slag piles, but failed to remove particulates from within the piles. A 6-in.-wide blade mounted on the down extension of the arm and the water jet from the pump were used to push the debris into a basket. Three full baskets (600 lb) were removed. This debris was visually inspected for fuel elements, but none was found.

4.4.9.10 Outer Tank Removal

The outer tank was a 15-ft-diameter, 19-ft-high, open-top vessel installed 8 ft below floor level and surrounded by thermal insulation (see Figure 45). The 1/4-in.-thick carbon steel tank was used for cover gas containment. Two horizontal corrugated cylinders (bellows) intersected the tank at 14 ft below floor level. A 3/4-in.-thick doubler plate reinforced the bellows-to-tank junction.

Removing the bottom of the outer tank consisted of removing all sections of the outer tank below the line where the tank flange was 1-3/4 in. thick. The lower half of the flange was 2 in. thick; the upper half tapered to a 1/2-in.-thick section. The carbon steel flange was welded to a 150-in.-diameter, 2-1/2-in.-thick carbon steel plate. Eight equally spaced locating cleats (2 by 2 by 9 in.) were fastened to the bottom of the tank.

To prevent water from saturating the thermal insulation, the outer tank was cut in an air environment. The guidepost was installed in the locating hole previously drilled into the bottom of the tank. The manipulator was installed on the guidepost with the radial arm bolted to the carriage in the outermost location. An asbestos cover installed over the hose bundle prevented damage from sparks. Contamination was fixed to the inside diameter of the tank by painting with zinc chromate primer. An airless paint sprayer attached to the manipulator was used to apply the paint. All platform openings were covered with plastic, and the radiological exhaust duct was connected to the platform.

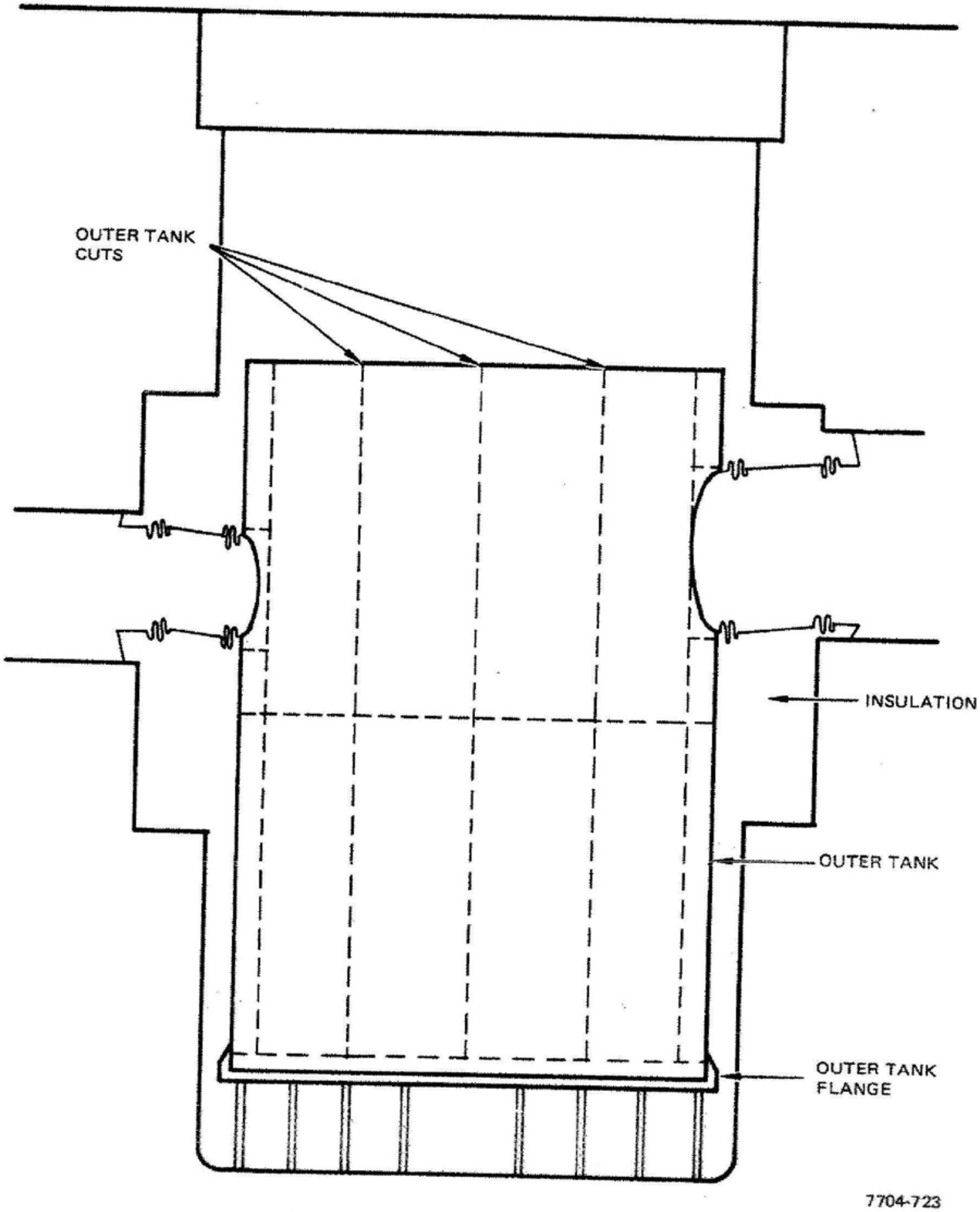


Figure 45. Outer Tank Cuts

The cutting pattern specified four rows of 55-in.-high segments, but since low activity levels permitted segments to be shipped in a wooden box, the height was doubled. Segments from the top row read 25 mR/h at 1 ft, and segments from the bottom row read 45 mR/h at 1 ft. Cutting the doubler plates around the bellows required using cutting parameters for 1-1/2-in.-thick stainless steel.

The outer tank bottom flange taper dimensions were not the same as indicated by the drawing dimensions. As a result, the horizontal cut severed the flange where its thickness was too great for lifting grips to be installed easily. Several grips were inadvertently installed in the wrong locations and could not be remotely removed. This caused the cutting pattern to be revised and produced two double and several half-size segments.

Cutting and removal operations were almost flawless. Changing the arm to carriage location produced a few uncut tabs at the cut start/stop points. The segment removal sequence was simplified by removing all but one segment. The 46-in.-diameter center section with an attached segment was loaded into an extra large shipping box. The maximum segment dose rate was 1 R/h at 1 ft. This concluded remote dismantling operations.

4.4.9.11 Insulation Removal

A 9-in.-thick layer of insulation covered the inside diameter of the core cavity liner. It was held in place by wires connected to studs welded to the cavity liner. Remote removal using the plasma-torch manipulator system was considered, but manual operation was selected.

Insulation tiedown wires were cut manually, and the 3- by 8- by 36-in. blocks were stacked in a wooden shipping container. Removal of 1100 ft^3 of wall insulation required 3 days. Removal of the floor insulation required 2 days.

4.4.9.12 Core Cavity Line Removal

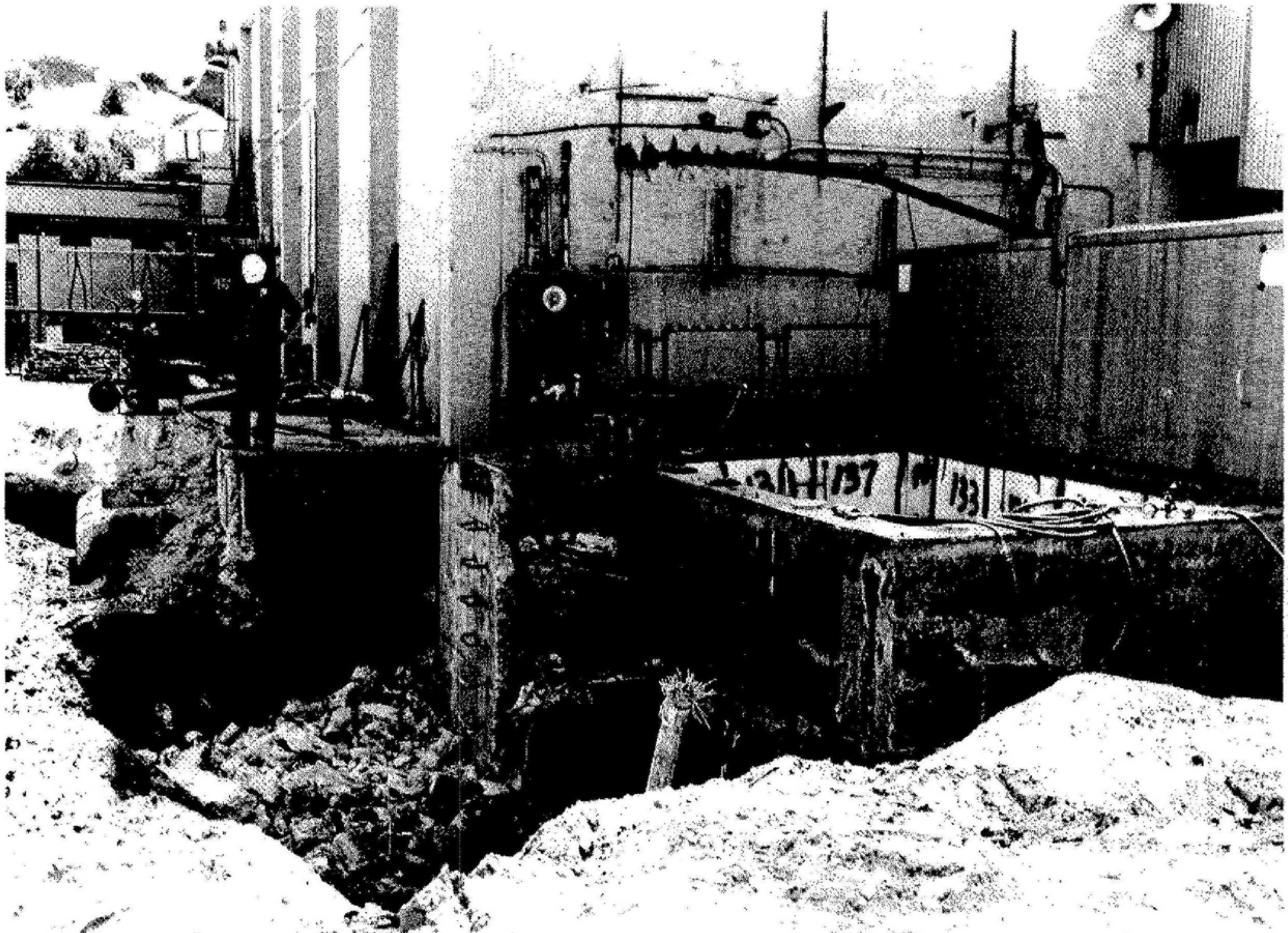
The reactor core cavity liner formed the inside surface of the biological shield. The 1/4-in.-thick steel liner was attached to the biological shield by the kerosene cooling coils which were welded to the liner and embedded in the concrete.

After all of the core components, tanks, and insulation were removed, the reactor core cavity liner was removed. The upper 3/4 section of the 1/4-in.-thick steel liner was cut into sections using a hand-held oxygen-acetylene torch. The lower 1/4 section of the core cavity liner was cut with a torch and pryed loose from the biological shield using a hydraulic Hy-Ram. Removal of the liner was phased with the biological shield removal to take advantage of having the concrete removed from behind the liner. The sections were packaged in wooden crates for disposal.

4.4.10 Excavation of Contaminated Soil

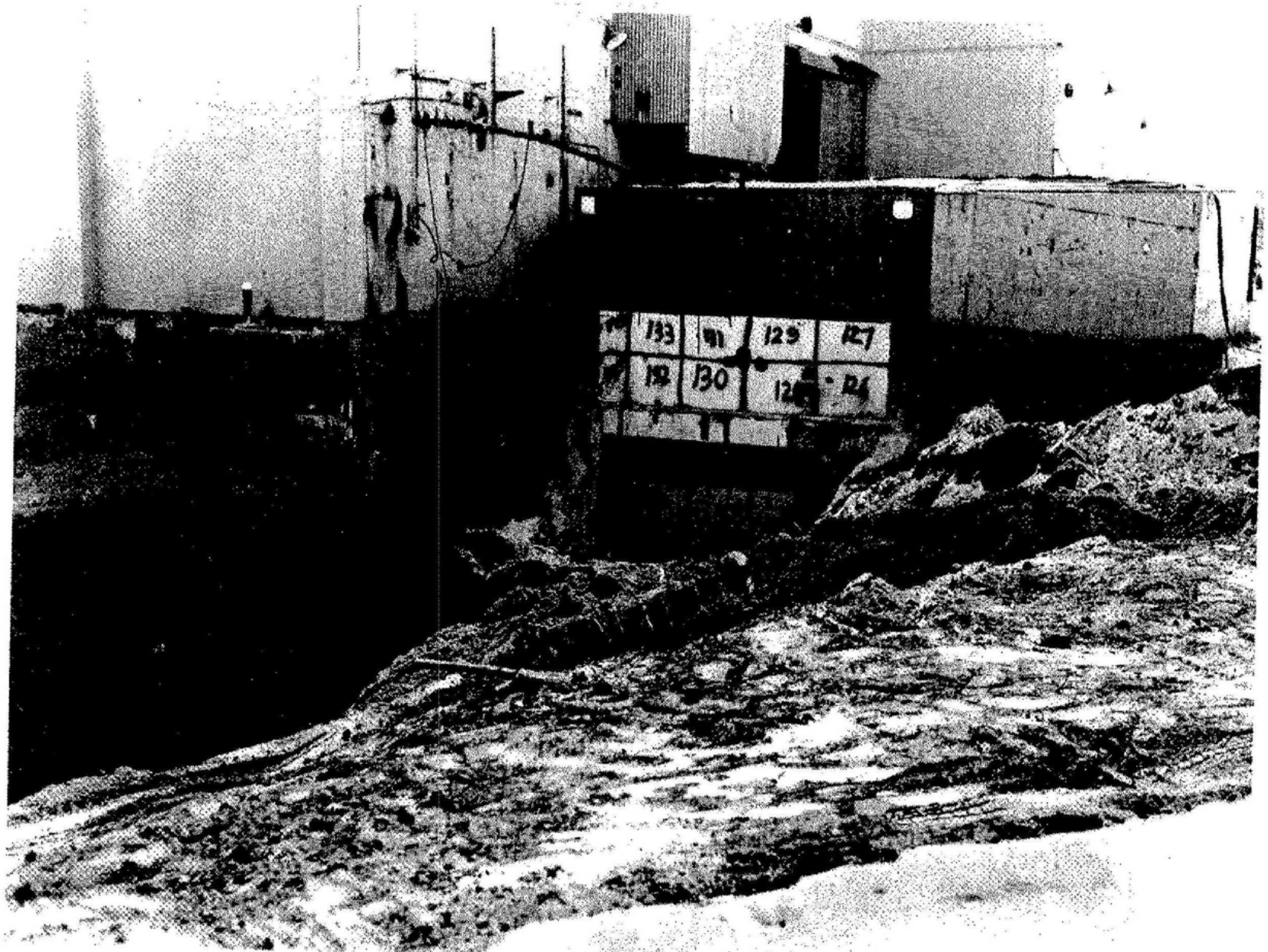
The primary sodium fill tank vault and the sodium service vault were located directly north of the reactor building high-bay area. During reactor operation, the concrete surfaces of these vaults became contaminated. Decontamination was best accomplished using the Hy-Ram and working inward from the outside of the vault. This required that an access ramp be excavated at the northeast corner of the SRE high bay. Figure 46 shows the initial excavation to expose the outside wall of the sodium service vault. Figure 47 shows a portion of the east exterior wall of the primary fill tank vault. This was a common wall between the two vaults. The numbered grids defined the interior wall of the sodium service vault.

