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Sta. #19

48 ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 601392

2. To: (Receiving Organization) K Basins	3. From: (Originating Organization) Safety Technical Support	4. Related EDT No.: NA
5. Proj./Prog./Dept./Div.: Fuel Storage Basins	6. Cog. Engr.: R. H. Meichle	7. Purchase Order No.: NA
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		10. System/Bldg./Facility: NA
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		13. Permit/Permit Application No.: NA
		14. Required Response Date: NA

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1	WHC-SD-WM-SAR-062	NA	0	SAFETY ANALYSIS IRRADIATED N REACTOR FUEL	1ESQ	2		

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
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2		Cog. Mgr. C. L. Bennett	C L Bennett	10/12/93	X0-44						
2	1	QA G. M. Davis	G M Davis	10/19/93	X1-80						
2	1	Safety R. V. Skinner	R V Skinner	10/19/93	S6-21						
2	1	Env. K. A. Gano	K A Gano	10/19/93	X0-21						
2	1	Operations Assurance	J. P. Schmidt		X0-41						
2	1	Fuel Storage Basins	J. E. [illegible]	11/24/93	X0-43						

18.	19.	20.	21. DOE APPROVAL (if required)
R H Meichle 10/12/93 Signature of EDT Originator Date	[illegible] 11/24/93 Authorized Representative for Receiving Organization Date	C L Bennett 11/24/93 Cognizant/Project Engineer's Manager Date	Ltr. No. 93-FTB-014 [X] Approved [ ] Approved w/comments [ ] Disapproved w/comments

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Part 1

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K Basins, fuel storage basins, N fuel storage, KE and KW fuel storage basins, irradiated fuel, fuel storage canisters, encapsulated fuel, safety analysis.

KMB 12/9/93 APPROVED FOR PUBLIC RELEASE

6. Author

Name: R. H. Meichle

Signature R H Meichle

Organization/Charge Code 11110/KK4DC

7. Abstract

This safety analysis report (SAR) covers the handling, segregation, and storage of N Reactor fuel in the modified 105-KE and 105-KW fuel storage basins to provide the basis for the conclusion that operation does not present an unacceptable risk. This document was originally issued by United Nuclear Industries as UNI-M-143. After consolidation with Westinghouse Hanford Company it was reissued as WHC-SP-0300 in July of 1988. WHC-SP-0300 was subsequently approved for public release on September 10, 1992. The content of WHC-SP-0300 is being reissued as WHC-SD-WM-SAR-062.

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9. Impact Level 1ESQ

10. RELEASE STAMP

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WP #0694U

SAFETY ANALYSIS REPORT

HANDLING AND STORAGE OF IRRADIATED N REACTOR FUEL IN 105-KE AND KW FUEL STORAGE FACILITIES

Prepared by: P A Carlson / for — 1/26/84
M. D. Zentner, Senior Engineer — Date
Safety Assessment & Analysis Section

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R L Moffitt / for — 1/26/84
R. L. Moffitt, Manager — Date
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Approved by: M A Payne — 1/26/84
M. A. Payne, Director — Date
Safety & Environmental Engineering Dept.

1.0 INTRODUCTION

This Safety Analysis Report (SAR) covers the handling, segregation, and storage of N Reactor fuel in the modified 105-KE and KW fuel storage basins. It also covers special safety modifications to railroad facilities and special operating procedures for railroad equipment adjacent to the basins. The handling and storage of irradiated Reactor fuel in 100-N Area is covered in Reference 1. Transport of the irradiated fuel between 100-N and the basins is the responsibility of another DOE contractor, Rockwell Hanford Operations.

This Safety Analysis Report was prepared in accordance with U. S. Department of Energy Order DOE 5480.1A "Environmental Protection, Safety, and Health Protection Program for DOE Operations".[2] Chapter V of DOE 5480.1A requires that a SAR be prepared for new or modified nonreactor nuclear facilities. It replaces two Safety Analysis Reports: UNI-341, "Handling and Storage of Irradiated N Reactor Fuel in 105-KE Fuel Storage Facility" and UNI-1072, "Handling and Storage of Irradiated N Reactor Fuel in 105-KW Fuel Storage Facility" and their associated addenda. It also provides information on additional modifications implemented under Project H-558, "Hangers for N Reactor Irradiated Fuel Storage, 105-KE and KW", Design Change DC-82180, "105-KE Fuel Segregation Facility", and Design Changes 82121 and 82223 which add Decapping/Recanning capability and new ion exchange modules to KW and KE respectively.

For the purpose of abbreviation, the term "KW facility", "KE facility", or just "facility" will be used throughout this document when referring to the K-Area Fuel Storage Facilities. In addition, the term "lower enriched fuel" will be used when referring to the natural uranium (0.71 w/o U-235) fuel elements, Mark IB and IVB, and the 0.95 w/o U-235 Mark IC and IV fuel elements, while the term "spike fuel" will be used when referring to the Mark IA fuel elements which have an effective enrichment of 1.25 w/o U-235.

1.1 Site History

The K Reactors are located on the right bank of the Columbia river about three miles upstream from N Reactor. The rail and highway routes between them are about 6 1/2 miles long. The geology, seismology, hydrology and meteorology for the K Reactor sites are discussed in Section 4 and are essentially the same as for N Reactor site, described in Chapter 2 of Reference 1. The K Reactors were built in the early 1950's. They were graphite moderated plutonium producing reactors using once-through cooling. Each reactor was provided with a large water system which provided the once- through coolant. The system included a pump house, filtration plant, clear well and combined outfall. Each reactor was provided with a large basin for underwater storage of irradiated fuel.

The K reactors were shut down, KW in February, 1970 and KE in February, 1971. The stored fuel, except for a few loose pieces, was shipped to the 200-E Area for processing. The storage basins were then idle but kept filled with water. The area water system was shut down, except for a small portion periodically activated to provide a reservior of water for sanitary and fire protection systems, process water for other activities, and make up water for the fuel storage basins.

1.2 Facility Description

The fuel storage basins are rectangular, reinforced concrete basins 125 ft. long, 67 ft wide, and 21 ft deep with a 16 foot water depth (Fig. 1.1). Connected to the south side of the basins and directly behind the reactor is a discharge pickup area, or pit, where fuel elements, as they were discharged from the reactor, were individually placed in baskets using manually operated, flotation-counter balanced slings. Loaded fuel baskets were moved from the pit to storage locations in the basin by a monorail hoist system. The storage basins have now been modified and reactivated to accomodate storage of N Reactor fuel. The KE facility is also provided with equipment for segregating N Reactor fuel into weapons stock, low blend stock, high blend stock, and remains stock. Both facilities have been provided with equipment for decapping, and at KE, recanning fuel storage canisters.

Projects H-501 and H-508 modified the fuel storage facilities to provide for storage and handling of the N Reactor fuel design (Mark IA, IB, IC, IV and IVB). Each modification included a recirculating system for the pool water with in-line filters, an ion exchange system, a sand filter system, heat exchangers and instrumentation to monitor radiation levels, heat generation rate and pool water level. Included with the monitoring equipment is a remote alarm system. Storage racks for the Reactor fuel canisters are installed on the floor of the cooling pool.

The 105-KW basin as modified under Project-H-508, "Supplemental N Reactor Irradiated Fuel Storage - 105-KW," was placed in service February 1981. These modifications were basically the same as those made at 105-KE under Project H-501, "Supplemental N Reactor Irradiated Fuel Storage - 105-KE," which was placed in service June 1975. The only significant differences between them as modified and used are:

- The 105-KW basin was coated with a pliable epoxy sealant,
- Only encapsulated canisters of fuel elements will be stored in 105-KW,

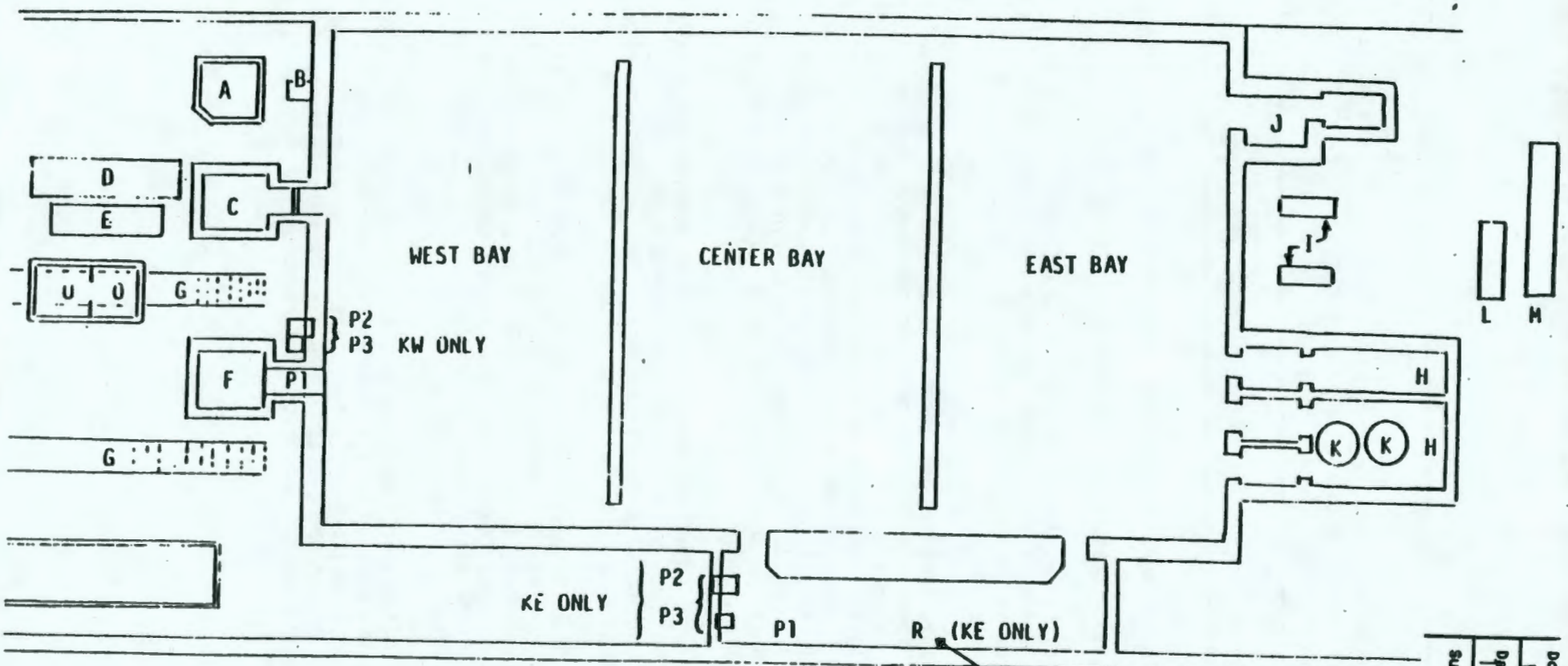
- The 105-KE basin storage racks contain open canisters of fuel elements,
- The fuel segregation activity is conducted in 105-KE,
- The decapping facilities are in different locations in each basin. In KE the decapping station is adjacent to the segregation equipment. In KW the decapping station is located in the transfer canal between the load out pit and the basin western bay.

Project H-558 was developed and implemented under a DOE-RL directive to provide additional spent fuel storage space in the K-Area basins. Fuel storage capability is potentially increased by 375 MTU (80% Mark IV and 20% Mark IA) in each basin. This is done by providing the capability of hanging fuel over the fuel already stored on the basin floor. This is done in a ratio of one hanging fuel canister over three fuel canisters on the basin floor (See Figures 1.2 and 1.3). Actual hanger storage is confined to the center and east bays of each basin and thus amounts to an additional 250 MTU storage capacity in each basin.

Design Change No. DC-82180 was initiated in 1982 to provide the capability for segregating N Reactor fuel by Pu-240 content into weapons stock, low blend stock, and high blend stock, and remains stock. This activity takes place only in the KE discharge-pickup chute area, Figure 1.1.

Design Change No. DC-82107 was initiated at KE to provide better basin water temperature control during the summer months. A water chiller was installed, replacing Heat Exchanger 1A in KE. The chiller can provide 55°F water to the basin. The resulting lower basin water temperature should decrease the dose rate to personnel in the basin area. A similar project, DC-83057, is scheduled for installation at KW in FY-84.

Design Change No's 82121 and 82223 were initiated to provide the capability to remove and replace the caps on Mark I and Mark II canisters. Mark I canisters will be decapped in KE, while Mark II canisters will be decapped in KW. Additionally, these design changes added new auxiliary ion exchange modules to assist in basin water cleanup, and to control radionuclide release to basin water during canister decapping.



N

LEGEND

A - Sand Filter
B - Sand Filter Pump
C - Backwash Pit
D - Demineralizer
E - Ion Tank Storage
F - Load out Pit
G - Railroad Track
H - Viewing Pit
I - Primary Pumps
J - Dummy Elevator Pit
K - Cartridge Filters
L - Chiller
M - Heat Exchanger
Ion Exchange Modules

Discharge Pickup Chute

P1 - Decapping Station
P2 - } Decapping Pumps
P3 - }
R - Segregation Facility

FIGURE 1.1

FIGURE 1.2
FUEL STORAGE CONFIGURATION

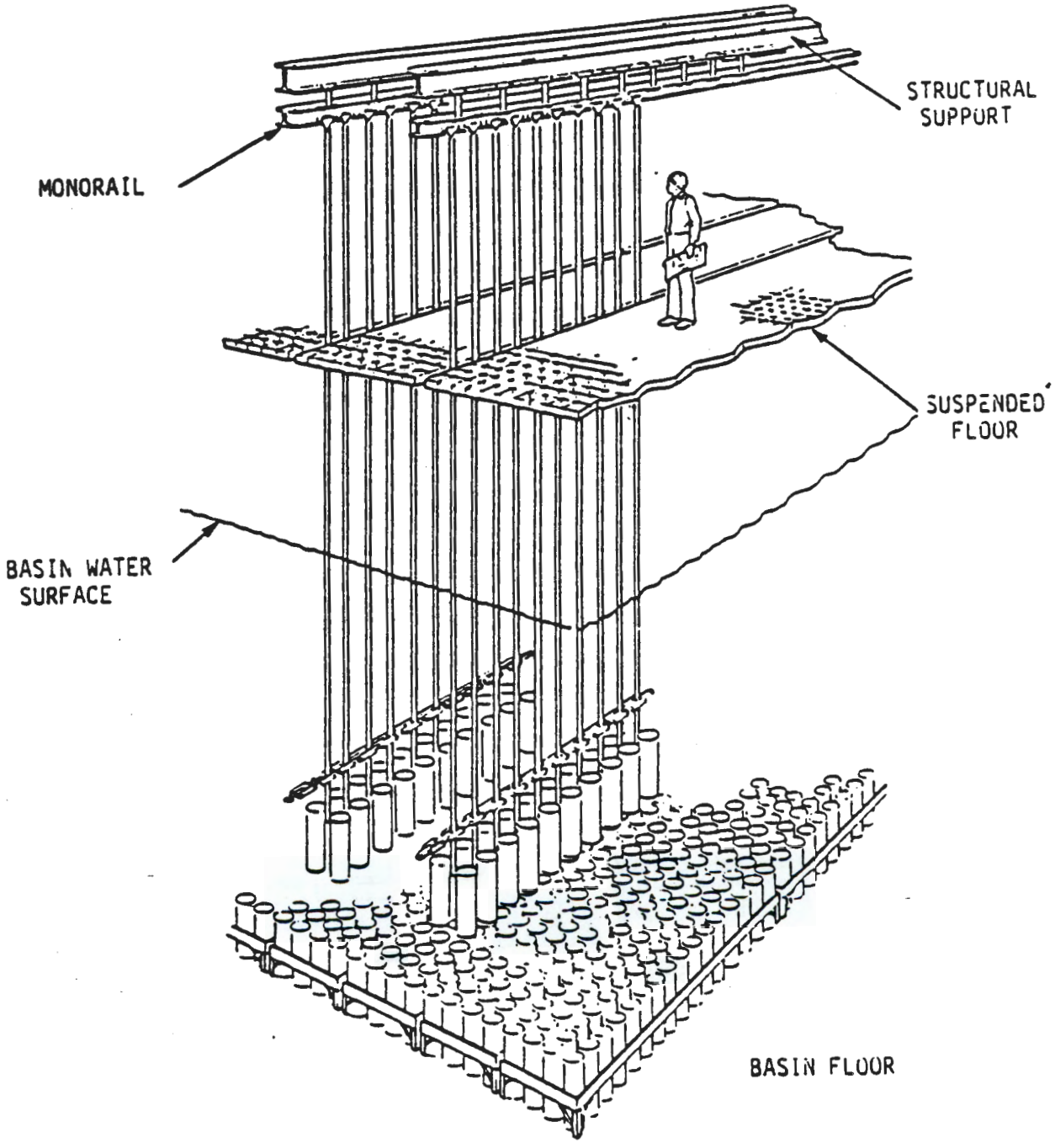
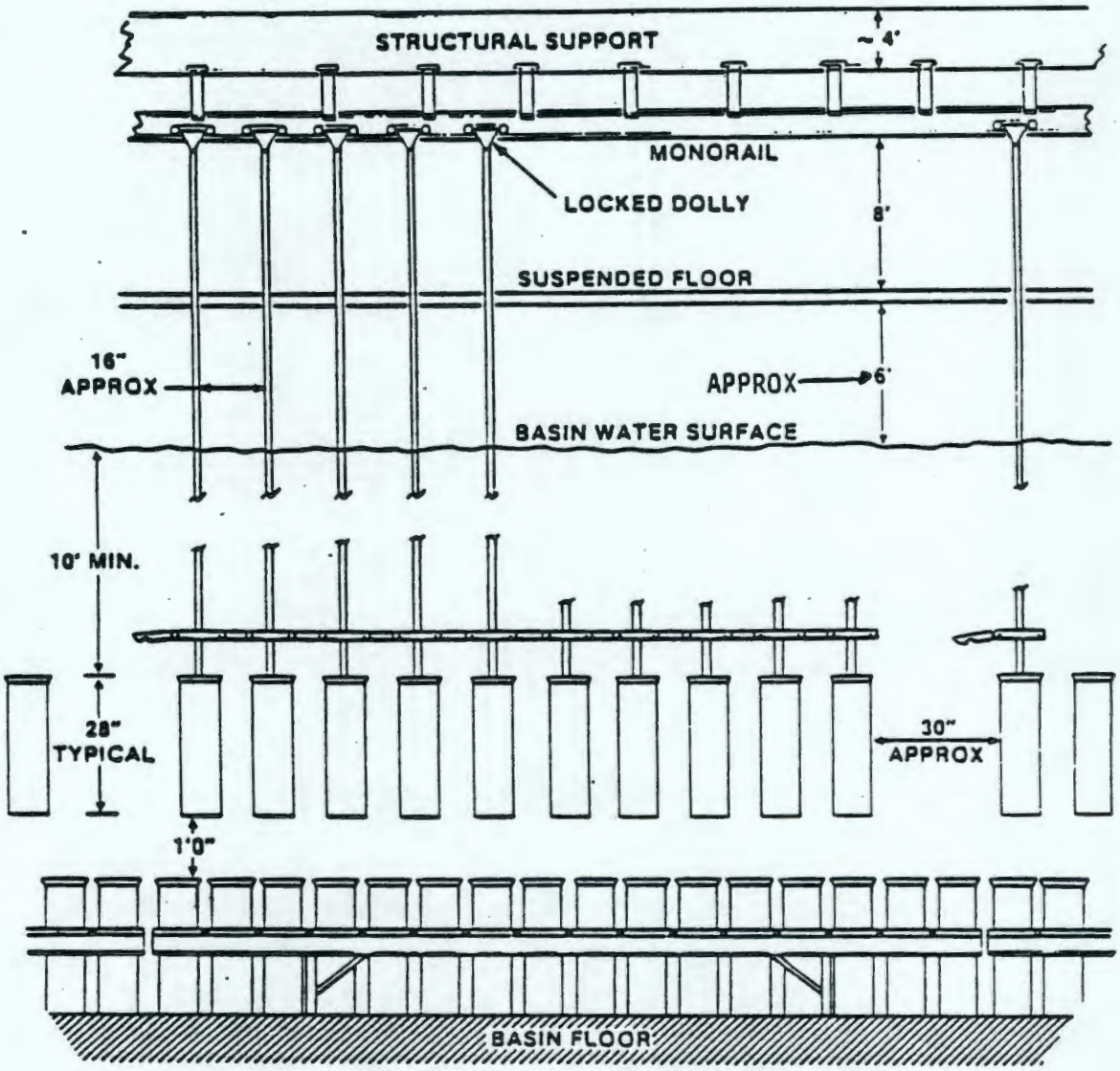


FIGURE 1.3
PROFILE OF FUEL STORAGE CONFIGURATION



2.0 SUMMARY

2.1 General

The conversion of the K fuel storage facilities to handle, store, segregate, decap and recan the N Reactor irradiated fuel elements packaged in the N Reactor canisters* required facility and equipment modifications and changes in some operating parameters. These changes and existing facilities have been studied to determine their capability to ensure nuclear and radiological safety. Results show that use of the converted facilities will not present any undue risk to the safety of plant personnel or the general public. Areas of particular significance are summarized below.

