**324 and 325 Building
Hot Cell Cleanout Program
Decontamination of C-Cell**

**Y. B. Katayama
L. K. Holton, Jr.**

October 1989

**Prepared for the U.S. Department of Energy
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**Pacific Northwest Laboratory
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Richland, Washington 99352

SUMMARY

During FY 1989 the decontamination of C-Cell of Hanford's 324 Building was completed as part of the 324 and 325 Building Hot Cell Cleanout Program sponsored by the DOE Nuclear Energy's Surplus Facilities Management Program. The decontamination effort was completed using a series of remote and contact decontamination techniques. Initial radiation readings in C-Cell averaged 50 rad/hr and were reduced remotely to less than 200 mrad/hr using an alkaline foam cleaner followed by a 5000-psi water flush. Contact decontamination was then permissible using ultra high-pressure water, at 36,000 psi, further reducing the average radiation level in the cell to less than 86 mrem/hr.

The approach used in decontaminating C-Cell resulted in a savings in radiation exposure of 87% and a cost savings of 39% compared to a hands-on procedure used in A-Cell, 324 Building in 1987. The radiation dose and the costs to achieve a 244-fold reduction in radiation contamination were 1.65 mrem per ft² and \$96 per ft² of cell surface area.

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Successful completion of the final decontamination of C-Cell resulted from team effort. This team consisted of Galen Buck, Jim Hutchens, Mark Culverhouse, Steve Halstead, Sam Morris, John Rau, Ed Doan, Jerry Duce, Ron Holeman, Jim Dunn, Jim Gose, and Frank Haun of the Process Application Section; Frank Gonzales and Jim Helms of Radiation Protection; and Terry Mohar, Mel Owen, Gene Robles, Dennis Smith, Jack Griffith, and Randy Odd of Engineering and Craft Services.

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DECONTAMINATION OF C-CELL

INTRODUCTION

C-Cell, a component of the 324 Building Radiochemical Engineering Facilities at the Pacific Northwest Laboratory (PNL),^(a) is one of the six hot cells designated for cleanout in the 324 and 325 Building Hot Cell Cleanout Program. This program is funded primarily by the Department of Energy's (DOE) Nuclear Energy-managed Surplus Facilities Management Program, with support from other DOE organizations. C-Cell, in service since the mid 1960s, has been used mainly for completing characterization studies of nuclear waste forms. Durability testing of spent fuels and high-level waste (HLW)-filled borosilicate glasses comprised the primary long-term studies completed in C-Cell. Shorter duration activities have most recently included the preparation of ^{137}Cs irradiation capsules for a Federal Republic of Germany commercial sewage plant, the thermal cycling of a WESF^(b) ^{137}Cs capsule, the recovery of noble metals from calcined HLW, and service as the support facility for analyzing samples from vitrification processing runs in B-Cell, 324 Building.

All these activities had led to an accumulation of surplus in-cell equipment and materials that needed to be cleaned from C-Cell to allow further use of the facility. Major portions of the resultant waste from these programs were removed remotely and placed into burial boxes for disposal. Cell decontamination, however, was needed to allow manned entries to remove residual attached material that could not readily be removed remotely.

This report describes the decontamination of C-Cell, and details are provided with the expectation that they may be helpful at other sites doing decontamination work.

(a) Operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

(b) Waste Encapsulation and Solidification Facility.

STATUS OF CELL BEFORE DECONTAMINATION

C-Cell is located beneath D-Cell, and these two half-height cells form the southern arm of the Radiochemical Engineering Facility as shown in Figure 1. All four cells are connected through the centrally located air lock. C-Cell measures 12 ft wide by 19.4 ft long by 15 ft high and has two oil-filled leaded glass viewing windows along its length, with a pair of manipulators at each window. Normally these manipulators are the 10-ft Model E type, but for the cell cleanout a heavier duty 10-ft Model F manipulator was substituted for the right-hand position of the west viewing window. In addition to the four cell penetrations for the manipulators, there are 14 4-in.-dia penetrations to the operating gallery and one 4-in. penetration to the cask-handling area, at the east wall of the cell. One of the 4-in. penetrations to the operating gallery is used as a transfer port. There are a transfer tray and a cell door connecting the air lock to the cell, and

FIGURE 1. 324 Building Radiochemical Engineering Cells

there is a stepped plug in the ceiling of the cell which is removable from D-Cell. All surfaces of the cell are lined with 11-gage stainless steel that has all seams welded. The lining in the sump is suspected to have a leak, the leaded glass shielding windows have become damaged over 21 years of use, and the cell captive overhead crane is in need of contact maintenance.

