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1.0 INTRODUCTION

After run HD-16 was completed, some portions of the Thorex pilot plant were decontaminated to permit replacement of faulty equipment and to install shielding. A jet for transferring solution from the feed adjustment tank to the feed tank required replacement because indications were that the jet throat had corroded out. The stripping column and silica gel column were decontaminated in order to lower the radiation level at the cubicle entrance so that maintenance personnel could install concrete block shielding. The partitioning column and BT evaporator (thorium product stream) were decontaminated to permit extending the shield walls to the top of the column, installing a monitor in the AU stream, and replacing a packed valve in the evaporator outlet line with a bellows-sealed valve. Several other pieces of equipment were also shielded, and a centrifuge in the solvent recovery system was removed.

During this work, decontamination and radiation exposure data were collected and are reported herein.

2.0 SUMMARY

The feed adjustment tank was decontaminated to a final radiation level of 950 mr/hr at contact with 30% nitric acid and 20% caustic--2% sodium tartrate solution. The activity retained in the outer jacket, a large open-top container in which the feed adjustment tank is contained and which collects material ejected from the tank, was especially difficult to remove, having been heated in a dry state several times at temperatures up to 150°C, and limited the extent to which decontamination could be achieved.

The top of the partitioning column was easily decontaminated to 13 mr/hr, but decontamination of the BT evaporator was limited by contamination on the walls of the cubicle. The radiation level at the evaporator was only decreased from approximately 600 mr/hr to 400 mr/hr.

Two acid treatments alternated with two caustic-tartrate treatments were sufficiently effective to reduce the radiation level at the bottom of the stripping column from 2,300 mr/hr to 230 mr/hr.

An elution of the silica gel column with 0.5 M nitric acid followed by 4% oxalic acid brought the radiation level of the column from 23,000 mr/hr to 4,000 mr/hr.

Maintenance personnel received an average exposure rate of 51 mr/man-hr while working in the feed adjustment tank cubicle. Seventeen men worked 35.7 man-hr while installing a new transfer jet and thermocouple on the feed adjustment tank.

In the BT evaporator cubicle, 3 men worked a total of 3.75 man-hr and received an average dosage rate of 37 mr/man-hr.

The removal of the centrifuge from Cell 7 resulted in an average exposure rate of 34 mr/man-hr for seven men who worked a total of 32.5 man-hr.

New shielding was installed in 18 locations in the pilot plant.

3.0 EQUIPMENT DECONTAMINATION

3.1 The Feed Adjustment Tank, S-2

The decontamination of this tank was encumbered by the external jacket in which the activity ejected from the tank (during pressure surges in the tank) was tenaciously retained because of being heated in a dry state for several hours at temperatures up to 150°C. The suction line of the jet for emptying the outer jacket was plugged, requiring that 400 gallons or more of solution be syphoned from the jacket before the suction line became unplugged.

After the tank was treated six times with 30% nitric acid and four times with 20% caustic--2% tartrate solution, the radiation from the vessel was 3,000 mr/hr at a distance of 2.5 ft away and 1 ft above the tank (Table 3-1). The outer jacket was filled to overflowing and approximately 400 gallons of water was allowed to overflow; the radiation level at the same point was 750 mr/hr and at contact with the tank was 1,600 mr/hr. After the internal surfaces were treated with another cycle of acid followed by caustic-tartrate solution and the external surfaces were treated with four cycles of acid and caustic-tartrate solution, the radiation level was not further decreased by additional decontamination. The final radiation level, after a total of nine acid and seven caustic-tartrate treatments were given to the tank interior, and five acid and four caustic-tartrate treatments were given to the tank exterior, was 950 mr/hr at contact. The radiation level at the tank nozzle where the S-2 to S-4 jet was to be replaced was 700 mr/hr, permitting 8.5 minutes of working time (based on 100 mr/day tolerance).

Table 3-1
Decontamination of the Feed Adjustment Tank

Solution ^a	Surface ^b Contacted	Volume, ^c liters	Radiation ^d Level at Shield mr/hr	Radiation Level at Contact, mr/hr
A	I	600	--	--
A	I	600	--	--
T	I	700	--	--
A	I	600	--	--
T	I	700	--	--
A	I	600	--	--
T	I	700	3,000	--
A	I	600	--	--
T	I	700	3,000	--
A	I	600	3,000	--
water	E	1500	750	1,600
A	I	600	--	--
T	I	700	750	1,500
A	E	400	--	1,000
T	E	400	--	--
A	E	400	--	--
T	E	400	--	--
A	E	400	--	--
T	E	400	--	--
A	E	400	280	950
T	E	400	--	--
A	E	400	--	--
A	I	600	300	950
T	I	700	--	--
A	I	600	300	950
T	I	700	300	950

a. A: 30% nitric acid; T: 20% sodium hydroxide--2% sodium tartrate.

b. I: internal; E: external.

c. All solutions were contacted for 1 hr at 75-85°C.

d. All measurements were taken with a paper-chamber cutie-pie instrument at a distance of 2.5 ft away and 1 ft above the tank.