2.2 Nuclear Criticality

The storage, handling, segregating, decapping, and recanning of N Reactor fuel in the facilities have been evaluated for potential nuclear criticality accidents and found to be safe and within the nuclear criticality safety criteria and limits established for UNC Nuclear Industries fuel storage basins.[3,4,5,6,7] The buildup of fissile concentrations in sludge, ion exchange columns, and filters has been evaluated.[6,7,8] It has been found that when decapping operations are under way, precautions must be taken to ensure components remain critically safe.[7]

The prevention of accidental formation of critical masses in the facility is based primarily on confining the fuel in a critically safe geometry. Further, the control is based on the double contingency criterion which states that at least two unlikely, independent, and concurrent changes in process conditions must occur before a critical configuration is possible. No single contingency shall result in criticality. For conservatism, the safety analyses were based on unirradiated fuel critical mass parameters.

The storage configuration used in the safety analyses is shown in Figure 1.2 and 1.3. Storage racks, shown in Figures 2.2 and 2.3, were installed on the floor of the cooling pool to insure the canistered fuel remains in the proper storage station. Each canister will have a storage station that is permanently identified for the purpose of Special Nuclear Material (SNM) accountability. It is physically impossible for any one storage station to hold more than one canister due to dimensional restrictions.

*As shown in Figure 2.1, a canister is a pair of connected cylindrical containers.

In addition, hanging fuel is suspended from the monorail and clamped at designated storage locations. Restraining devices will prevent the canisters from hitting each other should a seismic event occur. The hanging fuel configuration is shown on Figures 1.2 and 1.3. No hanging fuel canister storage of 1.25wt % scrap filled canisters* is allowed. Hanging canisters of any kind over canisters containing 1.25 t % scrap is not allowed.[7]

The fuel segregation equipment shown in Figure 2.4 is located in the KE discharge-pickup chute area. It is divided into five separate positions. The first is the presort area. The second contains the canister dumper and three adjacent single canister tables. The third position consists of the disassembler, scanners, sorting table, and storage rack. The fourth position includes the reassembler, canister loader and two adjacent single canister tables. The fifth is the post sort area. Each position contains less than a minimum safe mass and is separated from other positions by more than the 10 inches needed for neutron separation of safe masses in water[6].

The decapping equipment at KW is located in the transfer canal between the number 2 loadout pit and the western bay. The decapping/recanning equipment at KE is located adjacent to existing fuel segregation equipment. The fuel handling and storage requirements for canisters containing MKIA fuel assemblies are the same for KE as for KW once MKIA fuel has been introduced to KE, with the exception that MKIA fueled canisters are not required to be capped in KE. The safe storage requirements for the segregation area will be modified when MKIA fuel is being segregated to take into account its higher reactivity.

Canisters of 1.25wt % scrap can be stored with only two in adjacent locations, and areas in each basin must be set aside so that no other canisters are stored in adjacent storage rack locations. An effective water thickness of 12 inches is required for neutronic isolation of any two 1.25wt % scrap canisters from any other fissile material[7].

2.3 Radiological Control

There will be no planned release of significant quantities of radioactive materials to the environment. Contaminated or potentially contaminated building service floor drains within the facilities boundaries have been intercepted and routed to a liquid effluent sump. Unused or unnecessary

*During fuel segregation and decapping/recanning activities some canisters will be dedicated to MKIA scrap (operationally defined as pieces of fuel less than 6 inches long). These canisters will have additional handling constraints at both facilities.

drains have been plugged and sealed with concrete. A pliable epoxy sealant has been applied to the floor and walls of the KW basin to further limit leakage. The existing underbasin leakage collection system composed of an asphalt membrane and a pipeline to a dispersion tile field has been intercepted outside the facility. The contaminated effluents are routed to a sump and pumped back to the facility or to a radioactive waste holding tank (see Figure 2.5).

The design limit for radiation dose rates above the facility pool from the stored fuel, during normal fuel movements, is 1 mrem/hr.[9,10] Above the fuel segregation equipment the design limit is 4 mrem/hr.[11] A policy of exposure control is applied at the facility to maintain radiation exposure to personnel, from all sources, as low as reasonably achievable (ALARA).[12]

The radioactivity concentration in the facility exhaust air is about one millionth of that allowed by Table I of Reference 2. Consequently filters are not required[13].

2.4 Maximum Credible Accident

The maximum credible accident has been determined (section 8.2.4) to be the dropping and overturning of a loaded cask in the fuel transfer area with the fuel spilling out of the cask. Analyses show that the fuel would not melt,[14] however, a gaseous release might occur from any broken elements. Potential whole body exposure at the exclusion area boundaries from the airborne release would be 7.56×10^{-9} Rem[15] which is only a very small fraction of the guidelines given in 10 CFR 100. It is estimated that the dose of operating personnel would be less than 5 Rem. 15

2.5 Design Basis Earthquake

The Design Basis Earthquake (DBE) is defined as an event producing a maximum horizontal ground acceleration of 0.25 g simultaneously with a maximum vertical ground acceleration of 0.17 g at zero period. Analyses show that with the water depth limited to 16-1/2 feet, the facility will survive the DBE.[16] The cooling pool, cooling pool water supply and the recirculating systems equipment, equipment foundations and support structures, and the fuel storage racks and hangers will survive the design basis earthquake.

Calculations performed on the K-Area ventilation stacks[17] showed that they could not withstand a DBE. Project H-558, therefore provided for the removal of the upper 125 feet of each stack. The resulting height, 175 feet, reduces stress in the outer vertical reinforcing bars of the stacks so that they will be able to withstand a DBE.

Project H-558 also implemented the upgrading of the storage basin monorails for the addition of hanging fuel. Figure 1.2 shows the hanging fuel configuration. The design for this modification which added reinforcements to the monorails included consideration of the DBE. Dynamic testing of hanging fuel canisters provided design data to assure meeting the DBE.[18]

2.6 Tornado

The facilities were not designed to withstand the impact of a tornado. However, the structures were designed to withstand a bomb blast. Tornados would be expected to remove siding, but not collapse the structure.

Tornados in central Washington generally move from southwest to northeast. Items which could become airborne in the immediate vicinity of the facility are all located to the east or north. Along with the low probability of a tornado (6.82×10^{-6}/yr, see section 4.5) no airborne missiles are expected to be generated nearby which could impact on the stored fuel. Administrative controls will be instituted to insure that the areas adjacent to the storage basins will be kept free from potential tornado missiles.

A tornado is not expected to cause either the hanging fuel to drop or a loss of basin coolant. However, if such damage occurred it would not produce a criticality nor would the loss of coolant be an immediate problem (see section 8.2.7).

2.7 Monitoring Instrumentation

Surveillance and warning instrumentation and alarms are strategically placed to enhance the safety of personnel and plant equipment. These include systems for monitoring pool water level and temperature, normal and high radiation dose rates, radiation levels in the ion exchange tanks, and neutron dosimetry. There is also an air monitoring system to detect any airborne radioactivity. Figures 2.6 and 2.7 show the control room instrument panel and the gamma radiation monitoring equipment, respectively.

2.8 Personnel Safety

Areas in the 105-KW and KE Buildings have been provided to house the operating personnel and supporting crafts. The facilities have been equipped with the necessary sanitary and safety provisions, including fire protection as defined by DOE orders 5480.1A and 5483.1. These areas are separated from the pool area, with access through an air lock. Exhaust fans in the basin area ensure that any airborne radioactivity will not penetrate the office and personnel support area.

2.9 Industrial Security

A security system is provided to detect unauthorized personnel intrusion during periods that the facility is unmanned by authorized personnel. This system provides audible alarms in both the KE and KW facility control rooms, tne 105-N control room, and the 1112-N Building patrol headquarters. The system is tested routinely and will alarm upon system failure.

2.10 Quality Assurance Programs[19, 20]

Quality assurance programs were implemented to provide assurance that the design, procurement, construction, testing, inspection, operation, and maintenance activities conducted at the facilities conform to regulatory and contractual requirements.

2.11 Pollution Control

2.11.1 Chemical Pollution

The only chemicals that will be used routinely are those for control of the cooling pool water pH in the range of 6.5 to 9.5[21] and biocides for control of algae and other organisms. If needed, these chemicals will be introduced into the cooling pool water, which is part of a closed, recirculating filtered system, and no planned discharge of chemicals to the environment will occur. Other chemicals, such as those used for equipment decontamination, may be used occasionally and their use will be specifically authorized and controlled.

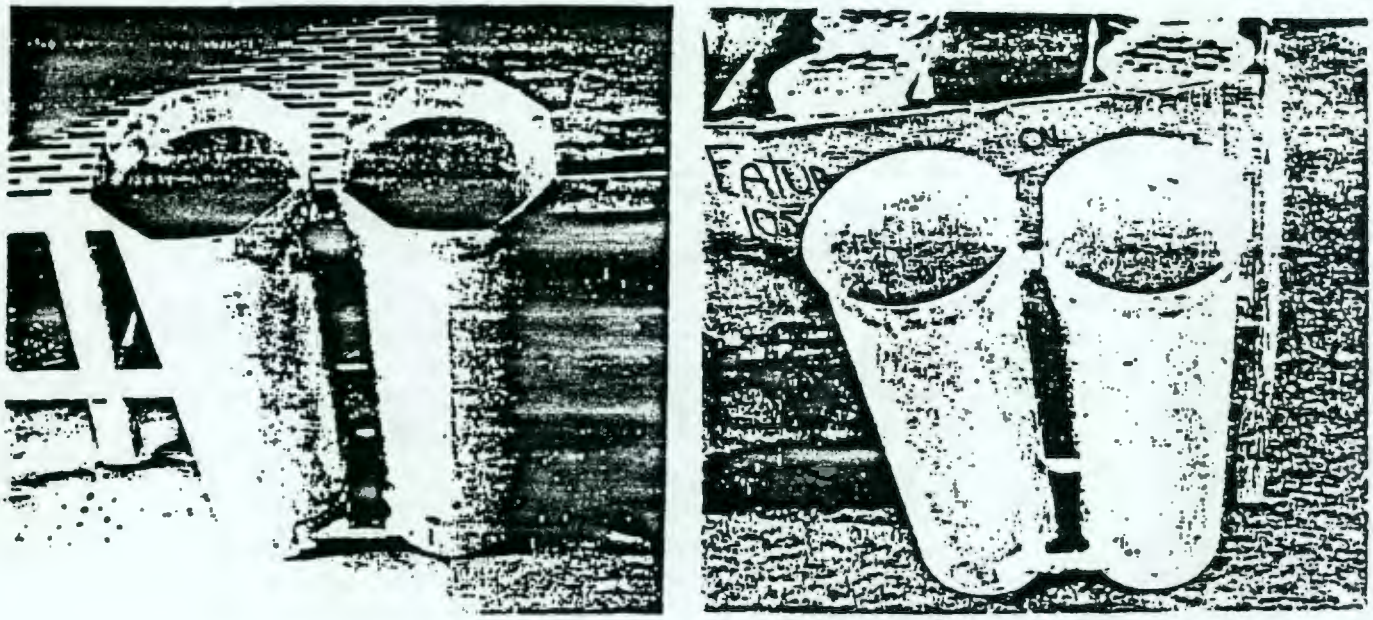
2.11.2 Thermal Pollution

With an average age of 1 year for the hanging fuel (assuming a maximum of 375 MTU per basin at 7,500 BTU per ton per hour) and 2 years for the fuel resting on the basin floor (1650 MTU per basin at 2000 BTU per ton per hour[22]) the estimated heat load is approximately 1790 kilowatts. If each facility were to operate at the thermal capacity of its heat removal system the temperature of the river at its minimum flow rate would be raised about 0.002F.

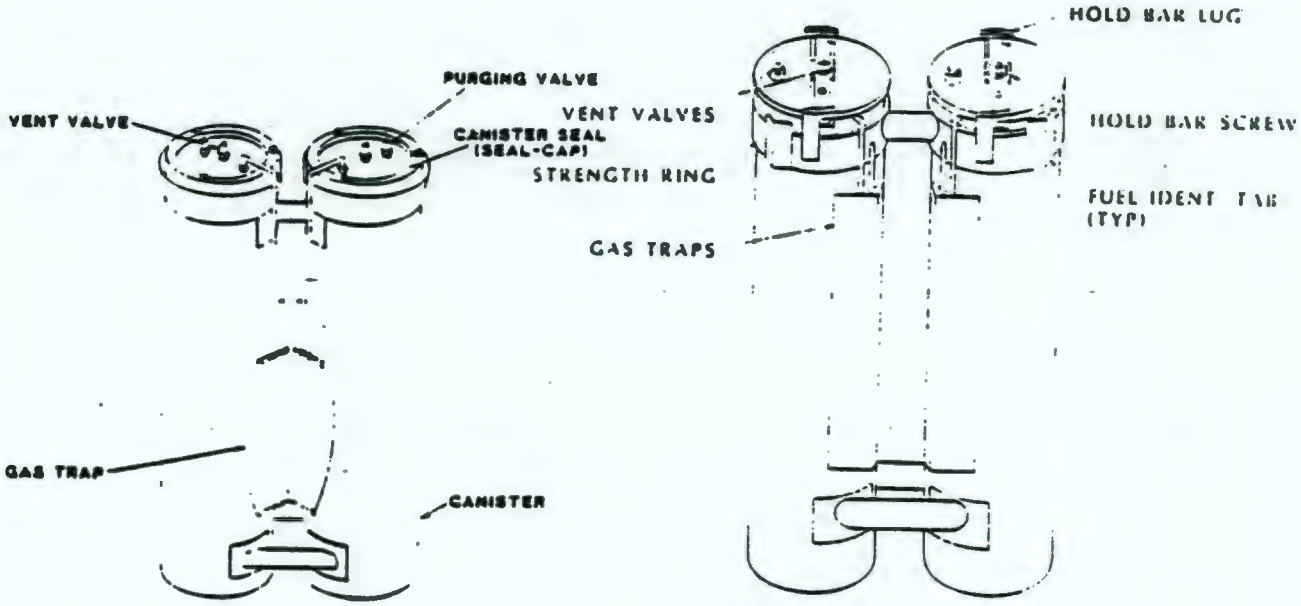
2.12 Decommissioning

When the facilities are emptied and are no longer needed for fuel storage they will be returned to an environmental status equivalent to or better than existed prior to modification. Decommissioning will be accomplished at some future time under a decommissioning program encompassing all 105-K structures.

