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FUEL STORAGE BASINS CLEANUP AND STABILIZATION PROJECT REPORT

Author

R. L. Miller and J. M. Steffes

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BM-5000-305 (11-79)

UNI-3958

FUEL STORAGE BASINS CLEANUP AND STABILIZATION PROJECT REPORT

Prepared By: _____ Date 7/11/86
R. L. Miller, Technical Analyst
Decommissioning Programs Department

_____ Date 7/14/86
J. M. Steffes, Information Coordinator
Decommissioning Planning

Reviewed By: _____ Date 7-15-86
J. F. Bertsch, Manager
Decommissioning Operations

_____ Date 7.15.86
M. A. Mihalic, Manager
Decommissioning Engineering

_____ Date 7/15/86
M. C. Hughes, Manager
Decommissioning Planning

Approved By: _____ Date 7/17/86
B. W. Mathis, Manager
Decommissioning Services

SUMMARY

There are eight fuel storage basins at the retired production reactors in the 100 Areas at Hanford. Two of these basins are still available for fuel storage (105-KE and 105-KW). Two other basins (105-F and 105-H) were filled with soil following their shutdown. The remaining four basins (105-B, 105-C, 105-D, and 105-DR) contained contaminated water, sediment, materials, and equipment that were left in the basins at the time those reactors were shut down between 1964 and 1969.

The U.S. Department of Energy, Richland Operations Office (DOE-RL), has contracted with UNC Nuclear Industries (UNC) to provide for the surveillance, maintenance, safe storage, and ultimate decommissioning of the shut-down facilities in the five (100-B/C, 100-D/DR, 100-KE/KW, 100-F and 100-H) retired reactor areas on the Hanford Site.

As part of the safe storage responsibilities, DOE-RL requested that UNC proceed with the project to clean up and stabilize the B, C, D and DR fuel storage basins. The project included the removal of the contaminated water, sediment, materials, and equipment in order to reduce the potential for a loss of contamination control and to minimize the surveillance and maintenance of these facilities while waiting for final decommissioning. The objective of the project was to leave the basins in an environmentally safe condition that would not effect the final decomissioning option selected through the National Environmental Policy Act (NEPA) process for the final disposition of the reactor buildings.

The project work was originally planned in nine phases. The first phase, preliminary engineering and project planning, was completed in January 1984. The ninth phase is project closeout which includes this project report. The other seven phases were divided into tasks to be performed by UNC Decommissioning Services and tasks to be performed by a subcontractor.

UNC Decommissioning Services

- Small material/equipment removal (Phase II)
- Concrete surface cleaning (Phase III)
- Large material/equipment removal (Phase IV)
- High dose rate item removal (Phase V)

Subcontractor

- Sediment removal and disposal (Phase VI)
- Contaminated water processing (Phase VII)
- Final concrete cleaning (Phase VIII)

These seven phases were to be completed sequentially for the D, DR, B, and C basins. The sediment removal and disposal and processing of the contaminated water by the subcontractor for all four basins was to be completed by September 30, 1984.

The actual work did not follow the planned sequence. The concrete surface cleaning (Phase III) was left until the final concrete sealing (Phase VIII) with both phases performed by UNC.

The subcontract was signed on May 22, 1984. However, as a result of substantial delays in mobilizing and startup and the unexpected hardpack of the sediment in the 105-D basin, the subcontractor did not complete the 105-D basin cleanup and packaging of the sediment until October 5, 1984. The processing of the water and packaging of the sediment from the 105-DR basin was completed on November 9, 1984. The packaged sediment was disposed of by UNC in the 200 Area low-level waste burial grounds.

The processing of contaminated water in the 105-B basin began November 7, 1984 and proceeded until higher than expected radiation levels were experienced from the sediment. The water level was returned to a depth of one foot in order to provide adequate radiation shielding to the workers in the basin

area, and the subcontractor was directed to move the processing system to the 105-C basin. As a result of similarly high radiation levels from the sediment in the basin, the contaminated water in 105-C basin was processed to a depth of one foot and operations were suspended on January 23, 1985.

Following preliminary ALARA and Allowable Residual Contamination Level (ARCL) evaluations, it was decided to move the sediment to the transfer pits in the 105-B and -C basins, dewater the sediment, and process and remove all of the remaining contaminated water. The transfer pits were to be capped and the dewatered sediment stored in the transfer pits until the final alternative for decommissioning the reactors and fuel storage basins is determined by the NEPA process. Final disposition of the sediment is also dependent upon confirmation that the sediment can be classified as low-level waste.

The subcontractor was requested to modify the contract work scope to accommodate this change in the disposition of the sediment from the 105-B and -C basins. When the subcontractor declined to modify the contract work scope, the scope was changed to conclude with the work accomplished and the contract was terminated.

UNC Decommissioning Services then took over the revised scope of the project. Cleanup of the 105-C basin was completed in August 1985 and 105-B basin in December 1985. The final concrete cleaning and sealing of the 105-D, -DR, -C and -B basins was completed by UNC on 9/3/85, 9/23/85, 10/29/85, and 1/31/86, repectively.

Waste generated during the project was from three primary sources: 1) miscellaneous hardware and debris remaining in the basins since shutdown of the facilities; 2) water with some suspended solids; and 3) sediments which covered the storage basin floors and to some extent adhered to the vertical surfaces of the facilities. None of the materials associated with the project were classified as hazardous chemicals, solids, or liquids according to Washington Administrative Code 173-303. A total of 24,469 ft^3 of solid waste was packaged and shipped to the 200 Area low-level waste burial ground.

The water was processed to release limits applicable at the start of the project work specified in Table II, DOE Order 5480.1 Change 2, and released to engineered ponds.

Personnel dose rates varied from 1 to 25 mrem/hr at the work deck level and 10 to 500 mrem/hr while working on the basin floor. The total occupational exposure incurred for cleaning the four basins was 41 man-rem.

Occupational exposure was kept to a level as low as reasonably achievable (ALARA) by using the basin water as shielding during removal of high dose rate items (up to 500 R/hr), by using remote handling techniques, and by restricting entry to the basin area to personnel whose presence was necessary to complete the job.

A number of management lessons were learned and axioms demonstrated during the course of this project, including:

- There is a critical need for detailed up-front planning and engineering for decommissioning projects, including a thorough investigation of the operating history and a radiological and chemical characterization of the existing conditions of the facility;

- A realistic assessment of the complexity and magnitude of a project must be made before commitments to milestones, schedules, and cost are made;

- A clear understanding of environmental release criteria and the sampling protocol to assure that the criteria are met must be specified prior to beginning work;

- Adequate contingency must be included in decommissioning project cost and schedule estimates in order to account for the unexpected;

- A site project engineer must be assigned to major projects with direct responsibility for project overview and cost and schedule control; this in lieu of an engineer assigned only as a technical advisor; and

- There must be an adequate cost and schedule control system available to the project engineer to assist in the management and control of the project.

The above management lessons were learned on this project and, where appropriate, were effectively applied by UNC in successfully completing this project. All of the project work performed by UNC, following the termination of the subcontract in January 1985, was accomplished on or ahead of the schedule and under the cost estimates and budget prepared by UNC for the completion of the basin cleanup project.

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1.0 INTRODUCTION

There are eight fuel storage basins at retired production facilities in the 100 Areas at Hanford. Two of these basins are still used for fuel storage (105-KE and 105-KW). Two other basins (105-F and 105-H) were filled with soil following the reactors' shutdown. The remaining four basins (105-B, 105-C, 105-D, and 105-DR) contained contaminated water, sediment, materials, and equipment left in the basins at the time the reactors were shut down between 1964 and 1969.

The U.S. Department of Energy, Richland, Washington, (DOE-RL) has contracted with UNC Nuclear Industries (UNC) to provide for the surveillance, maintenance, safe storage, and ultimate decommissioning of the shut-down facilities in five separate retired reactor areas at the Hanford Site.

As part of the safe storage responsibilities, DOE-RL requested that UNC proceed with the project to clean up and stabilize the 105-B, -C, -D and -DR fuel storage basins. The project included the removal of the contaminated water, sediment, materials and equipment in order to reduce the potential for a loss of contamination control and to minimize surveillance and maintenance of these facilities while waiting for final decommissioning. The objective of this project was to leave the basins in a condition that would not affect the final decommissioning option selected through the National Environmental Policy Act (NEPA) process for the final disposition of the shutdown reactor buildings.

The project work was originally planned in nine phases. The first phase, preliminary engineering and project planning, was completed in January 1984. The ninth phase is project closeout, which includes this project report.

The other seven phases were divided into the work tasks to be done by UNC Decommissioning Services and tasks to be performed by a subcontractor.

UNC Decommissioning Services

- Small material/equipment removal (Phase II),
- Concrete surface cleaning (Phase III),
- Large material/equipment removal (Phase IV), and
- High dose rate item removal (Phase V).

Subcontractor

- Sediment* removal and disposal (Phase VI),
- Contaminated water processing (Phase VII), and
- Final concrete cleaning (Phase VIII).

1.1 PURPOSE

The purpose of this report is to discuss and document the activities that were performed to clean and stabilize the fuel storage basins in the 105-B, -C, -D, and -DR reactor buildings.

1.2 SCOPE

The scope of this report includes a description of the 105-B, -C, -D, and -DR fuel storage basins; a summary of the project plan and its subsequent modification as the work progressed; the description of Decommissioning Services' organization and project management; a summary of the project activities by both UNC and the subcontractor; the waste management activities; a summary of lessons learned; and a summary of the budget and schedule used to finish the work.

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*Sediment is the term now used to describe the particulate solids in the basin water. This material tended to be a mixture of larger particles and material of a colloidal nature, which created visibility and filtering problems throughout the project. The word "sediment" was used in this report to avoid any confusion associated with the word "sludge", even though all initial documentation for the project used "sludge."

The water was processed to release limits listed in Table II of DOE Order 5480.1 Change 2 (Reference 1). The application was documented in the original contract (Special Agreement-SA-04136) for 105-D and -DR and in the memorandum from J. A. Hall to J. F. Beckstrom dated January 18, 1985, "Release Criteria for 105-B and -C Fuel Storage Basins." The processed water was discharged to engineered ponds adjacent to each reactor. The documentation for the final release of the discharge ponds is not included in the scope of this report, but will be recorded in separate reports (Reference 2).

2.0 DESCRIPTION OF FUEL STORAGE BASIN FACILITIES

2.1 HISTORY

The Hanford Site was commissioned in 1942 for the production of plutonium by the Manhattan Engineering District of the U.S. Army Corps of Engineers. Eight graphite-moderated, single-pass reactors and associated support facilities were constructed in the Hanford 100 Areas between 1943 and 1954 to support the plutonium production effort. The B, C, D, and DR reactors were part of the construction along with the F, H, KE, and KW reactors.

TABLE 1
OPERATING HISTORY

Basin/Reactor	Construction Start	Initial Startup	Shutdown
105-B	August 1943	09/26/44	02/13/68
105-C	June 1951	11/18/52	04/25/69
105-D	November 1943	12/17/44	06/26/67
105-DR	December 1947	10/03/50	12/30/64

The original eight production reactors, most of their support structures, and their associated ground disposal facilities were shut down between 1964 and 1971. They are maintained in a safe-storage mode until decommissioning, which began in 1983, can be completed.

2.2 LOCATION

The fuel storage basins are located in the 105-B, -C, -D, and -DR reactor buildings which are in the 100-B/C and 100-D/DR dual reactor areas. These areas are located along the south side of the Columbia River where it traverses the northern part of the Hanford Site in south-central Washington State. The reactor areas lie approximately 30 miles from the city of Richland (Figure 1).

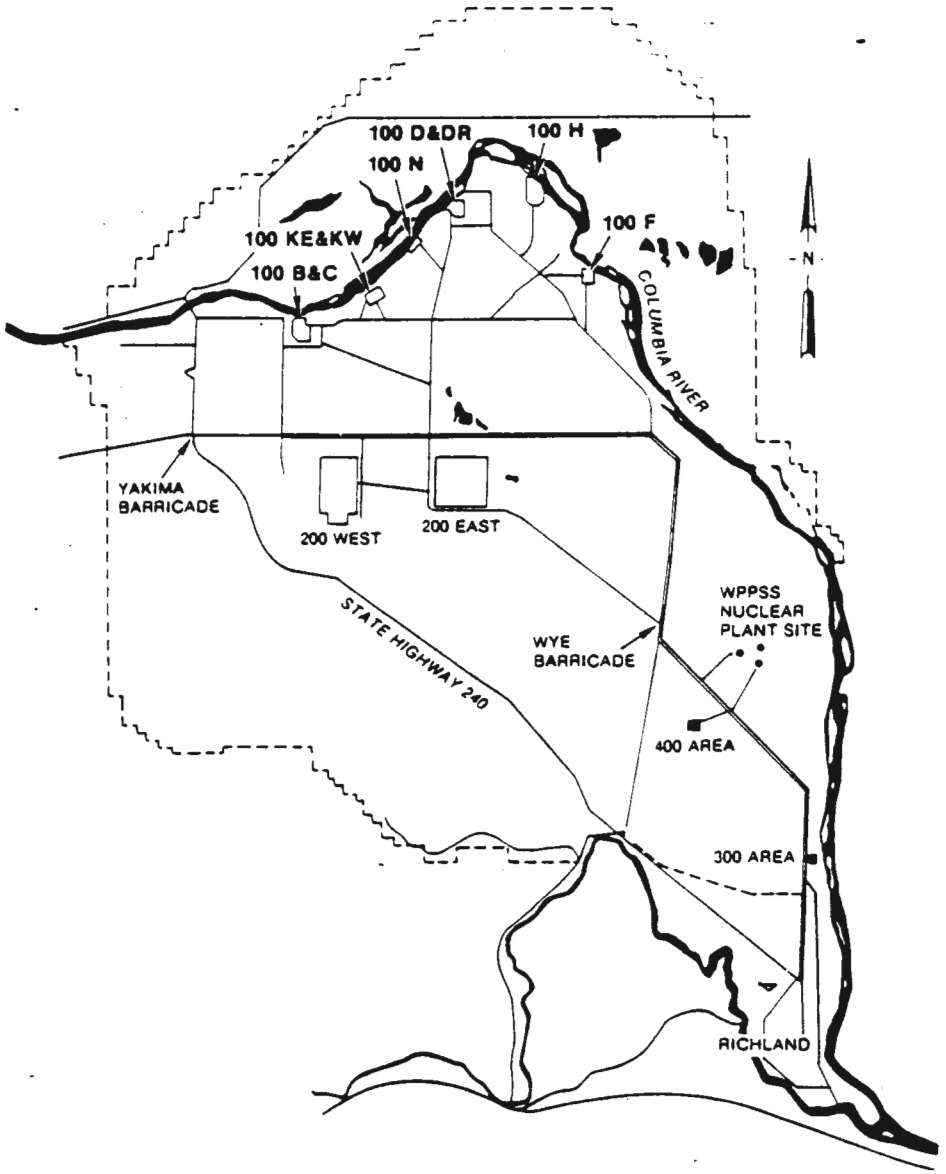

Figure 1. Hanford Site.

The siting of the reactor buildings within the areas is shown in Figures 2 and 3 for the four buildings.

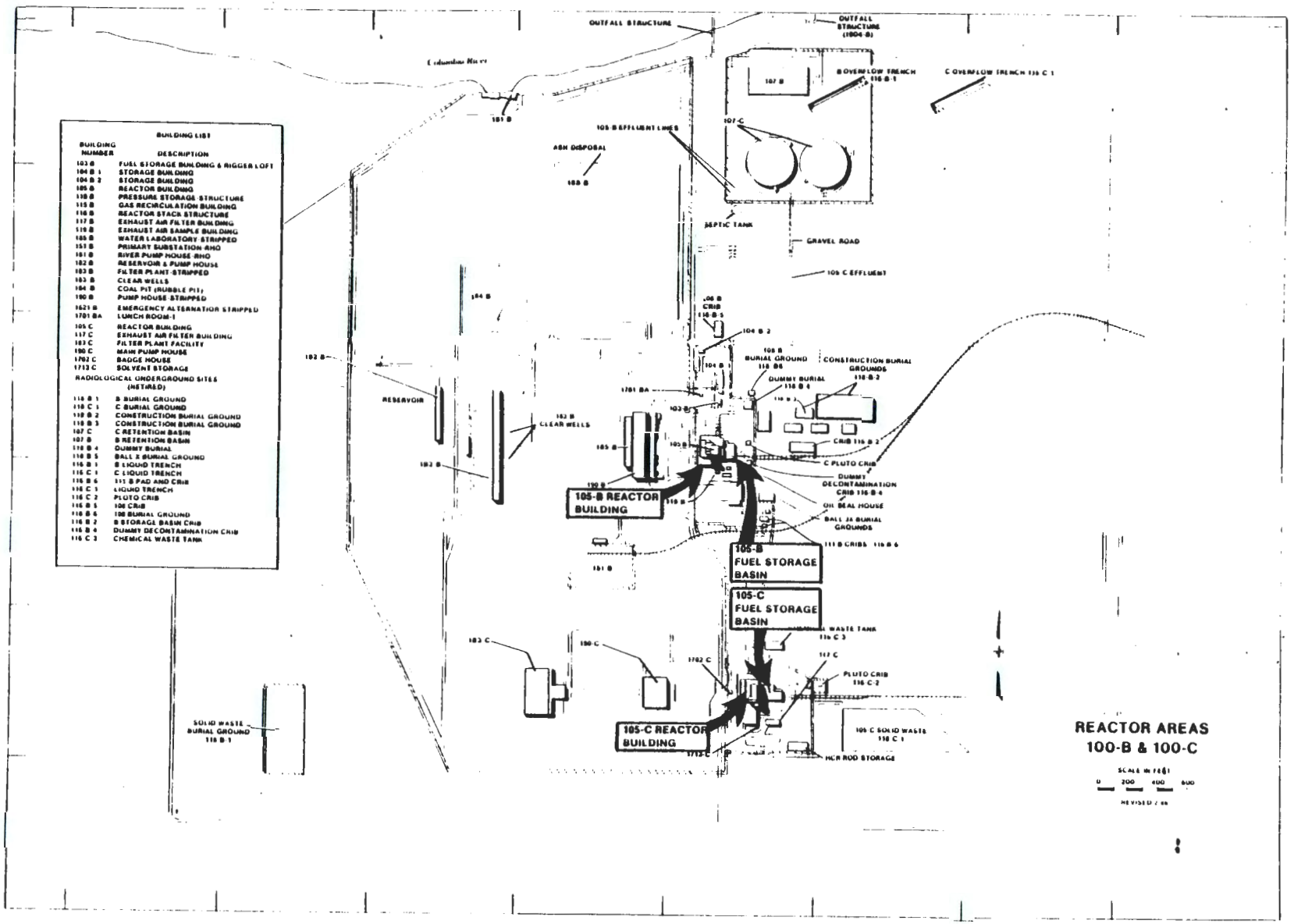

Figure 2. 100-B/C Reactor Area.

