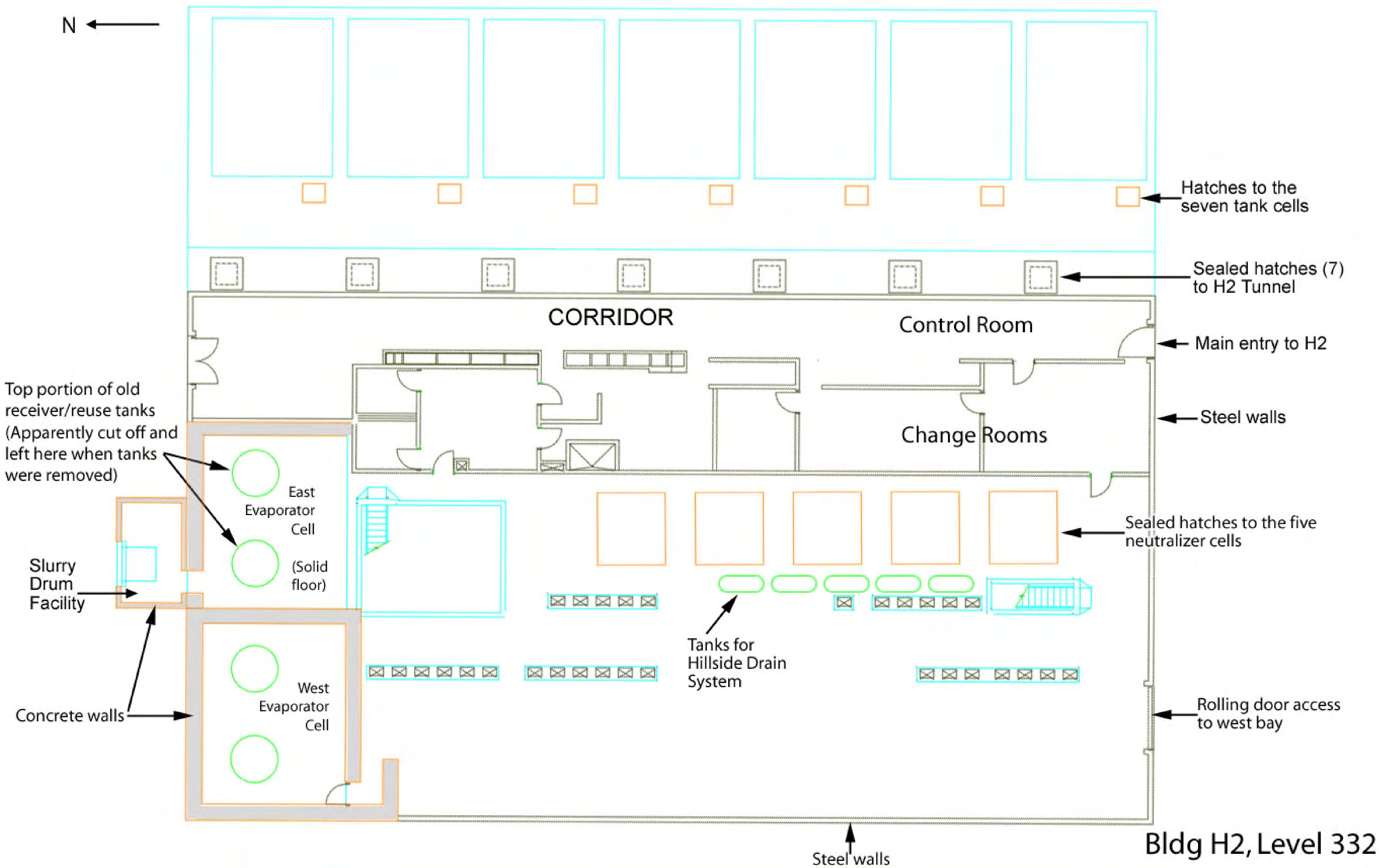


Figure 8-28. Floor Plan for 332-Foot Level

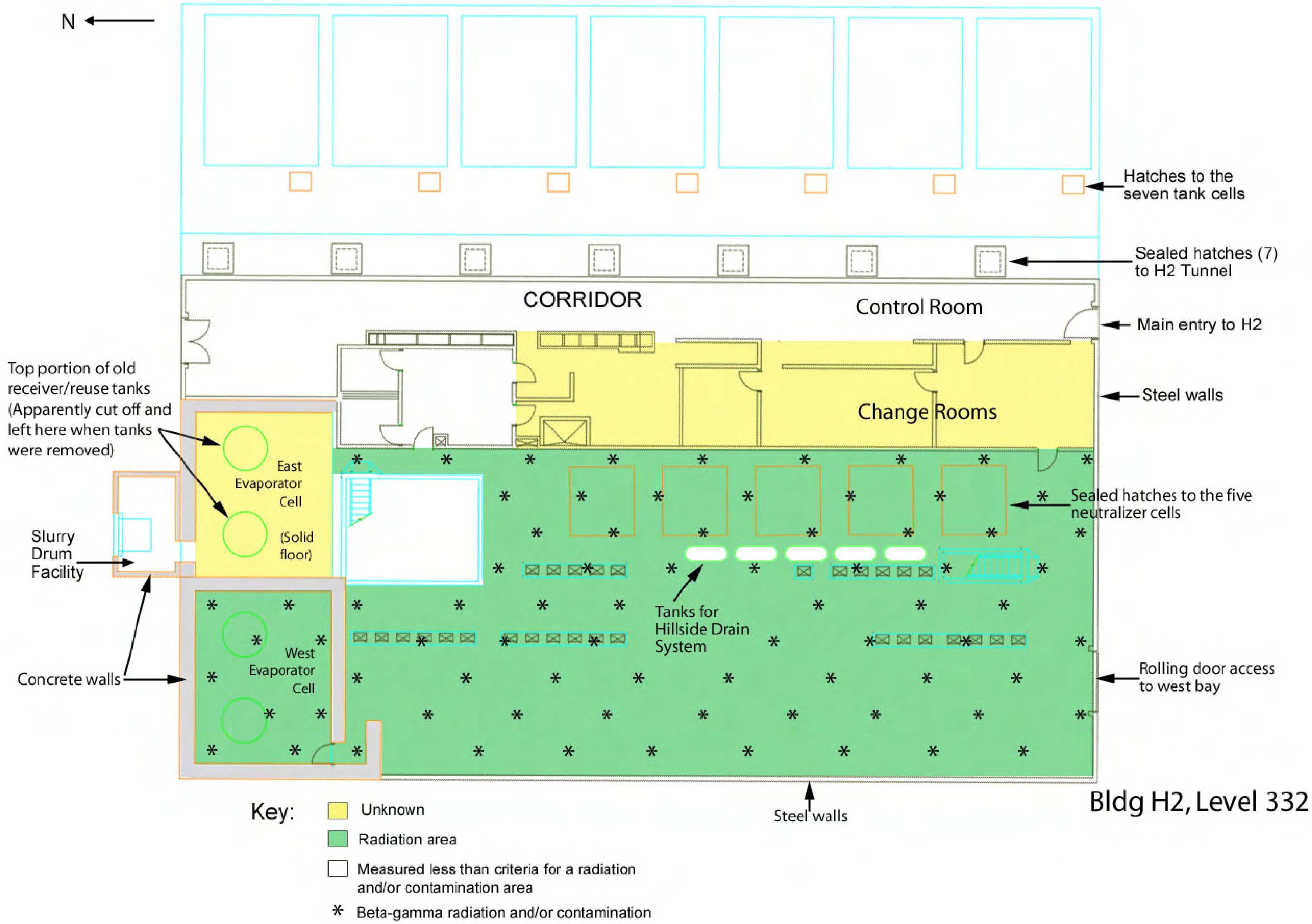


Figure 8-29. Current Radiological Conditions for the 332-Foot Level

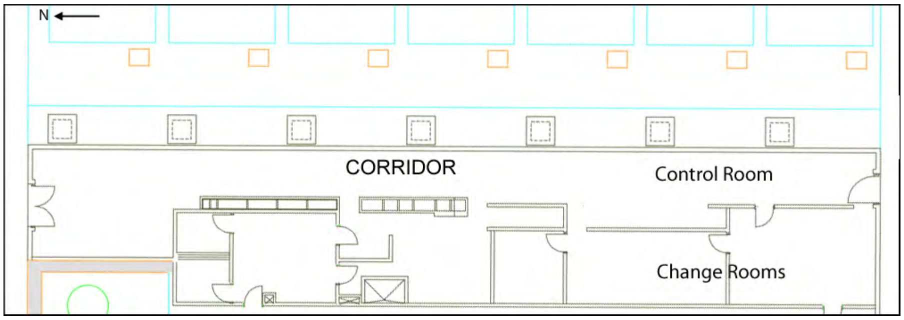


Figure 8-30. Control Room and Change Rooms, 332-Foot Level

Figure 8-31. Photo H2-65, H2 Control Room and Entryway, 332-Foot Level, undated

The Building H2 332-foot level was designated as a Controlled Surface Contamination Area on May 3, 1979. Subsequently, it was decided that gaskets should be installed on the collection tanks used for collecting water from the Hillside Drain System and the tanks sealed. During a survey performed prior to gasket installation, loose beta-gamma contamination of 675 picoCuries per 100 cubic centimeters was discovered on the middle collection tank at the gap between the tank and the cover. Direct measurements indicated 11,250 picoCuries of fixed beta-gamma radioactivity in the rust and mineral deposits. It was believed that the source of the contamination was hillside sump water splashing into the area in small quantities and evaporating, resulting in buildup of contamination over several years. Over the preceding several years, beta-gamma radioactivity levels in the sump water had ranged from 7.0×10^{-7} to 8.0×10^{-5} microCuries per milliliter. It was suspected that eleven additional loose surface contamination areas (missed during the original area release survey) resulted from releases due to leaching, vibration, or abrasion in localized contamination areas (C-000860, Attachment 1, Radiological History for H2).

8.3.2 Change Rooms

The Clean Change Room and Contaminated Change Room and bathroom facilities are located west of the Control Room on the south side of H2.

Table 8-20 presents a summary of radiological survey data available for the H2 332-foot level Change Room.

Table 8-20. H2 332-Foot Level Change Room Radiological Survey History

Date/Area	Visual Impressions	Summary Findings	Reference
10/4/04 Change Area	None	Contamination survey results: <450 pCi beta-gamma, <50 pCi alpha Radiation survey results near waste and anti-c bins: <0.2 (mR or mRem)/hr open window/closed window	R-000525

8.3.3 Former Sampling Corridor

In 1966, the west side of the former H2 Control Room Sampling Corridor was combined into one room and tile was removed from the floor. Fixed contamination remained at former sample unit locations and liquid level gauge lines following the renovation. The swipes measured less than 50 picoCuries per 100 square centimeters alpha and less than 450 picoCuries per 100 cubic centimeters beta-gamma (C-000122, p. 1).

8.3.4 Evaporator Cells

The East Evaporator Cell, like the West Evaporator Cell, extends from the 309-foot level to the 332-foot level (Figure 8-32).

Figure 8-33, Photo H2-24 shows the East Evaporator Bay current conditions upon exiting the 332-foot level Radiation Control area heading toward the stairs leading down to the 319-foot level.

Table 8-21 represents radiological data from the 2004 survey.

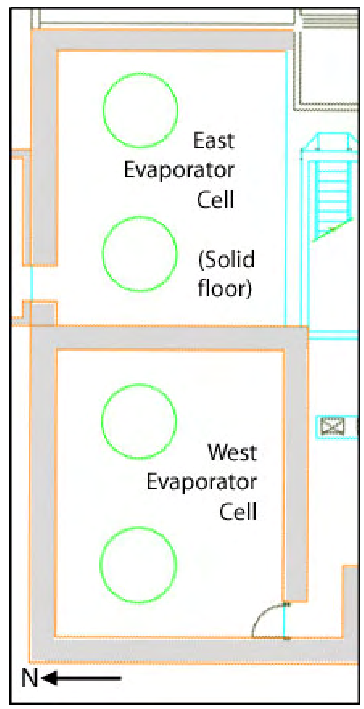


Figure 8-32. East and West Evaporator Cells, 332-Foot Level

Table 8-21. H2 332-Foot Level West Evaporator Bay Radiological Survey

Date/Area	Visual Impressions	Summary Findings	Reference
10/4/04 332' West Bay	None	Contamination survey results: <450 pCi beta-gamma, <50 pCi alpha Radiation survey results of various readings around the bay: <0.2 mRem /hr, 1.6 mRem)/hr, 0.8 mRem)/hr, 2.5 mRem /hr, 1.0 mRem /hr, 4.2 mRem /hr, and 10 mRem /hr	R-000525

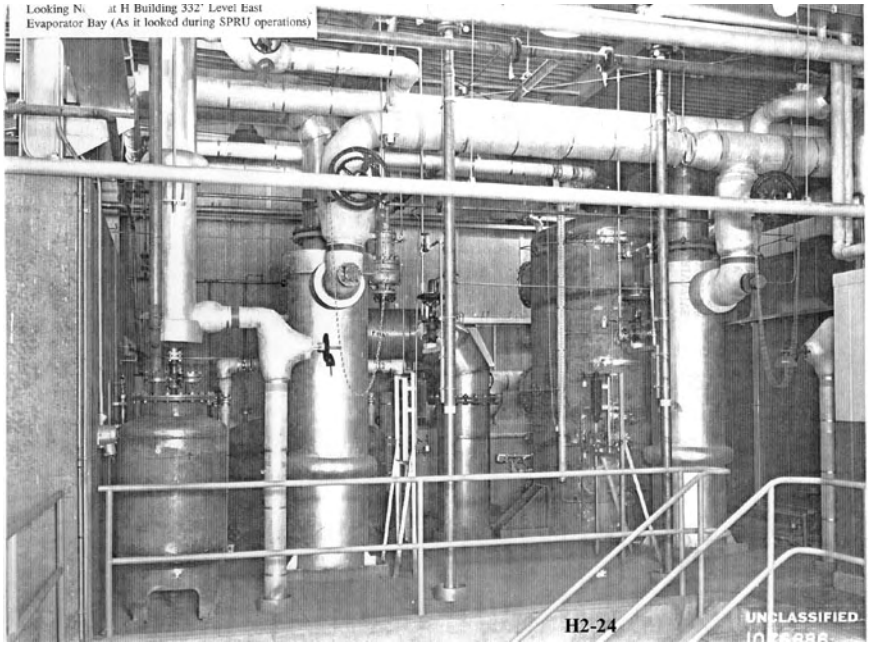


Figure 8-33. Photo H2-24, East Evaporator Bay, 332-Foot Level, undated

8.3.5 VENTILATION SYSTEM (WEST SIDE)

Heating of the H2 levels is maintained for personnel comfort and to prevent utilities from freezing. A HEPA-filtered ventilation system keeps Building H2 and the adjoining Tank Farm and connecting tunnel at a negative pressure relative to surrounding areas. In the mid-1960s, redundant ventilation filters and ductwork were removed to create more space for waste management activities. Approximately half of the HEPA filter exhaust system capacity was removed to gain more usable workspace on the 332-foot level. The filter banks removed were redundant systems, serving operationally inactive areas such as the neutralizer cells and pipe tunnels. Currently, the H2 exhaust ventilation system, which also exhausts the tank vaults and tunnels, consists of 16 HEPA filters in parallel and two exhaust blowers. One exhaust blower is normally used and the other remains in standby mode.

The Building H2 exhaust blower maintains controlled direction airflow into the H2 process areas. Air enters Building H2 at the 332-foot level and flows down the lifting shaft to the 319-foot and 309-foot levels. Air from the manned spaces of the 310- and 309-foot levels flows to ventilator ductwork in the areas exhausted at those levels. The exhaust ducts are connected to the HEPA filters and exhaust fan on the 332-foot level and exhaust to the atmosphere.

Air is drawn through ductwork at the 319-foot level of the H2 tunnel into the four parallel HEPA filters on the 332-foot level of H2, and into the exhaust blowers and the H2 exhaust stack. Two exhaust blowers are available with one normally in use and the other always on standby. If a blower fails, the standby exhaust blower starts automatically after 3 to 5 minutes. The capacity of the system is 22,000 cubic feet per minute with one exhaust blower in operation; normal flow is 10,000 cubic feet per minute. Sixteen HEPA filter units are in a system (some in parallel) that exhausts the waste storage tank vents, tunnels, the upper and lower drum dryer rooms, evaporator bays, and the solid waste compactor area. The exhaust suctions from the neutralizer cells are capped and the cell doors are closed.

8.4 Hillside Drain Treatment System

The Hillside Drain Treatment System consists of a series of footer drains constructed of vitrified clay pipe with open joints around the Building H2 perimeter (C-000197). It includes process equipment located in the west bay area of H2 (Figure 8-34), which connects to the hillside sump below the northwest corner of H2 on the lower hillside. Contaminated water is pumped back to H2 for processing and discharge.

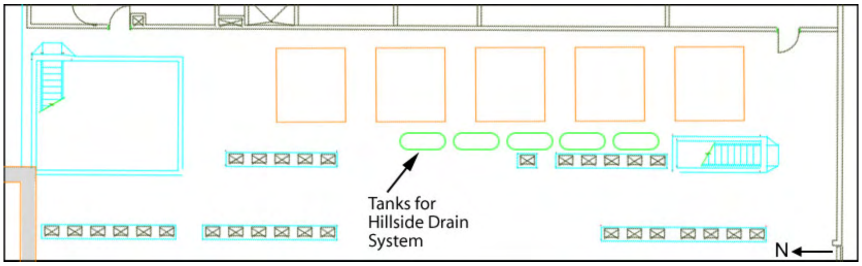


Figure 8-34. Hillside Drain System, 332-Foot Level

In 1979, KAPL conducted an extensive radiological surface survey of the west side (to approximately 35 feet from the security fence) and the north side of H2 (to approximately 35 feet from the building) attempting to identify and then reduce the contamination entering the system. Areas reading greater than background were noted. The area surrounding the hillside sump was also surveyed and no activity above background was observed. Subsequent core boring on the north, south, and east sides of the hillside sump confirmed that subsurface soil activity was less than the release limits for soil at that time (C-000429, p. 2)

The water originates from both surface water and groundwater percolation into the H2 footer drains (C-000429, p.1). In 1983, KAPL conducted a study to determine if they could reduce the amount of water being processed by the system. The report from this investigation cited that in 1982, 80,700 gallons of water were pumped and processed, 45% attributable to surface water and 55% attributable to groundwater. KAPL planned to eliminate the surface water portion by placing a tarp around the north, west, and east sides of H2. The source(s) of contamination was still unknown at that time (C-000154).

In 1989, KAPL conducted a historical documentation study and performed interviews in an attempt to determine the source(s) of contamination and volume of water in the footer drain system requiring treatment. In this study, they discounted the footer drains as the contamination source and identified the extensively torn tarp as the cause for water infiltrating into the system (C-000197).

The drain system was modified in 1989 to utilize five 1,000-gallon tanks located along the north-south building centerline and a process train along the north wall. Water from the hillside sump is pumped into three tanks. The raw water is pumped through the ion exchange process train to two tanks and sampled, verified, and discharged into the sewer system. Ion exchange resin beds are periodically disposed as low-level solid waste. This system will remain in operation until Building H2 decommissioning. Table 8-22 identifies available historical Hillside Drain System data.

Table 8-22. Hillside Drain Volume and Unprocessed Beta Activity (R-000432, R-002212)

Year	Number of Discharges	Gallons Collected and Discharged	Unprocessed Raw Feed (µCi/ml x 10^{-5})
1983	Not counted	75,000	.5
1984	Not counted	90,000	.5
1985	Not counted	65,000	2.2
1986	Not counted	120,000	4.0
1987	Not counted	90,000	4.5
1988	Not counted	65,000	2.3

Year	Number of Discharges	Gallons Collected and Discharged	Unprocessed Raw Feed (µCi/ml x 10^{-5})
1989	Not counted	85,000	1.4
1992	71	63,900	1.09
1993	86	77,400	.68
1994	139	125,100	.69
1995	64	57,600	.67
1996	89	80,100	.7
1997	68	61,200	.58
1998	74	66,600	.46
1999	77	69,300	.98
2000	86	77,400	.56
2001	76	68,400	.77
2002	98	88,200	.4
2003	128	114,750	.44
2004	98	81,100	.75
2005	111	88,800	.78

Figure 8-35 is a photograph showing Hillside Drain Treatment System tanks. The ventilation system is in the background, and a hatch cover is in the foreground.

Figure 8-35. Photo H2-76, Hillside Drain System Tanks and Neutralizer Hatch, undated

8.4.1 HATCH COVERS TO NEUTRALIZER CELLS

Figure 8-36 is a view of the 332-foot level Neutralizer Cell concrete hatch covers (circa 1965). Figure 8-37 is a view of a Neutralizer Cell as seen from a 332-foot level open hatch. Figure 8-38 is a photograph showing a current hatch cover.