After most of the surplus in-cell materials were removed, the cell floor was swept remotely with a broom and dustpan to remove the large debris, vacuumed to remove the smaller particulates, and then surveyed remotely with an in-cell Eberline R07^(a) medium-range radiation detection system. To monitor progress of cell decontamination, the floor area was divided into a 6 by 8 matrix and radiation exposure was periodically measured centrally in each ~2-ft² matrix area. Any localized hot spots found were noted on the radiation survey sheets. Measurement results from the first survey following a floor sweep and vacuum are shown in Figure 2. The radiation rate ranged

FIGURE 2. Measurements in rad/hr (beta + gamma) of C-Cell Contamination

(a) Manufactured by the ThermoElectron Corporation, Sante Fe, New Mexico.

from 2.6 to >200 rad/hr, the maximum limit of the medium-range radiation probe used. High radiation levels correlate with the locations of in-cell work table areas, in front of the shielded viewing windows, where most of the manipulator-handled activities had been performed. The transfer of B-Cell processing samples into C-Cell via the shelf on the cell door may account for the areas of increased radiation extending from the door shelf to the work tables.

Smear samples of selected areas measuring about 100 cm² were taken remotely on cotton dental rolls wetted with 2M HNO₃, and then packaged and shipped to the Radiochemistry Laboratory for analyses. The areas that were smear-sampled are shown as circled numbers in Figure 3. These numbers serve to locate the smear samples enumerated in Tables 1 and 2 as follows: Smear no. 1 was taken from a hot spot in the trough; no. 2 from the top surface of the electrical service rack on the west wall; no. 3 from a hot spot in front of the east window; no. 4 from a generally low-level area near the north

FIGURE 3. C-Cell Smearable Contamination Sampling Areas

TABLE 1. Radiochemistry of Five Surface Areas
in C-Cell After Vacuum Cleaning

Radionuclide	Smear Samples - 100 cm ²				
	dis/min/smear				
	1	2	3	4	5
¹³⁴ Cs	2.21E6	---	3.72E6	---	1.19E6
¹³⁷ Cs	5.84E9	2.22E9	3.21E9	2.92E9	5.08E8
¹⁵⁴ Eu	1.78E6	---	---	---	---
⁹⁰ Sr	3.98E9	8.75E9	1.39E9	2.84E9	4.32E8
²³⁹⁺²⁴⁰ Pu	1.36E5	6.41E4	1.51E5	7.08E4	4.66E4
²⁴¹ Am + ²³⁸ Pu	1.47E6	5.93E5	2.15E6	9.09E5	5.28E5
²⁴⁴ Cm	1.76E6	8.91E5	3.19E6	1.40E6	7.05E5
	μg/smear				
U	33	15	83	15	15

TABLE 2. Ratio of Activity Level of Radionuclide
to Activity Level of ²⁴⁴Cm

Radionuclide	Smear Samples				
	1	2	3	4	5
¹³⁷ Cs	3.32E3	2.49E3	1.01E3	2.09E3	7.21E2
⁹⁰ Sr	2.26E3	9.82E3	4.36E2	2.02E3	6.13E2
²³⁹⁺²⁴⁰ Pu	7.73E-2	7.19E-2	4.73E-2	5.06E-2	6.61E-2
²⁴¹ Am + ²³⁸ Pu	8.35E-1	6.66E-1	6.74E-1	6.49E-1	7.49E-1
U	1.88E-5	1.68E-5	2.60E-5	1.07E-5	2.13E-5
²⁴⁴ Cm	1.0	1.0	1.0	1.0	1.0

wall; and no. 5 from the top surface of the east exhaust filter housing. Results of the radiochemical analyses given in Table 1 show the presence of spent fuel along with indications of contaminating contributions from experiments using ^{137}Cs and ^{90}Sr . This indication becomes clearer when the analytical data are ratioed to ^{244}Cm , which was present in C-Cell solely from spent fuel, as shown in Table 2. The actinide elements are near constant whereas the cesium and strontium ratios are more varied, indicating an increase from sources other than spent fuel.