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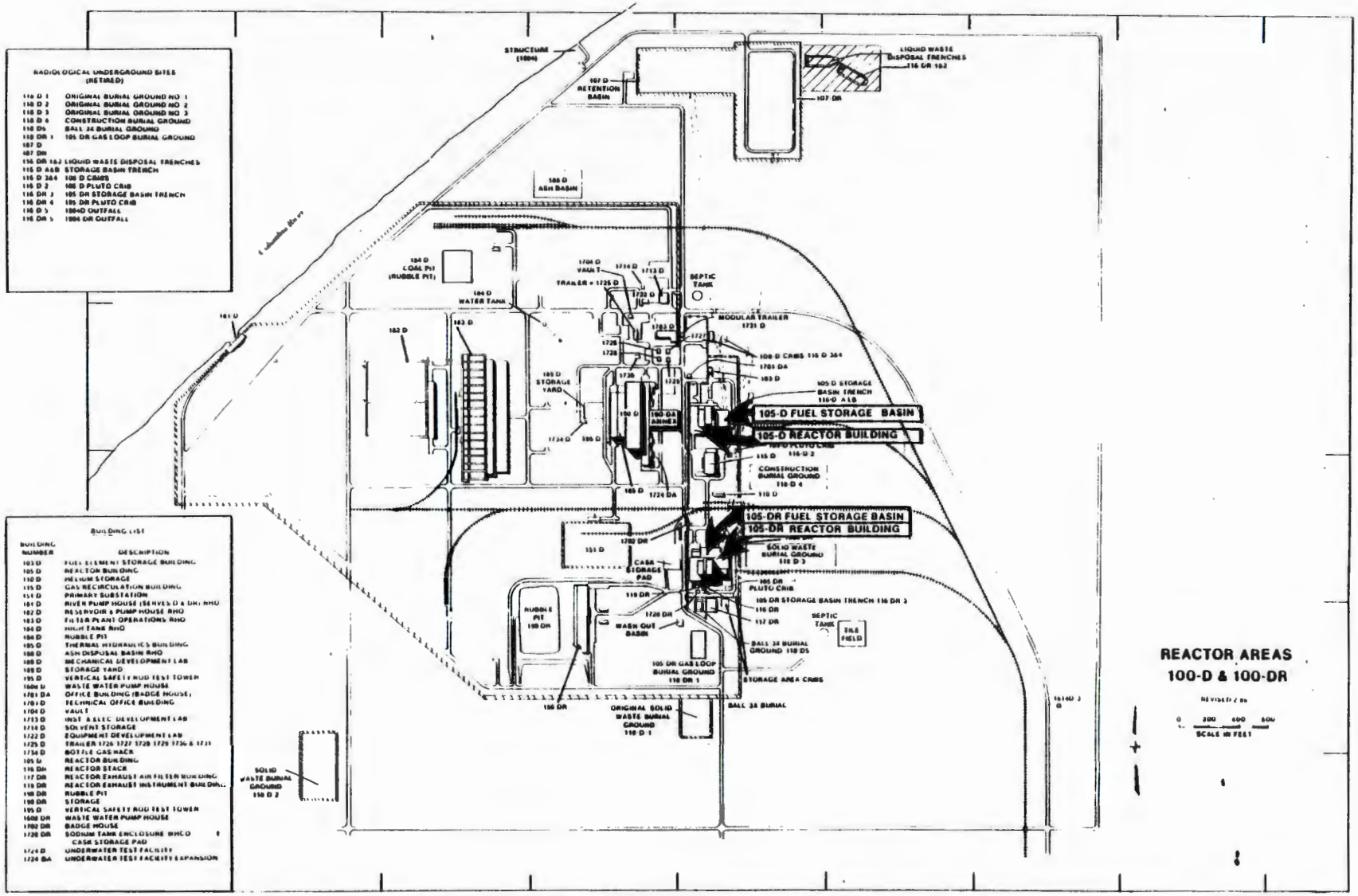

Figure 3. 100-D/DR Reactor Area.

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2.3 PHYSICAL AND RADIOLOGICAL DESCRIPTION OF THE FUEL STORAGE BASINS

The fuel storage basins are located at the rear of the reactors (Figure 4). The concrete basin area served as a collection, storage, and transfer facility for the irradiated fuel elements discharged from the reactor. The water in the basins served both as coolant and as shielding. Although the arrangement of the 105-C basin is slightly different, each reactor fuel storage basin

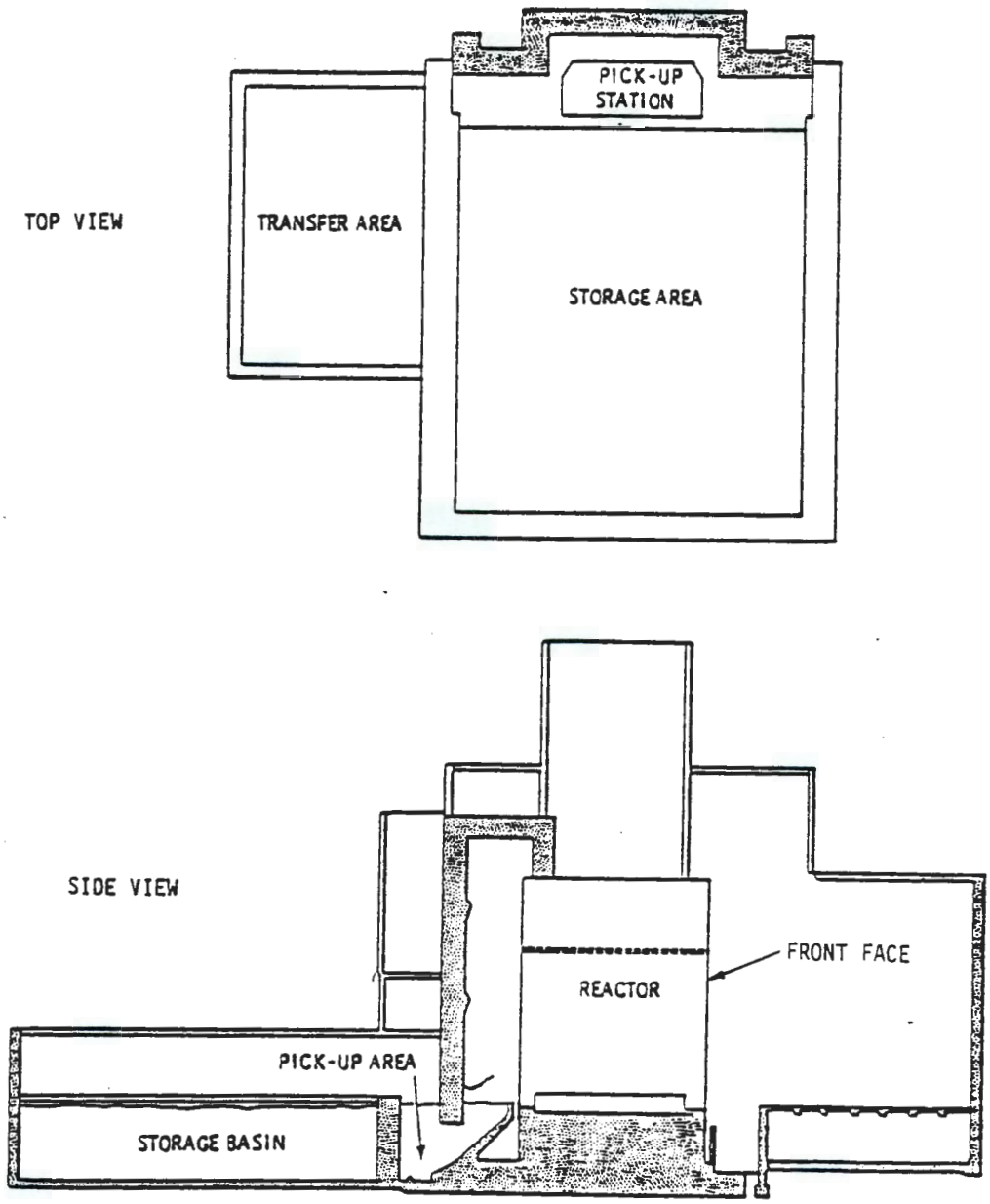

Figure 4. Layout of Fuel Storage Basin within Reactor Building.

consists of a discharge chute and fuel element pickup area, a storage area, a transfer area, and a wash pad area. The total floor area for these components averages between 7,000 and 10,000 ft^2.

Under 20 ft of water in the pickup chute area, irradiated fuel elements were sorted into storage buckets by long, hand-operated tongs. The buckets were then transferred by an overhead monorail system to the storage aisles where they were held for a time to allow the decay of short-lived radionuclides. Following the storage period, the buckets of fuel elements were moved by the overhead monorail system to the transfer area.

The transfer pits which measure 6 ft-4 in. x 9 ft are located at one corner of the fuel storage basins and at the inner end of the fuel transfer area. The transfer pits are 5 ft deeper than the basins and are connected to the basins by a canal over which the monorail system runs. Here the irradiated fuel was loaded into casks, then raised by a crane and placed in special railroad cars for shipment to the chemical reprocessing facilities in the Hanford 200 Area.

The washpad area was used to decontaminate equipment and reactor hardware and as a loadout area for all basin waste burial operations.

A general description and radiological characterization of the fuel storage basins appears in UNI-946, Radiological Characterization of the Retired 100 Areas (Reference 3). A more detailed discussion is presented below to describe the initial condition of the basins before work began.

2.3.1 105-B Fuel Storage Basin

The 105-B fuel storage basin shown in Figure 5 measures 72 x 94 x 20 ft and had a water depth of 5 ft (or about 250,000 gal) at the time work began. Once the heavy scum layer from dust and algae accumulated over the years was removed, water clarity was fair. The transfer area contained a special railroad car which was moved outside to allow initial cleanup of the area.

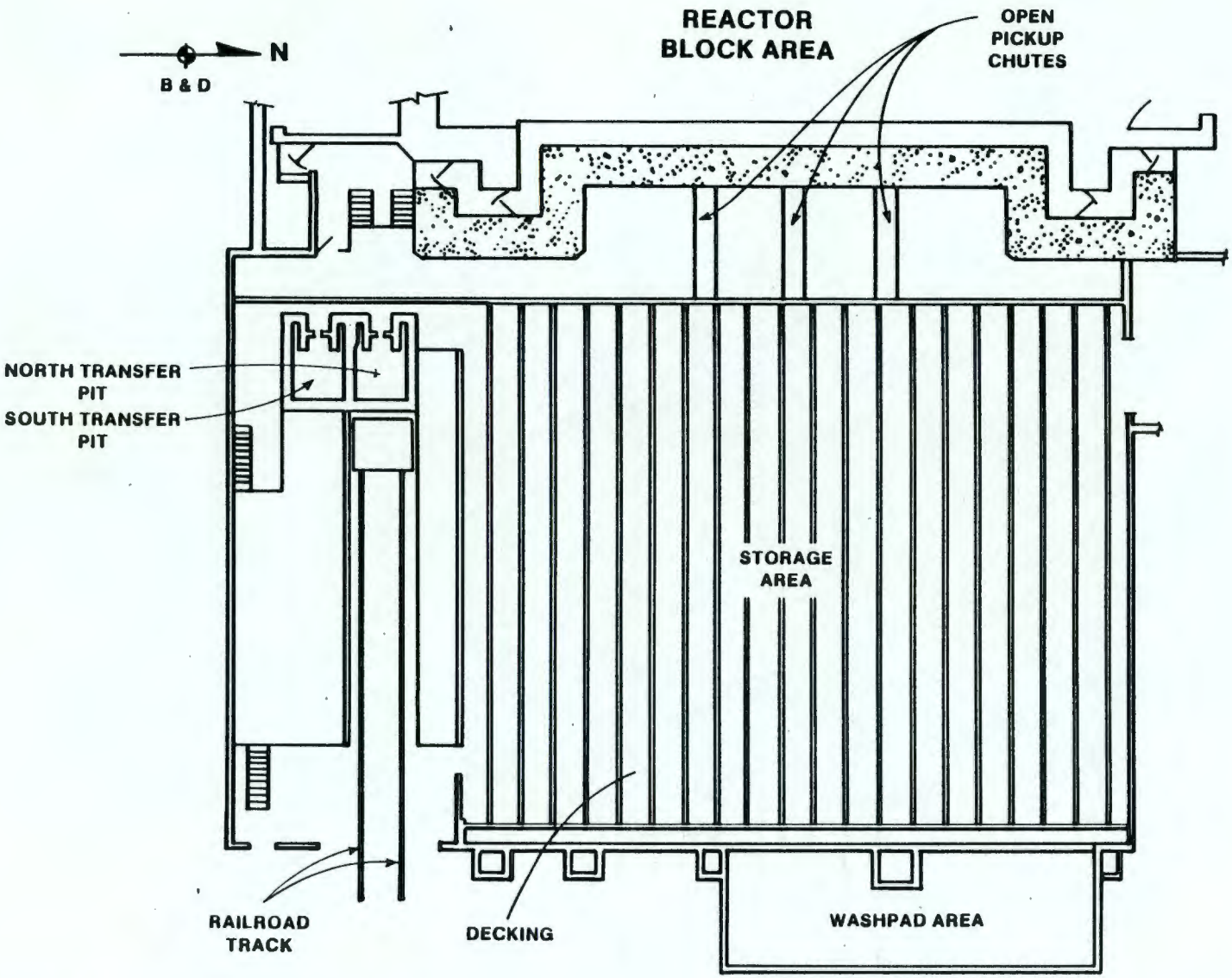

Figure 5. Typical Layout for 105-B, -D, and -DR Fuel Storage Basins.

A preliminary inventory of materials and equipment in the basin identified 41 fuel buckets, 60 perforated spacers (perfs), and 13 solid aluminum pieces. In addition, other miscellaneous debris was noted at 56 locations.

A preliminary radiological survey of the basin area above the water revealed dose rates of less than 100 mR/hr over most of the basin. Spot readings in the 400 to 800 mR/hr range to several R/hr were also recorded. An extreme hot spot reading of 150 R/hr was found near what appeared to be a ruptured fuel element inside an aluminum canister. The isolated canister read 500 R/hr on contact when removed from the water. Dose rates where personnel would have to work were less than 1 mR/hr due to shielding by the basin water and distance to the work platform.

Sediment depth was estimated at 1 to 2 in. and appeared to be mostly iron oxides and silt that varied in size from microscopic to 1 in. in diameter. The material was very fine grained and easily disturbed, which obscured visibility of underwater items.

2.3.2 105-C Fuel Storage Basin

The 105-C fuel storage basin (Figure 6) is the largest at 86 x 88 x 20 ft. The 105-C basin also features a fuel examination facility, which contained a substantial amount of equipment. Water depth was 10 ft or 570,000 gal with good clarity after the partial scum layer was removed.

Material and equipment inventory efforts revealed that the 105-C basin contained the most items to be removed. Approximately 120 fuel buckets, 100 perfs, and 50 solid aluminum pieces were located. There was a great deal of small debris scattered about the basin floor. Also present were three piles of zirconium process tubes. There were about 100 to 150 pieces of tubing ranging from 6 to 15 ft in length.