Figure 8-36. Photo H2-86, Removing Neutralizer Cell Access Hatch at the 332-Foot Level, undated

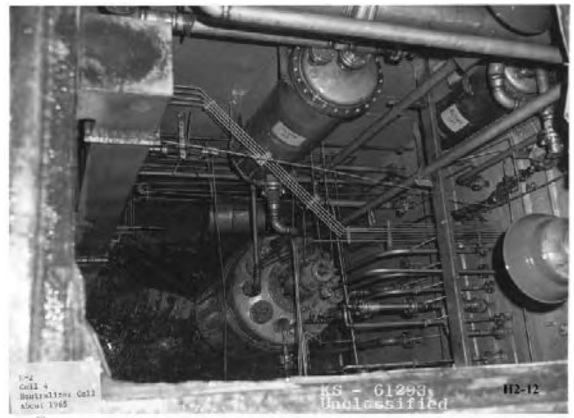


Figure 8-37. Photo H2-12, Cell 4, Neutralizer Cell (Circa 1965), undated

Figure 8-38. Photo H2-89, Hatch Cover, undated

8.4.2 West Evaporator Cell

The West Evaporator Cell area, which has not been modified since SPRU decommissioning, extends from the 309-foot level to the 332-foot level. No photographs of the West Evaporator Cell are available.

While performing a routine weekly survey of the Building H2 332-foot level west bay between September 20 and September 21, 1983, a radiological controls technician measured 5,400 picoCuries beta-gamma activity on a large area swipe and 1,800 picoCuries beta-gamma activity on a 100 cubic centimeter swipe. The contamination was on a pipe and flange connecting a pressure gauge to the unused west evaporator flash tank. The area had been de-posted in December 1981; this was the first time loose surface contamination had been detected in the area since de-posting. Two unused evaporator flash tanks were in the area; available floor space was used for storing higher dose rate radioactive waste prior to shipment and locked when unoccupied. The general west bay dose rate was 2 to 3 milliRem per hour and the evaporator flash tank dose rate was 10 to 20 milliRem per hour at contact. Of approximately 20 swipes taken on flanges, pipes, and joints associated with the evaporator flash tanks, one swipe in the gap between flanges measured 4,500 picoCuries beta-gamma per 100 cubic centimeters (C-000860, Attachment 1, Radiological History for H2).

8.4.3 SLURRY DRUM FACILITY

The Slurry Drum Facility is adjacent to the East (Cold) Evaporator Cell, attached to the north side of Building H2 exterior. The facility received slurry from the evaporator area for holding and transfer to storage facilities or disposal. Figure 8-39 shows the Slurry Drum Facility.

Figure 8-39. Photo H2-144, Slurry Drum Facility, North Side of H2, June 23, 2004

8.4.4 H1 COOLING TOWER

The Cooling Tower was originally used for H2 SPRU evaporator units and later provided cooling water to the KAPL computer facility and F Building closed-circuit cooling units. It was permanently shut down in 1992. KAPL periodically empties the rainwater basin and pumps the water into the river. Figure 8-40 is a plan drawing of the Cooling Tower and Pump House.

Hagatreat, a chromate-based water treatment, was used in the Cooling Towers until the 1970s. Since then, chemicals used for treating cooling water included sulfuric acid Baume 66 degree, Mogul sodium hypochlorite AS 494, HTH chlorine, and Mogul PC 122 phosphate for corrosion control. Preventative maintenance was performed about every 5 years.

The Pump House contains 300 feet of asbestos lagging for thermal insulation around tanks. It has not been determined if the Pump House siding or the material on the inside of the Cooling Tower contains asbestos.

KAPL considers the Cooling Tower a facility that requires Radiological Engineering evaluation for work other than minor renovation. Justification for this status involves the potential presence of radioactivity on the facility structures from weapons testing not related to KAPL or SPRU activities, and potential for the migration of contamination from surrounding soil areas into the tower basin (R-000413, p. 2).

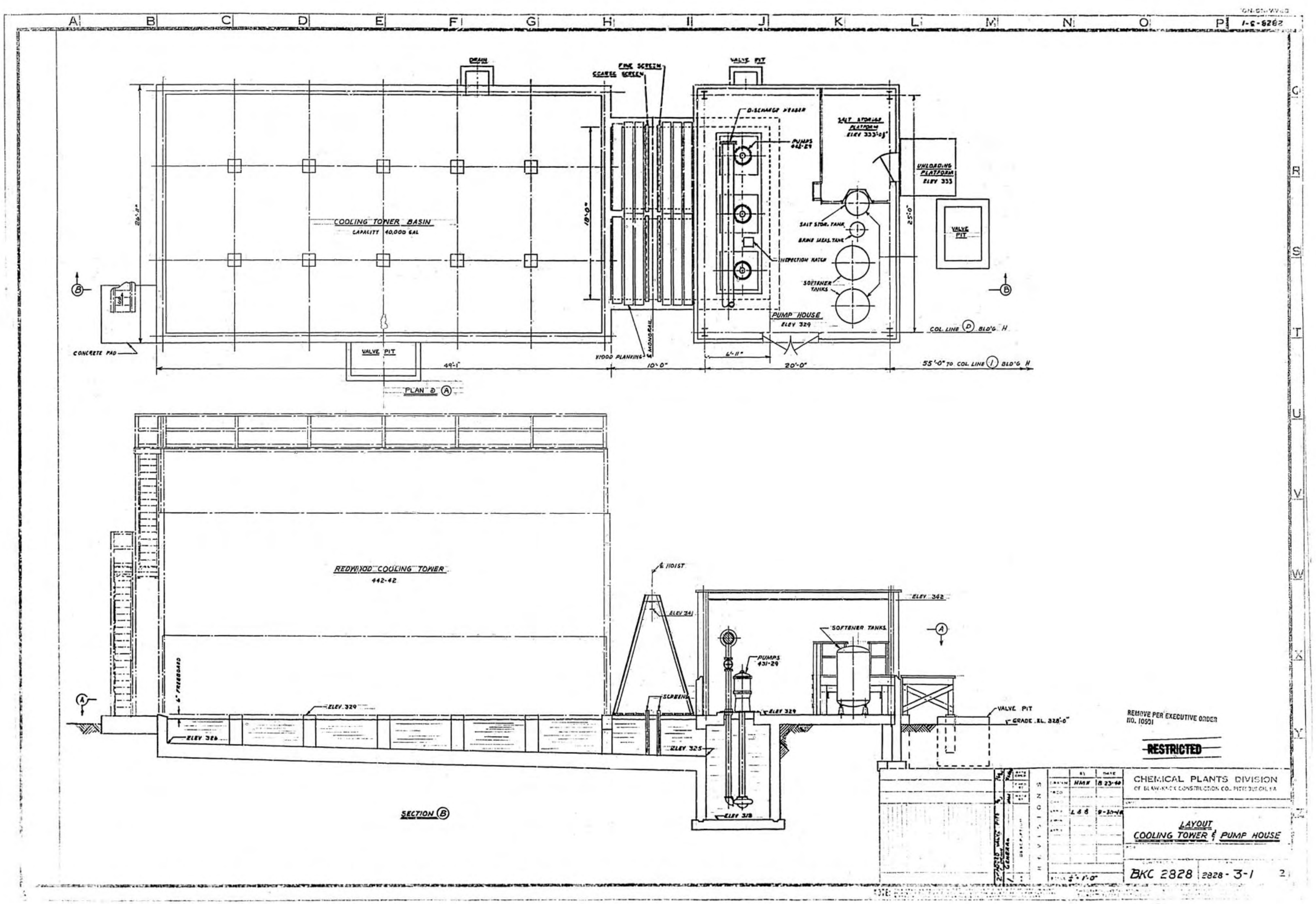


Figure 8-40. Drawing No. 2828-3-1, Cooling Tower and Pump House, August 23, 1948

8.5 H2 Sumps

Table 8-23 summarizes the sumps in H2.

Table 8-23. H2 Sumps

Location	Notes and References
H2 All cells	All cells in H2 have sumps (R-000164, p. 4). The floors slope towards the sumps so that materials from tank leaks, vessel overflow, condensate from pressure lines, seepage of ground water, etc., will be collected and pumped or jetted through the sump header to one of the waste-storage tanks (509D, E) (R-00034, p. 65).
H2 Basement area tunnels	All radioactive utilities are distributed through reinforced concrete tunnels in the basement area containing sump pumps (C-000014, p. 5).
H2 Neutralizer Cells 1-5, 308-Foot Level	H2 Neutralizer Cell No. 1, southwest corner (Drawing H309rev1LT.dwg) H2 Neutralizer Cell No. 2 northwest corner (Drawing H309rev1LT.dwg). The Cell 2 sump pump was found running during the 1989 inspection (C-000198, p. 4) H2 Neutralizer Cell No. 3, southwest corner (Drawing H309rev1LT.dwg) H2 Neutralizer Cell No. 4, northwest corner (Drawing H309rev1LT.dwg) H2 Neutralizer Cell No. 5, southwest corner (Drawing H309rev1LT.dwg)
H2 East Evaporator Bay	A sump exists in the northwest corner (Drawing H309rev1LT.dwg)
H2 North Hopper Cell	North Hopper Cell (308-Foot Level). The sump is covered with a stainless steel enclosure and is not visible (C-0000198, p. 3; R-001949, p. 126). The sump is in the northeast corner (Drawing H309rev1LT.dwg).
H2 Pipe Tunnel	There is a sump pump in the Pipe Tunnel (R-000164, p. 4).
H2 South Hopper Cell, southeast corner	South Hopper Cell (308-Foot Level). The floor sump was dry during the 1989 inspection (C-000198, p. 4).
H2 West Evaporator Bay, southeast corner	West Evaporator Bay (308-Foot Level). The sump pump in this area was not operating during the 1989 inspection (C-000198, p. 2).
Pump House	Cooling water is collected in a concrete basin below the tower. From the basin, the water flows through screens into a sump below the pump house. Pumps then circulate the water from this sump to a header that supplies G-2 and H buildings (R-000036, p. 56).

8.6 Findings

Data Gaps

The 1989 H2 inspection and radiological survey provide the best characterization and representative of current conditions in the accessible areas (C-000198). The former North Drum Dryer Cell was not accessed during the inspection. Some radiological constituents such as strontium-90 (half-life = 29 years) and cesium-137 (half-life = 30 years) have decayed since 1989. For most of the actinides, however, the half-lives are long enough that it can be conservatively assumed that the 1989 survey results are approximately the current conditions.

The 1989 survey results and overall SPRU buildings and tunnel status was documented in the 1992 KAPL report, *Preliminary Assessment of SPRU* (R-001949). Edited videotapes augment this report. The 1992 report is comprehensive regarding SPRU and H2 history and descriptions of observations during the inspection and laboratory analyses appear accurate with respect to current observations and interviews.

Impacted and Non-Impacted Areas

MARSSIM defines impacted areas as those with a reasonable possibility of containing residual radioactivity in excess of natural background or fallout level (MARSSIM Glossary, G1-10). Applying this definition, all H2 areas except the 332-foot level entryway are considered impacted and are under radiological controls. These areas were identified and described relative to the potential for contaminant migration

Determination of the origin of Building H2 contamination is based on evidence that radiological contamination occurred from SPRU activities; post SPRU cleanup activities, and non-SPRU related

KAPL activities. It is apparent that KAPL used the H2 waste management facility for non-SPRU related activities both during and after SPRU decommissioning. The 1989 survey results and interviews with KAPL personnel indicate that the Neutralizer Cells, North Hopper Cell, Evaporator Storage Tank Area, and the Pipe Tunnel are high radiation areas. Contamination in some 309- and 319-foot levels areas consists of loose surface particulate contaminated material. Most H2 radiological contamination is from fission products; the remainder is from actinides.

Except for the H2 entryway the entire H2 facility is a radiological controlled area because at least low levels of loose or surface contamination pervade the facility. The currently operating radioactive liquid waste reuse system and the Hillside Drain System also affect the H2 facility radiological status. Most 309-foot level areas have radioactive contamination and/or loose particulate contamination, including:

- Evaporator Storage Tanks A525-A, A525-B, and A525-C, currently used for the radioactive liquid waste reuse system and periodic draining of Tank Farm vaults.
- The 309-foot level Evaporator Storage Tank Bay area, with seven 55-gallon drums and a long wood crate that contains irradiated components, covered in a layer of radioactive loose particulate matter.
- The North Hopper Cell, where coatings of dried radioactive slurry or other similar matter cover large portions of the floor. Analysis indicates the dried slurry consists of salts of various radioactive elements such as plutonium, uranium, and cobalt, verified in an interview with a KAPL employee who inspected the cell (I-000423). Bases of steel vertical I-beams visible in the video appear to be corroded (C-000198).

Building H2 309-foot level areas with radiological contamination include:

- The 309- to 332-foot level West Evaporator Bay contaminated with fission products and actinides. The base of the evaporator has minor accumulation of evaporated slurry.
- The 309-foot level H2 Pipe Tunnel contaminated with a layer of radioactive loose surface particulate matter.
- The 309- to 332-foot level East Evaporator.
- All of the 309-foot Neutralizer Cells.

Figure 8-41 is a 1997 photo of waste drums stored in H2 on the 309-foot level near the entrance to the pipe tunnel.

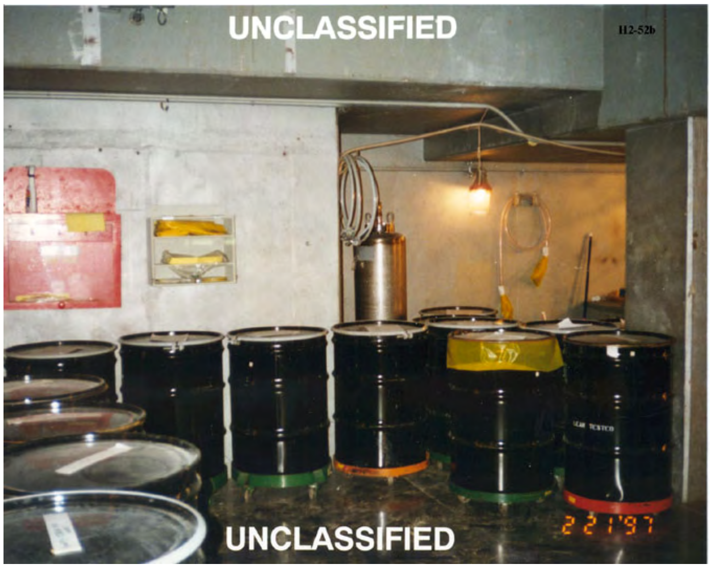


Figure 8-41. Photo H2-52b, 309-Foot Level Viewing the North Door and Waste Drums, undated

H2 319-foot levels impacted areas include:

- The RW Cell (originally the North Drum Dryer Room) which was decontaminated when it was decommissioned but was not surveyed in 1989. No survey data substantiates this (I-000426). The RW Cell has always been a restricted area. The outside wall of the cell is covered with an extra layer of magnetite brick, which is typically used as radiological shielding for high-energy gamma radiation. It is not known if the work conducted there was SPRU-related.
- The South Drum Dryer Room which was decontaminated and only loose surface contamination currently exists. The room is blocked from non-essential entry.
- A SPRU control panel with numerous mercury gauges on the south side of the 319-foot level.

Other 319-foot level areas with contamination from fission products and actinides are currently used for the Radioactive Materials Laboratory radioactive liquid waste reuse system. If a decision is made to decommission and/or demolish Building H2, the system will be shut down. Characterization of the radioactive liquid waste reuse system components will be possible at that time.

The Building H2 332-foot level west portion is dedicated to processing water collected from the Hillside Drain System. If H2 is demolished, the Hillside Drain System radioactive liquid waste reuse system will be shut down and the system characterized and removed.

The east side of the 332-foot level contains the main Control Room that has numerous mercury gauges but is otherwise uncontaminated.

Sources of Contamination

The radiological signature of materials found in contaminants is typical of the SPRU process, but also of many of the activities conducted in other on-site laboratories that reportedly used the H2 facility from 1950 through 2004, generating waste after SPRU was decommissioned in 1953. The radiological evidence does not support direct differentiation between sources of contamination, although the evidence indicates other laboratory waste as possible contamination sources in addition to SPRU.

Table 6-2 and Table 6-3 summarize the radiological and chemical materials used during SPRU research activities or identified in historical survey data. Although decontamination and cleaning activities since 1954 removed much contamination, radiological and chemical hazards remain. Potential contaminants revealed through document review are identified in sections describing process areas and other spaces.

Although potential contamination sources remain in H2, structural integrity, original protective design features (e.g., stainless steel floors in cell areas), isolated ventilation systems, and surveillance and maintenance activities reduce the likelihood of contamination spreading from contaminated areas.

Chemical hazards such as asbestos remain in H2. Chemical hazards may remain in process vessels, equipment, ventilation, chemical feed lines and valves, drains, and sumps.

Building H2 construction materials that are potential contamination sources include:

- Asbestos-containing materials – transite concrete structure, flooring, ceilings, walls, jacketed vessels and piping, roofing, sealant, noise-dampening equipment, and mastic
- PCBs – Fluorescent light ballasts and paint may contain PCBs. A PCB survey of the building has not been conducted
- Lead – Lead-based paint and shielding
- Mercury – Fluorescent light tubes, Mercoid switches, and other meters and equipment.

Likelihood of Contamination Migration

Presently, contamination migration from the H2 facility is unlikely as long as it is maintained as a radiation control area. Contamination is contained within primarily stainless steel system components or as loose and surface contamination contained in the H2 concrete structure. H2 foundation walls are at least 2 feet thick and sumps are stainless steel-lined. Videotaped building inspections and other surveillance and maintenance inspections document the flooring material integrity. Continued surveillance and maintenance and corrective actions for building floor deterioration indicate a low likelihood of contaminant migration from the building.

Negative pressure maintained by a filtered ventilation system designed to keep airborne contamination inside H2 provides protection against airborne releases. The ventilation system is monitored by the KAPL environmental monitoring program and includes alarms to provide indication of containment integrity (R-000164, p. 2).

Threat to Human Health

Threat to human health from H2 is primarily to workers currently working in the radioactive liquid waste reuse system or the Hillside Drain System, and workers involved in future decontamination and decommissioning activities. The public human health threat is extremely low because H2 contamination is being, and will continue to be contained.

Further Characterization Needs

The following areas and equipment are recommended for further characterization prior to remedial design:

- H2 South Tank (A525-A) 10,000-gallon tank that has high dose rates at the midpoint and accepts Radioactive Materials Laboratory discharge into the radioactive liquid waste reuse system
- Middle (A525-B) and north (A525-C) 10,000-gallon Tank Farm tanks
- H2 east-west receivers (Tanks 518A and 518B, both 5,000 gallons) that are used for Tank Farm pump down, receiving discharge from the three up-flow ion exchange columns
- Five neutralizer cells that were cleaned in the mid-1960s, but retain low to moderate activity levels according to the 1989 survey
- Tank A525-C
- Drums on the 309-foot level containing waste are stored near the north tank (A525-C)
- Plywood box on the 309-foot level approximately 14 to 15 feet long that was observed on the floor area next to the north and middle tanks (A525-B and A525-C). The box apparently contains refueling equipment
- Basement floor area adjacent to Tanks A525-A, A525-B, and A525-C
- Room on the 309-foot level below the former RW Cell that is reportedly covered with chemical salts associated with chromium and uranium
- H2 332-foot level east bay (not used since the 1960s and 1970s)
- West 319-foot level (not used since the 1960s and 1970s)
- 319-foot drum dryer room that was cleaned in the mid-1960s but still has low to moderate activity levels according to the 1989 survey
- Slurry Drum Facility
- H2 Pipe Tunnel and piping.

9 TUNNELS CURRENT CONDITIONS

A reinforced concrete pipe tunnel system transported liquid waste, process chemicals, and reuse water between the SPRU buildings, laboratories, equipment and nearby non-SPRU laboratories and buildings. This section describes current tunnel conditions, historical information, and survey findings.

The SPRU Nuclear Facility Disposition Project tunnels addressed in this chapter include:

- E1 Tunnels (north and south)
- G1 Tunnels (east and west)
- G2-H2 Tunnel (also called the Transfer Tunnel, Common Tunnel, Connecting Tunnel, and Under Road Tunnel)
- G2 Crossover Tunnel.

The following SPRU Nuclear Facility Disposition Project tunnels structure and radiological conditions are addressed in other sections:

- G2 Tunnels (G2 [East] Hot Tunnel and the G2 [West] Process Tunnel) – Section 7
- G2 Pipe Trench – Section 7
- H2 Pipe Tunnel – Section 8.

Figure 9-1 shows the current radiological conditions of the E1, G1, and G2-H2 tunnels. Table 5-1 defines the terms used in the figure.