FIGURE 2.1
FUEL STORAGE CANISTERS



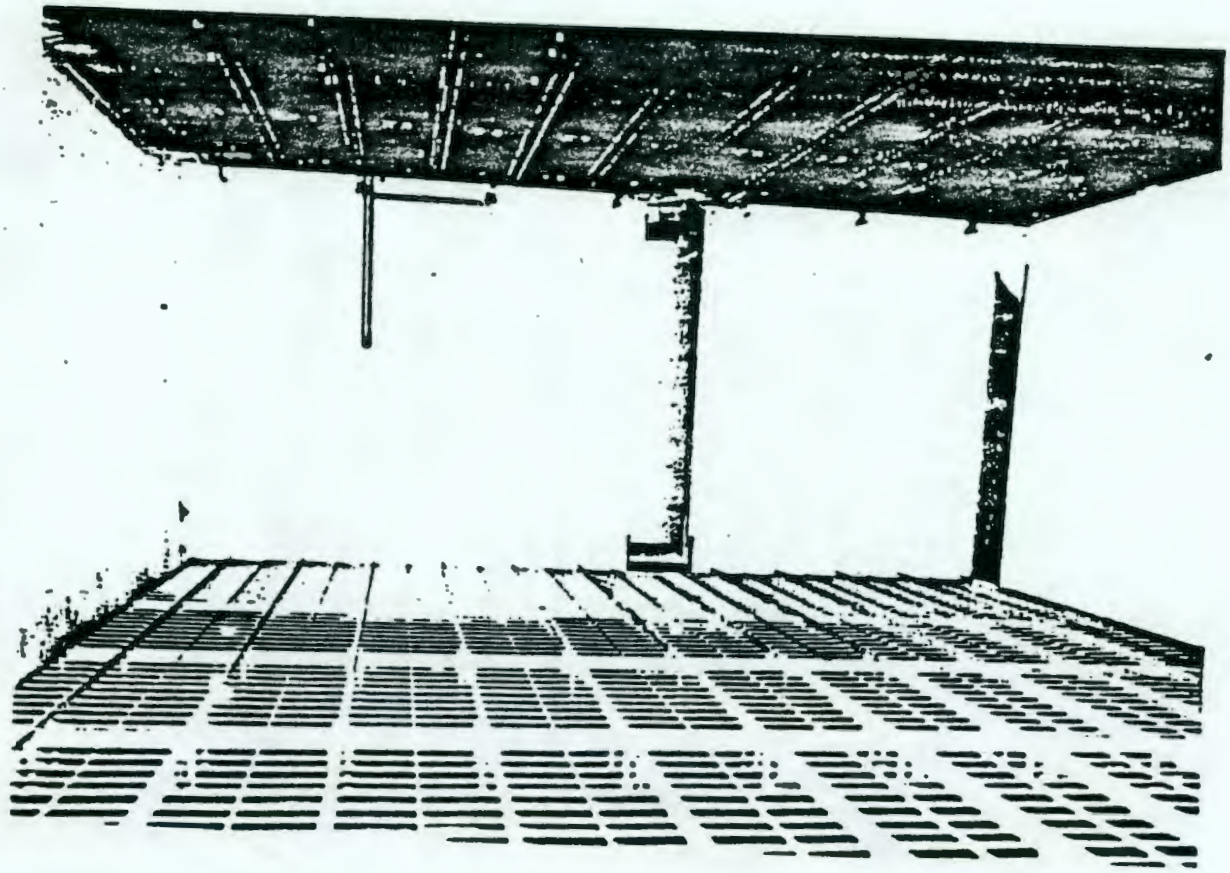
A. LOWER ENRICHED FUEL MARK O CANISTERS B. SPIKE FUEL MARK O CANISTERS



C. ENCAPSULATED FUEL MARK I CANISTERS D. ENCAPSULATED FUEL MARK II CANISTER

FIGURE 2.2
CANISTER STORAGE RACKS - PRIOR TO INSTALLATION

FIGURE 2.3
CANISTER STORAGE RACKS - INSTALLED



KE BASIN FUEL SORTING FACILITY

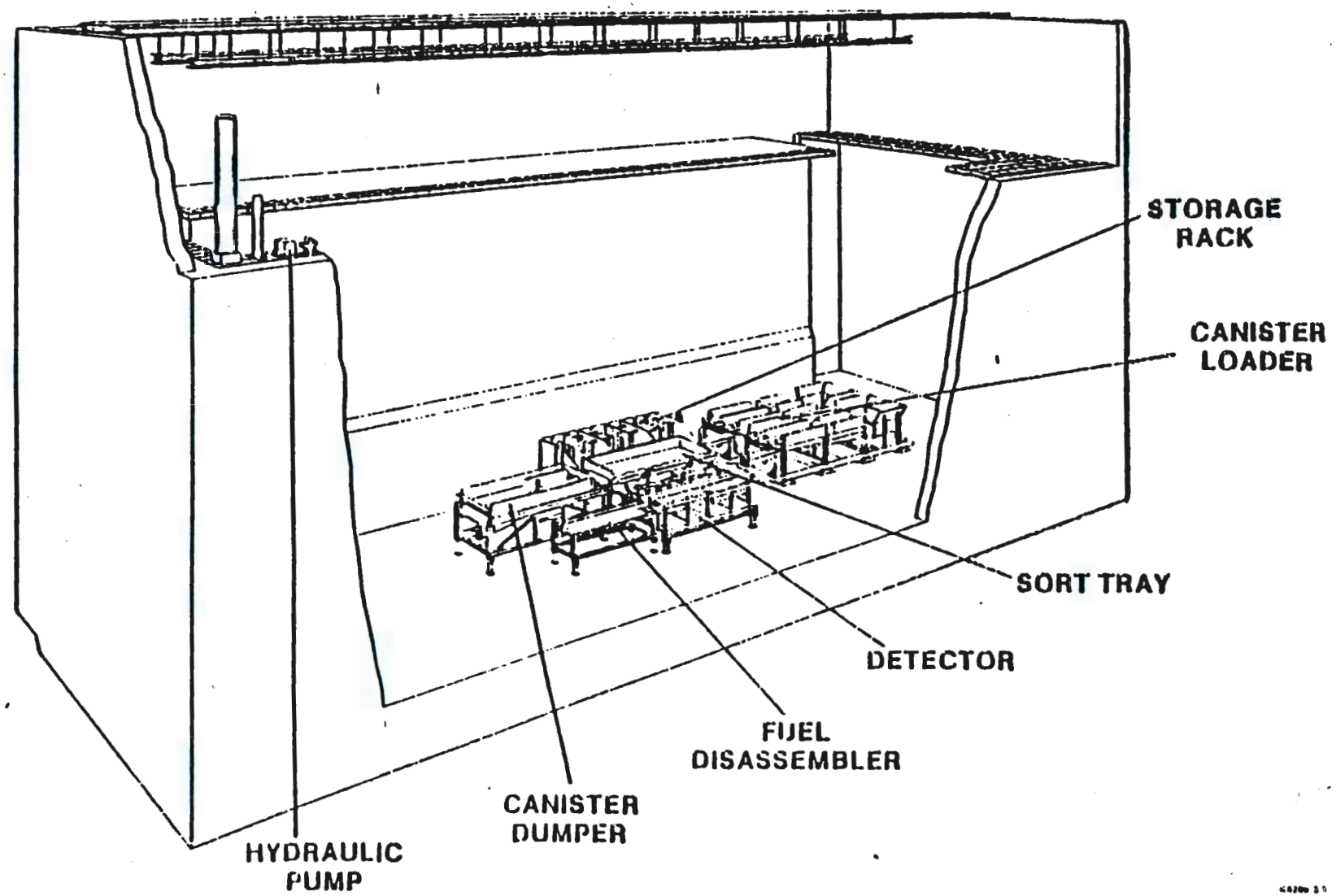
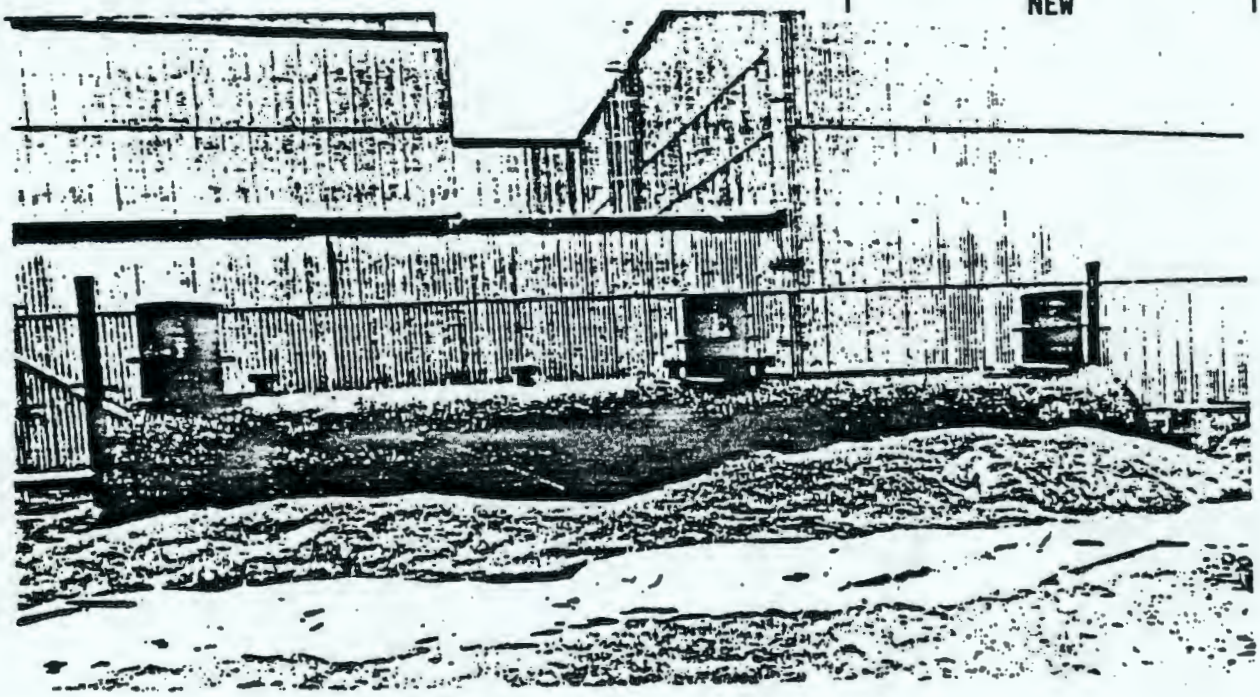


FIGURE 2.4
KE BASIN FUEL SORTING FACILITY



RADIOACTIVE WASTE HOLDING TANK DURING CONSTRUCTION

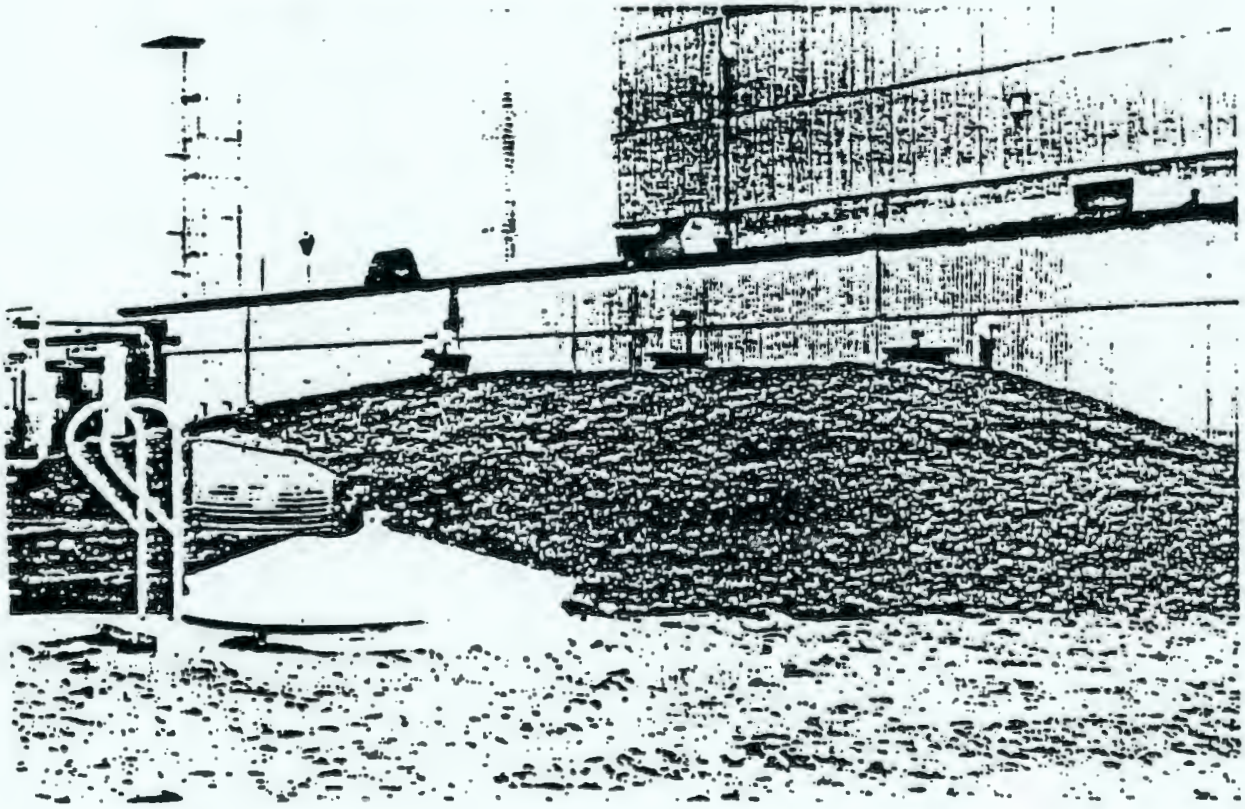


FIGURE 2.5
RADIOACTIVE WASTE HOLDING TANK FOLLOWING CONSTRUCTION

FIGURE 2.6
CONTROL ROOM INSTRUMENT PANEL

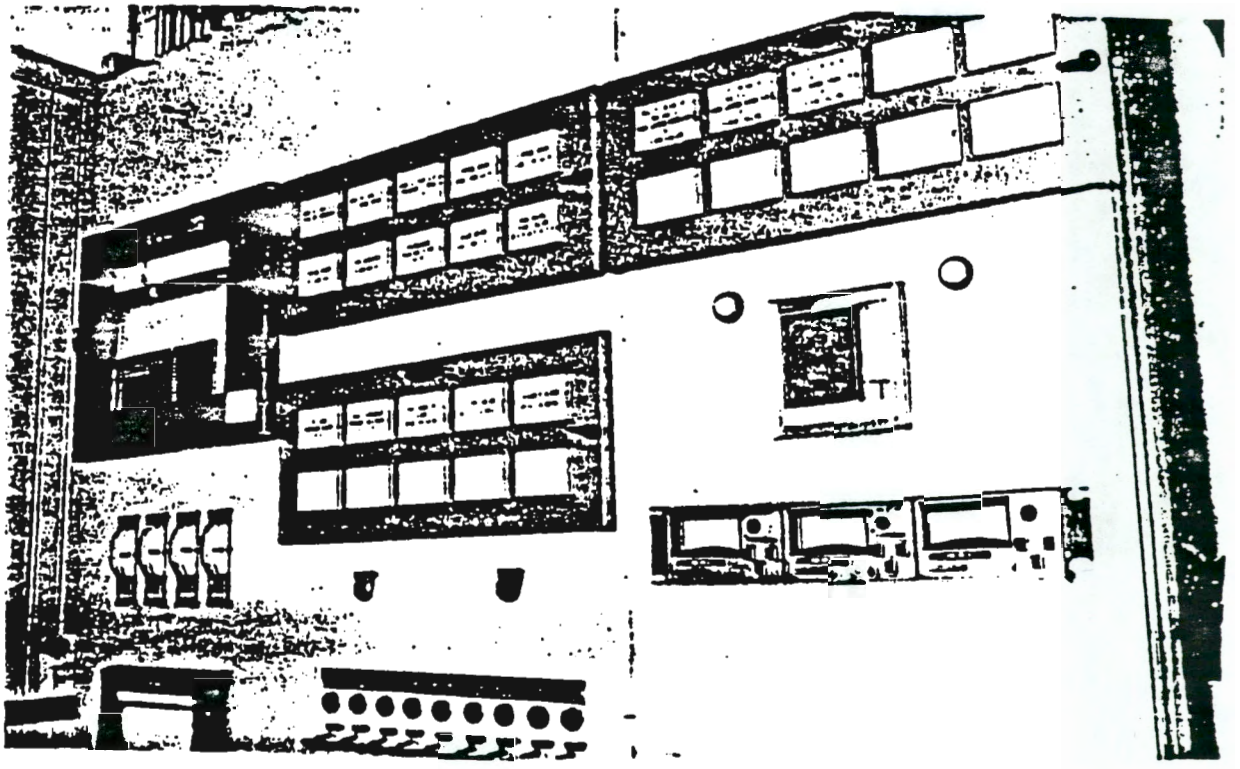
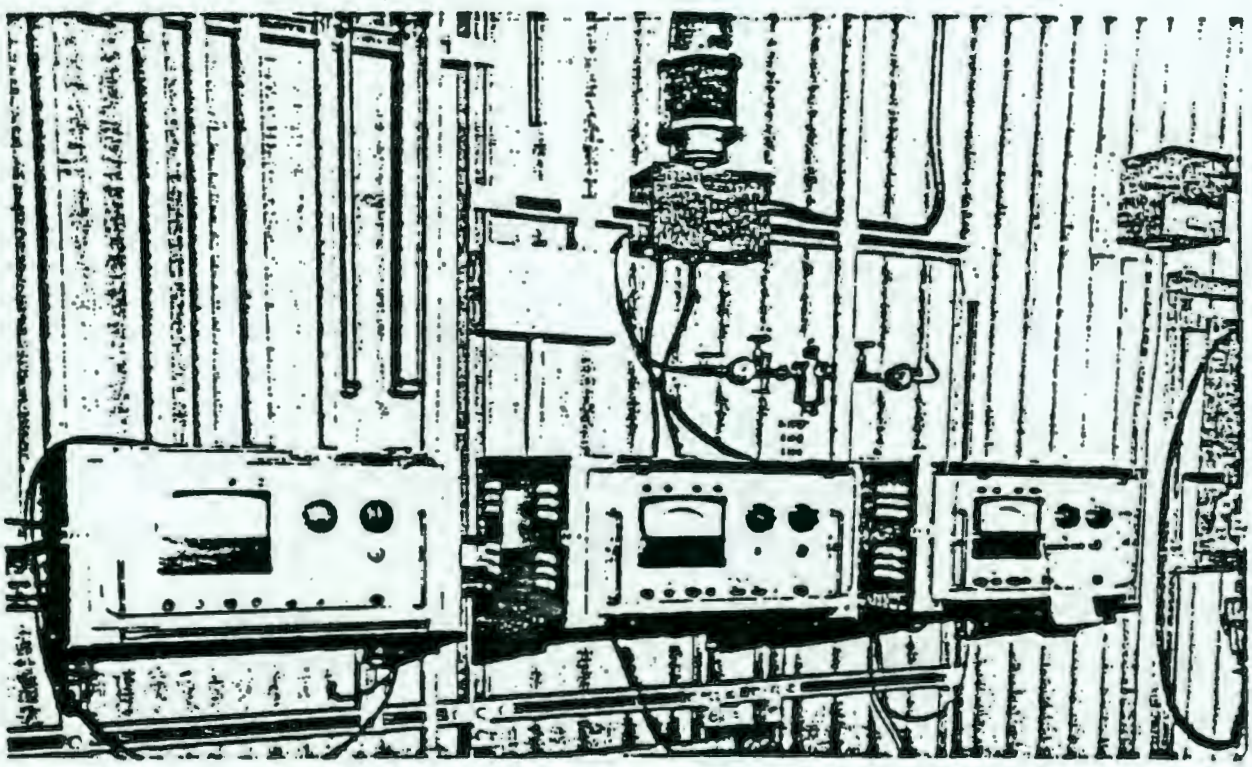
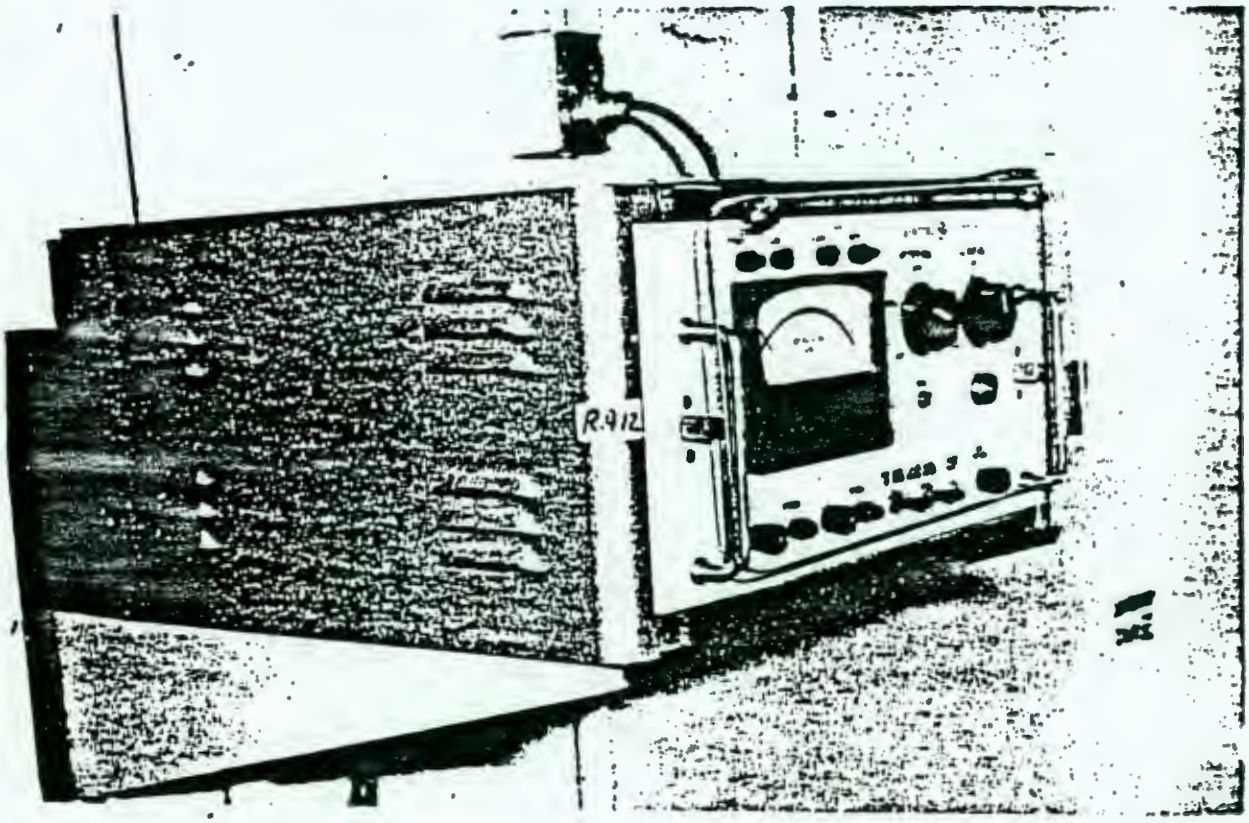