CELL DECONTAMINATION

STRATEGY

The radiation levels in C-Cell before decontamination were similar to those in A-Cell before it was decontaminated in 1987. For A-Cell, radiation exposures totalled about 33,000 mrem and the cost of decontamination totalled about \$420,000. Although these numbers were expected to be lower for C-Cell since the surface area there is 59% that of A-Cell, the extrapolated numbers of 20,000 mrem and \$250,000 were still considered inappropriately high. Since the major contributor to these large numbers had been the use of an essentially total hands-on decontamination process, it was decided to maximize the use of remote and/or technically advanced processes. For C-Cell, the choice was remote soak/pressurized water-rinse to a radiation level of about 200 mrad/hr or lower before manned entry for final decontamination with ultra high-pressure water. The soak/pressurized water rinse had effectively removed smearable contamination during a decontamination demonstration in July 1988 on the air lock cover blocks.

REMOTE PRELIMINARY DECONTAMINATION

The preliminary decontamination was done remotely by combining an alkaline cleaner foam spray system with a pressurized water system. A decontamination cycle included loosening the adhering surface contaminants with a foam soak followed by a pressurized water rinse.

The foam spray was applied through an ARO^(a) low-pressure, double-acting piston air pump with a 1:1 compression ratio, which limited the foam spray to the building air supply of about 100 psig. The chemical composition of the foam was determined during the initial equipment setup and consists of one part AE-3003 alkaline jet engine cleaner, two parts FOME ADD foam stabilizer, and ten parts water. Both additives are proprietary formulations of DuBois Chemical^(b). At 100 psig the pump flow rate is about 3 gpm and the maximum nozzle-to-surface working distance is about 12 ft. Figure 4 shows alkaline foam being sprayed on the C-Cell wall.

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FIGURE 4. Alkaline Foam Being Sprayed onto C-Cell Wall

(a) ARO Corporation, One ARO Center, Bryan, Ohio.

(b) DuBois Chemical is a division of Chemed Corporation, Cincinnati, Ohio.

The pressurized water system consists of a high-pressure plunger pump that is belt-driven with a 15-hp electric motor. Water pressure available to the spray nozzle may be set by adjustments to a regulating unloader valve. In the decontamination of C-Cell, the pressure unloader was set at 5000 psig to give a water flow rate of about 1.6 gpm through a spray nozzle having a 0.031-in.-dia. tungsten carbide orifice. Figure 5 shows the foam, after soaking for about 30 min., being spray-washed from the C-Cell wall. Figure 6 shows an extended articulated spray wand, suspended from the cell crane hook,

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FIGURE 5. Alkaline Foam, After About a 30-min. Soak, Being Washed from C-Cell Wall with Pressurized Water

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FIGURE 6. Articulated Spray Wand Suspended on Cell Crane

for washing the foam from the ceiling and from a ledge that encircles the placement of the cleaning wand nozzle, a remotely operated Rees Instruments CCTV camera with a 30- to 150-mm nonbrowning motorized zoom lens mounted atop a motorized pan and tilt unit was used. Figure 7 shows a view, photographed with the aid of a through-the-wall periscope, of the in-cell trough containing debris deposited during the first cleaning cycle. This material was removed with a remote vacuum cleaner prior to the second decontamination cycle.

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FIGURE 7. View Through C-Cell Viewing Periscope Showing Debris Washed to Trough During First Decontamination Cycle

The radiation level of the cell surface was measured after each decontamination cycle. The remote radiation detection system previously described was used, and progress was monitored employing the same 6 by 8 cell matrix plus six additional areas. These latter areas represented the wall, the top of the exhaust filter, and the top of the electrical wiring tray for both the east and west cell walls. The average radiation exposure for the 54 selected areas calculated for each decontamination cycle is as follows:

Start	21.0 rad/hr
First cycle	5.9 rad/hr
Second cycle	(no measurement made)
Third cycle	1.4 rad/hr
Fourth cycle	1.1 rad/hr
Fifth cycle	0.6 rad/hr
Sixth cycle	0.6 rad/hr.