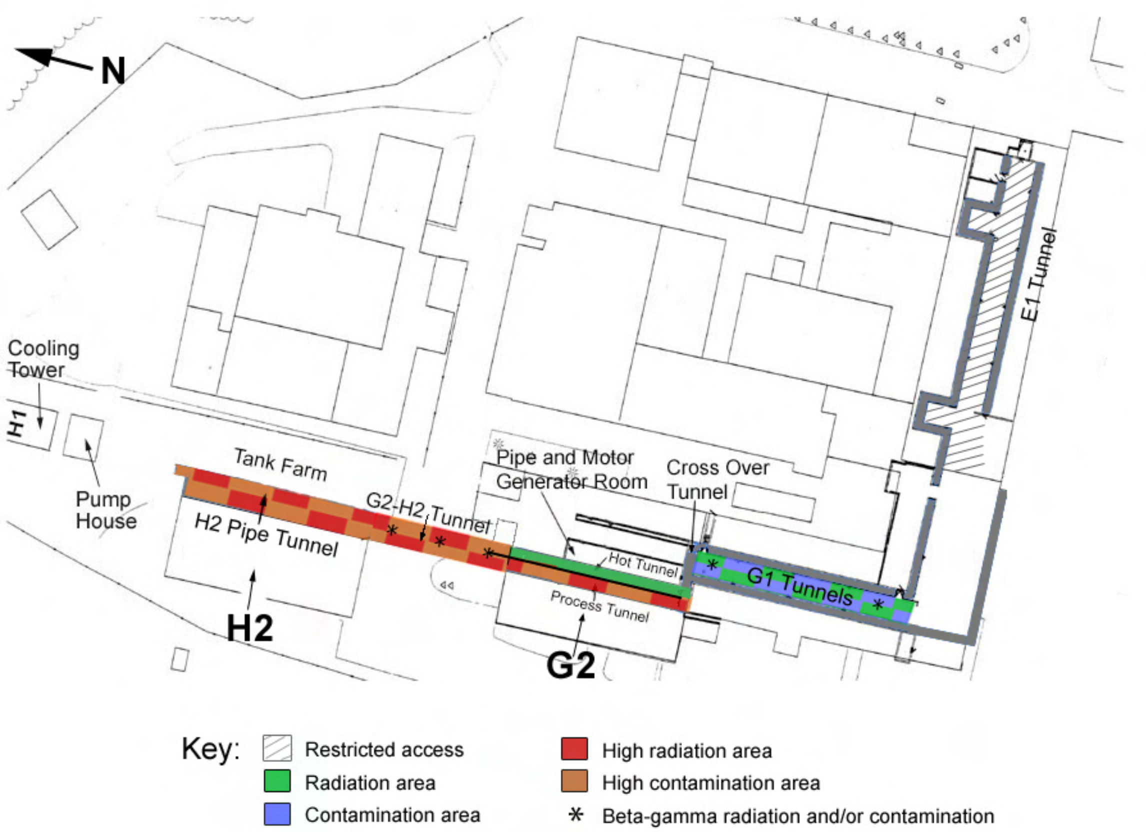


Figure 9-1. Radiological Status of the E1, G1, and the G2-H2 Tunnels (based on 1989 survey data)

The tunnels cannot be entered without dosimetry, protective clothing, and in some cases, supplied air. They are locked to control access, maintained under restricted radiological controls, and kept under surveillance and maintenance. A HEPA ventilation system maintains a negative pressure in the tunnels relative to surrounding areas. Tunnel areas remain contaminated with fixed and loose surface contamination. The G1, G2, and G2-H2 Tunnels were entered in 1989 and found to contain pipes and equipment in various configurations, including abandoned in place, removed, and some in current usage (R-001949, p. 79). The pipes include stainless steel waste lines and headers that collected liquid waste for transport to the H2 waste processing building, and process pipes that carried chemicals and water to equipment in the research laboratories. Fire protection lines, gas analyzer lines, and utilities are also located in the tunnels (C-000014).

The tunnels contain “interceptors,” which are 30- or 55-gallon vessels with sump pumps for collecting excess liquid waste or sludge. All but one of the original interceptors are disconnected and abandoned in place. The remaining one is located near the east end of the E1 Tunnel and reportedly contains radioactive sludge (I-000421).

Stainless steel sumps that collected liquids from pipe leaks or outside infiltration are also in the tunnels. The sumps were equipped with alarms to alert the control room of leakage (C-000014). G2 and G1 tunnel sumps were hard-plumbed and interconnected; during operations, liquids were pumped between sumps. Table 9-1 lists known tunnel sumps.

Table 9-1. Tunnel Sumps

Location	Notes and References
E1 Hot Tunnels	Sumps in the E1 hot tunnels are interconnected under the floors (I-000421). Lead shielding was added to the two interceptors, or drum drain traps, located in the eastern portion of the E1 Tunnel to lower the dose rates in the work area directly above the tunnel ceiling (C-000298, p. 1). These interceptors are 30-gallon drums with a sump pump.
Tunnel G1 West Tunnel	During the 1989 inspection a floor sump was sampled, producing 77,900 pCi/gm Cs-137, 54 pCi/gm Co-60, 440 pCi/gm Am-241, 124 pCi/gm, U-235 (R-0000114, p. 2).
Tunnel G1 to G2	A sump near the southwest corner of the tunnel between G1 and G2 is approximately 10 feet south of G2 (Drawing G-SF-1).
G2-H2 Tunnel	Nylabraid tubing between tank vaults and G2-H2 tunnel sump is still in place (I-000418, p. 1). Sump in G2-H2 Tunnel 2 was found to be very contaminated during the 1989 inspection; there is also a drain in close proximity to this sump that is highly contaminated (I-000418, p. 5). G2-H2 Tunnel is under surveillance and maintenance: video cameras monitored the tunnel expansion joint for ground water infiltration and the other monitored the sump at the north end of the tunnel for water accumulation (R-000255, p. 23). As of 2004 the cameras were not operational. A sump is located approximately in the center of the flat portion of the pipe tunnel. It is not known if the sump pump is currently (2003) operational (C-000997). General radiation readings were in the low range with readings on a floor sump (Note: The sump in the Hot Tunnel is located on the north side of the tunnel approximately 24 feet from Building H2 (Drawing G-SF-1, R-001949, p. 89).

9.1 E1 Tunnels

The E1 tunnels consist of two concrete pipe tunnels (process and hot). Tunnel walls, ceilings, and foundations are at least 1 foot thick reinforced concrete. The pipe tunnels are separated by a tunnel-aisle walkway to allow personnel access. Waste and process piping is mounted along the walls or suspended from ceiling supports. North and south tunnel and tunnel-aisle pipes are made of stainless steel (R-000255). Tunnel sumps are interconnected under the floors. Welded steel doors are located at the end of each tunnel. The E1 tunnels are under restricted radiological control access. Figure 9-2 is a plan view of the E1 Tunnel area. Figures 9-3 and 9-4 are photographs of the E1 welded steel door and radiological control warnings at the access to the tunnel aisle.

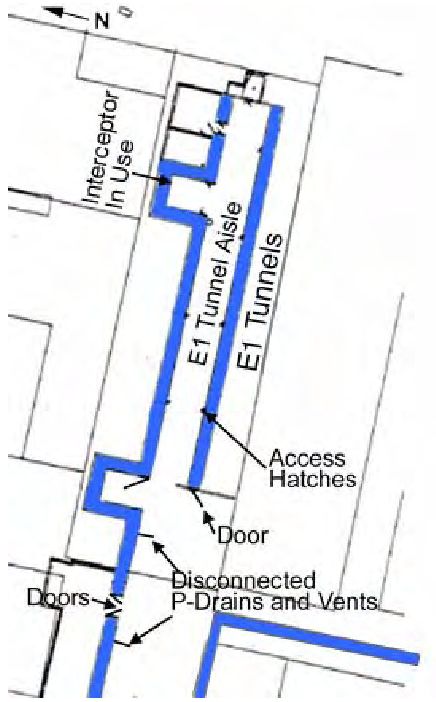


Figure 9-2. E1 Pipe Tunnel Plan Location

Buildings E1 and G1 are operating KAPL facilities and laboratories. Operational E1 and G1 tunnel pipes are used for liquid waste, water, and chemicals from Buildings E1, G1, and D.

The pipes are now routed to a new KAPL waste management facility in Building E11 that is not part of the former SPRU facilities, but waste from the Building E4 Radioactive Materials Laboratory radioactive liquid waste reuse system was sent through E1, G1, and G2 tunnel pipes for processing in H2 through the early 2000s (R-000255).

The Radioactive Materials Laboratory radioactive liquid waste reuse system was put in place in 1977 using the tunnel system to transport liquid waste from the Radioactive Materials Laboratory and the D, E, and G buildings to H2 for treatment and processing. This is a “closed loop” system where wastewater is treated in ion exchange resin columns in H2 and clean water is returned to the laboratories. Only the Radioactive Materials Laboratory currently uses the liquid waste reuse system.

In 1989, two waste interceptors (drum drain traps) from the Radioactive Materials Laboratory located in the eastern most end of E1 were surveyed and produced dose rates as high as 1.8 R. The interceptors are located under building E1 (C-000298). A tabulation of the survey results of the two tanks and associated equipment is presented in Table 9-2. Subsequent to the inspection, additional shielding was added to the interceptor system (C-000298).

Figure 9-3. Photo TNL-7, E1 North Side Tunnel Steel Door, 2004

Figure 9-4. Photo TNL-8, E1 Tunnel Aisle Entry, 2004

The 1989 E1 Tunnel radiological data presented in Table 9-2 is the most recent available.

Table 9-2. E1 Tunnel 1989 Inspection and Radiological Summary

Date	Area	Summary Findings (R-001949)
1989	Interceptor Tank #1 (near the most eastern portion of the tunnel under Building E1)	Radiation levels on contact (1st entry floats bottomed/2nd entry, tanks contained 8 inches liquid float indication): West side of tank – ---/10 mR (top); ---/24 mR (middle); ---/50 mR (bottom) South side of tank – 40/10 mR (top); 80/20 mR (middle); 500/1,200 mR (bottom) East side of tank – 20/10 mR (top); 100/25 mR (middle); 250/1,500 mR (bottom) North side of tank – 20/10 mR (top); 60/30 mR (middle); 100/1,500 mR (bottom) Tank top, west side – 10 mR (w/o shielding); 0.8 mR (w/shielding) Tank top, east side – 12 mR (w/o shielding); 1.2 mR (w/shielding) (C-000298, pp. 12, 22)
1989	Interceptor Tank #2 (near the most eastern portion of the tunnel under Building E1)	Radiation levels on contact (1st entry floats bottomed/2nd entry, tanks contained 8 inches liquid float indication): West side of tank – ---/10 mR (top); ---/25 mR (middle); ---/1,800 mR (bottom) South side of tank – ---/10 mR (top); ---/20 mR (middle); ---/40 mR (bottom) East side of tank – ---/10 mR (top); ---/25 mR (middle); ---/1,700 mR (bottom) North side of tank – 20/10 mR (top); 40/20 mR (middle); 40/900 mR (bottom) Tank top, west side – 15 mR (w/o shielding); 1.2 mR (w/shielding) Tank top, east side – 10 mR (w/o shielding); 1.5 mR (w/shielding) Tank bottom, east side – 1,700 mR (w/o shielding); 200 mR (w/shielding) (C-000298, pp. 12, 22)
1989	E1 Tunnel (near the most eastern portion of the tunnel under Building E1)	RML Ball Valve – 800 mR/hr (Teletector), 900 mR/hr (220A Shielded Tungsten) Inlet Line (hot spot) - 350 mR/hr (Teletector), 300 mR/hr (220A Shielded Tungsten) (C-000298, p. 21)

9.2 G1 East and West Tunnels

G1 West Tunnel piping transported liquid waste from the E1 and D4 interceptors through the G2 Hot Tunnel and into H2 waste processing tanks (Figure 9-5).

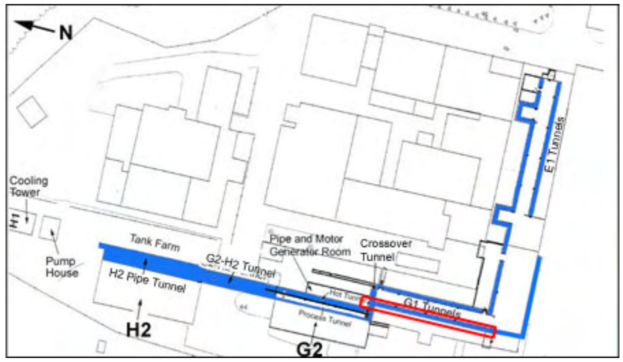


Figure 9-5. G1 West Tunnel

No tunnel aisle information has been collected to date beyond this point. Figure 9-6 shows a G1 West Tunnel door with caution labels. Steel access hatches along each process and hot tunnel are welded shut. Figure 9-7 shows a welded hatch in the G1 East Tunnel.

G1 drain lines had p-traps and vent lines that penetrated the tunnel ceiling. The vent lines have corroded. The p-traps, which are disconnected and capped, are in close proximity to the piping connection. They are approximately 6 inches high and potentially contaminated. Waste lines from the G1 West Tunnel to the G2 Hot Tunnel are cut and capped at the G1 basement wall. Figure 9-8 shows a G1 Capped Drain Pipe. A disconnected interceptor with two 55-gallon vessels is just inside the steel door shown in Figure 9-6. An interceptor placed in Tunnel G1 in the early 2000s is shown in Figures 9-9 and 9-10.

Figure 9-6. Photo TNL-3,
G1 West Tunnel Door, 2004

**Figure 9-7. Photo TNL-11,
G1 Tunnel Welded Hatch, 2004**

**Figure 9-8. Photo TNL-10a,
G1 Tunnel Capped Drain Pipe, 2004**

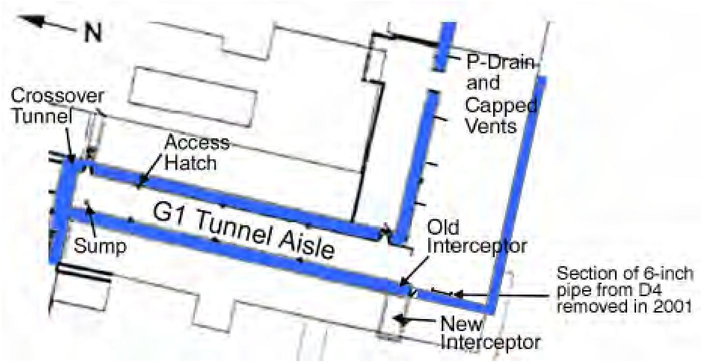


Figure 9-9. G1 Tunnel Showing New Interceptor Location

Figure 9-10. Photo TNL-16, New Interceptor Placed in G1 Tunnel, 2004

No G1 East Tunnel physical inspection or radiological survey data is available. The 1989 G1 West Tunnel inspection is the most recent physical and radiological information available; West Tunnel radiological survey findings are described in Table 9-3. It was noted during the inspection that the G1 West Tunnel floor was dry and no pipe insulation damage was evident. Miscellaneous tools and equipment from previous work remained at the south end of the tunnel. Lighting was operational in the north half of the tunnel (R-001949, p. 124).

Table 9-3. G1 West Tunnel 1989 Radiological Findings, 5/10/1989 to 6/15/1989

Summary Findings (R-001949, p 88)
General area radiation readings - <0.2 to 2 mRem/hr closed window and <0.2 to 7 mRem/hr open window
Localized readings of floor areas - up to 6 mRem/hr closed window and 36 mRem/hr open window
Over floor sump – 10 mRem/hr closed window and 20 mRem/hr open window
Loose surface alpha contamination of floor areas - <50 to 50 pCi/100 cm^2 due to Pu-238/239 and U-234 (as determined in Crossover Tunnel); however, radiochemical analysis showed up to 125.8 picoCuries per 100 cm^2 due to uranium-234.
Loose surface beta-gamma contamination of floor areas - <450 to 36,000 pCi/100 cm^2, with 166 to 23,500 pCi/100 cm^2 due to Cs-137 and one sample found to contain 51 picoCuries per 100 cm^2 due to strontium-90
Debris sample from sump – 77,900 pCi/gm Cs-137, 54 pCi/gm Co-60, 440 pCi/gm Am-241, and 124 pCi/gm U-235
Personal air sampler – maximum alpha radioactivity found during inspection of Crossover and G1 West Tunnel – 8.5×10^{-12} μCi/ml from thorium, U-234, and Pu-238/239 (R-000114, pp. 1-2)
1.7×10^{-10} microCuries of gross beta radioactivity from cesium-137 and strontium-90

The following Appendix C drawings are relevant to the G1 Tunnel:

Drawing G-SF-17, Building G1 Sections thru Tunnel, April 1, 1948
Drawing No. 2828-701-68, Piping Sections – Hot and Process Tunnel, August 1, 1949
Drawing No. 2828-701-69, Piping Sections – Hot and Process Tunnel, August 24, 1949
Drawing No. G-SF-1, G Buildings G1 and G2 Basement Floor Plan, April 1, 1949.

9.3 Crossover Tunnel

The Crossover Tunnel connects the G1 East and West Tunnels to the G2 Hot and Process Tunnels (Figure 9-11). It is approximately 44 feet long, connecting G1 and G2 internally to the G2 Pipe and Motor Generator Room and G2 Pipe Trench. The Crossover Tunnel is accessed through a locked Building G2 basement door (R-001949, p. 76). No photographs of the tunnel are available (R-001949, p. 64).

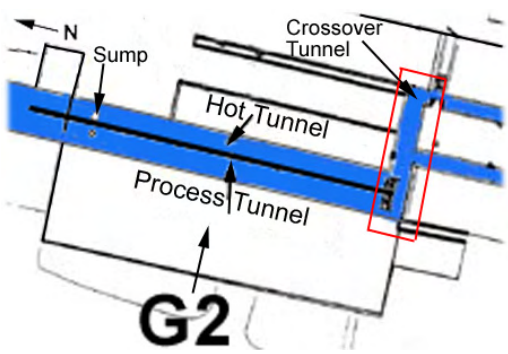


Figure 9-11. Crossover Tunnel

The most recent entry into the Crossover tunnel was the 1989 inspection. No physical damage to the tunnel structure was evident. Two heavy-duty black plastic reuse water pipes pass through the Crossover Tunnel. The plastic was intact, undamaged, and showed no evidence of leakage. Floor areas contained debris and supplies from previous work activities and overhead pipe insulation was degraded in some areas. Copper piping in this and all tunnel spaces contains heavy surface corrosion, but no leakage was evident. Stainless steel piping appeared in good condition in this and other tunnel spaces. The Crossover Tunnel floor was dry; however, watermarks from the 1983 interceptor tank overflow were visible on the walls. Permanently installed lighting was not operational, but a temporary light string was used (R-001949, p. 125). The 1989 radiological survey findings are described in Table 9-4.

Table 9-4. Crossover Tunnel 1989 Radiological Findings, 5/10/1989 to 6/15/1989

Summary Findings (R-001949, p 88)
General area radiation readings – 0.2 to 2 mRem/hr closed window and 2 to 8 mRem/hr open window
Localized readings of floor areas – up to 10 mRem/hr closed window and 50 mRem/hr open window

Summary Findings (R-001949, p 88)
Air sample data – 5.4 x 10^{-12} µCi/ml gross alpha radioactivity (Thorium, U-234, Pu-238/239) with 2.7 x 10^{-13} µCi/ml due to Pu-238/239 and 1.3 x 10^{-10} µCi/ml gross beta radioactivity due to Cs-137
Loose surface alpha contamination of floor areas - <50 to 50 pCi/100 cm^2 due to Pu-238/239 and U-234 (confirmed by presence of these isotopes on swipes in trace amounts on personnel protective clothing)
Loose surface beta-gamma contamination of floor areas – 2,250 to 15,750 pCi/100 cm^2, with 831 to 15,500pCi/100 cm^2 due to Cs-137
Debris sample from floor – 236,000 pCi/gm Cs-137, 806 pCi/gm Am-241, and 96 pCi/gm Co-60 (R-000114, pp. 1-2)

9.4 G2-H2 Tunnel

The G2-H2 Tunnel is a 90-foot long reinforced concrete structure. It is 9 feet high by 12 feet wide with a 3 foot thick roof, 2 foot thick walls, and a 14 inch thick floor slab (Figure 9-12). The floor slopes to a sump located approximately 15 feet from Building H2 (C-000014, p. 6; C-000396). A waterproof sealant was applied to tunnel walls and floors during construction and copper water stops were installed at all construction joints (R-001546, p. G-86). The G2-H2 concrete roof hatch outside of the north end of G2 was sealed as of August 1976 (R-001949, p. 79; C-000142, Attachment 1, p. 15).

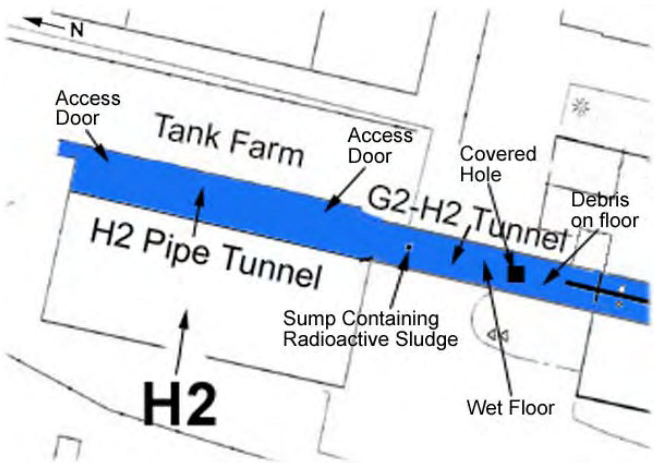


Figure 9-12. G2-H2 Tunnel Plan View

Figure 9-13 is a snapshot of the tunnel from the 1989 inspection video. Figure 9-15, Drawing No. 2828-703-16 is a cross section of the tunnel and piping.