During this excavation, contamination above the Table 3 limits was found in the soil surrounding the footing at the northeast corner of the high bay. Further excavation uncovered contamination as high as 13,000 pCi/g located in cracks in the bedrock east and north of the high bay (see Figure 48). Figure 49 shows the excavation along the east face of the building. Contaminated



7704-621438

Figure 46. Initial Excavation at Northeast Corner of the SRE High Bay



7704-621494

Figure 47. Excavation East of Primary Fill Tank Vault

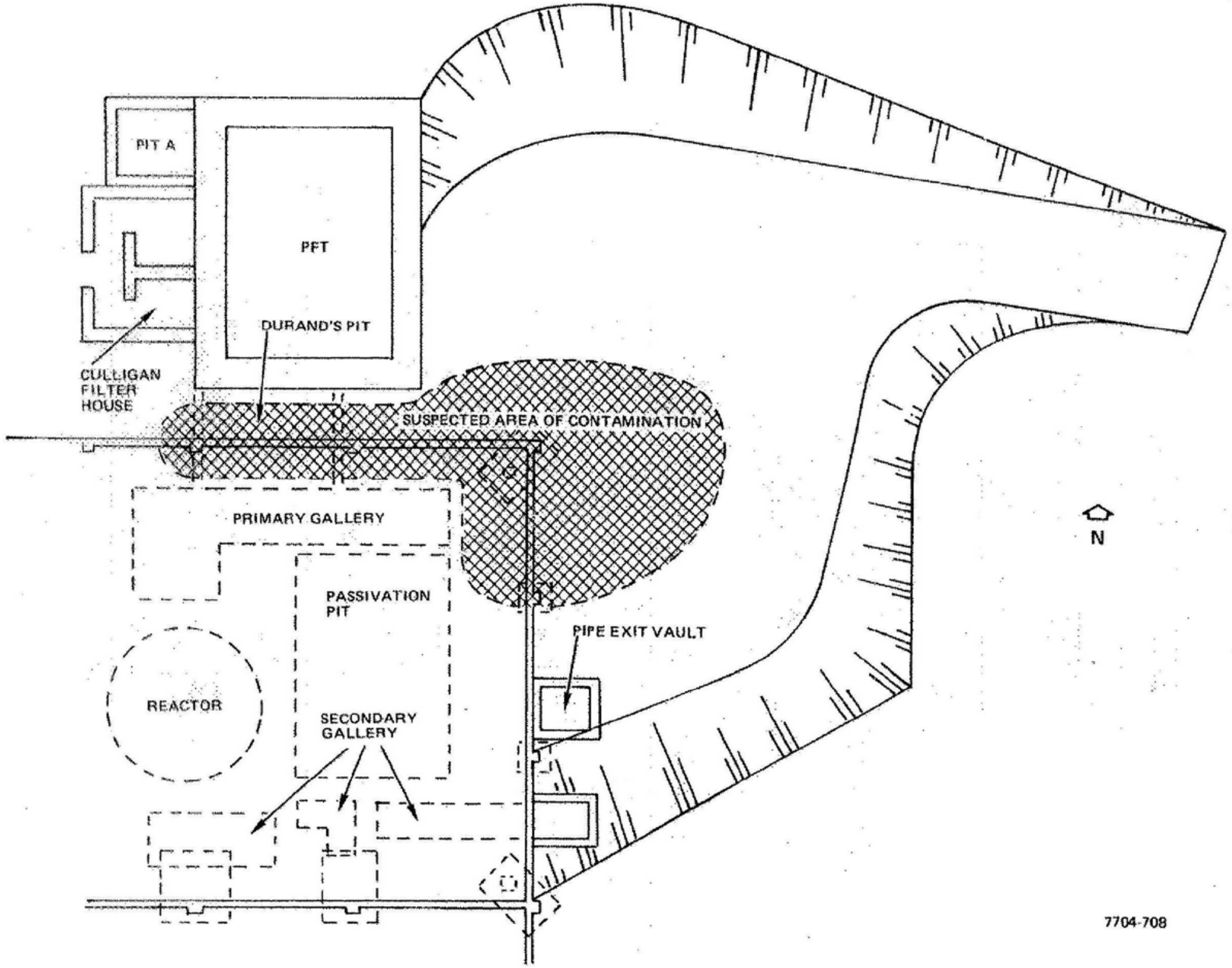
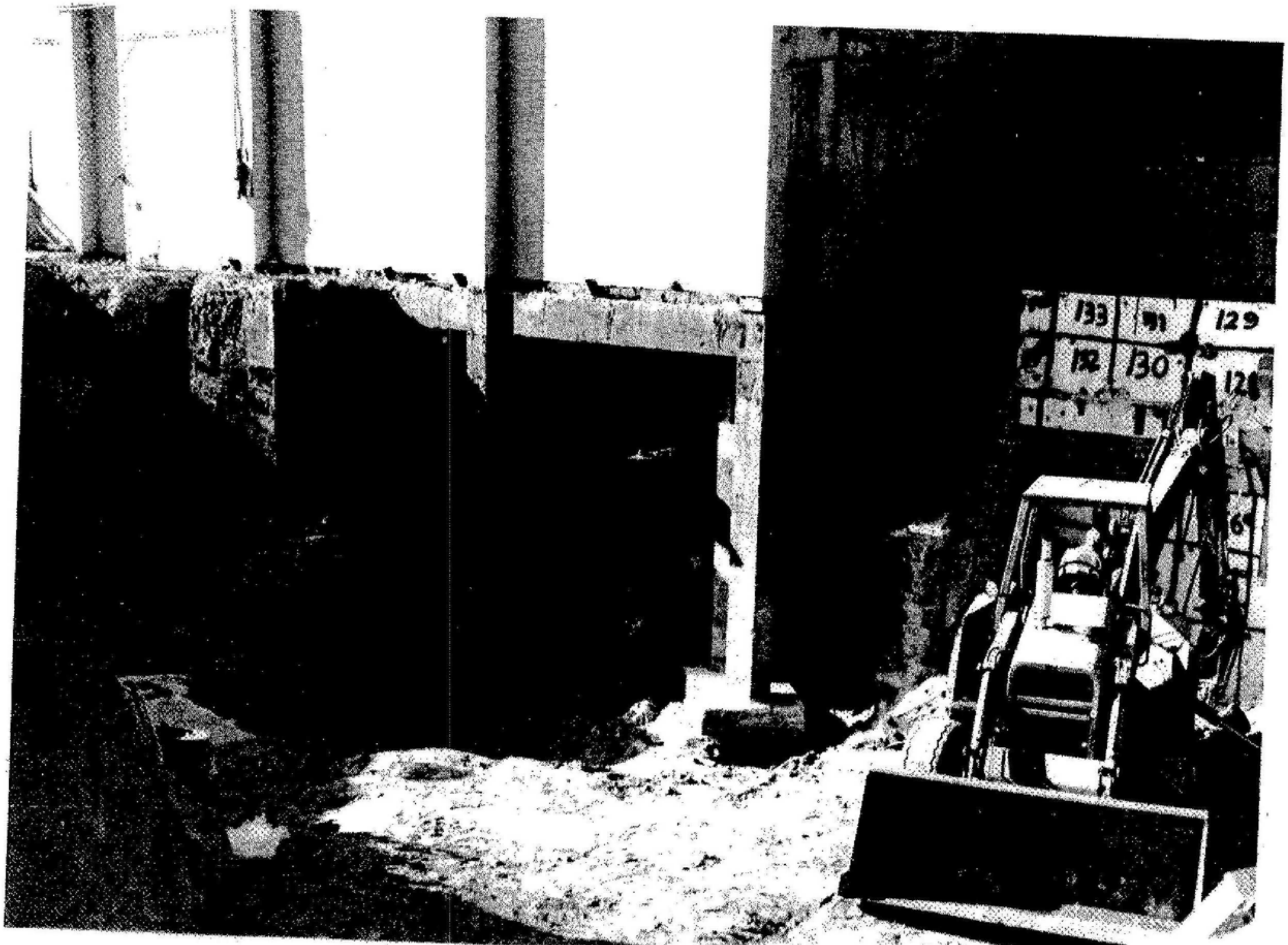


Figure 48. Access Ramp to High-Bay Excavation and Suspected Area of Contamination



7704-621540

Figure 49. Excavation East of SRE High Bay

soil and bedrock were packaged for disposal in tri-wall cardboard "King-Pac" containers. The containers, which were mounted on a plywood skid, held approximately 2000 lb each. All contamination above the release limit was removed from the area. The area was backfilled to provide machine access for further decontamination activity within the high bay.

Decontamination of the sodium service vault and the primary fill tank vault was completed using the Hy-Ram. Whenever possible, selective, rather than bulk, removal approaches were used to minimize the waste to be packaged and sent to burial. It was shown that the Hy-Ram could be equipped with chisel-like tools that could peel off selected layers of contaminated concrete in vaults and walls. Figure 50 shows the Hy-Ram in operation.

After the sodium service vault was demolished, access was provided to the interior of the primary fill tank vault. Contaminated surfaces were removed with the Hy-Ram. The east, south, and west walls were demolished and the clean rubble was stored onsite for future use as backfill material. The floor and the north wall remained and were subseqently buried during backfilling of the access ramp. Figure 51 shows the demolition of the primary fill tank south wall and the extent of the excavation along the east side of the high bay.

Access to the north and east exterior surfaces of the reactor biological shield was provided by demolishing the main and auxiliary primary vault walls. Prior to this time, it was decided to excavate the entire SRE high bay. This would provide equipment access to the remaining below-grade components that had to be removed. These included the fuel storage cells, wash cells, moderator element storage cells, and fuel element enclosure sleeves. Prior to the start of soil excavation, a consulting civil engineering firm was hired to evaluate the impact of the future excavation on the structural integrity of the building. The recommendations from the consultant were as follows:

1) Excavation work should not begin until completion of facility improvements.

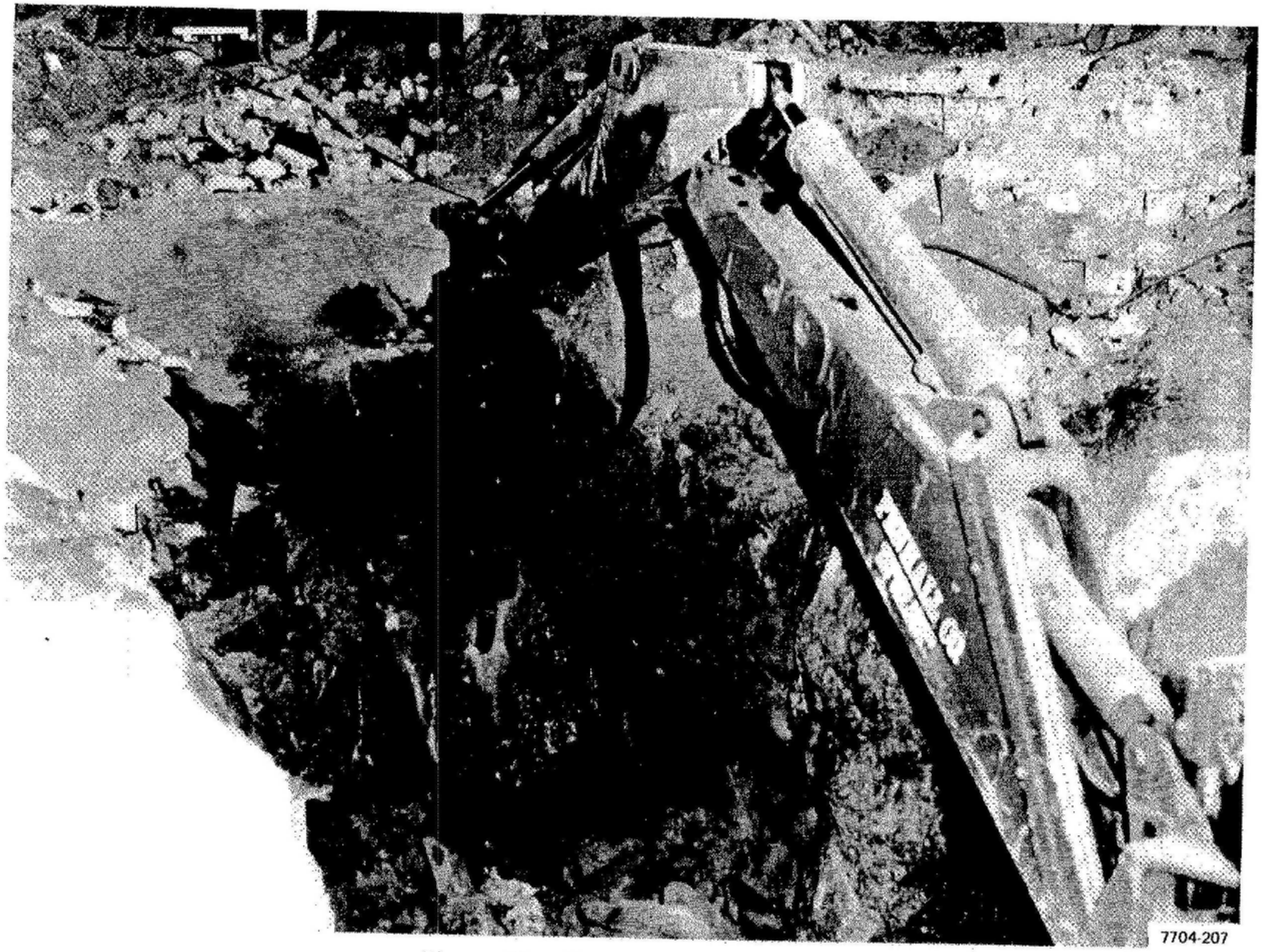


Figure 50. Hy-Ram in Operation

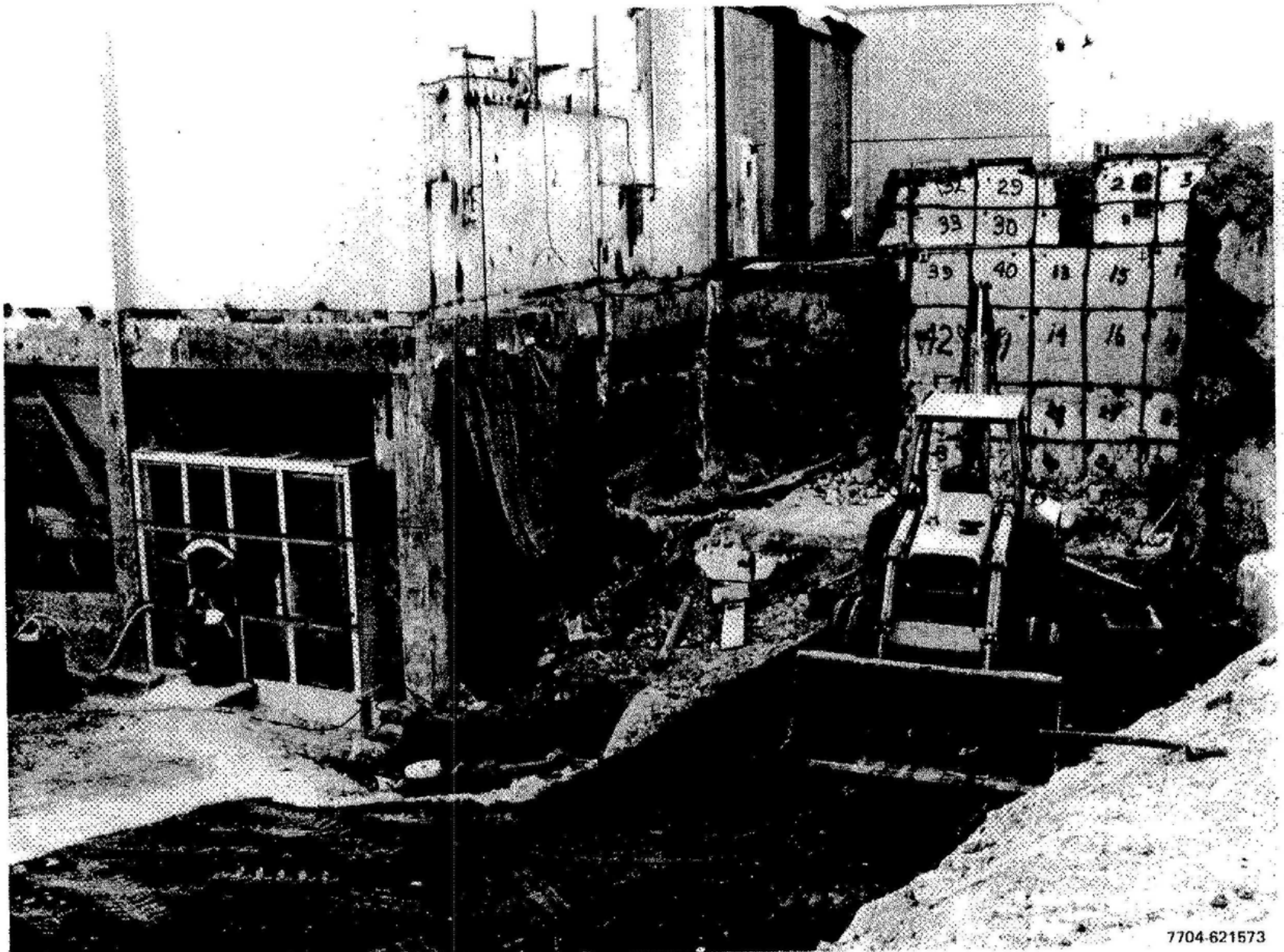


Figure 51. Demolition of Primary Fill Tank Vault

2) The 75-ton bridge crane should be down rated to 5 tons and stored at the far west end of the high bay when not in use.