Although the effectiveness of the decontamination to the fifth cycle is apparent, the sixth cycle does not appear to have helped lower overall radiation exposure in the cell. Likewise the redistribution of radioactivity observed between the decontamination cycles is not reflected in these averaged numbers.

Table 3 lists the radiation survey data and calculated decontamination factors (DF) for the six decontamination cycles. Figure 8 serves as a key to Table 3, locating the measured areas by their numerical designations. The increases and decreases in the radiation rates are random in location and in cycle number. Radioactivity from the walls and ceiling was observed to recontaminate lower horizontal surfaces, and the movement of radioactivity along horizontal surfaces with a manipulator-held spray wand was not always predictable. The overall DFs for the six cycles ranged from 2.97 to 1000, with the 2.97 value representing the cell sump. The radiation rate at the sump surface was never lower than 23 rad/hr and is believed to indicate that radioactivity was trapped between the stainless steel sump liner and the sump floor. The lack of starting radiation data for cell locations 49 through 54 may account for their lower overall DF values as they were calculated from measurements taken after the first cycle. The cell crane became marginally operative and was not used for remote radiation measurements after the

TABLE 3. Radiation Data Taken During Preliminary Remote Decontamination of C-Cell, in rads/hr, and Calculated Decontamination Factors

Location ^(a)	Start	After 1st Cycle		After 3rd Cycle		After 4th Cycle		After 5th Cycle		After 6th Cycle		Overall
			DF		DF		DF		DF		DF	DF
01	2.6	2.4	1.08	4.6	0.52	0.6	7.67	0.4	1.50	0.5	0.80	5.20
02	7.0	9.5	0.74	6.4	1.48	0.7	9.14	NA	NA			
03	8.5	3.0	2.83	4.0	0.75	0.5	8.00	0.5	1.00	0.3	1.67	28.33
04	2.5	2.6	0.96	2.8	0.93	0.5	5.60	0.3	1.67	0.2	1.50	12.50
05	3.6	3.8	0.95	2.5	1.52	0.5	5.00	0.2	2.50	0.2	1.00	18.00
06	4.6	3.9	1.18	2.5	1.56	0.5	5.00	0.2	2.50	0.2	1.00	23.00
07	3.8	3.8	1.00	2.3	1.65	0.4	5.75	0.2	2.00	0.1	2.00	38.00
08	3.9	3.0	1.30	2.4	1.25	0.5	4.80	0.2	2.50	0.1	2.00	39.00
09	5.0	4.8	1.04	2.6	1.85	0.5	5.20	0.9	0.56	0.1	9.00	50.00
10	4.0	5.2	0.77	2.4	2.17	0.5	4.80	0.2	2.50	0.1	2.00	40.00
11	7.0	8.0	0.88	2.6	3.08	0.5	5.20	0.2	2.50	0.1	2.00	70.00
12	8.0	6.0	1.33	2.6	2.31	0.5	5.20	0.2	2.50	0.2	1.00	40.00
13	8.0	5.0	1.60	2.8	2.86	0.5	16.00	0.4	1.25	0.2	2.00	40.00
14	6.0	4.5	1.33	3.7	1.22	0.6	6.17	0.7	0.86	0.3	2.33	20.00
15	18.4	12.0	1.53	3.0	4.00	0.6	5.00	0.4	1.50	0.5	0.80	36.80
16	3.8	3.2	1.18	3.4	0.94	0.6	5.67	0.4	1.50	0.4	1.00	9.50
17	8.0	7.5	1.07	3.4	2.21	0.7	4.86	0.4	1.75	0.4	1.00	20.00
18	15.0	12.5	1.20	3.0	4.17	0.7	4.29	0.7	1.00	0.4	1.75	37.50
19	11.0	22.0	0.50	3.1	7.10	0.6	5.17	1.3	0.46	0.3	4.33	36.67
20	6.3	5.0	1.25	3.7	1.35	0.5	7.40	0.3	1.67	0.2	1.50	31.50
21	15.0	45.0	0.33	2.5	18.00	0.5	5.00	0.2	2.50	0.2	1.00	75.00
22	17.0	10.0	1.70	2.6	3.85	0.5	5.20	0.2	2.50	0.1	2.00	17.00
23	8.2	5.7	1.44	2.5	2.28	0.5	5.00	0.2	2.50	0.2	1.00	41.00
24	7.9	5.8	1.36	2.8	2.07	0.5	5.60	0.4	1.25	0.1	4.00	79.00
25	19.0	18.0	1.06	3.0	6.00	0.6	5.00	0.3	2.00	0.1	3.00	190.00
26	18.0	11.0	1.64	2.5	4.40	0.5	5.00	0.2	1.50	0.2	1.00	90.00
27	15.0	15.0	1.00	2.8	5.36	0.6	4.67	0.2	3.00	0.2	1.00	75.00
28	46.0	34.0	1.35	3.0	11.33	0.6	5.00	0.3	2.00	0.2	1.50	230.00