Figure 9-13. G2-H2 Tunnel Structure and Piping, July 1989 (V-002008)

The G2-H2 Tunnel originally housed 46 stainless steel industrial and liquid process waste lines ranging up to 8 inches in diameter. The tunnel also contains original fire protection lines and a gas analyzer system. Most tunnel piping has been deactivated and abandoned in place (R-000255), and there is no evidence that original piping has been removed (V-002008). In 1992, it was reported that only four G2-H2 lines remained active. Two stainless steel drain lines provided pumped (but non-pressurized) Radioactive Materials Laboratory, Chemistry, and D4 complex radioactive waste to the H2 liquid waste collection tanks; the other two heavy duty plastic supply lines pump clean processed reuse water at 60 psig to the same laboratories (R-001949, p. 69).

The 1989 G2-H2 Tunnel inspection represents the most recent physical and radiological information (R-001949). The visual G2-H2 Tunnel inspection resulted in the following observations:

- A pile of concrete and debris, approximately 3 feet high, is on the floor along the east wall of the sloped portion of the tunnel. Directly above the pile is a piece of plywood, behind which concrete has been poured to patch the wall. Figure 9-14 is an excerpt of the 1989 inspection videotape.

Figure 9-14. G2-H2 Tunnel Debris Pile, July 1989 (V-002008)

- At the south end of the downhill slope, an expansion joint in the concrete structure shows evidence of groundwater leakage onto the tunnel floor. There was water on the floor flowing into the sump approximately 15 feet from the entrance to the H2 building. The floor area adjacent to the sump contained water (from 1 to 2 inches deep) covering approximately 400 square feet.

Water observed on the G2-H2 Tunnel floor was from two possible sources:

- Leakage through the joint between the concrete slab hatchway and the roof into the room just east of the G2 Hot Tunnel north end
- Groundwater leakage between the tunnels under G2 and the G2-H2 Tunnel through the construction joint (C-000196).

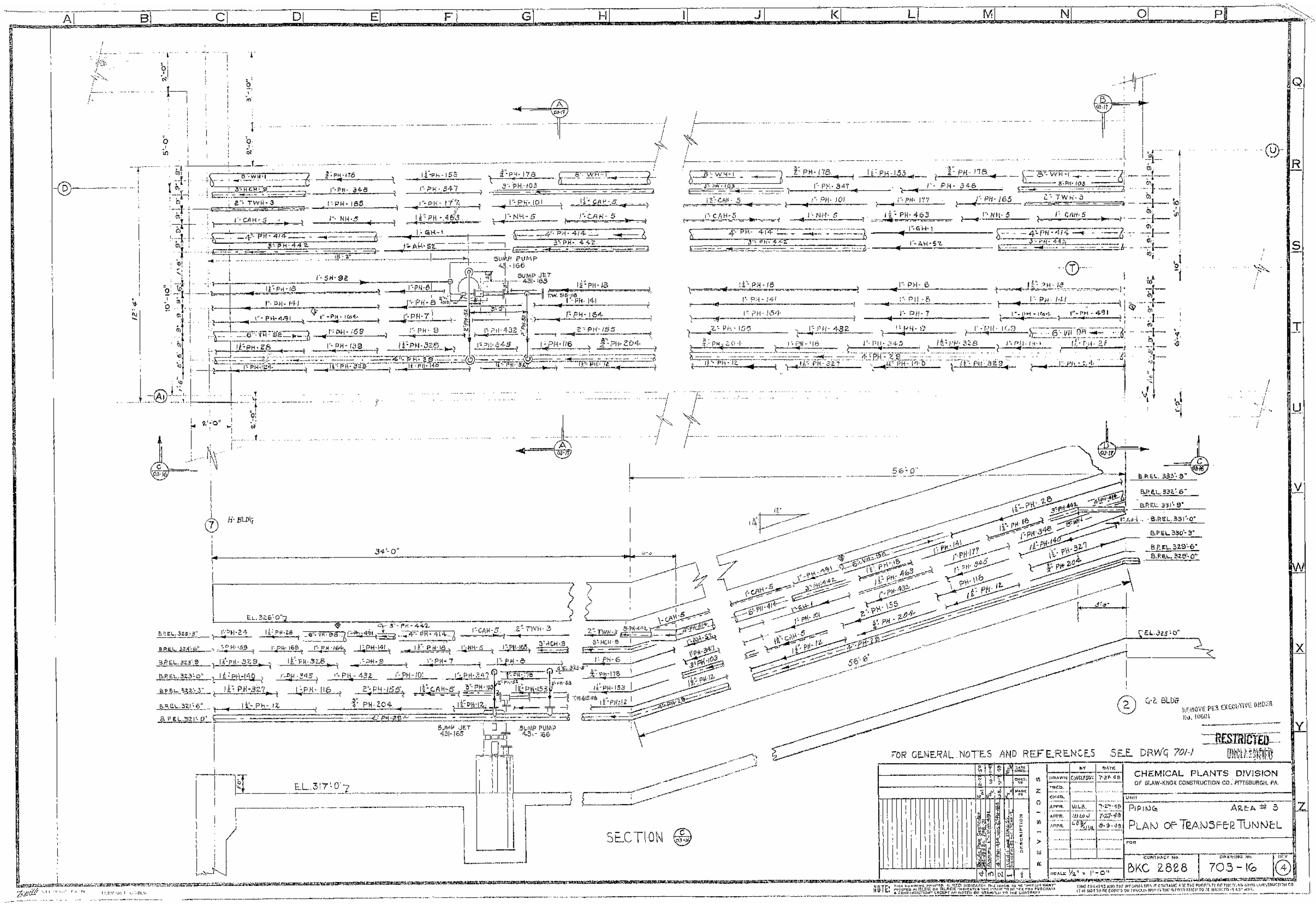


Figure 9-15. Drawing No. 2828-703-16 G2-H2 Tunnel Piping in Horizontal View, July 27, 1949

The G2-H2 Tunnel is currently within the surveillance and maintenance program. At the time of the 1989 inspection, one video camera monitored the tunnel expansion joint for ground water infiltration and another camera monitored the sump at the north end of the tunnel for water accumulation (R-000255, p. 23). As of 2004, these video cameras were not operational.

The G2-H2 Tunnel is shown in following drawings:

Drawing No. 2828-703-16, Plan-Transfer Tunnel [G2-H2 Tunnel], July 27, 1949
Drawing No. 2828-703-17, Sections-Transfer Tunnel [G2-H2 Tunnel], July 23, 1949
Drawing No. 2828-804-3, Tunnel from Building G2 to Building H [G2-H2 Tunnel], September 10, 1948
Drawing No. G2/H2-A-10643, Connecting Tunnel Plan and Section [G2-H2 Tunnel], February 17, 1984.

Available G2-H2 Tunnel radiological information is described in Table 9-5.

Table 9-5. G2-H2 Tunnel 1989 Inspection and Radiological Findings, 5/10/1989 to 6/15/1989

Summary Findings (R-001949)
General area radiation readings – <0.2 to 4 mRem/hr closed window and <0.2 to 10 mRem/hr open window
General area reading approximately 15 feet from floor sump is 300 mRem/hr open window
Maximum reading on contact with the sump is 1,000 mRem/hr open window
Air sample data – up to 8.5×10^{-12} µCi/ml gross alpha radioactivity (Thorium, U-234, Pu-238/239) with 1.7×10^{-12} µCi/ml due to Pu-238/239 and 5.12×10^{-10} µCi/ml gross beta radioactivity with 4.2×10^{-10} µCi/ml due to Cs-137
Loose surface alpha contamination of floor areas – 50 to 60 pCi/100 cm^2
Loose surface beta-gamma contamination of floor areas – 16,200 to 90,000 pCi/100 cm^2 with 7,040 to 65,000 pCi/100 cm^2 due to Cs-137
Debris sample from floor – 1,220 pCi/gm Cs-137
Water sample near floor sump – 0.188 µCi/ml Cs-137, 8.8×10^{-5} µCi/ml gross alpha radioactivity, and 0.240 µCi/ml gross beta radioactivity
Personal air sampler – maximum beta-gamma radioactivity found during inspection of G2 Hot Tunnel and G2-H2 Tunnel – 4.5×10^{-10} µCi/ml from Cs-137 (R-000114, pp. 1-3)

9.5 Findings

The tunnel system is contaminated from SPRU- and non-SPRU-related wastes that were conveyed through the tunnels. G2 was impacted by KAPL laboratory activities because waste and process lines carried wastewater to H2 for treatment. A memo dated September 28, 1953, stated that overflow on the drain lines leading from G1, E1, and D4 to H building overflowed and a “considerable portion of the corridor in G2 was inundated” (C-000489).

Data Gaps

Radiological surveys have identified some tunnel contamination sources and extent, but pipe contents have not been sampled. It is likely that pipes and equipment in the tunnels contain residual contaminants. Surveys have identified high dose rates in the eastern portion of E1, but a comprehensive tunnel survey identifying contamination sources, location, and extent has not been performed.

Impacted or Non-Impacted Tunnel Areas

MARSSIM defines impacted areas as those with a reasonable possibility of containing residual radioactivity in excess of natural background or fallout levels (MARSSIM Glossary, G1-10).

Applying this definition, all tunnel areas are impacted by radioactive contamination and potential chemical contamination inside pipes and equipment.

Sources of Contamination

Contamination sources are directly related to the G2 separation process and non-SPRU waste from the E1, E4, D4, and G1 laboratories. Figure 9-1, Radiological Status of the E1, G1, and G2-H2 Tunnels, summarizes radiological contamination levels in the tunnels.

Table 6-2 and Table 6-3 summarize the radiological and chemical materials used during SPRU research activities or identified in historical survey data. Although decontamination and cleaning activities since 1954 removed much contamination, radiological and chemical hazards remain. Potential contaminants revealed through document review are identified in sections describing process areas and other spaces.

Although potential contamination sources remain in the Tunnels, structural integrity, original protective design features (e.g., stainless steel floors in cell areas), isolated ventilation systems, and surveillance and maintenance activities reduce the likelihood of contamination spreading from contaminated areas.

Chemical hazards may remain in the Tunnels including:

- Asbestos-containing materials – transite concrete structure, flooring, ceilings, walls, jacketed piping
- PCBs – Fluorescent light ballasts and paint may contain PCBs. A PCB survey of the Tunnels has not been conducted
- Lead – Lead-based paint and shielding
- Mercury – Fluorescent light tubes, Mercoid switches, and other meters and equipment.

Likelihood of Contamination Migration

Tunnel contamination is contained physically, but inspections indicate that potential exists for water collected in the sumps to migrate through cracks and deteriorated copper water stops to groundwater. If demolition occurs, airborne contamination risk exists.

Negative pressure maintained by a filtered ventilation system designed to keep airborne contamination inside the Tunnels provides protection against airborne releases. The ventilation system is monitored by the KAPL environmental monitoring program (C-000164, p. 2).

Threat to Human Health

The tunnels have been under radiological controls since SPRU began operations and are accessed only with appropriate radiological protection. Tunnels are isolated from adjacent occupied areas by sealed and locked protective barriers and do not pose a threat to the public or workers outside the tunnels.

Further Characterization Needs

The extent of contamination in tunnel structures, pipes, and equipment is not known. Tunnel pipe flow is restricted, but only one instance of physically cutting a line to determine the extent and character of a restriction is recorded. Additional characterization of tunnel piping and equipment, sumps, underground sump interconnects, p-traps, vents, and other sealed areas should be considered.

9 TUNNELS CURRENT CONDITIONS

A reinforced concrete pipe tunnel system transported liquid waste, process chemicals, and reuse water between the SPRU buildings, laboratories, equipment and nearby non-SPRU laboratories and buildings. This section describes current tunnel conditions, historical information, and survey findings.

The SPRU Nuclear Facility Disposition Project tunnels addressed in this chapter include:

- E1 Tunnels (north and south)
- G1 Tunnels (east and west)
- G2-H2 Tunnel (also called the Transfer Tunnel, Common Tunnel, Connecting Tunnel, and Under Road Tunnel)
- G2 Crossover Tunnel.

The following SPRU Nuclear Facility Disposition Project tunnels structure and radiological conditions are addressed in other sections:

- G2 Tunnels (G2 [East] Hot Tunnel and the G2 [West] Process Tunnel) – Section 7
- G2 Pipe Trench – Section 7
- H2 Pipe Tunnel – Section 8.

Figure 9-1 shows the current radiological conditions of the E1, G1, and G2-H2 tunnels. Table 5-1 defines the terms used in the figure.

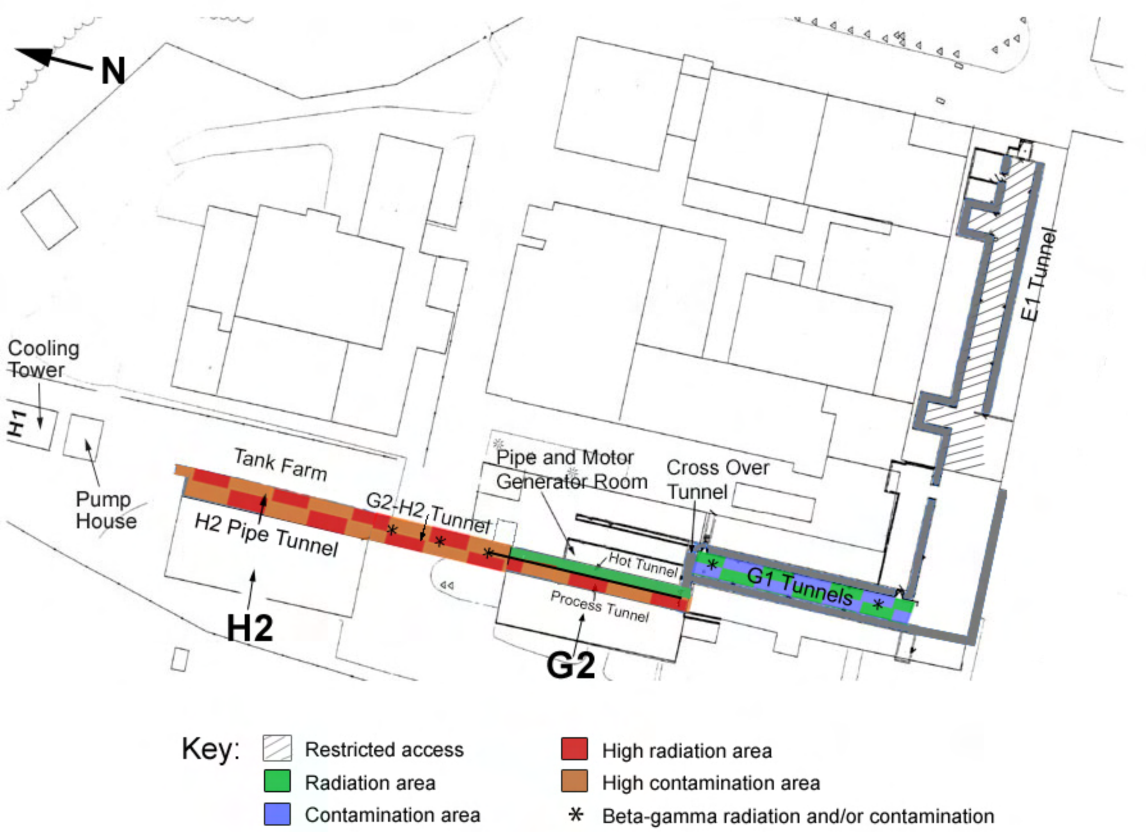


Figure 9-1. Radiological Status of the E1, G1, and the G2-H2 Tunnels (based on 1989 survey data)

The tunnels cannot be entered without dosimetry, protective clothing, and in some cases, supplied air. They are locked to control access, maintained under restricted radiological controls, and kept under surveillance and maintenance. A HEPA ventilation system maintains a negative pressure in the tunnels relative to surrounding areas. Tunnel areas remain contaminated with fixed and loose surface contamination. The G1, G2, and G2-H2 Tunnels were entered in 1989 and found to contain pipes and equipment in various configurations, including abandoned in place, removed, and some in current usage (R-001949, p. 79). The pipes include stainless steel waste lines and headers that collected liquid waste for transport to the H2 waste processing building, and process pipes that carried chemicals and water to equipment in the research laboratories. Fire protection lines, gas analyzer lines, and utilities are also located in the tunnels (C-000014).

The tunnels contain “interceptors,” which are 30- or 55-gallon vessels with sump pumps for collecting excess liquid waste or sludge. All but one of the original interceptors are disconnected and abandoned in place. The remaining one is located near the east end of the E1 Tunnel and reportedly contains radioactive sludge (I-000421).

Stainless steel sumps that collected liquids from pipe leaks or outside infiltration are also in the tunnels. The sumps were equipped with alarms to alert the control room of leakage (C-000014). G2 and G1 tunnel sumps were hard-plumbed and interconnected; during operations, liquids were pumped between sumps. Table 9-1 lists known tunnel sumps.

Table 9-1. Tunnel Sumps

Location	Notes and References
E1 Hot Tunnels	Sumps in the E1 hot tunnels are interconnected under the floors (I-000421). Lead shielding was added to the two interceptors, or drum drain traps, located in the eastern portion of the E1 Tunnel to lower the dose rates in the work area directly above the tunnel ceiling (C-000298, p. 1). These interceptors are 30-gallon drums with a sump pump.
Tunnel G1 West Tunnel	During the 1989 inspection a floor sump was sampled, producing 77,900 pCi/gm Cs-137, 54 pCi/gm Co-60, 440 pCi/gm Am-241, 124 pCi/gm, U-235 (R-0000114, p. 2).
Tunnel G1 to G2	A sump near the southwest corner of the tunnel between G1 and G2 is approximately 10 feet south of G2 (Drawing G-SF-1).
G2-H2 Tunnel	Nylabraid tubing between tank vaults and G2-H2 tunnel sump is still in place (I-000418, p. 1). Sump in G2-H2 Tunnel 2 was found to be very contaminated during the 1989 inspection; there is also a drain in close proximity to this sump that is highly contaminated (I-000418, p. 5). G2-H2 Tunnel is under surveillance and maintenance: video cameras monitored the tunnel expansion joint for ground water infiltration and the other monitored the sump at the north end of the tunnel for water accumulation (R-000255, p. 23). As of 2004 the cameras were not operational. A sump is located approximately in the center of the flat portion of the pipe tunnel. It is not known if the sump pump is currently (2003) operational (C-000997). General radiation readings were in the low range with readings on a floor sump (Note: The sump in the Hot Tunnel is located on the north side of the tunnel approximately 24 feet from Building H2 (Drawing G-SF-1, R-001949, p. 89).

9.1 E1 Tunnels

The E1 tunnels consist of two concrete pipe tunnels (process and hot). Tunnel walls, ceilings, and foundations are at least 1 foot thick reinforced concrete. The pipe tunnels are separated by a tunnel-aisle walkway to allow personnel access. Waste and process piping is mounted along the walls or suspended from ceiling supports. North and south tunnel and tunnel-aisle pipes are made of stainless steel (R-000255). Tunnel sumps are interconnected under the floors. Welded steel doors are located at the end of each tunnel. The E1 tunnels are under restricted radiological control access. Figure 9-2 is a plan view of the E1 Tunnel area. Figures 9-3 and 9-4 are photographs of the E1 welded steel door and radiological control warnings at the access to the tunnel aisle.

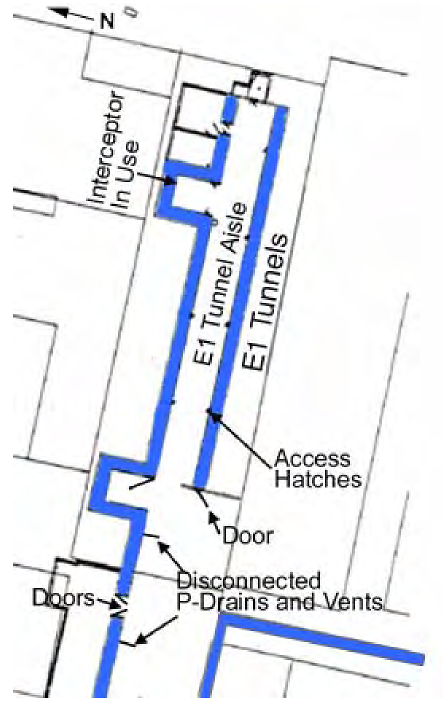


Figure 9-2. E1 Pipe Tunnel Plan Location

Buildings E1 and G1 are operating KAPL facilities and laboratories. Operational E1 and G1 tunnel pipes are used for liquid waste, water, and chemicals from Buildings E1, G1, and D.