FIGURE 2.7
GAMMA RADIATION INSTRUMENTS





3.0 CONCLUSION

Irradiated N Reactor fuel, which has been cooled for at least 150 days, will be safely stored in the K area fuel storage basins in a nominal 16 feet of water, using the storage configuration shown in Figures 1.2 and 1.3, and will present no undue risk to the health and safety of plant personnel or the general public. The storage configuration and segregation and decapping equipment capacities and operating procedures and limitations will prevent an accidental criticality. The water will prevent any significant release of radioactive materials to the environs and limit the radiation exposure in the work area. The potential whole body exposure at the exclusion area boundary from the airborne release due to the maximum credible accident would be 7.56×10^{-9} Rem compared to the 10 CFR 100 guideline of 25 Rem.

The storage configuration shown in Figure 1.2 consists of full density storage on the basin floor. The full density storage array will allow for storage of up to 1173 MTU of irradiated Mark IA fuel or up to 1648 MTU of Mark IV fuel. The hanging fuel concept provides capacity for storage of up to 291 MTU of spike fuel (Mark IA) or 409 MTU of Mark IV fuel. A normal mix of Mark IA and IV (20% and 80% respectively) hanging fuel is 375 MTU. These quantities will be reduced by one third as long as hanging storage is not allowed in the west bay of each basin. Any combination of enrichments of fuel can be stored in the full density (floor) array and one-over-three hanging array, except that hanging fuel canister storage of 1.25wt % scrap filled canisters are not allowed, nor are any hanging canisters of any kind allowed over canisters containing 1.25wt % scrap.

4.0 SITE CHARACTERISTICS

4.1 Location

The facility is located in the 100-K Area in the northwest quadrant of the 570 square mile DOE Hanford Reservation in the south central part of the State of Washington along the right bank of the Columbia River (see Figure 4.1). In addition to the two shutdown production reactors and the KE and KW Fuel Storage Facilities within the 100-K Area, the Hanford Reservation contains the following major facilities or activities: five additional reactor areas designated 100-B, 100-N, 100-D, 100-H, and 100-F, which contain six shutdown production reactors and one operating dual purpose reactor (N Reactor); the 300 Area which contains a fuel fabrication facility and laboratory facilities supporting all of DOE's Hanford Programs; two areas for fuel reprocessing, waste processing and waste storage designated 200-E and 200-W Areas; a commercial nuclear waste burial operation on land leased to the State of Washington; the Fast Flux Test Facility (FFTF); and three nuclear power plants under construction for the Washington Public Power Supply System (WPPSS).

Major metropolitan areas within the broad vicinity of the plant (see Figure 4.2) include Spokane, Washington, about 120 miles to the northeast; Seattle, Washington, about 130 miles to the northwest; and Portland, Oregon, about 150 miles to the southwest. Two other areas of significant population density include Moses Lake, Washington, about 30 miles north of the K-area and the Yakima Valley, in Washington, extending from Yakima, about 45 miles west of the plant, to the Tri-Cities, in Washington, about 35 miles southeast of the plant.

A more detailed description of the general site location and additional information on the surrounding population density may be found in the N Reactor Updated Safety Analysis Report (NUSAR) Reference 1, Section 2.1.

4.2 Associated Facilities

Both the KW and KE Facilities are located within the 100-K Area perimeter as shown in Figure 4.3. The following buildings contain supporting equipment in terms of water and electrical supply to both the storage facilities:

The 183-KE building is the water treatment plant where the water is filtered and chemically treated for removal of solids. Sedimentation basins No. 5E and 5W with a total capacity of 6.3×10^6 gallons of water have been reactivated for servicing the KE and KW Facilities.

The 181-KE river pump station contains the two raw water pumps used to pump water from the Columbia River to the filter plant (183-KE building). Each of these pumps, shown in Figure 4.4, has a 10,000 gpm capacity.

The 1706 building contains the demineralization plant (capable of producing 100 gpm) and a 16,000 gal demineralized water storage tank.

The 190-KE building contains the three service water pumps that supply the treated water to the KE and KW facilities. Each of these pumps, shown in Figure 4.5, has a 5,000 gpm capacity.

The 165-KE control building contains the station service transformers and the temperature indicators and annunciator equipment for monitoring the 181 and 190-KE pumps and motor operation, and additional office space.

The 1717 building houses maintenance shops and craft personnel.

The backup cooling water for the cooling pools is supplied from large underground storage structures commonly called the clearwells. Each of the two clearwells contains approximately 9.0 x 10^6 gallons of treated water. If electrical power is lost to the area (only one source of power is available), analysis of fuel heatup shows that at least 60 hours are available to restore the heat removal equipment to service before a maximum allowable basin water temperature of 130°F would reached. If necessary, once-through cooling water, supplied from the clearwells by portable pumps or fire trucks, would provide temporary emergency cooling. The overflow water would be collected in a crib outside the facility (see section 5.3.3.1).

4.3 Floods

The highest recorded flood stage of the Columbia River at the facility site occurred in 1894 and was 415 feet above mean sea level (MSL). The Probable Maximum Flood (PMF) as defined by the Corps of Engineers and described in section 2.4.3. of Reference 1 (NUSAR) will reach 423 feet MSL. The 181-KE river pump station is located at an elevation of 421 feet MSL, the fuel storage basin is located at an elevation of 465 feet MSL and the vital equipment located in the 165-KE, 183-KE and 190-KE are at an elevation of 459 feet MSL or higher.

Thus, if the PMF did occur, the two raw water pumps located at the 181-KE river pump station would be submerged in about 2 feet of water (these pumps are powered by electric motors which would probably be destroyed). However, the fuel storage facility and the vital supporting equipment would be at least 42 feet and 36 feet above the maximum flood level. In this instance, the clearwells are capable of supplying water to the cooling pools as needed.

Realistic modes of upstream dam failures or damage would produce a flood not exceeding the PMF.

For further information on the PMF, the general hydrology of the area, or the upstream dam failure analysis see Section 2.4 of Reference 1.

4.4 Seismology

The Hanford Reservation is in a region of low to moderate seismicity. The historical record of seismic activity within a 200 mile radius of the 100-K site dates from 1827. During this time there have been only 14 earthquakes which may have been felt or were recorded at or near the 100-K site. Five of these may have affected the site with an intensity of IV or greater on the Modified Mercalli Scale (MM). The most severe of these occurred on December 14, 1872 with a probable epicenter located about 85-100 miles north of the facility. No historical record of the effect of the 1872 quake on the 100-K site is available, but it is postulated to be in the intensity range of V to VI MM. For more information concerning the seismology and geology of this area, see Section 2.5 of Reference 1 (NUSAR).

4.5 Wind and Tornado

The site is subject to frequent strong westerly winds. The all-time peak gust of 80 mph was recorded Jan. 11, 1972. The 80 mph gust is expected to occur once every 30 years. A peak of 96 mph would be expected to occur once every 500 years[1].

The site is well outside of established tornado alleys. The probability of a tornado in any year at any point within the 100 mile radius of the Hanford Meteorology Station is 6.8×10^{-6}/yr.[24]

The Hanford design base tornado is defined as having a 150 mph rotational velocity and a 25 mph translational speed. When the facilities were designed and constructed this criterion had not been established. Consequently the facilities are not designed to withstand the impact of a tornado. The structural parts of the facilities were designed to withstand a bomb blast. Tornados would be expected to cause some structural damage but not collapse the structure. However, even if the structure were to collapse, the hanging fuel would be dropped, but would not cause a criticality.[3]

4.6 Ashfall

The Hanford reservation is in a region subject to ashfall from volcanic eruptions. The three major volcanic peaks closest to the project are: Mt. Adams about 100 miles away, Mt. Rainer at about 110 miles away, and Mt. St. Helens approximately 130 miles away.

Important historical ashfalls affecting this location were from eruptions of Glacier Peak about 10,000 BC, Mt. Mazama about 4000 BC, and Mt. St. Helens about 6000 BC. The most recent ashfall resulted from the May 18, 1980 eruption of Mt. St. Helens.

A design ashfall roof loading has not been established. However, a 6-inch depth of loose ash followed by an extremely heavy rain would produce a roof loading of approximately 25 pounds per square foot. This loading is well within the 105-K basin roof design of 47 pounds per square foot.[22]