3) A retaining wall should be built at the southern limit of the excavation in the high bay between the hot cell wall on the west and the auxiliary secondary gallery wall on the east (see Figure 52). The retaining wall was to consist of 50-ft-deep, steel-reinforced concrete pilings with 4 by 12 wooden shoring secured in channels imbedded in the piles. Figure 53 shows the installation of the wooden shoring. As the excavation deepened, additional shoring could be added.

4) Seismic bracing had to be added when the excavation was completed.

5) Additional bracing had to be added if excavations went below the bottom of a footing.

The pilings for the retaining wall were installed while the excavation of the access ramp was in progress. The ramp provided equipment access for the concrete vault demolition and the high-bay excavation. The SRE high-bay excavation lowered 90% of the high-bay floor area an average of 20 ft. Six seismic braces were added. Four 8-in.-diameter steel pipes tied the grade beam under the north wall to the floor of the primary fill tank vault. A single 8-in. pipe bisected the northeast corner from the grade beam to a new footing down in the excavation. Another 8-in. pipe tied the grade beam under the east wall to an existing concrete footing, located at grade, east of the high bay.

Contamination was found in the bedrock near the primary fill tank vault and the main primary vault. The bedrock in this area consisted of multilayered sandstone. Numerous cracks and slip planes were visible. Individual cracks could be traced for 10 ft or more along the surface. Contaminated liquids had come into contact with this particular rock formation and traveled along numerous pathways. The source of the contaminated liquid was probably surface and ground water and water leaks from a temporary storage pool in the primary pipe vault.

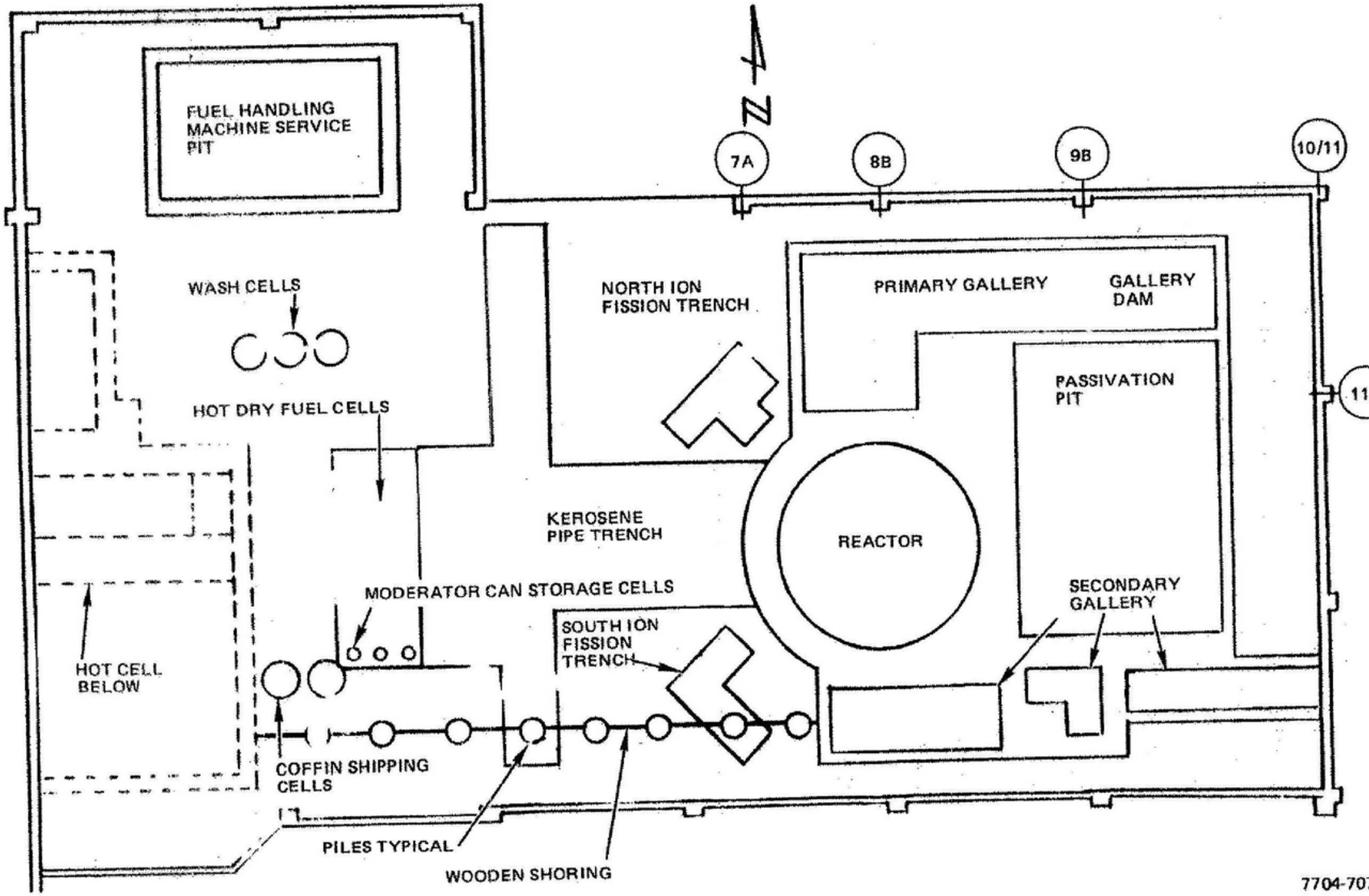


Figure 52. Location of High-Bay Retaining Wall and Column Identification

7704-1038

Figure 53. Installation of Wooden Shoring in High-Bay Retaining Wall

The main primary pipe vault was used for underwater storage during reactor vessel disassembly. It was constructed of concrete with a few pipe penetrations. In preparing for the work, the vault was sealed watertight. The surfaces were cleaned, and the cracks were filled. The pipe penetrations were sealed, and the entire surface was coated with an epoxy material. Despite the preparation, a water leak developed during the segmentation project. It may have resulted from the explosive cutting operation. The leak resulted in water containing fission and activation product contamination being released into the soil at the north and east quadrant of the building. As soon as the loss of shielding water was noted, a steel tank was fabricated to fit inside this vault, and contaminated material and water were transferred to the tank.

Contaminated rocks and soil were found around five facility support column footings. Three footings were along the north wall (7A, 8B, and 9B). One was along the east wall (11D). And one footing was at the corner where the north and east walls meet (10/11) (see Figure 52). The structural consultant previously contacted was again brought in on contract. A series of temporary footings, cross bracing, and support columns needed to be installed if excavations were required near or below these five column footings. Exploratory excavations in this area were performed using jackhammers and hand tools. Rock and soil samples were analyzed, and the results were compared with previous samples. Extrapolation was used to estimate the depth of radioactive contamination in several visible cracks. Based on this information, it was apparent that the only solution was to remove the contaminated soil from beneath the footings.

Three levels of effort were suggested by the consultant:

1) A footing could be partially undermined to remove local soil contamination
2) The footing could be completely undermined to remove deep soil contamination
3) The column and footing could be removed to provide access for deep excavation.

The level chosen for a specific column footing was based on the extrapolated amount of contamination expected. One column was partially undermined (10/11). Two columns were totally undermined (7A and 11D). And two columns and footings were removed and later replaced (8B and 9B). The installation of temporary footings and columns was subcontracted. Only one column was worked on at a time, and a full, 28-day cure was permitted on a foundation or column before work was started on an adjacent footing. Figure 54 shows the column supports and the seismic braces anchored to the floor of the primary fill tank vault. Figure 55 shows the column bracing inside the high bay. Column 7A, on the left, already has a new foundation and reinforced footing in place. Note that Column 9B has been removed.

The excavation east of Column 11D was opened once access through this area was no longer required. The contaminated bedrock directly under the column footing was removed and a new concrete foundation was installed. Excavation of contaminated soil was continued east of the facility. A 6- by 10- by 12-ft-deep hole was excavated below Column 11D to remove all of the contaminated bedrock. Figure 56 shows a part of this excavation.

The column support bracing remained in place until the high-bay excavation backfill and compaction was started. The seismic bracing, which was anchored above the lower level of the excavation, remained in place until the backfill soil reached the level of the primary fill tank floor.

4.4.11 Biological Shield Demolition

The SRE biological shield was a solid, high-density concrete structure surrounding the core cavity liner. The shield was 4 ft thick, with the exception of the pipe bellows area (see Figure 5). Prior to the start of demolition activities, a biological shield removal methods trade study was performed. Three methods were evaluated: (1) using the large hydraulic Hy-Ram, (2) using standard jack hammers and scabbling tools, and (3) using conventional explosives. To aid the study, six core samples were taken of the biological shield and analyzed for activation. The samples were obtained

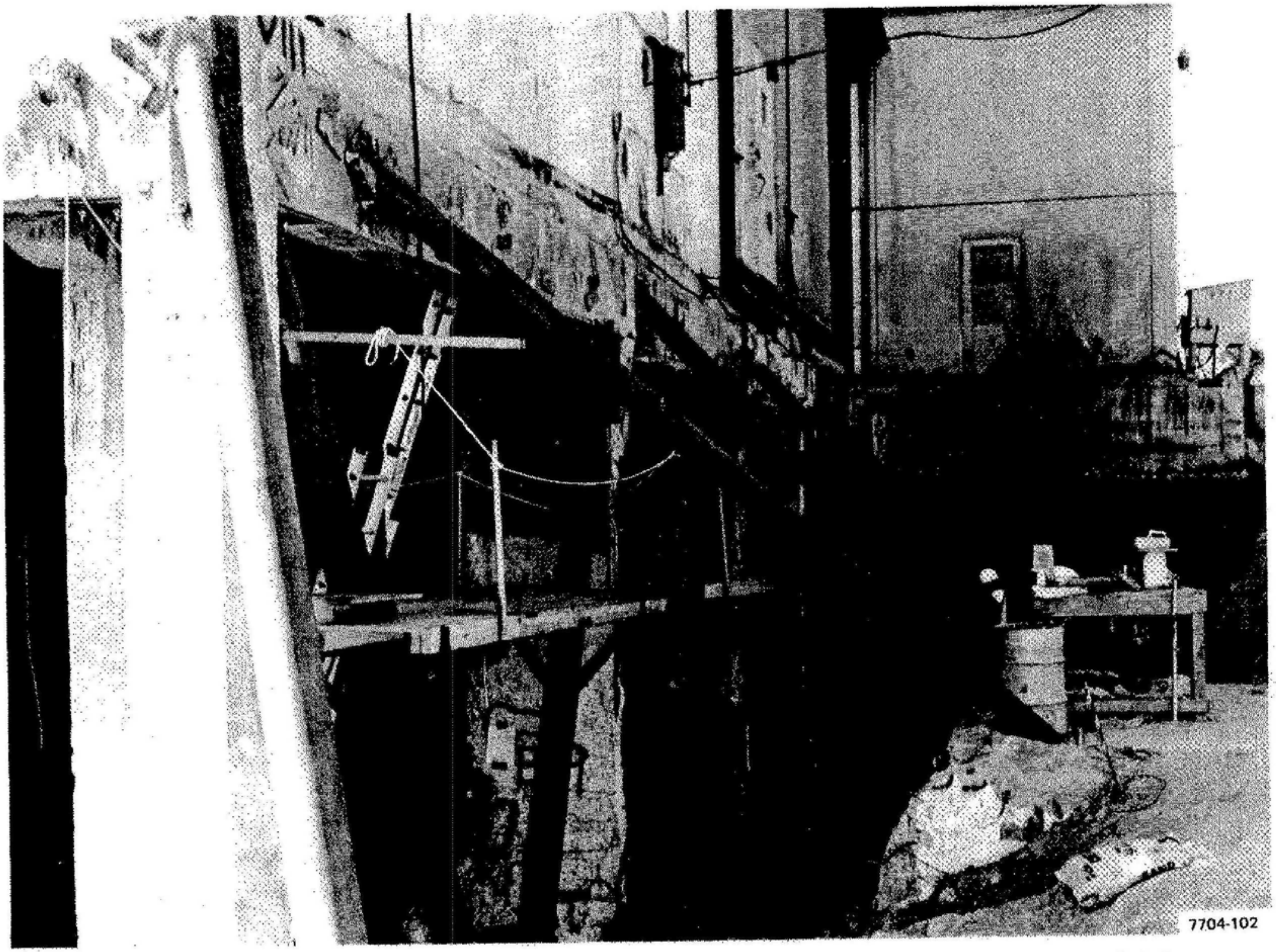
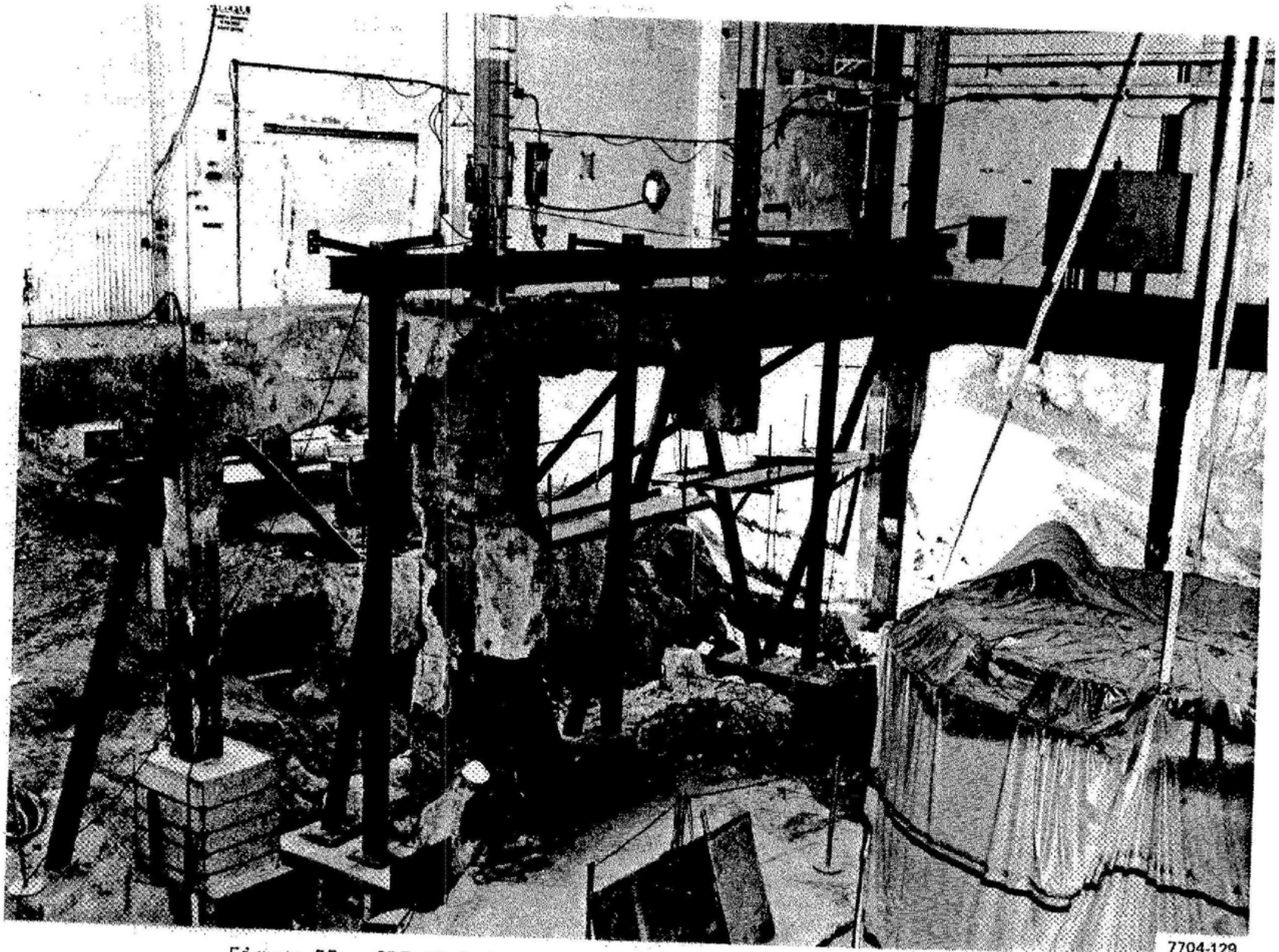


