ESG-80-23

DIAMOND ORDNANCE RADIATION FACILITY

DECOMMISSIONING PROGRAM

FINAL REPORT

by

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ABSTRACT

The Atomics International (AI) Division of the Energy Systems Group (ESG) of Rockwell International was contracted by the Department of the Army to dismantle and decontaminate the Diamond Ordnance Radiation Facility (DORF) located at the Forest Glen Section of Walter Reed Army Medical Center in Silver Spring, Maryland. The contract was for a firm fixed price with a schedule duration of 8 months.

All the contracted terms specified in DAAK 21-79-C-0136 were fulfilled within the required schedule and budget. There was no significant radiation exposure to personnel or internal deposition of radioactive material as a result of decommissioning the Diamond Ordnance Radiation Facility.

I. INTRODUCTION

The objective for dismantlement and decontamination of radioactivity of the Diamond Ordnance Radiation Facility (DORF) was to make the facility acceptable for unrestricted use by removing radioactivity to levels below those requiring surveillance and licensing.

Dismantling the reactor and removing the radioactive components was the mode selected for decommissioning DORF. Specifically identified reactor components were dismantled, packaged, and shipped to Westinghouse's Hanford Engineering Development Laboratories (HEDL) in Richland, Washington. The pool tank, lead shield doors, lead shield hoist, exposure room wood lining, rolling shield door, and activated concrete were dismantled, removed from the facility, and disposed to clean salvage/disposal or to radioactive disposal.

The regulatory agency governing operations at DORF was the U.S. Army. The Army specified Nuclear Regulatory Commission (NRC) Regulatory Guide 1.86 as the governing document for the decommissioning activity. This guide specifically requires decontamination to levels which are as low as reasonably achievable (ALARA), but in all cases to levels below those listed in Table 1. To show compliance with ALARA, Rockwell established the limits shown in Table 2 as a target. These limits are based on experience regarding levels that in most cases are reasonably achievable and can be effectively monitored.

Radioactive materials and components which exceeded Table 1 limits were removed from the facility. The limits shown in Table 2 were also met in all areas of the facility except in the exposure room where, due to room geometry and the accumulative properties of activation products, the activity ranged from 0.08 to 0.24 mrad/h as measured with a Technical Associates Mark III Cutie Pie - CP7M. The overall average was slightly higher than 0.1 mrad/h. Individual pieces of concrete from the higher activity areas, when removed from the exposure room, indicated levels below 0.1 mrad/h. These activity levels were deemed acceptable by the contracting officer's representative and by the United States Army Environmental Health Agency (USAEHA) radiation survey team.

TABLE 1

ACCEPTABLE SURFACE CONTAMINATION LEVELS FROM NRC REGULATORY GUIDE 1.86

Nuclide*	Average†§	Maximum†**	Removable†,††
U^{nat}, U^{235}, U^{238}, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra^{226}, Ra^{228} Th^{230}, Th^{228}, Pa^{231}, Ac^{227}, I^{125}, I^{129}	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th^{nat}, Th^{232}, Sr^{90}, Ra^{223} Ra^{224}, U^{232}, I^{126}, I^{131}, I^{133}	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr^{90} and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

*Where surface contamination by both alpha- and beta-gamma-emitting nuclides exist, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

†As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

§Measurements of average contaminant should not be averaged over more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

**The maximum contamination level applies to an area of not more than 100 cm^2.

††The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

TABLE 2

CONTAMINATION LIMITS FOR DECONTAMINATION AND DISPOSAL OF DORF

	Total	Removable
Beta-Gamma Emitters	0.1 mrad/h average* and 0.3 mrad/h maximum† at 1 cm with 7 mg/cm^2 absorber	100 dpm/100 cm^2
Alpha Emitters	100 dpm/100 cm^2	20 dpm/100 cm^2

*Measurements of average contaminant should not be averaged over more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

†The maximum contamination level applies to an area of not more than 100 cm^2.

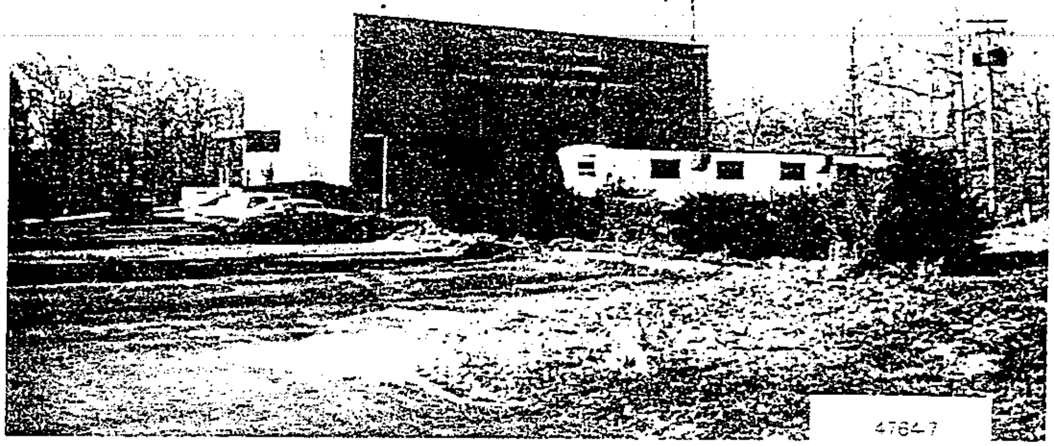

Figure 1. Exterior View of DORF

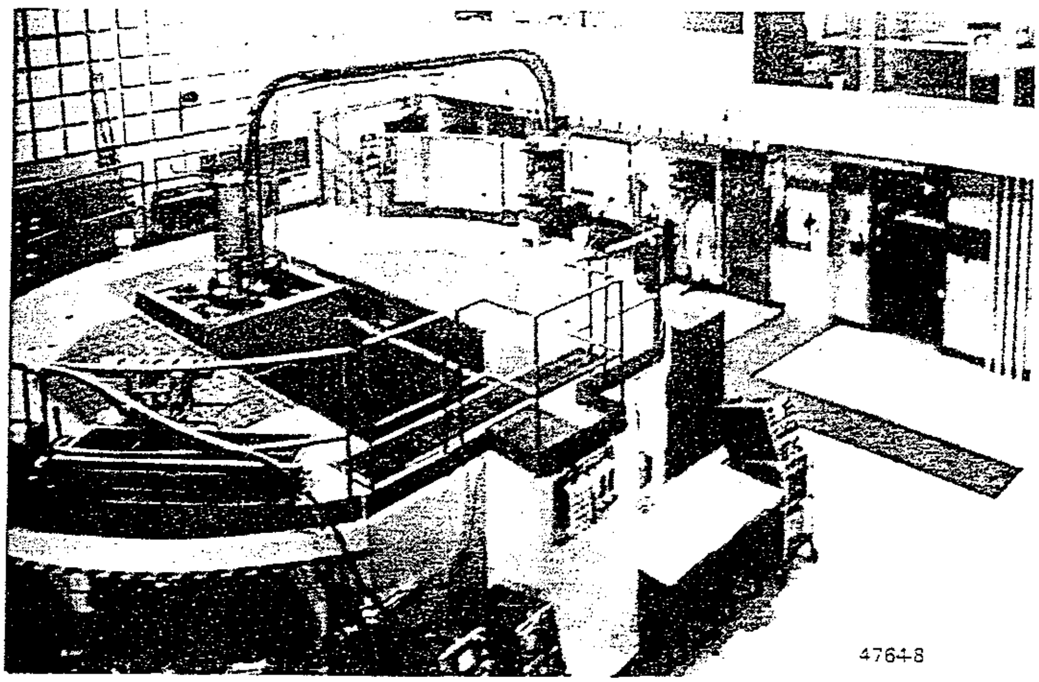

Figure 2. Interior View of DORF Showing TRIGA Reactor Carriage and Control Drive Housing Located on Parapet

II. FACILITY DESCRIPTION

The Diamond Ordnance Radiation Facility (DORF), Figure 1, was operated by the Department of the Army's Harry Diamond Laboratories (HDL). The facility housed a TRIGA Mark F Reactor, Figure 2, as the principal research tool in the study of neutron and gamma radiation effects on electrical and electronic components.

DORF is located within the metropolitan area of Washington, D.C. at the Forest Glen section of the Walter Reed Army Medical Center (WRAMC), which is 8 miles due north of the center of Washington, D.C. The building containing the reactor is 65 ft by 50 ft and 25 ft high. It is encircled by an exclusion fence with a radius of about 240 ft. Access to the 4.2-acre site is controlled at a single entrance gate.

The reactor was designed and built by Gulf General Atomics, San Diego, California. It was designed for both steady-state and pulsed operation with a design capability of:

1) Steady-state or square-wave operation up to 250 kW for a maximum power generation of 1 mW-h/day.

2) Pulsed operation resulting in a peak power of 2,000 MW with a pulse width of 9.5 ms at half maximum.

On September 18, 1961, the DORF-TRIGA Mark F reactor achieved criticality for the first time. The first core was aluminum clad, but it was replaced with a stainless steel clad core in 1964. This stainless steel clad core was operated from 1964 through September of 1977, when reactor operations at DORF were terminated. An estimate of the burnup on the core at the time of shutdown was 0.48% based on 242,451 kWh of operation.

In the spring of 1979, the core was removed from the reactor. It was dispositioned to several university programs and to the DOE-Hanford Engineering Development Laboratories in Richland, Washington.

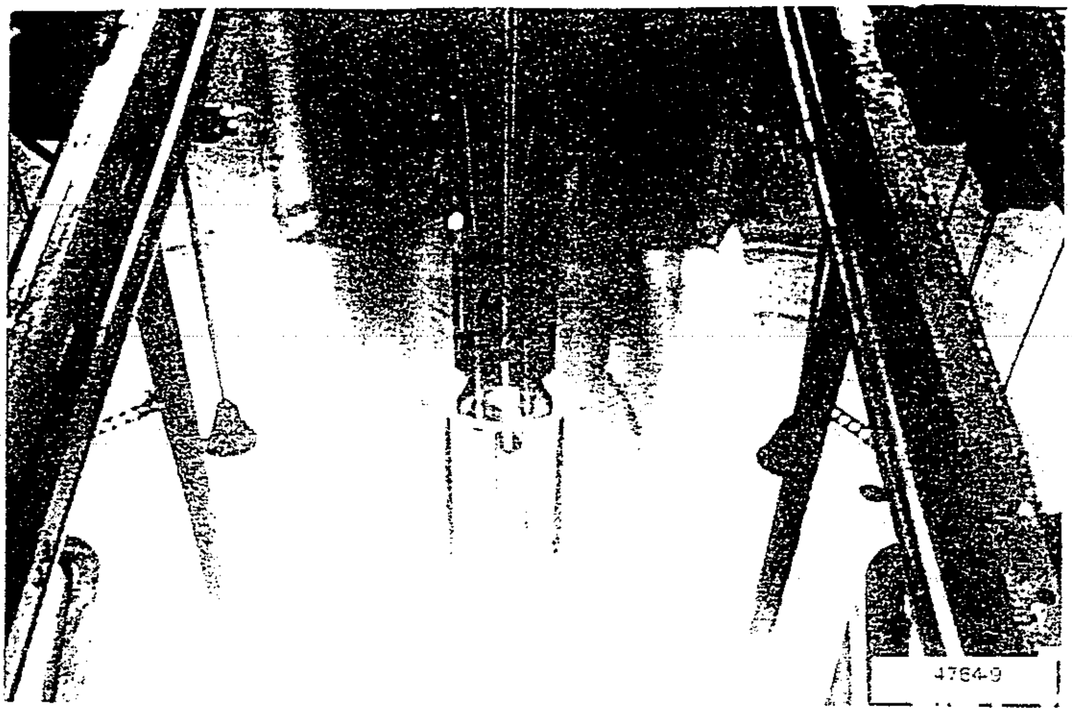

Figure 3. View of Reactor Core Housing and Support Structure

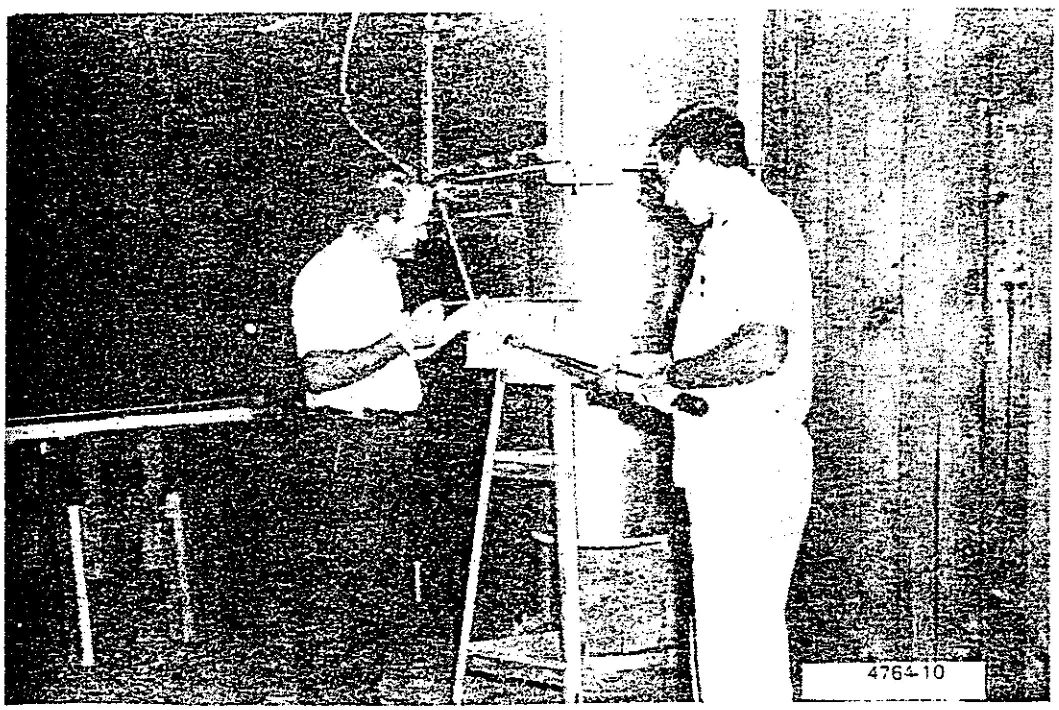

Figure 4. Test Setup in Exposure Room

The reactor core, Figure 3, was located near the bottom of a 15,000-gal aluminum tank which was about 13 ft in diameter and 20 ft deep. The core was suspended by a support structure from a motor driven carriage mounted on rails at the top of the tank. The carriage was capable of traversing the tank to enable the reactor to be positioned behind lead doors so that entry could be made into the exposure room immediately after a test. Figure 4 shows a typical test setup in the exposure room. Figure 5 is a diagram showing a cross-section view of the facility and the relative position of reactor to exposure room. With the lead doors open, the reactor could traverse the tank to a position by the lead shield.

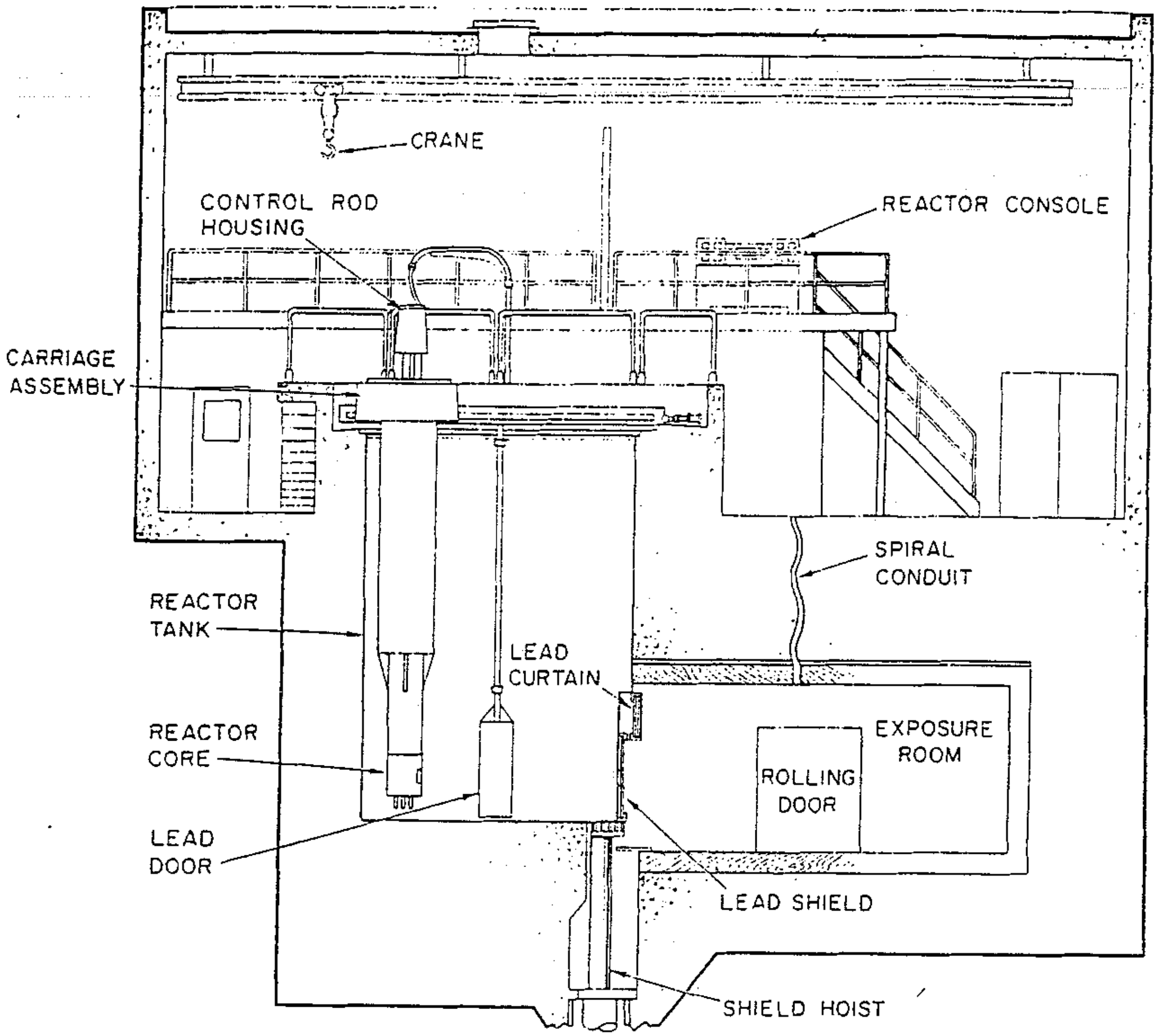

Figure 5. Vertical Section of DORF Reactor

III. SUMMARY OF DECOMMISSIONING ACTIVITIES

The activities which comprise the decommissioning of DORF were grouped into three phases. Phase I consisted of the planning, procurement, and staffing activities required to conduct Phases II and III. Phase I was conducted in Canoga Park, California. Phase II consisted of those activities required to remove and dispose of the radioactive and nonradioactive components and materials identified in the RFQ. Phase III consisted of the demolition of nonradioactive portions of the facility. Phases II and III were conducted in Silver Spring, Maryland.