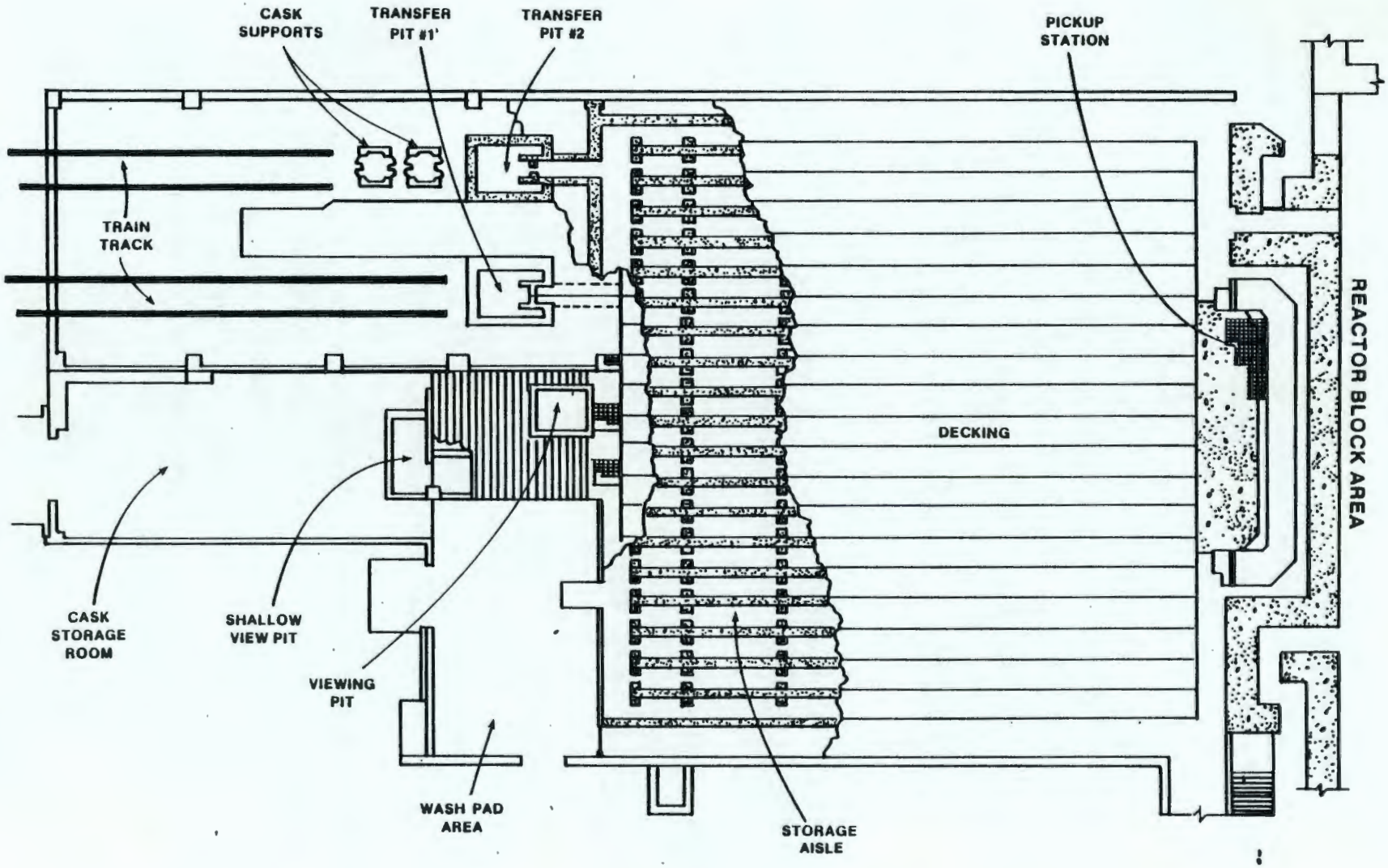

Figure 6. 105-C Fuel Storage Basin.

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The preliminary radiological profile of this basin showed contact dose rates on the basin floor from less than 100 mR/hr to hot spots of 25 R/hr. The zirconium tubing dose rates were 3 to 5 R/hr on contact. Subsequent surveys during material/equipment collection identified 4 solid pieces with contact readings of 35 to 100 R/hr. Dose rates in working areas were less than 1 mR/hr.

Sediment depth at the 105-C basin was uniformly less than one inch. The sediment appeared to be iron oxide and silt. Particle size seemed to be larger than that at 105-B and, though easily disturbed, it settled out quite quickly.

2.3.3 105-D Fuel Storage Basin

The 105-D fuel storage basin (Figure 5) was identical in design and construction to the 105-B basin. Water depth was 5 ft or 250,000 gal and underwater visibility was fair once the scum was removed.

There were 90 fuel buckets, at least 70 perfs, 20 solid pieces and miscellaneous small debris at 25 other locations on the basin floor. In addition, Row 1 was blocked by 16 bucket yokes and the 25-ft deep transfer pit contained about 20 perfs and other small debris.

The initial radiological surveys showed no contact readings greater than 100 mR/hr with working area dose rates of less than 1 mR/hr.

Sediment characteristics at 105-D were similar to those at 105-B. Where the sediment was one to two inches deep, it was easily disturbed. However, the areas from six to twelve inches deep were hard packed, which caused difficulties in the processing and removal of the sediments.

2.3.4 105-DR Fuel Storage Basin

The 105-DR fuel storage basin (Figure 5) was somewhat smaller than 105-D or 105-B, measuring 74 x 78 x 20 ft with a water depth of 4 ft or 140,000 gal. As with the other basins, 105-DR also had fairly clear water.

This basin had the least amount of material to be removed with only 41 buckets, 25 perfs, 7 solid pieces and small debris noted at 18 other locations.

An underwater probe survey showed no areas in excess of 100 mR/hr on contact in the basin and dose rates less than 1 mR/hr in working areas.

The sediment in the 105-DR basin was very similar to that in 105-B and 105-D in all respects.

2.3.5 Inventory of Radioactive Material in the Basin Sediments

Characterization samples of the sediment and water in the 105-B, -C, -D and -DR fuel storage basins were taken in April 1975. This sampling data indicated that concentrations of plutonium-238 and plutonium-239/240 were present in the storage basin sediments. A maximum of 9.5×10^4 pCi/g of plutonium-239/240 was detected in a sediment sample taken from the 105-B basin pickup chute. Federal regulations require retrievable storage of waste materials containing average transuranic (TRU) concentrations above 1.0×10^5 pCi/g. Average plutonium-239/240 concentrations for the 105-B and -C basin sediment were approximately 3.0×10^4 pCi/g. Further characterization may be necessary to assure that this material is disposed of correctly according to its final identification as either TRU or low level waste. Plutonium-239/240 concentrations in the 105-D and -DR basin sediment were about two orders of magnitude less than retrievable storage levels.

Beta-gamma concentrations in the basin sediment averaged 2.2×10^6 pCi/g. The primary radionuclides present were strontium-90, europium-152, europium-154, europium-155, cobalt-60, cesium-137, and nickel-63.

Estimated radionculide concentrations for sediment in the fuel storage basins as of April 1975 are given in Table 2, quoted from the Environmental Evaluation prepared for this project, Environmental Evaluation of 105-B, 105-C, 105-D, and 105-DR Fuel Storage Basin Cleanup and Contamination, January 1984.

When sampled, the radionuclide inventory of the sediment in a fuel storage basin was on the order of 100 curies. The lowest sludge inventory was 94 curies in the 105-D basin, and the highest was 150 curies in the 105-B basin.

Average beta-gamma and plutonium-239/240 concentrations in the basin water were 2.2×10^5 and 3.7×10^1 pCi/l, respectively. Radionuclide inventories in the basin water were approximately 0.1 curies which is negligible when compared to the basin sediment.

3.0 PROJECT PLAN AND OBJECTIVES

The objective of the Fuel Storage Basin Cleanup and Stabilization Project was to remove the contaminated water and sediment from the 105-B, -C, -D, and -DR fuel storage basins in order to reduce the potential for a loss of radioactive contamination control and to minimize surveillance and maintenance of these facilities while waiting for final decommissioning disposition. The intent of this effort was to leave the basins in a condition that would not require any substantial subsequent decontamination to effect the final decommissioning mode.

The work would remove the water from each storage basin to preclude any possibility of leakage, and to leave the dry basins in a condition that would prevent any potential for spread of contamination to the environment. In order to do this the sediment and debris would also have to be removed from the main basin area. Further, the basin walls would be hosed down as the water level was lowered so that the additional sediment generated by the cleaning action could also be removed. When the water was completely drained, the basin walls would be surveyed and if a potential existed for possible

TABLE 4

105 STORAGE BASIN SEDIMENT SAMPLES

		Concentration (pCi/g)										
Area	Location	Pu-238	Pu-239/240	Sr-90	H-3	Eu-155	Cs-137	Eu-154	Co-60	Eu-152	U	Ni-63
105B	Techview Pit	8.0×10^{2}	1.7×10^{4}	4.3×10^{4}	1.2×10^{2}	5.7×10^{4}	3.6×10^{5}	2.6×10^{5}	8.7×10^{5}	4.1×10^{3}	1.3×10^{2}	
105B	Dummy Ele. Chute	5.0×10^{1}	1.3×10^{4}	6.2×10^{5}	1.1×10^{2}	4.5×10^{4}	2.9×10^{5}	2.4×10^{5}	8.6×10^{5}	4.0×10^{4}	1.3×10^{2}	
105B	Pickup Chute	5.0×10^{3}	9.5×10^{4}	7.3×10^{5}	2.1×10^{3}	4.4×10^{4}	7.9×10^{5}	9.2×10^{4}	5.0×10^{5}	6.5×10^{4}	3.6×10^{2}	
105B	Transfer Area	1.9×10^{2}	4.0×10^{3}	2.2×10^{4}	6.1×10^{1}	1.8×10^{4}	1.1×10^{5}	1.6×10^{5}	9.5×10^{5}	7.8×10^{4}	9.4×10^{1}	1.2×10^{6}
Ave.		1.5×10^{3}	3.2×10^{4}	3.5×10^{5}	6.0×10^{2}	4.1×10^{4}	3.9×10^{5}	1.9×10^{5}	8.0×10^{5}	4.7×10^{4}	1.8×10^{2}	
105C	Dummy Ele. Chute	1.7×10^{3}	6.8×10^{4}	2.3×10^{4}	1.1×10^{2}	7.5×10^{4}	1.4×10^{5}	3.4×10^{5}	1.2×10^{6}	1.8×10^{5}	1.9×10^{2}	
105C	Techview Pit	7.9×10^{2}	3.3×10^{4}	1.8×10^{4}	2.0×10^{2}	2.1×10^{4}	2.5×10^{5}	1.0×10^{5}	6.4×10^{5}	4.8×10^{4}	4.6×10^{1}	
105C	Transfer Area	6.6×10^{2}	1.6×10^{4}	1.0×10^{4}	5.4×10^{1}	1.4×10^{5}	1.3×10^{5}	5.8×10^{5}	1.4×10^{6}	3.0×10^{5}	9.4×10^{1}	
105C	Pickup Chute	2.5×10^{2}	3.6×10^{3}	1.8×10^{4}	7.2×10^{1}	2.4×10^{4}	1.4×10^{5}	1.8×10^{5}	1.5×10^{6}	1.1×10^{4}	2.2×10^{1}	3.1×10^{5}
Ave.		8.5×10^{2}	3.0×10^{4}	1.7×10^{4}	1.1×10^{2}	6.5×10^{4}	1.6×10^{5}	3.0×10^{5}	1.2×10^{6}	1.4×10^{5}	8.8×10^{1}	
105D	Pickup Chute	9.0×10^{1}	2.1×10^{3}	4.6×10^{3}	3.1×10^{2}	1.4×10^{5}	5.4×10^{4}	3.7×10^{5}	1.0×10^{6}	2.8×10^{5}	4.3×10^{1}	
105D	Transfer Pit	1.8×10^{2}	1.1×10^{3}	2.2×10^{4}	3.6×10^{2}	5.1×10^{4}	6.3×10^{4}	2.6×10^{5}	1.0×10^{6}	1.9×10^{5}	3.0×10^{1}	
105D	Northwall	8.8×10^{1}	4.9×10^{2}	7.5×10^{3}	4.9×10^{2}	6.4×10^{4}	2.1×10^{4}	2.2×10^{5}	1.1×10^{6}	1.5×10^{4}	1.9×10^{1}	2.0×10^{5}
105D	Techview Pit	5.0×10^{1}	9.4×10^{2}	6.4×10^{3}	5.4×10^{2}	3.5×10^{4}	3.1×10^{4}	1.7×10^{4}	5.3×10^{5}	1.7×10^{5}	2.2×10^{1}	
Ave.		1.0×10^{2}	1.2×10^{3}	1.0×10^{4}	4.2×10^{2}	7.2×10^{4}	4.2×10^{4}	2.6×10^{5}	9.1×10^{5}	1.6×10^{5}	2.8×10^{1}	
105DR	Techview Pit	1.0×10^{2}	1.4×10^{3}	8.5×10^{3}	7.6×10^{2}	4.2×10^{4}	6.4×10^{4}	2.8×10^{5}	1.3×10^{6}	2.2×10^{5}	4.2×10^{1}	4.3×10^{5}
105DR	Wash Pad	3.6×10^{1}	7.1×10^{2}	3.1×10^{0}	4.5×10^{2}	1.3×10^{4}	5.0×10^{4}	6.7×10^{4}	4.8×10^{5}	3.6×10^{4}	1.3×10^{1}	
105DR	Pickup Chute.	1.0×10^{2}	3.0×10^{3}	6.3×10^{4}	3.2×10^{2}	2.3×10^{4}	3.1×10^{5}	1.3×10^{5}	6.4×10^{5}	5.5×10^{3}	4.2×10^{1}	
105DR	Transfer Area	5.3×10^{1}	1.1×10^{3}	1.8×10^{4}	2.0×10^{2}	3.3×10^{4}	5.3×10^{4}	2.2×10^{5}	9.9×10^{5}	5.3×10^{4}	1.3×10^{1}	
Ave.		7.2×10^{1}	1.6×10^{3}	2.2×10^{4}	4.3×10^{2}	2.8×10^{4}	1.2×10^{5}	1.7×10^{5}	8.5×10^{5}	7.9×10^{4}	2.8×10^{1}	

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airborne contamination, the applicable areas would be "stabilized" in a manner to preclude any possibility of contamination spread.

The objectives for this project supported the overall Decommissioning Programs' main objective, which is to decommission all of the shut-down facilities in the 100 Areas of the Hanford site in the safest, most environmentally sound, and most cost-effective way possible.

The original nine phases of the work were changed to accommodate new information about the conditions of the basins and the material in them as the work progressed. The original phases are listed below. After that, the modifications that were eventually implemented are described.

- Phase I - Preliminary Activities (Preliminary Engineering, Project Plan)
- Phase II - Small Material/Equipment Removal
- Phase III - Concrete Surface Cleaning
- Phase IV - Large Material/Equipment Removal
- Phase V - High Dose Rate Item Removal
- Phase VI - Sediment Removal
- Phase VII - Contaminated Water Processing
- Phase VIII - Final Concrete Cleaning and Sealing
- Phase IX - Project Closeout (Project Report)

The work in Phases VI, VII and VIII was originally subcontracted to a fixed price subcontractor who completed 105-D and -DR basins but only partially finished 105-B and -C basins when higher than expected dose rates caused a re-evaluation of the work scope. The subcontractor did not accept the changed scope and the contract was negotiated to completion. Prior to leaving the site in January 1985, the subcontractor had processed the water down to approximately the one-foot level in both 105-B and -C basins, but had not removed the sediment. Decommissioning Services took over the project and completed it using UNC personnel (including Rockwell D&D workers) and the majority of the subcontractor's equipment, purchased under an option in the original contract.

Phase VI and VII work was combined to include removing and processing the contaminated water to release limits and storing the contaminated sediment. The phase was broken into three subphases:

- Phase VII-I - Consisted of the engineering and planning to design, procure, fabricate, and test a system, utilizing the existing contractor equipment where possible, for relocating the sediment to the fuel storage basin transfer pits and processing the remaining water. Consisted of emptying and inspecting the fuel transfer pits to assure that they did not contain overlooked reactor fuel elements.

- Phase VII-II - Consisted of verifying that the fuel transfer pits were clean and then moving the sediment from the basin floors to the pits.

- Phase VII-III - Consisted of removing, processing, and releasing the remaining water to the engineered ponds. The concrete surface cleaning (original Phase III work) was completed with this phase.

Phase VIII, as called for by the Project Plan, consisted of cleaning the previously submerged concrete surfaces and processing resulting particulate material and contaminated water. Also included was coating the concrete surfaces with a suitable fixative in order to achieve contamination control until the actual method for final decommissioning of the reactor buildings was determined. The major change in this phase came because the work was done by UNC rather than the subcontractor. Also included in this phase was the shipment of the stored drums of contaminated sediment from the 105-D and -DR fuel storage basins to the 200 Area burial ground.

Since the only major deviation from the original plan had been to place the sediment in the fuel transfer pits (105-B and -C basins only) and complete the project using UNC resources, the project plan was not revised. Rather, abstracts describing the changes were added to the Decommissioning Project Readiness Review packages to explain the work.

4.0 PROJECT MANAGEMENT

The Decommissioning Services Section was created as a part of UNC Nuclear Industries' Decommissioning Programs Department in 1983. The Decommissioning Planning, Engineering, and Operations Subsections were responsible for planning and completing decommissioning projects in a safe and cost-effective manner. The Surveillance and Services (now Surveillance and Maintenance) Subsection was given the responsibility for maintaining the retired Hanford 100 Areas in a safe condition prior to decommissioning activities and for providing craft support to prepare sites for decommissioning project work.

Before work began on the project, advanced engineering documents were prepared to acquire a subcontractor and outline the safety requirements of the job. Once these documents were prepared and reviewed, and the subcontractor chosen, work was started with an engineer from the Decommissioning Engineering Subsection assigned as the technical advisor to the subcontractor. These documents and other materials prepared for the Decommissioning Project Readiness Review (DPRR) are listed in Section 4.1. The review process used to assure that all elements of safety, QA, and procurement were addressed is discussed in Section 4.2.

All decommissioning projects are subject to a Decommissioning Project Readiness Review (DPRR) in accordance with UNI-M-176 (Reference 4). The process assures that every effort has been taken prior to beginning actual decommissioning activities to make the job as safe as possible, avoid delays, and to be certain that all necessary approvals are in place. The review addresses all aspects and requirements of safety (industrial, radiological, and environmental), engineering, and operations. The process also assures a review of the documentation by DOE-RL and UNC management up through the Director of the Decommissioning Programs Department. Work is allowed to begin only when management is convinced that all aspects of the project have been covered and all organizations are ready to support the project.

The project site and activities are photographed before, during, and after the work is performed. These photographs are kept as permanent documentation and may be used for reports and presentations.