TABLE 3. Cont'd.

Location ^(a)	Start	After 1st Cycle		After 3rd Cycle		After 4th Cycle		After 5th Cycle		After 6th Cycle		Overall
		DF	DF	DF	DF	DF	DF	DF	DF	DF	DF	DF
29	9.0	18.0	0.50	2.9	6.31	0.6	4.83	0.4	1.50	0.2	2.00	45.00
30	20.0	15.0	1.33	3.3	4.55	0.6	5.50	2.0	0.30	0.3	6.67	66.67
31	45.0	14.0	3.21	5.0	2.80	1.3	3.85	1.6	0.81	1.3	1.23	34.62
32	21.6	60.0	0.36	5.8	10.34	2.3	2.52	1.0	2.30	0.8	1.25	27.00
33	40.8	11.0	3.71	9.6	1.15	3.0	3.20	2.7	1.11	3.6	0.75	11.33
34	200.0	55.0	3.64	19.0	2.89	5.2	3.65	3.8	1.37	3.8	1.00	52.63
35	200.0	30.0	6.67	3.7	8.11	1.1	3.36	1.5	0.73	0.3	5.00	666.67
36	16.0	13.0	1.23	4.2	3.10	1.3	3.23	0.5	2.60	0.3	1.67	53.33
37	10.0	17.5	0.57	8.3	2.11	1.2	6.92	0.5	2.40	0.6	0.83	16.67
38	40.0	25.0	1.60	3.2	7.81	1.1	2.91	0.3	3.67	0.2	1.50	200.00
39	200.0	55.0	3.64	3.2	17.19	1.0	3.20	0.4	2.50	0.2	2.00	1000.00
40	20.0	9.0	2.22	5.5	1.64	1.8	3.06	0.5	3.60	0.2	2.50	100.00
41	18.0	16.0	1.13	12.0	1.33	3.6	3.33	0.2	18.00	0.5	0.40	36.00
42	50.0	12.4	4.03	5.5	2.25	1.2	4.58	0.9	1.33	0.6	1.50	83.33
43	22.0	23.0	0.96	4.6	5.00	1.0	4.60	0.4	2.50	0.5	0.80	44.00
44	23.0	30.0	0.77	5.8	5.17	1.5	3.87	0.6	2.50	0.5	1.20	46.00
45	42.0	38.0	1.11	5.8	6.55	1.8	3.22	1.2	1.57	0.5	2.40	84.00
46	200.0	75.0	2.67	12.0	6.25	3.2	3.75	1.6	2.00	0.5	3.20	400.00
47	200.0	150.0	1.33	35.0	4.29	10.0	3.50	4.6	2.17	2.8	1.64	71.43
48	85.0	28.0	3.04	46.0	0.61	23.0	2.00	24.3	0.95	28.6	0.85	2.97
49	NA	13.7		14.2	0.96	6.7	2.12	6.5	1.03	2.5	2.60	5.48
50	NA	10.7		3.7	2.89	2.7	1.37	3.0	0.90	1.6	1.88	6.69
51	NA	2.9		4.8	0.60	0.8	6.00	1.0	0.80	0.4	2.50	7.52
52	NA	2.0		5.9	0.34	0.8	7.38	0.3	2.67	0.4	0.75	5.00
53	NA	5.5		7.4	0.74	1.2	6.17	0.8	1.50	1.5	0.53	3.67
54	NA	7.8		8.6	0.91	1.2	7.17	0.9	1.33	0.5	1.80	15.60

(a) For in-cell location of radiation measurement see Figure 8.