3.2 The Partitioning (B) Column and BT Evaporator

The partitioning column was decontaminated in order to permit the extension of a cement block shield from the top of the cubicle to the top of the column and to install a monitor in the AU stream. The BT evaporator was decontaminated in order that a packed valve in the aqueous outlet line could be replaced with a bellows-sealed valve.

The radiation level at the point where the AU monitor was installed was reduced from 2,000 mr/hr at the start to 200 mr/hr at the end of decontamination. The radiation level at the top of the column was decreased from 300 mr/hr (Table 3-2) at the start of decontamination to 13 mr/hr (both readings taken at about 1 ft from the column). The column cubicle was later enclosed by extending the south face with concrete blocks to the top of the column and by erecting a 0.5-in.-thick lead wall on the east side of the cubicle.

After the evaporator had been treated with 8 acid and 8 caustic-tartrate passes of decontamination solutions, the radiation level at evaporator still measured 400 mr/hr owing to contamination on the wall of the cubicle. The general background in the cubicle was 400 mr/hr, the west wall was 600 mr/hr, and the background at the valve that was to be replaced was 80 mr/hr. Working time for maintenance personnel was 75 min.

Table 3-2

Decontamination of the Partitioning Column and BT Evaporator

Solution	Volume, liters	Radiation Level at Top B-column, mr/hr	Radiation Level at Evaporator, mr/hr
none	--	300	~600
T ^{a, c}	700	--	--
A ^{b, c}	600	--	--
T ^c	700	--	--
A ^c	600	130	350
T ^c	700	--	--
A ^c	600	--	--
T ^c	700	--	--
water ^d	700	--	--
water ^d	700	13	--
A ^e	600	--	--
T ^e	700	--	400
A ^e	600	--	500
T ^e	700	--	--
A ^e	600	--	--
T ^e	700	--	400
A ^e	600	--	--
T ^e	700	--	400
A ^e	600	--	400

- a. T: 20% sodium hydroxide--2% sodium tartrate, contacting for 1 hr.
- b. A: 30% nitric acid, contacting for 1 hr.
- c. Solution allowed to flow from B-column through the evaporator.
- d. Water rinse on B-column only.
- e. Solution used to treat only the evaporator.

3.3 The Stripping (C) Column

At the start of decontamination, the radiation level near the organic inlet line to the bottom section of C-column was 2,300 mr/hr, and after 2 acid and 2 caustic-tartrate treatments, the radiation level was 230 mr/hr (Table 3-3).

Table 3-3
Decontamination of the Stripping Column

Solution	Volume, liters	Radiation Level, mr/hr
none	--	2,300
A ^a	600	--
T ^b	700	--
A	600	--
T	700	230

a. 30% nitric acid, contacting
for 1 hr.

b. 20% sodium hydroxide--2%
sodium tartrate, contacting
for 1 hr.

3.4 The Silica Gel (R-5) Column

The radiation level of the silica gel column was reduced from 23,000 to 4,000 mr/hr at 6 in. with dilute nitric acid and 4% oxalic acid solution (Table 3-4).

The procedure for eluting protactinium, zirconium, niobium, and mixed fission products and for reconditioning the silica gel sorption column is ⁽¹⁾:

1. Wash with 2 to 3 volumes of 0.5 M HNO_3 to remove traces of thorium and uranium which might precipitate in the elution step.
2. Wash with 1 to 2 volumes of water to remove excess acid from step (1).
3. Pass 2 to 4 volumes of eluant, 4% oxalic acid, through the column for activity removal.
4. Wash the column with water or 0.01 M HNO_3 for removal of eluant and to recondition the column.

(1) ORNL-1431, p. 39.

This procedure was followed except that the entire sequence was repeated and several more volume changes of solutions were used. Since the capacity of the column is 40 liters, the solutions were continuously jetted from the column to the miscellaneous waste catch tank, N-16.

Table 3-4
Decontamination of the Silica Gel Column

<u>Solution</u>	<u>Volume, liters</u>	<u>Radiation Level, mr/hr</u>
none	--	23,000
0.6 M HNO ₃	240	--
H ₂ O	150	--
4% Oxalic	300	--
0.01 M HNO ₃	80	--
H ₂ O	380	6,500
0.6 M HNO ₃	240	--
H ₂ O	150	--
4% Oxalic	300	--
0.01 M HNO ₃	80	--
H ₂ O	380	--
H ₂ O	380	4,000

3.5 The Solvent Recovery System

The solvent system was flushed with soap and water. The solvent head tanks M-13 and M-14 were filled with water and a box of Tide was added; this solution was steam-sparged for 1 hr and drained. The tanks were flushed with water. This flush reduced the radiation level from 70 mr/hr at contact to 30 mr/hr.