FIGURE 4.1
SITE LOCATION

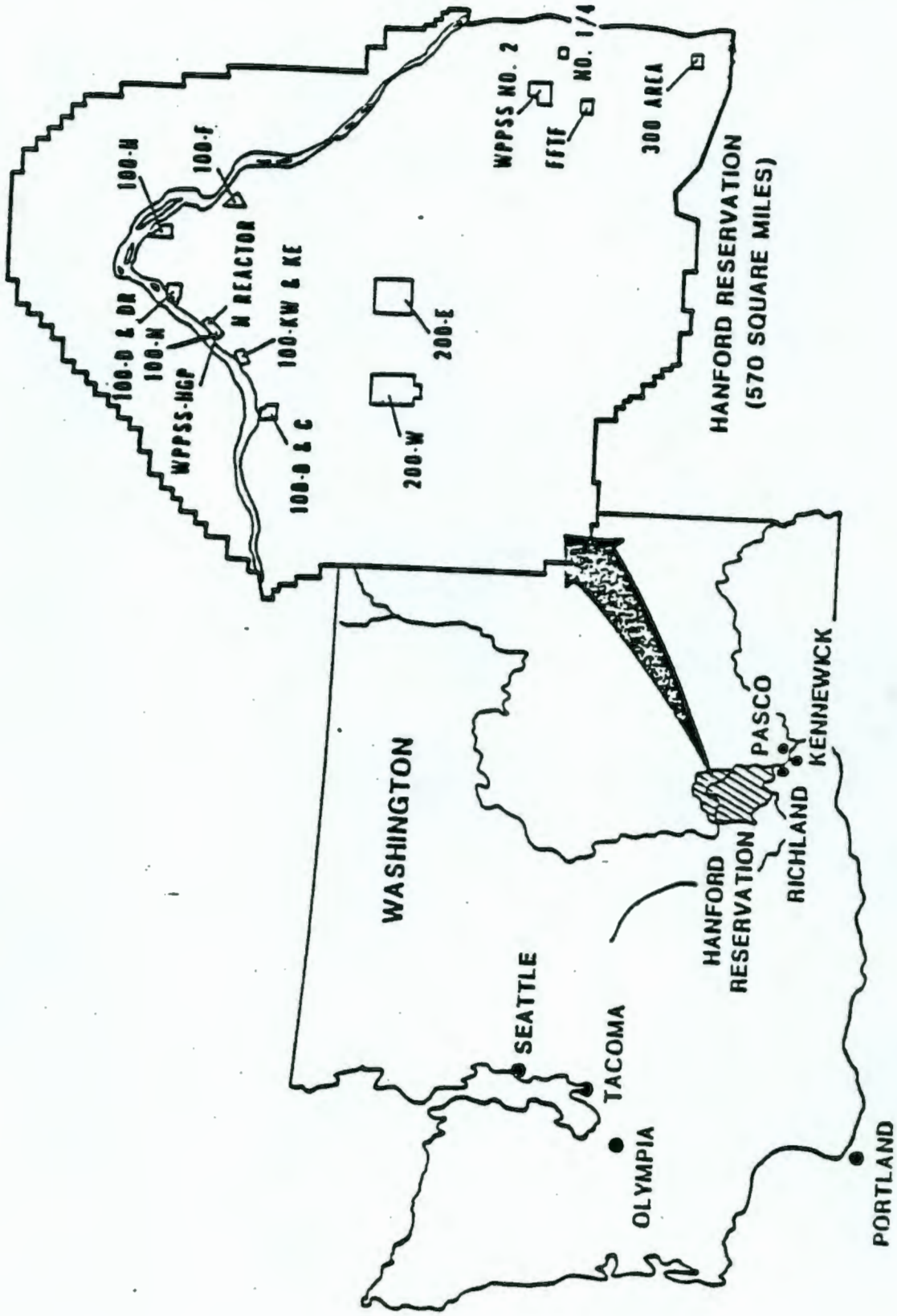


FIGURE 4.2

LOCATION OF PLANT RELATIVE TO MAJOR METROPOLITAN AREAS

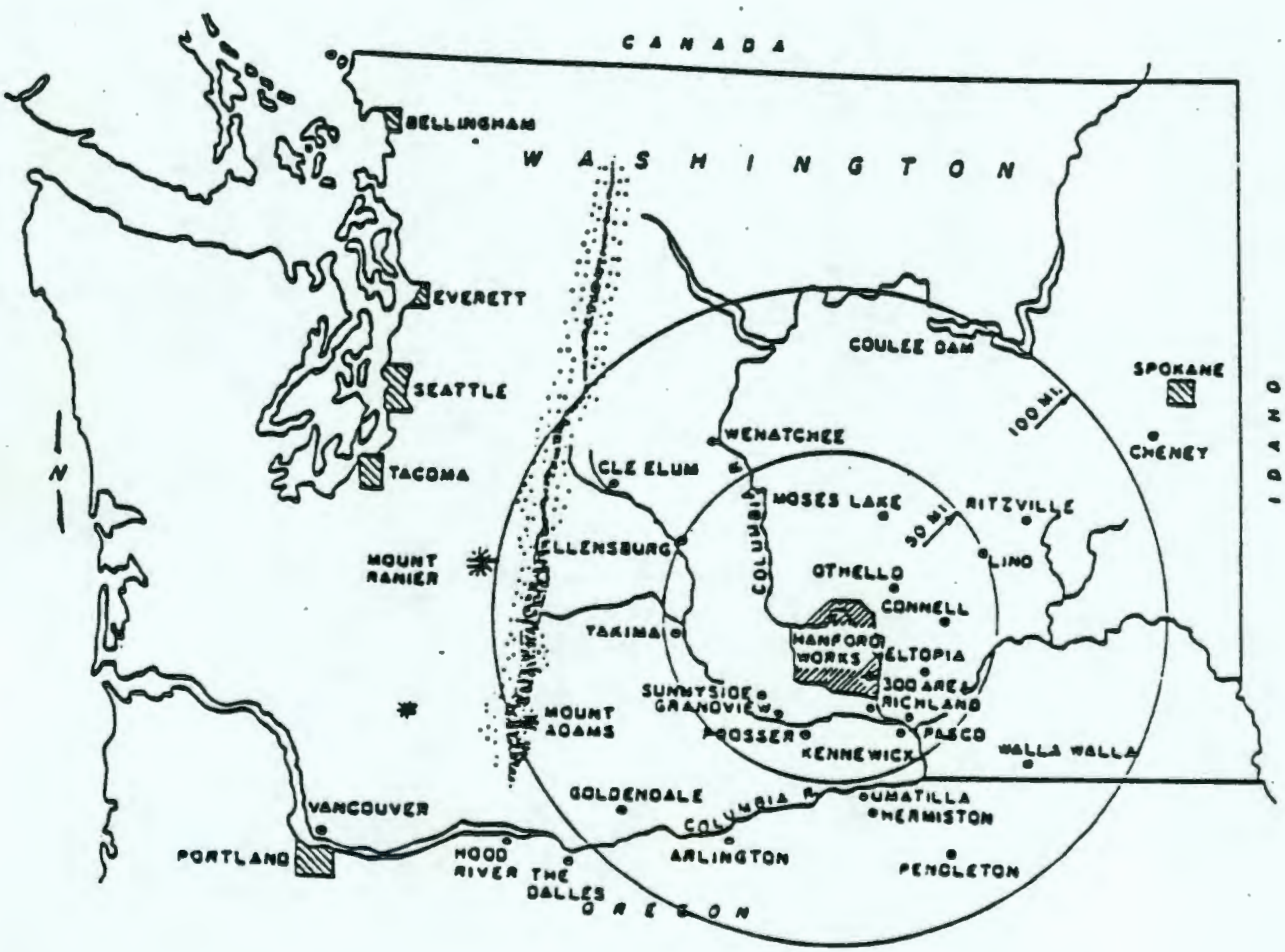


FIGURE 4.3

100-K AREA

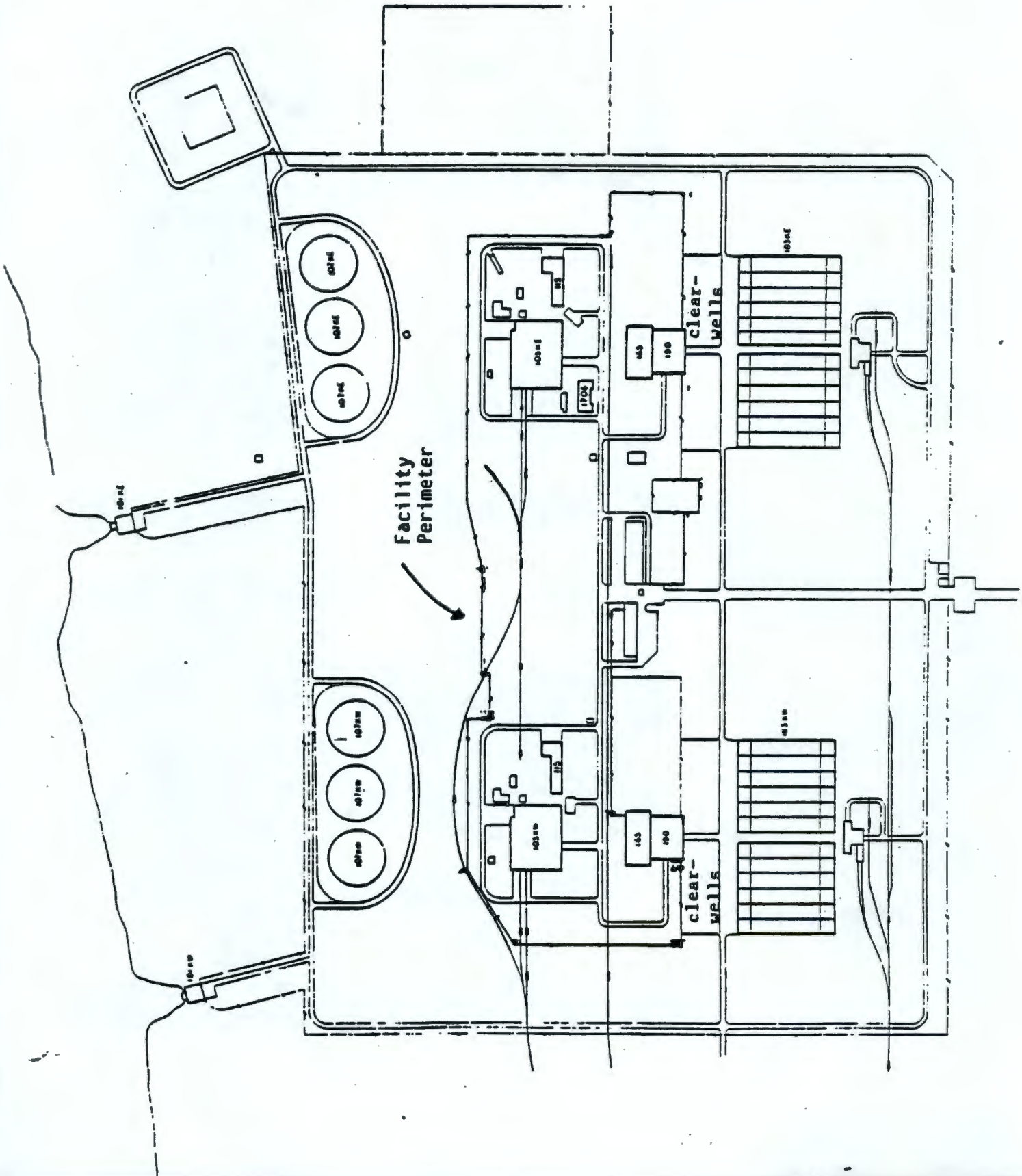


FIGURE 4.4
181-KE RIVER PUMP

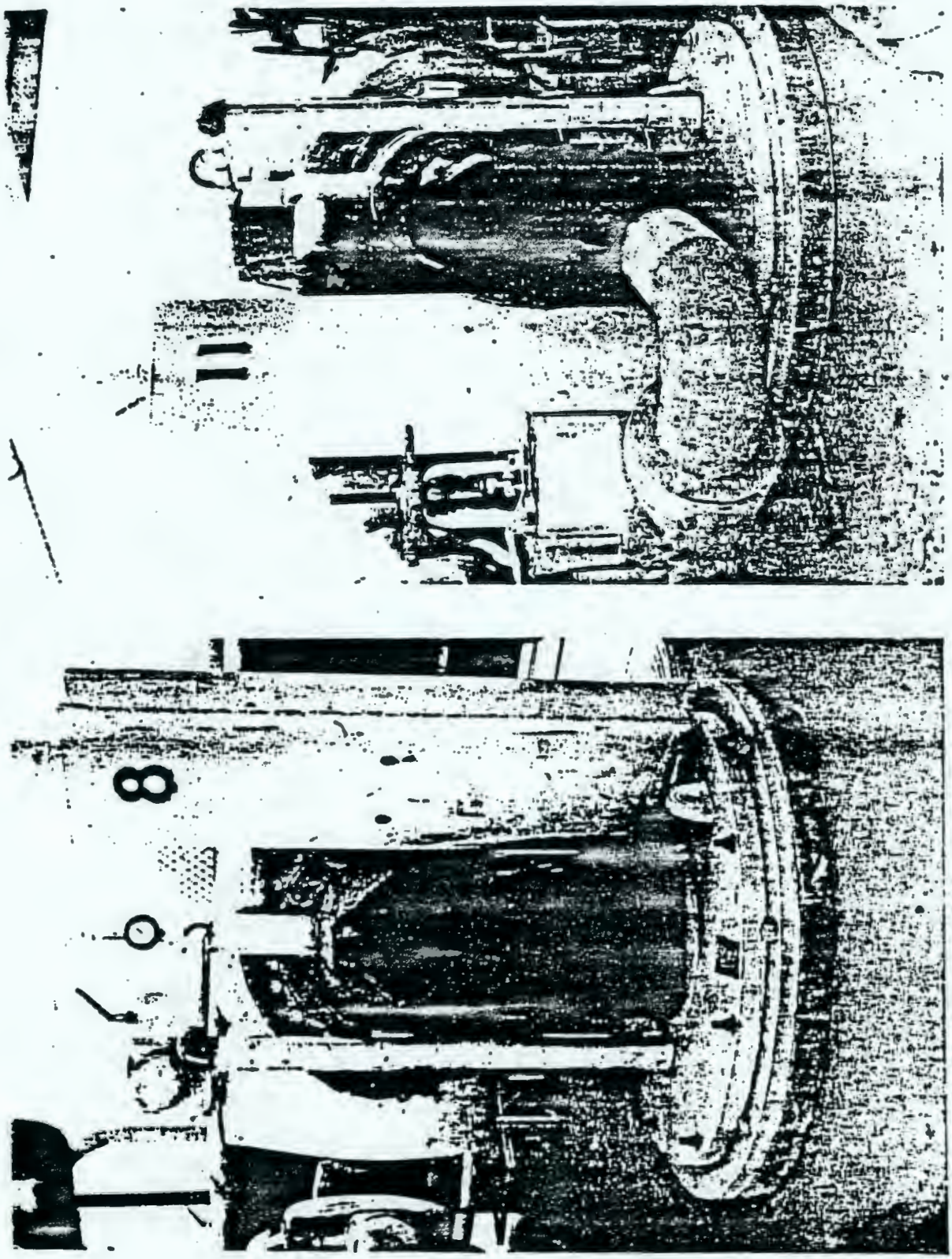
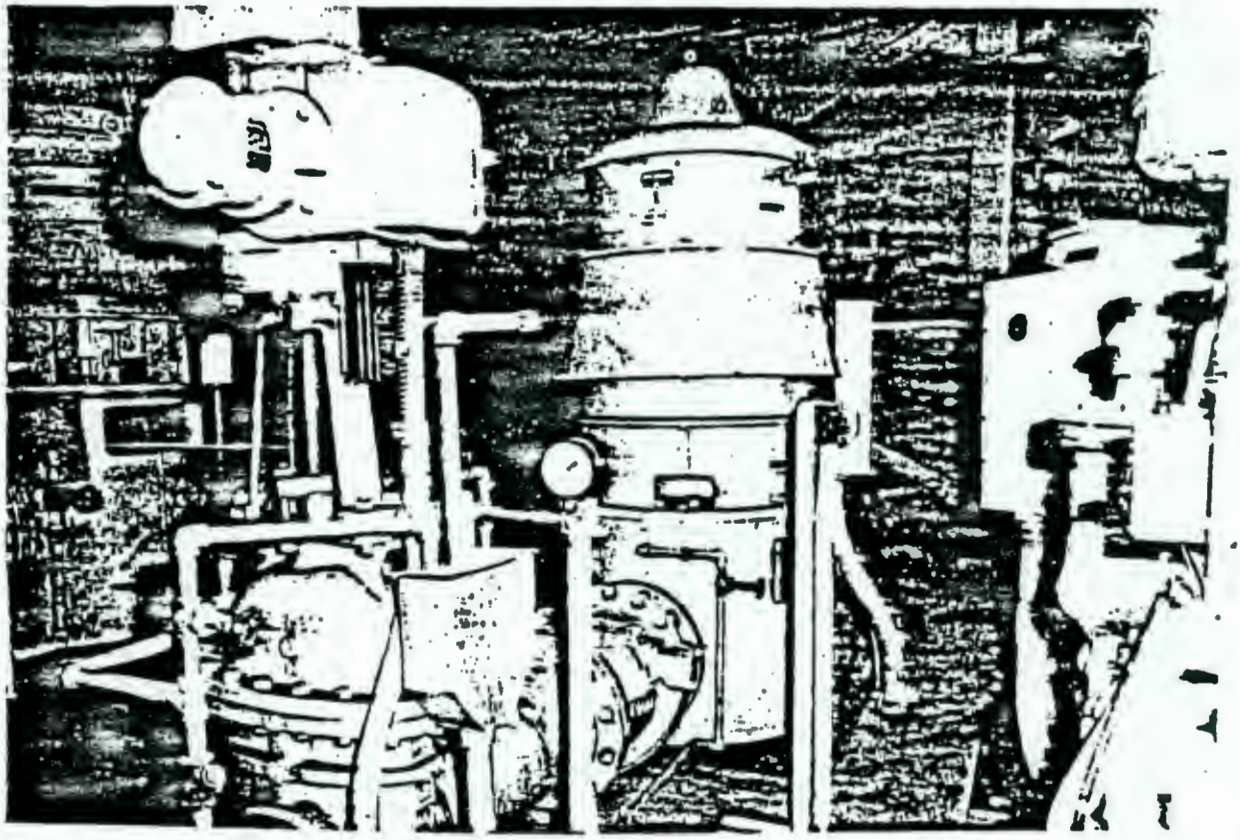
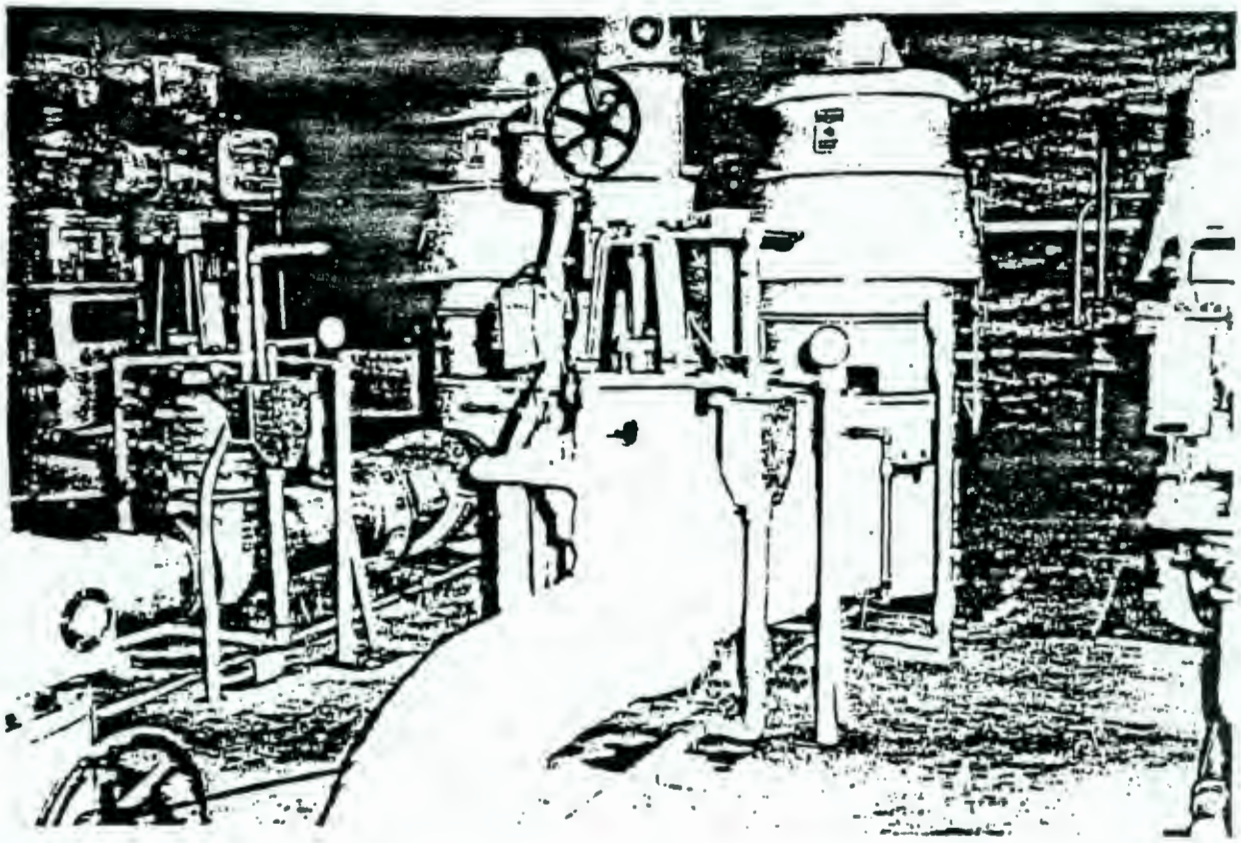


FIGURE 4.5

190 KE SERVICE PUMPS





5.0 STRUCTURE, COMPONENTS, AND SYSTEMS

5.1 General

The KW and KE reactor facilities were originally of essentially the same design and the modifications made to the KW facility under Project H-508 and to the KE facility under Project H-501 were basically the same.

Significant differences between the KE and KW facilities are:

- o A pliable epoxy seal has been applied to the KW concrete basin,
- o The KE storage racks have been filled with open (unencapsulated) canisters,
- o Only encapsulated canisters of fuel elements are stored in KW,
- o Fuel segregation activity is in KE, and
- o The locations of the decapping stations.

The epoxy sealing of KW basin and the use of encapsulated canisters are improvements made due to experience at KE. The epoxy seal reduces the probability of basin leakage and will facilitate decontamination on deactivation. The encapsulated canisters will significantly reduce the release of radioactive contaminants into the cooling water and consequent load reduction on ion exchange and filtering systems. It also provides a significant reduction in personnel radiation exposure.

5.1.1 Comparison to 10 CFR 50 Appendix A

Although compliance with 10 CFR 50 is not required, a comparison with 10 CFR 50 Appendix A was made to aid in judging the adequacy of the facility. It was concluded that only Paragraph VI, "Fuel and Radioactivity Control", Criteria 60, 61, 62, 63 and 64 are applicable for comparison to the fuel storage basins and that the facility design is in conformance with these criteria except No. 60 which is discussed below.

Criterion 60 - "Control of Release of Radioactive Material to the Environment"
The facility design does not include means to control the release of radioactive gaseous effluents nor provide any holdup capacity for retention of gaseous effluents containing radioactive materials.

The fuel storage basin design criteria specifies transportation and storage of N Reactor irradiated fuel, cooled for a minimum of 150 days after reactor discharge. Based on previous irradiated fuel storage experience at N Reactor and at the other Hanford Reactors, a small amount of radioactive noble gases

may be released due to corrosion of broken fuel, but the amounts are so small that no provisions for containment of radioactive gases are included in the functional design criteria. However, monitoring equipment is provided to monitor the facilities atmosphere for gaseous radioactivity that may be released during normal operation, including anticipated operational occurrences and from postulated accidents. Measured concentrations of radioactive gases in the facilities' discharges are about one millionth of that allowed by Table I of Reference 2. Consequently filters are not required.[13]

5.1.2 Comparison to NRC Regulatory Guide 1.13 - "Spent Fuel Storage Facility Design Basis"

NRC Regulatory Guide 1.13 provides design details based on the requirements of 10 CFR, Part 50, Appendix A, 1973, Paragraph VI, Criterion 61. Although compliance is not required, a comparison with the requirements of Regulatory Guide 1.13 was made to aid in judging the adequacy of the facility, and it's design was found to be in substantial comformance.

A k-effective of 0.98 is used in lieu of 0.95 because the Regulatory Guide is directed at commercial power reactor fuels that are more highly enriched than N Reactor fuel. The mass difference between a k-effective of 0.98 and a k-effective of 1.0 for N Reactor fuel enrichments is greater than the mass difference between a K-effective of 0.95 and a k-effective of 1.0 for power reactor fuel enrichments. In addition, subcriticality measurements, detailed in Reference 4, and other data developed over the years at Hanford give a high degree of confidence in the results of the criticality analysis.

5.1.3 Basic Design Requirements

The original basic design requirements for modification to the facilities and associated equipment under the three primary modification projects were:

- Store irradiated N Reactor fuel for a period of 15 years.
- Limit radioactive release to the environment to within established limits.
- Protect personnel from undue physical and radiological hazards during normal or abnormal operation of the facility and related equipment.

The more specific design requirements may be found in the Functional Design Criteria, References 25, 26, and 27.

5.2 Facility Cooling Pool

As discussed previously, the cooling pools are existing structures that were modified for the purpose of storing irradiated N Reactor fuel. They are rectangular reinforced concrete structures 125 feet long, 67 feet wide and 21 feet deep. The pools are divided into three sections by concrete walls which are open at each end (see Figure 1.1). The bottom of the pools are approximately 20 feet below grade. The cooling pools are filled to a nominal depth of 16 feet. The water passively circulates through the pool by drawing water from one end of each basin section, circulating the water through filters, the heat exchanger or water cooler, and the ion exchange columns, then discharging it back at the opposite end of the sections. The maximum operational water temperature will be 100°F.[26,27] The water provides radiation shielding and cooling for the stored fuel. The storage racks and hangers provide individual storage stations for the canisters and insure the storage configuration remains intact during a design basis earthquake.

The original modifications were made to the cooling pools under Projects H-501, H-508, and H-558. Installation of the segregation equipment was done under design change DC-82180. Heat exchangers 1A were replaced with water chillers in each basin under DC-82107 for KE and DC-83057 for KW. Decapping facilities were added to KW and KE under DC-82121 and DC-82223, respectively.

5.2.1 Design Description

Fuel storage racks, shown in Figure 2.2, were installed in the cooling pools as shown in Figure 2.3. These storage racks were developed under Projects H-501 and H-508 and are designed with individual storage stations large enough for only one fuel canister per station. The individual racks are interlocked to form one solid unit across the pool floor and are butted tight to the pool walls.

Project H-558 provides an additional capacity of 1240 fuel canister storage positions per basin. The fuel will be hung from the monorails with 40 canisters to a monorail. There are 32 monorails of which 31 could be used for storage. The remaining monorail is to be maintained as a spare and for operating flexibility. However, only 21 monorails are now usable since hanging storage is not currently allowed in the west bay of either basin. Additional bracing was added to the monorail supporting structure under Project H-558 to meet seismic criteria.