The pipes are now routed to a new KAPL waste management facility in Building E11 that is not part of the former SPRU facilities, but waste from the Building E4 Radioactive Materials Laboratory radioactive liquid waste reuse system was sent through E1, G1, and G2 tunnel pipes for processing in H2 through the early 2000s (R-000255).

The Radioactive Materials Laboratory radioactive liquid waste reuse system was put in place in 1977 using the tunnel system to transport liquid waste from the Radioactive Materials Laboratory and the D, E, and G buildings to H2 for treatment and processing. This is a “closed loop” system where wastewater is treated in ion exchange resin columns in H2 and clean water is returned to the laboratories. Only the Radioactive Materials Laboratory currently uses the liquid waste reuse system.

In 1989, two waste interceptors (drum drain traps) from the Radioactive Materials Laboratory located in the eastern most end of E1 were surveyed and produced dose rates as high as 1.8 R. The interceptors are located under building E1 (C-000298). A tabulation of the survey results of the two tanks and associated equipment is presented in Table 9-2. Subsequent to the inspection, additional shielding was added to the interceptor system (C-000298).

Figure 9-3. Photo TNL-7, E1 North Side Tunnel Steel Door, 2004

Figure 9-4. Photo TNL-8, E1 Tunnel Aisle Entry, 2004

The 1989 E1 Tunnel radiological data presented in Table 9-2 is the most recent available.

Table 9-2. E1 Tunnel 1989 Inspection and Radiological Summary

Date	Area	Summary Findings (R-001949)
1989	Interceptor Tank #1 (near the most eastern portion of the tunnel under Building E1)	Radiation levels on contact (1st entry floats bottomed/2nd entry, tanks contained 8 inches liquid float indication): West side of tank – ---/10 mR (top); ---/24 mR (middle); ---/50 mR (bottom) South side of tank – 40/10 mR (top); 80/20 mR (middle); 500/1,200 mR (bottom) East side of tank – 20/10 mR (top); 100/25 mR (middle); 250/1,500 mR (bottom) North side of tank – 20/10 mR (top); 60/30 mR (middle); 100/1,500 mR (bottom) Tank top, west side – 10 mR (w/o shielding); 0.8 mR (w/shielding) Tank top, east side – 12 mR (w/o shielding); 1.2 mR (w/shielding) (C-000298, pp. 12, 22)
1989	Interceptor Tank #2 (near the most eastern portion of the tunnel under Building E1)	Radiation levels on contact (1st entry floats bottomed/2nd entry, tanks contained 8 inches liquid float indication): West side of tank – ---/10 mR (top); ---/25 mR (middle); ---/1,800 mR (bottom) South side of tank – ---/10 mR (top); ---/20 mR (middle); ---/40 mR (bottom) East side of tank – ---/10 mR (top); ---/25 mR (middle); ---/1,700 mR (bottom) North side of tank – 20/10 mR (top); 40/20 mR (middle); 40/900 mR (bottom) Tank top, west side – 15 mR (w/o shielding); 1.2 mR (w/shielding) Tank top, east side – 10 mR (w/o shielding); 1.5 mR (w/shielding) Tank bottom, east side – 1,700 mR (w/o shielding); 200 mR (w/shielding) (C-000298, pp. 12, 22)
1989	E1 Tunnel (near the most eastern portion of the tunnel under Building E1)	RML Ball Valve – 800 mR/hr (Teletector), 900 mR/hr (220A Shielded Tungsten) Inlet Line (hot spot) - 350 mR/hr (Teletector), 300 mR/hr (220A Shielded Tungsten) (C-000298, p. 21)

9.2 *G1 East and West Tunnels*

G1 West Tunnel piping transported liquid waste from the E1 and D4 interceptors through the G2 Hot Tunnel and into H2 waste processing tanks (Figure 9-5).

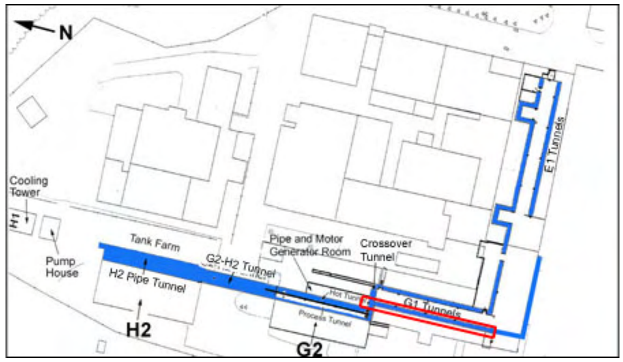


Figure 9-5. G1 West Tunnel

No tunnel aisle information has been collected to date beyond this point. Figure 9-6 shows a G1 West Tunnel door with caution labels. Steel access hatches along each process and hot tunnel are welded shut. Figure 9-7 shows a welded hatch in the G1 East Tunnel.

G1 drain lines had p-traps and vent lines that penetrated the tunnel ceiling. The vent lines have corroded. The p-traps, which are disconnected and capped, are in close proximity to the piping connection. They are approximately 6 inches high and potentially contaminated. Waste lines from the G1 West Tunnel to the G2 Hot Tunnel are cut and capped at the G1 basement wall. Figure 9-8 shows a G1 Capped Drain Pipe. A disconnected interceptor with two 55-gallon vessels is just inside the steel door shown in Figure 9-6. An interceptor placed in Tunnel G1 in the early 2000s is shown in Figures 9-9 and 9-10.

**Figure 9-6. Photo TNL-3,
G1 West Tunnel Door, 2004**

Figure 9-7. Photo TNL-11, G1 Tunnel Welded Hatch, 2004

Figure 9-8. Photo TNL-10a, G1 Tunnel Capped Drain Pipe, 2004

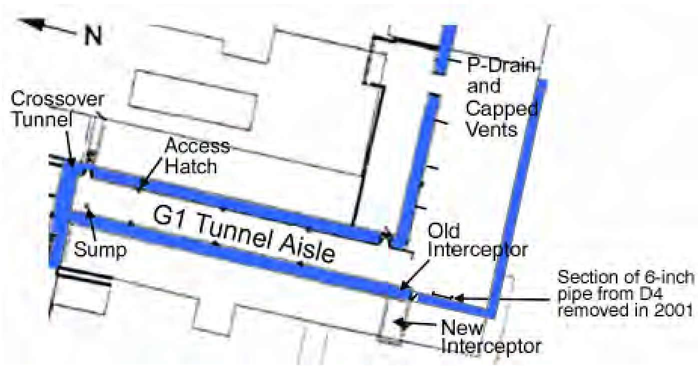


Figure 9-9. G1 Tunnel Showing New Interceptor Location

Figure 9-10. Photo TNL-16, New Interceptor Placed in G1 Tunnel, 2004

No G1 East Tunnel physical inspection or radiological survey data is available. The 1989 G1 West Tunnel inspection is the most recent physical and radiological information available; West Tunnel radiological survey findings are described in Table 9-3. It was noted during the inspection that the G1 West Tunnel floor was dry and no pipe insulation damage was evident. Miscellaneous tools and equipment from previous work remained at the south end of the tunnel. Lighting was operational in the north half of the tunnel (R-001949, p. 124).

Table 9-3. G1 West Tunnel 1989 Radiological Findings, 5/10/1989 to 6/15/1989

Summary Findings (R-001949, p 88)
General area radiation readings - <0.2 to 2 mRem/hr closed window and <0.2 to 7 mRem/hr open window
Localized readings of floor areas - up to 6 mRem/hr closed window and 36 mRem/hr open window
Over floor sump – 10 mRem/hr closed window and 20 mRem/hr open window
Loose surface alpha contamination of floor areas - <50 to 50 pCi/100 cm^2 due to Pu-238/239 and U-234 (as determined in Crossover Tunnel); however, radiochemical analysis showed up to 125.8 picoCuries per 100 cm^2 due to uranium-234.
Loose surface beta-gamma contamination of floor areas - <450 to 36,000 pCi/100 cm^2, with 166 to 23,500 pCi/100 cm^2 due to Cs-137 and one sample found to contain 51 picoCuries per 100 cm^2 due to strontium-90
Debris sample from sump – 77,900 pCi/gm Cs-137, 54 pCi/gm Co-60, 440 pCi/gm Am-241, and 124 pCi/gm U-235
Personal air sampler – maximum alpha radioactivity found during inspection of Crossover and G1 West Tunnel – 8.5×10^{-12} µCi/ml from thorium, U-234, and Pu-238/239 (R-000114, pp. 1-2)
1.7×10^{-10} microCuries of gross beta radioactivity from cesium-137 and strontium-90

The following Appendix C drawings are relevant to the G1 Tunnel:

Drawing G-SF-17, Building G1 Sections thru Tunnel, April 1, 1948
Drawing No. 2828-701-68, Piping Sections – Hot and Process Tunnel, August 1, 1949
Drawing No. 2828-701-69, Piping Sections – Hot and Process Tunnel, August 24, 1949
Drawing No. G-SF-1, G Buildings G1 and G2 Basement Floor Plan, April 1, 1949.

9.3 Crossover Tunnel

The Crossover Tunnel connects the G1 East and West Tunnels to the G2 Hot and Process Tunnels (Figure 9-11). It is approximately 44 feet long, connecting G1 and G2 internally to the G2 Pipe and Motor Generator Room and G2 Pipe Trench. The Crossover Tunnel is accessed through a locked Building G2 basement door (R-001949, p. 76). No photographs of the tunnel are available (R-001949, p. 64).

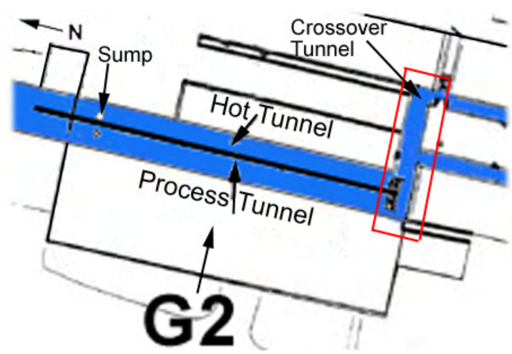


Figure 9-11. Crossover Tunnel

The most recent entry into the Crossover tunnel was the 1989 inspection. No physical damage to the tunnel structure was evident. Two heavy-duty black plastic reuse water pipes pass through the Crossover Tunnel. The plastic was intact, undamaged, and showed no evidence of leakage. Floor areas contained debris and supplies from previous work activities and overhead pipe insulation was degraded in some areas. Copper piping in this and all tunnel spaces contains heavy surface corrosion, but no leakage was evident. Stainless steel piping appeared in good condition in this and other tunnel spaces. The Crossover Tunnel floor was dry; however, watermarks from the 1983 interceptor tank overflow were visible on the walls. Permanently installed lighting was not operational, but a temporary light string was used (R-001949, p. 125). The 1989 radiological survey findings are described in Table 9-4.

Table 9-4. Crossover Tunnel 1989 Radiological Findings, 5/10/1989 to 6/15/1989

Summary Findings (R-001949, p 88)
General area radiation readings – 0.2 to 2 mRem/hr closed window and 2 to 8 mRem/hr open window
Localized readings of floor areas – up to 10 mRem/hr closed window and 50 mRem/hr open window

Summary Findings (R-001949, p 88)
Air sample data – 5.4 x 10^{-12} µCi/ml gross alpha radioactivity (Thorium, U-234, Pu-238/239) with 2.7 x 10^{-13} µCi/ml due to Pu-238/239 and 1.3 x 10^{-10} µCi/ml gross beta radioactivity due to Cs-137
Loose surface alpha contamination of floor areas - <50 to 50 pCi/100 cm^2 due to Pu-238/239 and U-234 (confirmed by presence of these isotopes on swipes in trace amounts on personnel protective clothing)
Loose surface beta-gamma contamination of floor areas – 2,250 to 15,750 pCi/100 cm^2, with 831 to 15,500pCi/100 cm^2 due to Cs-137
Debris sample from floor – 236,000 pCi/gm Cs-137, 806 pCi/gm Am-241, and 96 pCi/gm Co-60 (R-000114, pp. 1-2)

9.4 G2-H2 Tunnel

The G2-H2 Tunnel is a 90-foot long reinforced concrete structure. It is 9 feet high by 12 feet wide with a 3 foot thick roof, 2 foot thick walls, and a 14 inch thick floor slab (Figure 9-12). The floor slopes to a sump located approximately 15 feet from Building H2 (C-000014, p. 6; C-000396). A waterproof sealant was applied to tunnel walls and floors during construction and copper water stops were installed at all construction joints (R-001546, p. G-86). The G2-H2 concrete roof hatch outside of the north end of G2 was sealed as of August 1976 (R-001949, p. 79; C-000142, Attachment 1, p. 15).

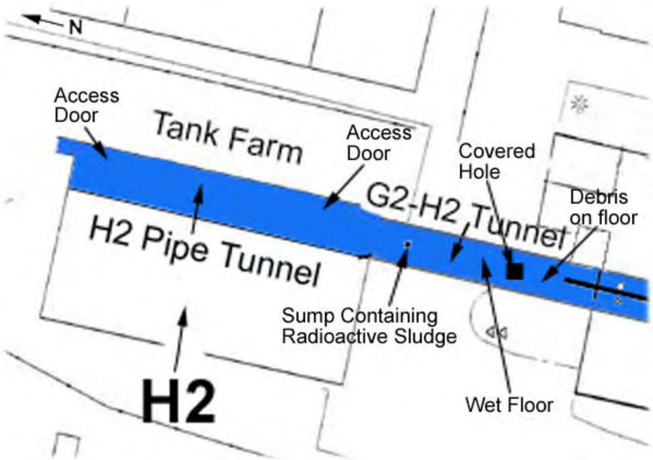


Figure 9-12. G2-H2 Tunnel Plan View

Figure 9-13 is a snapshot of the tunnel from the 1989 inspection video. Figure 9-15, Drawing No. 2828-703-16 is a cross section of the tunnel and piping.

Figure 9-13. G2-H2 Tunnel Structure and Piping, July 1989 (V-002008)

The G2-H2 Tunnel originally housed 46 stainless steel industrial and liquid process waste lines ranging up to 8 inches in diameter. The tunnel also contains original fire protection lines and a gas analyzer system. Most tunnel piping has been deactivated and abandoned in place (R-000255), and there is no evidence that original piping has been removed (V-002008). In 1992, it was reported that only four G2-H2 lines remained active. Two stainless steel drain lines provided pumped (but non-pressurized) Radioactive Materials Laboratory, Chemistry, and D4 complex radioactive waste to the H2 liquid waste collection tanks; the other two heavy duty plastic supply lines pump clean processed reuse water at 60 psig to the same laboratories (R-001949, p. 69).

The 1989 G2-H2 Tunnel inspection represents the most recent physical and radiological information (R-001949). The visual G2-H2 Tunnel inspection resulted in the following observations:

- A pile of concrete and debris, approximately 3 feet high, is on the floor along the east wall of the sloped portion of the tunnel. Directly above the pile is a piece of plywood, behind which concrete has been poured to patch the wall. Figure 9-14 is an excerpt of the 1989 inspection videotape.

Figure 9-14. G2-H2 Tunnel Debris Pile, July 1989 (V-002008)

- At the south end of the downhill slope, an expansion joint in the concrete structure shows evidence of groundwater leakage onto the tunnel floor. There was water on the floor flowing into the sump approximately 15 feet from the entrance to the H2 building. The floor area adjacent to the sump contained water (from 1 to 2 inches deep) covering approximately 400 square feet.

Water observed on the G2-H2 Tunnel floor was from two possible sources:

- Leakage through the joint between the concrete slab hatchway and the roof into the room just east of the G2 Hot Tunnel north end
- Groundwater leakage between the tunnels under G2 and the G2-H2 Tunnel through the construction joint (C-000196).

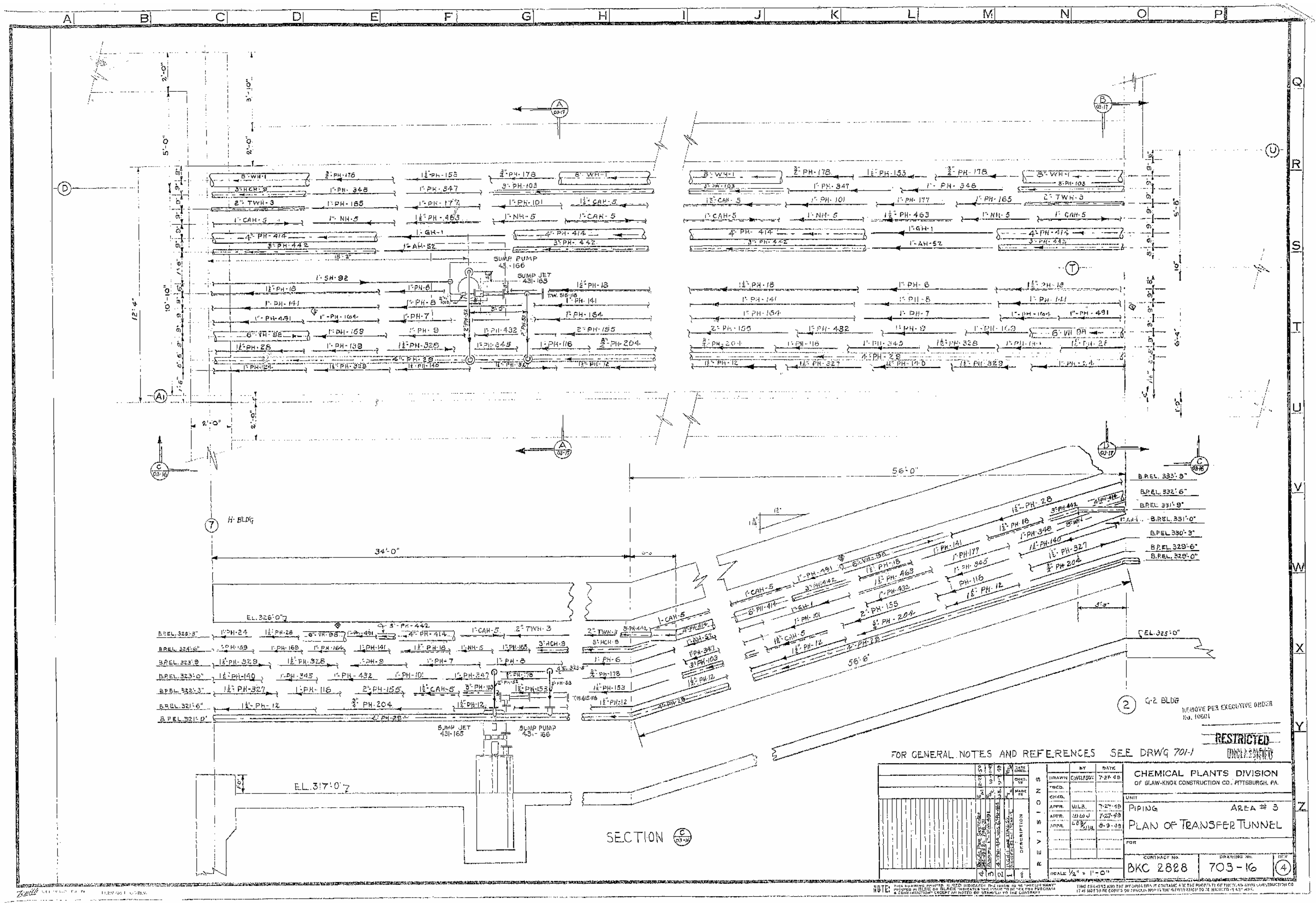


Figure 9-15. Drawing No. 2828-703-16 G2-H2 Tunnel Piping in Horizontal View, July 27, 1949

The G2-H2 Tunnel is currently within the surveillance and maintenance program. At the time of the 1989 inspection, one video camera monitored the tunnel expansion joint for ground water infiltration and another camera monitored the sump at the north end of the tunnel for water accumulation (R-000255, p. 23). As of 2004, these video cameras were not operational.

The G2-H2 Tunnel is shown in following drawings:

Drawing No. 2828-703-16, Plan-Transfer Tunnel [G2-H2 Tunnel], July 27, 1949
Drawing No. 2828-703-17, Sections-Transfer Tunnel [G2-H2 Tunnel], July 23, 1949
Drawing No. 2828-804-3, Tunnel from Building G2 to Building H [G2-H2 Tunnel], September 10, 1948
Drawing No. G2/H2-A-10643, Connecting Tunnel Plan and Section [G2-H2 Tunnel], February 17, 1984.

Available G2-H2 Tunnel radiological information is described in Table 9-5.

