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DECONTAMINATION AND REMODELING OF A
HIGH LEVEL CHEMISTRY CELL

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Abstract

A hot cell containing a separations pilot plant, after operating for three years at high activity level, was decontaminated and remodeled. The timing, cost and manpower requirements for the reconstruction and decontamination are discussed. Decontamination procedures and corresponding radiation reductions are reported, followed by a discussion of the design revisions necessary to reduce future maintenance.

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Decontamination and Remodeling of a High Level Chemistry Cell

B. V. Coplan and D. J. Smith

I. Introduction

A miniature chemical separations pilot plant was constructed in a hot cell at the Knolls Atomic Power Laboratory in 1951. Known as the Engineering High Level Laboratory, this unit provides a small scale facility for feed preparation and liquid-liquid extraction of high level radioactive solutions. The system is designed to provide a flexible, compact, and easily operated unit at a low initial investment. Plate 11111.33 is a picture showing the operating face of the original cell installation. The liquid-liquid extraction system can be seen through the observation window in the cell in Plate 11111.32. Cell construction and operation is described in KAPL Report No. 812.

Following three years of satisfactory operation, the decision to do a complete decontamination and remodeling of the Engineering High Level Laboratory was reached because of three limitations on the unit. First, the existing feed preparation system had insufficient capacity to supply the extraction system. Second, the unit lacked adequate facilities for carrying out new program ideas. Third, valve failures which had occurred during operation of the system were limiting the usefulness of the pilot plant. The stainless steel valves failed in two ways. The first was a freezing of the valve stem drive thread to the valve body and the second was the destruction of the valve stem teflon packing by radiation.

II. Cost, Manpower, Schedule

For cost analysis, manpower requirements, and scheduling, the project is divided into three phases, decontamination of the cell to receive the new equipment, pre-

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fabrication of all new equipment, and installation of the prefabricated assembly in the cell.

The project took 14 weeks to complete and cost a total of \$30,418. Table I presents the total costs and over-all time involved for each phase. The direct labor charge includes the direct labor charge of all crafts and shops plus the direct labor charge for one chemical engineer and three laboratory assistants who planned and supervised the operation. The overhead charge varies slightly from month to month and from craft to craft but averages about 155% for all the types of direct labor involved. It includes such items as administration, plant services, purchasing and security.

Table II is a breakdown of the manpower used in the operation. An additional 70 man hours were used which is not included in the specific categories of Table II. A number of men volunteered their services for short periods of time in high radiation zones for decontamination purposes and their time was not charged by the KAPL accounting procedure to the EHLL project.

III. Decontamination

The reduction in radiation at four check points during the decontamination procedure as well as the elapsed time for specific decontamination operations is reported in Table III. (The radiation readings were taken at the center of the cell, two feet above the floor.)

Internal flushing of the tanks, lines and valves was accomplished by adding the following solutions to the system in the order given and allowing eight hours of contact in each case.

1) 10% Nitric Acid

3) 10% Oxalic Acid

2) 10% Citric Acid

4) 3% Hydrofluoric Acid - 20% Nitric Acid

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It was not possible to determine the extent of decontamination for each reagent due to the inoperability of the unit samplers but a decrease of one-half in the over-all gamma cell radiation was observed in the cell interior at the end of the procedure.

The persistent high beta radiation readings following the internal flush indicated that active solution had spilled on the outsides of tanks and lines from leaky valves and fittings. An exterior rinse of the tanks, valves, lines, and framework was made by spraying them alternately with 5% nitric acid and water until no significant activity was detected in the rinse solution. The beta radiation level was reduced by a factor of ten in the cell interior by this procedure.

The contaminated equipment in the cell was cut into approximately foot lengths using an electric arc and the sections were then transferred to 55 gallon stainless steel drums for disposal. The maximum contact radiation reading at the surface of the drums as prepared for storage was 3000 mr/hr. This reading decreased to 1000 mr/hr after a three months storage period.

Finally, the strip coat was removed from the cell walls and decontamination of a stainless steel catch tray which covers the bottom of the cell was completed. The tray was decontaminated by placing a solution of 0.04 M KMnO_4 and 5 M HNO_3 in the tray for a period of 16 hours. This solution was then drained out and a solution of 1 M NaNO_2 and 1 M HNO_3 was added. By repeating this operation twice the tray radiation was reduced to background level.

In order to secure a reasonable working time limit in the cell interior, it was necessary to provide additional shielding over small areas of the wall and floor at points where contamination had penetrated the strip coat and soaked into the concrete. The final radiation level in the cell at the end of the decontamination period was 100 mr/hr.