Figure 54. Column Supports and Seismic Bracing Installed under North Wall of SRE High Bay



7704-129

Figure 55. SRE High-Bay North Wall Column Supports Interior View

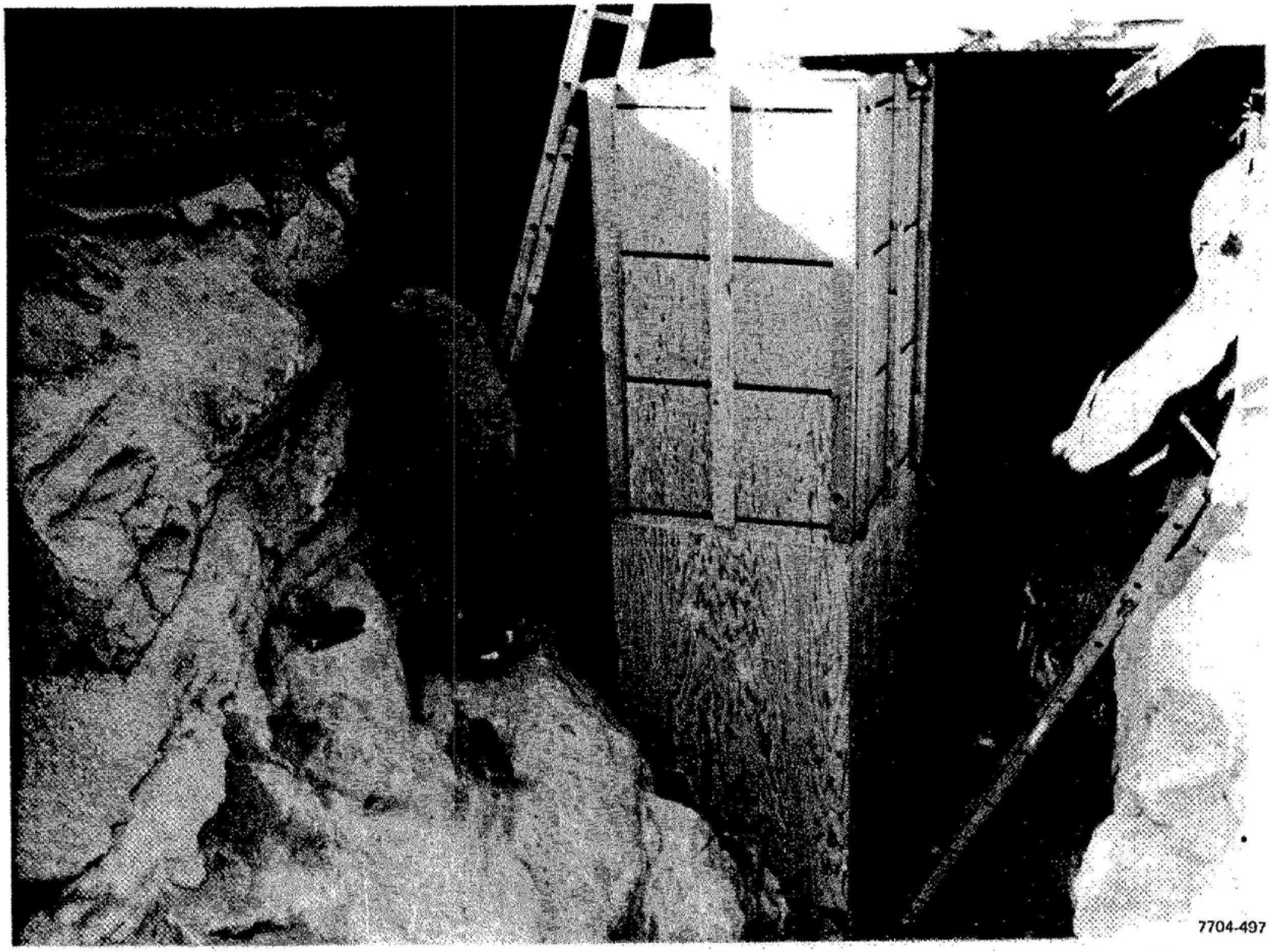
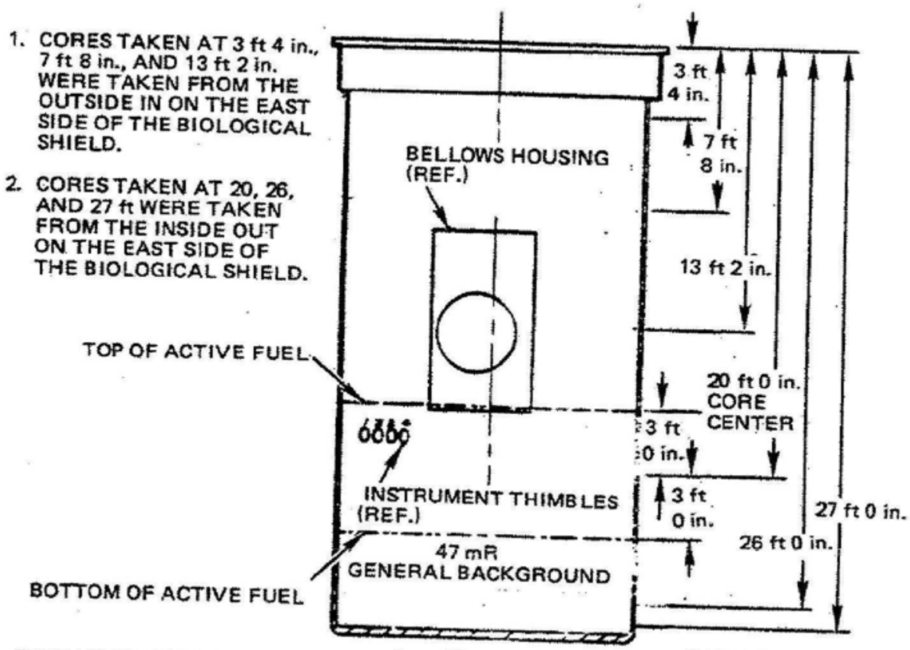


Figure 56. Construction of Form for Replacement Foundation under High-Bay Column 11D

using a Milwaukee heavy-duty drilling rig with a 2-in.-diameter by 12-in.-long, diamond-impregnated core drill.

The first three samples were taken at 3 ft 4 in., 7 ft 8 in., and 13 ft 2 in. below-grade level. The drilling was accomplished from the outside of the biological shield to the inside. The next three samples were removed from 20, 26, and 27 ft below grade and were drilled from the inside of the biological shield out. The sample locations and their relationship to the reactor core are shown in Figure 57.



RADIATION READINGS AT CORE HOLES

ELEVATION (ft)	AT SUPPORT (mR)	AT 1 meter (mR)	AT CENTERLINE (mR)
20	200	100	47
26	65	65	75
27	30	45	47

RADIATION READINGS AT INSTRUMENT THIMBLES

INSTRUMENT THIMBLE	1	2	3	4
NORTH SIDE (mR)	250	400	250	200
SOUTH SIDE (mR)	250	400	250	250

7704-709

Figure 57. Biological Shield Core Sample Locations

Samples for radiometric analysis were removed from the concrete cores using a hand hacksaw with a tungsten carbide blade. Radiometric analysis was performed using a thin window gas proportional counter having a background of approximately 20 counts per minute (cpm). A 1-g KCl standard was used to determine counter efficiency. The data generated from the analysis are presented in Table 12.

The accumulated data taken from the six core samples indicated that the removal of approximately 24 yd^3 of rubble was required to achieve the 100-pCi/g limit in both the concrete and steel reinforcing bar. This volume of concrete is small compared with the total volume of the biological shield, which would represent approximately 1418 yd^3.

The excavation of contaminated soil from the northeast corner of the high bay provided access to the exterior surface of the biological shield. Thus, it was decided to use the hydraulic Hy-Ram to remove the concrete from the biological shield. First, the clean soil was removed from around the outside surface to a depth of 18 ft below grade. Starting at the top, the Hy-Ram removed the nonactivated concrete from the outside in. Health, Safety & Radiation Services provided concrete sample analysis as new concrete surfaces were exposed. Prompt sample analysis combined with the core drilling data enabled the Hy-Ram to selectively remove nonactivated concrete from the biological shield without exposing the activated material close to the core cavity liner. This resulted in considerable cost savings in the packaging, transportation, and burial of contaminated waste.

Removal of contaminated material required some modifications to the concrete removal procedure. A plastic tent was suspended from a plywood platform around the entire biological shield. The plywood platform was held by an overhead bridge crane. The facility radioactive exhaust duct was connected to the tent to provide a negative pressure. A high-pressure, low-volume water spray was used to help control dust when the Hy-Ram was operating. With this arrangement, it was possible to demolish the activated concrete with a minimum release of airborne contamination.

TABLE 12

SRE BIOLOGICAL SHIELD RADIOMETRIC ANALYSIS

Core Location (Below Grade)	Sample	Sample Location (In Inches From Core Cavity Liner)	pCi/g (Gross Beta)
3 ft 4 in.	1	1/2	1.5
	2	3	NAD[a]
	3	6	7.6
	4	12	NAD[a]
	5	18	NAD[a]
	6	24	7.6
7 ft 8 in.	1	0	125.0
	2	6	32.2
	3	12	17.6
	4	18	27.9
	5	24	24.8
13 ft 2 in.	1	1/2	220.0
	2	1-1/2	348.0
	3	3-1/2	118.0
	4	5-1/2	128.0
	5	9-1/2	9.2
20 ft 0 in.	1	1	3300.0
	2	2-3/4	4780.0
	3	6	1350.0
	4	12	228.0
	5	15	93.9
	6	18	30.5
	7	23	18.2
26 ft 0 in.	1	1	503.0
	2	6	164.0
	3	8	72.0
	4	11	40.4
	5	18	14.8
27 ft 0 in.	1	1	150.0
	2	6	63.0
	3	11	29.7
	4	18	27.7
	5	23	27.7

[a]NAD = No activity detected.

Once the biological shield was removed to the level of the high-bay excavation (approximately 18 ft below grade), the core cavity liner was removed (see Figure 58). The remaining portion of the biological shield continued below the bottom of the excavation for another 16 ft. Activated concrete in this region was removed from the inside out. Figure 59 shows the remaining biological shield just prior to backfill and compaction. Archive samples were taken from the walls and floor and remain at the Santa Susana Field Laboratories.

4.4.12 Below-Grade Component Removal

Within the SRE high bay were several operational components that were located below grade. Among them were the hot dry fuel cells, the moderator can storage cells, and the wash cells (see Figure 52). The fuel element enclosure sleeves, located in the primary hot cell, and the main and auxiliary primary pump dip legs, located in their respective vaults, were also below grade. The two fuel element enclosure sleeves and the two dip legs were the deepest components since their top surface was approximately 20 ft below grade.

4.4.12.1 Fuel Storage Cells

There were 96 fuel storage cells located at the SRE. They were used to store dry reactor fuel elements. The cells consisted of steel tubes, 5-1/4 in. in diameter by 22 ft 6 in. long. The tubes were arranged in 6 rows with 16 tubes in each row, all encased in a concrete monolith. Each tube had its own kerosene cooling line. The fuel storage cells internals were removed and packaged for burial early in the SRE decommissioning. The tubes remained in place until concrete surface decontamination could be completed in that area of the high bay. Once access was available, the Hy-Ram was used to fracture the concrete encasing the tubes. A steel plate anchored each storage tube to the concrete at 5 ft below grade level. Once this plate was cut, all of the tubes were easily removed. The fuel storage cells were cut into 6-ft lengths, packaged in boxes, and shipped to land burial. Figure 60 shows the Hy-Ram fracturing the concrete around the upper portion of the fuel storage

Figure 58. SRE Core Cavity Liner after Demolition of Biological Shield

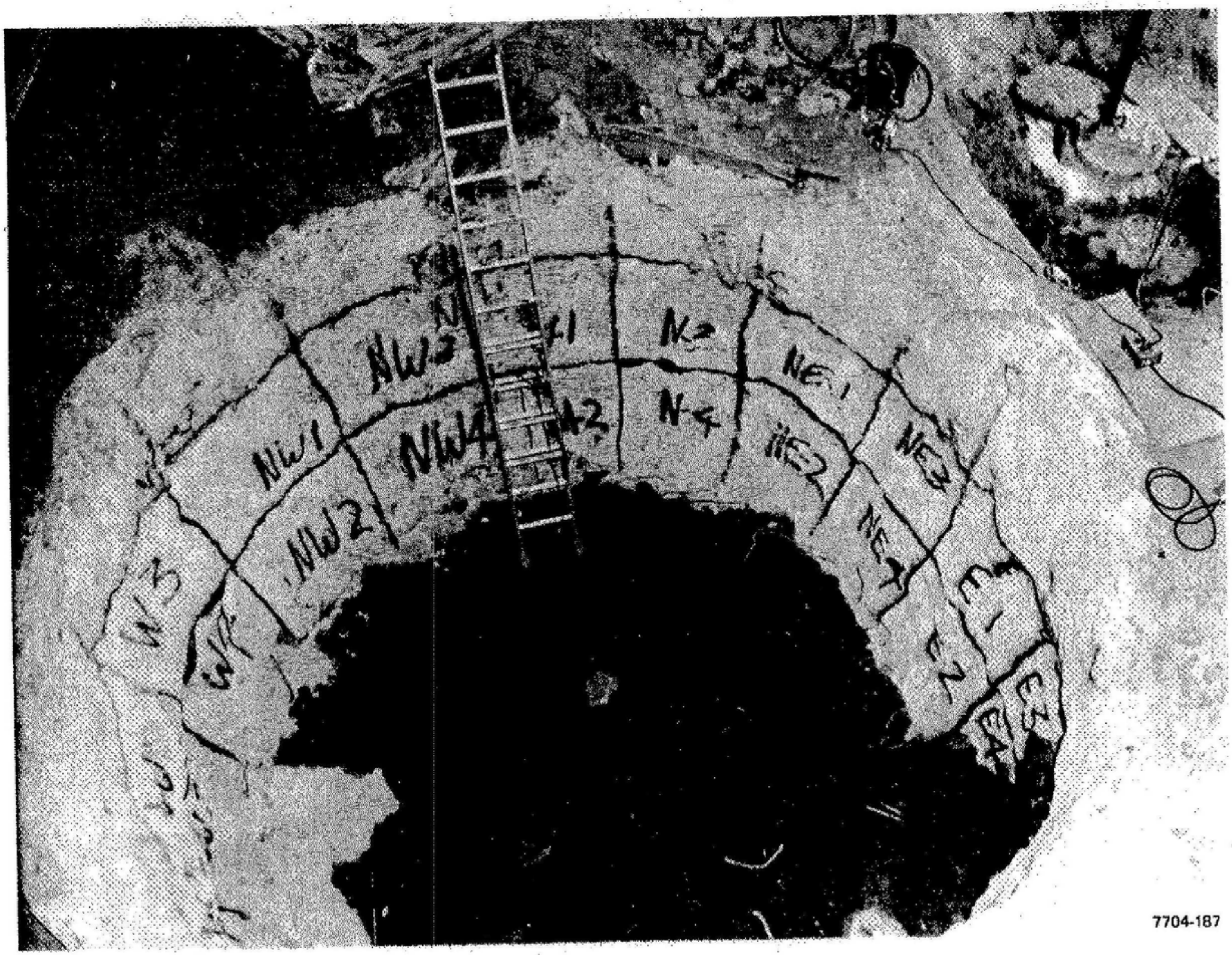
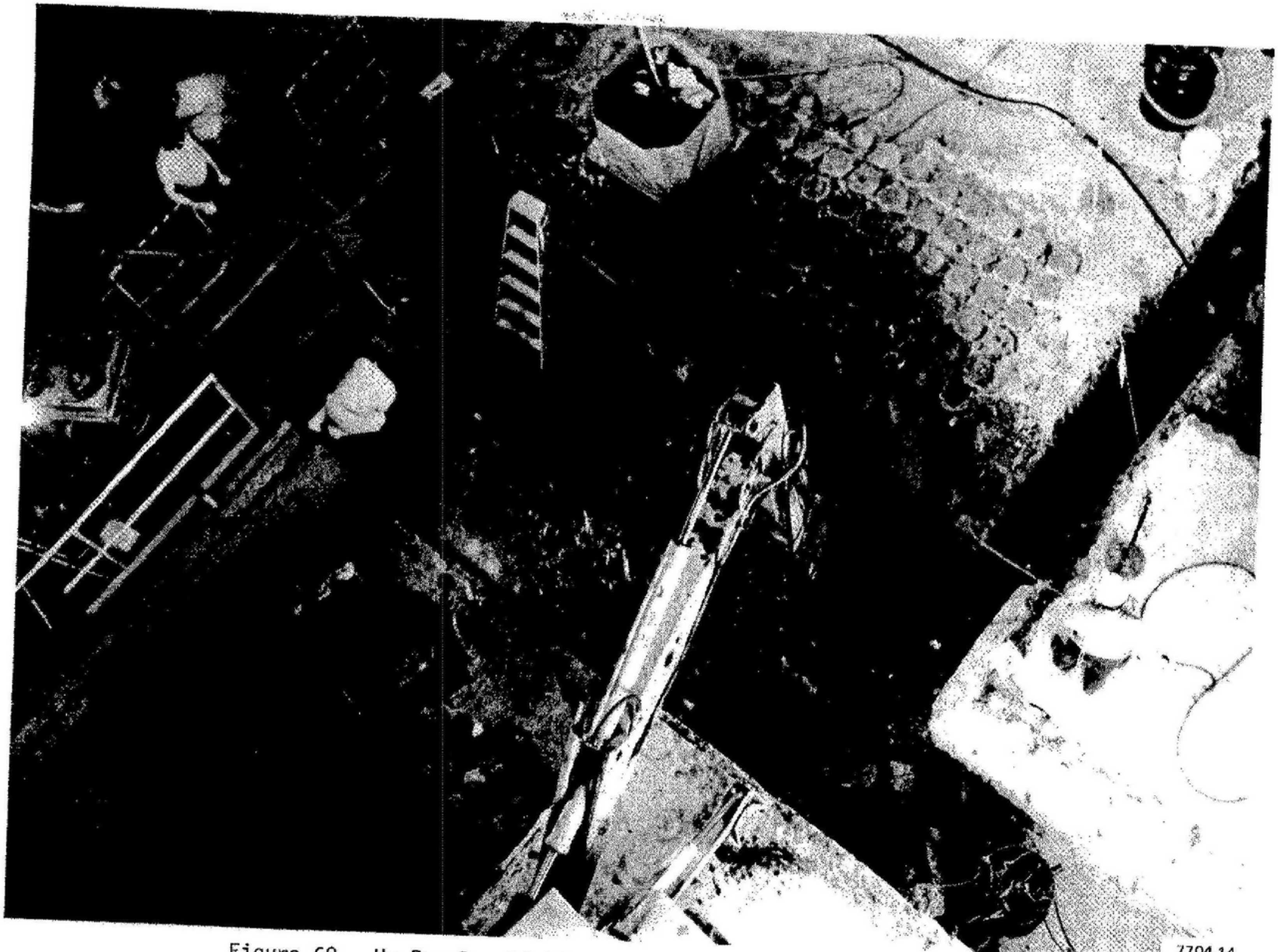