Table 9-5. G2-H2 Tunnel 1989 Inspection and Radiological Findings, 5/10/1989 to 6/15/1989

Summary Findings (R-001949)
General area radiation readings – <0.2 to 4 mRem/hr closed window and <0.2 to 10 mRem/hr open window
General area reading approximately 15 feet from floor sump is 300 mRem/hr open window
Maximum reading on contact with the sump is 1,000 mRem/hr open window
Air sample data – up to 8.5×10^{-12} µCi/ml gross alpha radioactivity (Thorium, U-234, Pu-238/239) with 1.7×10^{-12} µCi/ml due to Pu-238/239 and 5.12×10^{-10} µCi/ml gross beta radioactivity with 4.2×10^{-10} µCi/ml due to Cs-137
Loose surface alpha contamination of floor areas – 50 to 60 pCi/100 cm^2
Loose surface beta-gamma contamination of floor areas – 16,200 to 90,000 pCi/100 cm^2 with 7,040 to 65,000 pCi/100 cm^2 due to Cs-137
Debris sample from floor – 1,220 pCi/gm Cs-137
Water sample near floor sump – 0.188 µCi/ml Cs-137, 8.8×10^{-5} µCi/ml gross alpha radioactivity, and 0.240 µCi/ml gross beta radioactivity
Personal air sampler – maximum beta-gamma radioactivity found during inspection of G2 Hot Tunnel and G2-H2 Tunnel – 4.5×10^{-10} µCi/ml from Cs-137 (R-000114, pp. 1-3)

9.5 Findings

The tunnel system is contaminated from SPRU- and non-SPRU-related wastes that were conveyed through the tunnels. G2 was impacted by KAPL laboratory activities because waste and process lines carried wastewater to H2 for treatment. A memo dated September 28, 1953, stated that overflow on the drain lines leading from G1, E1, and D4 to H building overflowed and a “considerable portion of the corridor in G2 was inundated” (C-000489).

Data Gaps

Radiological surveys have identified some tunnel contamination sources and extent, but pipe contents have not been sampled. It is likely that pipes and equipment in the tunnels contain residual contaminants. Surveys have identified high dose rates in the eastern portion of E1, but a comprehensive tunnel survey identifying contamination sources, location, and extent has not been performed.

Impacted or Non-Impacted Tunnel Areas

MARSSIM defines impacted areas as those with a reasonable possibility of containing residual radioactivity in excess of natural background or fallout levels (MARSSIM Glossary, G1-10).

Applying this definition, all tunnel areas are impacted by radioactive contamination and potential chemical contamination inside pipes and equipment.

Sources of Contamination

Contamination sources are directly related to the G2 separation process and non-SPRU waste from the E1, E4, D4, and G1 laboratories. Figure 9-1, Radiological Status of the E1, G1, and G2-H2 Tunnels, summarizes radiological contamination levels in the tunnels.

Table 6-2 and Table 6-3 summarize the radiological and chemical materials used during SPRU research activities or identified in historical survey data. Although decontamination and cleaning activities since 1954 removed much contamination, radiological and chemical hazards remain. Potential contaminants revealed through document review are identified in sections describing process areas and other spaces.

Although potential contamination sources remain in the Tunnels, structural integrity, original protective design features (e.g., stainless steel floors in cell areas), isolated ventilation systems, and surveillance and maintenance activities reduce the likelihood of contamination spreading from contaminated areas.

Chemical hazards may remain in the Tunnels including:

- Asbestos-containing materials – transite concrete structure, flooring, ceilings, walls, jacketed piping
- PCBs – Fluorescent light ballasts and paint may contain PCBs. A PCB survey of the Tunnels has not been conducted
- Lead – Lead-based paint and shielding
- Mercury – Fluorescent light tubes, Mercoid switches, and other meters and equipment.

Likelihood of Contamination Migration

Tunnel contamination is contained physically, but inspections indicate that potential exists for water collected in the sumps to migrate through cracks and deteriorated copper water stops to groundwater. If demolition occurs, airborne contamination risk exists.

Negative pressure maintained by a filtered ventilation system designed to keep airborne contamination inside the Tunnels provides protection against airborne releases. The ventilation system is monitored by the KAPL environmental monitoring program (C-000164, p. 2).

Threat to Human Health

The tunnels have been under radiological controls since SPRU began operations and are accessed only with appropriate radiological protection. Tunnels are isolated from adjacent occupied areas by sealed and locked protective barriers and do not pose a threat to the public or workers outside the tunnels.

Further Characterization Needs

The extent of contamination in tunnel structures, pipes, and equipment is not known. Tunnel pipe flow is restricted, but only one instance of physically cutting a line to determine the extent and character of a restriction is recorded. Additional characterization of tunnel piping and equipment, sumps, underground sump interconnects, p-traps, vents, and other sealed areas should be considered.

10 TANK FARM CURRENT CONDITIONS

The Tank Farm waste storage and processing facility was used from 1949 to 1978. Located below-grade (304-foot level) on the east side of the H2 Pipe Tunnel, the Tank Farm consists of one 5,000-gallon waste transfer tank and six 10,000-gallon stainless steel waste storage tanks arranged in a north-south row. The Tank Farm was designed for storing concentrated radioactive liquid waste, but waste could be transferred from the Tank Farm to the H2 evaporator system (R-000255, p. 15). Tank Farm use was terminated shortly after the Radioactive Materials Laboratory Reuse System was brought online in 1978 (C-000396, p. 2). Figure 10-1 is a photograph of the Tank Farm area, looking north. The east side of H2 is on the left; vault hatches and tank vents protected with metal covers are visible above ground. Figure 8-2 in Section 8 displays an isometric view of the Tank Farm. The current radiological conditions of the Tank Farm are indicated on Figure 8-4 in Section 8 (Building H2), Current Radiological Conditions for the 309-Foot Level.

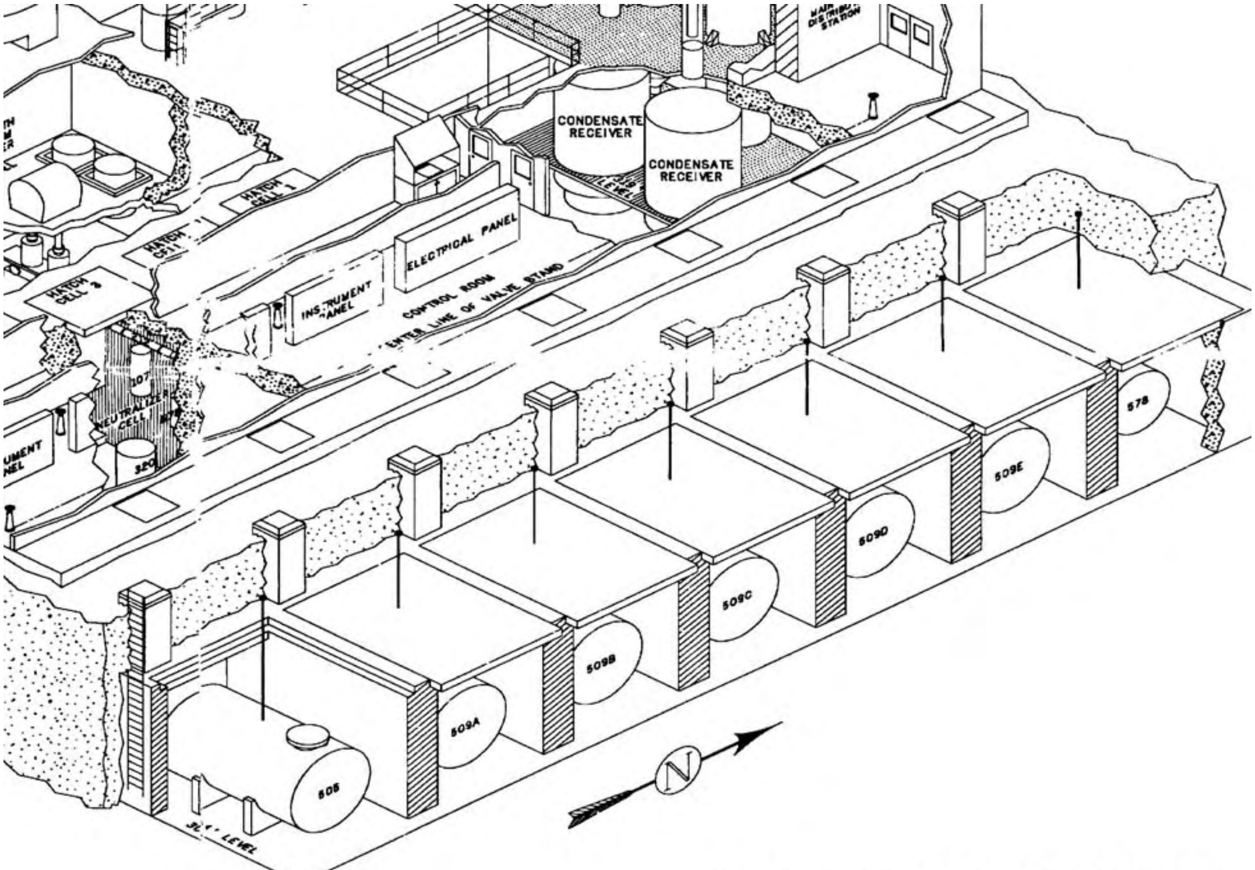
Figure 10-1. Photo H2-93, Tank Farm Area East of Building H2, Looking North, 2004

The contamination status of Tank Farm tanks and vaults are documented (R-000115, C-002033, C-000201, and C-002035) in four radiological and chemical surveys:

- Tank 505 only, prior to 1965
- All tanks, sometime in the 1970s
- All tanks except 509B and 505, in 1989
- All vaults except 509A and 509E, in 1998.

The 1998 Tank Farm vault inspection survey is the most current description of vault conditions. The inside of the tanks were not inspected in 1998. During the 1989 inspection, Tank Farm vaults and tank interiors were all surveyed as indicated above.

Figure 10-2 is an isometric illustration of the Tank Farm vaults and tanks.



(Source – R-001949)

Note: Representation of building interior is not to scale

Figure 10-2. Tank Farm Isometric Illustration

10.1 Tank Farm Vaults

Seven tanks are enclosed in underground concrete vaults at the 304-foot level. The vault tops are approximately 9 feet below grade. Inside vault dimensions are approximately 14 feet wide by 24 feet long by 16 feet high (R-002058, H-Building section, p. 6; R-000255, p. 15). Figure 10-3 is a cross section of a Tank Farm vault looking south (R-000255, p. 18; C-002035, p. 18; R-001304, Attachment 1, p. 24).

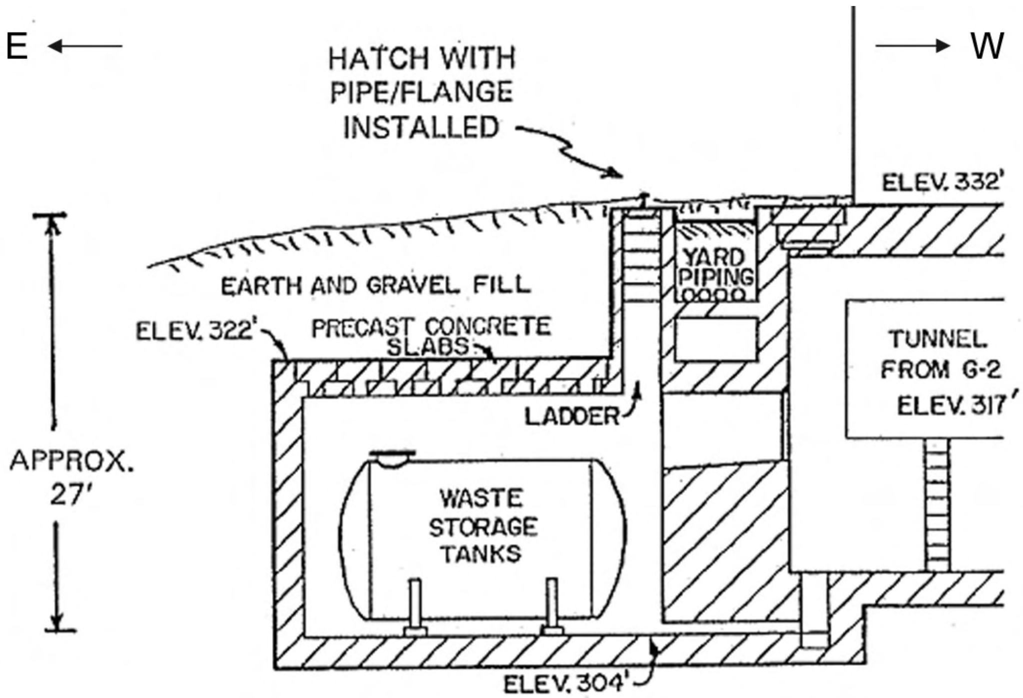


Figure 10-3. Vertical Section of a Tank Farm Vault Looking South

The concrete walls between vaults are approximately 2 feet thick and the west wall shared with the H2 Pipe Tunnel is 6 feet thick (R-000056). The outer walls are 4 feet thick. The vault ceiling is constructed of seven removable concrete "T" blocks approximately 2 feet deep through the stem and 1 foot deep at the crosspiece. Vault floors are concrete, approximately 2 feet thick (R-000056, p. 1). During vault construction, a waterproof sealant was applied to the floors and walls, and copper water-stops were installed to prevent water infiltration (R-000432, p. 11). The ceiling blocks were sealed with asphalt and tarpaper (C-000203, Part I, p. 5). Appendix B Drawing No. 2828-802-28 contains details of the vault construction.

The vaults are accessed through ground-level steel hatches and vertical personnel access ways located in the southwest corner of each vault. In 1989, the hatch covers were fitted with 6-inch pipes and 12-inch flanges with sealed poly sleeves and metal protective covers, enabling periodic remote tank and vault inspections. The pipes/flanges are visible above the ground (R-001304, Attachment 1, p. 5; R-000255, p. 15).

Each vault drains to an individual sump in the northwest corner of each of the seven vaults (C-000142, p. 15, H2 Drawing No. 2828-2-1, Appendix B). The Tank Farm is connected to the H2 Pipe Tunnel at the floor level by sump channels located in the northwest corner of each vault (C-000142, p. 15; R-001304, Attachment 1, p. 4). The sump channels are about 1 foot 8 inches wide (R-002051, p. 3-3). The sumps beneath the H2 Tank Farm vault are interconnected (I-000423, p. 1). During the 1989 inspection, Nylabraid® hoses were installed in the vault sumps from the H2 Pipe Tunnel for pumping water from the vaults. The hoses were tied to a common header located adjacent to the north Pipe Tunnel door at the 309-foot level of H2. In 1997, the hose locations were checked and verified during an inspection performed in May 2004 (C-000396, p. 3).

The earth around the Tank Farm Vaults is composed primarily of clay. During a 1952 test well drilling project just north of the 578 Vault, shale bedrock was noted at elevation 255.5 feet (ground level is approximately 331 feet). It was also noted that the H2 and Tank Farm foundations and structures are located on a bed of gravel (R-000057, p. 2 and Figure 2). Nine feet of earth and gravel fill cover the Tank Farm vaults.

Water infiltration problems around the Tank Farm were addressed as early as 1952, when a drainage tile system designed to alleviate rainwater seepage was installed above the Tank Farm vaults. The tile sections connect at the 320-feet elevation to the mail drainage system, which runs parallel to the east side of the Tank Farm, along the north side of H2, and down an embankment to a concrete catch basin (R-000057, C-000063). Draining accumulated water and maintaining dry vaults was recommended and implemented in 1956 as a groundwater contamination preventative measure (R-000057, C-0000063, and C-0000067).

A Tank Farm Vault survey (C-002035) conducted in 1998 characterizes current Tank Farm Vault radiological conditions. As with the tanks, the primary radioactive constituents are fission products. Since 6 years have passed since the survey was conducted, it can conservatively be assumed that present contamination levels in the Tank Farm Vaults are unchanged from the 1998 survey (even though pump downs of some vaults occurred intermittently in 2000). The Tank Farm vault sump contamination levels may be similar to the vaults, but no relevant survey data are available.

Table 10-1 summarizes Tank Farm Vault radiological information and water levels at the time of the 1998 inspection (R-001304, pp. 16-17). Vaults 509A and 509E water was pumped intermittently in 2000. No additional pumping has been performed since 2000.

Table 10-1. Summary of the 1998 Tank Farm Vault Inspection

Vault	Visual Inspection	Radiological Analysis (1) (2)	Chemical Analysis
Vault 505	Tank and vault are structurally sound. Standing water present over part of floor, estimated 2 to 3 inches, estimated 25 gallons; no active water in-leakage observed; ¼ inch debris present One stalactite on ceiling Two asphalt sealant stains on tank Some streaks and stains on walls Two pipes with blank flanges installed on west wall.	Swipe of Radiac Probe Holder: <50 alpha/<450 beta-gamma pCi/100 cm^2 Floor Swipe: 40 alpha/19900 beta-gamma pCi/100 cm^2 Debris Bottle Radiation Level: 1.2 mR/hr open window beta-gamma reading; 0.3 mR/hr closed window gamma reading Maximum Dose Rate Measured in vault: 400 mR/hr open window beta-gamma reading at 305-foot and 304-foot levels; 134 mR/hr closed window gamma reading at 304-foot level (floor) Debris analysis: Cs-137 – 9.0 x 10^{-7} Ci Ba-137M – 8.6 x 10^{-7} Ci Sr-90 – 9.0 x 10^{-7} Ci Y-90 – 9.0 x 10^{-7} Ci Am-241 – 9.0 x 10^{-9} Ci Pu-239 – 7.2 x 10^{-8} Ci Pu-240 – 1.8 x 10^{-8} Ci Pu-241 – 4.5 x 10^{-8} Ci Pu-238 – 1.8 x 10^{-9} Ci (R-001304, Att. 1, pp. 14-15; C-002035, p. 12; R-000419, p. 14)	Analysis of debris samples for metals (concentration [detection limit/reporting limit]) (µg/kg): Mercury – 4,930 (8.99/133) Silver – Not detectable (240/3,340) Arsenic – 6,440 (1,520/3,340) Barium – 34,300 (180/3,340) Cadmium – Not detectable (127/1,670) Chromium – 102,000 (254/3,340) Manganese – 202,000 (2,370/3,340) Nickel – 37,900 (210/3,340) Lead – 59,700 (524/1,670) Selenium – 1,600 (902/1,670) Zinc – 77,900 (1,240/6,680) (C-002035, p. 14)
Vault 509A	Tank and vault structurally sound Standing water observed beneath access location; estimated 24 inches; estimated 4,500 gallons;	Radiological survey could not be completed due to standing water beneath the access opening. Radioactivity estimates from water samples taken from vault (results in pCi/ml):	Shotgun swab sample analysis (metals) results given in net concentration per gram of waste (ppm):

Vault	Visual Inspection	Radiological Analysis (1) (2)	Chemical Analysis
	water is clear and floor is visible beneath; some debris and asphalt sealant visible through water Some paint blistering on ceiling in area of access shaft Wood plank lying on top of tank; corroded lantern on top of tank; deformation of metal support straps present; appears that tank "floated" at some time in the past Water stains and asphalt sealant stains on walls; some paint blistering on east wall Two pipes with blank flanges on west wall	1,600 Cs-137 1,514 Ba-137M 1,600 Sr-90 1,600 Y-90 16.2 U-234 0.7 U-235 16.2 U-238 0.7 Th-231 16.2 Th-234 16.2 Pa-234M 0.13 Pu-238 2.6 Pu-239 0.65 Pu-240 3.24 Pu-241 0.65 Am-241 (R-001304, Att. 1, pp. 14, 19; C-002035, pp. 11-12)	Arsenic – 56 Barium – 37,000 Cadmium – 105 Chromium – 968 Lead – 392 Selenium – 69 Silver – 95 Mercury – 2,660 (C-000201, p. 2)
Vault 509B	Tank and Vault structurally sound No active water in-leakage observed Standing water present over north half of floor adjacent to sump channel about 2 inches; estimated 50 gallons; tar globs/stains present on floor; thin layer of debris/gravel Multi-colored streaks and water marks on outer tank; one drip observed Streaks and stains on walls; one thin streak of asphalt sealant from ceiling to floor level on east wall	Swipe of Radiac Probe Holder: <50 alpha/<450 beta-gamma pCi/100 cm^2 Floor Swipe: 20 alpha/19900 beta-gamma pCi/100 cm^2 Debris Bottle Radiation Level: 15 mR/hr open window beta-gamma reading; 1.2 mR/hr closed window gamma reading Maximum Dose Rate Measured in vault: 600 mR/hr open window beta-gamma reading at 305- and 304-Foot Levels; 70 mR/hr closed window gamma reading at 304-Foot Level (floor) Debris analysis: Cs-137 – 6.1×10^{-6} Ci Ba-137M – 5.8×10^{-6} Ci Sr-90 – 6.1×10^{-6} Ci Y-90 – 6.1×10^{-6} Ci Am-241 – 6.1×10^{-8} Ci Pu-239 – 4.9×10^{-7} Ci Pu-240 – 1.2×10^{-7} Ci Pu-241 – 3.1×10^{-7} Ci Pu-238 – 1.2×10^{-8} Ci (R-001304, Att. 1, pp. 13-14; C-002035, pp. 10-11; R-000419, p. 10)	Analysis of debris samples for metals (concentration [detection limit/reporting limit]) (µg/kg): Mercury – 78,700 (204/3,020) Silver – 7,690 (275/3,820) Arsenic – 24,000 (1,740/3,820) Barium – 113,000 (206/3,820) Cadmium – 484 (145/1,910) Chromium – 266,000 (290/3,820) Manganese – 754,000 (2,710/3,820) Nickel – 121,000 (241/3,820) Lead – 294,000 (600/1,910) Selenium – 4,630 (1,030/1,910) Zinc – 506,000 (1,410/7,640) (C-002035, p. 14)
Vault 509C	Tank and Vault structurally sound Some active water in-leakage observed; estimated 20 gallons standing water present Small tar-like stalactites on ceiling; one active drip (about 1 drop every 15 – 20 seconds) Outer tank wet where water dripping; mineral deposits observed in area of drip; hole in coating material; colored streaks Streaks and water marks present on walls Two pipes (in good physical condition) with open ends; flanges hanging from lower bolts on west wall Floor wet ranging from no standing	Swipe of Radiac Probe Holder: <50 alpha/<450 beta-gamma pCi/100 cm^2 Floor Swipe: 20 alpha/4,500 beta-gamma pCi/100 cm^2 Debris Bottle Radiation Level: 13 mR/hr open window beta-gamma reading; 1.6 mR/hr closed window gamma reading Maximum Dose Rate Measured in Vault: 200 mR/hr open window beta-gamma reading at 305-foot level; 91 mR/hr closed window gamma reading at 304-foot Level (floor) Debris analysis: Cs-137 – 1.2×10^{-5} Ci Ba-137M – 1.1×10^{-5} Ci Sr-90 – 1.2×10^{-5} Ci Y-90 – 1.2×10^{-5} Ci Am-241 – 1.2×10^{-7} Ci Pu-239 – 9.6×10^{-7} Ci Pu-240 – 2.4×10^{-7} Ci	Analysis of debris samples for metals concentration (detection limit/reporting limit) (µg/kg): Mercury – 81,500 (210/3,110) Silver – 7,930 (121/1,680) Arsenic – 19,700 (764/1,680) Barium – 215,000 (90.7/1,680) Cadmium – 5,270 (63.8/840) Chromium – 543,000 (128/1,680) Manganese – 631,000 (1,190/1,680) Nickel – 241,000 (106/1,680) Lead – 493,000 (264/840) Selenium – 3,270 (454/840)