A. PHASE I

Facilities Dismantling Plan for DORF N001-FDP-960-001 was prepared to delineate the activities necessary to achieve the stated objectives. These were categorized as: planning, monitoring, and control; radiological survey; dismantlement and disposal; and documentation. This dismantling plan was reviewed and approved by the Rockwell D&D Program Office, Health, Safety and Radiation Services, and by the Engineering Department. It was then reviewed and approved by the Army Reactor Committee for Health and Safety (ARCHS).

Activities concurrent with planning were: (1) the acquisition of equipment, tools, and material; (2) placement of service contracts; and (3) the recruitment and training of personnel. Phase I activities were initiated on September 17, 1979, and were completed on November 21, when ARCHS approved the dismantling plan.

B. PHASE II

Phase II was initiated on November 26, 1979, with the movement of personnel to the DORF site in Silver Spring, Maryland, and was completed on February 22, 1980, with the return and reassignment of personnel to other projects.

Phase II consisted of the following activities: (1) site preparation, (2) packaging and shipping reactor components to HEDL, (3) exposure room dismantlement, (4) pool tank removal, (5) concrete excavation, (6) site survey, and (7) waste disposal.

1. Site Preparation

Site preparation included those activities required to move the Rockwell staff and their equipment to the DORF site and to establish a base of operations in Maryland. A radiological survey of the nonradioactive portions of the site was conducted for documentation and an analysis of the pool water was performed to determine compliance with 10 CFR 20.303.

On November 26, 1979, a six-man team from Rockwell International's Energy Systems Group in Canoga Park, California, arrived in Maryland to begin the Phase II work outlined in the contract. A base of operations was established within the first week including a site radiological survey. An agreement was made with Holy Cross Hospital in Silver Spring wherein they would accept for treatment any radioactively contaminated person from DORF.

A radiological survey taken of one of the floor drains adjacent to the parapet near the main experimental area indicated activity in the range of 250 cpm $\beta\gamma$. The floor grating over the drain was removed and the radioactive residue was vacuumed into an approved radioactive waste container. Resurvey of this drain and all other areas of the facility outside the exposure room indicated levels of activity well below those listed in Tables 1 and 2.

Water samples from the pool tank were analyzed by Teledyne Isotopes, WRMAC, and Rockwell. The data are shown in Table 3. These data show the water to be well within the allowable limits given in 10 CFR 20, Appendix B, Table 1, Column 2. Walter Reed Hospital's Health and Safety Branch granted Rockwell permission to drain the water through their sanitary sewer system.

2. Packaging and Shipping Reactor Components to HEDL

The TRIGA reactor and its components were disassembled, packaged, and shipped to DOE-Hanford Engineering Development Laboratories (HEDL), Richland,

TABLE 3

ANALYSIS OF POOL WATER

	μCi/ml
Rockwell	4.4×10^{-9} βγ 6.85×10^{-10} α
Teledyne Isotopes	<1×10^{-9} gross β 1.41×10^{-6} H-3
WRAMC	<Detectable gross β 5×10^{-7} H-3

Note: 10 CFR 20 limits were interpreted to be as follows: 4×10^{-7} μCi/ml βγ; 4×10^{-7} μCi/ml α; 3×10^{-3} μCi/ml H-3

Washington. The packages and shipment conformed to Department of Transportation (DOT) specification, Title 49, Code of Federal Regulations (49 CFR).

The reactor and components were disassembled to the degree necessary to permit packaging. All of the items listed in Table 4 were removed, packed into weatherproof containers, and transported to HEDL. Figures 6 and 7 show reactor and component disassembly. Figures 8 and 9 show packaging activities. Figure 10 shows packages loaded into a truck for shipment.

Each package was monitored by the Health Physicist to determine its radioactive content. Only one of the containers had significant detectable radiation at the surface. It was Container No. 158, a DOT-type A-7A drum containing the 10 Ci americium-beryllium neutron source. Its radiation measured 120 mrad/h neutron-beta-gamma at the surface and 4 mrad/h at 1 m. All of the other containers were <10 mrad/h at the surface and near background at 1 m. Table 5 is a list of containers, their volumes, weights, and contents.

TABLE 4

LIST OF REACTOR COMPONENTS SHIPPED TO HEDL

Item No.	Description	Unit	Quantity
1	Core Support Structure, Upper Section	Each	1
2	Core Support Structure, Lower Section	Each	1
3	Top and Bottom Grid Plates	Each	1
4	Connecting Rods for Control Rods	Set	1
5	Control Rods	Set	1
6	Carriage Drive Motor	Each	1
7	Water Pump: 1.5 hp	Each	1
8	Incore Experiment Tube	Each	1
9	Ion Chamber Support and Ion Chambers	Set	3
10	Carriage Support Rails	Set	1
11	Lead Shield Door Drives and Linkage	Set	1
12	Pool Cover Plates	Set	1
13	Fuel Storage Racks, Underwater	Each	8
14	Fuel Measurement Tool with Dial Micrometer	Each	1
15	Aluminum Water System Piping	Each	1
16	Water Pumps	Each	3
17	Demineralizers, 3 ft^3	Each	4
18	Flowmeters, 25 gpm	Each	2
19	Neutron Source, 10 Ci, Am-Be	Each	1
20	Neutron Source Holder	Each	1
21	Pool Lights	Set	1
22	Carriage Positioning Potentiometer	Each	1
23	Carriage Umbilical Arm	Each	1
24	Fuel Element Location Diagram	Each	1
25	Water Box, 1 ft^3 Capacity	Each	1
26	Charcoal Filter, 1 ft^3 Capacity	Each	1

Figure 6. Removal of Reactor Support Structure From Pool Tank

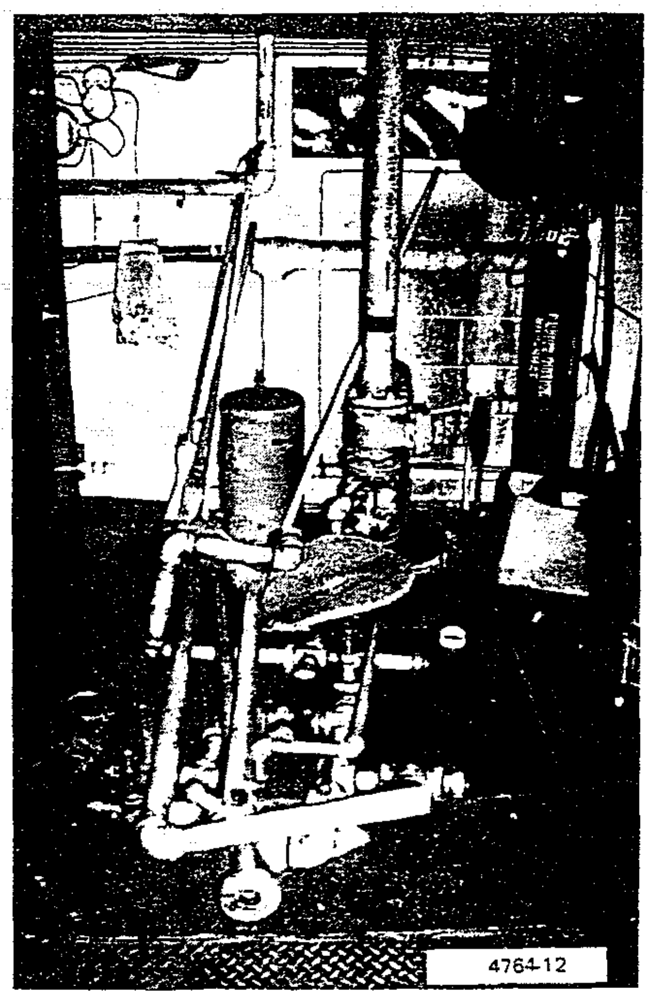

Figure 7. Reactor Cooling System Piping After Disassembly but Prior to Packaging

Figure 8. Reactor Cooling System Piping Partially Packaged (Box No. 156)

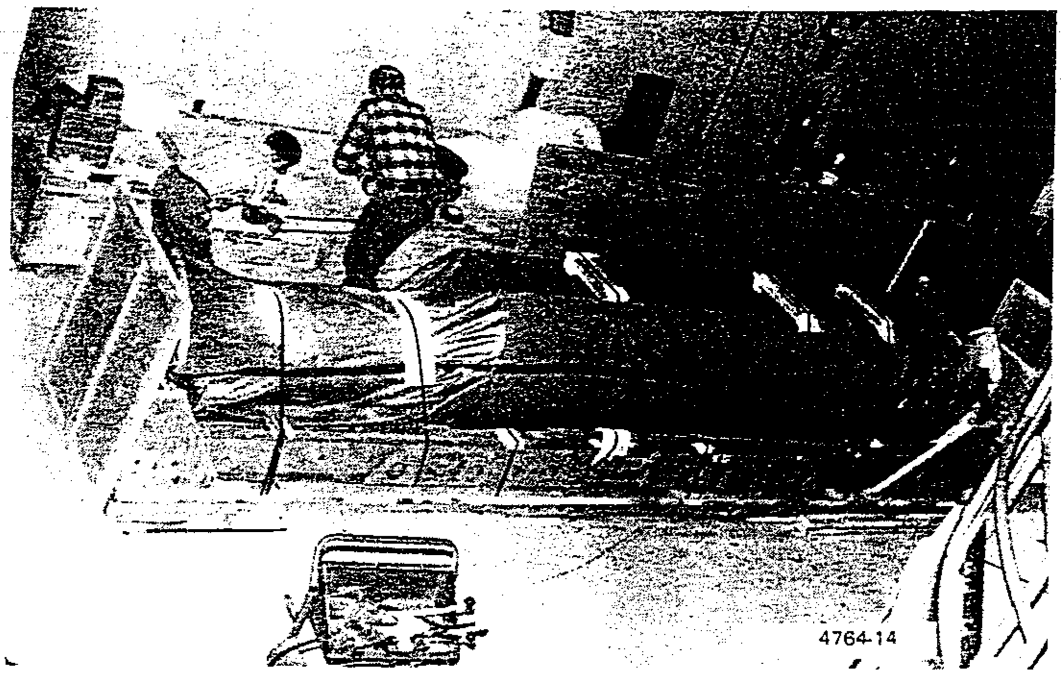

Figure 9. Partially Packaged Reactor Core Support Structure (Box No. 154)

TABLE 5

CONTAINER PACKING LIST FOR HEDL SHIPMENT
(Sheet 1 of 2)

	Quantity
Box No. 151 (38 ft^3, 1100 lb)	
No. 11 Lead Shield Door Drive and Linkage	
Motor and Clutch	1
Transmission Tee	1
Right Angle Transmission	2
Door Transmission	2
Short Shaft	2
Long Shaft	2
No. 16 Water Pump	3
Seals	4 boxes
Carriage Drive Motor (Spare)	1
Box No. 152 (112 ft^3, 700 lb)	
No. 9 Ion Chamber Supports	4 sets
No. 4 Connecting Rods for Control Rods	7
No. 5 Control Rods (2), 1 graphite	3
No. 14 Fuel Measurement Tool and Dial Micrometer	1
Dip Leg (Water Diffuser Pump), 1 long, 1 short	2
Standard Control Rod FFCR	2
Ion Chamber Guide	2
Control Rod Guide	2
Core Thimble Guide	4
No. 20 Neutron Source Holder	1
Box No. 154 (333 ft^3, 4500 lb)	
No. 1 Core Support Structure, Upper Section	1
No. 2 Core Support Structure, Lower Section	1
No. 12 Pool Cover Plates	4
No. 13 Fuel Storage Racks	16
Connecting Rods and Bolts	
No. 21 Pool Lights	4
No. 10 Carriage Support Rails	2
No. 24 Fuel Element Location Diagrams (Picture Frames)	3
No. 5 Control Rod and Connecting Rod	2
Box No. 155 (159 ft^3, 3200 lb)	
No. 6 Carriage	1
No. 7 Water Pump	
No. 22 Potentiometer	
No. 17 Demineralizer Tanks	4

TABLE 5

CONTAINER PACKING LIST FOR HEDL SHIPMENT
(Sheet 2 of 2)

	Quantity
Box No. 156 (192 ft^3, 1700 lb)	
No. 15 Aluminum Piping - Water System	1
No. 16 Flowmeter (NK 398-00150)	2
No. 23 Carriage Umbilical Arm	1
Post	1
No. 25 Water Box	1
No. 26 Charcoal Filter	1
Barrel Assembly (Spare)	1
Connecting Rod	4
Drum No. 157 (17H Drum) (7.5 ft^3, 200 lb).	
No. 3 Lower Core Assembly	1
Top and Bottom Grid Plates	
Drum No. 158 (17H Drum) (7.5 ft^3, 550 lb)	
No. 19 Americium-Beryllium Neutron Source	1

Figure 10. Truck Being Loaded with Boxes and Drums of Reactor Components for Shipment to HEDL

3. Exposure Room Dismantlement

The exposure room was stripped of its wood lining, lead shields, lead shield hoist, and other removable components. The material was separated and dispositioned based on radiological analysis.

The three floor drains were temporarily plugged to prevent transporting radioactive materials into the facilities holdup tanks. The aluminum tracks on the ceiling and the masonite covering the wood lining were removed from the exposure room. Radiation survey analysis determined that about two-thirds of the wood lining could be disposed of as clean wood, the remaining one-third was packaged and disposed of as radioactive waste. The clean wood was removed from the exposure room, put into a large dumpster, transported to a local dump site, and buried to prevent its reuse. The wood was structurally damaged as a result of neutron irradiation and might have been tempting for use as structural material if left unburied. Figures 11 through 15 show these activities. The concrete wall of the exposure room (Figure 16) was covered with the phenolic-coated tar paper listed in the RFQ as being attached to the aluminum pool tank. Two lead shields were removed from the wall adjacent to the pool tank. These were coated on one side with the phenolic-coated paper from the wall which was activated. The coating was scraped from the lead and the lead was recovered as clean scrap. Figure 17 shows the lead removal task.

Six 1-in. thick pieces of lead were removed from the top portion of the exposed pool section of the tank in the exposure room. The aluminum frame was removed from the lead and disposed of as radioactive waste. The lead was analyzed and determined to be acceptable as clean scrap. Figures 18 and 19 show these operations.

The lead shield was removed from the lead shield hoist as shown in Figure 20. This shield was activated slightly and was packaged as radioactive waste. The lead shield hoist was drained of hydraulic oil. The oil was analyzed and was found to be nonradioactive. This oil was picked up by a "reclaimed oil" processor at no cost to the program. The lead shield hoist was removed by first

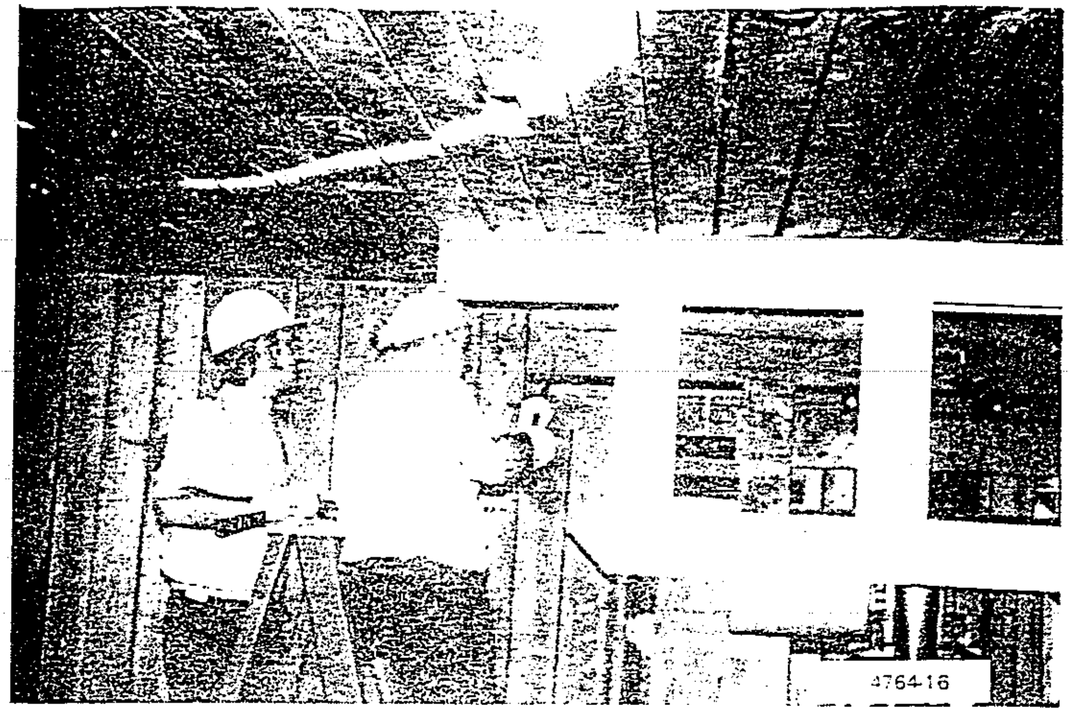

Figure 11. Start of Wood Removal from Exposure Room by First Removing Load Bearing [illegible] from Over Doorway While Lifting [illegible]ibbing