Figure 59. Biological Shield Cavity



7704-14

Figure 60. Hy-Ram Demolishing Concrete around Fuel Storage Tubes

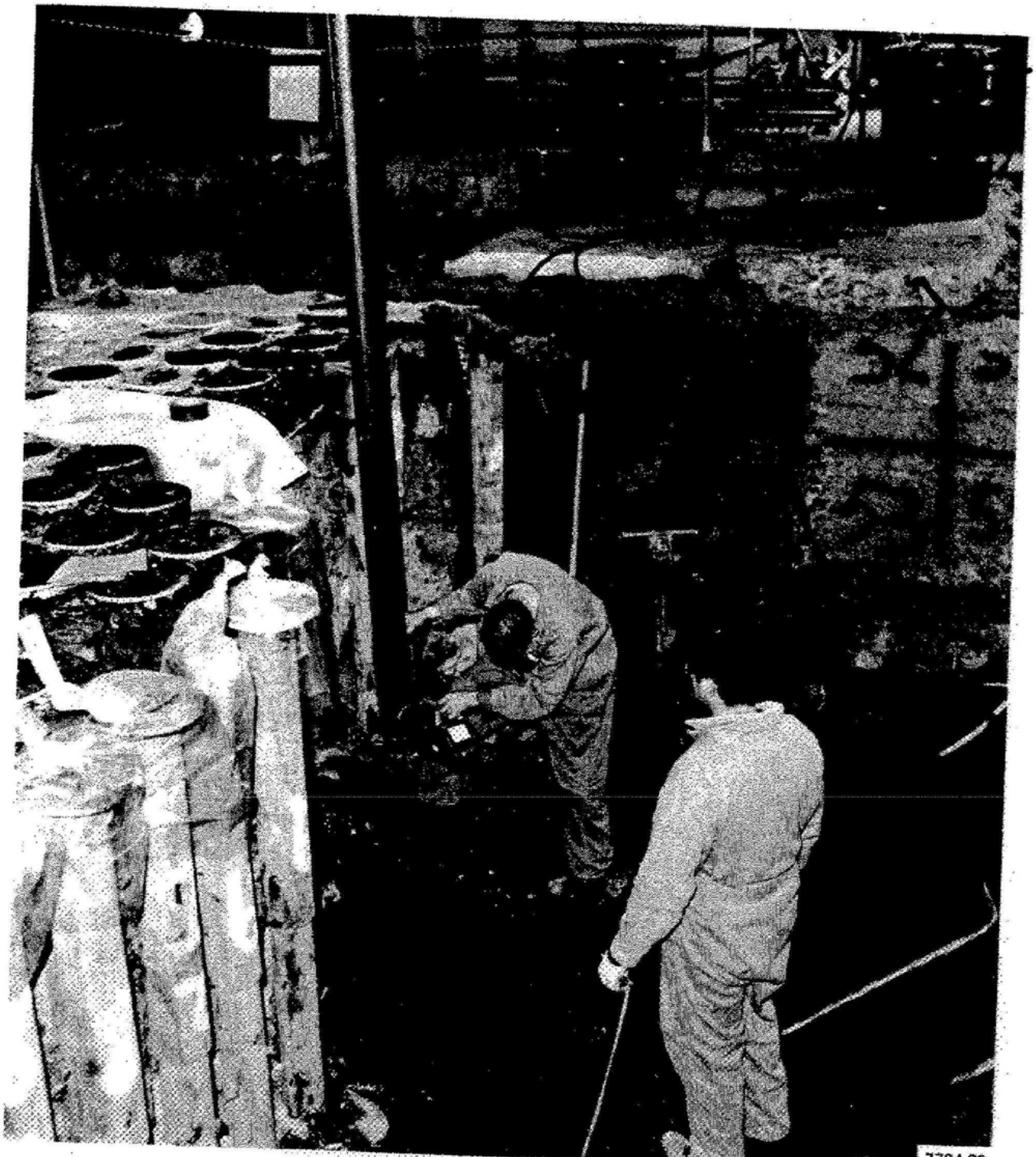
cells. The high-pressure, low-volume water spray was used to control dust. Figure 61 shows a health physicist surveying a fuel storage tube as it is removed. The kerosene cooling line can be seen along the side and looping around the bottom of the tube. Figure 62 shows the demolition of the remaining fuel storage cell concrete structure after the tubes were removed. One tube can be seen next to the moderator element storage cells. Note the detail of the retaining wall construction.

4.4.12.2 Moderator Element Storage Cells

The three moderator element storage cells were located adjacent to the fuel storage cells. They were larger (20 in. in diameter by 22 ft long). Like the fuel storage cells, the moderator cells internals were removed and properly disposed of early in the SRE decommissioning activity. The Hy-Ram was used to fracture the concrete around the cells, and the facility bridge crane was used to remove each cell from the rubble. The cells were reduced and packaged in Building 163. Figure 63 shows the concrete removal around the tops of the cells.

4.4.12.3 Fuel Cleaning Cells

The three fuel cleaning cells (or wash cells) were used to remove residual sodium from a fuel assembly that had been removed from the reactor core. The wash cells were 24 in. in diameter and 25 ft long. The top 2 ft 8 in. of the cells were encased in concrete with the remainder of the units surrounded by a sandy soil backfill. As with the previous cells, the wash cells internals were removed and disposed of as radioactive waste early in the decommissioning. A unique feature of the wash cells was the presence of drain lines running from the bottom of each cell to the valve pit adjacent to the hot cell service gallery. The drain lines precluded the use of the facility crane to pull the cells as had been done with the fuel storage tubes. Instead, access had to be provided to the bottom of the cells. A pit was dug and shoring installed along the walls of the excavation before employees could be allowed



7704-20

Figure 61. Fuel Storage Tube Removal

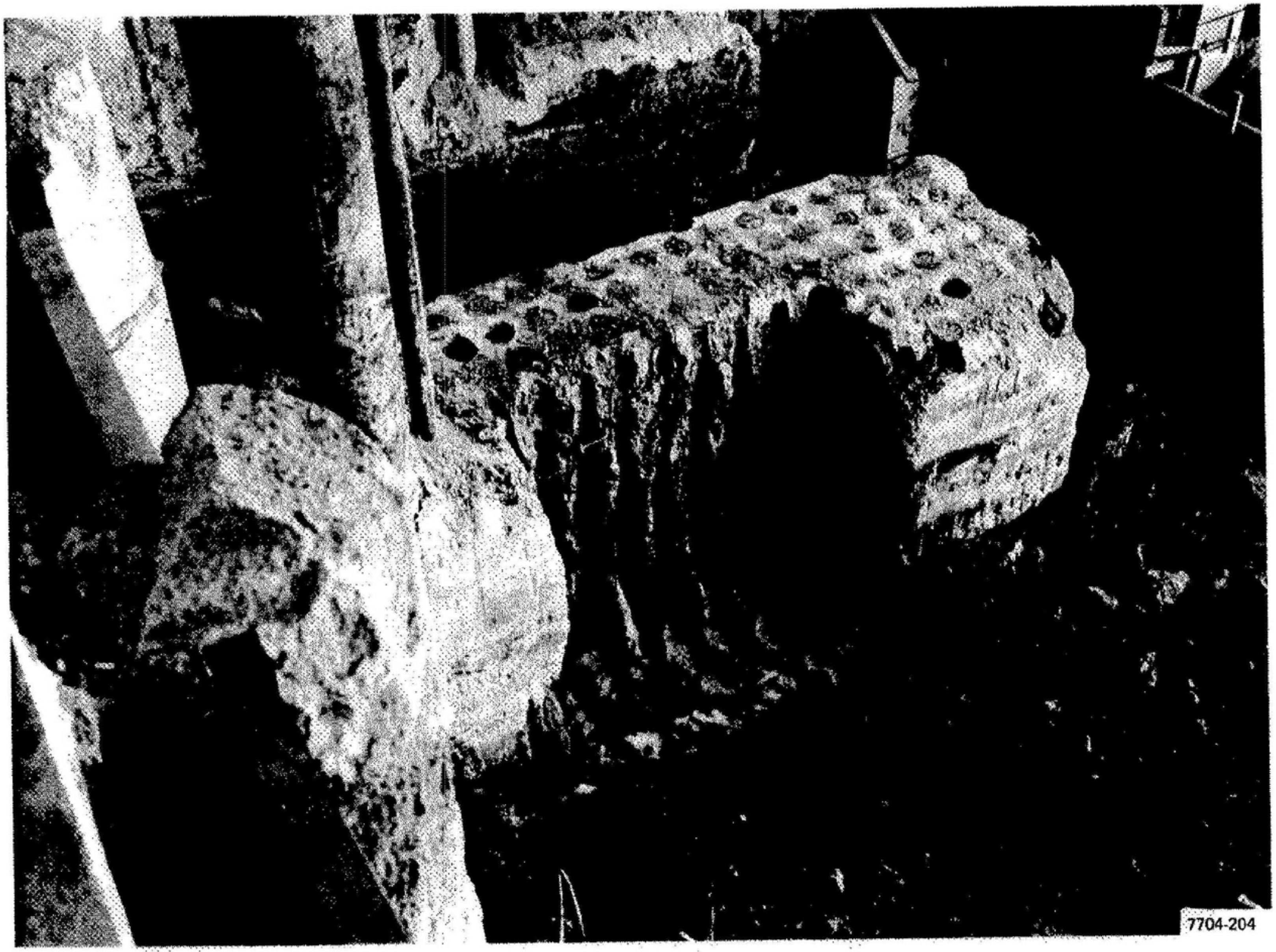


Figure 62. Fuel Storage Cell Concrete Demolition

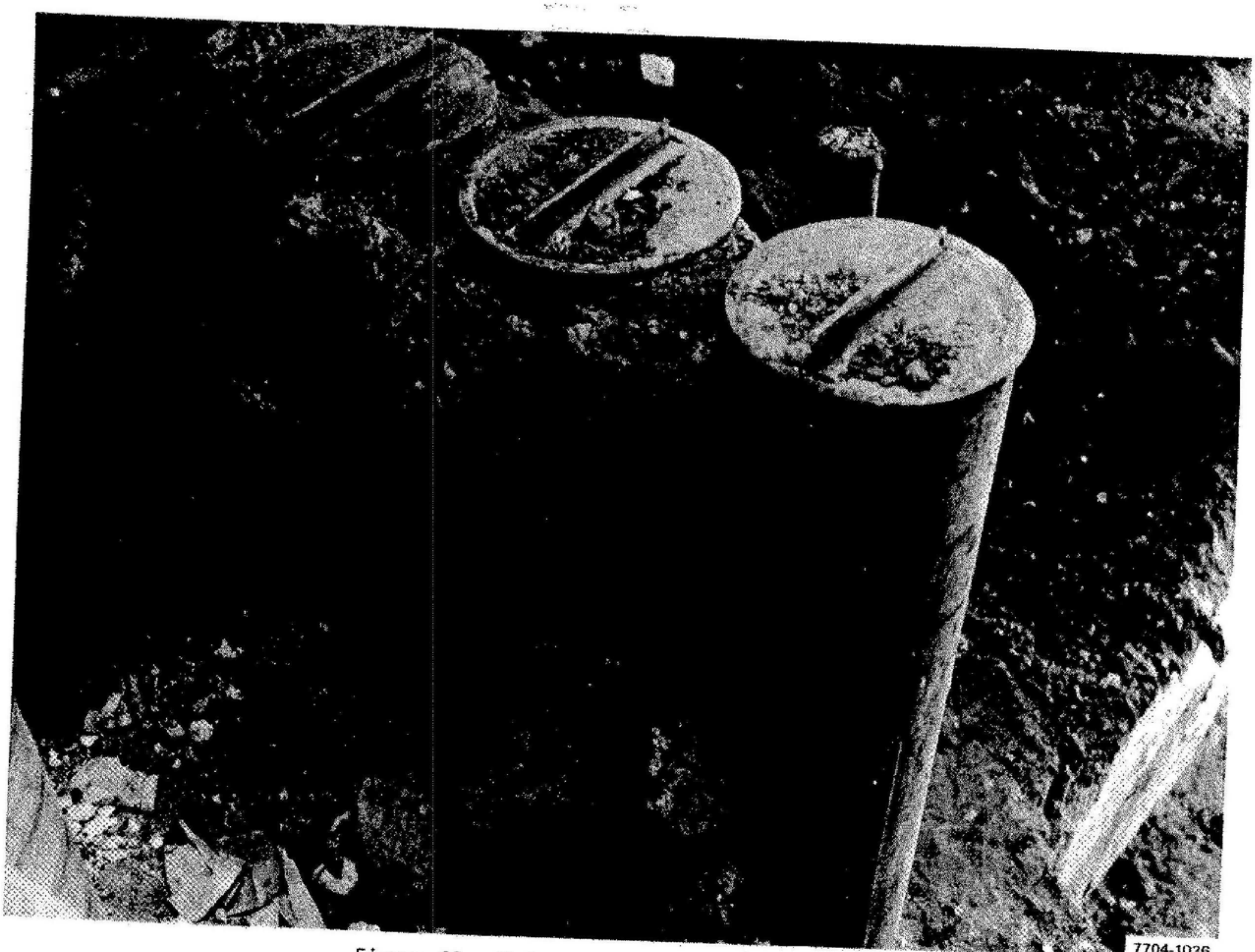


Figure 63. Moderator Element Storage Cells

to remove the drain pipes. The upper right corner of Figure 62 shows a portion of the shoring installed for the wash cell drain line removal.