The project progress was tracked and reported through the weekly subsection highlights, monthly status reports, and monthly schedule statusing. Weekly meetings were also held to discuss problem areas and progress, and to assign responsibilities for action items.

As a result of substantial delays by the subcontractor in mobilization and in proceeding with the actual sediment removal and water processing, it became evident that close project management attention would be required for this project. (Work performance by the subcontractor was judged to be marginal.) The decision was made to assign a full-time UNC Project Engineer from Decommissioning Operations to provide project supervsion and closer cost and schedule control. At the same time, a UNC Health Physicist was also assigned full-time to the project to provide radiological guidance to the subcontractor.

When the 105-B and -C basin cleanouts were underway, higher dose rates than expected were encountered. The decision was made to store the sediment in the transfer pits rather than package the material for shipment to the 200 Areas for burial. The subcontractor considered this action to be a change of scope of sufficient magnitude to require re-negotiation of the contract. The contract was then negotiated to an end and the subcontractor officially left the project in March 1985. UNC completed the project using UNC personnel and Rockwell D&D workers.

During this project, Decommissioning Services implemented a modified version of the Cost/Schedule Control System (C/SCS) described in UNI-M-109 REV1 to track the project (Reference 5). Implementation of C/SCS required that the project be rebaselined and replanned in detail prior to UNC's resuming the work. A detailed Work Breakdown Structure (WBS) was developed and Task/Work Packages were outlined so that all incurred project costs could be monitored and controlled.

4.1 PROJECT DOCUMENTATION

The Project Plan was prepared early in 1984. The plan allowed for the preparation of the initial Decommissioning Project Readiness Review (DPRR) report, which explained the original phases of the project, called for the preparation of the facilities, and set up the procurement process for the subcontractor's portion of the work. When the project was replanned prior to UNC's finishing the sediment storage, water processing, and concrete cleaning and stabilization, additional DPRR reports were prepared.

The Project Readiness Reports contain documentation such as the appropriate NEPA document, The Project Plan, The Hazard Assessment, detailed checksheets for safety, operations, and engineering, Open Item Resolution Worksheets, Decommissioning Work Procedures needed for the project work, Radiation Work Procedures, Job Safety Analyses, Summary Checksheets, and the authorization to proceed with the work.

The documents prepared for the fuel storage basin project are presented in the following annotated list.

- 105-B, 105-C, 105-D, and 105-DR Fuel Storage Basin Cleaning Project Plan, R. C. Shilkett Jr., UNI-2742, January 20, 1984.

  This document describes the project scope, responsibilities, organization, and describes the project phases.

- Project Readiness Report for Decommissioning the 105-B, -C, -D, and -DR Fuel Storage Basins.

  This document contains the major planning documents for the original project as described by the Project Plan.

- Basin Cleanout Project Pre-Procurement Plan.

  This document provided the estimated cost and pre-procurement engineering and planning for DOE review and approval.

  The pre-procurement plan was submitted to UNC Procurement on January 16, 1984, and received DOE-RL approval to proceed on February 1, 1984.

- Cleanup of 105-B and 105-C Storage Basins, (with attachment to include 105-D and 105-DR basins) Purchase Requisition, R-133832.

  This document provided technical direction to UNC Procurement, Subcontracts, for preparing the request for proposal.

- Request for Proposal, RP-133832, "105-B, 105-C, 105-D, and 105-DR Fuel Storage Basin Cleanout."

  This RFP provided the administrative controls and technical guidance to be used by prospective contractors to prepare and submit a complete proposal.

- Special Agreement - SA-04136, "105 Basin Cleanup," May 22, 1984.

  This document is the final contract between UNC Nuclear Industries and the subcontractor to allow performance of the work.

- Project Readiness Report for Decommissioning the 105-B, 105-C, 105-D, and 105-DR Fuel Storage Basins, Phase VII-II.

  The document reflects the planning and work definition after UNC took over the project. This report covers the sediment removal work.

- Project Readiness Report for Decommissioning the 105-B, 105-C, 105-D, and 105-DR Fuel Storage Basins, Phase VII-III.

  This document contains the planning for the contaminated water processing portion of the work.

- Project Readiness Review for Decommissioning the 105-B, 105-C, 105-D, and 105-DR Fuel Storage Basins, Phase VIII.

  The document contains the planning for the final concrete cleaning and sealing in the four basins.

4.2 TECHNICAL REVIEWS

Technical reviews for the fuel storage basin cleanup project included both a subcontractor proposal review and evaluation and the routine technical reviews conducted by UNC Decommissioning Programs Department and Decommissioning Services prior to beginning work on a project.

Proposals for the basin cleanout project were reviewed independently by an Evaluation Committee. The committee members represented Procurement, Procurement Quality Assurance, Decommissioning Programs (Engineering and Health Physics), Industrial Safety, and Legal.

The reviewers concurred that Pacific Nuclear Systems and Services was the highest rated subcontractor based on their proposal. Following review by UNC Procurement, the notice to proceed was issued and Special Agreement SA-04136 was finalized for approval. The Special Agreement was signed by both parties on May 22, 1984.

A technical review of the project items or readiness review was held four times, including once for the initial startup and once each for the three phases planned after UNC took over the work. Management and supervisors in the operations, engineering, and safety groups reviewed the project documentation, and personally inspected the work locations to assure that everything was ready to safely proceed with the tasks. All open items on the DPRR check sheets were listed in the Open Item Resolution Work Sheets and were resolved prior to starting the corresponding portion of the work.

5.0 PROJECT ACTIVITIES

The original schedule of activities shown in the project plan indicated the consecutive accomplishment of Phases I through IX for each of the four fuel storage basins. The activities to clean out the four basins were to be performed nearly concurrently, with Phase I to be completed in the second quarter of FY 1984 and Phase IX to be completed by April 1, 1985. As the work commenced it became apparent that the original sequencing of tasks (Phases) would not provide an efficient use of resources. In addition several unexpected occurrences required that the project be rebaselined and a more realistic schedule be prepared. The following narrative is an approximate chronological description of the project activities from 1983 until successful completion of the project in 1986.

5.1 PRELIMINARY ACTIVITIES

Prior to actual cleanout work there were many details to be considered. Power was restored to the fuel basin areas, lifting devices were tested and certified by an independent inspector, a visual inspection and estimate of the quantity of debris and hardware remaining in the basins was performed, and samples were collected of the sediments and cover water from each basin for characterization. Concurrently, cleanup equipment was modified to work better with the lowered water levels of the basins and engineering documentation was developed to support the project through completion. Dose rate mapping of the basins was performed to locate high dose rate areas and to assist in separating items which required special handling. Figure 7 shows a typical fuel storage basin area prior to start of cleanout. Figure 8 shows temporary safety railings erected before removing the flooring. Chain safety barriers, which were more convenient to handle, were also used to protect workers from the open area. Figures 9 and 10 are typical for the basin material involved.

Figure 7. 105-C Fuel Storage Basin Decking and Work Area.

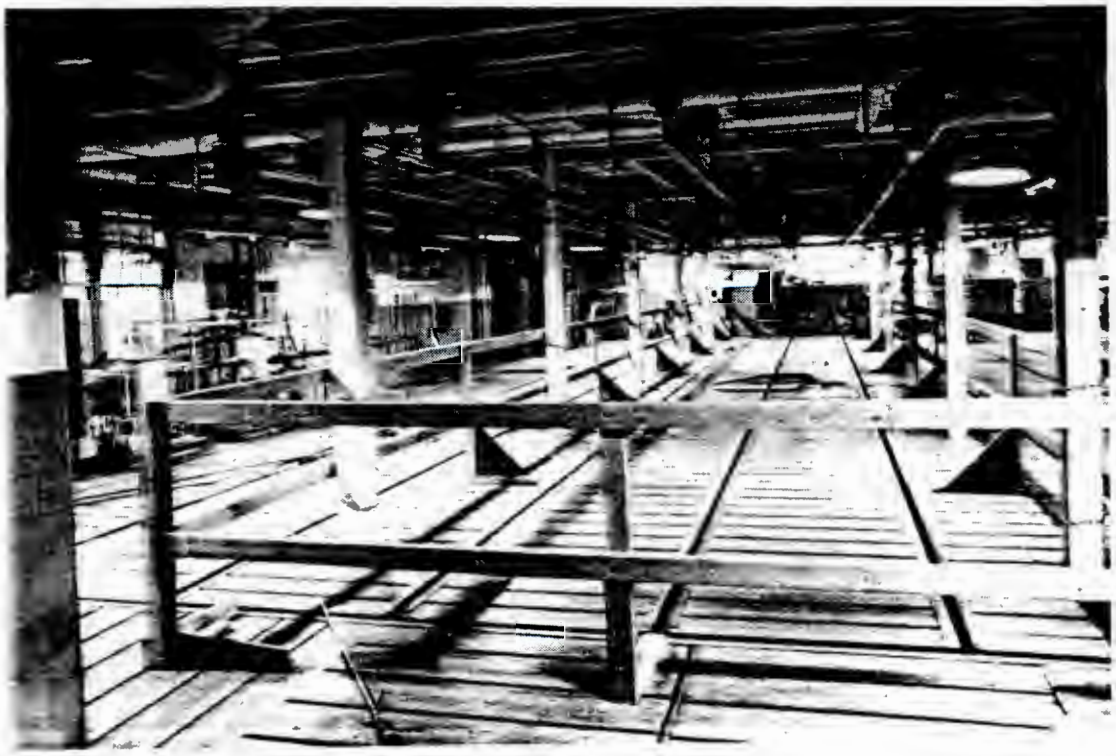

Figure 8. Temporary Safety Railings.

Figure 9. Fuel Storage Basin Water Condition Prior to Cleanup.

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Figure 10. Fuel Storage Basin Debris Prior to Cleanup.

All four basins contained fuel storage buckets left after facility shutdown. The buckets were consolidated in one area of the basins and served as convenient sorting receptacles to separate high dose rate items (from 5 R/hr to 500 R/hr) for interim storage. The 105-C basin contained the greatest amount of debris and hardware and consequently had the greatest quantity of high dose rate items. The high dose rate items consisted of potential reactor fuel elements, thermocouple train, zirconium tubing and other items that may have been irradiated in the reactor for test purposes. The high dose rate items were mainly thermocouple trains and zirconium tubing.

Engineered ponds were excavated near each reactor building to receive the processed water.

5.2 SMALL MATERIAL/EQUIPMENT REMOVAL

Small material/equipment removal began at 105-B basin in early 1984. Equipment and hardware that would fit into the fuel storage buckets and have a contact dose rate of less than 200 mR/hr were removed. The loaded buckets were placed into 10 mil plastic bags with industrial grade vermiculite as an absorbent and then placed into fiberboard boxes for disposal. Other small items with contact dose rates of greater than 200 mr/hr were removed and packaged in shielded containers for transport and disposed. Any item having high dose rates and having the dimensions of a fuel element were stored in small underwater shielded casks for later packaging and transport to 100-N Area. Remote handling techniques were used for removal of small items; consequently, personnel dose rates were usually less than 100 mrem/hr. The small material/equipment removal phase of the project proceeded as planned. Removal of all visible small items from 105-B basin was completed during the week of February 9, 1984, and completion of the other three basins shortly thereafter. Figure 11 shows several of the buckets and the typical small items encountered.

Figure 11. Small Material and Buckets Prior to Removal.

5.3 LARGE MATERIAL/EQUIPMENT REMOVAL

Some special tooling was designed and fabricated to assist in the removal of large items. Large items were present in all the basins and ranged from pieces of large piping and structural steel to process tubing. The 105-C basin had the greatest quantity of large items mainly in the form of zirconium process tubing. The zirconium tubing required segmenting to piece sizes that would easily fit into shipping containers. Cutting of the longer pieces of tubing to lengths that would fit into the shipping containers was accomplished by use of a remote-controlled tubing cutter jig. Even though contact dose rates on some tubing sections were several R/hr, personnel dose rates averaged less than 100 mrem/hr during the packaging operation. Due to high dose rates, all zirconium tubing segments were packaged into special lead- or concrete-lined boxes (UNI-4476 containers). Figure 12 shows the segmented tubing after placement in a shipping container.

Figure 12. Zirc Tubing in Concrete-Lined Burial Box.

When all visible hardware (small and large) was removed and packaged, the basin floors were raked to uncover any remaining items that may have been covered with sediment. A significant number of small items were removed as a result of the raking. The concrete walls and structures above the cover water in the basins were washed down with water to remove loose contamination.

5.4 WATER AND SEDIMENT REMOVAL

Concurrent with removal of items at 105-B and 105-C, a fixed-price subcontractor began work at the 105-D basin to remove the water and sediment. The subcontractor was Pacific Nuclear Systems and Services, Inc. (Pacific Nuclear) of Richland, Washington.

5.4.1 105-D Basin

Pacific Nuclear began processing water and sediment from the 105-D basin in July 1984. Their original processing system water flow diagram is shown in Figure 13 and consisted of the following equipment:

1. A vacuum head for vacuuming sediment from the basin floor;

2. A 20-ft^3 filter press for removing sediment vacuumed from the basin floor and for removing particulate from the water being processed for release;

3. Six ion exchange columns arranged into two parallel systems. Each system consisted of one 30-ft^3 zeolite column and two 30-ft^3, sodium-form, cation resin columns;

4. One "CUNO" filter to act as a final particulate filter for processed water;

5. Three 20,000-gal holdup tanks for storage of processed water until analyses verified that the water met the release limits;

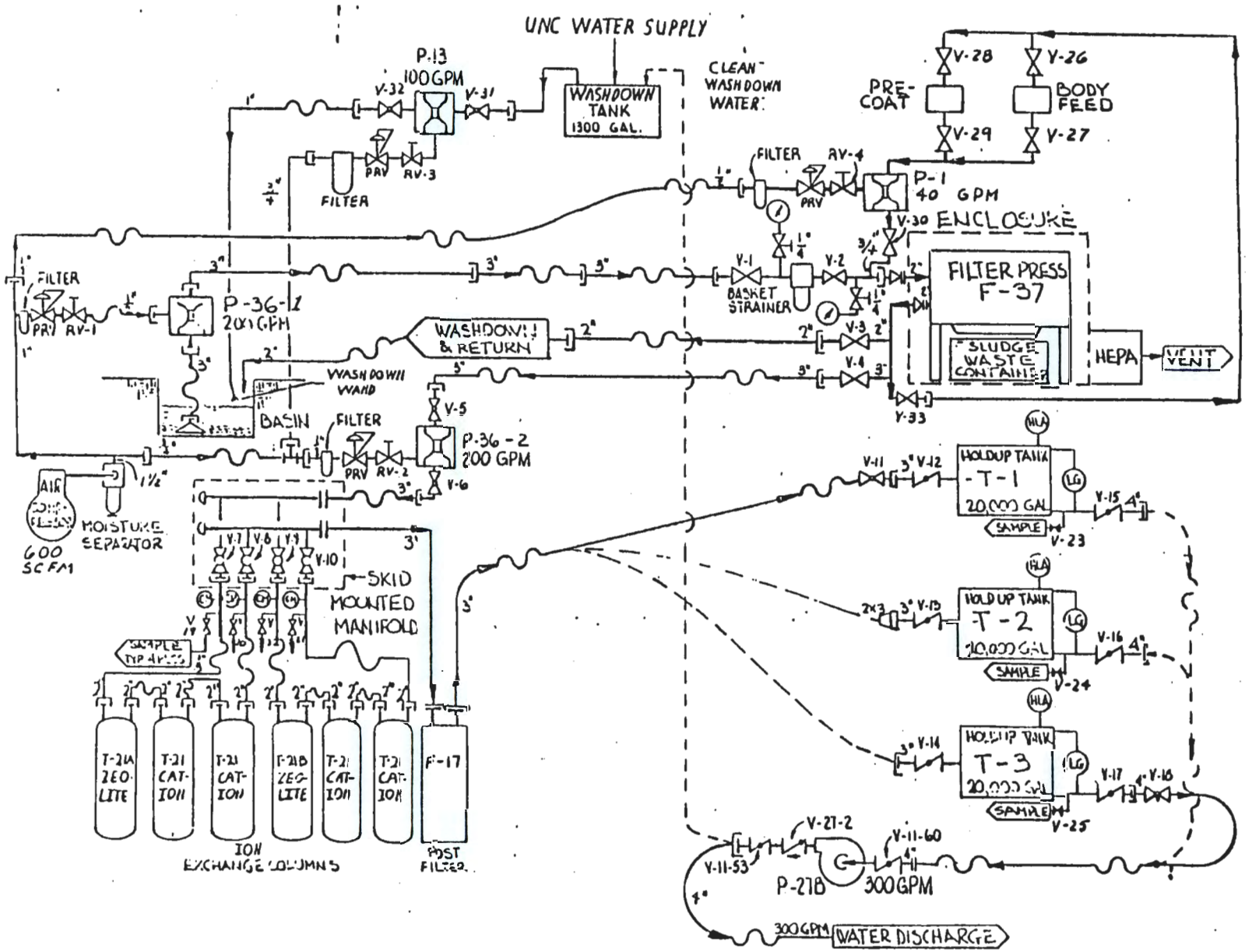

Figure 13. Water Processing System Schematic, Pacific Nuclear Design.

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6. Two air-operated diaphragm pumps for vacuuming and processing the water and sediment;

7. One centrifugal pump for discharging water from the holdup tanks to the discharge ponds.

Pacific Nuclear processed approximately 620,000 gal of water from the 105-D storage basin, of which 500,000 gal were discharged following once-through processing to the 105-D discharge pond. Approximately 120,000 gal had to be reprocessed prior to discharge because the water failed to meet the release limits. During the water processing phase, Pacific Nuclear experienced several difficulties with their water processing equipment. The following points briefly summarize these difficulties.