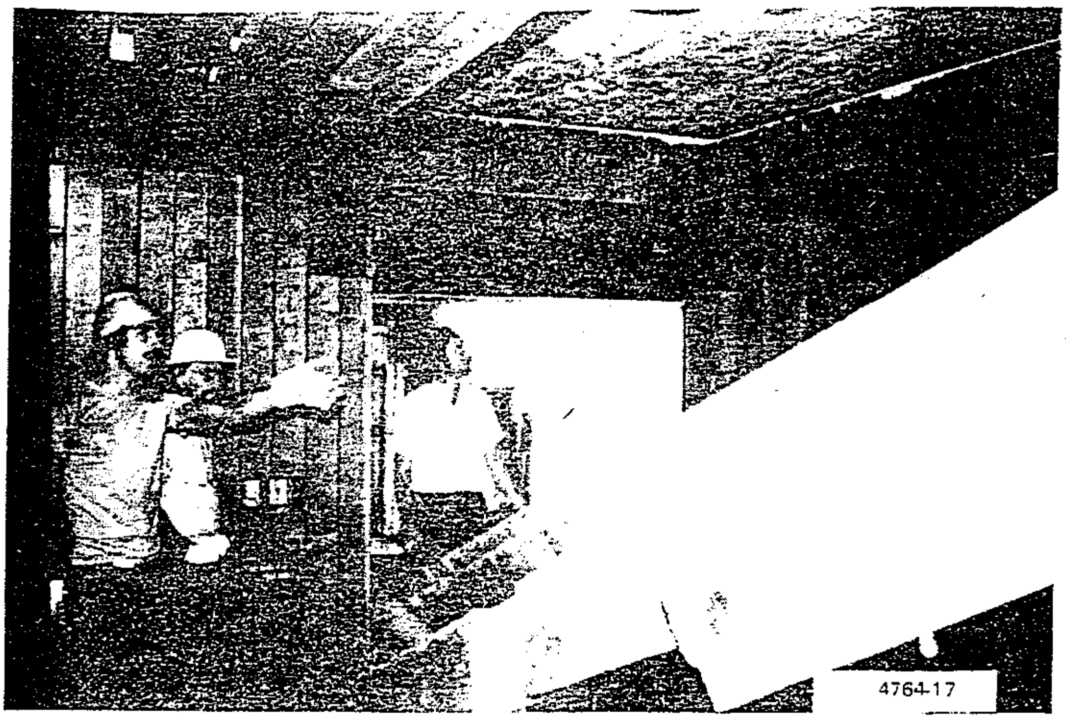

Figure 12. Ceiling Timbers Partially Removed After Lowering Cribbing With Fork Lift

Figure 13. Using Chain Saw to Cut Wood Into Disposable Pieces

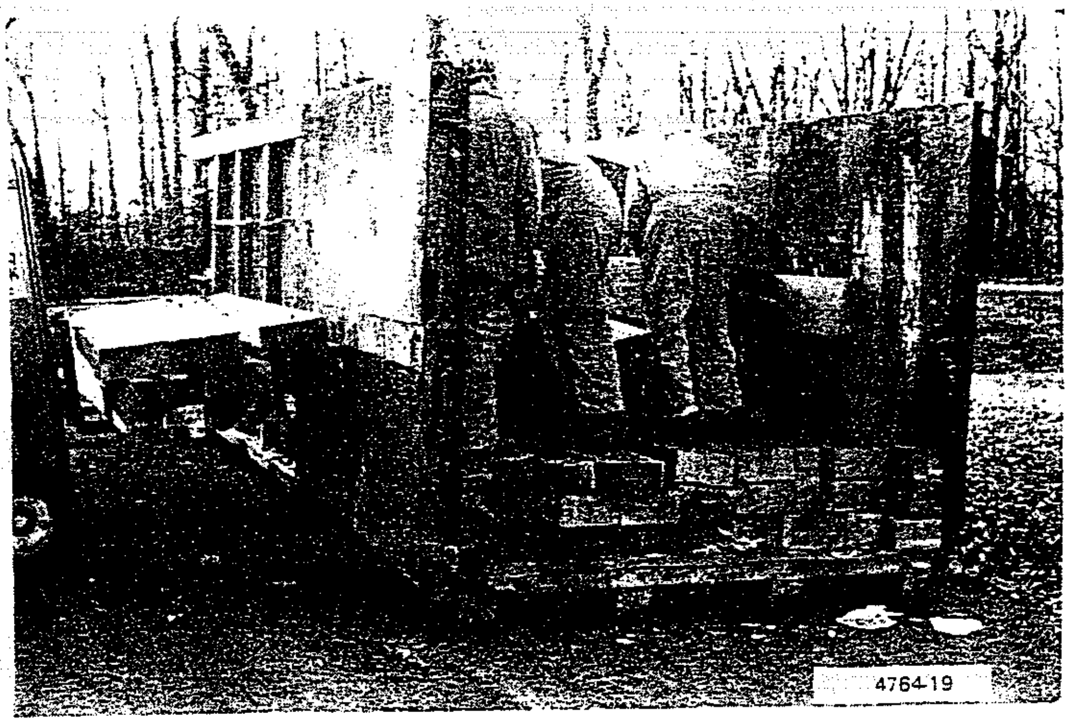

Figure 14. Clean Wood Being Loaded Into Dumpster for Disposal

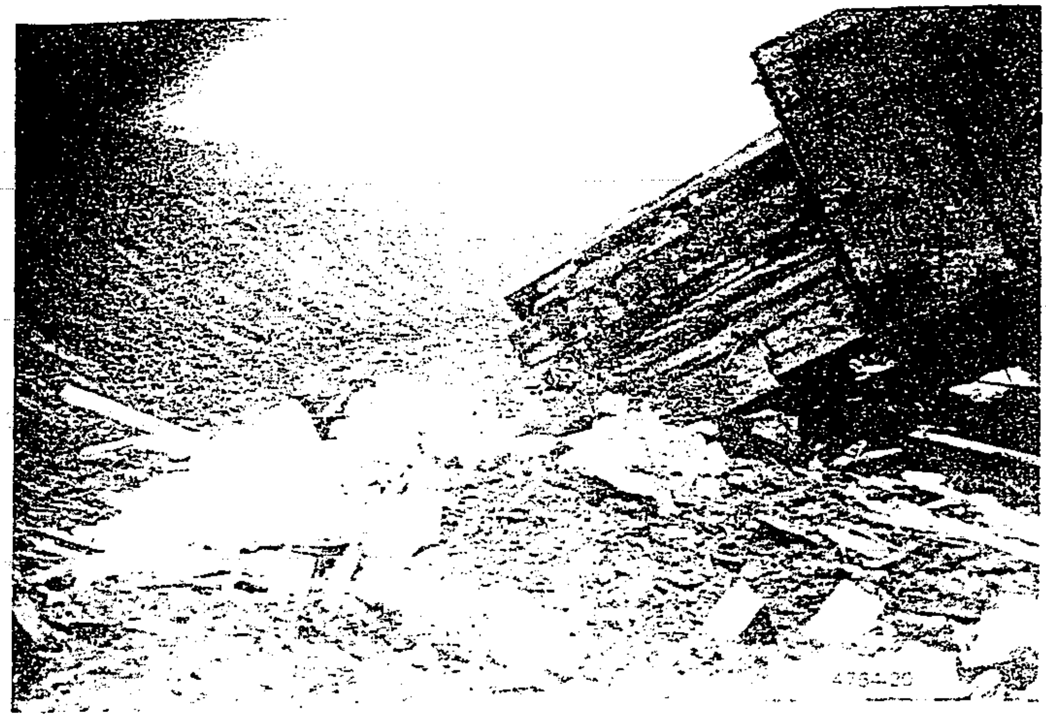

Figure 15. Clean Wood Being Dumped at Disposal Site

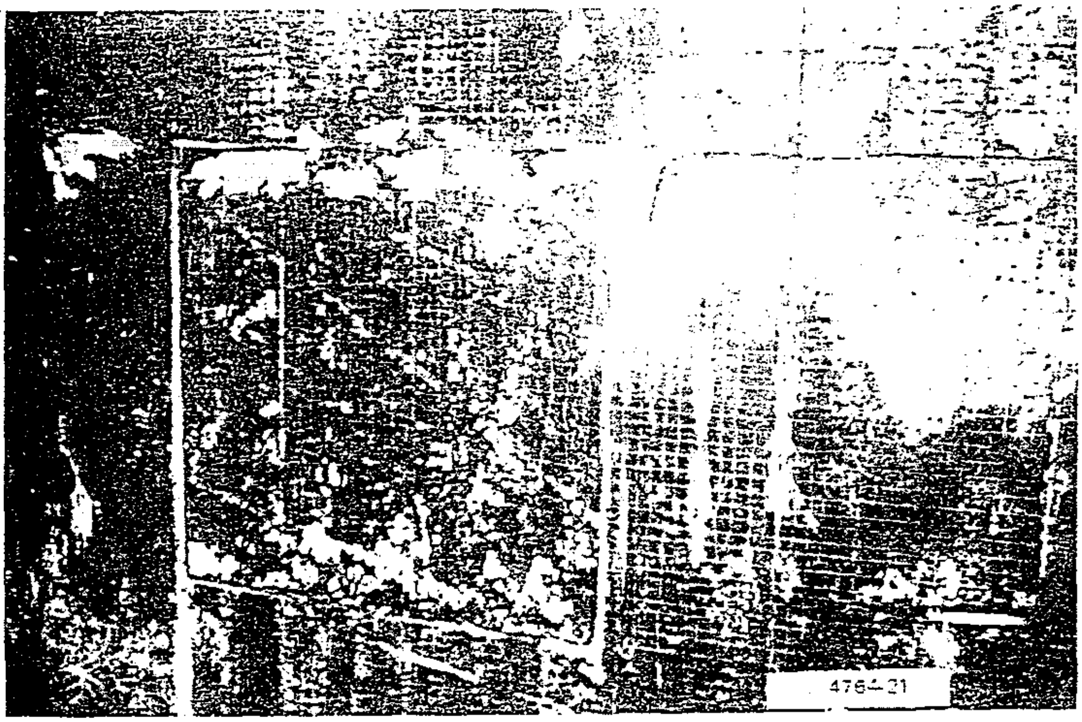

Figure 16. Phenolic-Coated Tar Paper Covering Concrete Wall of Exposure Room

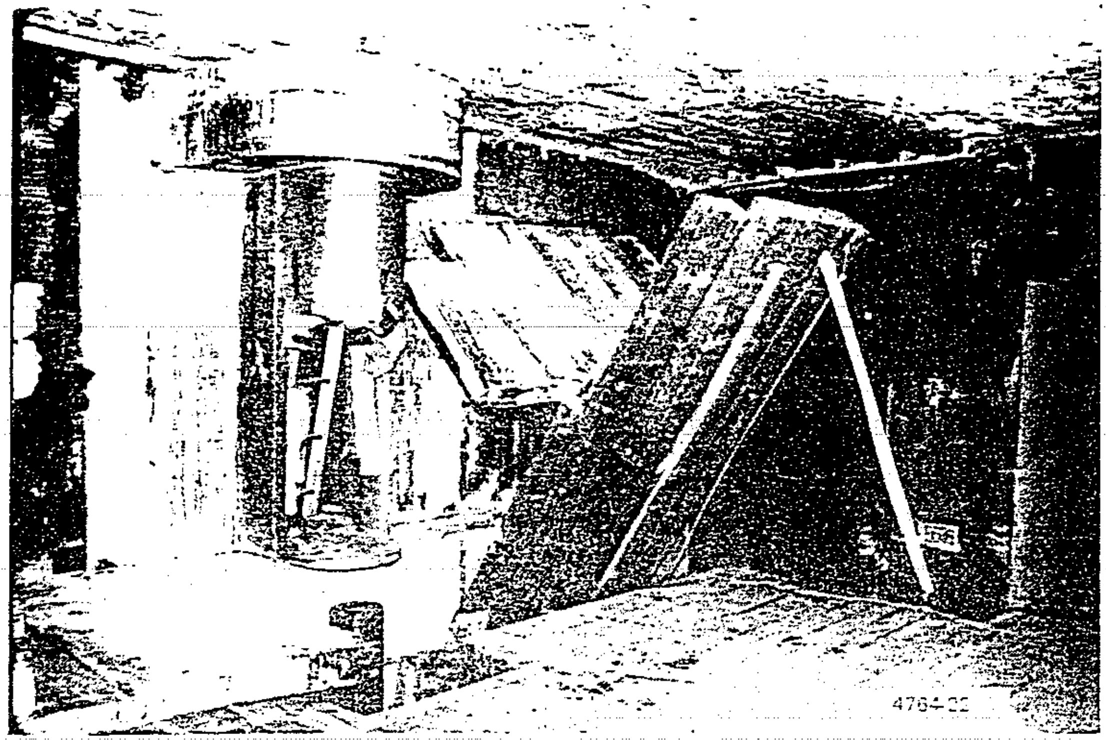

Figure 17. View of East Wall of Exposure Room Showing One Lead Shield Lying on Floor to Left and One Lead Shield in Motion on Right

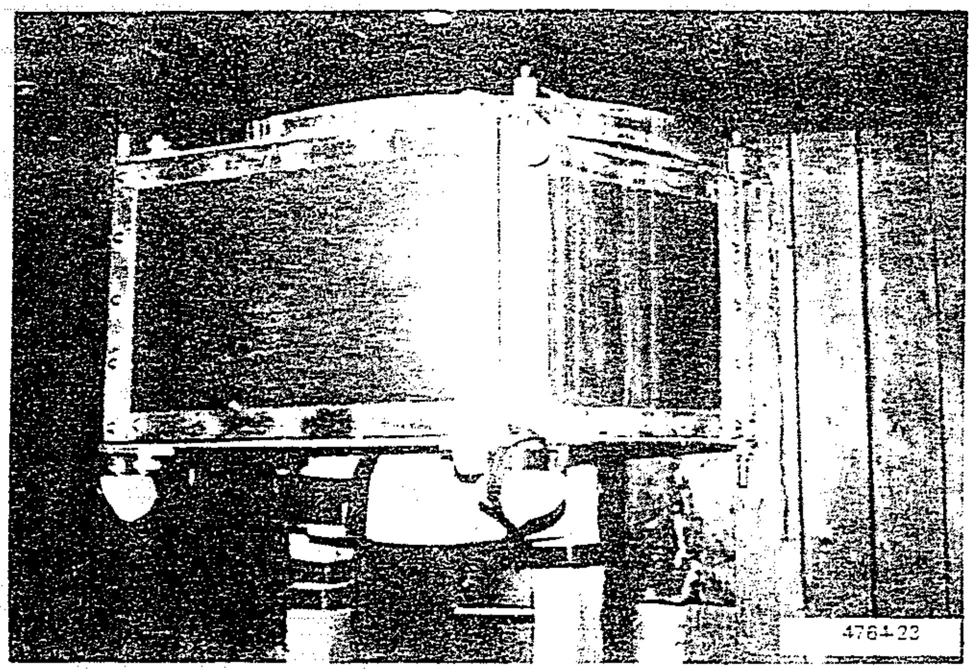

Figure 18. Lead Shields in Exposure Room Prior to Removal

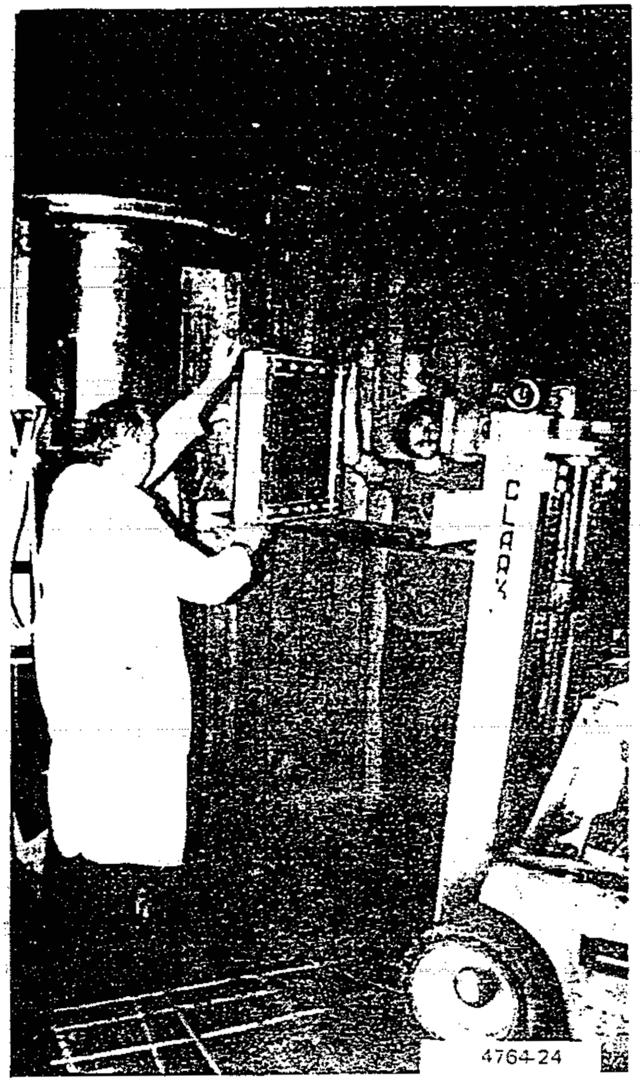

Figure 19. Shielding Being Removed From Exposure Room

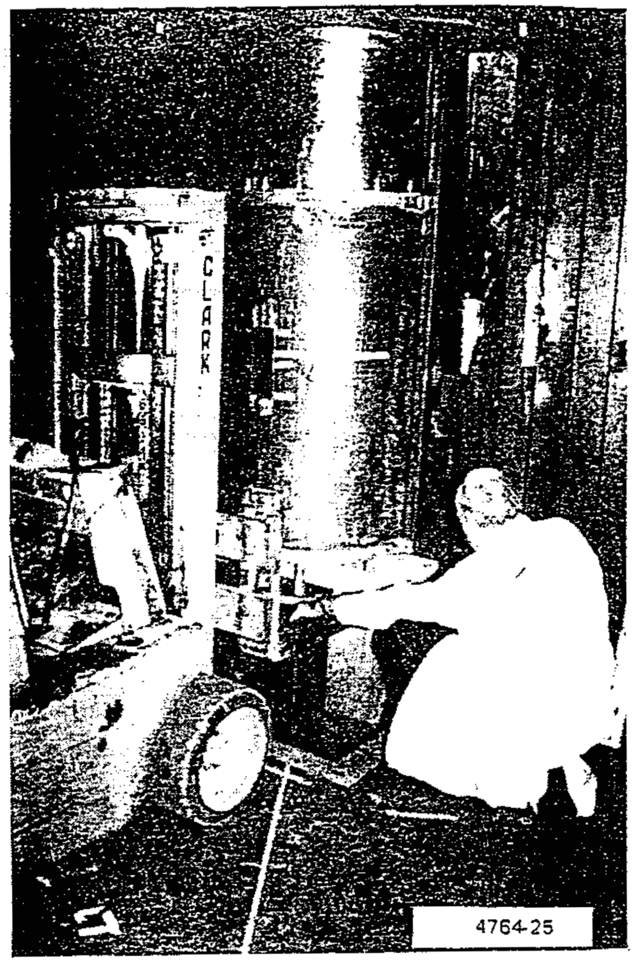

Figure 20. Lead Shield Being Removed From Lead Shield Hoist

excavating the sand surrounding it (Figure 21) and then breaking the 8-in.-thick layer of concrete that surrounded its base with a jackhammer. Figure 22 shows the hoist removed. The hoist was activated and was therefore packaged and disposed of as radioactive waste.