The wash cells themselves were removed in sections. As the upper concrete collar was removed, the upper 3 ft of the cells was cut free. This was accomplished by using a large-diameter pipe cutter. During the high-bay excavation, another larger section of each cell was removed in the same manner. Immediately following a cut, the top of the cell was sealed with a cover to prevent the introduction of foreign material into the wash cell. Figure 64 shows the removal of the wash cell drain lines. Caution was used to prevent the spilling of any contaminated liquids onto the surrounding soil. Once the drain pipes were removed, the remaining portions of the wash cells were removed and transferred to Building 163 for size reduction and packaging for disposal.

4.4.12.4 Hot Cell Fuel Element Enclosure Sleeves

The fuel element enclosure sleeves were the deepest elements in the SRE facility. The two sleeves were located within a 6-ft-deep pit at the bottom of the primary hot cell. Figure 65 is a sketch of the SRE hot cell area. The hot cell floor was 20 ft below the high-bay floor. This meant that the tops of the sleeves were 26 ft below grade. The sleeves themselves were 8 in. in diameter by 25 ft 6 in. long. Thus, the bottom of the sleeves were over 50 ft below the original high-bay floor.

When the sleeves were uncapped, they were found to contain 2 to 4 ft of water. Analysis of samples indicated levels above the maximum permissible concentration for mixed fission products. The small side diameter of the sleeves made decontamination of the interior surface virtually impossible. It was decided to remove the sleeves. The Hy-Ram was used to expose the top section of the two units. It quickly became apparent that the small backhoe/Hy-Ram combination would not be capable of excavating a hole deep enough to reach the bottom of the sleeves. The preliminary excavation also showed that the two units were most likely encased in concrete for their entire length.


7704-195

Figure 64. Wash Cell Drain Line Removal

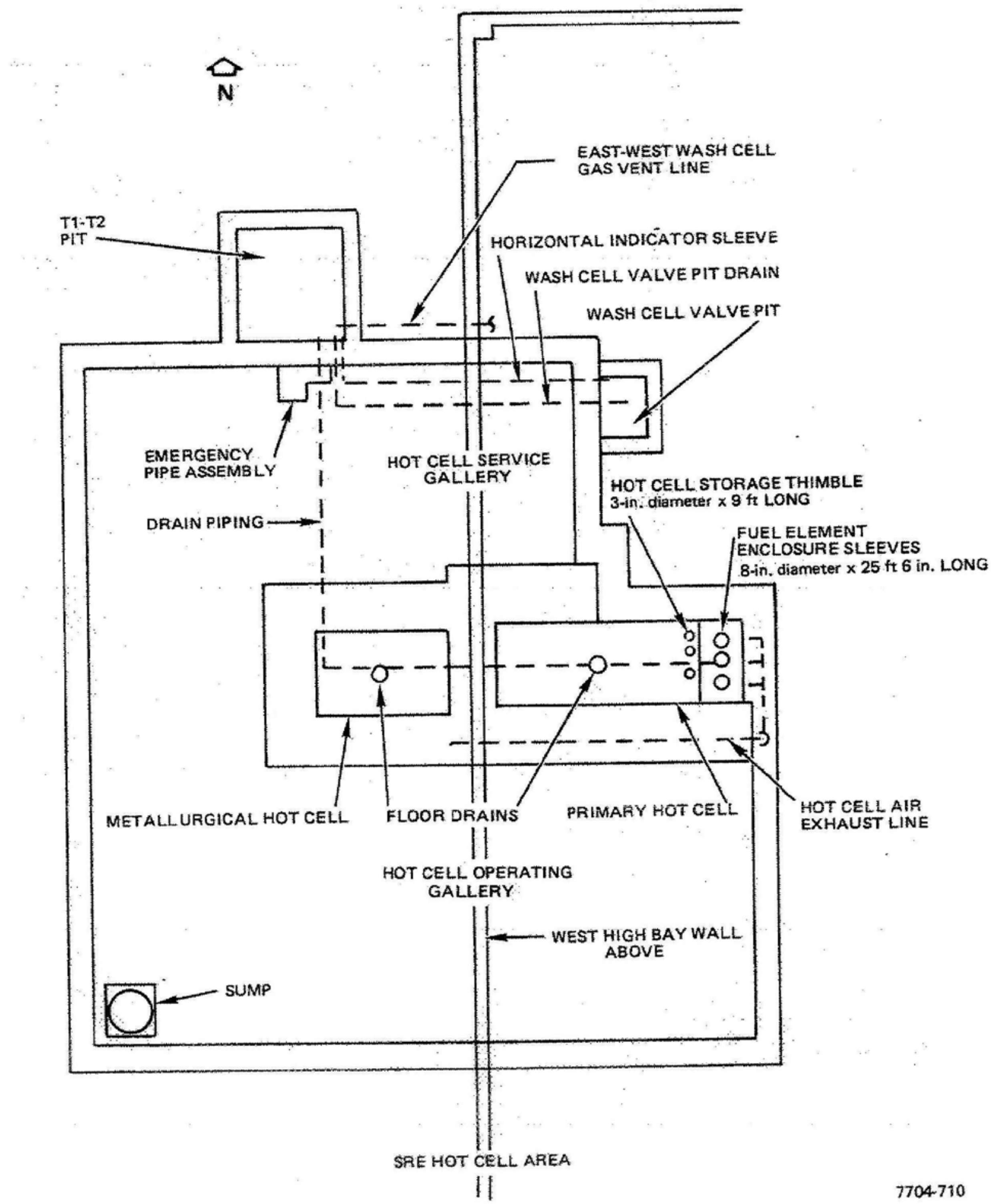


Figure 65. SRE Hot Cell Area

Meetings with various contractors and consultants were held to explore methods of excavating the bedrock adjacent to the sleeves. The following combination was selected to provide the needed access:

1) A low-strength concrete mix was placed in the excavation dug by the small backhoe. This provided a smooth, solid surface for a rock drill, adjacent to the sleeves.
2) A rock drill was used to drill a pattern of 93 holes in approximately a 10-ft by 10-ft area. The holes were a minimum of 30 ft deep.
3) A large backhoe capable of excavating 35 ft straight down was brought onsite. The large backhoe was also equipped with a Hy-Ram to fracture the bedrock which had been weakened by the rock drilling.
4) The two sleeves were pumped dry and then filled with an expanding polyurethane foam to fix contamination. If the Hy-Ram or backhoe had inadvertently punctured a sleeve, the foam would have minimized the spread of contamination.

Figure 66 shows the rock drill in operation. Figure 67 shows the large backhoe in operation inside the high-bay excavation. Figure 68 shows one of the two sleeves being removed from the excavation.

Samples for analysis were taken every 6 ft during the rock drilling as well as the excavation. No contamination was found in the 10- by 12- by 32-ft-deep excavation. Archive samples were taken and the hole was backfilled with 100 yd^3 of low-strength concrete. This proved to be cost effective compared with the labor charge of backfilling and compacting by hand, since access was limited for machine compactors. The two sleeves were transferred to Building 163 for size reduction and packaging for disposal. Figure 69 shows the size reduction booth set up in Building 163.