Vault	Visual Inspection	Radiological Analysis (1) (2)	Chemical Analysis
	water in SW corner to 2 to 4 inches deep in sump channel area (NW corner); two clevis pins with wire cable; rag and piece of tape; many tar-like globs; thin layer of dirt and debris; water clear	Pu-241 – 6.0 x 10^{-7} Ci Pu-238 – 2.4 x 10^{-8} Ci (R-001304, Att. 1, pp. 12-13; C-002035, pp. 9-10; R-000419, p. 8)	Zinc – 1,990,000 (31,100/168,000) (C-002035, p. 14)
Vault 509D	Tank and Vault structurally sound No active water in-leakage observed No standing water present Black streaks and water marks on outer Tank and north wall Grind marks on west side of Tank Two pipes with open ends; flanges hanging from lower bolt on west wall Sump area clear Floor dry; small amount of debris; no sludge; some discoloration beneath access shaft	Swipe of Radiac Probe Holder: <50 alpha/<450 beta-gamma pCi/100 cm^2 Floor Swipe: <20 alpha/<450 beta-gamma pCi/100 cm^2 Debris Bottle Radiation Level: 1.2 mR/hr open window beta-gamma reading; 0.2 mR/hr closed window gamma reading Maximum Dose Rate Measured in Vault: 200 mR/hr open window beta-gamma reading at 305-foot level; 13 mR/hr closed window gamma reading at 304-foot level (floor) Debris analysis: Cs-137 – 1.5 x 10^{-7} Ci Ba-137M – 1.4 x 10^{-7} Ci Sr-90 – 1.5 x 10^{-7} Ci Y-90 – 1.5 x 10^{-7} Ci Am-241 – 1.5 x 10^{-9} Ci Pu-239 – 1.2 x 10^{-8} Ci Pu-240 – 3.0 x 10^{-9} Ci Pu-241 – 7.5 x 10^{-9} Ci Pu-238 – 3.0 x 10^{-10} Ci (R-001304, Att. 1, pp. 11-12; C-002035, p. 9; R-000419, p. 12)	Analysis of debris samples for metals (concentration [detection limit/reporting limit]) (µg/kg): Mercury – 50,100 (135/2,000) Silver – 3,490 (1,390/19,200) Arsenic – 57,600 (8,750/19,200) Barium – 317,000 (1,040/19,200) Cadmium – Not detectable (731/1990,620) Chromium – 26,600 (1,460/19,200) Manganese – 829,000 (13,600/19,200) Nickel – 402,000 (1,210/19,200) Lead – 225,000 (3,020/1990,620) Selenium – 9,040 (5,190/1990,620) Zinc – 369,000 (7,120/38,500) (C-002035, p. 14)
Vault 509E	Tank and vault structurally sound Standing water observed beneath access opening; approximately 4 inches, estimated 800 gallons; water is clear and floor is visible beneath; no organic sheen; debris, asphalt sealant stains/globs, dust/dirt present Stalactite on ceiling; black tar-like drips present; little water drips observed Black streaks and stains on outer tank and walls of vault Damage to coating on east wall of tank Water marks present on north wall Piping structurally sound Two open-end pipes with flanges and nuts hanging Water partway up sump channel	Radiological survey could not be completed due to standing water beneath the access opening. Radioactivity estimates from water samples taken from vault (results in pCi/ml): 5,850 Cs-137 5,534 Ba-137 5,850 Sr-90 5,850 Y-90 2.5 U-234 0.1 U-235 2.5 U-238 0.1 Th-231 2.5 Th-234 2.5 Pa-234M 0.02 Pu-238 0.4 Pu-239 0.1 Pu-240 0.5 Pu-241 0.1 Am-241 (R-001304, Att. 1, pp. 10-11, 19; C-002035, pp. 8-9)	Shotgun swab sample analysis (metals) results given in net concentration per gram of waste (ppm): Arsenic – 143 Barium – 2,215 Cadmium – 99 Chromium – 3,084 Lead – 5,856 Selenium – 193 Silver – 309 Mercury – 717 (C-000201, p. 2)
Vault 578	Several indications of water in-leakage; water leaks at ceiling joints; east wall wet	Swipe of Radiac Probe Holder: <50 alpha/<450 beta-gamma pCi/100 cm^2 Floor Swipe: 1,000 alpha/54,000 beta-gamma	Analysis of debris samples for metals (concentration [detection limit/reporting limit]) (µg/kg):

Vault	Visual Inspection	Radiological Analysis (1) (2)	Chemical Analysis
	Black streaks and stains on outer Tank and walls of Vault Tank structurally sound Piping structurally sound Two open-end pipes with flanges hanging from west wall Floor damp; no standing water below access opening	pCi/100 cm^2 Debris Bottle Radiation Level: 5.0 mR/hr open window beta-gamma reading; 0.5 mR/hr closed window gamma reading Maximum Dose Rate Measured in Vault: 300 mR/hr open window beta-gamma reading at 307-foot level; 96 mR/hr closed window gamma reading at 304-foot level (floor) Debris analysis: Cs-137 – 1.4 x 10^{-6} Ci Ba-137M – 1.3 x 10^{-6} Ci Sr-90 – 1.4 x 10^{-6} Ci Y-90 – 1.4 x 10^{-6} Ci Am-241 – 1.9 x 10^{-8} Ci Pu-239 – 1.5 x 10^{-7} Ci Pu-240 – 3.8 x 10^{-8} Ci Pu-241 – 9.5 x 10^{-8} Ci Pu-238 – 3.8 x 10^{-9} Ci (R-001304, Att. 1, pp. 9-10; C-002035, pp. 7-8; R-000419, p. 16)	Mercury – 5,150 (11.0/163) Silver – 438 (138/1,920) Arsenic – 2,020 (872/1,920) Barium – 158,000 (103/1,920) Cadmium – 1,030 (72.8/199058) Chromium – 58,600 (146/1,920) Manganese – 262,000 (1,360/1,920) Nickel – 33,800 (121/1,920) Lead – 85,000 (301/199058) Selenium – 1,050 (517/199058) Zinc – 125,000 (709/3,830) (C-002035, p. 14)

(1) Open window radiation measurement (beta and gamma) and closed window radiation measurement (gamma only)

(2) Maximum open and closed window readings were typically found at different elevations within the vault since the tank was typically the most significant gamma source and the floor the most significant beta source.

Vault 505

During the 1989 and 1998 Vault 505 inspection, water on the floor (approximately 25 gallons in 1998) and indications of moisture on the walls (both past and present) was noted. No water in-leakage was observed, however, and condensation was believed to be the cause of moisture. No water was pumped from this vault immediately prior to the 1989 inspection (C-000203, Part I, pp. 18-19; R-001304, Attachment 1, pp. 14-15; C-002035, p. 12).

Vault 509A

In both the 1989 and 1998 inspections of the 509A Vault, water on the floor (approximately 4,500 gallons in 1998) and indications of moisture on the walls (both past and present) were noted. The 1998 vault inspection was not completed due to standing water beneath the access opening. Additionally, it was noted that there was deformation of the metal straps around the tank and indication that the tank may have floated at some point. The 509A Vault contained approximately 7,900 gallons of water when it was pumped down in 2000. The 1998 inspection summarized in Table 10-1 estimated the level of radioactivity of the water in the 509A Vault (C-000203, Part I, pp. 8-9; R-001304, Attachment 1, p. 14; C-002035, pp. 11-12).

Vault 509B

In both the 1989 and 1998 Vault 509B inspections, water on the floor (approximately 50 gallons in 1998) and indications of moisture on the walls (both past and present) were noted. No water in-leakage was observed, however, and condensation was believed to be the cause. Before the 1989 inspection, the vault was pumped down from a 295-gallon level, but no water was pumped immediately prior to the 1998 inspection and no record of pumping since the 1998 inspection is known.

The 1998 inspection described in Table 10-1 best characterizes the current 509B Vault radiological condition (C-000203, Part I, pp. 10-11; R-001304, Attachment 1, pp. 13-14; C-002035, pp. 11-12). Debris considered to be foreign to the vault (some introduced during inspections) consisted of a pipe identification tag lying on the floor, a tie-wrap in the area just below the access shaft, a cut-out from the access hatch cover, and a camera lens.

Vault 509C

In early November 1963, a 600-square-foot-area of ground contamination was detected near the 509C hatch cover, between the 509B and 509D hatch covers and vent sample lines. Maximum readings around the 509C hatch cover were 750 milliRem (originally reported as millirad) per hour beta and 60 milliRem per hour gamma on the ground surface. Radiation levels of the remaining 600 square foot ground surface area were up to 150 milliRem (originally reported as millirad) per hour beta and 5 to 25 milliRem per hour gamma. Three feet of soil around the hatch cover and 10 inches over the remaining 600 square foot area was removed. Since it was not known if ground contamination existed at other depths (down to 40 feet around the vault walls), a decision was made to cease soil removal activities. Following decontamination, the Tank Farm area was posted for radiological controls for any work in the area (C-000111, pp. 1-2 and App. D). The *Semiannual Radioactive Waste Data Report* for July through December 1963 reported that the cause of the ground contamination around the 509C hatch cover was believed to be a bellows effect caused by temporary 509C Vault pressurization. Subsequently, the liquid level in all the underground vaults was reduced to a level intended to prevent vault pressurization by ensuring a continuous negative pressure between the cells and the Building H2 Pipe Tunnel (R-001993, p. 4).

In 1989, low-level fixed contamination on the 509C hatch cover was documented. Blue large-area swipes dampened with 409 Detergent showed 175 and 240 counts per minute beta-gamma activity on the hatch cover. Additionally, debris from around the bolt head on the southeast corner of the plate read 240 and 280 counts per minute beta-gamma. The affected surfaces were wiped with 409-dampened rags, clean white facilon was laid over the rags, and a raised plywood cover was installed over the flange onto the facilon (C-000860, Attach. 1, Radiological History for H2).

In both the 1989 and 1998 Vault 509C inspections, water on the floor (approximately 20 gallons in 1998) and indications of moisture on the walls (both past and present) were noted. Some active water in-leakage was observed. No water was pumped from this vault immediately prior to the 1998 inspection and no record of pumping since the 1998 inspection is known. The 1998 inspection, as detailed in Table 10-1, best characterizes the current radiological condition of the 509C Vault (C-000203, Part I, pp. 12-13; R-001304, Attachment 1, pp. 12-13; C-002035, pp. 9-10).

Vault 509D

Indications of past moisture and standing water were noted in the 1989 and 1998 inspections of the 509D Vault; however, no standing water or active in-leakage of water was observed during the inspections. No water was pumped from this vault immediately prior to the 1998 inspection and no known Vault 509D pumping has occurred since the 1998 inspection. The 1998 inspection summarized in Table 10-1 best characterizes the current 509D Vault radiological condition (C-000203, Part I, pp. 14-15; R-001304, Attachment 1, pp. 11-12; C-002035, p. 9).

Vault 509E

During the 1998 Vault 509E inspection, water on the floor (approximately 800 gallons) and indications of moisture on the walls (both past and present) were noted and active water in-leakage was observed. Approximately 2,650 gallons of water were pumped from the vault prior to the 1989 inspection. Tank Farm inspection results were not completed in 1998 because of the water in the vault. However, the estimated level of radioactivity in the 509E Vault water at the time of the 1998 inspection is included in the radiological history summarized in Table 10-1 (C-000203, Part I, pp. 16-17; R-001304, Attachment 1, pp. 10-11; C-002035, pp. 8-9). Approximately 1,482 gallons were pumped from the 509E Vault in 2000.

Vault 578

A damp floor and active water in-leakage were noted during the 1998 578 Vault inspection. Active water in-leakage was not noted in the 1989 inspection report, but a damp floor was observed. No water was pumped from this vault immediately prior to the 1998 inspection, and no known pumping has occurred since the 1998 inspection. The 1998 inspection detailed in Table 10-1 best characterizes the current radiological condition of the 578 vault (C-000203, Part I, pp. 5-7; R-001304, Attachment 1, pp. 9-10; C-002035, pp. 7-8).

10.2 Tank Farm Tanks

The 10,000-gallon stainless steel waste storage tanks are approximately 11 feet by 15 feet and the 5,000-gallon waste transfer tank measures approximately 8 feet by 12 feet (Drawing Nos. 2828-505-1 and 2828-578-1, Appendix B). Capped vent lines extending from the tank tops to a point above grade are approximately 3 inches in diameter above ground and 2 inches in diameter at the tank. The vent lines are located 1 foot off the tank centerlines except for Tank 578, where the vent line is located on the centerline (R-002051, p. 3-3; C-000203, Part II, p. 2).

Transfer equipment included two 3-inch headers with valves for regulating transfer of solutions to and from the tanks (R-000056, p. 1). Transfer could occur only through the hot header or cold header (R-000036, p. 7), with the exception that contents of Tank 578 could be moved to the Tank A525-A and Tanks 505, 509A, 509B, 509C, 509D, and 509E could be transferred to Tank 578 and subsequently to A525-A (H2 south tank). Drawings No. 2828-702-5 and 2828-702-6 (in Appendix B) contain original piping diagrams from the tanks to the H2 Tunnel. Figure 10-1 shows the Tank Farm area east of H2, showing vault hatch and tank vent protective metal covers visible above ground**.**

Tank 505

Tank 505 is a 10,000-gallon waste storage tank that was used for storing high-activity level liquid waste from the H2 Neutralizers and designated for waste not planned for evaporation. Beta or gamma activity was expected to be approximately 10^7 to 10^{10} counts per minute per milliliter at the time of SPRU research activities (R-000036, pp. 7-8).

Tank 509A

Tank 509A is a 10,000-gallon waste storage tank used for storing high-activity level liquid waste from the H2 Neutralizers. It was designated as a storage tank for waste not planned for evaporation. Beta or gamma activity at the time of the PUREX research activities was expected to be approximately 10^7 to 10^{10} counts per minute per milliliter (R-000036, pp. 7-8). By 1965, the tank was emptied of liquid waste, the vault was inspected, and the tank valves were locked in the H2 Control Room (R-000056, p. 1).

Tank 509B

Tank 509B is a 10,000-gallon waste storage tank used for storing high-activity level liquid waste from the H2 Neutralizers. It was designated as a storage tank for waste not planned for evaporation. Beta or gamma activity at the time of the PUREX research activities was expected to be approximately 10^6 to 10^7 counts per minute per milliliter (R-000036, pp. 7-8). Following the mid 1960s cleanout, Tank 509B was used to store sump water collected from the E2 pipe tunnel and floors until approximately 1978 (R-000056, p. 1).

Tank 509C

Tank 509C is a 10,000-gallon waste storage tank used for storing high-activity level liquid waste from the H2 Neutralizers. It was designated as a storage tank for waste not planned for evaporation. Beta or gamma activity at the time of the PUREX research activities was expected to be approximately 106 to 107 counts per minute per milliliter (R-000036, pp. 7-8). Following the mid-1960s cleanout, Tank 509C was used for storing sump water collected from the E2 pipe tunnel and floors until approximately 1978 (R-000056, p. 1). Reportedly, Tank 509C also was used to store excess water from the hillside drains (I-000418).

Tank 509D

Tank 509D has a 10,000-gallon storage capacity. It was used to store waste that could be evaporated by blending radioactive waste with waste that was less radioactive. Beta or gamma activity at the time of the PUREX research activities was expected to be approximately 10^5 counts per minute per milliliter (R-000036, pp. 7-8). Tank 509D was emptied of liquid waste, the vault inspected, and the tank valves locked at the H2 control room by 1965 (R-000056, p. 1).

Tank 509E

Tank 509E has a 10,000-gallon capacity. It was used to store colder liquid waste collected in buildings G2 and H2 sumps. Tank 509E had both radioactive and non-radioactive header tie lines and a direct open line from the incinerator building drain. When the incinerator was in operation during PUREX, Tank 509E could have received 10 to 50 gallons a day through this direct open line. Beta or gamma activity at the time of the PUREX research activities was expected to be approximately 10^3 to 10^4 counts per minute per milliliter (R-000036, pp. 7-8; C-000015, p. 2). Following the mid-1960s cleanout, Tank 509E was routinely used to store Radioactive Materials Laboratory hot cell liquid waste prior to processing in H2 until approximately 1978 (R-000056, p. 1).

Tank 578

Tank 578, the only transfer tank in the Tank Farm, has capacity to store 5,000 gallons of waste. It was used for both storage and make-up of 509D and 509E waste that was sent to the Building H2 south evaporator feed Tank A525-A (R-000036, pp. 7-8). Tank 578 was emptied of liquid waste, the vault inspected, and the tank valves locked at the H2 Control Room by 1965 (R-000056, p. 1). The Tank 578 vent line is different from the other six tanks in its location on the centerline of the tank rather than 1 foot off centerline (R-002051, p. 3-3; C-000203, Part II, p. 2).

The most current radiological characterization of the Tank Farm tanks is contained in the 1989 radiological survey information (C-000203). Since 1989, some activity of constituents such as strontium-90 (half-life = 29 years) and cesium-137 (half-life = 30 years) has decayed away. However, the half-lives of most of the actinides are long enough in comparison to the intervening years since the 1989 inspection that it can be conservatively assumed that the 1989 survey results approximately represent the current status (Table 10-2). The 1989 survey results indicate that fission products are the primary source of radioactive contamination in the tanks, sumps, and vaults. Fission products were waste byproducts of SPRU and Radioactive Materials Laboratory activities. One survey from the 1970s indicates the presence of cobalt-60 in Tank 578, which can be attributed to activities in the Radioactive Materials Laboratory. Waste streams from SPRU, Radioactive Materials Laboratory, Buildings D3 and D4, and Building E1 contain actinides.

Tank residue quantities and depth, gamma radiation levels, and estimated total Curie contents were documented during the 1989 inspection (C-000203, Part II, p. 4). No waste has been added to or removed from the tanks since the 1989 inspection.

Figure 10-4 is a photograph of a tank top, looking east.

Figure 10-4. Tank Top in Tank Farm Vault, Looking East, undated

The 1989 tank inspection surveyed all tanks except 509B and 505 and identified eight heavy metals. The 1998 survey identified heavy metal contamination in excess of reportable limits. The survey reports assumed that mercury and lead contained in the tanks came from other KAPL radiological laboratories, because neither contaminant was used in the SPRU process (C-000394, p. 4). Further, the source of mercury was attributed to the E1 building chemical laboratories (C-000201, p. 4). Table 10-2 presents a summary of the 1989 tank inspection.