4. Pool Tank Removal

Transformer oil and lead-shot were drained from the lead shield doors, the doors were removed from the pool tank, and the pool tank was removed from the concrete cavity.

To facilitate reactor component disassembly, an opening was cut into the pool tank to provide access to it from the exposure room. This opening was enlarged to about 7-ft^2 (Figure 23) when pool tank removal was started.

Samples of the transformer oil (Figure 24) were removed from the lead doors and analyzed by Garnett-McCreath Labs in Harrisburg, Pennsylvania, for polychlorinated biphenals (PCB). PCB concentrations were determined to be <1 ppm, a factor of 50 below the established limits for controlled disposal as given in 40 CFR Part 761. About 180 gal of oil was drained from the lead doors into four 55-gal metal drums. This oil was given to a "reclaimed oil" processor at no cost to the program.

Lead was drained from the doors into thirteen 55-gal drums. Figure 25 shows this operation. Each drum weighed about 2,150 lb or a total of 28,000 lb. Lead samples from each drum were analyzed to determine radioactive content. All samples were well under the allowable limit for release for unrestricted use. Table 6 presents the results of these analyses. When sufficient lead had been drained from the doors, they were lifted from the tank with the overhead crane and removed to a low-background area for a radiological survey. Removable and fixed contamination levels were well below limits as depicted in Table 2. The doors and the lead were disposed of as salvageable scrap.

The aluminum pool tank was cut into several sections to enable its removal from the concrete cavity. Figures 26, 27, and 28 show this activity. Each piece

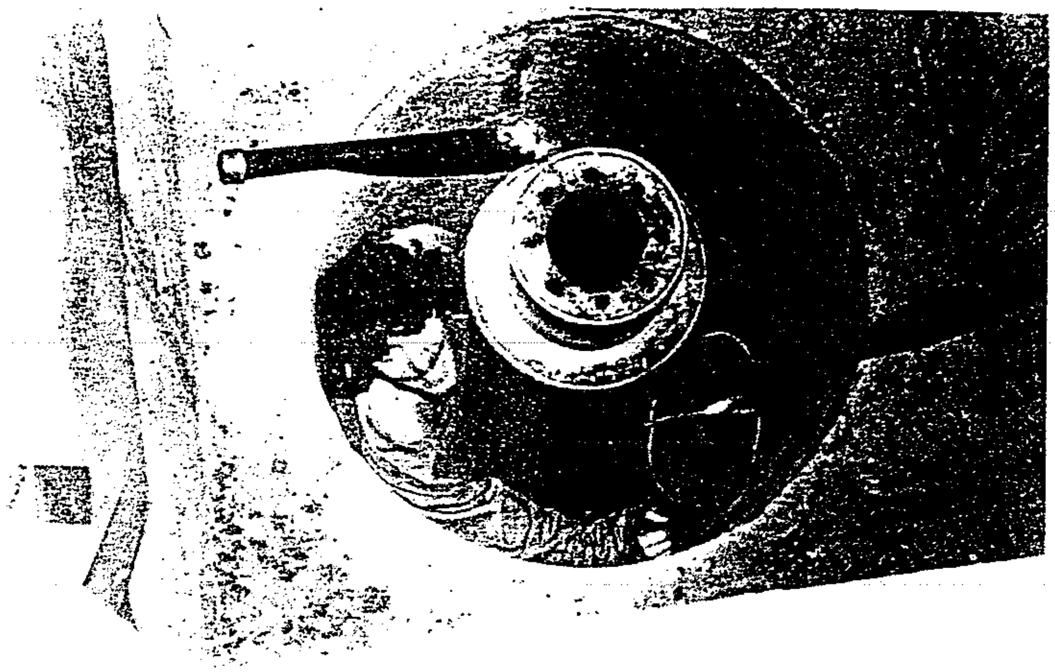

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Figure 21. Excavating Sand From Around Lead Shield Hoist

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Figure 22. Removal of Lead Shield Hoist

Figure 23. Cutting an Opening Into Reactor Pool Tank From Exposure Room

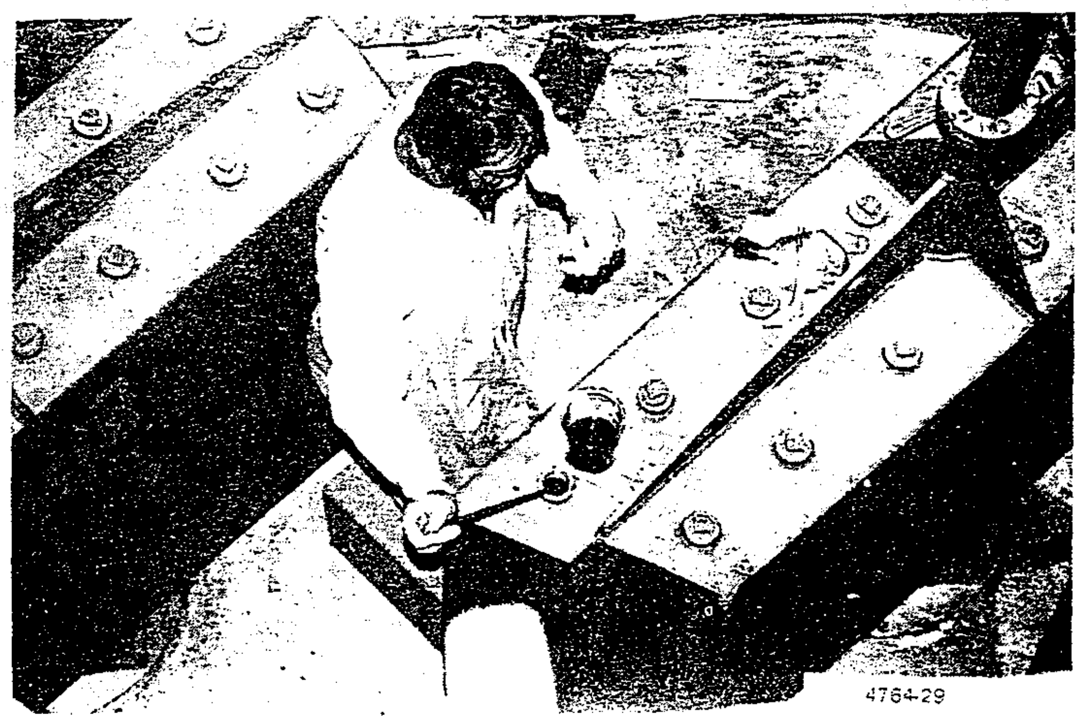


Figure 24. Sampling Transformer Oil in Lead Shield Doors for PCB Analysis

Figure 25. Draining Lead From Lead Doors

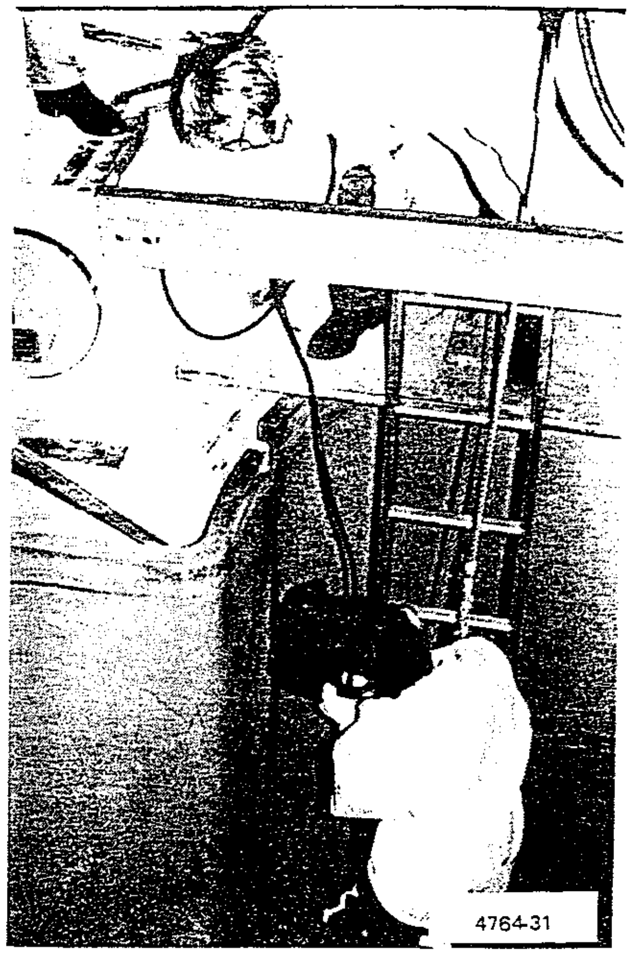


Figure 26. Cutting a Section of Reactor Pool Tank

TABLE 6

ANALYSIS OF LEAD FROM SHIELD DOORS
(Gross detectable beta activity)

Sample Number	pCi/g	Sample Number	pCi/g
Control	0.17	7	0.17
1	0.11	8	LTD
2	0.07	9	0.10
3	0.24	10	LTD
4	0.25	11	0.16
5	0.11	12	0.19
6	LTD*	13	0.10

*Less than detectable limit.

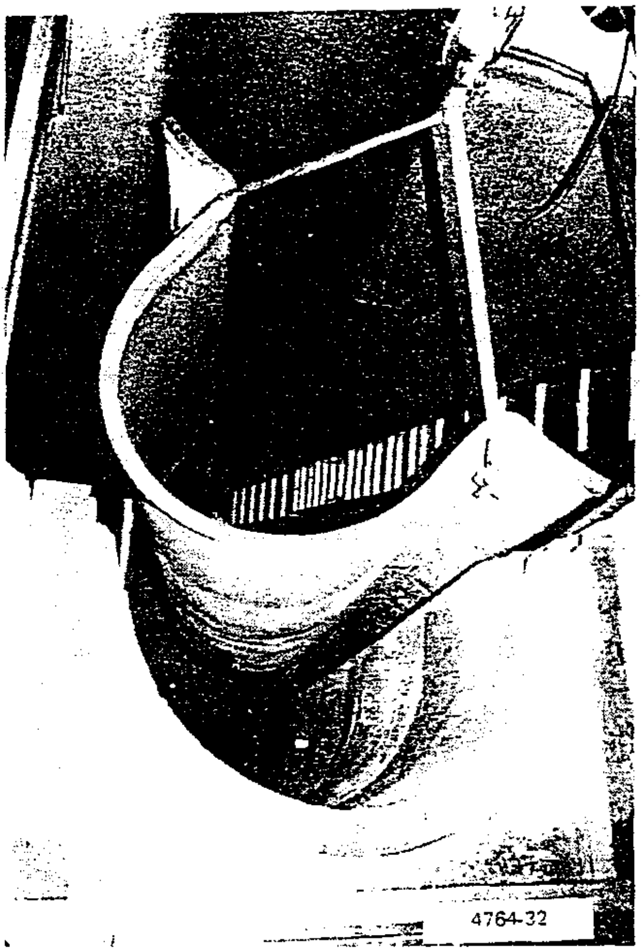


Figure 27. Hoisting Section of Pool Tank From Pool Tank Cavity.

Figure 28. Transferring Section of Pool Tank to Low Background Area for Radiological Survey

was surveyed in a low background area to determine radioactive content. The area of the tank that was exposed to the exposure room and an area 180^0 from that position and 2 ft to either side of the core centerline was removed and packaged as radioactive waste. The remaining aluminum from the tank was below the limits shown in Tables 1 and 2. This aluminum was disposed of as salvageable scrap. The pool tank had a coating of epoxy-based paint instead of the phenolic-coated tar paper liner described in the RFQ. There was very little adhesion of the tank to the concrete as a result of its being painted instead of coated with tar paper.

5. <u>Concrete Excavation</u>

Following exposure room dismantlement and pool tank removal, a detailed radiation survey was conducted of the exposed concrete structures to establish a map of radioactivity. Concrete samples were cored (Figure 29) from selected areas to establish the extent and levels of activation in the concrete structures. Figure 30 shows the DORF sampling plan identifying the location where core samples were taken. Table 7 shows the results of the core sample analysis and Table 8 is a comparison of the results of analysis from two independent laboratories. The core samples that were provided for comparative analysis were taken from two areas of the exposure room. Sample Nos. 3, 3A, and 3B were taken from the wall and Sample Nos. 34, 34A, and 34B were taken from the floor. Each group of samples were cored as close to each other as possible.

Core samples were prepared for analysis at DORF and at ESG using existing ESG procedures. The samples were cut with a tungsten carbide saw blade at the appropriate distance from the end designated "the surface." The powder generated by sawing was contained, weighed, and counted on an NMC Model 72, automatic counting system for alpha and beta-gamma simultaneously.

Due to preferential cutting through softer material in the core sample, i.e., binder and soft rock as opposed to the harder rock matrix, this sampling technique did not permit obtaining a fully representative sample of the total activity.

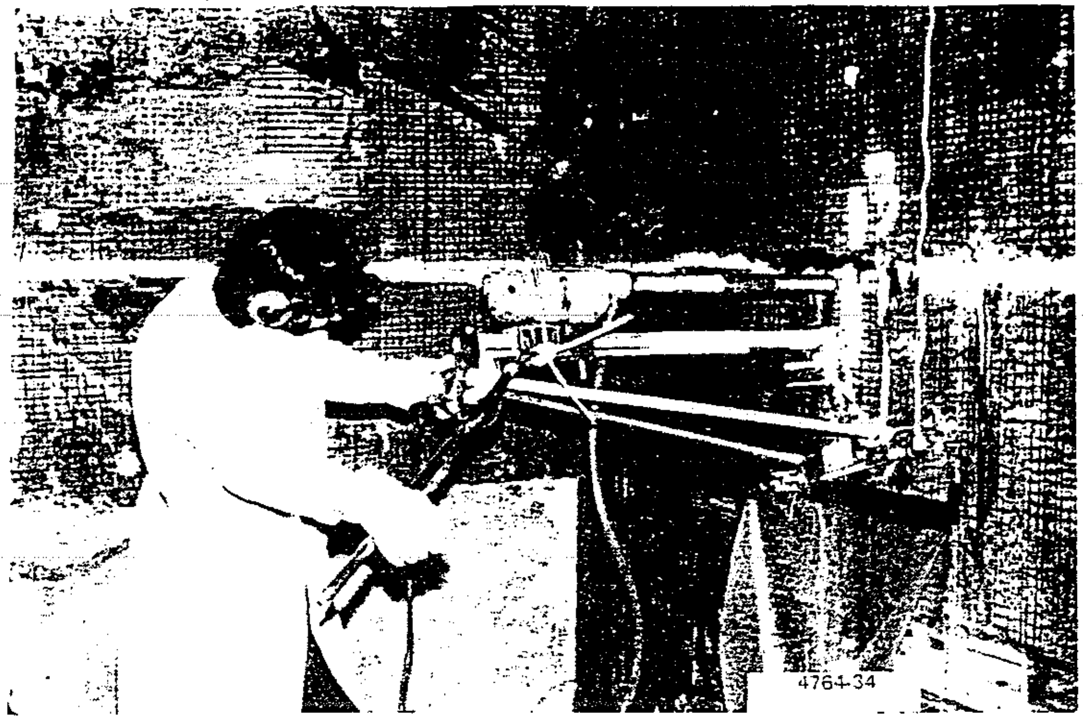


Figure 29. Core Sampling of Concrete in Exposure Room

Teledyne Isotopes prepared their samples by cutting through the entire core sample to segment it into 1-in. thick samples. The entire sample was then counted to determine activity. This technique was most representative of the total activity remaining in the concrete at DORF. The results of the concrete sample analysis formed the basis for the concrete excavation plan. Figures 31 and 32 show diagrams of the planned excavations.