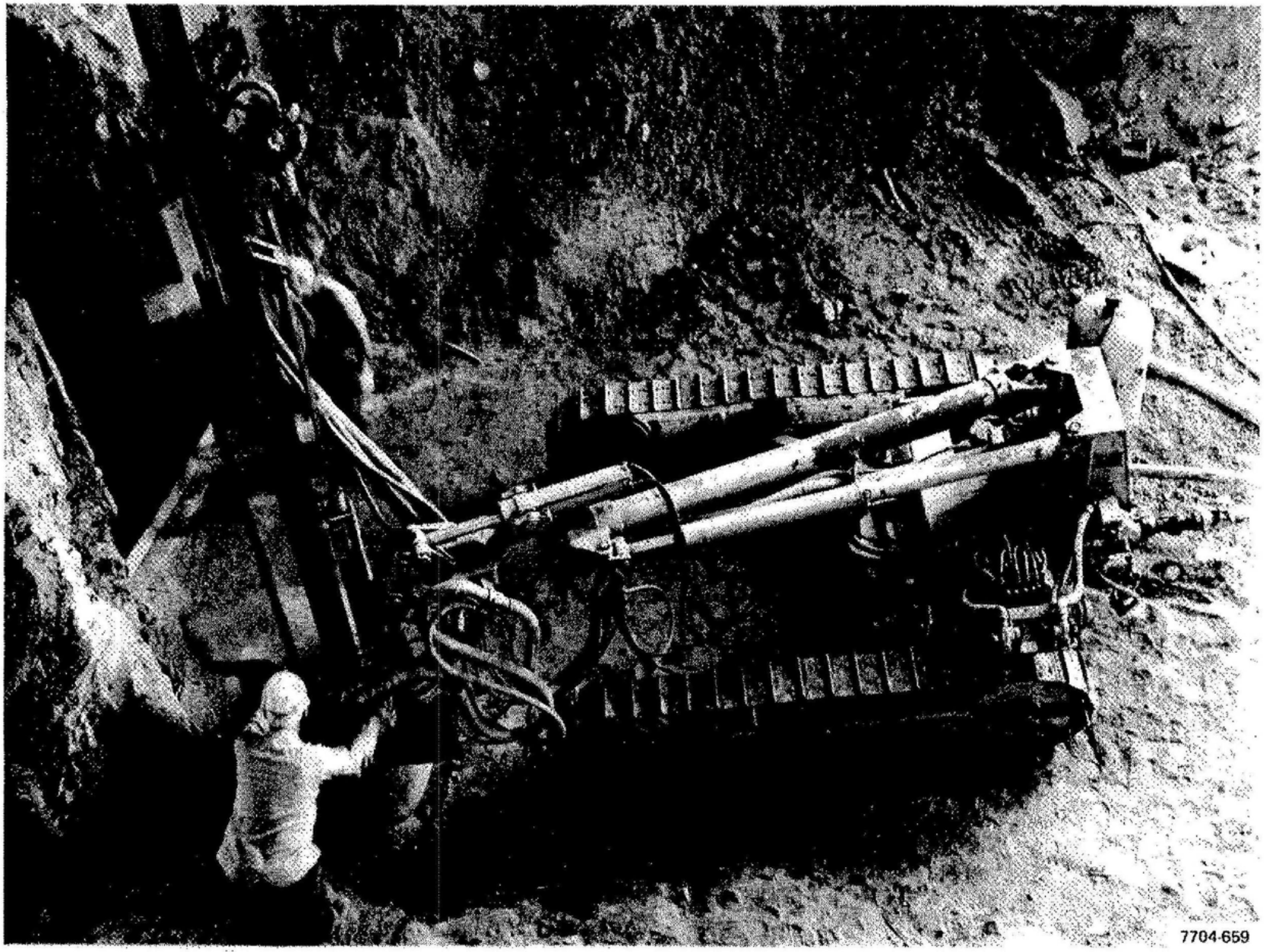


Figure 66. Rock Drill in Operation

7704-334

Figure 67. Large Backhoe in SRE High-Bay Excavation

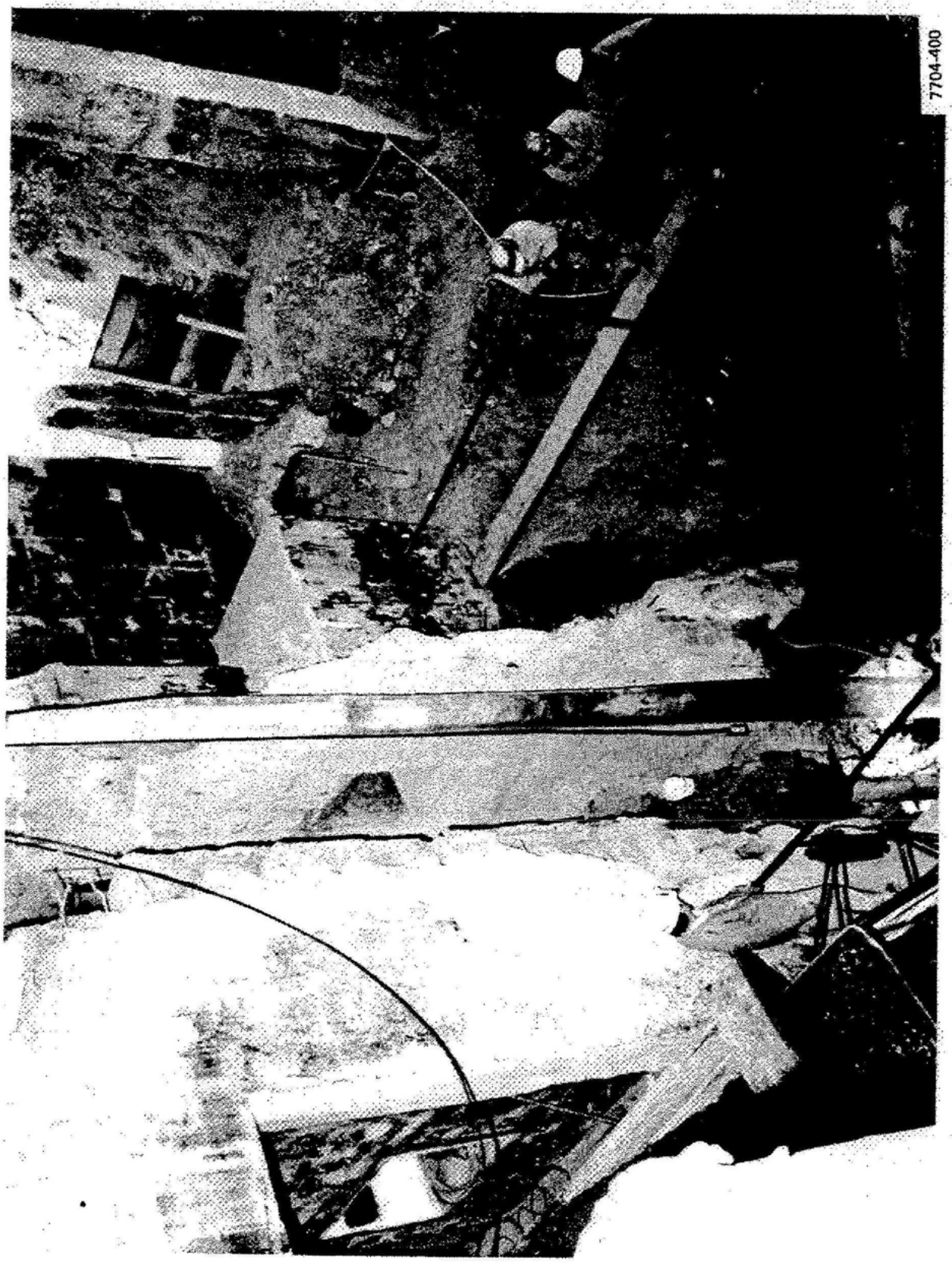


Figure 68. Fuel Element Enclosure Sleeve Removal

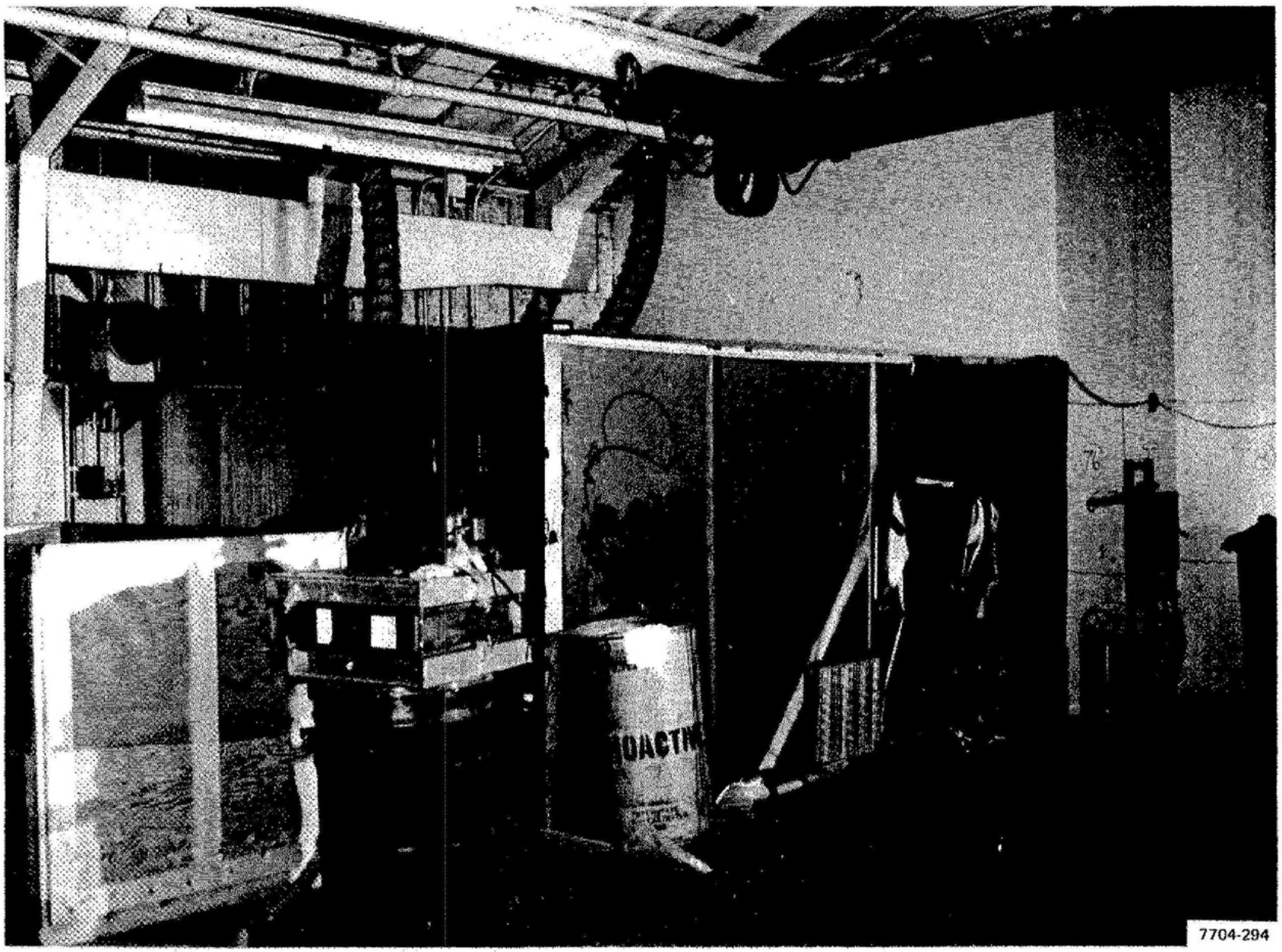


Figure 69. Building 163 Size-Reduction Booth

4.4.12.5 Sodium System Dip Legs

The main primary and auxiliary primary sodium loops each contained a dip leg. The sodium pumps were designed to accommodate a certain amount of leakage past the hydrostatic bearing and labyrinth seals into the upper part of the pump case. An overflow line permitted sodium collected in the pump case to be transferred back to the suction side of the pump through the dip leg. The dip leg provided a low point in the loop.

After the sodium systems were removed and main and auxiliary primary vaults were demolished, the dip legs remained as 24-in.-diameter by 25-ft-deep pipes at the bottom of the excavation. The two units were surveyed internally by lowering instrument probes to the bottom. The auxiliary unit was found to be clean. It was filled with concrete and a steel plate was welded to the top. The primary dip leg was internally contaminated and work was begun to remove it. First, a series of holes were drilled around the circumference of the pipe to a 24-ft depth. (The top 2 to 3 ft of the pipe had been removed after the vault floor was demolished.) During this operation, the dip leg was found to be embedded in concrete for its entire length. Several methods were tried to lift the dip leg out of the cored hole. The facility bridge crane, onsite mobile equipment, and a 25-ton hydraulic jack were all tried without success. The dip leg was removed only after the Hy-Ram was used to excavate a shaft along side the pipe. Figure 70 shows the Hy-Ram working on the excavation. The dip leg was found to have three equally spaced 1/2-in.-diameter by 4-in.-long horizontal anchors. The bottom plate was 2 in. larger in diameter than the pipe, which prevented the dip leg from being pulled after the core drilling was completed. (There was no indication of any type of anchor on the facility construction drawings.) The dip leg was transported to Building 163 and cut up and packaged for disposal.

4.4.13 Decontamination and Dismantling of the Hot Cell Area

The SRE facility had its own onsite hot cell. It was located below grade at the west end of the high bay (see Figure 3). There were two cells – a

7704-211

Figure 70. Dip Leg Excavation

primary cell with two windows and two remote manipulators and a metallurgical cell with one window and one manipulator. Access to the hot cell operating and service galleries was by a stairway from the west end of the high bay or through two access hatches from the outside.

The first step in decontaminating the hot cell area was to remove the cell doors, windows, and manipulators. The operating and service gallery walls were stripped of all unnecessary piping and electrical components. Next, a thorough radiological survey was performed. Surface contamination found on the concrete walls and floor was removed. The walls of the cells were 3-ft-thick, high-density magnetite concrete covered inside and out with a 1/8-in.-thick carbon steel plate, except for the floor pans in the cells which were 1/8-in.-thick stainless steel. Since the cells had never been exposed to a neutron field, there was no activation, only surface contamination. Since a considerable amount of contamination could be masked by the steel plates, they were removed. Figure 71 shows the removal of the steel plates from the interior of the primary cell. Carbon steel plates were removed with a conventional oxyacetylene cutting torch. The stainless steel floor pans were cut using the plasma-arc torch.

The in-cell floor drains and the hot cell air exhaust line were removed. The exhaust line was an 8-in.-diameter, thin wall tube used to discharge the primary cell atmosphere to the above-grade radioactive exhaust system. The tubing was embedded in the concrete wall between the primary hot cell and the hot cell operating gallery, inches away from the grade beam supporting the west wall of the high bay. A method was found to remove the tubing without endangering the structural integrity of the building. A combination of concrete sawcutting and jackhammering by hand was successful. The exhaust line was removed intact without damage to the facility. Figure 72 shows the primary cell wall and the exposed exhaust line.

Hot cell drain line removal posed a different challenge. The high point of the drain system was below the 6-ft-deep pit at the east end of the primary

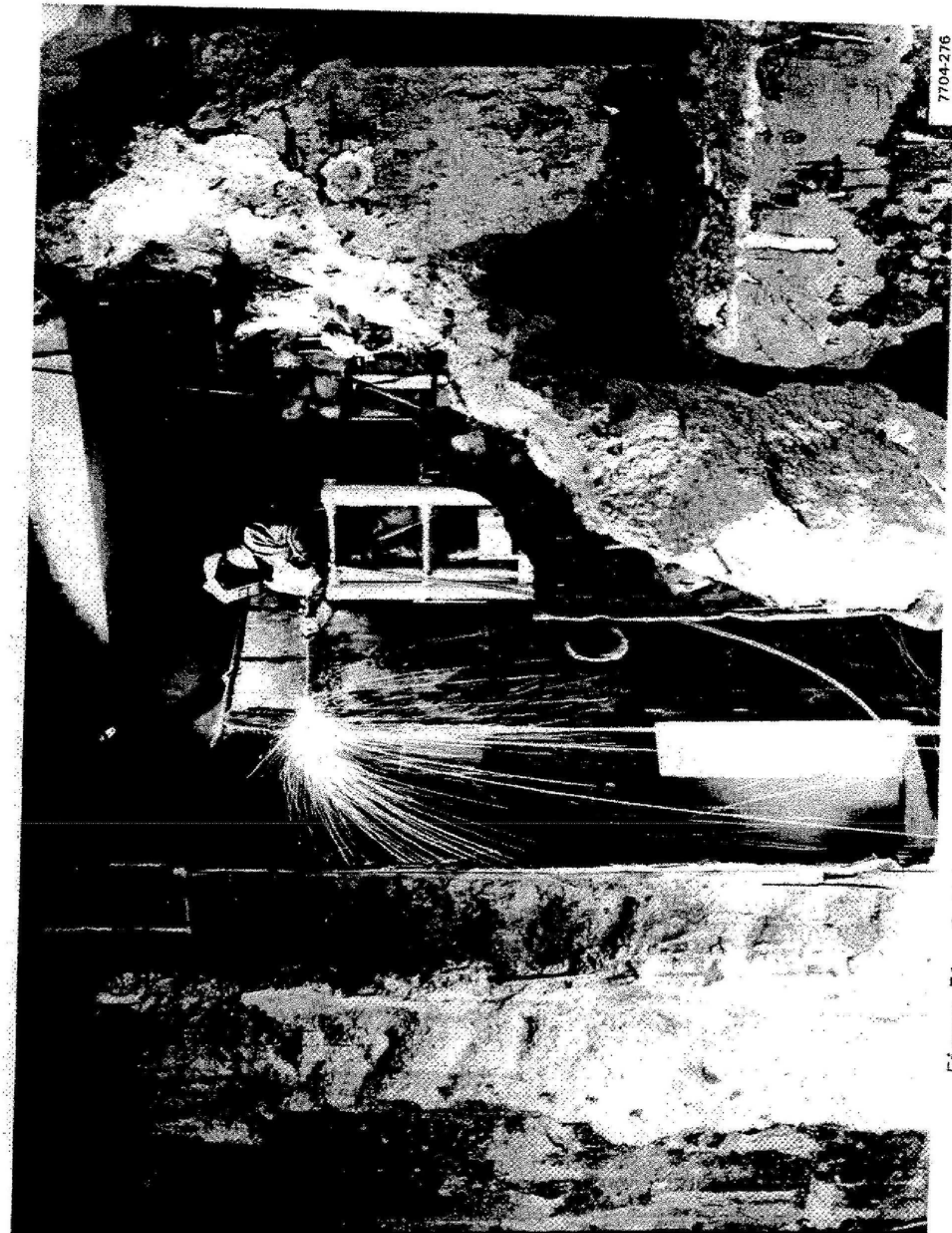


Figure 71. Cutting Steel Plates from Interior of SRE Primary Hot Cell

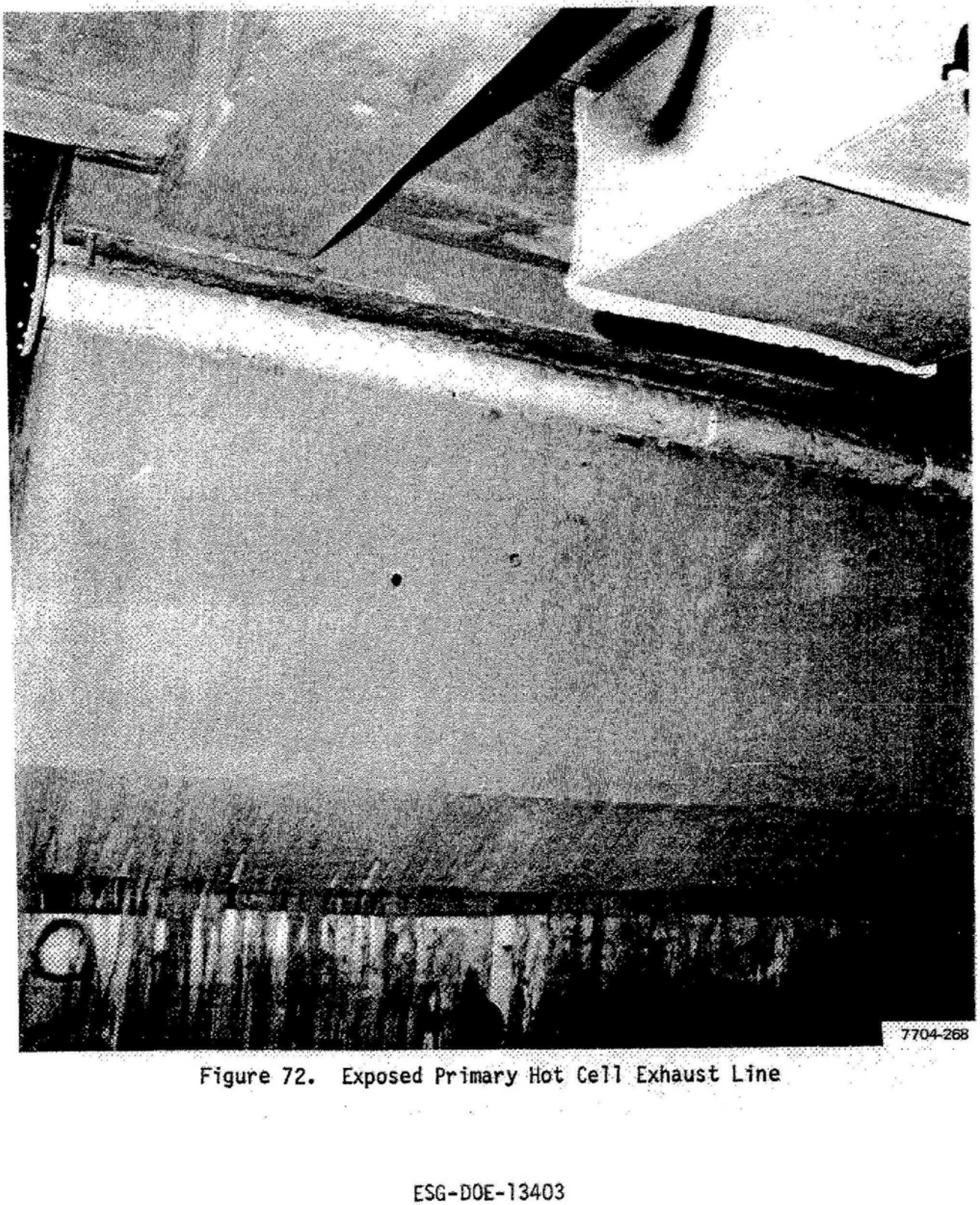


Figure 72. Exposed Primary Hot Cell Exhaust Line

cell. This put the drain line almost 7 ft below the floor of the metallurgical cell and close to 9 ft at the point where it entered the T1-T2 pit. Excavating the pipe by hand would have been costly; machine access was needed. Since the high-bay excavation had exposed the east wall of the hot cell, a doorway was made through this wall. A concrete wall saw was used to cut an opening in the 18-in.-thick wall into the operating gallery. The Hy-Ram was used to remove the concrete. Access into the primary cell was provided by demolishing the east wall of the cell. Access into the metallurgical cell was provided by demolishing the west wall of that cell. A concrete saw was used to cut the floor in the cells and the service gallery. The backhoe was used to excavate above the drains. The final few inches of soil were removed by hand, so as not to risk damaging the pipe. The contaminated drain line was removed and packaged for burial. No contamination was found in the soil. The excavation in the service gallery also provided access to the wash cell valve pit drain. Some additional concrete sawcutting and backhoe operation uncovered this drain line, which entered the T1-T2 pit at approximately the same elevation as the hot cell drain. In the same vicinity was the wash cell gas vent line which also entered the T1-T2 pit. A hole was found in the gas vent line and contaminated soil up to 21,000 pCi/g was found adjacent to the pipe. Some hand excavation was required to remove all of the contamination. No contamination was found near the wash cell valve pit drain. The wash cell valve pit itself was found to be contaminated. The Hy-Ram was used to demolish the concrete, and the rubble was packaged for burial.

Since the hot cell was below grade, it was subject to the effects of ground water at the site. Several temporary sumps were installed in the high-bay excavation, but the hot cell had its own permanent sump. Leach lines installed under the concrete floor channeled the ground water to the sump during the rainy season. A sump pump was used to pump the water up and away from the building. During the operation of the reactor, the drain from a radioactive sink was plumbed into the sump. The pump discharge was connected to a radioactive holdup tank adjacent to the discharge line. The sump, sump pump, piping, and a small portion of the leach lines were contaminated. All of the contaminated components were removed, and a new sump was installed. A portion of the leach lines was replaced. A new sump pump and some piping were required. The radioactive holdup tank was excavated and shipped to burial. No additional contaminated soil was found.