- Sediment and water were never processed simultaneously.

- High pressure losses across the zeolite ion exchange columns resulted in low process flow rates. As a result, the zeolite columns were bypassed.

- Particulate material was not completely removed by the system. This required reprocessing approximately 120,000 gal of water in order to meet the release limits.

- Particulate material collected in the holdup tanks, contaminating the holdup tanks and the discharge pond. Both the tanks and the pond required subsequent decontamination. Reference 2 addresses the release of the discharge pond at 105-D. Additional reports are being prepared for the discharge ponds at 105-DR, -B, and -C.

- Particulate material collected in the inlet screens of the sodium-form cation exchange resin columns, resulting in low process system flow rates due to plugging.

Pacific Nuclear removed approximately 400 ft^3 of sediment from the 105-D storage basin. Two vacuum head designs were tried in unsuccessful attempts to collect the sediments on the filter press. Finally, the basin sediment was washed with a fire hose into the transfer pits and manually shoveled into 55-gal drums. The contact dose rate on the sediment in the pit was 1.5 R/hr. Personnel dose rates ranged from 200 to 350 mrem/hr while the sediments were shoveled into the drum.

During the washdown, it was discovered that what was thought to be the floor surface was actually compacted sediment. The compacted sediment ranged in thickness from zero (bare floor) to eight to ten inches. During the removal of this compacted sediment, additional basin debris was uncovered which included two suspect fuel pieces. These suspect fuel pieces were shipped from 105-D to 105-C which served as a collection point until all suspect pieces could be shipped to 100-N for further identification and confirmation as fuel pieces.

Pacific Nuclear completed removal of the water and sediment from 105-D basin after 90 working days at the end of September 1984 and began setting up at the 105-DR basin.

5.4.2 105-DR Basin

Pacific Nuclear began processing water and sediment from the DR basin during October 1984. A bag filter had been added to their processing system at 105-D and was added at the pond discharge for 105-DR to protect against possibly contaminating the discharge pond with particulate materials.

Pacific Nuclear processed approximately 240,000 gal of water from the DR storage basin, of which 170,000 gal were discharged following once-through processing to the 105-DR discharge pond and approximately 70,000 gal had to be reprocessed prior to discharge because the water failed to meet the release limits. Pacific Nuclear again experienced problems with processing the basin water due to particulate material.

Pacific Nuclear removed approximately 400 ft^3 of sediment from the DR storage basin. A new vacuum head design was tried in an unsuccessful attempt to collect the sediment on the filter press. As at 105-D basin, the sediment was finally removed by washing it into the transfer pits with a fire hose and manually shoveling it into 55-gal drums. Dose rates were similar to those experienced at the 105-D basin.

Fewer total items were found in the sediment, but final examination of three items identified them as fuel elements. The fuel elements were transferred to 105-C for examination, and eventually sent to 100-N.

Pacific Nuclear completed removal of the water and sediment from 105-DR basin after 30 working days at the beginning of November 1984 and began setting up at 105-B basin.

5.4.3 105-B Basin

Pacific Nuclear began processing water and sediment from the 105-B basin in November 1984. Another "CUNO" filter was added to the process system upstream of the ion exchange columns to protect against plugging by particulate material.

Pacific Nuclear processed approximately 100,000 gal of 105-B basin water, of which 60,000 gal were discharged following once-through processing to the 105-B discharge pond and approximately 40,000 gal had to be reprocessed prior to discharge because the water failed to meet the release limits. Processing problems were traced to contamination by particulate material in the holdup tanks. As a result, the holdup tanks were decontaminated.

As the water was lowered to the 6-in. level, increased rates were encountered around the pickup chute. Attempts by Pacific Nuclear to remove sediment from this area resulted in increased rates to personnel from the lowered water level and from particulates accumulated in the process equipment. As a

result, UNC directed Pacific Nuclear to raise the water level for shielding, to suspend operations at 105-B, and to mobilize at the 105-C fuel storage basin. Pacific Nuclear had worked 30 days in 105-B.

The final cleanout of the 105-B basin was completed later by UNC forces (Section 5.4.5).

5.4.4 105-C Basin

Pacific Nuclear began processing water and sediment from the 105-C basin in December 1984. When the cover water was processed down to about the 1-ft level, the dose rate above the water and at the work areas began increasing significantly. Work was then suspended by UNC after 15 working days.

The subcontract with Pacific Nuclear was renegotiated to allow completion of the agreement with the current status of the basin. UNC purchased all of Pacific Nuclear's equipment by exercising the options provided in the original contract. Pacific Nuclear left the facilities in April 1985. UNC resumed operations at the 105-C basin in May 1985, after completing the advanced planning required by the Decommissioning Services C/SCS.

Prior to resuming operations, the process equipment utilized by Pacific Nuclear was evaluated and several modifications were made to both the equipment and operating procedures. Figure 14 shows the changed system schematic. Figures 15 and 16 show the equipment as set up at 105-B. The following is a brief summary outlining these changes.

1. The majority of Pacific Nuclear's processing problems were caused by particulate material. This material caused low flow rates through the system due to plugging and process water contamination. To eliminate these problems, the following design and procedural modifications were made by UNC.

BASIN WATER PROCESSING EQUIPMENT INSTALLATION DRAWING

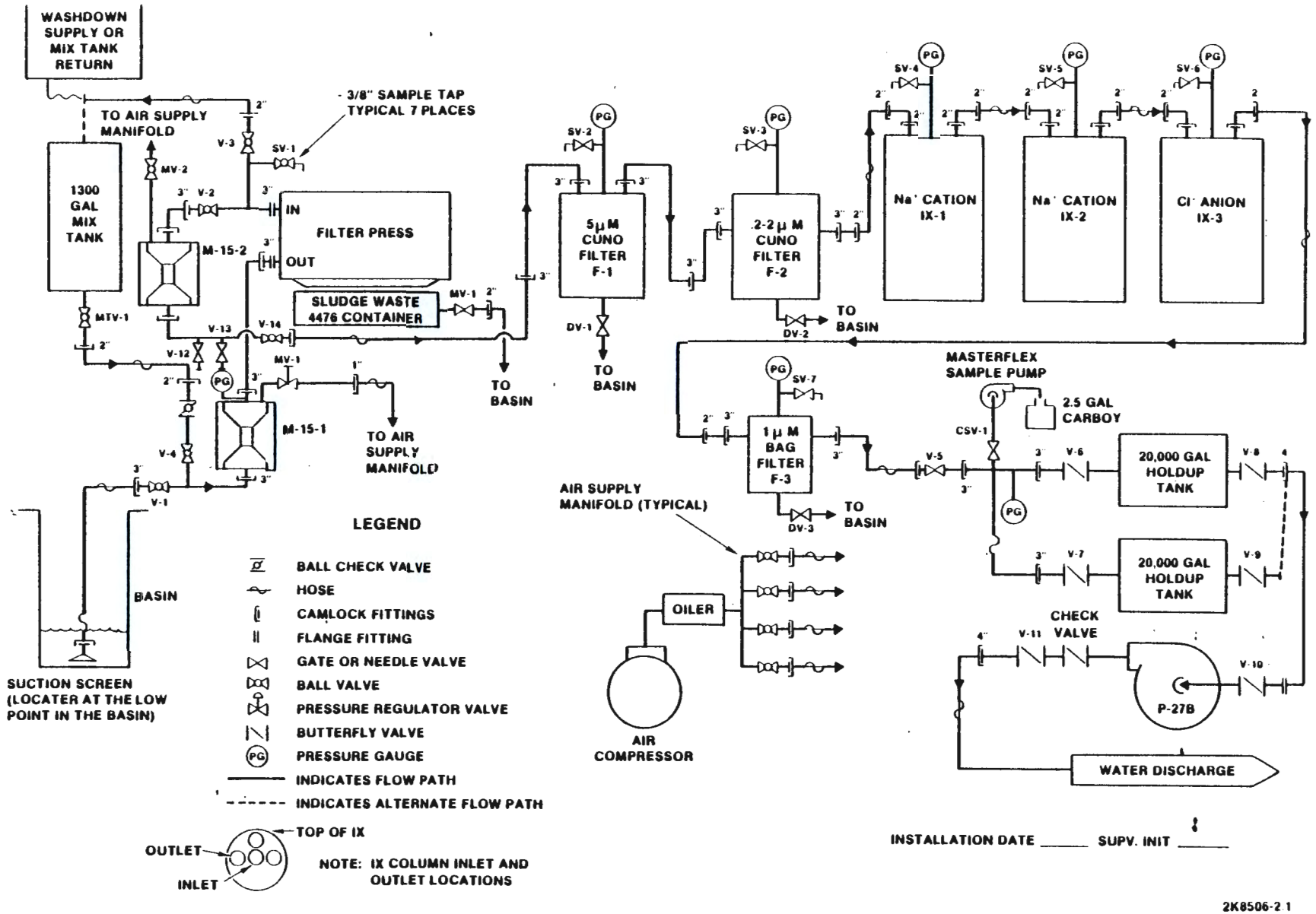

Figure 14. Water Processing System, UNC Design.

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UNI-3958

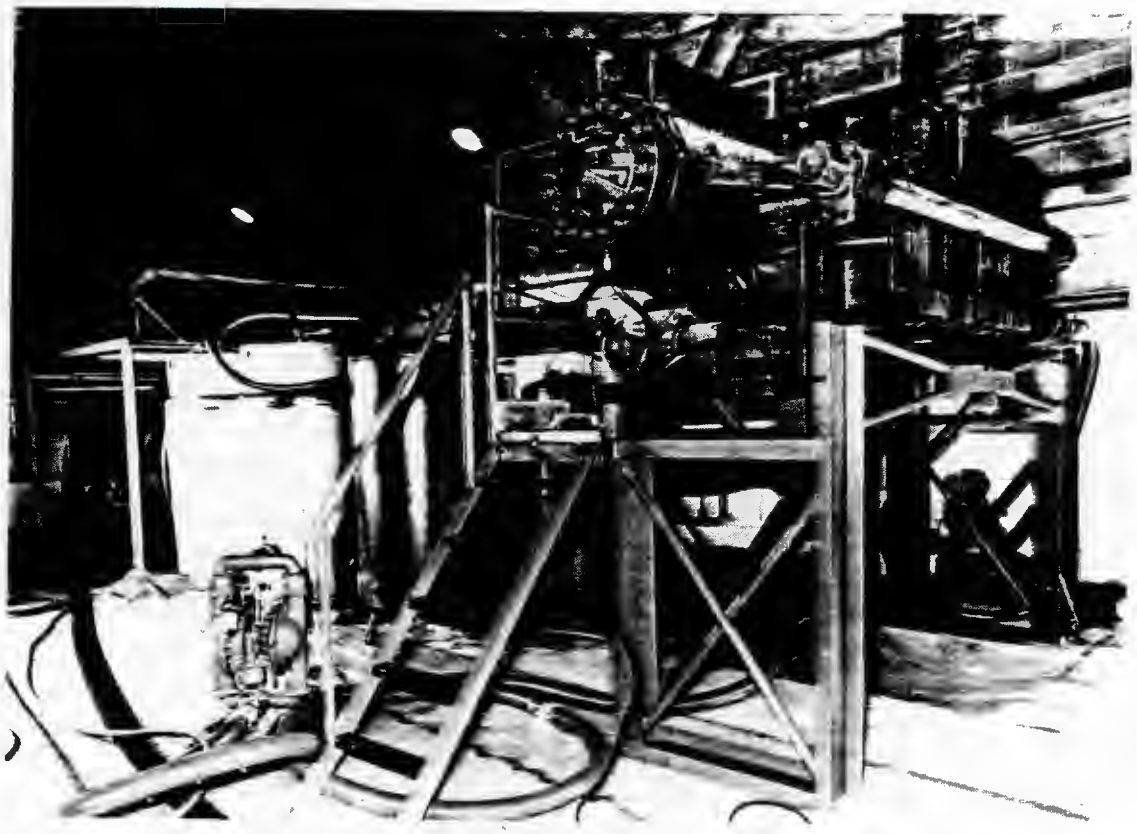

Figure 15. Pump, Filter Press, and Ion Exchange Columns at 105-B.

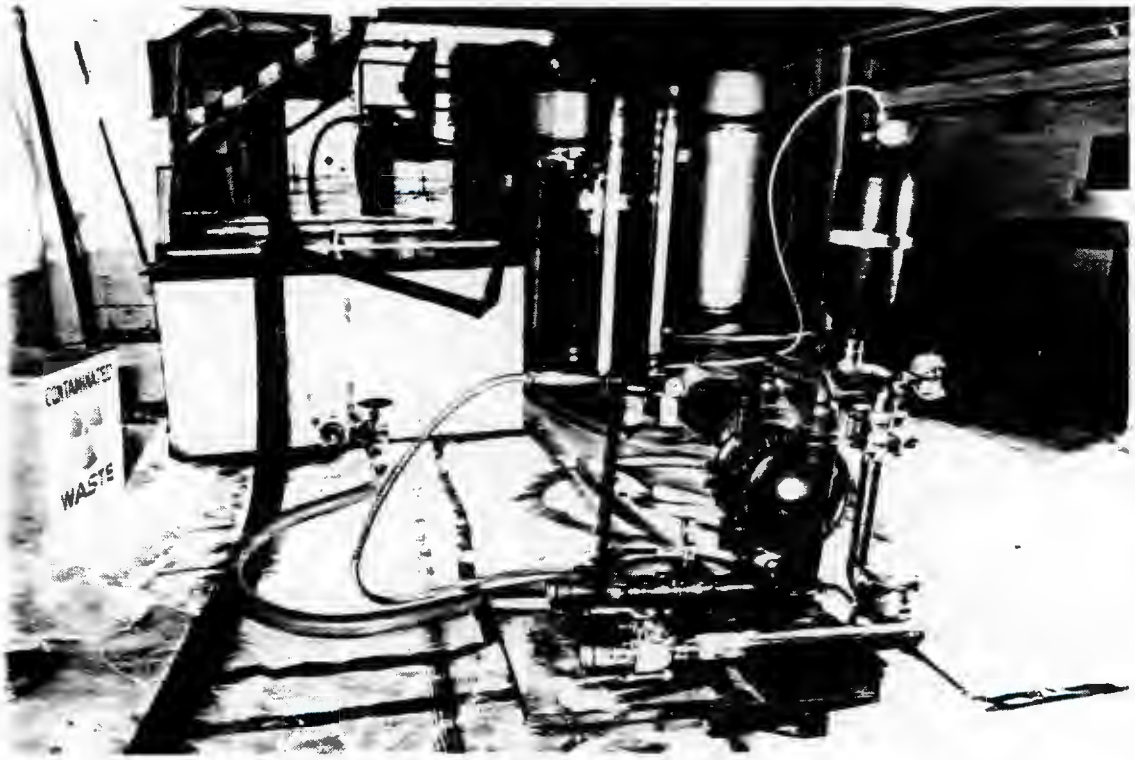

Figure 16. Mix Tank, Pump, Filters, and Ion Exchange Columns at 105-B (From Opposite Side)

A. Particulate bursts from the filter press were eliminated by recirculating the water through a 1300-gal mix tank during interruptions in system flow, which eliminated pressure and flow transients across the filter press. In addition, the filter press was precoated with diatomaceous earth and water clarity was checked prior to commencing operations.

B. Two "CUNO" filter units were placed between the filter press and ion exchange columns to protect the inlet screens from becoming plugged with particulate material. The plugged screens were replaced with clean screens to ensure good system flow rates.

C. An ion exchange column containing IRA-938 Anion Resin was included in the system to remove any colloidal material from the process water.

D. A bag filter was placed downstream of the ion exchange columns to capture possible resin fines.

E. Two 20,000-gal holdup tanks were thoroughly decontaminated prior to commencing operations. In addition, the tanks were coated with ALARA Coat to ensure that any residual contamination remained fixed.

2. Only three ion exchange columns were utilized: two 25-ft^3, sodium-form, cation exchange resin columns and one IRA-938 anion exchange resin column.

3. A new vacuum head was designed by UNC. A bronze, swimming pool-type, vacuum head was utilized. In order to maintain the sludge in suspension, several high pressure water nozzles were added to the vacuum head (Figure 17).