The hanging fuel canisters on each monorail will be interlocked into four groups of 10 to prevent them from knocking together should a seismic event occur. Thirty inches of space between groups are provided to prevent them from bumping each other. There will be about 44 inches between rows of

hanging canisters, a sufficient distance to prevent them from colliding during a seismic event. The hangers will be attached to trolleys and each trolley will be clamped to the monorail at a specific marked location.

All the pool floor drains are plugged and sealed with concrete. The floor and walls of the KW pool are coated with a pliable epoxy sealant. Water provides the radiation shielding over the irradiated fuel in the pool. The level in the pool is maintained at a nominal 16 feet which provides for 10 feet of water over the fuel during all normal operation conditions in the basins.

5.2.2 Design Evaluation

The installed fuel storage racks and hangers in the cooling pool provide 6133 canister storage locations in each facility plus an additional 174 spaces in the KW discharge chute area. Calculations, supplemented with subcritical mass experiments provided in PT-506,[4] show that by using the fuel storage configuration shown in Figures 1.2 and 1.3, a criticality could not occur with the failure of a single contingency. The approved storage configuration consists of full density storage for fuel located on the basin floor. Hanging fuel, in a 1 over 3 array can consist of all spike fuel. The full density Storage array plus the hanging fuel locations will allow for storage of a maximum of 1925 MTU (2125 tons) of irradiated fuel in each facility plus an additional 55 MTU (60 tons) in the KW discharge chute.

Upon deactivation of the single-pass reactors, a small number of irradiated single-pass reactor fuel elements remained stored at the KE fuel storage pool. Single-pass reactor fuel can safely be stored in the same facility with the Mark IA and Mark IV N Reactor fuel in quantities up to 5% of the minimum critical mass (MCM) in each single-pass reactor fuel container.[2,28] This limit is compatible with analyses performed for any accident that can occur with the N Reactor fuel stored in the facility. Each N Reactor fuel canister contains up to 5% MCM. Therefore, if a container of single-pass reactor fuel were dropped or spilled into the storage array of N Reactor fuel canisters, the change in the k-effective value of the storage array would be no more than for the dropping or spilling of a canister of N Reactor fuel into the storage array. (See Section 8.1.3.)

The container weight limit of 545 pounds(5% MCM) of single-pass reactor fuel, identification, labeling and isolation requirements are specified in the Process Standards for the facility.

5.2.3 DISCUSSION

The following discussion concerns operations in the main basin area only. The segregation facility is discussed in section 5.5. Decapping operations are discussed in section 5.7.

The fuel cask is physically prevented from traversing over the irradiated fuel storage pool by the building structure and the absence of crane rails into this area.

Assurance against the storage configuration being altered by a cask dropping onto the racks is provided by the absence of rails that would allow crane travel in this area. The crane cannot position a cask over the racks and stored canisters.

The canister hoists and hangers are the only installed mechanical lifting devices capable of moving objects over the irradiated fuel racks. The rated capacity of the hoist is 0.9 metric tons (one ton) working load. A steel grating platform covers the entire cooling pool area which serves as a platform to work from and as a guide for installing canisters of fuel into individual storage rows (see Figure 5.1). The grating also prevents a hoist from dropping onto the irradiated fuel storage racks and canisters. Lighting fixtures and other components of the building above the cooling pool are not sufficiently massive to destroy the grating and cause damage to the fuel racks or canisters below this level.

The consequence of a transfer cask dropping into the cooling pool loadout pit has been analyzed[16] and is discussed in Section 8.2.3.

By maintaining the water level in the cooling pool at approximately 16 feet at least 10 feet of water will be over the irradiated fuel during all normal operating modes. Assurance against loss of water, which would result in an increase in radiation levels, is provided by sealing all floor drains in the pool with concrete. Additional protection is provided at KW by coating the walls and floor of the pool with a pliable epoxy sealant. The only escape route for the water from the pool is through overflow weirs located approximately 2.5 feet above the pool water level. With 10 feet of water over the irradiated fuel, the radiation dose rate from the fuel was calculated to be less than 1.0 mR/hr.[9] However, actual experience at KE has shown dose rates to be higher than predicted due to the presence of dissolved radionuclides in the basin water. The dose rates are still within acceptable limits for controlled radiation zone work.

A radiation monitoring system has been provided at the facilities for personnel protection and general surveillance. Continuous monitoring and recording readouts and high radiation level alarms have been provided in the facility control rooms, the N Reactor control room and the Central Fire Station. Audible and visual indicators are also provided in facility pool areas.

5.3 Facility Pool Cooling and Cleanup System

Each facility pool cooling and cleanup system is designed to perform three primary functions:

1) Remove the decay heat generated by the irradiated fuel stored in the basin.
2) Maintain water quality and clarity.
3) Control the concentration of soluble and particulate radioactive nuclides in the water to minimize personnel radiation exposure.

Table 5.1 describes the design parameters for the system, the design data are included in Table 5.2. The more specific design requirements for this system may be found in the Functional Design Criteria, References 26 and 27.

5.3.1 System Description

Each pool cooling and cleanup system consists of a recirculation system, an ion exchange system, a sand filter system, and several other small subsystems (see Figures 5.2 and 5.3 for typical arrangement). The recirculation system includes the recirculation pumps, heat exchanger, chiller, ion columns, cartridge filters, and the necessary valves and piping. Table 5.1 provides the design and operating parameters for this system.

The recirculation system draws water from the three cooling pool sections through a common header to the suction side of the recirculation pumps. The water is then pumped through a 5-micron disposable cartridge type filter to the shell side of a heat exchanger and then returned to the cooling pool. Part of the discharge, 150 gpm, passes through the ion exchange system before returning to the pool. The pH controlling chemicals are added to the water after heat removal prior to returning to the cooling pool if necessary.

Water is supplied to the ion exchange tanks through a common header connected to the recirculation system. Flow from the ion exchange system is discharged into the cooling pool through return piping.

Water is drawn from the cooling pool through the skimmer (see Figure 5.2) to the suction side of the skimmer pump, and then pumped through the sand filter and back into the basin (see Figure 5.3). Included with the sand filter system is a settling pit for backwash water.

At KE, a filtered water supply line with a manual control valve supplies the cooling pool with normal or emergency makeup. The makeup line discharge is above the normal water level and visible so that makeup can be confirmed. A

2-inch pipe from this line has been added to provide automatic water level control. At KW, a demineralized water supply is used for cooling and pool makeup.

5.3.2 Component Description

Following is a brief description of the major components that make up the fuel pool cooling and cleanup system.

5.3.2.1 Cooling Pool Recirculation Pumps (Figure 5.4)

The cooling pool recirculation system in each basin includes two pumps which are the primary units for moving the pool coolant through the recirculating system.

5.3.2.2 Cooling Pool Recirculation Filters (Figure 5.5)

Two cooling pool filters were installed to improve the pool water clarity by removing particulate matter. The filters can use various pore-sized cartridges. Currently five-micron size cartridges are used. These filter assemblies can be used in parallel or as single units. Each has a flow capacity of 500 gpm at an operating pressure of 50 psig.

5.3.2.3 Cooling Pool Heat Exchangers and Chillers (Figure 5.6)

A heat exchanger and a water chiller have been installed in the recirculation system to remove heat from the irradiated fuel cooling pool water. The cooling pool heat exchanger is a water-water type capable of handling the total heat load. The chiller, capable of emitting water at 59°F, will be put in service during the summer when the secondary water temperature is such that an optimum fuel pool temperature cannot be maintained by the heat exchanger.

Filtered water is circulated through the secondary (tube) side of the heat exchanger on a once-through basis, then discharged to the river. The fuel storage pool water is pumped from the pool through the primary (shell) side of the heat exchanger, and then discharged back to the storage basin. Each heat exchanger is equipped with a pressure switch which senses the pressure differential between the primary and secondary sides. The pressure switch, which is adjustable, trips at a selected differential pressure (currently 8 psi). A trip shuts off the primary circulating pumps and simultaneously initiates an alarm in the control room. A low differential pressure trip ensures that radioactivity will not be discharged to the Columbia River through heat exchanger leakage. Operating the heat exchanger with a pressure sufficiently higher on the secondary side than on the primary side will also preclude any otherwise undetected leakage of the radioactively contaminated pool water to the river.

5.3.2.4 Ion Exchange System (Figure 5.7)

The ion exchange system located in the transfer area, consists of three small carbon steel ion exchange tanks operating in parallel. To provide adequate radiation shielding, the ion exchange tanks are installed in a large concrete block with three wells. The wells are 3 feet square with 18 inches of shielding around each well. The 60 gallon capacity tanks may be charged with up to 5 ft^3 of either natural or manufactured inorganic ion exchange material. This material is quite specific for adsorption of cesium and is not rapidly depleted by other competing cations in the water. A mixed cation and anion organic resin may also be used in the ion exchange tanks, if necessary, to reduce the radionuclide concentrations in the water.

The ion exchange tanks also serve as the burial containers for the radioactive resin. A reusable shipping cask, conforming to the requirements of a Department of Transportation (DOT) Type B container is used to transport the depleted ion exchange tanks to the 200 Area waste management facility for disposal. As part of the decapping design changes (DC No.'s 82121 and 82223), a new ion exchange system was installed to supplement the existing system. The new system uses ion exchange tanks similar to those already in use; however, in the new system the tanks are permanently sealed in a large concrete block that is approximately 7'x7'x6'. The block will serve as both shipping container and radiation shield. The new system will be installed on the north rail spur coming into the basin, protected by a bumper capable of stopping a one car train with a speed of 4 mph.

5.3.2.5 Sand Filter System (Figure 5.8)

Each sand filter system, located adjacent to the ion exchange system in the transfer area, consists of a skimmer system, pump, piping, and a pressurized sand filter with shielding. A settling pit is also provided for the backwash water. During filter operation, the skimmer pump will deliver 400 gpm of storage basin water through the sand filter and back into the basin. During backwash periods, the same pump will provide a back flow into the settling pit. After the suspended solids in the backwash water have settled to the bottom of the settling pit, the clear water will be pumped from the pit into the inlet of the sand filter. The sediments accumulate in bottom of the settling pit from successive backwash cycles.

The sand filter system is designed to operate independently of, or in conjunction with, the present cartridge filters described in Section 5.3.2.2.

5.3.2.6 Liquid Waste Transfer Pump (Figure 5.8)

The liquid waste transfer system utilizes a 50 gpm electric pump. This system will be used to empty liquid waste from the underground holding tank to transportation vehicles for shipment to and disposal at the 200 Areas.

A 60 gpm pump is located adjacent to the discharge chute and under each reactor's rear face elevator. This pump will transfer collected coolant leakage from the discharge chute area to the liquid waste holding tank.

5.3.2.7 Cooling Pool Leakage Catch Tank Pumps (Figure 5.9)

Two 80-gpm vertical, extended-shaft-centrifugal sump pumps have been installed to return the leakage water collected by the under basin asphalt membrane back to the cooling pool. The pumps are equipped with electrical controls to alternate the pumping cycle from one pump to the other and operate both pumps when the demand exceeds the capacity of one pump.

5.3.2.8 Irradiated Fuel Cask Transfer Area Sump Pumps (Figure 5.10)

Two 40 gpm vertical centrifugal sump pumps were installed outside the cask transfer area to either return drainage water to the cooling pool, or pump it (when contaminated with detergents or other chemical agents) to a holding tank located outside the facility building.

The pumps are equipped with electrical controls to alternate the pumping cycle from one pump to the other and operate both pumps when the demand exceeds the capacity of one pump.

5.3.2.9 Valves and Piping (Figures 5.2 and 5.3)

Manually operated gate, globe and ball valves are used to isolate equipment and control the water flow. All piping in contact with the cooling water is either Schedule 40 or Schedule 80.

5.3.3 Design Evaluation

5.3.3.1 Availability and Reliability

Each irradiated fuel pool cooling and cleanup system is a manually controlled system that can be shut down for periods of time for maintenance or replacement of malfunctioning components. Limitations, based on a 54°F water temperature rise, are specified in the process control documents. The system has some redundant equipment (e.g., a heat exchanger and a water chiller, two cartridge filters, two primary pumps, two separate ion exchange systems, etc.). Loss of electrical power could be a serious but not critical event.

During any power outage all normal fuel handling activity will cease, since normal instrumentation will be lost. Radiation levels, coolant temperature, and coolant level can be determined with portable instruments or other means. The most important need during a power outage is to maintain adequate cooling of the stored fuel.

A sixty hour quiescent cooling period (no forced circulation or addition of coolant) for a basin full of fuel has been established.[23] This was based on a maximum water temperature limit of 130°F which still provides a suitable working environment adjacent to the pool. Sixty hours is sufficient time to bring in emergency engine-driven pumps. A more urgent cooling problem would arise if the power outage occured during the short time interval when the crane lifts the cask from the well car and lowers it into the basin. However, the probability of a power outage occuring during the period that the cask is in aerial transit is estimated at about 1.3×10^{-7}/yr, based on historical data. Alternate cooling is not necessary for the first 4 hours for a cask in such a position [29]. The few power outages occuring in recent years have been short, not approaching 4 hour duration, indeed most lasted only a few seconds. For these reasons an emergency power source is not considered cost effective.

5.3.3.2 Cooling Pool Dewatering

Hypothetically, the most serious failure of each system would be complete loss of water in the cooling pool. However, it has been concluded that loss of water from the pool sufficient to uncover the fuel is not credible. The basin structure was analyzed for its ability to withstand the DBE. Also, the adjoining cask transfer pits were analyzed for a postulated cask drop accident.[16] In both cases, the loss of coolant from the pool would be insignificant (less than 25 gpm).[30] A railroad cask car falling into the basin and causing an uncontrolled leak is discussed in Section 8.2.8, which concludes this also is not a credible accident. The cooling pool bottom drains have been sealed closed with concrete. Additionally, a pliable epoxy sealant has been applied to the walls and floor of the KW cooling pool. The only exit for the cooling water is through the overflow weirs, left in service to provide an overflow mechanism to mitigate level controller failure. An emergency water makeup valve is immediately available to the operating crews and can supply 1500 gpm to the cooling pool, to recover from an abnormal reduction in water level.

In the unlikely event of a leak beyond the capacity of the emergency make-up system the basin would be expected to drain and personnel would be evacuated due to high radiation levels (about 1 mrem/hr at 3 miles).

A peak temperature of 1697°F would be reached for encapsulated fuel which had been stored for the minimum 150 days at N Reactor prior to shipment to the facilities.[31] At these temperatures, aluminum canisters used in hanging storage could be expected to fail and drop the suspended fuel. This would not cause a criticality.[3] The fuel currently stored in the facilities would not exceed a temperature of 781°F and would not melt aluminum canisters.

5.3.3.3 Water Quality

Prior to storing N Reactor fuel in the cooling pools, the pool floors were cleaned. It is expected that some debris will be introduced to the pool during the transfer and storage of the irradiated fuel elements. KW should be the cleaner of the two facilities since only encapsulated canisters will be stored in it. However by controlling the pH and temperature and passing the water through filters in the recirculating system, the ion exchange tanks and the sand filter, the water in each facility will be maintained at an acceptable quality as defined in the facility process standards.

5.3.3.4 Instrumentation

The instrumentation provided for each pool cooling and cleanup system is discussed below. Alarms and indicators are provided as noted. A system alarm for one facility annunciates and identifies the system and problem in that facility. It annunciates in the other facility and in the N Reactor control room only as a "system failure" without identifying the particular system or problem. However, a radiation alarm originating in one facility annunciates in the other facility and N Reactor control room as a "high radiation" alarm even though the indication in the originating facility alarms as low, intermediate or high radiation.

5.3.3.4.1 Temperature

Local instrumentation is provided to measure the temperature of the water in the pool and give indication and annunciation in the KE and KW facility control rooms and the N Reactor control room. Local instrumentation is also provided to give indication of the temperature of pool water as it leaves the heat exchangers. Pool temperature shall not exceed 100F.[26,27]

5.3.3.4.2 Pressure

Local instrumentation is provided to measure and give indication of the pressures in the pool pumps suction and discharge lines. Instrumentation is also provided to measure pressure differential on the pool filters, the cask transfer area sump pump filters and the underbasin leakage collection sump pump filters.

5.3.3.4.3 Flow Rate

The cooling water discharges into each of the three separate bays or sections of the pool. The discharge lines are equipped with flow indication instruments and flow throttling valves to permit balancing of the cooling water flow rate through the three separate cooling pool areas. Instrumentation has been provided to indicate that the secondary cooling water is flowing. Loss of secondary cooling water will alarm in the facility control rooms and in the N Reactor control room.

5.3.3.4.4 Level

Instrumentaion is provided to measure the pool coolant level and to alarm on a high or low water level condition. A high or low alarm is annunciated in both facility control rooms. The alarm will also transmit and annunciate in the N Reactor control room.

5.3.3.4.5 Ion Exchange Tank Radiation Monitors

Portable instruments are used to monitor radiation levels in the ion exchange tanks.

5.3.4 Test and Inspections

Each project (Projects H-501, H-508, and H-558) design included an acceptance test procedure that demonstrated the ability of the cooling pool systems and auxiliary equipment to operate as designed. These acceptance test procedures are: ATP No. 3158 for Project H-501,[32] ATP No. 3404 for Project H-508,[33] and ATP No's 4386 & 4387 for Project H-558 [34,35].

Active components of the pool cooling and cleanup systems will be in continuous or intermittent use during normal system operation. Periodic visual inspection and preventive maintenance will be conducted as outlined in the 100-K Irradiated Fuel Storage Operating Procedure System.

5.4 Fuel Handling System

The fuel handling system consists of equipment and structures utilized at both the KW and KE facilities for handling irradiated fuel elements in a safe manner during storage operations and transfer into and out of the basins. The design requirements for the KW and KE facilities[21] are very similar.

5.4.1 System Description

The fuel handling system consists of equipment required for the transfer and storage of N Reactor irradiated fuel elements in the facility cooling pool. The structures associated with the fuel handling equipment are the cask loadout areas and the canister trolley & track systems at both the facilities.

Fuel handling equipment was designed to handle the spent fuel under water from the time it is loaded into shielded casks until it is stored in canister racks or on hangers in the facility cooling pools. Underwater transfer and movement of the fuel provides an effective, economical and transparent radiation shield as well as a reliable cooling medium for removal of decay heat.

The associated fuel handling structures may be generally divided into two areas: (1) the facility cooling pools, which are full of water and are always accessible to operating personnel, and (2) each facility cask loadout area which houses a 30-ton overhead crane for transferring the shielding casks from the railroad cars to the cooling pools.