Concrete excavation began in the pool tank cavity with the removal of the pedestal which extended under the tank into the exposure room. Jackhammers were used to break this pedestal (Figure 33) and the thin wall section between the pool tank cavity and the exposure room. Reinforcing bar (rebar) was removed as necessary to permit further concrete removal or because of activation. Activated concrete in the back of the pool tank cavity was then removed. This area, shown in Figure 34, extended about 2 ft to each side of the core centerline and followed the curvature of the wall. Maximum depth of the excavation was 10 in. at core centerline and tapered to about 2 in. at 2 ft from the centerline. Radiological

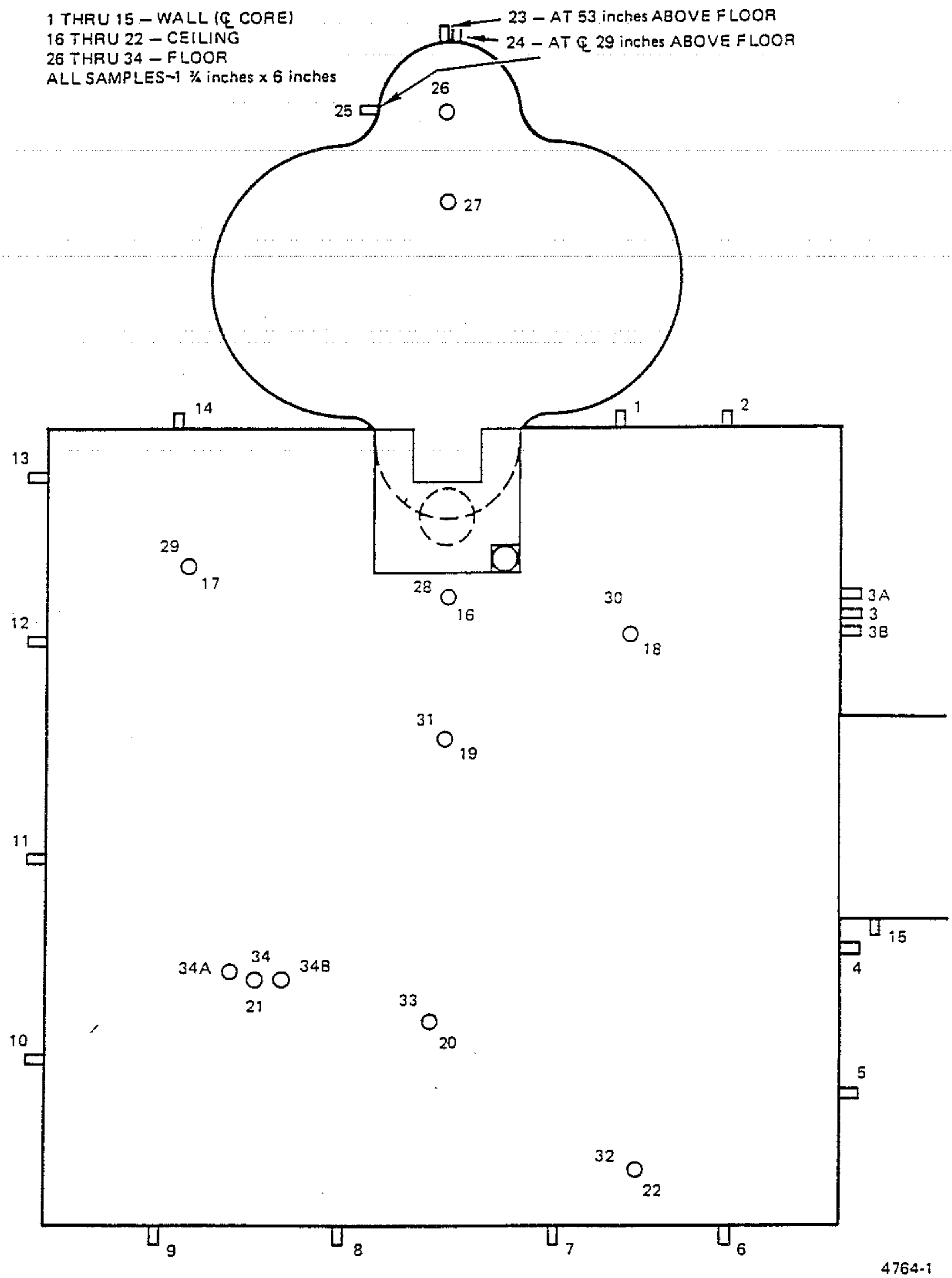


Figure 30. DORF Sampling Plan

TABLE 7

PRE-EXCAVATION ANALYSIS OF CONCRETE BY ESG AT DORF
(Gross Detectable Beta Activity)
(Sheet 1 of 2)

	Core Number	PUG*	pCi/g						
			Distance from Concrete Surface (in.)						
			0	1	2	3	4	5	6
	Ref. 1	Background		3.2	5.2	9.0	LTD	5.0	LTD
	Ref. 2	Background	12.4	9.7	LTD	LTD	3.1	LTD	LTD
Exposure Room Walls	1	Background	28.0	37.7	23.8	16.6	19.7	10.4	13.3
	2	25 cpm	20.5	23.0	11.0	6.8	11.8	8.5	10.6
	3	300 cpm	126.8	98.0	63.8	65.8	31.4	36.6	35.8
	4	100 cpm	42.1	18.0	22.0	12.0	21.5	18.6	20.1
	5	Background	12.8	11.4	9.1	6.0	10.7	4.6	LTD
	6	∿25 cpm	22.8	8.3	9.5	19.1	5.2	13.1	7.3
	7	100 cpm	34.0	27.1	23.4	22.8	13.1	12.8	10.6
	8	Background	12.0	19.5	20.1	11.6	8.3	11.8	6.2
	9	25 cpm	21.5	10.2	17.0	17.4	14.7	13.7	13.7
	10	50 cpm	18.4	16.2	7.0	7.3	5.6	13.3	3.7
	11	25 cpm	25.3	22.6	19.1	6.4	12.2	5.6	16.0
	12	100 cpm	42.1	33.6	41.0	17.8	14.9	21.1	8.7
	13	50 cpm	50.4	27.6	43.3	34.6	18.4	23.8	22.6
	14	50 cpm	21.8	15.1	3.1	1.5	LTD	5.8	0.2
	15	Background	9.9	7.0	LTD	1.2	4.4	5.4	5.8
Ceiling	16	200 cpm	49.9	396.8	26.3	23.8	14.5	17.0	13.9
	17	50 cpm	43.9	21.8	27.8	20.1	15.3	6.4	7.5
	18	100 cpm	37.7	15.5	35.2	19.5	16.6	17.8	24.2
	19	150 cpm	57.2	11.0	20.7	30.9	16.6	14.7	12.6
	20	Background	17.4	9.5	15.7	1.0	1.7	8.2	9.9
	21	Background	23.8	11.4	7.0	3.5	6.2	9.1	8.1
	22	50 cpm	17.0	11.2	8.1	2.3	8.3	9.5	5.4

TABLE 7

PRE-EXCAVATION ANALYSIS OF CONCRETE BY ESG AT DORF
(Gross Detectable Beta Activity)
(Sheet 2 of 2)

	Core Number	PUG*	pCi/g Distance from Concrete Surface (in.) 0	1	2	3	4	5	6
Tank	23	Background	—	11.8	10.3	—	—	—	5.0
	24	400 cpm	59.5	28.2	31.3	29.2	12.6	22.8	19.7
	25	150 cpm	29.8	14.7	25.5	18.4	5.4	9.9	9.3
	26	Background	9.7	15.1	9.5	6.0	1.0	2.9	4.6
	27	Background	3.5	0.6	1.2	LTD	LTD	LTD	2.1
Floor	28	100 cpm	43.9	32.9	24.0	26.7	38.3	13.5	18.0
	29	100 cpm	20.9	17.6	7.9	11.6	2.3	5.6	12.2
	30	50 cpm	18.6	13.3	14.7	14.3	2.5	10.8	10.4
	31	50 cpm	19.9	12.6	5.6	9.9	8.3	12.2	LTD
	32	Background	7.3	7.7	8.3	3.3	0.6	5.6	11.8
	33	25 cpm	19.3	2.3	1.7	7.5	3.7	5.2	LTD
	34	Background	15.3	6.0	10.2	11.2	LTD	8.3	5.0

*Count rate meter with a 2-in. thin window pancake G-M detector.

survey of the pool tank cavity indicated compliance with Regulatory Guide 1.86, stipulations of which are listed in Tables 1 and 2.

Nuclear Controls Corporation (NCC) was contracted to break the activated concrete from the rolling door and to remove the remainder of the door from the site. This operation, shown in Figures 35, 36, and 37, was supported by the Rockwell staff and took place between January 28 and February 4, 1980. NCC used a rock splitter, a jackhammer, and a mobile hydraulic ram (hyram) to break up the door and remove it from the facility. The clean rubble from the door was staged on site for removal during Phase III. The activated rubble was packaged by Rockwell for disposal as radioactive waste.

TABLE 8

PRE-EXCAVATION ANALYSIS OF CONCRETE BY TELEDYNE ISOTOPES

Depth	pCi/g						
	Surface 0-1	1-2	2-3	3-4	4-5	5-6	6-7
3A							
K^{40}	12.7	10.4	5.4	—	12.3	—	—
Co^{60}	154.0	136.0	86.6	443.0	55.3	27.5	20.2
Eu^{152}	281.0	188.0	141	96.6	166.0	93.0	31.2
Eu^{154}	19.0	13.6	5.29	7.3	12.2	7.0	2.3
	466.7	348.0	238.3	546.9	245.8	127.5	53.7
34A							
K^{40}	—	3.8	—	4.0	—	1.9	1.9
Co^{60}	18.2	15.8	6.8	7.8	5.0	4.5	2.2
Eu^{152}	34 6	36.9	14.2	18.1	14.6	9.7	3.2
Eu^{154}	2.9	2.5	0.9	1.2	<0.6	0.9	<0.3
	55.7	59.0	21.9	31.1	20.2	17.0	7.6
	ESG Data*						
	0 in.	1 in.	2 in.	3 in.	4 in.	5 in.	6 in.
3B	74.5	70.2	41.3	26.2	24.4	19.0	17.8
34B	12.9	6.7	6.7	11.3	6.3	9.0	4.5

*Gross βγ pCi/g

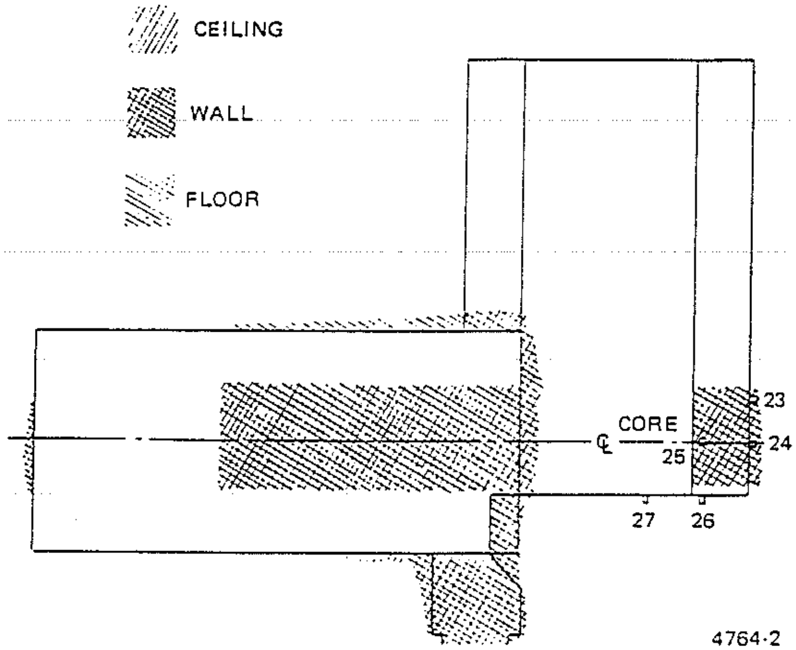


Figure 31. Planned Excavation
(Side View)

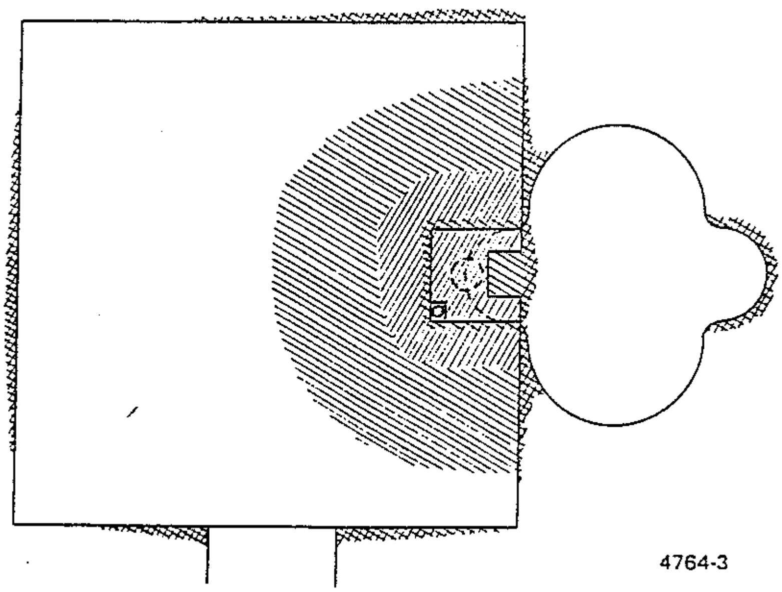


Figure 32. Planned Excavation
(Top View)

Figure 33. Excavating Concrete From Area Below Primary Reactor Operating Position

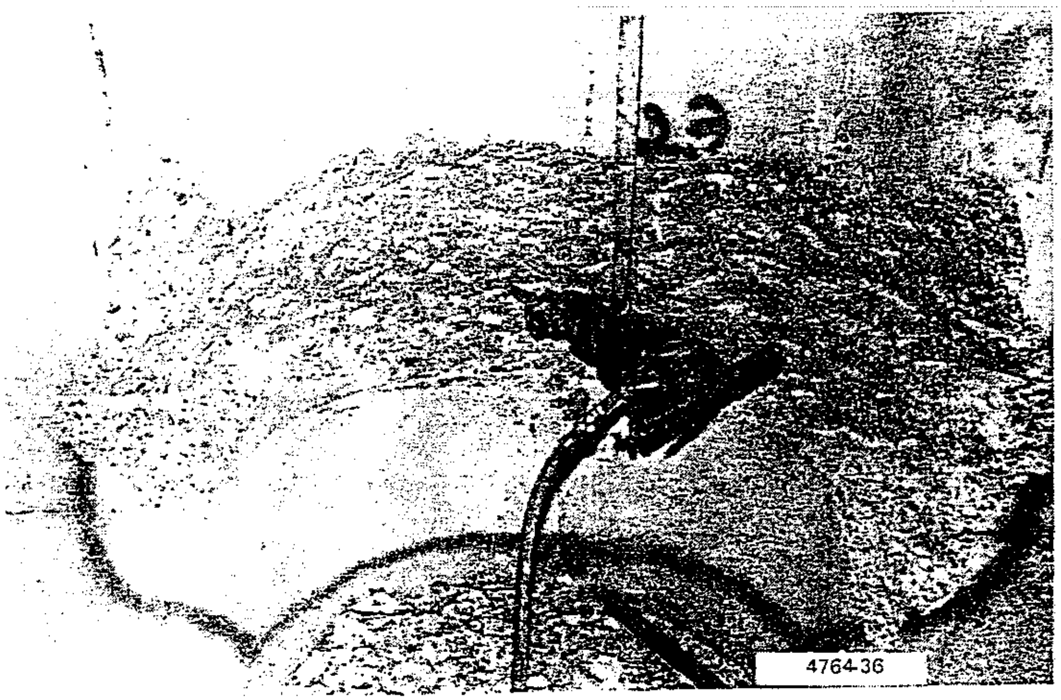


Figure 34. Excavating Concrete From Wall Surrounding Secondary Reactor Operating Position

Figure 35. Using a Rock Breaker to Form Cracks in Activated Portion of Rolling Door

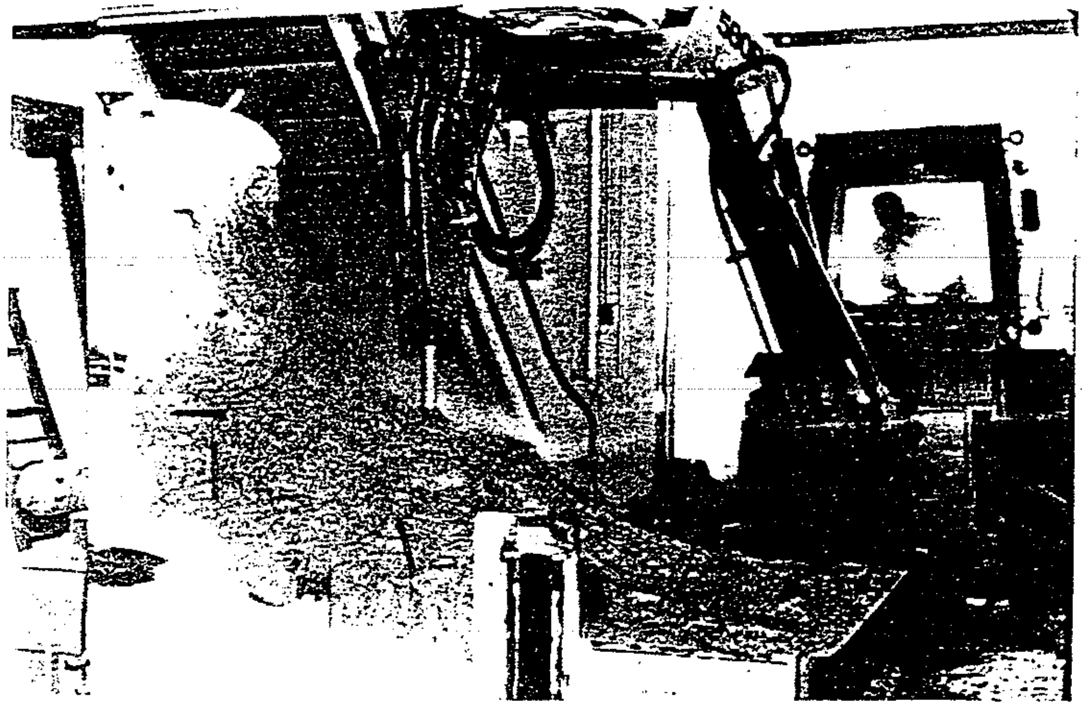
Figure 36. Using a Pry Bar to Remove Fractured Concrete

The first effort in the exposure room was the removal of some of the phenoline liner (tar paper) from the concrete walls to determine its effect on background radiation in the room. A surface area of about 150 ft^2 of the north and east walls was removed by scabbling with bushing tools in 15-lb chipping hammers. This activity is shown in Figure 38. Radiation measurements with a PUG 1 before and after scabbling indicated no difference in reading even to where 1/4 in. of concrete was removed. Based on these results, removal of the phenoline liner from the concrete was terminated.

Based on the core sample analysis and contact radiation readings, there were five areas of the exposure room significantly above background. These areas are identified in Figures 31 and 32. Concrete was removed from these areas to depths of 6 to 8 in. using a combination of hydraulic crack forming and impact. A commercial rock splitter was used to hydraulically compress the concrete to form cracks, a jackhammer or chipping hammer was then used to break the concrete from the walls and ceiling. Figures 39 through 42 show this activity. About 40,000 lb of concrete was removed from the exposure room, packaged in DOT-approved shipping containers, and disposed of as radioactive waste.

6. Site Survey

Concurrent with and following the removal of radioactive components and materials from the DORF site, radiological surveys were conducted to document the levels of radioactivity left in the facility. Table 9 presents data generated from analyzing concrete for fixed contamination. No fixed or removable contamination or activation was detectable outside of the exposure room above Tables 1 and 2 limits. Concrete activation in the exposure room was greater than the Table 2 limits but less than the limits specified in the NRC Regulatory Guide 1.86. Figures 43 through 45 show the detectable activity remaining in the exposure room as determined during the final site survey. Continuous air monitors were operated in the reactor building during the demolition. An NMC Model was located in the high bay and an Eberline Model was located in the exposure room. Table 10 shows the air sample results for those areas.