4. A new diaphragm pump was ordered. The 2-in. flap valve design could pump material as large as 1-3/4 in. in diameter.

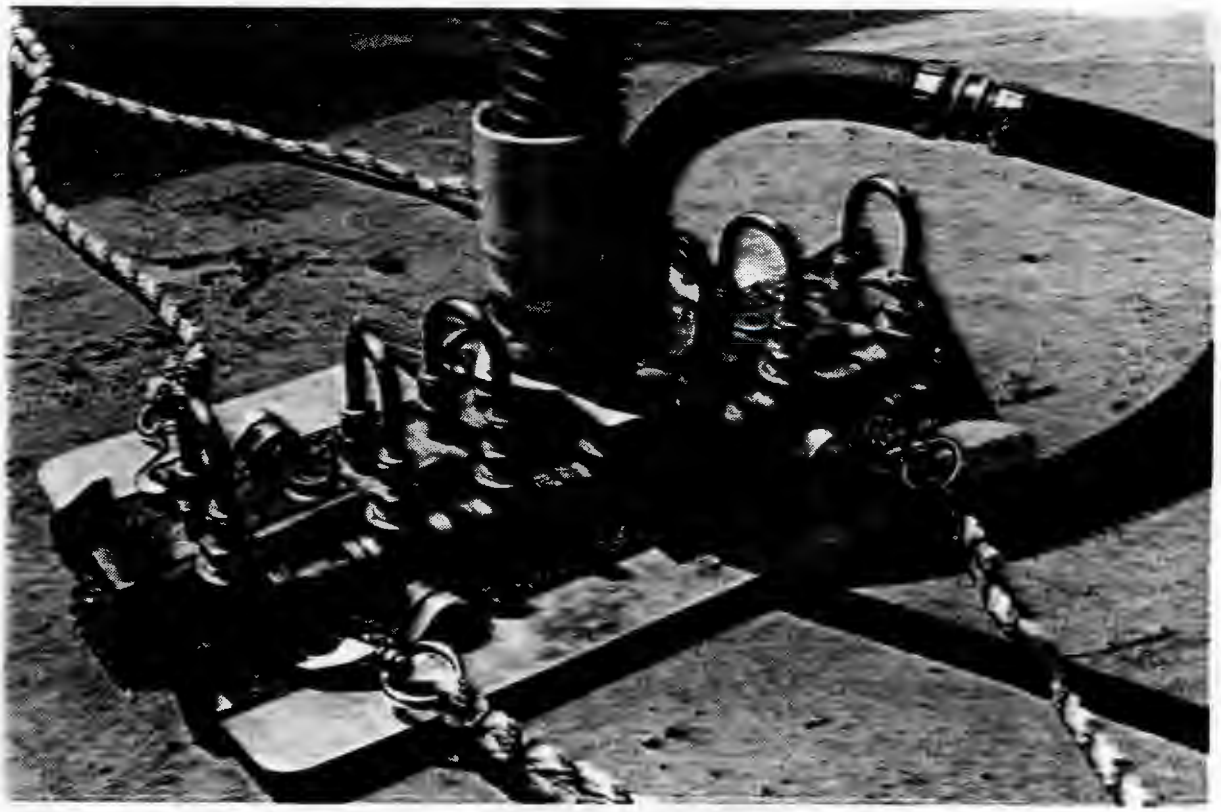

Figure 17. The Vacuum Head as Modified for Use in the Fuel Storage Basin.

After preliminary ALARA and ARCL investigations, a criticality calculation, and a heat generation evaluation, it was assumed, pending further characterization of the sediment's TRU content, that the sediment at the basins could be left in place if it was moved to the transfer pit areas. Following cleanup of the transfer pits to ensure no fuel elements remained prior to sediment storage in the transfer pits, dams were fabricated for the transfer pit areas at the basins to add depth and prevent solid items from entering the pits. Portable dams were devised to help direct the sediment to the pits and to provide sufficient settling time for the sediment. See Figure 18 for the conceptual drawing of the sediment transfer. In addition, dewatering manifolds consisting of a matrix of CUNO filters (Figure 19) were placed at the bottom of the transfer pits along with 18 in. of sand and gravel to dewater the sediment after transfer was complete.

UNC processed approximately 80,000-gal of water from C basin and discharged it to the 105-C discharge pond. All water processed was well within the release limits.

UNC moved approximately 600 ft^3 of sediment to the C basin transfer pits. Approximately 50% of the sediment was transferred utilizing the vacuum head described above. Because of the large amounts of debris (plastic sheeting, paper, clothing, etc.) present in the sediment, it was necessary to transfer the remaining material using fire hoses. It had proved too difficult to manipulate the vacuum head through the debris. The water was supplied to the fire hoses by recirculating water out of the transfer pits, through the filter press, and back to the basin. As a result, approximately 30 ft^3 of sediment were removed by the filter press and subsequently packaged for disposal as low-level waste based on sediment sample analysis. Final sediment transfer was performed manually using shovels. Screens were devised to make sure that no specks of fuel or other debris were accidentally allowed into the pits.

While fuel elements (real or suspect) were stored at the 105-C basin facility it was necessary to provide direct security measures to protect the material.

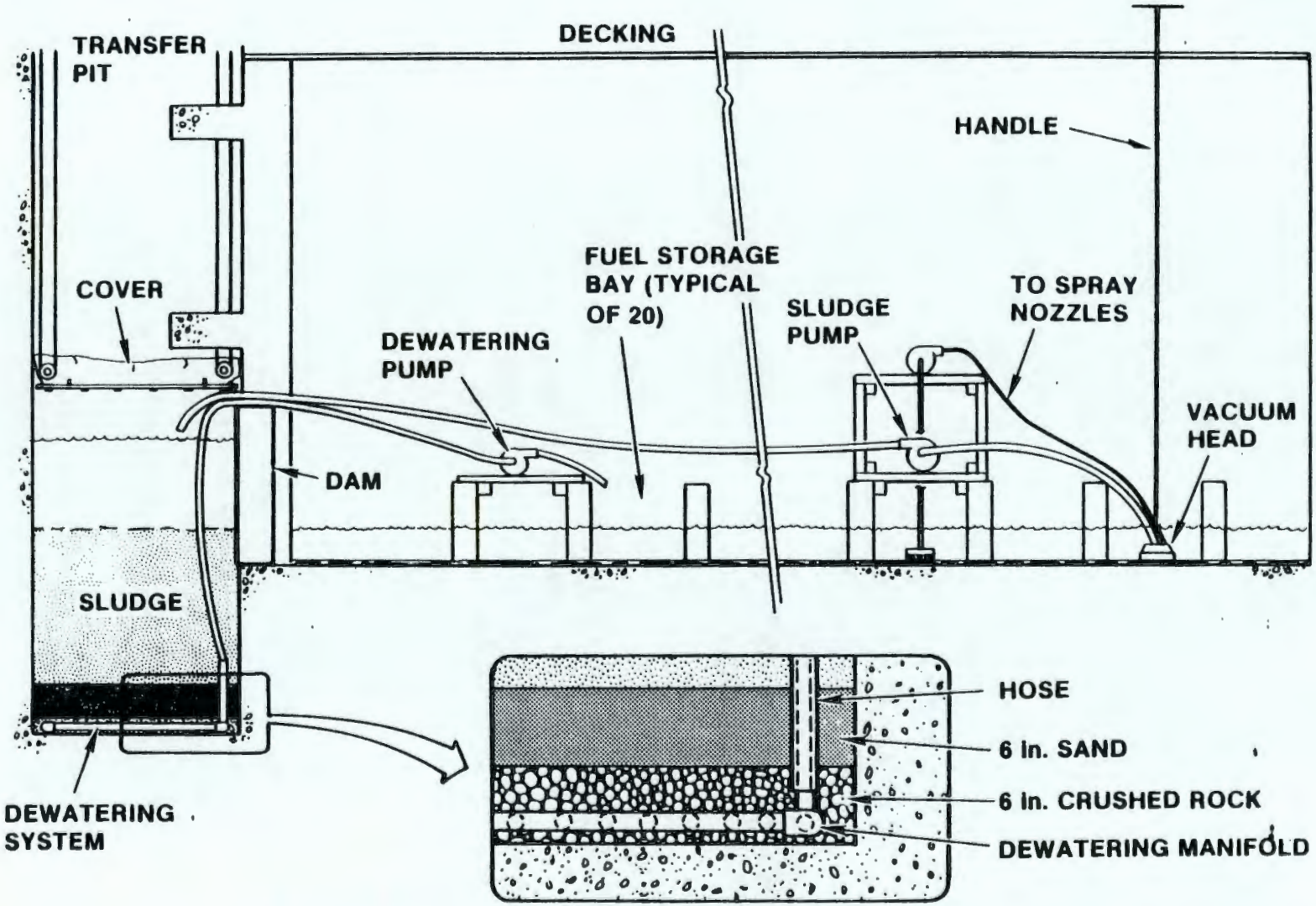

Figure 18. Transfer Pit Containment Design.

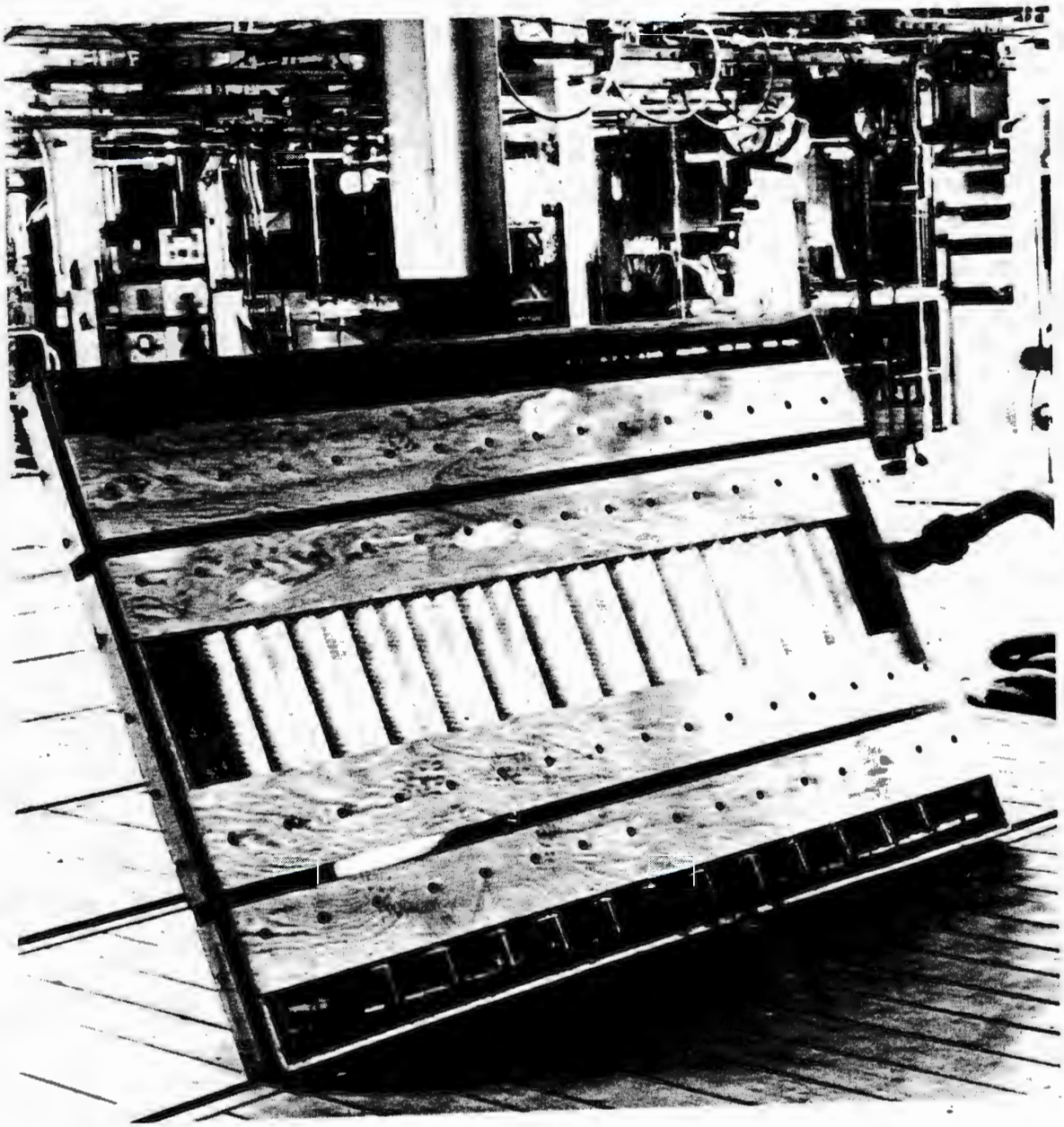

Figure 19. Dewatering Manifold.

A full-time patrolman was required until the elements could be loaded into casks and transferred to 100-N Area. As suspect fuel elements were uncovered at the 105-B basin, they were transferred to 105-C for interim storage until final shipment to 100-N. The security procedure called for a patrolman to check the building and security tags to be attached to all entrances to the storage basin area when no work was being performed.

UNC completed the sediment transfer and water removal from the 105-C basin in August 1985. Containment covers fabricated to place over the sediment in the pits were put in place August 16.

5.4.5 105-B Basin (UNC)

Water processing began at 105-B basin in September 1985 with the improved system developed at 105-C basin. Approximately 50,000 gal of water were processed to release limits and discharged to the 105-B discharge pond. UNC's experience at the 105-C basin with the equipment and the situation led to two major decisions about handling the sediment at the 105-B basin: 1) Because of personnel exposure and waste packaging requirements, a decision was made to move the sediments into the transfer pits for interim storage; 2) Because of the operational difficulties experienced with the vacuum head at the C basin, the decision was made to utilize the washdown approach for transferring the sediments into the transfer pits except for high dose-rate areas, where the vacuum system was required to reduce dose rates prior to washdown. The vacuum system removed enough sediment from the high dose-rate areas so that the use of the dams that had been built as a contingency to maintain water levels for shielding were not required.

Approximately 600 ft^3 of sediment was moved to the transfer pits. Approximately 30 ft^3 of sediment was removed from the filter press after the recirculation of washdown water from the transfer pits.

UNC completed removal of the water and transfer of the sediment in the 105-B storage basin in December 1985. Containment covers were placed over the

sediment in the pits January 20, 1986. Figure 20 shows a cover in place. Final dose rates over the sediment were 15 mR/hr at the deck level at each pit except the south pit at 105-C, where the rate was 5 mR/hr. Dose rates on contact (the cover was not shielded) were 1 R/hr at both 105-B pits and 1.5 R/hr (south pit) and 350 mR/hr (north pit) at 105-C.

A total of 14 suspect fuel elements were found during the 105-B basin cleanout. These elements were ultimately transferred to 100-N for final examination and identification.

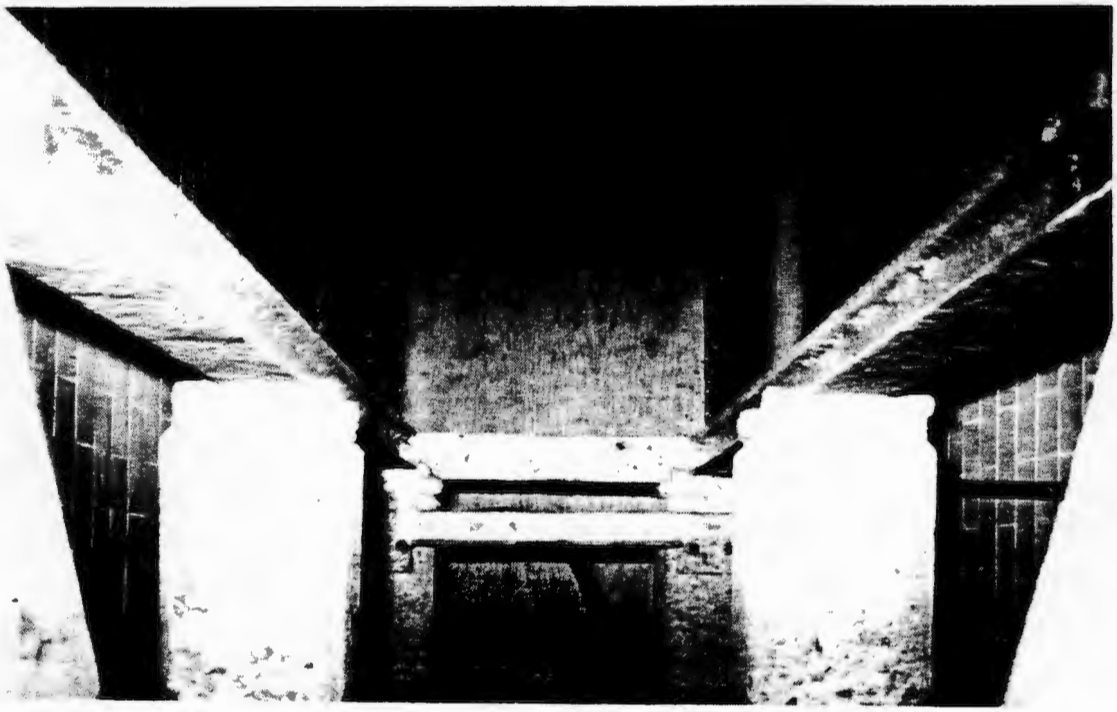

Figure 20. 105-C Transfer Pit after Installation of Cover.

The total number of fuel elements found during the 105-C basin cleanout has not been finalized. Many items were transferred to 100-N, but were not confirmed as fuel prior to transfer. A high cesium content was used to identify items as potential fuel. Since the cesium check required both personnel exposure and time, any suspect item was sent to 100-N where a more efficient detection system was available.

5.5 FINAL CONCRETE CLEANING AND SEALING

While the final cleanout of the 105-B and 105-C basins was still underway, preparation for the final fixing of contamination on the concrete walls and floors of the basins was initiated. Several sealers were tested and an asphalt emulsion (ATCO 1840) was selected for the project.

Due to the deterioration of the concrete in many areas, the walls were swept and vacuumed to remove dust and loose pieces. To control airborne contamination during this task, the basin deck was covered with plastic and two HEPA ventilation units were installed. Before the asphalt was applied, concrete samples were taken for final characterization. The average working dose rate before and after fixing the contamination was less than 5 mrem/hr.

The ATCO 1840 was rolled on and stabilization of the 105-D basin was completed on September 3, 1985. Similarly stabilization was completed at the 105-DR basin on September 23, 1985. Figure 21 shows the 105-D basin after cleanout was completed. Figure 22 shows the walls after application of ATCO 1840.

Sweeping of the 105-C basin was completed on October 17, 1985. A new Graco Bulldog airless sprayer was used to apply the ATCO 1840. The use of the sprayer reduced the time required to coat the basin from 14 days to 4 days. Similarly, sweeping and coating of the 105-B basin was completed on January 24, 1986.

5.6 PROJECT CLOSEOUT

Actual basin cleanout work was completed on January 31, 1986 with the sampling of the concrete surfaces at 105-B basin, application of the ATCO 1840, and equipment demobilization. Project closeout (except for 105-B and 105-C transfer pit sediment characterization and discharge pond release) will be completed with the publication of this report.