FIGURE 8. Numerical Designations, as used in Table 3, for Areas in the 6 x 8 Radiation Survey Matrix and for the Six Additional Remotely Surveyed Areas

seventh decontamination cycle. On completion of the preliminary decontamination phase totalling eight cycles, the radiation level within C-Cell measured between 150 and 200 mrad/hr for most of the cell. The exception was a higher radiation level immediately atop the cell sump. Here radioactivity is suspected to have seeped under the stainless steel liner through a liner breach that is yet to be located. A semiremote dye-penetrant test of the sump liner showed no macroscopically obvious cracks in the liner although many signs of pitting were present. A radiation shielding cover of stainless steel and lead was placed over the sump during the first manned entry into C-Cell.

FINAL DECONTAMINATION

An ultra high-pressure water decontamination system manufactured by Admac, Inc. was used for the final decontamination. A diesel-powered Jetpac ultra high-pressure pump system, with four parallel, hydraulically driven,

double-acting fluid intensifiers, was used to feed a Model 5050 MKII-A Jetlance™ system. The hand-held Jetlance had a hydraulic motor-driven, high-speed rotary spray head containing eight fluid jet nozzles with 0.008-in.-dia orifices.

For ALARA purposes, a 36-in. stem set was used to maximize the distance between the technician and the surfaces being cleaned. A hands-on training session, held in a nonradioactive area and prerequisite for in-cell qualification, allowed each technician to become familiar with the operational features of the Jetlance. Figure 9 shows the Jetlance with the 3-ft extension being used during the training session. Potential hazards from improper handling of the Jetlance were demonstrated by spray-damaging samples of in-cell protective apparel and equipment such as shown in Figure 10.

For the final decontamination, the technicians wore water-shedding plastic sheeting taped over the normal paper-based hood and a fresh air-supplied mask. Figure 11 shows a technician as the water is turned on to the Jetlance. The technicians had their individual ways to handle the thrust from the water jets; some would rock back as the water was turned on and then move the nozzle to the effective working distance of 1 in., and others would start with the nozzles close to the wall. Figure 12 is a typical view of the activated Jetlance at the normal decontamination distance from the work surface.

For safety, only the Jetlance operator was allowed in C-Cell during decontamination. The observer was stationed at the C-Cell viewing windows, with visual communication to the in-cell operator and vocal communication to the air lock door attendant. The wash water was seen to contain dark particulates when the ledge that encircled the cell at the 12-ft level was being cleaned with the Jetlance. The stainless steel wall liner was observed to become shinier as the Jetlance was passed over its surface.

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FIGURE 9. Training Session on Use of Admac Jetlance with 36-in. Extension

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FIGURE 10. Demonstration of Potential Hazards Resulting from Careless Use of Jetlance

It was fatiguing to use the 28-lb Jetlance, with its heavy trailing water and hydraulic hoses, on the ceiling and elevated wall areas (Figure 13), where the actual cleaning times ranged from 10 to about 30 min. To decrease the effect of the water thrust, nozzle pressure was lowered to about 26,000 psig for the ceiling and elevated wall areas. The lower walls and floor were done at about 39,000 psig water pressure, and cleaning times increased to range from 20 to 40 min.

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FIGURE 11. View of Operation When Ultra High-Pressure Water Is Initially Turned On in Jetlance

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FIGURE 12. Typical Distance Between Jetlance and Surface
During Decontamination

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FIGURE 13. Physical Conditions for Elevated Hand-Held Jetlance Operation

POST-DECONTAMINATION ANALYSES

The final radiation dose measurements and smear samples were taken on typical areas of cell surface distributed as shown in Figure 14. Squares of 100 cm^2 were marked on the surfaces, and direct radiation readings with a black widow CP and smear samples were both taken for each area. These smear samples were packaged and removed from the cell for radioactivity measurements with a pancake-probed Geiger-Müller counter. Table 4 shows the radiation data from the final radiation survey of C-Cell. The smear sample from position 13, where a temporary sump pump was located, measured off scale, $>100,000$ counts per minute, with the pancake-probed GM, and 13 mrad/hr with a CP. This smear sample contained macroscopically visible particulates. The remaining 12 smear samples averaged 11,800 counts/min/ 100 cm^2 , which corresponds to about 1 mrad/hr/ 100 cm^2 . Direct radiation measurements of the same 12 areas before smear sampling averaged 149 mrad/hr and 97.5 mR/hr.