Table 10-2. Summary of the 1989 Inspection of Tank Farm Tanks

Tank	Visual Inspection	Radiological Survey (1) (2)
Tank 505	No physical discrepancies; internal piping and supports intact; however, external peeling or flaking condition noted on several pipes; some pitting of pipes noted in vicinity of flaking condition but no pits appear to extend through pipe wall; some surface discontinuity noted in vicinity of piping penetrations in top of tank appear to be grind marks from fabrication Layer of sludge on bottom of tank 7 inches deep (37 ft^3) Film of water noted in a few places, particularly where piping penetrates sludge layer and also what appears to be craters in sludge Sludge is dark charcoal to black color and appears to be tar-like in consistency Stains noted on tank interior; horizontal lines from liquid level noted; broad bands on walls possibly from sludge settling and adhering; stains consistent with those observed in other tanks; one difference is an area of mottled discoloration near a piping penetration at top of tank – greenish yellow in appearance with little depth – a condition not noted in any other tanks No foreign objects noted in tank Tank man access cover noted to have shiny spots resembling water droplets but no water noted to form or fall from this location	Eberline RO-7-BM: Beta-gamma readings range from <100 mRem/hr at the 330.5-foot elevation to 1,300 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Eberline RO-7-LD: Gamma readings range from <1 mRem/hr at the 330.5-foot elevation to 760 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Large cotton swab lowered into sludge read 80 mRem/hr open window and 7 mRem/hr closed window on contact RO-2 radiac Tank Sludge Radionuclide and Curie Content: Cs-137 – 25.1%, 3.6 Ci content, 0.042 g Pu-239 – 29.1%, 4.2 Ci content, 68.0 g Am-241 – 3.4%, 0.49 Ci content, 0.140 g Sr-90 – 42.3%, 6.1 Ci content, 0.045 g (C-000203, Part II, pp. 16-17) Curie Content 14.4

Tank	Visual Inspection	Radiological Survey (1) (2)
	Air flow into vent pipe during inspection > 157 ft^3/min; normally no air flow into tank	
Tank 509A	No physical discrepancies; internal piping and supports intact Some grind marks noted on tank walls which appear to be from tank construction Layer of sludge 9 inches deep (51 ft^3) on tank bottom Sludge primarily dry with small puddle of water contained in crater in the sludge around one pipe and a film of water on the sludge in one end of tank Sludge is dark charcoal to black color Stains noted on tank interior; horizontal lines from liquid level noted; black stains on walls; some piping penetrations in top of tank had stains of various coloration where liquids had previously entered the tank; stains consistent with those observed in other tanks No foreign objects noted in tank Air flow into vent pipe during inspection > 157 ft^3/min; normally no air flow into tank	Eberline RO-7-BM: Beta-gamma readings range from 100 mRem/hr at the 330.5-foot elevation to 2,400 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Eberline RO-7-LD: Gamma readings range from 4 mRem/hr at the 330.5-foot elevation to 1,578 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Large cotton swab lowered into sludge read 6 mRem/hr closed window and 50 mRem/hr open window on contact Due to shielding around pipe vent at ground level, apparent fixed contamination in upper portion of vent pipe; radiation levels at top of vent pipe with cover removed were 5 mRem/hr open window and 0.2 mRem/hr closed window with a RO-2 radiac Tank Sludge Radionuclide and Curie Content: Cs-137 – 78.0%, 9.1 Ci content, 0.110 g Pu-239 – 1.6%, 0.19 Ci content, 3.1 g Am-241 – 0.3%, 0.036 Ci content, 0.010 g Sr-90 – 20.1%, 2.3 Ci content, 0.017 g (C-000203, Part II, pp. 14-15) Curie Content 11.6
Tank 509B	No physical discrepancies; internal piping and supports intact Layer of sludge on bottom of tank 3 inches deep (14 ft^3) Sludge primarily dry with small puddle of water contained in crater in the sludge around one pipe Sludge is dark charcoal gray to black color; whitish color noted around one pipe penetrating sludge pile Internal piping and support brackets had layer of sludge which increased in thickness as the bottom of the tank was approached Sludge appeared to be drier than that noted in other tanks Internal surfaces of tank had stains around various penetrations and at various fluid levels; dark stains randomly distributed throughout the bottom half of tank No foreign objects noted in tank Air flow into vent pipe during inspection > 157 ft^3/min; normally no air flow into tank	Eberline RO-7-BM: Beta-gamma readings range from <100 mRem/hr at the 330.5-foot elevation to 800 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Eberline RO-7-LD: Gamma readings range from <1 mRem/hr at the 330.5-foot elevation to 267 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Large cotton swab lowered into sludge read 60 mRem/hr open window and 7 mRem/hr closed window on contact Radiation readings at uncovered tank vent were 0.2 mRem/hr open window and <0.2 mRem/hr closed window Tank Sludge Radionuclide and Curie Content: Cs-137 – 15.9%, 0.91 Ci content, 0.011 g Pu-239 – 12.7%, 0.73 Ci content, 12.0 g Am-241 – 1.5%, 0.086 Ci content, 0.025 g Sr-90 – 69.9%, 4.0 Ci content, 0.029 g (C-000203, Part II, pp. 12-13) Curie Content 5.7
Tank 509C	No physical discrepancies; internal piping and supports intact Layer of sludge on bottom of tank 16 inches deep (111 ft^3) Sludge has thick tar-like consistency with water present Interior of tank and piping has random dark stains Piping and tank interior have material deposited on them ranging from tar-like to flaky appearance. Airflow into vent pipe during inspection > 157 ft^3/min; normally no airflow into tank.	Eberline RO-7-BM: Beta-gamma readings range from <100 mRem/hr at the 330.5-foot elevation to 500 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Eberline RO-7-LD: Gamma readings range from <1 mRem/hr at the 330.5-foot elevation to 278 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Large cotton swab lowered into sludge read 300 mRem/hr open window and 26 mRem/hr closed window on contact; swab heavily coated with sludge Radiation levels at vent pipe opening with blank flange removed were 2.9 mRem/hr open window and <0.2 mRem/hr closed window with RO-2 radiac Tank Sludge Radionuclide and Curie Content: Cs-137 – 8.5%, 2.0 Ci content, 0.023 g Pu-239 – 11.2%, 2.6 Ci content, 42.0 g

Tank	Visual Inspection	Radiological Survey (1) (2)
		Am-241 – 1.8%, 0.42 Ci content, 0.120 g Sr-90 – 78.5%, 18.5 Ci content, 0.14 g (C-000203, Part II, p. 11) Curie Content 23.5
Tank 509D	No physical discrepancies; internal piping and supports intact; however, an external corrosion condition was noted on several pipes varying from a film to a scale-like consistency Bottom of tank coated with dark brown sludge 3 inches deep (14 ft^3) Standing water noted in vicinity of a pipe at west end of tank; pipe runs vertically from top of tank to bottom terminating 3 inches from bottom; air bubbling up from this pipe (similar to conditions noted in 509E and 578) Air flow into vent pipe during inspection > 157 ft^3/min; normally, with exception of bubbling in sludge, no air flow into tank	Eberline RO-7-BM: Beta-gamma readings range from <100 mRem/hr at the 330.5-foot elevation to 1,600 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Eberline RO-7-LD: Gamma readings range from <1 mRem/hr at the 330.5-foot elevation to 460 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Large cotton swab lowered into sludge read 500 mRem/hr open window and 45 mRem/hr closed window on contact; Q-tip swipe of sludge read 1.5 mRem/hr open window and 0.2 mRem/hr closed window; direct probe of Q-tip read 44,000 cpm beta-gamma and 100 cpm alpha (Q-tip wet so alpha count probably higher) Tank Sludge Radionuclide and Curie Content: Cs-137 – 23.0%, 1.4 Ci content, 0.016 g Pu-239 – 4.3%, 0.27 Ci content, 4.3 g Am-241 – 0.4%, 0.025 Ci content, 0.0073 g Sr-90 – 72.3%, 4.5 Ci content, 0.033 g (C-000203, Part II, pp. 9-10) Curie Content 6.2
Tank 509E	No physical discrepancies; internal piping and supports intact; however, piping within tank coated with uniform corrosion layer varying from film to visible scale flakes Tank interior stained in higher elevations with what appears to be water level lines; deposits evident in lower elevations varying from hard scale-like substance to gray/brown sludge and water slurry approximately 9 inches deep (37 ft^3) Air bubbles near one of the pipes that penetrates the top of the tank and terminates at bottom of tank below level of sludge heel; bubbling rate increased when opening in vent pipe used to access the tank was partially covered, indicating bubbling is related to the magnitude of negative pressure within the tank; bubbling creates pool-like region within sludge bed where water accumulates White deposit resembling pipe sealing compound and surface discontinuity with no apparent depth noted in tank vent line Air flow into vent pipe during inspection > 157 ft^3/min; normally, with exception of bubbling in sludge, no air flow into tank	Eberline RO-7-BMMD: Beta-gamma readings range from <100 mRem/hr at the 330.5-foot elevation to 4,400 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Eberline RO-7-LD: Gamma readings range from <1 mRem/hr at the 330.5-foot elevation to 1,340 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Large cotton swab lowered into sludge read 40 mRem/hr open window and 6 mRem/hr closed window at about 2 inches with RO-2 radiac Reading of device used to measure sludge depth was 120 mRem/hr open window and 10 mRem/hr closed window on contact Tank Sludge Radionuclide and Curie Content (represents greater than 99 percent of total activity): Cs-137 – 67.1%, 5.3 Ci content, 0.061 g Pu-239 – 5.2%, 0.41 Ci content, 6.6 g Am-241 – 0.8%, 0.063 Ci content, 0.018 g Sr-90 – 26.8%, 2.1 Ci content, 0.015 g (C-000203, Part II, pp. 7-8) Curie Content 7.9
Tank 578	No physical discrepancies; internal piping and supports intact Hole noted in vent pipe (in area inside vault) 16.5 feet from top of vent piping and 4 feet from top of tank; hole extends over 1/3 of pipe circumference and is about 1 inch wide; concluded that hole is piping penetration Tank contains a 6-inch deep layer of watery sludge (25 ft^3) Sludge dark charcoal gray color Water noted on sludge on west end of tank covering area of 4 feet by 4 feet Crater in sludge surrounding pipe in east end of tank filled with water; crater approximately 1 to 2 feet in diameter with air bubbling up through the water from pipe opening	Eberline RO-7-BM: Beta-gamma readings range from <100 mRem/hr at the 330.5-foot elevation to 1000 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Eberline RO-7-LD: Gamma readings range from <1 mRem/hr at the 330.5-foot elevation to 528 mRem/hr 1 foot, 3 inches above tank bottom (306.5-foot elevation) Large cotton swab lowered into sludge read 120 mRem/hr open window and 7 mRem/hr closed window on contact with RO-2 radiac Radiation levels measured at top of open vent pipe were 6 mRem/hr open window and 0.5 mRem/hr closed window with RO-2 radiac

	Surface of sludge uneven with film of water in some low spots Air flow into vent pipe during inspection > 157 ft³/min; normally, with exception of bubbling in sludge, no air flow into tank	Tank Sludge Radionuclide and Curie Content (represents greater than 99 percent of total activity): Cs-137 – 45.2%, 1.7 Ci content, 0.020 g Pu-239 – 13.6%, 0.51 Ci content, 8.2 g Am-241 – 1.0%, 0.038 Ci content, 0.011 g Sr-90 – 40.2%, 1.5 Ci content, 0.011 g (C-000203, Part II, pp. 5-6) Curie Content 3.8

(1) All measurements were made 1 foot off centerline except for 578 which is on centerline
(2) As measured at elevation 306.5 foot or 1 foot, 3 inches above bottom of tank

The following drawings in Appendix B are additional references for the Tank Farm Vaults and Tanks:

Drawing No. 2828-2-1, Layout Plan – Waste Disposal Area, H2, April 24, 1948
Drawing No. 2828-2-2, Layout Building H, April 24, 1948
Drawing No. 2828-92-101, SPRU Flow Diagram, SPRU Process, June 29, 1948
Drawing No. 2828-92-4, Flow Diagram, SPRU Process, May 8, 1948
Drawing No. 2828-702-5, Piping Elevation of holdup tank 578, December 9, 1948
Drawing No. 2828-702-6, Piping Elevation of waste disposal tank item 509E and pipe trench, December 3, 1948.

The following videotaped documentation provides additional Tank Farm vault and tank information:

Videotape: SPRU Tank Farm 1998, Copy of Tape No. 1, Vault 578, 1998 (V-002002)
Videotape: 1998 SPRU Tank Farm Inspection, Mock-Up Training, 1998 (V-002003)
Videotape: KAPL Vault Inspection – 1998 – 1944237, Robotassist 3-D Simulation, 1998, (V-002004)
Videotape: 1998 SPRU Tank Farm Video Inspection Overview Copy, 1998, (V-002005, V-002006)
Videotape: 1998 SPRU Tank Farm Inspection Overview Video, 1998 (V-002006)
Videotape: Overview of SPRU 1989 Tank Farm Inspection RT: 14 minutes, 1989, (V-002007)
Videotape: G1 and G2 Tunnel Inspection May/June 1998 SPRU Inspection June/July 1998 1:30 Tape 1. 1998, (V-002008)
Videotape: H2 Composite run time 30 minutes SPRU Inspection H2 Composite Tape 2, (V-002009)
Videotape: A. H2 Tanks and Vaults 578 509E, 1998, (V-002010)
Videotape: B. H2 Tanks and Vaults 509e, 578, 509D, 509C, 1998, (V-002011).

10.3 Findings

Data Gaps

The Tank Farm vaults were last inspected and surveyed in 1998 (R-002101) and tanks were inspected and surveyed in 1989 (C-000203). It is assumed that these surveys represent current conditions.

Impacted or non-impacted

MARSSIM defines impacted areas as those with a reasonable possibility of containing residual radioactivity in excess of natural background or fallout level (MARSSIM Glossary, G1-10). The Tank Farm vaults, tanks, sumps, and immediate surrounding environment have been identified, as evidenced in the radiological survey history tables and recorded incidents, as containing residual radioactivity and are classified as impacted. Also, heavy metals have been identified in all vaults surveyed in 1998. It may be anticipated that heavy metals are also present in the two vaults (Nos. 509A and 509E) that were not surveyed in 1998 due to the presence of water on the vault floor. Therefore, these areas are also classified as impacted.

Sources of Contamination

Radiological and chemical contamination in the Tank Farm tanks, vaults, and sumps are from activities associated with SPRU, as well as non-SPRU KAPL activities. There is insufficient information in the radiological and chemical surveys to provide for a level of discrimination between contaminations attributable to SPRU compared to that attributable to non-SPRU KAPL activities. However, certain radionuclides such as cobalt-60 and chemicals such as mercury and lead came from sources other than SPRU.

The Preliminary Evaluation of the Status of the Separations Process Research Unit (SPRU) summarizes the Curie content in Table C-3 (R-001949). The Curie content is also shown in Figure 5-1.

Table 6-2 and Table 6-3 in Section 6 summarize the radiological and chemical materials used during SPRU research activities or identified in historical survey data. Although decontamination and cleaning activities since 1954 were performed, radiological and chemical hazards remain. Potential contaminants revealed through document review are identified in sections describing process areas and other spaces.

Potential contamination sources remain in the Tank Farm. Structural integrity, original protective design features (e.g., stainless steel floors in cell areas), preventative measures, and surveillance and maintenance activities reduce the probability of contamination spreading from contaminated areas.

Likelihood of Contamination Migration

Contamination in the Tank vaults is assumed to be the result of past operations. However, the tanks are not known to have leaked into the vaults (R-002047, p. 4). The Tank Farm is currently inactive, with residue remaining in the tanks (16 inches deep at the most) and little potential for future overflow into the vaults. A HEPA-filtered ventilation system in H2 maintains negative pressure exists in the Tank Farm tanks, which was confirmed during the 1989 tank inspection by measuring air pressure in open tank vent lines (R-001949). The 1989 tank inspection concluded that no apparent risks of release to the environment from the tanks or vaults exist under current conditions.

Previous Tank Farm groundwater sampling results, however, suggest that some contamination from the Tank Farm vaults may have leaked or seeped into the surrounding soil. In 1983, sampling results indicated gross beta activity ranging from less than or equal to 4.2×10^{-9} to $(1.41 \pm 0.88) \times 10^{-8}$ microCuries per milliliter and gross gamma activity in the range of less than or equal to 1.8×10^{-8} to $(3.15 \pm 2.22) \times 10^{-8}$ microCuries per milliliter near the vaults. Strontium-90 was identified in these samples. Gross alpha analysis indicated all samples to be less than or equal to 2×10^{-9} microCuries per milliliter (C-000154, Table 1 and Figure 1). The Tank Farm area is covered with a tarp to help prevent rainwater from seeping into the vaults and from the vaults into the surrounding soil (C-000197). Additionally, the vaults are scheduled for pumping down once every 3 years to control accumulation of water (C-001304).

Migration of contamination from the tanks to the vaults is considered unlikely given the observed structural integrity of the tanks during both the 1989 and 1998 inspections and the minimum residue in the tanks.

Threat to Human Health

The Tank Farm area is a controlled area and is not accessible to the public or unauthorized workers. Routine monitoring of potential radiological and chemical airborne and groundwater contamination sources by KAPL has been determined to be protective of public health (R-002032, p. 1). KAPL cooperates with and is inspected by regulators, including NYSDEC and the EPA Region II, to monitor potential public health concerns.

The EPA Region II KAPL fact sheet states, "no imminent danger to human health or the environment has been identified … The on-going routine monitoring programs undertaken by Knolls, in addition to the corrective action programs, are designed to alert Knolls and the NYSDEC of any health or environmental risks" (R-000430). Considering ongoing routine operations, the threat of significant human health impacts from the Tank Farm is unlikely.

Further Characterization Needs

The inspections performed in 1989 and 1998 resulted in relatively thorough characterization of potential radiological and chemical contamination within the Tank Farm. Further chemical characterization of Vaults Nos. 509A and 509E as well as Tanks 509B and 505 may be considered, if the existing survey data is considered inadequate.

11 SUMMARY

The *Nuclear Facility Historical Site Assessment for the SPRU Disposition Project* documents the identification, collection, organization, cataloguing, review, and analysis of available information. More than 3,000 documents, 13 videotapes, 680 historical photographs, and 2,000 drawings were assessed, and eight interviews and several facility inspections conducted. The assessment also included review of documents in the KAPL Technical Library, off-site storage areas, and drawings in the KAPL Engineering Information Process and Control repository. Information in this historical site assessment is a comprehensive presentation and assessment of available relevant information for the SPRU facilities, and provides a basis for review, input, and disposition decisions.

The *Nuclear Facility Historical Site Assessment for the SPRU Disposition Project* covers the following facilities:

- Building G2 – contains laboratories, hot cells, separations process testing equipment, and the pipe tunnels in G2
- Building H2 – contains equipment and tanks for liquid waste processing and includes the H2 Pipe Tunnel and H1 Cooling Towers
- Tunnels – contain piping, utilities, and equipment in each building and also connect G2 and H2 and buildings G1 and E1
- Tank Farm – contains subsurface tank vaults and tanks along the eastern side of Building H2 for storing liquid waste.

In addition to summarizing the historical documentation, this historical site assessment addresses whether areas are impacted or not impacted by radioactive contamination, the contamination sources, the probability of contamination migration, threats to human health, and further characterization needs.

Impacted versus Non-impacted

The SPRU facilities are considered impacted by radioactive contamination above background levels, as defined by MARSSIM.

Sources of Contamination

SPRU processes contributed to the contamination in each of the facilities. The SPRU facility decontamination and decommissioning events through at least 1966 also generated radioactive waste. However, non-SPRU KAPL activities in G2, H2, the Tunnels, and the Tank Farm after SPRU decommissioning continued to contaminate these areas. Building H2 was used for waste management at least until 2001 when a new waste management facility at E11 became operational. Some Tunnel piping is still used to transport liquid waste.

Likelihood of Contamination Migration

The Tank Farm vaults pose the highest potential for contamination migration relative to the other SPRU facilities. Contaminated water from unknown sources around H2 is collected in the H2 footer drains and treated in the Hillside Drain System. Buildings G2 and H2 are concrete structures with contaminated concrete and abandoned equipment, but there is no evidence of migration from inside the buildings. If the facilities are demolished, a risk of releases to the air and soil exists. There is evidence of prior water seepage into the G2-H2 Tunnel and evidence of radioactive sludge in the north tunnel sump. There is no evidence that other SPRU areas are probable contamination pathways to the environment.

Natural events such as earthquakes, flooding, fire, or human accident scenarios have the possibility of both altering the physical conditions reported in this historical site assessment and increasing the probability of contaminating the environment.

Threat to Human Health

The SPRU facilities are identified and managed as radiological control areas with specific area access restricted as appropriate. Human health risk to the public and current workers is considered as low as reasonably achievable. The greatest risk to human health is to workers should demolition of the facilities occur, although the risk is considered manageable.

Further Characterization Needs

The Tunnels and the piping in the Tunnels potentially require additional characterization prior to demolition activities because there is little information regarding contamination in the Tunnels and piping. There are interview references to pipes nearly full of sludge and other references indicating the pipes were flushed to remove residual sludge. Two H2 areas recommended for further characterization include the Hopper Cells and the Pipe Tunnel. The accessible areas of Building G2 were surveyed in 2004, and the Tank Farm tanks and vaults were characterized during the 1989 and 1998 surveys.

The conditions summarized above are based on historical site assessment information and assessments and are relevant only for the near future. Under current conditions and surveillance and maintenance activities, SPRU-related contamination is contained within the facilities, equipment, tanks, piping, and managed in the Hillside Drain System.