In the facility pools, canisters of irradiated fuel elements are moved about by 1-ton capacity electric hoists hanging from monorails. When lifting canistered fuel, the monorail hoists are limited by an electrical uptravel switch and backed up by a mechanical system which will prevent lifting the fuel elements any closer than 10 feet from the cooling pool surface. This ensures that sufficient radiation shielding is always maintained. Long handled tongs with adjustable jaws are available to handle individual fuel elements when the occasional need arises. Operating and radiation practice procedures govern the use of tongs for handling irradiated material.

Decay heat generated by the fuel elements is initially dissipated in the 105-N reactor cooling pool for at least 150 days before they can be transferred to the facility cooling pools. After the fuel cools for 150 days at N Reactor, it can then be loaded into a shielded cask and transferred by railroad cars (Figure 5.11) to the facilities for storage. Each railroad car has three wells (compartments). Each well can contain only one cask.

When a railroad car arrives at one of the facilities, the casks are unloaded one at a time into the fuel transfer pit by using the 30-ton overhead crane. The canisters are then removed from the shielded casks, one at a time, using a 1-ton electric hoists and placed in storage racks or on hangers in the facility cooling pools. To transfer the canisters out of the facilities, the canisters are brought in one at a time and loaded into the shielded casks which are loaded, when ready, into the railroad cars for shipping.

5.4.2 Component Description

Following is a brief description of the major components that make up each fuel handling system.

5.4.2.1 Storage Canister (Figure 2.1)

The irradiated fuel storage canisters are 28 inches high and consist of two upright cylinders approximately 8.2 inches in diameter. Each cylinder will hold seven N Reactor fuel elements. The canisters are currently constructed of aluminum or stainless steel. Other materials may be used in the future.

The original N Reactor fuel storage canisters, designated Mark 0 (shown in parts A and B of Figure 2.1), were modified by welding a seal plate on the bottom and a sealing cap on the top, as shown in part C of Figure 2.1. A vent was provided on the cap to permit escape of gases generated by corrosion, without water interchange between the canister and the basin. Fittings were also provided for the introduction of solutions or gases into the canister or for sampling the solution in the canister.[36,37] These modified Mark 0 canisters were designated Mark I canisters. The Mark II encapsulated canister (part D of Figure 2.1) is currently being used. It is similar to the Mark I encapsulated canister except that it uses new body cylinders and an improved cap, closure and gasket assembly.

The tops of the Mark 0 and Mark I lower enriched fuel storage canister are flared into a circle, as shown in part A of Figure 2.1, while the tops of the spike fuel canisters are flared into an octagon, as shown in part B of Figure 2.1. Mark II canisters have an identification tab welded on to indicate the presence of spike fuel. These visual differences provide an additional check on the storage locations of spike and lower enriched fuel.

5.4.2.2 Fuel Shipping System (Figure 5.11)

Several railroad well cars have been provided to ship the casks used for transferring N spent fuel to the facility cooling pools. Each car is compartmented to handle three casks. Each compartment is an independent well with its own water pipes so that fuel coolant can be removed without disturbing the adjoining wells. To add water, the car lid is opened and the compartments are filled by overhead building piping. The existing railroad track system is used to move the railroad cars to and from the facilities, the 105-N fuel handling area, or PUREX. The actual transport is the responsibility of Rockwell Hanford Co., another DOE contractor. The safety analyses for transport is covered in References 38 and 39.

5.4.2.3 Cask Crane - KE and KW Facilities (Figure 5.12)

The design capacity of each facility cask load-out crane is 30 tons. Weight of a loaded cask is approximately 24 tons. The crane is a traveling bridge type with motorized trolley bridge and hoist.

5.4.2.4 Storage Canister Hoists (Figure 5.13)

One-ton electrically operated hoists are used at each facility to raise and lower loaded fuel canisters and baskets from and into shipping casks and cooling pool storage stations.

5.4.2.5 Storage Canister Hooks (Figures 5.14, 5.15, 5.16)

Canister hooks are provided for moving canisters in and out of storage in each facility cooling pool. Two types of hooks are used. One, a straight bar with a hook on the end permits storage in the rows directly under the slots in the floor grating. The other type has an offset mechanism that permits storage in the alternate rows which are underneath the grating (Figure 5.15).

The trolley and storage hook for suspended fuel storage are shown in Figure 5.16. These hooks have a spacing bar which prevents the canisters from hitting each other during seismic events. This spacing bar is locked in place and unlocked using a disengaging tool also shown in Figure 5.16.

5.4.2.6 Canister Elevator (Figure 5.17)

A small hydraulic elevator (21 inch maximum lift) operating on demineralized water is used when unloading canisters designated for suspension storage. The elevator receives the canisters (one at a time) from the storage canister hoist and then raises and lowers the canister for engaging the canister trunion on the storage hook.

5.4.3 Fuel Handling Sequence

The general fuel handling sequence starts with spotting the railroad car at the unloading station and ends with each canister of fuel placed in a specific location in a facility cooling pool. The sequence of operation is:

5.4.3.1 Unloading the Railroad Shipping Car

- At the facility cask load-out areas, the well lids are manually cranked opened and the 30-ton overhead crane hooks engage the trunions of the first cask.

- The hooks safety latches are properly engaged for safe lifting.

- The first cask is then lifted from the railroad car and lowered into the south cask transfer pit.
- Lowering of the cask in the pit is stopped where the cask lid mechanism can be seen.
- At this point the lid is unlocked using an air-operated impact wrench.
- The cask is then slowly lowered into the water filled transfer pit where the lid overhang comes in contact with two wall mounted steel structures that hold the lid in suspension while the rest of the cask continues down toward the pit floor.
- The cask is stopped prior to contacting the pit floor but low enough to pass under the supporting structural steel in the pit.
- The cask is moved in a easterly direction until the cask cavity is in full view for removing the canisters of fuel.
- Using a one-ton electrically operated hoist, the canisters are removed from the cask one at a time and moved via the monorail system into the irradiated fuel cooling pool area and stored individually in predesignated racks. When unloading casks containing canisters designated for suspended storage, the hoist is used to set canisters (one at a time) on the canister elevator. The canister elevator is activated to raise the canister to the up position and a support hook is moved over to engage the canister trunion. The elevator is then lowered back to its original position and the trolley with the suspended canister is moved to its storage position. The entire operation is accomplished under at least 10 feet of water.
- After removing all the fuel filled canisters from the cask, it is moved in a westerly direction with the overhead crane until it is directly under its suspended lid.
- The cask is slowly raised and as it ascends from the pit it will pick up the suspended lid.
- The cask is stopped at or near the water surface, where it is confirmed that the lid is in the proper position to be locked and radiation levels are measured if the cask is loaded for shipping.
- The cask is raised from the pit and moved west over a raised platform with a drip pan which will return any excess dripping water back into the loadout pit. A spray of water may be used to wash radioactive particulate matter back into the transfer pit.

- The cask is then transferred via the overhead crane system back into the railroad car.
- The above steps are repeated until all three casks are unloaded and returned to the railroad car.
- The railroad car is then surveyed by Radiation Monitoring personnel to insure the radiation level and smearable contamination are within limits, prior to releasing the car for return to N Reactor for another load.

5.4.3.2 Loading the Railroad Shipping Car

The loading out procedure is essentially the reverse of the unloading described above in Section 5.4.3.1.

5.4.4 Safety Evaluation

Each facility transfer area 30-ton crane design includes several features to assure safe unloading of casks containing N Reactor irradiated fuel. Two independent brakes are supplied on the hoist. The mechanical load brake is a double-disc screw type and is applied to and automatically sustains the load and assists the motor to control the operation of lowering. The electric brake provides positive stoppage and control. It is held open by hoisting current and is instantly applied when current is interrupted. A safety switch is provided to automatically prevent overtravel. After it is thrown, stopping the hoist, the load may be lowered without resetting the switches. Track type limit switches are provided to prevent bridge and trolley overtravel. A screw type limit switch is provided to limit motion at top and bottom of lift. In addition, there is an extra limit switch in the system to prevent overtravel at the top of the lift.

The facility cooling pool hoists and related equipment design includes the following features to assure safe handling of canistered fuel elements in the irradiated fuel cooling pool and transfer areas.

Each electrical hoist and fuel hanger is equipped with a long steel canister hook that is designed to handle only one canister at a time. The upper geared limit switch on the hoist is backed up with mechanical protection that prevents the inadvertent lifting of fuel above the 10 feet of water shielding. Each hoist and fuel hanger is securely pinned to a four wheel trolley that rides a monorail system. Mechanical stops are provided at ends of the monorail and at transfer points to prevent losing the hoist or fuel hangers from the rails.

5.4.5 Tests and Inspections

Each project (Projects H-501, H-508, and H-558) design included an acceptance test procedure that demonstrated the ability of the project fuel handling system to function as designed. As part of the normal facility operation, the irradiated fuel handling equipment will be inspected and maintained according to practices outlined in the 100-K Irradiated Fuel Storage Operating Procedures.

Cask cranes are given third party inspection annually. Load tests are performed at facility startup as specified in the crane and hoist inspection program. Monthly inspections and lubrication on all cranes and hoists are performed under the preventive maintenance program.

5.5 Fuel Segregation

The fuel segregation activity consists of separating the Mark IV fuel stored in the KE facility into weapons stock, low blend stock, high blend stock, and remains stock. The segregation activity is conducted in the reactor discharge-pickup chute area, Figure 1.1.

The equipment is designed:

- To process nine canisters of fuel per eight hour shift.
- For five years underwater service.
- For installation and removal without draining the pit.
- To withstand the effects of high gamma radiation.
- To limit personnel exposure to ALARA.

The design criteria[11] provides additional design parameters.

5.5.1 System Description

The fuel segregation activity involves moving individual canisters of fuel stored in the KE basin into the discharge-pickup chute area. There the canisters will be emptied and the inner and outer elements measured for their Pu-240 content. Matching stock elements will be reassembled and canisters refilled with matching assemblies. The filled canisters, with identification covers, will be relocated in the basin.

5.5.2 Components

Following is a brief description of the major equipment pieces which were designed by Kaiser Engineers Hanford, fabricated and installed by J. A. Jones Construction Service Co., and directed by UNC Nuclear Industries. The general arrangement of equipment is shown in Figures 2.4 and 5.18.

5.5.2.1 Canister Dumper (Figure 5.19)

The canister dumper consists of a tilting table on which a canister of fuel is placed. The canister is laid on its side, the table is tipped so the fuel will slide out of the canister. The dumper is hydraulically controlled from the operating floor. The hydraulic fluid is demineralized water with ethylene glycol added for lubrication.

5.5.2.2 Disassembler-Detector (Figure 5.20)

The hydraulically operated disassembler separates the inner from the outer element. The inner element is pushed into the inner detector while the outer element is retained in the outer detector. The detectors scan each element, measuring the ^{240}Pu content. The detectors are cooled by chilled air supplied from an independent system. Data from the detectors is fed through a computer with a digital readout on the operators desk on the work platform. Hydraulic lifters deposit the measured fuel on the pickup tray.

5.5.2.3 Reassembler and Repackaging System (Figure 5.21)

The reassembler recombines the inner element with the outer element and is capable of recombining two assemblies simultaneously. The assemblies are then placed in canisters by the canister repackager. All operations are hydraulically powered and controlled from the operating floor.

5.5.2.4 Peripheral Equipment

Peripheral equipment includes:

1. Five single canister tables, one at the end of and two at the side of the dumper and two for refilled canisters at the canister repackager.

2. Two trolley hoists equipped with canister hooks shorter than those used in the basin. These shorter hooks (which can lift canisters to within seven feet of the surface) are used to place canisters on and off the segregation equipment.

3. Air tongs, which are manually operated, flotation counter-balanced manipulators for handling fuel assemblies or elements from the work platform.

4. Detector calibration sources and holders are provided for the different fuel exposure catagories.

5.5.3 Sequence of Operation

Single canisters are moved from their storage location by one of the existing trolley hoists into the segregation pit from the main storage basin and placed on a single canister holding table. The canister is removed from the table and placed on the canister dumper by one of two trolley hoists equipped with special (shortened) canister hooks. The fuel elements are dumped from the canister. Flotation-counterbalanced tongs (air tongs) similar to those used in N Basin are used to place the fuel assemblies in the outer segment detector. The hydraulically operated disassembler shoves the inner element out of the outer element and into the inner element detector. Depending on the direction the inner element is moved, disassembly results in shearing either the locking clip or the positioner stop and also may damage or remove some of the support feet. Following disassembly the detectors and computer system determine the Pu-240 content of each element. Hydraulic lifters remove the elements from the detectors and place them on the pickup tray. Air tongs are used to place the analyzed elements into one of three storage racks according to their Pu-240 content (weapons stock, low blend stock, and high blend stock). Remaining stock elements (12wt % Pu-240) are immediately reassembled and placed in canisters. When sufficient matching elements have been accumulated, tongs are used to individually place them in the hydraulically powered reassembler. The reassembler reinserts the inner element into the outer element and reloads the fuel asemblies into canisters. Because the support feet may have been damaged during disassembly, the inner element may not be concentric with the outer element. However, this has routinely occurred in the past and does not impact safe storage of the fuel. The second trolley hoist with a special hook removes the loaded canister from the equipment. A category identification lid is placed on each canister. A standard basin hoist moves the canister out of the segregation area and places it back into an assigned main basin storage rack.

Fuel element debris will accumulate at the canister dumper and disassembler detector. The debris consists of segments of broken fuel elements, support feet, and "W" springs. Such debris will be placed in canisters (broken fuel separate from other debris), which when full will be stored in a main basin floor storage rack.

5.5.4 Safety Analysis

The safe hemispherical masses established in Reference 6 for unirradiated Mark IV fuel (unirradiated fuel is more reactive than irradiated fuel) are:

1. 7722 pounds of uranium for assembled fuel assemblies, which is equal to 149 of the heaviest assemblies, or

2. 6963 pounds of uranium for outer elements, which is the equivalent of 198 of the heaviest outer elements, or

3. 3927 pounds of uranium for inner elements, which is the equivalent of 238 of the heaviest inner elements, or

4. 3451 pounds of uranium for broken fuel segments, which is the equivalent of 66 of the heaviest fuel assemblies.

The equipment is arranged such that the major components are separated by more than the 10 inch neutronic separation under water required for safe masses as established in Reference 6.

The safe mass assures that double batching of two safe masses under accident conditions will not exceed k-effective of 0.98.

The segregation activity should not significantly affect the amount of radioactive material in solution, consequently there will be no increased load on the ion exchanger (demineralizer resins). The canisters have holes in the bottom, and since the particulate matter settles to the bottom it is partially flushed out as the canisters are lifted and moved. The rest of the particulate matter is dumped along with the fuel on the canister dumper. Some additional particulate matter will be released when the fuel is disassembled. Most of it will quickly settle to the floor.[40] A small amount of suspended particulates will end up in the filters, which, at the most, will increase the frequency of filter cartridge change-out or backwash of the sand filter. Filter cartridge change-out and sand filter backwash is performed when the differential pressure across the filters indicates that the maximum filter loading has been reached, or when the operational frequency limit is reached, as described in facility operating procedures. The impact of sludge and dissolved corrosion products on criticality were considered in the criticality evaluation described in Reference 8. It concluded criticality is not possible in such low enriched (0.95wt % U-235) uranium solutions and sludges. (See Section 5.7.4.2 for a discussion of the effects of decapping 1.25wt % U-235 fuel.)

A canister full of broken Mark IV fuel scrap is more reactive than a canister full of unbroken Mark IV fuel. However, it is less reactive than a canister full of unbroken Mark IA fuel. Therefore, dropping a single canister of broken fuel segments will be less of a reactivity perturbation than dropping multiple canisters of Mark IA in a one over three configuration, which was analyzed in Reference 3. Since such a canister drop would occur under water, there would be no releases to the environment.

Storage of canisters with broken fuel segments in a one over three configuration has not been analyzed for a multiple canister drop. Because of the limited amount of broken fuel segments expected, such an analysis is not planned. Therefore, canisters of broken fuel segments are limited to floor storage only.

Low exposure fuel is more reactive than higher exposure fuel or the average unsegregated fuel. However, low exposure Mark IV fuel is less reactive than Mark IA fuel[3]. In addition, all criticality calculations are based on unirradiated fuel. Therefore storage of low exposure fuel is safe even in a one over three configuration.

The equipment operates hydraulically using demineralized water as the hydraulic fluid. Up to 5% ethylene glycol may be added to water to provide lubrication. Leakage from the hydraulic system into the basin coolant is expected. However, the effect of the ethylene glycol on the filters or demineralizer resins should be negligible.[41]

5.5.5 Test and Inspections

Appendix C of Design Change DC-82180 provides the acceptance test procedure that demonstrated the ability of the segregation equipment to function as designed. The equipment is under water and its intended period of use is two years. Any breakdown will require removing the equipment from the pool for repair.

5.6 Railroad Track and Equipment

The railroad track and equipment are under the control of the Rockwell Hanford Co. The derailers, heavier railstops and bumpers were installed under Project H-501, H-508 & H-558. The rail bumper on the northern spur was removed and replaced under DC-82121 in KW.

Procedures are in place requiring a UNC facility supervisor or other qualified person (as defined in Facility Operational Safety Standards) to control entry into either facility.

5.6.1 System Description

A railroad switch, which is kept in the position for entry into KE, controls entry to the facility. The switch to the auxiliary railspur, located in front of the derailer on the KE line will normally be kept open, diverting any runaway trains away from the KE facility. Derailers are provided outside of the facilities to derail trains unless a UNC supervisor unlocks and deactivates the derailer. Within the derailers is a second switch which allows the rail car to enter the facility on one of two tracks. This switch

is kept in position so that the south track will normally be used. Within the facility at the edge of the basin, rail stops and/or bumpers are provided on both tracks to prevent a rail car from entering the basin should the engineer fail to stop the train.

5.6.2 Components

5.6.2.1 Derailers (Figure 5.22)

The derailers are installed 520 feet from the rail terminations at the side of the basin. The derailers are designed to derail a one-car train traveling at a speed of up to 5 mph. A derailed train would enter a loose gravel area which would then completely stop it. The derailers are locked in the active position and are unlocked and opened by a UNC supervisor only after the train has stopped adjacent to the derailers.

5.6.2.2 Rail stops (Figure 5.23)

Rail stops are provided on the rail spurs entering each facility. Stops are designed to lift the train thereby absorbing kinetic energy. The maximum amount of energy that can be absorbed is estimated to be 31,500 ft-lbs.

5.6.2.3 Bumpers (Figure 5.24)

In addition to the rail stops a spring loaded bumper is mounted on a beam connected to two building columns. The combination of bumper and structural member deformation will absorb about 59,000 ft-lbs.

5.6.2.4 Bumping Posts

Bumping posts permanantly embedded into the rails will be installed on the northern rail spurs entering each facility, to protect the auxiliary on exchange modules. The posts are designed to absorb a maximum energy of 252,000 ft-lbs.

5.6.2.5 Crash Car or Rail Spur

A railroad car (crash car) loaded to a weight equal to or exceeding that of the heaviest cask car may be positioned, with brakes locked, 200 feet or more ahead of the KE derailer. The car will absorb the impact of an uncontrolled train to stop or reduce the train speed to derailer capability. Alternatively, the switch to the auxiliary rail spur may be locked open, to divert an uncontrolled train away from the basin.