Figure 21. 105-D Basin Aisles and Support Columns after Cleanup.

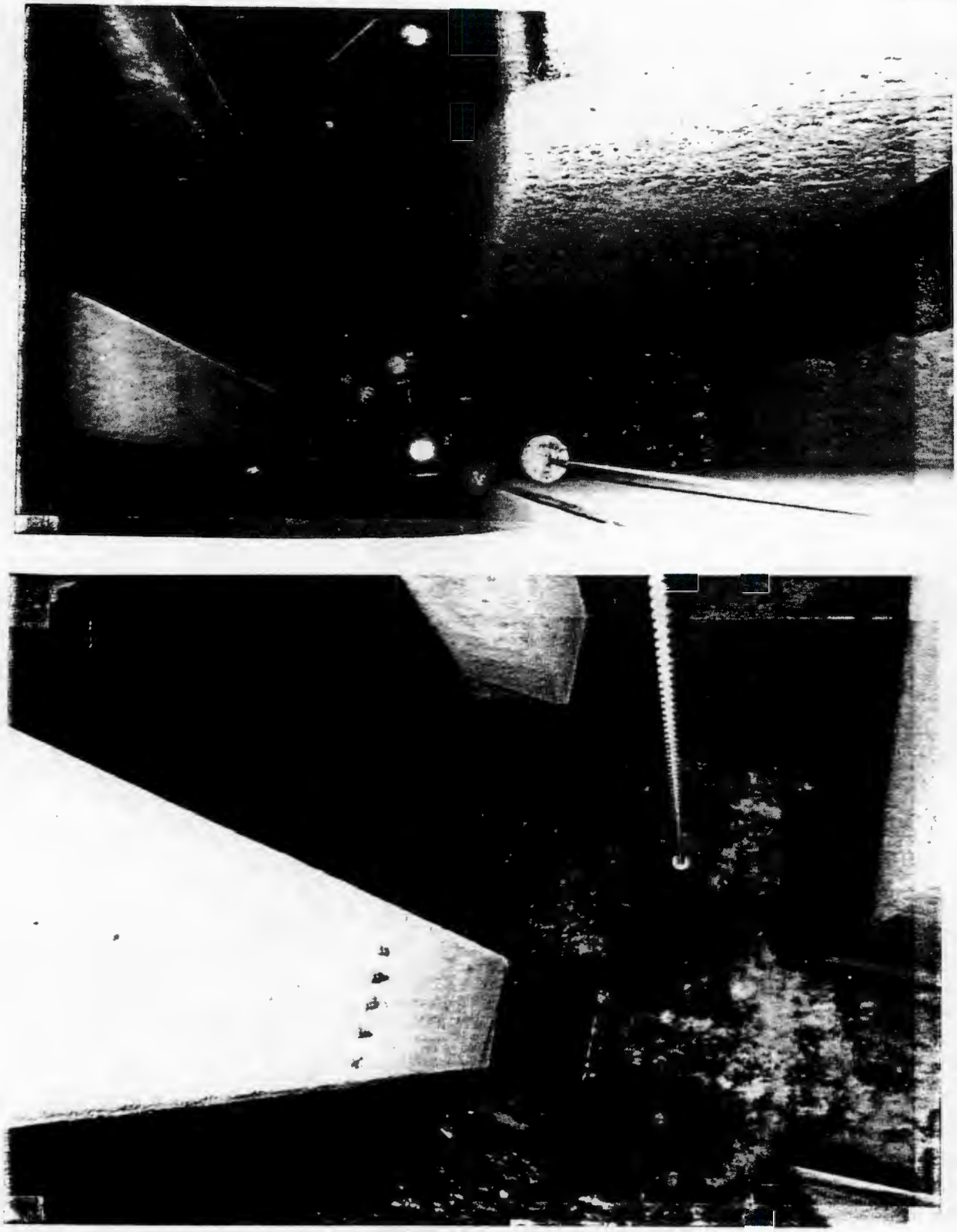

Figure 22. 105-D Basin Comparison of Before Cleanup and After Stabilization.

The present condition of the four fuel storage basins is considered to be sufficiently stable to require minimal surveillance and maintenance until final disposition. Prior to final disposition, the sediments in the transfer pits will be characterized and the final ARCL reports for the discharge ponds will be completed. The final disposition of the basin facilities will be determined by the NEPA process currently underway for decommissioning the surplus Hanford production reactors. The radioactive inventories remaining in the 105-B and 105-C transfer pits and in the contaminated concrete surfaces are included in the document prepared for the reactor Environmental Impact Statement (EIS), Radionuclide Inventory and Source Terms for the Surplus Production Reactors at Hanford (Reference 6).

Over the course of the project, there was one lost workday accident (a Rockwell D&D worker), ten minor first aid injuries, and eleven skin contamination occurrences. Five of those individuals received skin contamination when a hose clogged, became disengaged, and sprayed the workers. They were all successfully decontaminated and no internal contamination was received by any individual. One Radiation Occurrence Investigation was held. During packaging of radioactive waste, radiation dose rates higher than those permitted by the Radiation Work Permit were exceeded. One individual received 160 mrem which could have been avoided if proper work methods had been followed. Disciplinary action was taken against a UNC Supervisor and a Rockwell manager as part of the corrective action (Ref: Radiation Occurrence Report #R048-B-84). A total of 41 man-rem of exposure was used to perform the project.

The final inventory of suspect or identified fuel elements has not been determined. However, 45 pieces were identified as fuel, 55 pieces were identified as non-fuel (spacers, test material holders), and 33 pieces required further testing. This information is taken from the memo from D. A. Tollefson to N. N. Takata dated December 20, 1985, "Retired Basin Suspect Fuel Inspection Results."

6.0 WASTE MANAGEMENT

Waste generated during the project was from three primary sources:- 1) miscellaneous hardware and debris remaining in the basins since shutdown of the facilities; 2) water with some suspended solids; and 3) sediments which covered the storage basin floors and to some extent adhered to the vertical surfaces of the facilities. In general, the materials associated with the project are not classified as hazardous chemicals, solids, or liquids, as designated in Washington Administrative Code 173-303, "Dangerous Waste Regulations," June 27, 1984.

The general approach to cleaning the basins was to first remove as much of the miscellaneous hardware as possible with the basin still partially filled with water for radiological control. Second, the water in the basin was drawn down and processed through filters and ion-exchange columns to remove the suspended solids and ions in the solution. The clean water was released to a pond constructed near each facility at radionuclide concentrations below the values listed in Table II of DOE Order 5480.1 Change 2. Finally, the sediments and remaining hardware and debris were removed. Concurrently with the final step, the remaining water was processed and released to the ponds.

6.1 DISPOSAL OF MISCELLANEOUS HARDWARE AND DEBRIS

Miscellaneous hardware and debris included a large number of fuel storage buckets, some process tubes, and numerous spacers, expendables, and perfs. Other materials included thermocouple wires and trash (plastic gloves, tools, paper, etc.) that had accumulated over the years.

The fuel storage buckets were lifted from the basins, washed with water and placed into plastic bags. The plastic bags with the buckets were placed into large (DOT Spec 7A) fiberboard boxes. The void spaces in the boxes were filled with Vermiculite and the boxes sealed with tape. A total of 460 fuel storage buckets were removed from the basins. The fuel storage buckets

contributed 4100 ft^3 of the total solid waste volume from the basin cleanup project.

The largest volume of the contaminated solid waste was designated "miscellaneous waste mixture." This mixture contained a total volume of 16,775 ft^3 and was primarily metallic items, trash, and expendable items used as part of the project. Packaging for this material included 55-gallon drums, 12B65 fiberboard boxes, plywood boxes (4x4x8 ft), and steel bins (4400 and 4476).

Several items recovered from the basins during the general cleanout of hardware and debris required special handling due to the high dose rate (greater than 5 R/hr). These items were identified as thermocouple wire, perfs, and spacers. Packaging for these "hot" items was accomplished with "Single Pass Fuel Shipping Casks." The casks were previously used during single pass reactor operation but are not suitable for N Reactor use. Since the casks were considered excess, they provided a convenient means to save cost for packaging the "hot" items and for use as burial containers.

The zirconium process tubes in the 105-C basin were segmented and placed into specially shielded steel bins (4476). Figures 23 and 24 show the concrete shielding inside the bin and the fabicated cover for the bin.

Solids that accumulated on the filters and in the filter press of the water processing system were placed into steel bins and 55-gallon drums for disposal.

Several additional packages of miscellaneous materials were removed from the basin floors during sediment removal. This material is discussed in Section 6.3.

Suspect fuel pieces were collected at 105-C prior to shipment by railroad car to 100-N for positive identification. They are not considered to be waste materials.

Figure 23. Concrete Was Added to 4476 Steel Bins for Additional Shielding.

Figure 24. Concrete Lid for 4476 Steel Bins.

6.2 DISPOSAL OF WATER

At the beginning of the project, each basin was partially filled with water to varying depths. The 105-B basin had water to a depth of 5 feet (250,000 gallons). 105-C basin had a depth of about 10 feet (570,000 gallons). 105-D basin had a water depth of about 5 feet or 250,000 gallons. The 105-DR basin had a water depth of about 4 feet or 140,000 gallons. Water clarity at all four basins was fair to good prior to initiation of the work.

The water was sampled at each reactor basin as part of the characterization of the 100 Areas (UNI-946). Decay correcting the previous sample analyses to March 1984 results in the values shown in Table 3.

TABLE 3

105 BASINS PRE-PROCESSING WATER SAMPLE ANALYSIS

(pCi/Liter)

Area	Pu-238	Pu-239	Sr-90	H-3	Eu-165	Cs-137	Co-60	U-238
105-B	9.2×10^{0}	8.6×10^{1}	1.2×10^{5}	4.5×10^{3}	1.8×10^{2}	4.7×10^{5}	2.5×10^{3}	6.4×10^{1}
105-C	9.4×10^{-1}	1.5×10^{1}	2.5×10^{4}	4.6×10^{2}	2.8×10^{2}	1.0×10^{4}	2.1×10^{2}	4.4×10^{1}
105-D	*	1.8×10^{1}	3.1×10^{3}	2.7×10^{4}	3.3×10^{2}	1.1×10^{4}	1.9×10^{2}	7.0×10^{0}
105-DR	5.0×10^{0}	2.7×10^{1}	7.4×10^{3}	2.8×10^{4}	1.5×10^{2}	6.8×10^{3}	1.1×10^{2}	6.3×10^{0}

*Not recorded

Water samples were taken of the basin water just prior to processing to verify the concentration listed in Table 3.

All water removed from the basins was processed through the water processing system described in Section 5. Before discharging the water to the ponds, composite samples were taken from the holdup tanks to assure that the radionuclide concentrations were below the concentrations listed in Table II of DOE Order 5480.1 Change 2.

6.3 DISPOSAL OF SEDIMENTS

As mentioned in Section 5.0, attempts to vacuum the sediments from the 105-D and 105-DR basins were only partially successful. The sediments were washed into the fuel transfer pits by personnel on the basin floor using fire hoses. The sediments were then manually shoveled from the transfer pits into 55-gallon drums for disposal. The 55-gallon drums contained 4-mil thick plastic bag liners which were secured (horse-tailed) prior to placing the lids on the drums. The filled drums were stored on the transfer pad at 105-D in preparation for shipment to the 200 Area for burial.

During the washing of the sediments to the transfer pits, additional hardware and debris were uncovered in the sediment layer. Some of the items uncovered were highly radioactive relative to the items previously encountered. These high dose rate items ranged from "specks," which are postulated to be pieces of irradiated thermocouples, to larger items which were later found to be fuel elements. The fuel elements (two at 105-D and three at 105-DR) were put in shielded casks and transferred to 105-C for examination and later transferred to 105-N for storage. The high dose rate "specks" along with several high dose rate perfs and spacers were packaged in casks for shipment to the 200 Area for disposal.

Final cleanout of the 105-D and 105-DR basin sediments resulted in 84 55-gallon drums of material. Several of the drums had surface dose rates in excess of 500 mR/hr. Prior to shipment for burial, these high dose rate drums required external shielding to bring the external contact dose rate below 500 mrem/hr.

At 105-B and 105-C basins the sediment material had higher dose rates than experienced at either 105-D or 105-DR. Based on ALARA and the sediment handling experiences at 105-D and 105-DR, the decision was made to directly move the material to the transfer pits with final disposal to be addressed in the EIS for the reactor decommissioning if characterization showed it to be

low level waste. Characterization as TRU would require its removal prior to decommissioning the reactors.

A modified vacuum head was developed to keep the material in suspension so an efficient transfer to the pits could be made. A dewatering system was placed in the pits prior to sediment transfer with the water being returned to the basins.

The sediment resulting from the recirculation of washdown water from the transfer pits to fire hoses was collected from the filter press. This added 60 ft^3 of sediment, which was packaged and disposed of in the 200 Area burial grounds.

The sediments at 105-B and 105-C were left in the fuel transfer pits. A containment lid was fabricated to cover the material in the pits to preclude inadvertent personnel exposure prior to final disposition addressed in the NEPA process for the reactor facilities.

6.4 SUMMARY OF WASTE REMOVAL

Table 4 provides a summary of the material and packaging used for the cleanout of the 105 Basins.

TABLE 4

WASTE MANAGEMENT SUMMARY

FOR THE FUEL STORAGE BASIN PROJECT

Basin	Material	Container	Number of Containers	Volume Ft^3
105-B	Fuel buckets	Large fiberboard box	19	144
	Misc. waste mixture	12B65 fiberboard box	557	2764
	Misc. waste mixture	4x4x8 ft plywood box	2	256
	Storage basin dams	1x4x18 ft plywood box	1	80
	Resin tank	Tank	1	202
	Misc. waste mixture*	4400 steel bin	1	59
	Misc. waste mixture*	4476 steel bin	4	460
	Sediment	4476 steel bin	2	230
	Thermocouple wire	"J" cask	4	296
	Cuno filters	55-gallon drum	6	45
	Misc. waste	Plastic wrap	--	256
		TOTAL	597	4792
105-C	Fuel buckets	Large fiberboard boxes	224	1850
	Misc. waste mixture	12B65 fiberboard boxes	447	2066
	Misc. waste mixture	4x4x8 ft plywood boxes	23	2944
	Storage basin dams	1x4x18 ft plywood box	1	80
	Resin tank	Tank	1	202
	Misc. waste mixture	4400 steel bins	7	413
	Misc. waste mixture*	4476 steel bins	9	1035
	Hot parts, thermo-couple, etc.	Single pass fuel cask	2	270
	Desicant	55-gallon drums	3	22
	Resins	55-gallon drums	16	192
	Misc. materials	Plastic wrap	--	654
	Zirconium tubing	4476 steel bins	6	690
		TOTAL	739	10418

*Miscellaneous waste mixture consists of discarded reactor hardware, paper, plastics and sediment from the filter press.

Basin	Material	Container	Number of Containers	Volume Ft^3
105-D	Fuel buckets	Large fiberboard box	63	504
	Misc. waste mixture	12B65 fiberboard box	162	734
	Misc. waste mixture	4x4x8 ft plywood box	20	2560
	Resin tank	Tank	1	202
	Misc. waste mixture	4400 steel bins	7	413
	Misc. waste mixture	4476 steel bins	8	920
	Sediments	4476 steel bins	2	230
	Misc. waste mixture	55-gallon drum	27	202
	Sediment	55-gallon drum	53	398
		TOTAL	321	5997
105-DR	Sediments	4476 steel bins	2	230
	Sediments	55-gallon drum	31	233
	Fuel buckets	Large fiberboard boxes	154	1600
	Misc. waste mixture	12B65 fiberboard boxes	231	1034
		TOTAL	418	3097

7.0 LESSONS LEARNED

The complexity and duration of the basin cleanout project provided several areas where the original approach to the task did not provide the most efficient or cost-effective solution. As the project progressed, there were a number of design and operational changes that were made to the equipment systems and a number of evaluations and decisions made that can benefit future decommissioning projects.

Four major "lessons learned" areas have been identified from the experience gained on this project. These areas are: 1) design of the water processing system, 2) the sediment removal system, 3) selection of the fixative for the basin surfaces, and 4) project management and control. These four areas are discussed below.

7.1 WATER PROCESSING EQUIPMENT

As noted earlier in Section 5, the majority of Pacific Nuclear's processing problems were associated with particulate material causing low flow rates and system plugging. The modifications to the Pacific Nuclear system by UNC to provide an adequate operating system are described in Section 5. The main design features of the modified (UNC) system were:

- Both CUNO filters were placed upstream of the ion exchange (IX) columns to protect against plugging of the inlet headers.

- The modified system utilized only one train of IX columns rather than the two-train system of the original design.

- An anion resin (IRA-938) column was placed in the system to act as the final filter for any colloidal material that may have passed through the other filters.

- "ZETA Plus" CUNO filters were used for added protection against colloidal material.

- UNC's design recognized the need to pre-coat the filter press and to maintain flow and pressure on the filter press at all times. The flow and pressure were maintained by including a 1300-gallon mix tank in the design for recirculation of the water. In addition, the mix tank provided a convenient means of adding the pre-coat material (diatomaceous earth) to the system.

In addition to the above items, during the installation of the UNC system, particular attention was given to the rubber hoses and fittings used to interconnect the various components. Earlier delays of operation with the Pacific Nuclear system due to hose failure and leakage at fittings were a significant problem.

In summary, the following items were noted in the Pacific Nuclear system and thus were modified (or eliminated) in the UNC system:

- Insufficient attention was given to the interconnection of process equipment resulting in delays due to hose failures, leakage, etc.