4764-39

Figure 37. Mobile Hydraulic Ram Being Used to Break Nonradioactive Portion of Rolling Door

4764-40

Figure 38. Scabbling Concrete from Surface of Exposure Room Wall

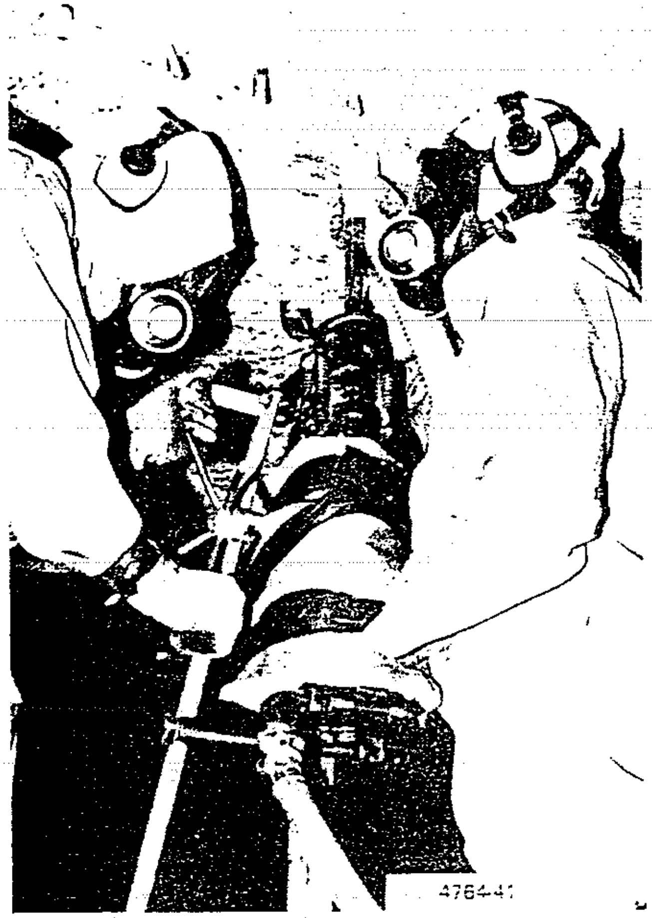


Figure 39. Using Rock Drill to Bore Holes Into Ceiling of Exposure Room (preparation for inserting rock splitter)

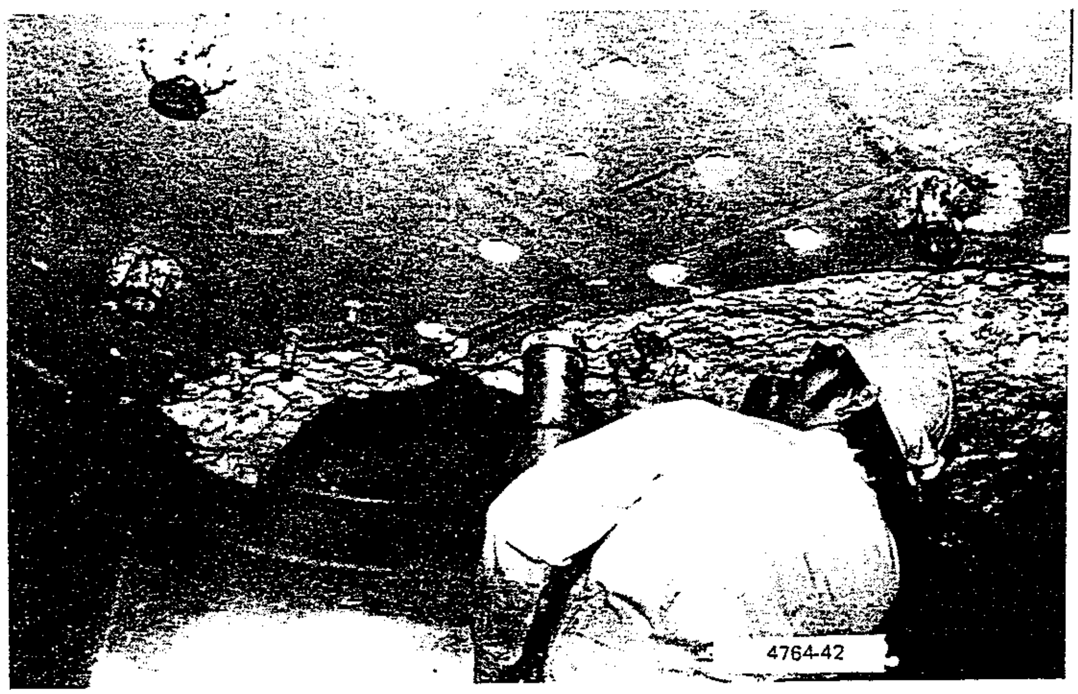


Figure 40. Using Rock Splitter to Form Cracks in Concrete Ceiling

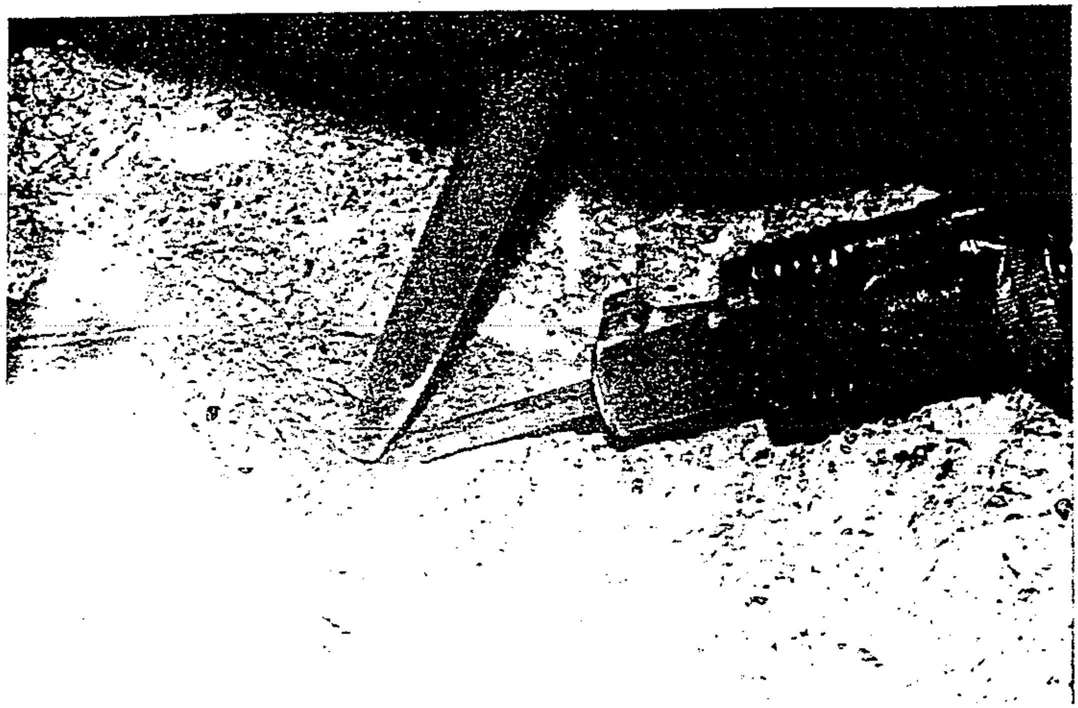


Figure 41. Spalling Concrete From Surface of Exposure Room After Crack Forming

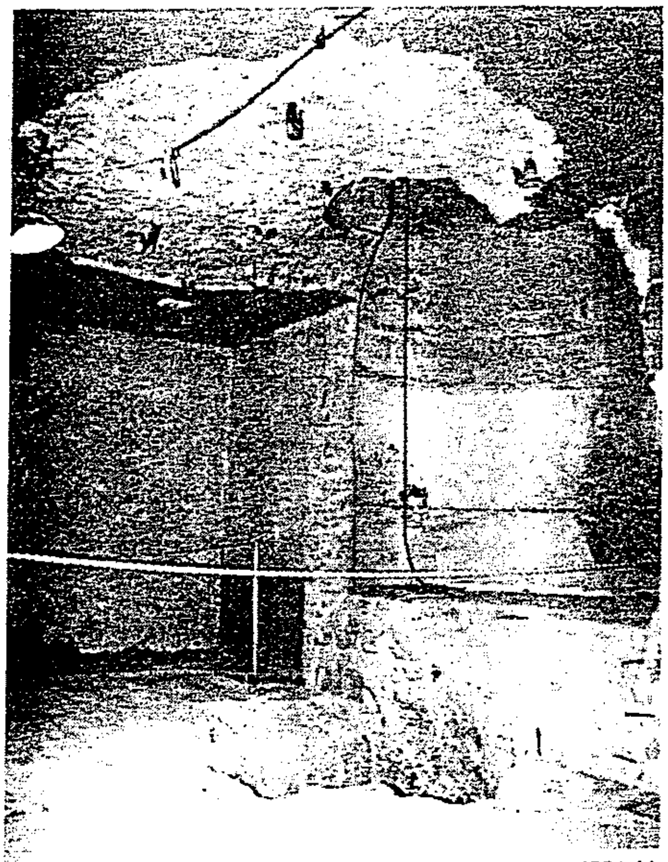


Figure 42. View of Concrete Excavation of Ceiling, Floor, East and North Walls of Exposure Room and Portion of Pool Tank Cavity

TABLE 9

POST-EXCAVATION ANALYSIS FOR FIXED CONTAMINATION IN CONCRETE

Sample No.	Location	PCi/g Dry			
		Co^{60}	Eu^{152}	Eu^{154}	Total
P-1	Excavated South Wall	27	--	4	31
P-2	Nonexcavated South Wall	21	54	4	79
P-3	Excavated Pit Wall	14	37	2	53
P-4	Excavated Pit Wall	19	43	2	67
P-5	Nonexcavated Floor	32	68	4	104
P-6	Nonexcavated South Wall	16	33	—	49
P-7	Excavated South Wall	13	28	2	43
P-8	Nonexcavated West Wall	28	61	4	93
P-9	Excavated West Wall (Plug)	29	37	3	69
P-10	Nonexcavated North Wall	134	28	—	162
P-11	Excavated North Wall	18	36	2	56
P-12	Scabbled East Wall	15	24	—	39
P-13	Nonexcavated South Reactor Wall	1	6	—	7
P-14	Excavated South Reactor Wall	5	30	2	37
P-15	Excavated Ceiling	15	68	5	88
P-16	Nonexcavated Ceiling	34	82	6	122
P-17	Nonexcavated Ceiling	19	56	4	79

Note: Five samples contained approximately 10 pCi/g K^{40}, two samples contained approximately 15 pCi/g Co^{57}, and one sample contained 96 pCi/g Cs^{134} (P-17).

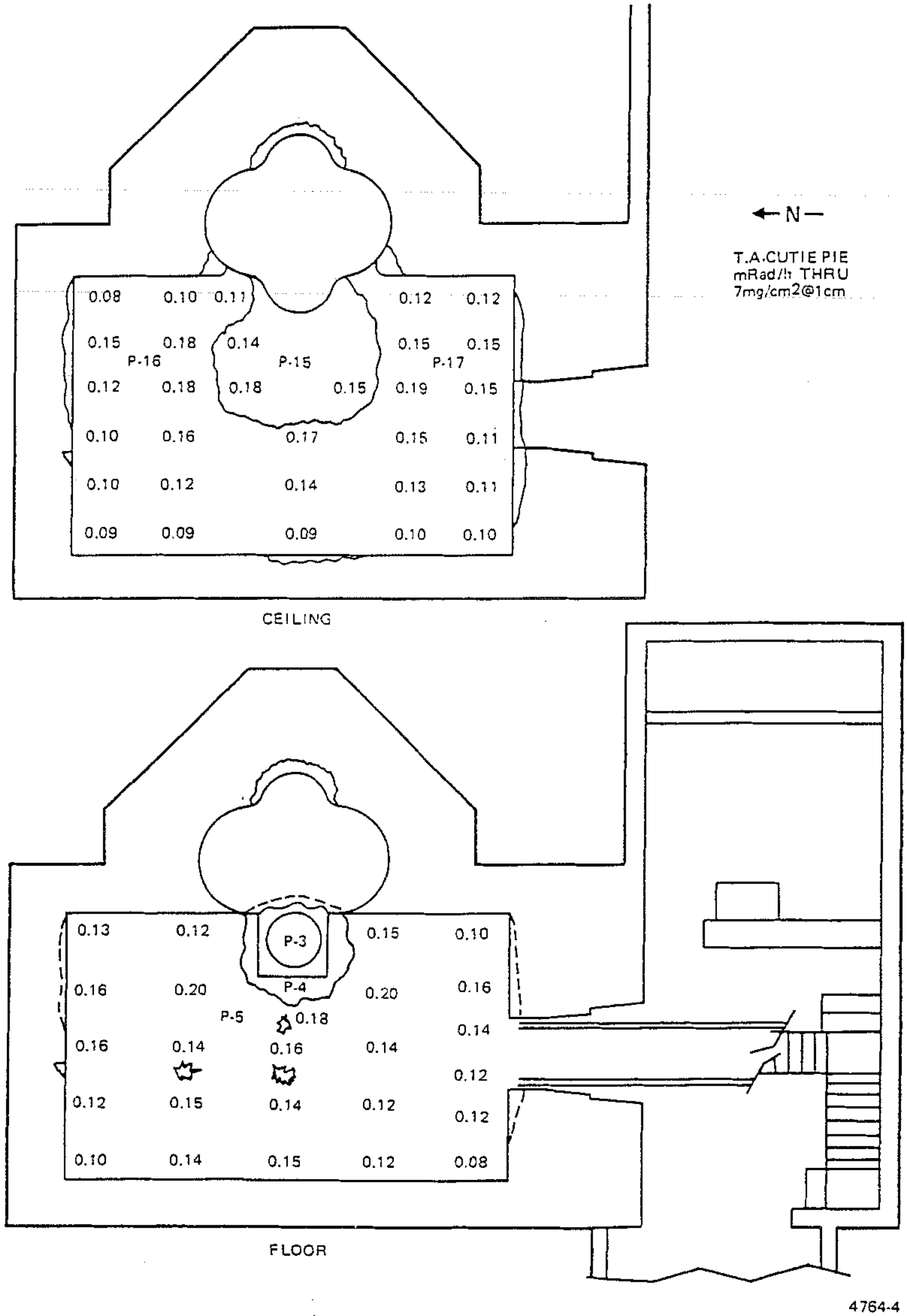


Figure 43. DORF Final Survey, Exposure Room

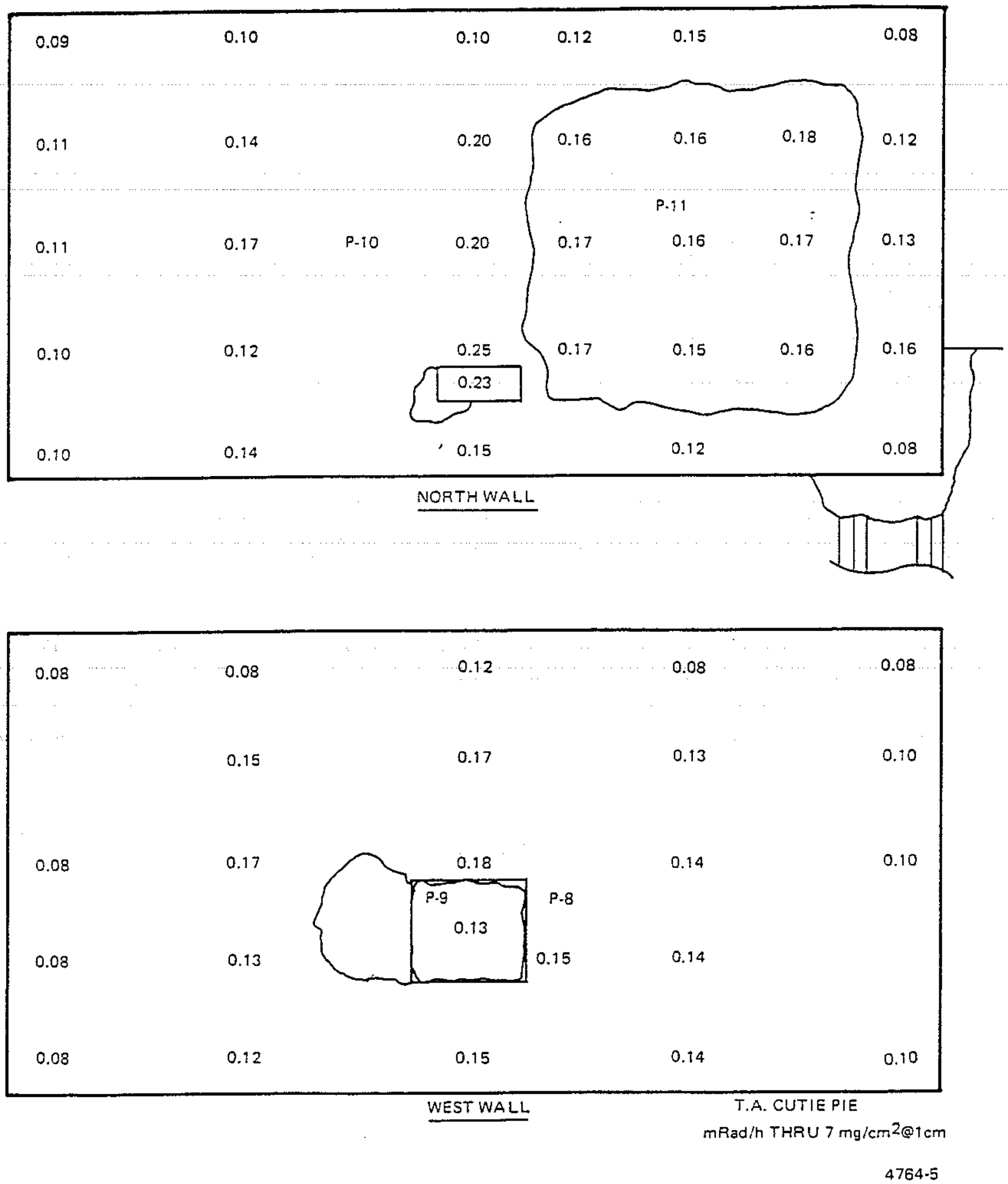
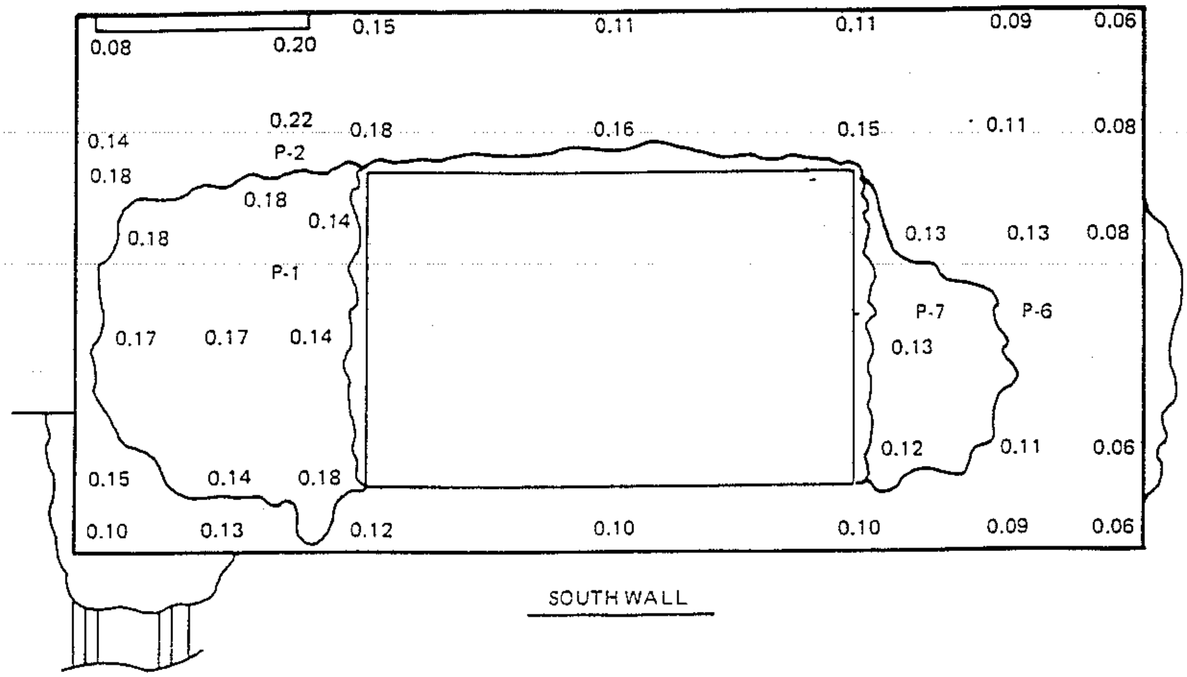