Numerous penetrations existed between the operating and service galleries and the insides of the two hot cells. There were also penetrations between the two cells. Most of these consisted of small-diameter (2-in. or less) pipe and electrical conduit. Some of these pipes were surveyed and found to be internally contaminated. Those that could not be decontaminated easily were removed by core drilling a 4-in.-diameter hole around the pipe and removing the solid core with the pipe intact. Located in the floor of the primary cell were three storage thimbles. They were 3 in. in diameter and 9 ft long. They were easily removed by the Hy-Ram as part of the cell floor demolition.

The T1-T2 pit adjacent to the hot cell originally contained radioactive liquid waste holdup tanks. They were removed early in the SRE decommissioning. The pit was constructed of concrete and required surface decontamination over a large area. Jackhammers and hand scabblers were used as machine access was limited.

All of the trenches and excavations in the floor of the hot cell were backfilled and compacted. The floor was patched at the completion of hot cell decontamination.

4.4.14 Excavation Backfilling

Backfill and compaction of the SRE high-bay excavation began immediately following the completion of the below-grade final survey. A procedure was written and approved, and the excavation contractor was retained to provide the labor and equipment necessary to complete the backfill. The procedure specified the compaction density to be a minimum of 90% of maximum density as determined by the Uniform Building Code (UBC) Standard No. 70-1 (ASTM D1557). Field density testing in accordance with UBC Standard No. 70-2 (ASTM 1556) was also required. A geotechnical engineering consultant provided the field tests and a final report verifying the compaction density of the high-bay backfill. This report is on file with the Facilities & Industrial Engineering Department of Rockwell International, Energy Systems Group.

The wooden shoring wall was removed from the bottom up, as the backfill soil raised the level of the high-bay excavation (see Figure 73). The column support bracing was removed when the soil level reached the tops of the temporary footings. Seismic bracing installed outside the high bay was also removed when the backfill soil reached the footings. Figure 74 shows the high-bay excavation during the early phase of backfill and compaction.

Approximately 7000 yd^3 of material was used to backfill the SRE excavation. About half was available onsite and consisted of soil from the excavation and clean concrete rubble. Large pieces of concrete were reduced in size with a mobile crane and a wrecking ball. The remaining soil was purchased from a nearby land development.

While the high-bay backfill was in process, Energy Systems Group's Facilities Design engineers were designing a replacement floor for the high bay. Construction of the new floor started shortly after the completion of backfilling. The excavation surface area outside the building was paved with asphalt. Since the high-bay walls had yet to be decontaminated, precautions were taken to prevent the new floor from being contaminated. Two coats of a concrete sealer were applied. Next a coat of strippable latex paint was applied to prevent liquid contaminates from getting into the porous concrete. In the event a spill occurred, a second coat of paint would have been applied over any residual contamination that could not be removed. Then both coats of paint would be stripped off and fresh paint reapplied. The theory was not tested since the floor was not cross contaminated during any remaining decontamination activities.

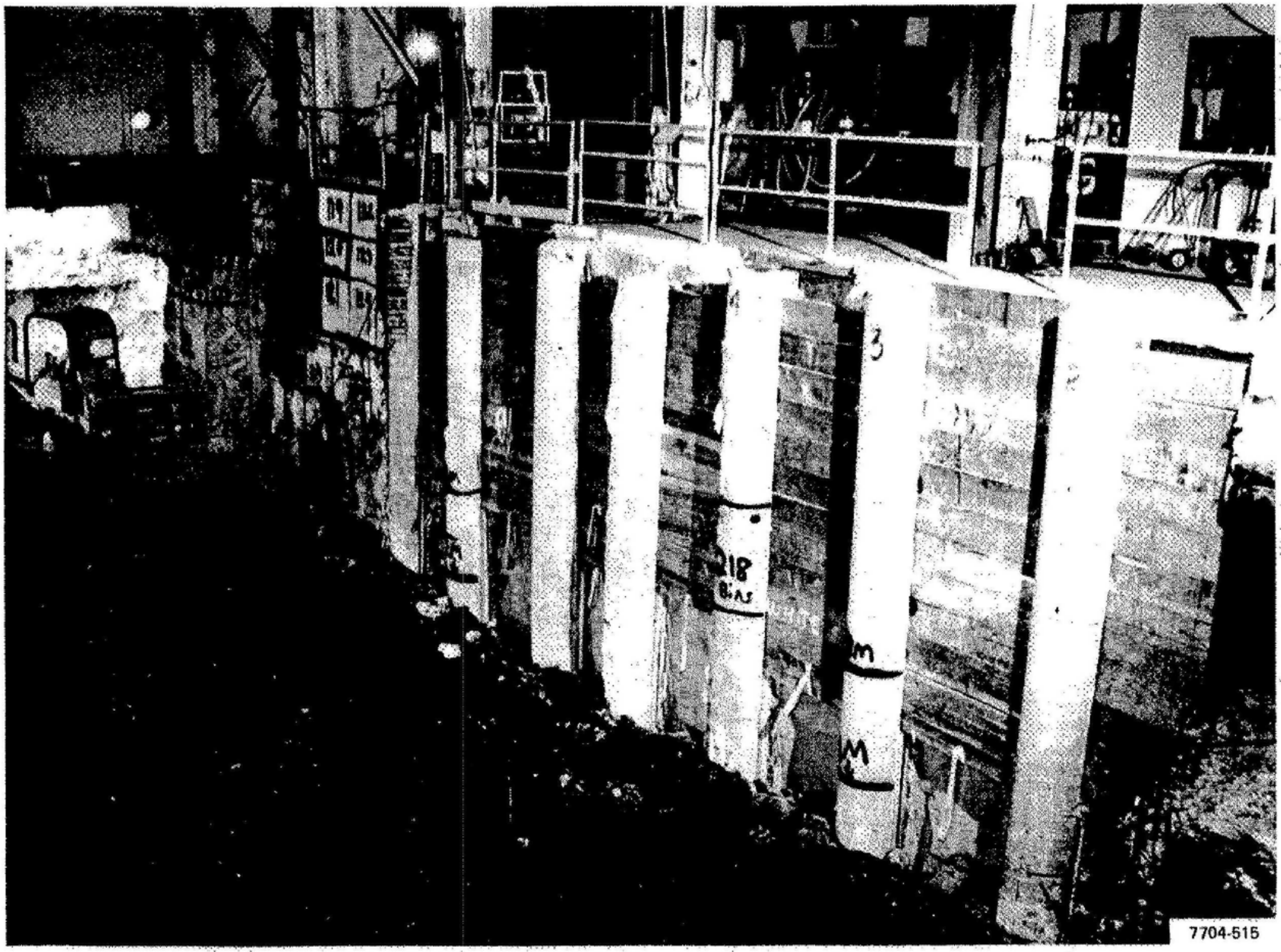


Figure 73. High-Bay Excavation Retaining Wall with Lower Wooden Shoring Removed

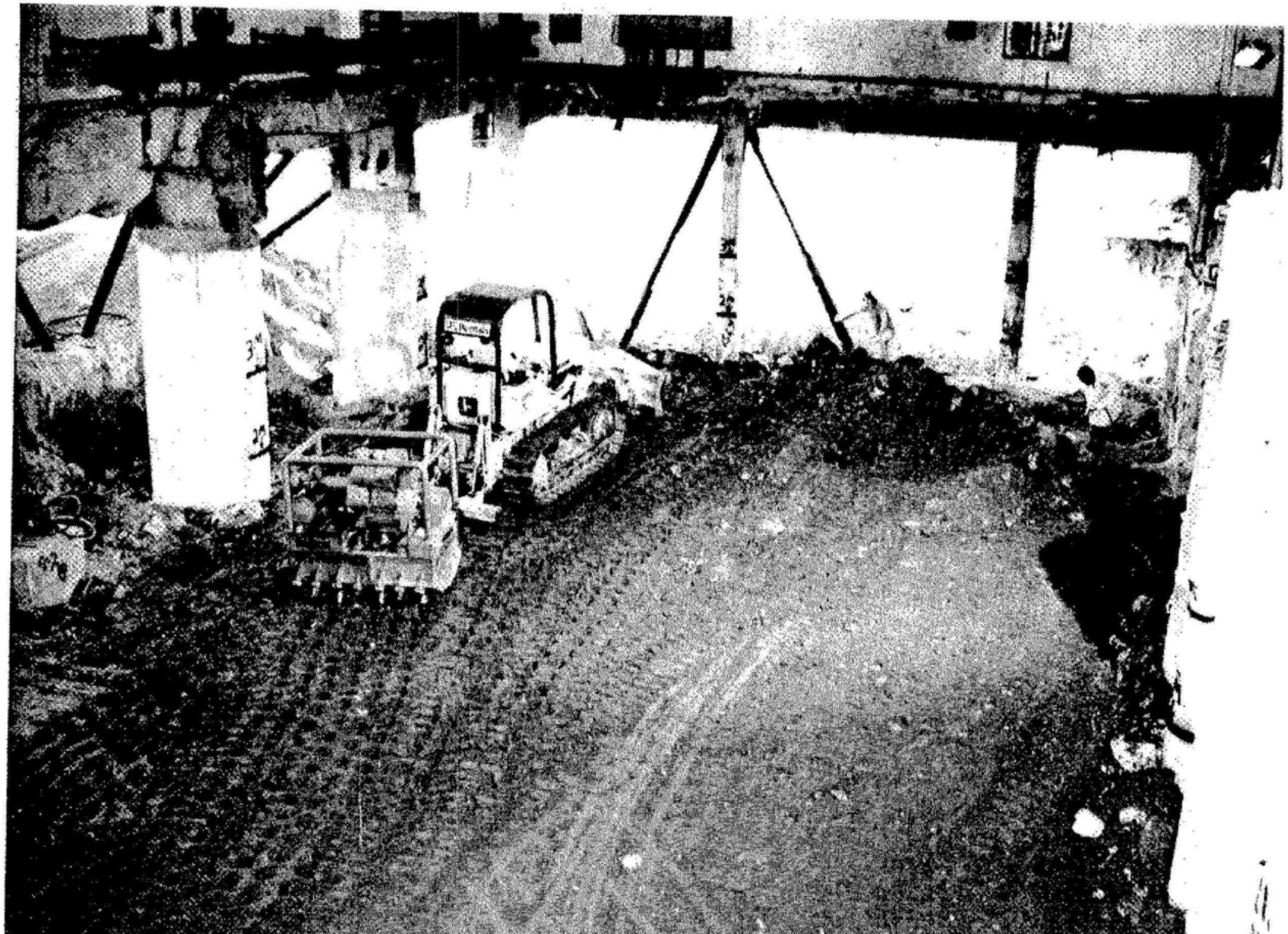


Figure 74. SRE High-Bay Excavation Backfill and Compaction in Progress

4.4.15 Decontamination of High-Bay Walls, Ceiling, and Cranes

With the replacement of the high-bay floor, below-grade decontamination activities at the SRE were completed. Only the high-bay interior and the radioactive exhaust system remained to be decontaminated. Since the radioactive exhaust would be needed for high-bay decontamination, it was left for last. A characterization survey was performed on the high-bay interior surfaces to determine the extent of the contamination. Locations of high instrument readings were identified on the walls. Smear samples indicated no removable contamination. Samples of the paint and the concrete behind the paint were obtained and analyzed. In all cases, contamination was found in the paint but not in the concrete. An evaluation of different paint removal methods was initiated. Sandblasting was selected over mechanical or chemical means. A sandblasting contractor who could work to our procedures was selected and a contract was awarded. Concurrently, a contract to install scaffolding in the high bay was awarded. The scaffolding provided access to 100% of the high-bay walls, the perimeter of the ceiling, and a portion of the three bridge cranes. Access to the remainder of the ceiling and cranes was accomplished by using a manlift. Figure 75 shows the scaffolding along the east wall of the high bay.

Prior to the start of sandblasting, the high bay was sealed and the radioactive exhaust units on the roof were activated. A negative pressure was maintained in the high bay to prevent the release of airborne contamination. The rooftop exhaust system had been designed for this purpose since the high bay was at a negative pressure during reactor operation. Sandblasting was very effective in removing the many layers of paint on the concrete and steel surfaces. The large amount of dust generated necessitated a much higher than normal frequency of filter changes in the exhaust system, and the large volume of sand deposited on the floor each day necessitated regular floor cleanup after the contractor had left for the day.

For the decontamination by sandblasting method to be effective, the paint has to be removed as completely as possible, especially from the horizontal

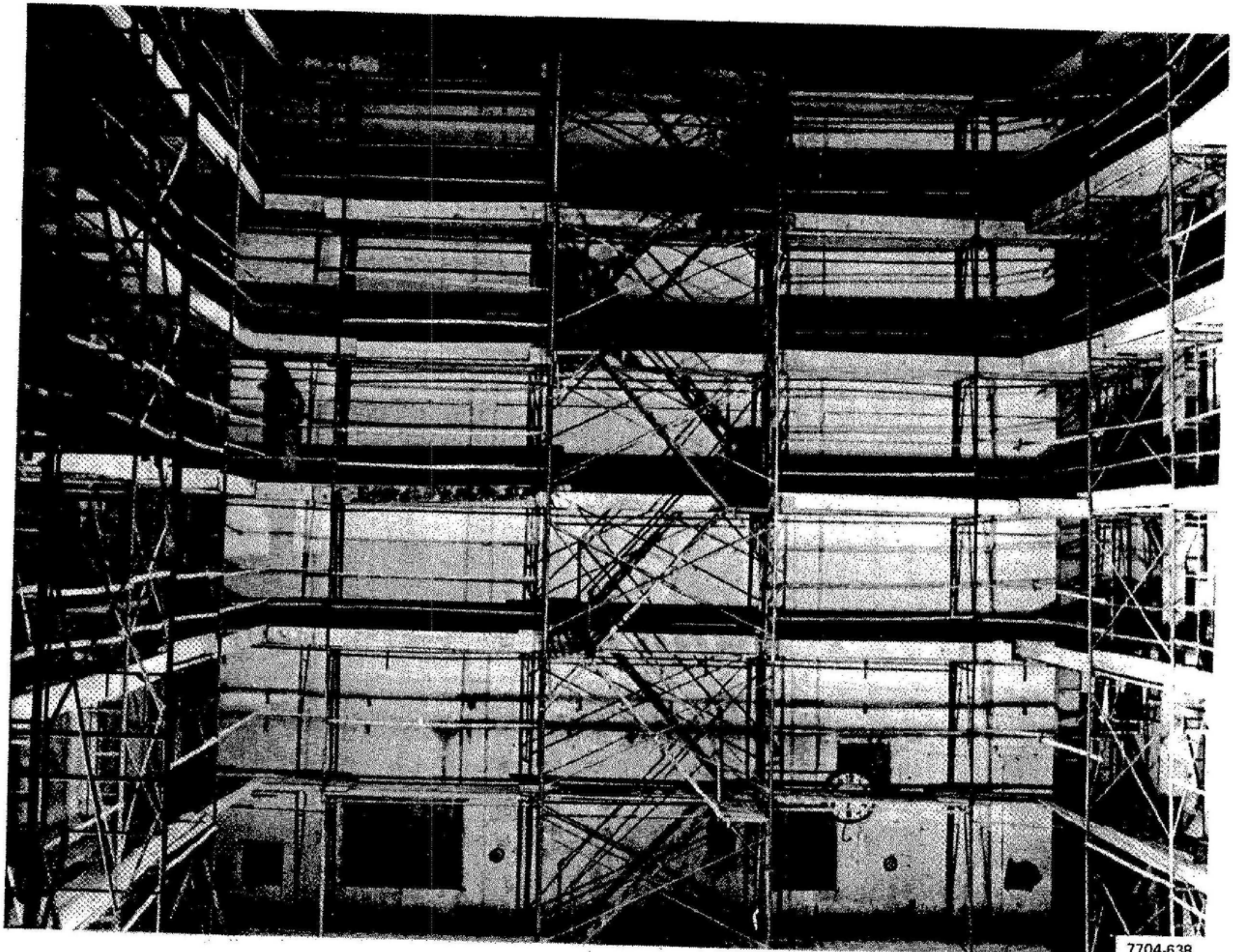


Figure 75. High-Bay Scaffolding