4.0 RADIATION EXPOSURES

4.1 Exposure Received During Installation of S-2 Transfer Jet and Temperature Thermocouple

Seventeen men worked a total of 35.7 man-hr and received a total of 1,815 mr (as indicated by film badge PTR reading) during the installation of the transfer jet and thermocouple in the feed adjustment tank. The average exposure was 51 mr/man-hr (Table 4-1).

Table 4-1
Exposure Received During Installation
of a Transfer Jet and Thermocouple in S-2 Tank

Number ^a	Date	Time Spent in Area, hr	Exposure, ^b mr	Craft
18	2-28	0.5	0	laborer
69	2-28	7.25	50	laborer
18	3-6	7.0	160	laborer
63	3-6	7.0	65	laborer
61	3-7	0.75	140	laborer
104	3-7	0.75	125	laborer
100	3-7	0.75	0	laborer
16	3-7	1.0	60	lead burner
17	3-7	1.0	60	lead burner
26	3-8	0.33	150	pipefitter
71	3-8	0.33	100	pipefitter
26	3-9	2.5	200	pipefitter
71	3-9	2.5	200	pipefitter
85	3-9	2.5	115	welder
106	3-9	0.5	130	inst. mech.
72	3-12	0.5	130	electrician
95	3-12	0.5	130	electrician
Total	--	35.7	1,815	--

a. All maintenance personnel are identified by a number.

b. Each person wore a special film badge while working on this job. The exposure is reported as film badge PTR reading.

4.2 Exposure Received While Replacing the Density Control Valve on the BT Evaporator

The density control valve was replaced by two pipefitters and one welder who worked a total time of 3.75 man-hr and received 140 mr (film badge PTR readings), or an average of 37 mr/man-hr.

4.3 Removal of T-3 Centrifuge

The centrifuge, being no longer used for solvent cleanup, was removed from Cell 7. Seven men worked 32.5 hr on this job and received a total PTR of 1,095 mr, or an average of 34 mr/man-hr (Table 4-2).

Table 4-2
Exposure Received During Removal of T-3 Centrifuge

Number	Date	Time Spent in Area, hr	Exposure, mr	Craft
26	2-24	7.0	150	pipefitter
28	"	7.0	150	welder
59	"	0.75	120	laborer
63	"	0.75	90	laborer
71	"	7.0	235	pipefitter
72	"	5.0	175	electrician
95	"	5.0	175	electrician

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5.0 SHIELDING

New and additional shielding was installed at eighteen locations throughout the plant during the period of February 27 to March 24, 1956 (Table 5-1).

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Table 5-1

Description of Shielding Installed in the Thorex Pilot Plant

Location	Item Shielded	Type Shielding	Thickness, in.	Added Shielding Description	Date Installed	Equipment Accessibility
Make-up Room	M-13, LAX solvent tank	lead sheet	0.5	3/4 of circum. to floor	3/8	valves not covered
	M-14, LBS solvent tank	lead sheet	0.5	1/2 of circum. to floor	3/8	valves not covered
	M-10, thorium make-up tank	concrete block	6	on front and side	3/3	back and side open
	M-11, thorium head tank	concrete block	6	on front and side	3/3	back and side open
Isol. Lab	L-13, U product tank	lead sheet	0.5	front side	2/28	two sides open
	L-4, elution waste tank	lead sheet	0.5	1-in. front, 0.5 in. side	2/29	valves not covered
Attic	CU standpipe	lead sheet	0.5	4 sides to floor	3/8	top open, sliding door
Pipe Tunnel	T-8, pulser leakage tank	lead sheet	0.5	all circum. and top	3/14	removable top sections
Cell 5	N-8 recycle pump	lead sheet	0.5	3 sides and top	3/1	removable sections
Cell 6	B-column top	6-in. Barytes block	12	front side ^a	3/6	cubicle top open
	B-column top	lead sheet	0.5	east side ^a	3/20	cubicle top open
	P-4 pump	lead sheet	0.5	3 sides and top	3/15	removable sections
	P-4 cubicle, BTC catch tank	concrete block	6	front side ^a	3/15	requires removal ^b
	AU stream monitor	lead brick	4	4 sides, top and bottom	3/16	removable top
Cell 7	C-column cubicle	6-in. Barytes block	12	front side ^a	3/15	requires removal ^b
	T-column cubicle	6-in. concrete block	12	1 6-in. layer to front ^a	3/7	requires removal ^b
	P-50, P-60 cubicle	concrete block	6	1 side on balcony	3/5	front open
	P-65 ET evaporator	lead brick	2	3 sides, 1-in. lead top	3/20	requires removal ^b
	R-11 pump	lead sheet	0.5	3 sides, top	3/12	removable top

a. Shielding was added to an open side, or front. On the top of B-column, the east side was also open. On T-column cubicle, a second 6-in. thick layer of concrete block was added to an existing 6-in. thick wall.

b. The concrete blocks will have to be removed before equipment in these cubicles can be repaired.