- Due to plugged IX column inlet headers and high filter press DP's, delays were incurred due to pump "freezing", poor flow rates, CUNO filter changeout, and IX column backwashing which results in poor IX performance.

- Operational errors such as dislodged CUNO filters resulted in holdup tank contamination which caused delays when holdup tank cleaning became a necessity.

- Failure to adequately protect the IX columns from particulates by not placing CUNO filters upstream of the IX columns caused delays due to plugged flow headers, the need to backwash IX columns due to high IX column DP and poor resin performance.

- Backwashing of IX columns resulting in disturbance of the "radiation band" eliminated the possibility of predicting resin depletion. This resulted in delays due to time spent operating with depleted resin beds.

- Failure to precoat and maintain filter press flow and pressure resulted in poor filter efficiency and loss of filter cake to the rest of the process system. This resulted in delays due to the need for CUNO filter changeout, high IX column and CUNO filter DP's (poor flow rates), pump failures due to "freezing", poor process performance.

7.2 SEDIMENT REMOVAL SYSTEM

Pacific Nuclear experienced difficulties with removing sediments from the basin floors. In fact, most of the sediment material removed by Pacific Nuclear's vacuum system consisted of the sediments that were easily disturbed and were suspended in the water. All other sediment removal by Pacific Nuclear was accomplished by washing the material to the transfer pits with fire hoses and then manually shoveling the material into plastic-lined 55-gallon drums.

Investigation of the vacuum head design indicated that Pacific Nuclear assumed that if the water velocity in the suction piping exceeded the terminal settling velocity of the particles to be removed, then the system would pick up the particles. This assumption was correct only if the particles to be removed by the vacuum were in suspension. However, the water velocity required to break up the packed sediment layer and to pick up a particle from the floor and put it into suspension greatly exceeded the velocity necessary to transport the particles once they were in suspension. Since there were so many parameters involved in designing a system to pick the particles from the floor (particle size, mass, particle interactions, and cohesiveness of the material, etc.), using only the vacuum-action velocities would have been an extremely complicated problem. UNC's approach to the design was to provide a vacuum head that could place the particles in suspension and at the same time

provide sufficient water velocity to carry the suspended particles into the suction piping. Although Pacific Nuclear eventually recognized the need to devise a means (water jets) to place the sediments in suspension, they never recognized the need to maintain adequate velocities at the point where particle suspension was obtained.

The UNC sediment removal system utilized a proven commercial swimming pool vacuum head, the "ALANTIAN" Model 5990, manufactured by Standard Bronze Company, Bayonne, N.J. Six high pressure water jets were installed into the head to place the floor sediments into suspension under the head for easy removal by the suction piping. The jets produced a high impact flat spray pattern at 100 psi and used less than 10 gpm. The spray pattern was 36° from the vertical and directed toward the centrally located inlet opening. A wire mesh screen was located over the vacuum head inlet to prevent debris such as canvas, rubber gloves, etc., from clogging the inlet. The water jets served a dual purpose. They not only placed the sediment into suspension but also forced off any debris that might blind the screen by simply raising the head off the floor. Figure 25 shows the "ALANTIAN" as purchased and as modified.

As an added improvement to prevent the spray jets from clouding the water ahead of the vacuum head, two 2-1/2-inch deflector plates were added which extended the side plates of the head. The addition of side plates forced the incoming water through a narrow opening between the side plates and the bottom into the vacuum head inlet. This restricted flow path created a high water velocity on the concrete floor up to the vacuum inlet nozzle, preventing sediment particles from escaping the head before they were taken up by the vacuum.

The UNC vacuum system gave excellent performance at flow rates of 70-100 gpm. The Pacific Nuclear proposal indicated system flow rates of 200 gpm. It appears obvious that with a properly designed vacuum head Pacific Nuclear should have experienced no difficulties in removing the sediments.

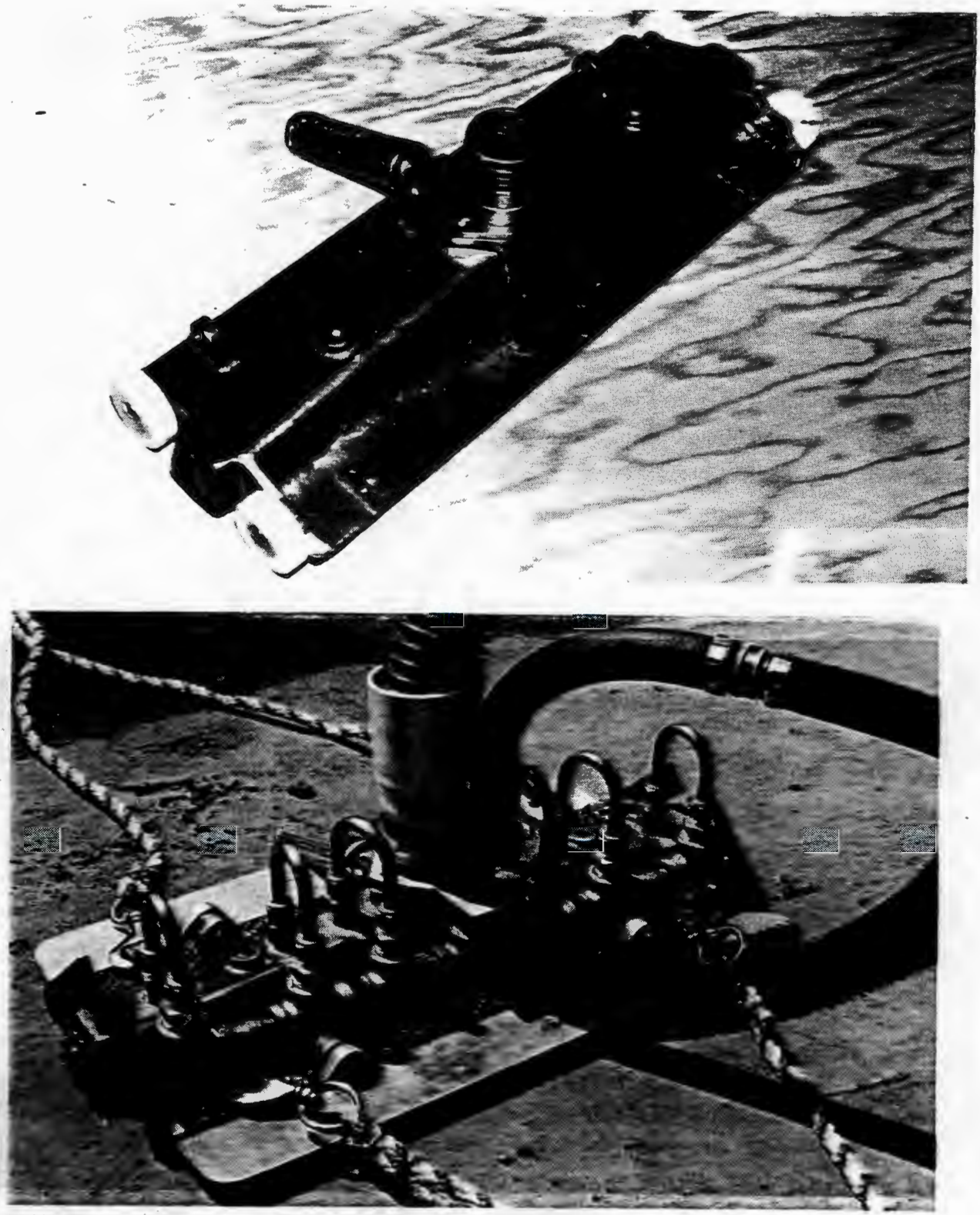

Figure 25. The Vacuum Head as Purchased and as Modified.

7.3 CONCRETE SURFACE FIXATIVE

Many materials and commercial products were reviewed for suitability as a fixative for contamination remaining on the concrete surfaces of the cleaned-out basins. Although cost was not the primary consideration, a number of products were rejected without further testing due to the high cost relative to other products. Five candidate products were selected for further evaluation and selection. The materials selected for testing were:

1. Catimic Asphalt Emulsion

   CMS type beta potential

   AKZO Chemie Co.
   8401 West 49th St.
   McCook, IL 60535
   Contact: Jack Dybilski

   OR

   Johnson Construction Co.
   N. 3003 Crestline
   Spokane, Washington
   Contact: Jack Lynch
   (509) 489-9467

2. Fibrated Asphalt Emulsion

3. Asphalt Emulsion 1840

   Both from: American Tar Co.
   Seattle, Washington
   Contact: Bill Burnside
   (206) 632-0828

4. Raycon-X

   Western Feed Supplements, Inc.
   P.O. Box 454
   Yakima, Washington 98907
   (509) 452-8211

5. Latex Wall Paint

   No specific supplier other than Rockwell Hanford stores.

Raycon-X is a pulp mill byproduct (ligninsulfonate) and was chosen for testing because of its low cost, ease of application, and availability. Raycon-X has been used by the highway department to fix volcanic ash along the shoulders of

the states' highways. It was later learned that the material is consumed by rodents and insects, hence, is not acceptable for contamination fixing.

Testing of the five products consisted of the following:

TEST 1 - Five pieces of concrete "chunks" were dried in an oven at 250°F over night, then soaked in water contaminated with cesium-137 for 96 hours. The pieces were removed and allowed to dry for 24 hours. The test pieces were then coated with the above fixative materials and allowed to cure for five days.

The test pieces were then immersed in demineralized water. After immersion for four hours, a 3-ml sample of water was evaporated onto a planchet and counted.

Sample	alpha-cpm	beta-gamma-cpm
Catimic Asphalt	0	24
Fibrated Asphalt	7	616
Asphalt 1840	0	255
Raycon-X	67	7116
Latex Paint	14	1568

TEST 2 - The second phase of the test was to apply one gallon of each type of fixative to the 105-D basin wall. The fixatives were applied using a standard paint roller on the punky unvacuumed surface.

Product	Area Covered by One Gallon (ft^2)
Catimic Asphalt	55
Fibrated Asphalt	60
Asphalt 1840	58
Raycon-X	100
Latex Paint	113

These are conservative numbers since two other small areas were also covered, the floor and a previously painted wall. There was also a small amount of material left in the cans. No attempt was made to be neat.

The painter estimated that it took about five minutes for each application. He also remarked that there were no significant differences in the application of the materials.

With no adverse effect, the asphalts can be diluted by 10% with water for ease in application and for extending the coverage.

About a week after application, the fixatives were inspected and they all appeared to be intact. Radioactive smears of the coated surfaces were all negative. There was some powder on the floor and ledges but any of the asphalts would fix this without vacuuming.

	COSTS
Catimic Asphalt	$1.00 to $2.00/gallon*
Fibrated Asphalt	$85.25/55-gallon drum
Asphalt Emulsion 1840	$85.25/55-gallon drum
Raycon-X	Less than $1.00/gallon
Latex Paint (Rockwell Stores)	$6.00/gallon

*Price range depends on west coast or east coast supplier.

A west coast supplier for Catimic could not be located easily, so the decision was made to use Asphalt Emulsion 1840 based on cost and performance as well as availability.

7.4 PROJECT MANAGEMENT AND CONTROL

A number of management lessons were learned and axioms demonstrated during the course of this project, including:

- There is a critical need for detailed up-front planning and engineering for decommissioning projects, including a thorough investigation of the operating history and a radiological and chemical characterization of the existing conditions of the facility;

- A realistic assessment of the complexity and magnitude of a project must be made before commitments to milestones, schedules, and cost are made;

- A clear understanding of environmental release criteria and the sampling protocol to assure that the criteria are met must be specified prior to beginning work.

- Adequate contingency must be included in decommissioning project cost and schedule estimates in order to account for the unexpected;

- A site project engineer must be assigned to major projects with direct responsibility for project overview and cost and schedule control; this in lieu of an engineer assigned only as a technical advisor; and

- There must be an adequate cost and schedule control system available to the project engineer to assist in the management and control of the project;

The above management lessons were learned on this project and, where appropriate, were effectively applied by UNC in successfully completing this project. All of the project work performed by UNC, following the termination of the subcontract in January 1985, was accomplished on or ahead of the schedule and under the cost estimates and budget prepared by UNC for the completion of the basin cleanup project.

8.0 PROJECT COSTS AND SCHEDULE SUMMARY

8.1 PROJECT COSTS

The original estimated cost for removal and cleanup of sediments from the 105-B, -C, -D, and -DR fuel storage basins was $1,836,000 for expenses, $400,000 for subcontractor, and $415,000 for the procurement of capital equipment used for removal of water and sediment from the basins. The estimate at completion was revised in FY 1985 to account for the additional work required to clean sediment and debris from the basin floors and replacement of the subcontractor with UNC decommissioning personnel to complete the cleanup of the 105-B and 105-C basins.

The final costs were $4,320,000 for expenses, which includes $921,000 for Decommissioning Services Program Support. Program Support includes cost/schedule control and miscellaneous service costs from other Hanford contractors, such as laundry, transportation, maintenance, photography, and graphics. A total of $460,000 was paid to the subcontractor, which included $150,000 for settlement of claims and $340,000 for capital equipment. See Table 5 for a complete summary of costs.

8.2 SCHEDULE SUMMARY

As originally planned, the nine phases of the basin cleanup project would have been finished by April 1985, after work was started in January of 1984. Work was planned to proceed simultaneously in the four basins and sequentially through the nine phases.

The actual flow of work differed because the subcontractor chose to work on one basin at a time. Each basin was to have taken about a month to clean. The schedule began to slip with the unexpected materials in the basins and the difficulty the subcontractor encountered with the colloidal solids in the sediments. Tables 6, 7, and 8 show the original and actual schedule dates. Project work was finished at 105-B in January 1986.

TABLE 5

FUEL STORAGE BASIN CLEANUP

PROJECT COSTS
($000)

	105-D	105-DR	105-C	105-B	Capital Equip.	Total
Project Management	13	24	48	39		124
Engineering	73	39	56	63		231
Characterization	31	23	78	86		218
Decontamination	228	227	690	553		1698
Demolition	0	0	0	0		0
Direct Material	1	15	33	20		69
Waste Disposal	4	40	19	23		86
Program Support	153	299	200	269		921
General & Administrative Department Overhead	175	183	319	296		973
Subcontractor	208	106	81	65		460*
Subtotal Expense	886	956	1524	1414		4780
Capital Equipment					340	340
Total Project Costs	886	956	1524	1414	340	5120

*Includes $150K claims paid to subcontractor.

TABLE 6

BASIN CLEANING PROJECT SCHEDULE

(EXCLUDING SEALING)

Basin	Contractor	Start		Complete		Total Days Duration
		Original	Actual	Original	Actual	
105-D	PNSSI*	6/27/84	6/29/84	7/18/84	9/29/84	90
105-DR	PNSSI	7/18/84	9/28/84	8/2/84	10/30/84	30
105-B	PNSSI	8/2/84	11/1/84	8/17/84	12/3/84**	30
105-C	PNSSI	8/17/84	12/3/84	9/19/84	1/23/85**	60

*Pacific Nuclear Systems and Services, Inc.
**Contractor left work site. UNC re-negotiated contract to termination and completed work with revised schedule using UNC and Rockwell D&D workers.

Once UNC took over, the project was rescheduled. The milestones were met, and in some cases, work was completed ahead of schedule. The final work was completed January 24, 1986 with the sampling and fixing of concrete surfaces at 105-B basin and demobilization of equipment. The projected completion date for the work was February 14, 1986. The publication of this report completes the final milestone for the project.

TABLE 7

BASIN CLEANING PROJECT REVISED SCHEDULE

(EXCLUDING SEALING)

Basin	Contractor	Start		Complete		Total Days Duration
		Original	Actual	Original	Actual	
105-C	UNC	4/1/85	3/1/85	8/16/85	8/16/85	105
105-B	UNC	8/16/85	8/23/85	1/3/86	12/20/85	120

TABLE 8

BASIN SEALING SCHEDULE

Basin	Contractor	Start	Finish
105-D	UNC	7/25/85	9/3/85
105-DR	UNC	9/11/85	9/23/85
105-C	UNC	10/4/85	10/29/85
105-B	UNC	1/2/86	1/24/86

9.0 CONCLUSIONS

The fuel storage basin cleanup and stabilization included the removal and disposal of material, equipment, debris, sediment, and contaminated water from each basin. The work included limited decontamination of basin floors, walls, and concrete support columns after the water had been drained and the solid materials removed. The remaining contamination was fixed in place in a manner that puts the basins in a radiologically stable condition.

These actions safely disposed of radioactive material, which then reduced the maintenance expenses and removed a potential source for release of radioactive materials to the environment.

The work in no way influenced the NEPA process underway to determine the most suitable alternative mode for decommissioning the reactor buildings. Rather, it reduced the work necessary to maintain the fuel storage portion of the reactor buildings until the decommissioning begins.

The planning and preliminary engineering work began in 1983. The project plan was issued in January 1984, and the project was completed in January 1986, after changes were made in the project scope and schedule to accommodate the termination of the subcontractor and the completion of the project using UNC forces. The duration and complexity of the project and the problems that were overcome provided UNC with valuable technical and management lessons that will benefit future decommissioning projects.

10.0 REFERENCES

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4. Tyler, D. K., Decommissioning Project Readiness Review Manual, UNI-M-176, UNC Nuclear Industries, Richland, WA, November 1984.

5. Letter, R. F. Potter to C. E. Miller, Jr., dated August 26, 1985, "Decommissioning - Cost/Schedule Control System (D-C/SCS) Implementation for FY 1986."

6. Miller, R. L. and Steffes, J. M., Radionuclide Inventory and Source Terms for the Surplus Production Reactors at Hanford, UNI-3714, UNC Nuclear Industries, Richland, WA, June 6, 1986.

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