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FIGURE 14. Locations of Final Radiation Survey in C-Cell Shown on a Floor and Wall Layout Sketch

TABLE 4. Final Radiation Survey Measurements in C-Cell. Direct surface readings were taken with a black widow CP, and 100-cm² smear-sample readings were made with a pancake-probed GM and a CP.

<u>Location</u>	<u>Direct Reading</u>		<u>Smear Samples</u>	
	<u>Black Widow CP</u> <u>mrad/hr</u>	<u>mR/hr</u>	<u>GM</u> <u>counts/min</u>	<u>CP</u> <u>mrad/hr</u>
1	50	50	10,000	1
2	40	40	4,500	
3	40	40	3,000	
4	100	100	2,000	
5	110	110	15,000	
6	120	120	25,000	2
7	110	110	15,000	
8	80	80	8,000	
9	100	80	20,000	
10	40	40	14,000	
11	<Detectible Limit	<Detectible Limit	10,000	
12	1,000	400	15,000	
13	1,000	400	>100,000	13

Radiation measurements taken facing north, east, south and west while standing in the center of the cell were 100/50, 120/80, 150/100 and 120/80, respectively, for window open (mrad/hr)/window closed (mR/hr). These compass direction measurements average 122 mrad and 78 mR/hr and are in good agreement with the averaged cell surface readings.

The stainless steel floor of C-Cell contains many surface pits and scratches, which provide readily accessible collection sites for contamination particulates. The low water flow rate of the Admac system, about 6 gpm, made it difficult to wash fine particulates over this rough surface to the sump even though the floor slopes down 1.5 in. in the 12-ft north-south direction of the cell towards a trough along the south cell wall. This fact is evident in the gradation of radiation rate measurements from the rear to

the front of the cell, as shown in Figure 14. Some fine particulate material can be observed, with the aid of the periscope, on the front portions of the cell floor.

A total of 26 cell entries were made by hot-cell technicians, with an average Jetlance operating time of about 21 min per entry. The overall Jetlance cleaning rate for the 1592 ft² surface of the hot cell was 176 ft²/hr. Since about 20 additional minutes per entry is spent in putting on and removing the hot-cell protective apparel, considerable savings may be realized by extending the use time of the Jetlance per cell entry. Most of the short-duration cell entries occurred in cleaning the ceiling and high elevations on the walls, where lifting the Jetlance and hoses (while holding the trigger-type on/off valve), coupled with the water jet thrust, was physically tiring. Future manned in-cell use of the Jetlance for decontaminating elevated surfaces will utilize a weight-supporting fixture and a nozzle-to-surface spacer.

A radiation dose of 2,626 mrem was accumulated during the 26 cell entries by hot-cell technicians and four cell entries by radiation protection technologists required to complete C-Cell decontamination. This dose corresponds to 1.65 mrem/ft² of surface decontamination. Thus the use of a remote predecontamination process and a final decontamination with ultra high-pressure water reduced radiation dose by about 87% compared to the totally hands-on methods employed previously.

The decontamination cost was \$153,000, with technician labor costs being 68% of this total. This latter cost could have been reduced by improved methods for handling the Jetlance as described previously and by improved design of the remotely held spray wand used for the preliminary decontamination. The eight decontamination cycles used during the preliminary decontamination may be reduced to about four cycles with a properly designed spray wand. Based on the surface area of C-Cell, 1,592 ft², the unit cost to decontaminate from 36,360 mrad/hr to 149 mrad/hr was \$96/ft². This cost is about 39% lower than the unit cost for surfaces cleaned previously using totally hands-on methods.

A total of 1,476 gal of waste water, 0.93 gal/ft², was generated during the decontamination and was transferred to a low-level waste treatment facility after sampling.

CONCLUSIONS

The 324 Building C-Cell, with a 1,592-ft² stainless steel lining, was decontaminated from an average of 36,360 mrad/hr to an average of 149 mrad/hr. A remote predecontamination process was used followed by a final decontamination with ultra high-pressure water, yielding these results:

- Cost was \$96/ft².
- Radiation dose was 1.65 mrem/ft².
- Ultra high-pressure water cleaning rate was 176 ft²/hr.
- Low-level waste water generation rate was 0.93 gal/ft².

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