Figure 44. DORF Final Survey, Exposure Room



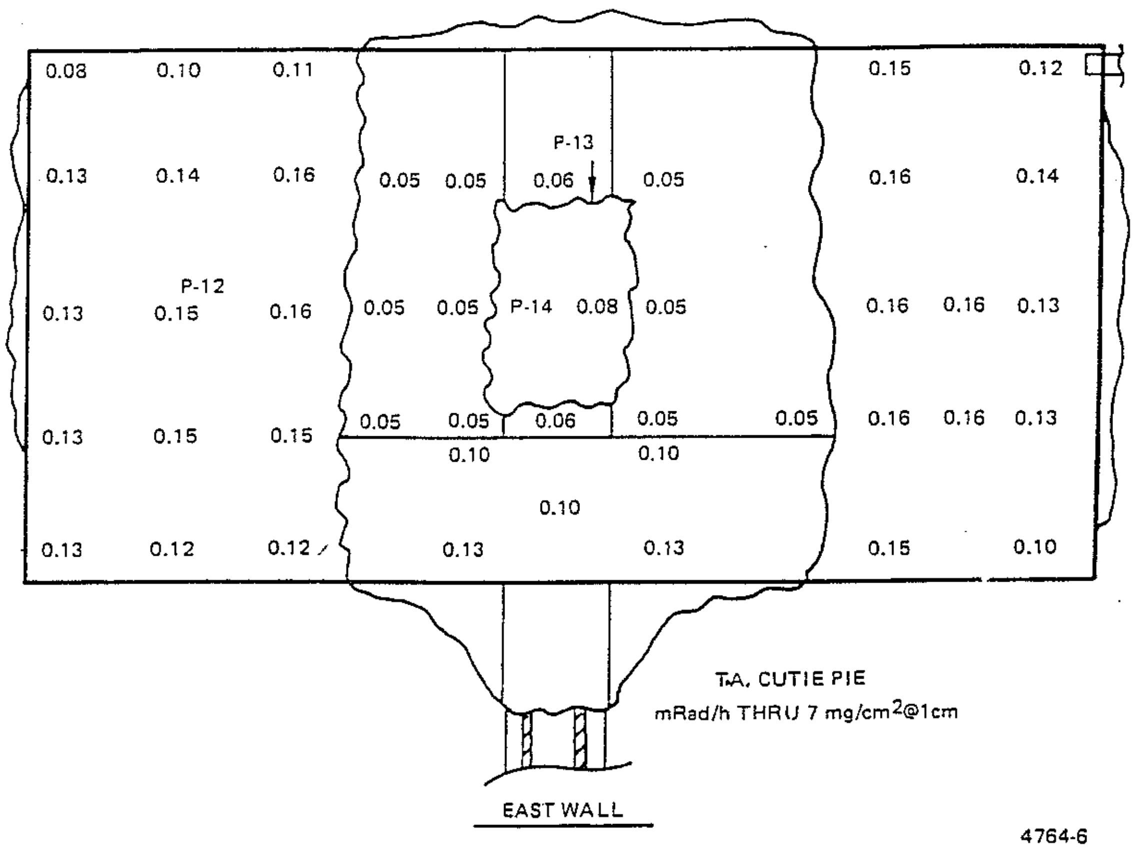


Figure 45. DORF Final Survey, Exposure Room

TABLE 10

RESULTS OF AIR SAMPLING AT DORF

	μCi/cc	
	High Bay	Exposure Room
1979		
27 Nov. to 3 Dec.	1.6×10^{-14}	1.8×10^{-13}
3 Dec. to 10 Dec.	1.3×10^{-14}	1.1×10^{-13}
10 Dec. to 17 Dec.	1.3×10^{-14}	1.9×10^{-13}
17 Dec. to 20 Dec.	1.7×10^{-14}	9.1×10^{-13}
1980		
8 Jan. to 14 Jan.	1.7×10^{-14}	9.0×10^{-14}
14 Jan. to 18 Jan.	1.2×10^{-14}	4.5×10^{-14}
18 Jan. to 22 Jan.	1.3×10^{-14}	1.2×10^{-13}
22 Jan. to 25 Jan.	1.7×10^{-14}	6.1×10^{-13}
25 Jan. to 28 Jan.	2.0×10^{-14}	4.6×10^{-13}
28 Jan. to 31 Jan.	1.7×10^{-14}	2.2×10^{-13}
31 Jan. to 7 Feb.	0.7×10^{-14}	7.3×10^{-14}
7 Feb. to 12 Feb.	1.2×10^{-14}	4.3×10^{-14}
12 Feb. to 16 Feb	3.6×10^{-14}	0.7×10^{-14}

Note: MPC for Eu^{154} in air is 4×10^{-9} μCi/cc. This was the most restrictive isotope present.

7. Waste Disposal

Radioactive (RA) waste was packaged into DOT-approved containers as the waste was generated. The types of material removed from the DORF site as RA waste included concrete, wood, aluminum, steel, plastic, and rubber. Forty-seven steel drums and eight wooden boxes containing 1143.5 ft^3, weighing 60,425 lb, and 1.17×10^{-4} Ci were removed from DORF. The waste was disposed of by land burial. Due to State of South Carolina restrictions on the volume of RA waste permitted for burial at the Barnwell site, the earliest space allocation available to DORF waste was in April. In order to complete the DORF contract on schedule, the waste was shipped to the Nuclear Engineering Company (NECO) site in Beatty,

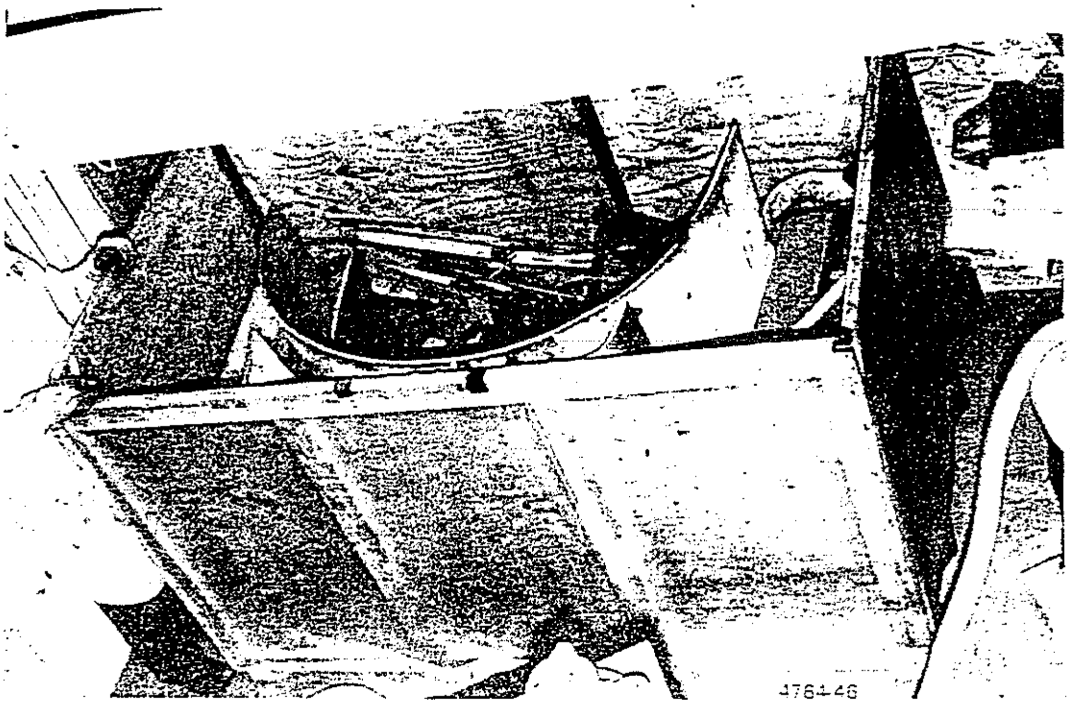


Figure 46. Partially Filled Box of Radioactive Waste

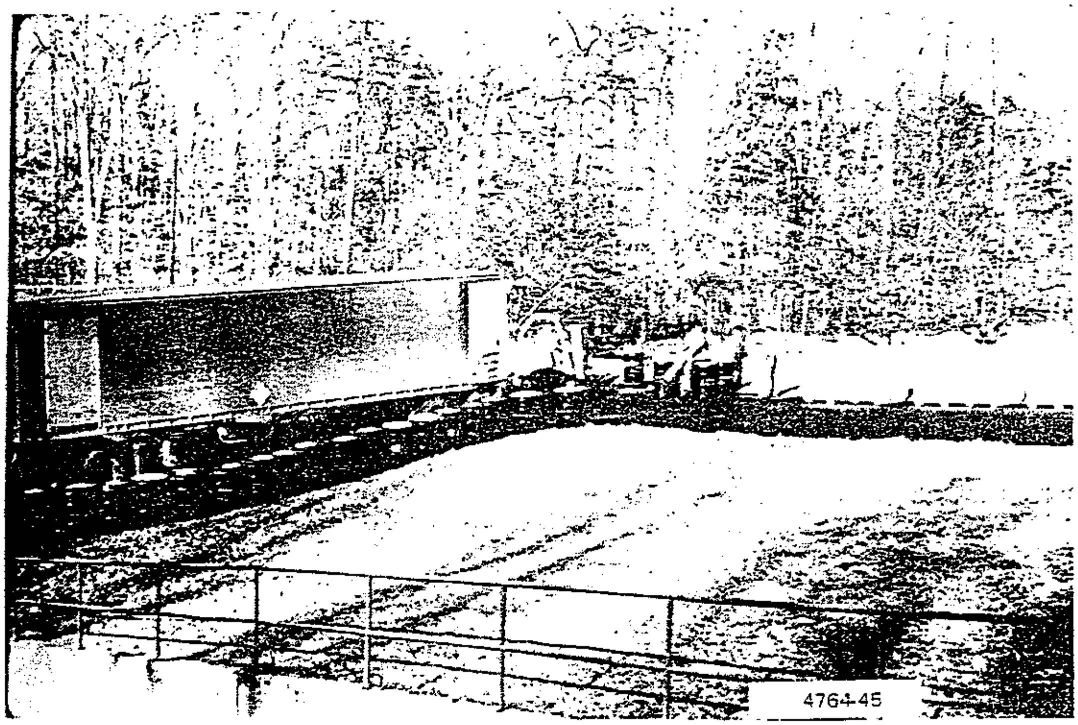


Figure 47. Radioactive Waste Containers Being Loaded Onto Truck for Disposal by Land Burial

Nevada. Chem-Nuclear Systems was contacted to act as broker for the disposal of the RA waste. In that capacity, they handled the arrangements for the transportation and disposal of the waste taking possession of it at the DORF site boundary. Figures 46 and 47 show waste being loaded for shipment to land burial.

C. CONFIRMATORY SURVEY

A survey of the DORF site was conducted between February 25, 1980 and February 27, 1980 by a U.S. Army Environmental Health Agency radiation survey team. This survey was conducted to confirm compliance with NRC Regulatory Guide 1.86 prior to the Army's acceptance of the facility for unrestricted use. The survey team's recommendation, following analysis of the data from the onsite survey, was to accept the facility for unrestricted use. A copy of this recommendation and the preliminary results of their survey are appended in Appendix A. Compliance with NRC Regulatory Guide 1.86 was a contracted prerequisite to conducting Phase III tasks.

D. PHASE III

Phase III consisted of dismantling the concrete parapet to the main floor level, the restoration of any disrupted services to the building, and the repair of facilities damaged by the dismantling activities. An option was given to haul all of the debris from the site or to put it in the pool tank cavity, provided a barrier was erected between the exposure room and the cavity.

Phase III began on April 21, 1980 when ESG was officially notified that DORF was in compliance with NRC Regulatory Guide 1.86, and was completed on May 9, 1980.

Nuclear Controls Corporation (NCC), a subsidiary of the Penhall Company, was contracted by ESG to perform all of the Phase III work. They elected to construct a barrier between the exposure room and the pool tank cavity to permit the debris from the parapet to be disposed in the cavity. The barrier was constructed with a single course of the No. 4 reinforcing bar in the wall and a double course in the roof extension to the exposure room ceiling. The barrier wall was formed by

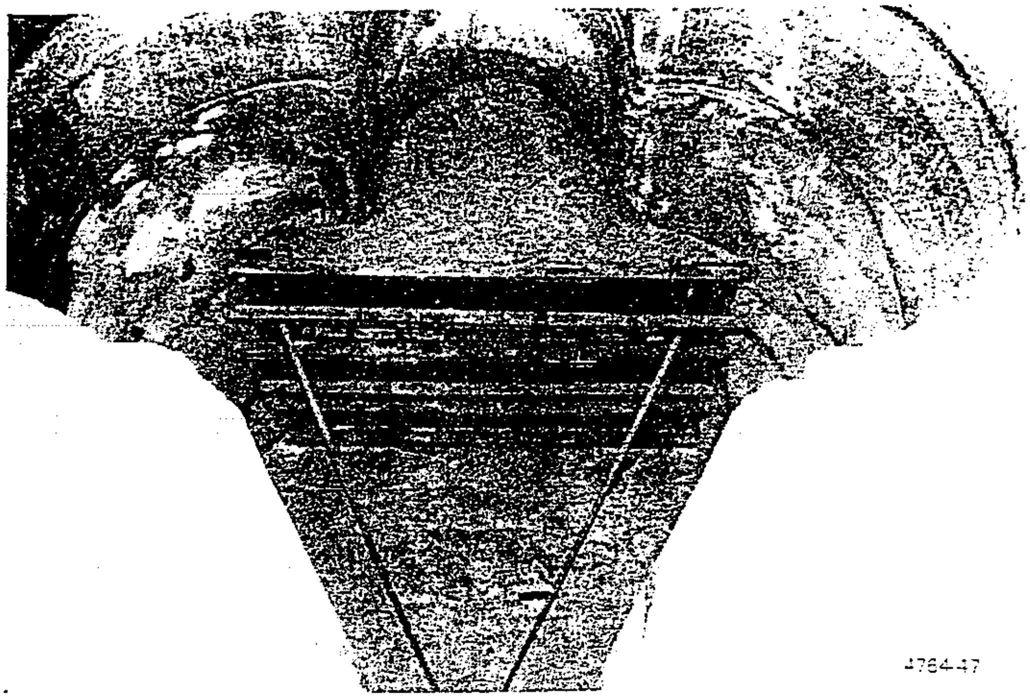


Figure 48. View of Barrier Wall From Parapet

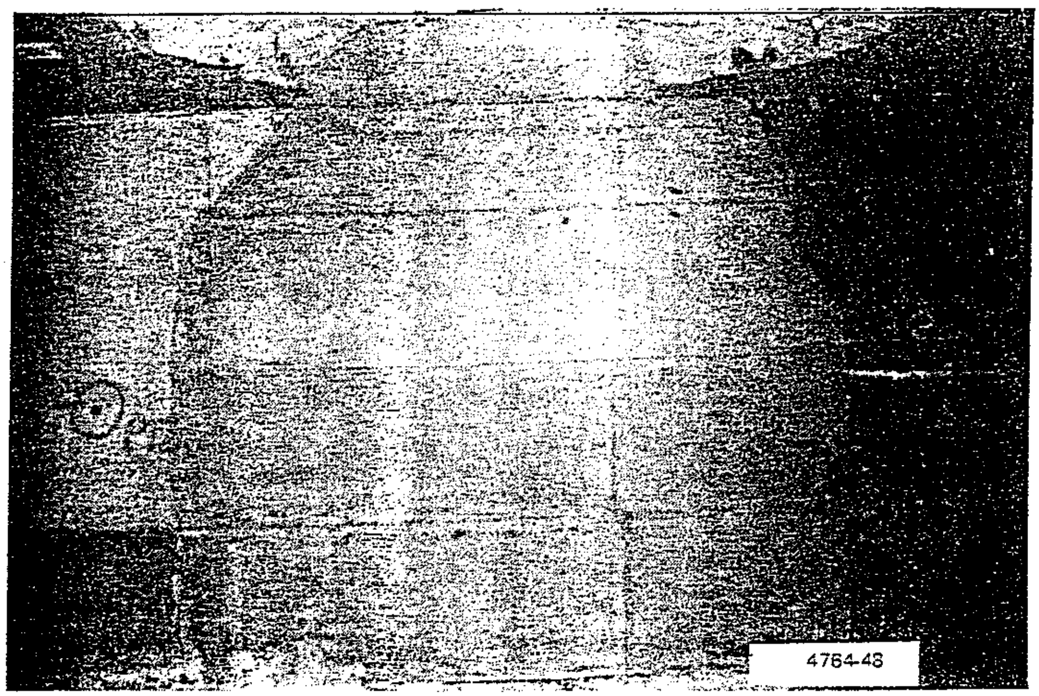


Figure 49. View of Barrier Wall From Exposure Room

a single pour of concrete to a minimum thickness of 8 in. Figures 48 and 49 show the barrier.