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IV. Prefabrication

Concurrent with the decontamination step, the fabrication of new equipment was carried out. The tanks, valves and lines were assembled on a stainless steel framework of such a size that the package could be moved into the cell without disassembly. In order to increase the ease of equipment operation, provide maximum equipment life, and reduce direct maintenance, provision was made in the design during prefabrication for remote replacement of valves, direct observation of liquid levels, remote sampling, and increased capacity. Plate 1132371 is a picture of the prefabricated unit.

A. Remote Replacement Valves

Twenty-eight valves are located in the cell area. Each of these may be remotely replaced, working through a one and one-half inch stainless steel pipe section which extends through the cell wall to the front face of the cell at a point level with each set of two valves. The valve mounting consists of two stainless steel blocks fastened together with a large bolt. Tubing which extends through holes in the blocks is sealed into a valve on either side of the bolt using standard stainless steel ferrule fittings. The blocks act in place of the standard compression nut of the fitting to seal the ferrule to the tubing. The bolt is remotely loosened to release the valves for replacement.

B. Direct Observation of Liquid Level

Six tanks are installed in the cell in which direct observation of the liquid level can be made. They vary in capacity from 500 ml to 5000 ml. Each tank is constructed from a flanged section of double tough Pyrex glass pipe with a rounded glass bottom. A stainless steel plate is gasketed to the flanged section of the glass pipe at the top of the tank using a teflon gasket. All of the entry lines to

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the tank are stainless steel and pass through the top plate of the tank using standard stainless steel fittings.

C. Remote Sampling

It is possible to take samples from four tanks in the unit. The sampling system consists of a length of stainless steel tubing which originates at a dip line in the tank and passes through a plug valve to a glass surge pot. By placing a vacuum on the surge pot with a syringe, the sample is sucked through the valve into the surge pot where the presence of the sample can be observed. The plug valve is then rotated remotely 90° and the solution that is held up in the plug is discharged through a line in the side of the valve into a traveling cart sample container which brings it to the outside of the cell.

The size of the sample is regulated by the size of the hole that is originally drilled in the plug of the plug valve.

V. Installation

The prefabricated framework was moved into the cell during the tenth week of construction. The valves were lined up with the existing valve stem holes in the cell wall and then ears were welded from the cell framework to the prefabricated assembly to lock the new system in place.

The service facilities from the cell exterior to the new unit as installed are steam, cooling water, chemical entries, sampler vacuum, electric heaters and thermocouples. Plate 1132781 is a picture of the operating face of the completed cell.

The entire system was leak tested before operations were undertaken. Twenty-five psi water pressure was used for the initial pressure check. When all leakage under these conditions had been corrected the water pressure was increased to 85 psi. Again all leaks were corrected. The system was drained and each section of the system was evacuated to 26" Hg. Adjustments were made until the section would hold

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this vacuum for at least one hour. Finally the entire system was subjected to Freon leak testing at 25 psi.

Table IEHLR Remodeling Cost

Decontamination (9 weeks)	Direct Labor	\$ 2,250
	Overhead	3,414
	Material	<u>80</u>
		\$ 5,744
Prefabrication (9 weeks)	Direct Labor	4,209
	Overhead	6,580
	Material	<u>1,607</u>
		\$12,396
Installation (5 weeks)	Direct Labor	4,294
	Overhead	6,690
	Material	<u>1,294</u>
		\$12,278
	TOTAL	\$30,418

Table IIEHLI Remodeling Manpower Requirements

		<u>Man Hours</u>
Decontamination	Engineer	180
	Laboratory Assistants	620
	Health Physics	175
	Shops	0
	Crafts	<u>20</u>
		995
Prefabrication	Engineer	180
	Laboratory Assistants	460
	Health Physics	0
	Shops	130
	Crafts	<u>124</u>
		204
Installation	Engineer	200
	Laboratory Assistants	600
	Health Physics	0
	Shops	104
	Crafts	<u>143</u>
		2047
TOTAL		5056

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Table III

EHLL Decontamination

<u>Operation</u>	<u>Radiation Level Following Operation</u>	
	<u>mr/hr</u>	<u>mrep/hr</u>
Initial	3,000	100,000
Internal Flush (2 weeks)	1,500	100,000
External Rinse (2 weeks)	1,500	11,000
Equipment Removal (3 weeks)	500	500
Cell Cleanup (2 weeks)	100	0

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