NCC contracted Controlled Demolition Incorporated (CDI) to dismantle the concrete parapet. CDI specializes in explosive demolition. The parapet was reduced to rubble and placed into the pool tank cavity by the combined use of explosive charges, jackhammers, and a "Bobcat" skiploader. Figures 50, 51, and 52 show the parapet during dismantlement. Figure 53 shows the parapet demolition completed with the rubble completely below the floor level. A railing was installed around the open pit to provide a safety barrier. Restoration of the floor was not included in this contract.

Rubble, remaining on site from the demolition of the rolling door during Phase II, was removed from the site and, that area where the rubble had been piled was leveled and reseeded.

The building was cleaned of the debris generated by the demolition work. Minor repairs were made to restore the facility's lighting system and other utilities were verified to be functioning satisfactorily.

DORF facility drawings were redlined to reflect the changes made by the performance of the contracted work. These drawings were presented to the DORF Contracting Officer's Representative. A list of the drawings and a description of the changes are given in Table 11.

Figure 50. Explosive Charges Being Loaded Into Pre-drilled Holes

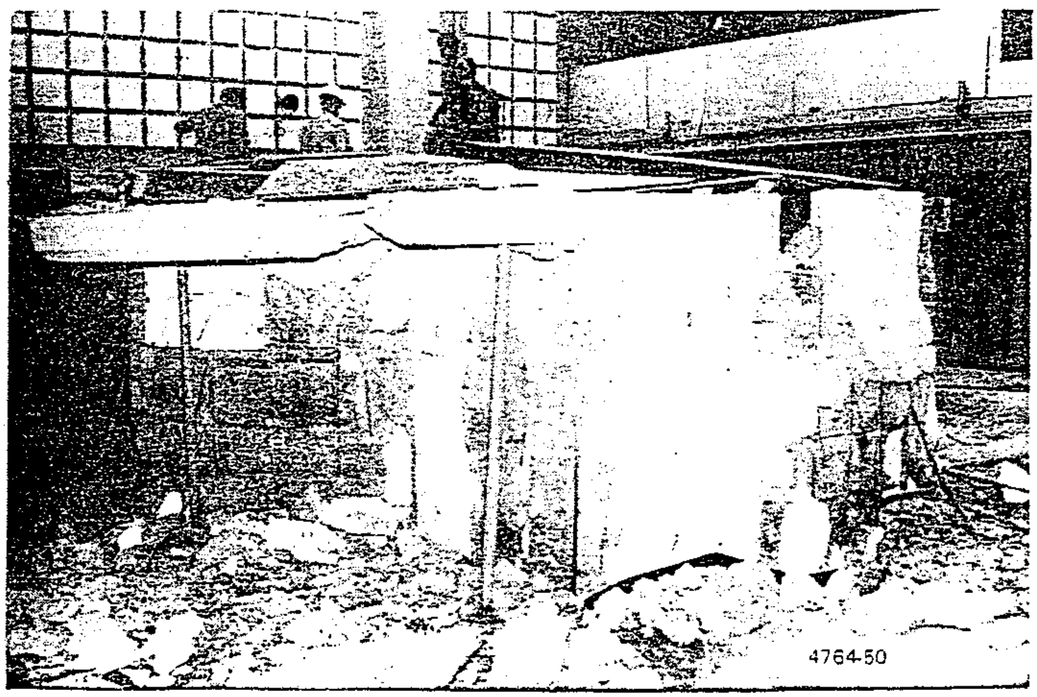


Figure 51. Parapet After Several Explosive Charges Set Off

Figure 52. Concrete Rubble Being Pushed Into Pool Tank Cavity

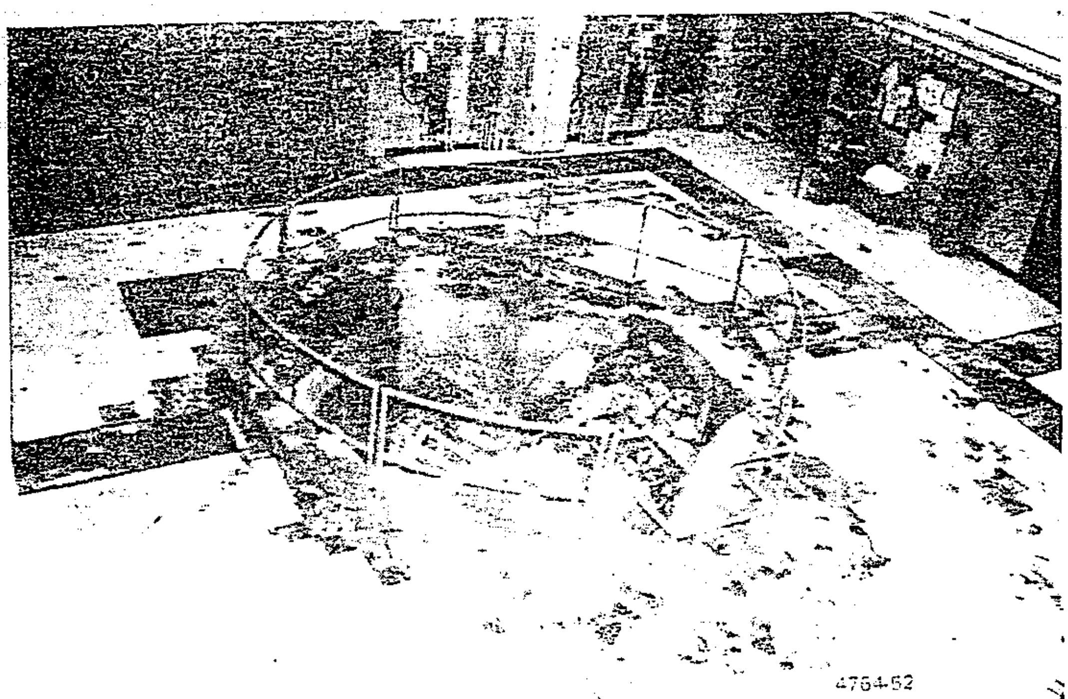


Figure 53. Parapet Demolition Completed

TABLE 11

REDLINE CHANGES TO DORF DRAWINGS
(Sheet 1 of 2)

DRAWING NUMBER

A-1 FLOOR PLANS AND SCHEDULES

Shows parapet removed.

Shows lead shielding removed.

Reference to Drawings #S-1, 2, 3, and 4 for changes.

A-2 ELEVATIONS AND SECTIONS

Crosshatched Section A to show deletion of parapet and Exposure Room wood.

Also crosshatched elevation B-1 to show deletion of details for Exposure Room.

A-3 SECTIONS AND DETAILS

Crosshatched Details 5, 10, 11, and 12 to show deletion of wood in Exposure Room.

E-1 SINGLE LINE DIAGRAM

Circled portion of line diagram showing the recirculating water pumps, lead shield door, rolling door, and core dolly electrical systems disconnected.

E-2 GROUNDING PLANS AND SYMBOLS

Circled parapet and Exposure Room grounding references to show them removed.

E-4 POWER

Marked up print to reflect disconnected circuits.

E-6 SAFETY INTERLOCK DIAGRAMS

Noted that fuses were removed from the relay panel in order to disable those circuits.

M-1 PLANS AIR CONDITIONING

Noted that wood was removed from the Exposure Room.

TABLE 11

REDLINE CHANGES TO DORF DRAWINGS
(Sheet 2 of 2)

DRAWING NUMBER (Continued)

M-2 EQUIPMENT ROOM DETAILS

Showed that reactor cooling equipment was removed and that the hydraulic system for the lead shield hoist was drained and the hydraulic cylinder removed.

M-3 PLUMBING

Crosshatched details 5, 6, and 8, and Section B to show deletion.

M-5 ROLLING DOOR - EXPOSURE ROOM

Noted that the door was demolished.

S-1 PLANS

Crosshatched Detail 4 to show deletion.

S-2 SECTIONS

Crosshatched Detail 1, Section C and Section D to show deletion. Also crosshatched to show approximate areas affected by the excavation of concrete.

S-3 DETAILS

Crosshatched rolling door frame to show deletion. Also circled and crosshatched area of doorway affected by concrete removal.

S-4 RAMP PLANS AND DETAILS

Crosshatched ramp plan, ramp reinforcing plan, Section A, and Details 1 and 2 to show deletion.

APPENDIX A

DEPARTMENT OF THE ARMY HARRY DIAMOND LABORATORIES

DEPARTMENT OF THE ARMY
HARRY DIAMOND LABORATORIES
2800 POWDER MILL ROAD
ADELPHI, MD. 20783

DELHD-N-RBI

22 April 1980

Rockwell International Corp.
Energy Systems Group
8900 De Soto Avenue
Canoga Park, CA 91304

RECEIVED
APR 25 1980
Correspondence Dept.

Reference: Contract DAAK 21-79-C-0136

The inclosed letter of 17 April 1980 from the U.S. Army Material Development and Readiness Command, D. Taras states that the NRC Regulatory Guide 1.86 criteria for unrestricted use has been achieved at the Diamond Ordance Radiation Facility (DORF) based upon the preliminary report from the U.S. Army Environmental Hygiene Agency, 3 April 1980. Accordingly, this letter constitutes official notification that Section F.5.1 of the above contract has been accomplished and you now have thirty days from the date of this letter to initiate the phase III tasks (i.e. F.5.2 - F.10 as amended) as indicated in Section H.3 of the contract.

Sincerely,

Charles Ware

Charles Ware
Contracting Officers
Representative

incl. - 2
CF
J. Rosado 22000
D. Schallhorn 22900
A. Mazzone 091
J. Harris Rockwell Int.

DEPARTMENT OF THE ARMY
HEADQUARTERS US ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND
5001 EISENHOWER AVENUE, ALEXANDRIA, VA. 22333

D. Taras/seb/AUTOVON 284-9340

DRCSF-P

17 April 1980

SUBJECT: Decontamination of Diamond Ordnance Radiation Facility

THRU: Commander
US Army Electronics Research and Development Command
ATTN: ~~DRDEL-SS~~
Adelphi, MD 20783

TO: Commander
Harry Diamond Laboratories
ATTN: DELHD-N-RBI
Adelphi, MD 20783

1. Reference is made to the following report: Radiation Protection Special Study No. 28-43-0982-80, Close-Out Survey of Diamond Ordnance Radiation Facility (DORF), 25-28 February 1980.

2. On 10 April the Army Reactor Committee for Health and Safety reviewed the referenced report and concluded that decontamination is consistent with the criteria in NRC Regulatory Guide 1.86 and is as low as reasonably achievable. In PHONECON, 17 April 80, LTC Quillin, WRAMC Radiation Protection Officer, stated these acheived levels are acceptable to WRAMC. Based on the above, the facility is suitable for unrestricted use and occupancy.

DARWIN N. TARAS
Member, Army Reactor Committee
for Health and Safety

CF:
HQDA(DASG-PSP-E); (DAPE-HRS)
DRCIS
DRCSG

DEPARTMENT OF THE ARMY
U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND MARYLAND 21010

Mr. Lodde/cw/AUTOVON
584-3526

HSE-RH/WP

3 APR 1980

SUBJECT: Preliminary Report, Radiation Protection Special Study No. 28-43-0982-80, Close-Out Survey of Diamond Ordnance Radiation Facility (DORF), 25-28 February 1980

Commander
US Army Materiel Development and
Readiness Command
ATTN: DRCSG
5001 Eisenhower Avenue
Alexandria, VA 22333

1. AUTHORITY. Letter, DELHD-N-RBI, Harry Diamond Laboratories, 2 November 1979, subject: Request for a Radiological Health Special Study, and indorsement thereto.

2. PURPOSE. This special study was performed to determine the presence and extent of radioactive contamination and whether the facility met the radioactive contamination levels stated in Nuclear Regulatory Commission, Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors, June 1974, following decontamination.

3. GENERAL.

a. This radiation protection special study was conducted by Mr. Gordon M. Lodde, Health Physicist, and 2LT Roger M. Davis, Jr., Health Physics Division, this Agency, during the period 25-28 February 1980.

b. An entrance interview and an exit briefing were provided to Mr. Charles Ware, Contracting Officer's Representative, Harry Diamond Laboratories.

4. FINDING.

a. The results of smear surveys are provided in Inclosure 1.

b. The results of concrete analysis are provided in Inclosure 2.

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c. Surveys by direct radiation measurements indicated that the highest radiation values were obtained on the north, south, and west walls of the exposure room. The values ranged from 20-400 microroentgen per hour (μR/h) on contact as measured with an Eberline, Model PRM-7, Micro-R-Meter and up to 350 μR/Hr when measured with a Victoreen, Model 440, Ionization Chamber. These two methods of radiation measurements are in close agreement.

5. DISCUSSION.

a. Samples were taken from the wastewater holding tanks and the sewage system down stream from the holding tanks.

b. Core samples were taken off site and soil and vegetation samples were taken both on and off site.

c. The final report will be forwarded in about 60 days following analysis of the samples.

6. CONCLUSION. A review of the findings indicated that after decontamination the facility conformed to the requirements of Regulatory Guide 1.86.

7. RECOMMENDATION. None

FOR THE COMMANDER:

2 Incl
as

FRANK E. McDERMOTT
COL, MSC
Director, Radiation and
Environmental Sciences

CF:
Cdr, ERADCOM
Cdr, HSC (HSPA-P)

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RESULTS OF ANALYZING WIPE TEST SAMPLES

Sample Identification	RCB Lab No.	Disintegrations per Minute ±2 Standard Deviations/100 cm^2 Gross Alpha Activity	Gross Beta Activity
1	L244	< 1.4	4.4 ± 2.5
2	L245	< 1.4	< 2.5
3	L246	< 1.4	< 2.5
4	L247	< 1.4	< 2.5
5	L248	< 1.4	< 2.5
6	L249	< 1.4	< 2.5
7	L250	< 1.4	< 2.5
8	L251	< 1.4	2.8 ± 2.0
9	L252	< 1.4	< 2.5
10	L253	< 1.4	6.0 ± 2.7
11	L254	< 1.4	2.6 ± 2.0
12	L255	< 1.4	< 2.5
13	L256	< 1.4	< 2.5
14	L257	< 1.4	< 2.5
15	L258	< 1.4	< 2.5
16	L259	< 1.4	3.6 ± 1.9
17	L260	< 1.4	< 2.5
18	L261	< 1.4	< 2.5
19	L262	< 1.4	14.6 ± 3.7
20	L263	4.7 ± 2.4	14.0 ± 3.6
21	L264	< 1.4	< 2.5
22	L265	< 1.4	6.2 ± 2.3
23	L266	< 1.4	7.0 ± 2.6
24	L267	3.2 ± 1.9	< 2.5
25	L268	< 1.4	5.2 ± 2.4
26	L269	< 1.4	< 2.5
27	L270	< 1.4	3.0 ± 2.0
28	L271	< 1.4	< 2.5
29	L272	< 1.4	< 2.5

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Sample Identification	RCB Lab No.	Disintegrations per Minute ±2 Standard Deviations/100 cm^2 Gross Alpha Activity	Gross Beta Activity
30	L273	< 1.4	3.2 ± 2.2
31	L274	< 1.4	9.8 ± 3.2
32	L275	< 1.4	3.2 ± 2.3
33	L276	< 1.4	< 2.5
34	L277	< 1.4	< 2.5
35	L278	< 1.4	3.2 ± 2.4
36	L279	< 1.4	3.2 ± 2.1
37	L280	< 1.4	5.0 ± 2.4
38	L281	< 1.4	4.8 ± 2.3
39	L282	< 1.4	< 2.5
40	L283	< 1.4	< 2.5
41	L284	< 1.4	3.4 ± 2.1
42	L285	< 1.4	< 2.5
43	L286	< 1.4	< 2.5
44	L287	< 1.4	< 2.5

Alphus L. Jones
ALPHUS L. JONES, Chief
Radl & Biol Chem Div, USAEHA

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INTERIM RESULTS OF ANALYZING CONCRETE SAMPLES

Sample Identification	RCB Lab No.	Microcurie per Gram ±2 Standard Deviations: Europium-152 Activity	Europium-154 Activity	Cobalt-60 Activity
EX-N	RC1	$3.5 \times 10^{-5} \pm 0.1 \times 10^{-5}$	$2.8 \times 10^{-6} \pm 0.6 \times 10^{-6}$	$1.0 \times 10^{-5} \pm 0.4 \times 10^{-6}$
EX-S	RC2	$5.9 \times 10^{-5} \pm 0.1 \times 10^{-5}$	$4.5 \times 10^{-6} \pm 0.8 \times 10^{-6}$	$3.4 \times 10^{-5} \pm 0.1 \times 10^{-5}$
ES In Pool	RC3	$1.6 \times 10^{-5} \pm 0.1 \times 10^{-5}$	$1.4 \times 10^{-6} \pm 0.4 \times 10^{-6}$	$5.4 \times 10^{-6} \pm 0.3 \times 10^{-6}$
ES-W	RC4	$2.8 \times 10^{-5} \pm 0.1 \times 10^{-5}$	$2.2 \times 10^{-6} \pm 0.5 \times 10^{-6}$	$1.4 \times 10^{-5} \pm 0.1 \times 10^{-5}$
EX LIFT-S	RC5	$1.1 \times 10^{-4} \pm 0.2 \times 10^{-5}$	$7.9 \times 10^{-6} \pm 0.9 \times 10^{-6}$	$3.0 \times 10^{-5} \pm 0.1 \times 10^{-5}$

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