5.6.3 Sequence of Operation

- The railroad track switch west of KW area which routes the train to either the KW or KE storage basin shall always be in the KE position except when the train is actually entering, within, or exiting the KW storage basin area.

- To slow down and then stop or derail a runaway train approaching the KE fuel basin, a railroad car, weighing 230,000 pounds or more, shall be parked with brakes locked on the KE track leading to the storage basin, at a distance of 200 feet or more west of the KE basin derailers. This car shall be in the above position whenever a train is not entering, within, or exiting from that point toward the derailers. Normally the train crew will move this car to the second KE facility track to have access to the KE facility, and reposition it in its protective position when the locomotive leaves the facility.

- An additional rail spur is located at the entrance to KE. This switch for this rail spur may be locked open, to divert any runaway train away from the KE basin. If the switch is so positioned, the crash car need not be present.

- The train derailer devices shall not be opened until the train has come to a full stop before them and a UNC lock has been installed on the locomotives throttle return and throttle position limiting device, if an old model locomotive (see section 5.6.4) is used. If a new model locomotive is used, before the lock is removed the Pace Setter controls must be verified to be in the required positions.

- When entering the storage basin transfer area, the fuel transfer train shall be controlled at a speed not greater than 2 mph. A Fuel Processing Supervisor, or other qualified person, shall ride the locomotive cab whenever a cask car is being moved into the storage basin transfer area to ensure by a trip of the emergency stop that the train speed does not exceed 2 mph. An increase in speed is detected by increased locomotive engine noise, in the old model locomtives, or by the vehicle speedometer in the new model locomotives.

  The UNC Supervisor, or other qualified person, is essentially a safety backup for the engineer. He will exercise his best judgement in determining when speed is excessive and when the engineer is not responsive for timely application of the emergency stop switch.

5.6.4 Safety Evaluation

A railroad cask car entering the basin could damage the building structure, the fuel handling equipment, and the basin. Possible consequences are loss of coolant or a criticality caused by geometrical rearrangement of stored fuel. Procedures and mechanical controls are in place to the extent that the probability of such an event is negligible.

There are two locomotive types (an old and a new model) used to deliver cask cars to the facilities. The principal difference of interest between them is in their speed control. The old model is completely manually controlled, while the new model is equipped with an optional electronic speed control. Each is provided with an emergency stop switch.

On the first type the manual control can be locked at a 2 mph setting. However, a finely tuned engine could reach a speed of 4 mph at the 2 mph setting. The UNC supervisor, who boards the locomotive after unlocking and deactivating the derailer, locks the throttle in the 2 mph position and rides the locomotive until the cask car is positioned and the locomotive is back outside of the derailer. An emergency switch is available should the speed exceed 2 mph. Excessive speed is determined by engine noise.

The other type of locomotive has two modes of operation, manual and automatic. A master switch must be in the "Manual" or "Pace Setter" position. The Pace Setter control unit is an electronic device capable of very exact speed controls. The Pace Setter is equipped with a three position speed range selector (0.1 to 1 mph, 1 to 10 mph, and 10 to 100 mph). A speed dial can be set to any speed in any of the three ranges. The Pace Setter also has a "Manual-Auto" switch which must be in the Manual position in order for the train to start moving, it must then be put in the "Auto" position for automatic speed control. The UNC supervisor also boards this type of locomotive at the derailer. He ensures that the Engineer has all switches and dials in the proper position and that the Engineer flips to "Auto" appropriately. An emergency stop switch is available if necessary. Excessive speed is determined by a digital speedometer reading in one mph increments.

The railstops and bumpers combined on the southern rail spur are designed to stop a one car train at a speed of 2 mph. The rail stops will absorb half the kinetic energy (31,500 ft-lbs) of a one car train moving at 2 mph[40]. The shock absorbers are designed to absorb about 59,000 ft-lbs. Total kinetic energy of a one car train moving at 2 mph is 63,100-ft-lbs[40].

The bumping posts on the northern rail spur are designed to stop a one-car train moving at 4 mph.[43,44] Total kinetic energy of a one-car train at 4 mph is 252,000 ft-lbs.

The derailers are designed for 5 mph train speed. Procedures require the train to stop in front of the derailer. The UNC supervisor will then unlock and deactivate the derailer and board the locomotive for the slow speed entry into the facility.

To prevent an uncontrolled train from entering the KW Facility the switch diverting to KW is locked in the KE position. At KE the crash car, spotted with locked brakes, will slow the train, or the switch will divert the train onto the auxiliary railspur away from the basin. Procedures direct the respotting of this crash car when the locomotive leaves the KE facility, or the relocking of the switch.

A two-car train is prohibited from entering either facility beyond the derailers.

5.6.5 Testing & Inspection

Testing and inspection of rail equipment and track are the responsibilities of Rockwell Hanford Co.

5.7 Decapping/Recanning

Fuel encapsulated in Mark I canisters must be repackaged into other canisters prior to shipment to PUREX because of incompatibility of the Mark I grafoil seals with the PUREX process. Since PUREX does not have a decapping capability, Mark II canisters will also be required to be decapped prior to shipment.[42]

Decapping facilities will be located in both the KW and KE basins. The KW decapping station will be in the transfer canal between the loadout pit and the western bay of the basin. The KE decapping station will be adjacent to the existing segregation equipment, in the pickup chutes.

The equipment is designed to:

- decap Mark I and Mark II canisters in the KE pickup chutes;
- provide a contamination control system for decapping operations in the pickup chutes;
- repackage fuel into grafoil free canisters;
- decap Mark II canisters in the KW transfer canal;
- provide a contamination control system for decapping operations in the transfer canal.

5.7.1 System Description

The decapping activity in KW involves moving individual Mark II containers to the transfer canal, decapping them, and then loading the decapped canisters into transfer casks for shipment to PUREX. Mark I decapping will be more complicated, since these canisters will be snipped from KW to KE, decapped and dumped, the fuel then processed through the segregation facility (if necessary) and then either stored in open canisters in the basin, recapped and stored (in Mark II canisters), or shipped directly to PUREX.

5.7.1.1 KW Decapping System

A decapping station[43] will be provided in the KW transfer canal, only to be used for Mark II decapping. A purging tool will be used over the decapped canisters to flush out contamination. An under-water manifold and associated pumps and piping will be used as a suction device to remove the contaminated water from the canal and process it through the auxiliary ion exchange modules. These modules will be installed on the center rail tracks in the transfer bay. A barrier door will be placed at the transfer canal entrance to provide additional contamination control to the main basin. Tools used will be similar to those in use at N-Basin to encapsulate and decap Mark II canisters.

5.7.1.2 KE Decapping System

The decapping station in KE[44], primarily to be used for Mark I decapping, will be integrated with the existing segregation equipment. A flushing system similar to KW will be used to remove contaminants from the decapped canisters. The auxiliary ion exchange modules will be located in the same place as in KW, necessitating some longer piping runs to deliver and return the processed water. Tools similar to those used in KW will be provided for use in KE. Mark II canister capping will be possible in KE.

5.7.2 Components

Following is a brief description of the major components of the two decapping systems.

5.7.2.1.1 KW Decapping Station

The decapping station in KW consists of a receptacle capable of holding only one canister with a single storage rack capable of holding one additional canister attached (additional storage racks capable of holding two canisters are located at the entrance to the transfer canal, see section 5.7.2.4). The

suction manifold for the ion exchange system is attached to the top of the receptacle where it can remove the contaminants flushed out by the purging tool.

5.7.2.1.2 KE Decapping Station

The decapping receptacle in KE is similar to KW except that a six canister storage rack is attached.

5.7.2.2.1 KW Auxiliary Ion Exchange System

The auxiliary ion exchange system (IXM) consists of the suction manifold in the receptacle, a 150 gallon per minute shielded pump, two ion exchange modules which contain six tanks each and a return line to the west bay of the basin. A composite sampling system is used to determine radionuclide concentrations in the modules.

5.7.2.2.2 KE Auxiliary Ion Exchange system

The ion exchange system in KE is similar to KW, with the ion exchange return line outlet located close to the disassembler/detector.

5.7.2.3.1 KW Purging Tool

Removal of soluble contaminants from the decapped canisters is accomplished by lowering a showerhead type purging tool over the open canister and spraying basin water into it. This will cause the soluble contaminants to be flushed from the canister and into the manifold where they will be transported to the IXMs. A separate pump and associated piping is used to provide the necessary water pressure for this system.

5.7.2.3.2 KE Purging Tool

The system in KE is similar to that used in KW.

5.7.2.4 Peripheral Equipment

At KW there are two single canister storage racks at the entrance to the transfer canal from the loadout pit.

At each basin, protecting the auxiliary ion exchange modules from a one-car train impact, is a bumper capable of stopping such a train with a speed of up to four mph.

Other peripheral equipment includes miscellaneous handling tools as described elsewhere (e.g. Sec. 5.5.2.4), for each facility.

5.7.3 Sequence of Operation

The following sequences will be followed at each facility to process canisters.

5.7.3.1 KW Basin Decapping Sequence of Operation

At the beginning of each operation, flow will be established through the contamination control manifold, the ion exchange modules, and the purging tool. The water sampler will be set up. Necessary flow and pressure checks, tool inspections, and radiation monitoring will be completed.

The desired canister will be located in the storage basin, transferred through the barrier wall at the entrance to the transfer channel, and placed in the decapping station in the transfer channel. The canister will be decapped and the lids placed in a temporary storage container for later disposal. The purging tool will be positioned onto the open canister to flush contaminants from the canister via the contamination control manifold, into the IXM. When the flush cycle has completed, the purging tool will be removed from the canister. The canister will be moved from the decapping station and placed into the temporary storage rack or into the cask, if available.

At the end of each operation, the purging tool will be shut off. The contamination control system may be left on to remove soluble contamination from the transfer channel area, or valved to remove soluble contamination from the storage basin.

5.7.3.2 KE Basin Decapping/Repackaging Sequence of Operations

The sequence of operation for KE will be similar to KW (except for the difference in station location), up to the end of the canister purging cycle. From there, the fuel will be removed from the canisters with the segregation equipment, go through the segregation operation if desired, and then repackaged into grafoil free canisters at the other end of the segregation equipment. The loaded canister will be placed into temporary storage or into a shipping cask if available.

The end of operation sequence will be the same as for KW.

5.7.4 Safety Analysis

Introduction of Mark IA fuel into KE required a re-evaluation of nuclear criticality safety limits in those areas in which this higher enriched fuel will be processed, stored, or transported. Additionally, an analysis of the impact of sludge and dissolved corrosion products on criticality was performed to take into account the higher enriched sludge which could result from

decapping canisters containing Mark IA fuel.[7] Finally, a safety analysis of the new auxiliary ion exchange modules, which will be located on the tracks of the northern rail spur, was completed.

5.7.4.1 Effect of Decapping Station Activity on Basin Operations

5.7.4.1.1 KW Basin

The decapping station must meet the hemispherical safe mass storage requirements of Table 5.4. All canisters containing fuel must be recapped before being returned to the main basin.

Canisters containing Mark IA scrap may be significantly more reactive than canisters filled with unbroken fuel. They will require separate storage areas and may not utilize hanging storage. Operational Safety Requirements and Process Standards will specify how these requirements will be met.

5.7.4.1.2 KE Basin

The major change caused by the initiation of the decapping effort in KE is the introduction of higher enriched Mark IA fuel assemblies into the basin. The criticality limits previously established in the segregation area were based on Mark IV fuel only. Therefore, the adequacy of these limits must be re-established or modified to take the higher enriched Mark IA fuel into account. Table 5.4 shows how the hemispherical safe mass limits have changed. As can be seen, there is a significant decrease in the safe mass of assemblies, outers, and scrap. Modifications to the segregation equipment will be required when Mark IA fuel is being processed, to ensure these limits are not exceeded. Specific requirements must be given governing the storage of canisters containing Mark IA scrap. These canisters will be the most reactive in the basin. They will require separate storage areas and may not utilize hanging storage.

Operational Safety requirements and Process Standards will specify how these requirements will be met.

5.7.4.2 Analysis of Effect of Higher Enriched Dissolved Fuel

If the uranium to plutonium ratio, as found in the spent fuel, is maintained, any basin operation, including corrosion of fuel elements and sediment buildup, can be conservatively covered by using unirradiated uranium critical mass limits.

However, it is possible for certain chemical reactions to occur whereby the uranium to plutonium ratio in solutions and sludges is perturbed. Therefore, conservative assumptions must be made to protect against possible buildup of

higher concentration of plutonium in vessels, pumps, and pipe. Since knowledge of how much the uranium to plutonium ratio has been perturbed will not be available before the event, the most conservative plutonium limits must be followed.

Table 5.4 shows the nuclear criticality safety limits established using the above criteria. Operational requirements for periodic monitoring of gamma radiation from all pumps, piping and pump drip catch pans will be developed to provide trend information to indicate any radioactive material buildup.

Sludge layer limits apply to both KE and KW basins, even though use of encapsulated canisters in KW has significantly reduced the sludge buildup problem.

These limits are very conservative and will ensure safe operation of the equipment and areas analyzed.

5.7.4.3 Auxiliary Ion Exchange Modules

Table 5.6 is an estimate[45] of the maximum allowable radionuclide buildup in the ion exchange modules used in the K-Basins. It is assumed that the zeolite modules in KE will remove 100% of the influent cesium, 40% of the influent strontium, and 10% of all other isotopes, while the mixed bed resin will remove 100% of all influent radionuclides. As can be seen, at the time of change out, the KE IXM's could contain 800 Ci of radionuclides, while KW could contain over 2900 Ci. The IXM's are set up in groups of two, so potentially there could be 1600 Ci in KE, 5800 Ci in KW.

These modules will be located on the northern rail spurs coming into both of the basins. Thus, there is a potential for a one car train to impact on these modules, with a resulting release of radioactive contamination. Even if only 1% of the burden were released, this would be a significant release, with all the associated cleanup problems.

To eliminate the possibility of this type of accident, a rail bumper, capable of withstanding an impact of a one car train (235 tons) traveling 4 mph, has been installed. Since the train size is limited to one car and the train speed is limited to 2 mph (Sec. 5.6), the possibility of this accident is essentially eliminated.

TABLE 5.1

DESIGN AND OPERATING PARAMETERS FOR EACH COOLING POOL SYSTEM

Recirculation Pumps	
Number of Units	2
Design Pressure, psig	75
Design Temperature, °F	100
Design Flow, gpm	500*
Material	Cast Grey Iron

*The KE backup pump is rated 300 gpm at 140 psig

Skimmer Pump	
Number of Units	1
Design Pressure, psig	60
Design Temperatuare, °F	100
Design Flow, gpm	400
Material	Cast Grey Iron

Heat Exchangers	
Number of Units	1
Design Heat Transfer, BTU/hr (Kw)	7.85 E6 (2300)

	Shell	Tube
Design Pressure, psig	100	100
Design Temperature, °F	200	250
Design Flow, gpm	1000	1500
Inlet Temperature, °F	100	70
Outlet Temperature, °F	86	79

TABLE 5.1 cont.

	105 KW	105 KE
Fluid Circulated	Demineralized Water	Filtered Water
Material	Steel ASTM A-285 Gr "C"	ASTM B-111 cupro-nickel (90-10 annealed)
Water Chiller		
Number of Units		1
Design Heat Transfer, BTU/hr (Kw)		2.4 E6 (700)
Design Flow, gpm		500
Outlet Temperature °F		55
Recirculation Filters		
Number of Units		2
Design Pressure, psig		150
Design Flow, liters/sec (gpm)		1000
Filtration Requirement		5 micron
Material (Structural)		Carbon Steel
Ion Exchange Tanks		
Number of Units		3
Design Pressure, psig		75
Design Flow, gpm		50
Resin Capacity, ft^3		5
Material (Structural)		Carbon Steel

TABLE 5.1 cont.

Auxiliary Ion Excnange Tanks	
Number of Units	2
Design Pressure, psig	60
Design Flow, gpm	160
Resin Capacity, ft^3	21
Sand Filter	
Number of Units	1
Design Pressure, psig	90
Design Flow, gpm	400
Material (Structural)	Carbon Steel
Skimmers	
Number of Units	3
flow Rate, gpm	100
Acid Injection Pump	
Number of Units	1
Design Pressure, psig	2000
Design Flow, ml/min	15
Design Temperature, °F	100
Material	Carpenter 20 SS
Caustic Injection Pump	
Number of Units	1
Design Pressure, psig	2000
Design Flow, ml/min	15
Design Temperature, °F	100
Material	Carpenter 20 SS

TABLE 5.2

COOLING POOL SYSTEM DESIGN DATA

Maximum Racked Irradiated Fuel Storage Capacity,	metric tons	-	1648
Maximum Hanging Irradiated Fuel Storage Capacity,	metric tons	-	375
Volume (Water),	ft^3	-	1.37E5
	gal		1.02E6
Normal Water Level,	feet		16.0

TABLE 5.3

IMPACT OF THE INTRODUCTION OF MKIA ON HEMISPHERE MASS LIMITS

	Hemisphere Safe Mass (lb U)*	
	MKIV	MKIA
Assemblies	7722	2052
Outers	6963	1524
Inners	3927	3927
Scrap (rods)	3451	744

*The safe mass assures that bringing two safe masses together under accident conditions will not exceed k-eff of 0.98. These safe masses, 33% of the hemispherical critical masses, are conservative because the safety factor ranges from about 33% to 45%, for the cases listed above, for the safe mass equal to one-half of the mass for k-eff = 0.98.

TABLE 5.4

NUCLEAR CRITICALITY SAFETY LIMITS, FOR EQUIPMENT AND AREA, BASED ON DISSOLVED FUEL CONSIDERATIONS

Nuclear Criticality Safety Lmits

Equipment	Mass	Dimension	Sludge Layer
Pumps	---	ID 15.9 inches	---
Piping	---	ID 15.9 inches	---
Pump Drip Catch Pans	---	Height 5.8 iches	---
Canister Receptacle	---	---	Thickness 5.8 in.
IXMs	225 g Pu/set	---	---
Area			
Main Basin (KE/KW)	---	---	Thickness 5.8 in
Fuel Segregation (KE)	---	---	Thickness 5.8
inUecapping Station (KW)	---	---	Thickness 5.8 in

TABLE 5.5

RADIONUCLIDES IN SPENT ION EXCHANGE MODULES

Isotope	KE zeolite module	KW mixed bed module
Cs-137	210 CI	210 Ci
Cs-134	13 Ci	28 Ci
Co-60	0.14 Ci	2.20 Ci
Mn-54	0.30 Ci	6.04 Ci
Sr-90f	600 Ci	2700 Ci
Fissile	16 gm	6.6 gm

FIGURE 5.1

FUEL POOL HANGERS

FIGURE 5.2

ENGINEERING FLOW DIAGRAM PT

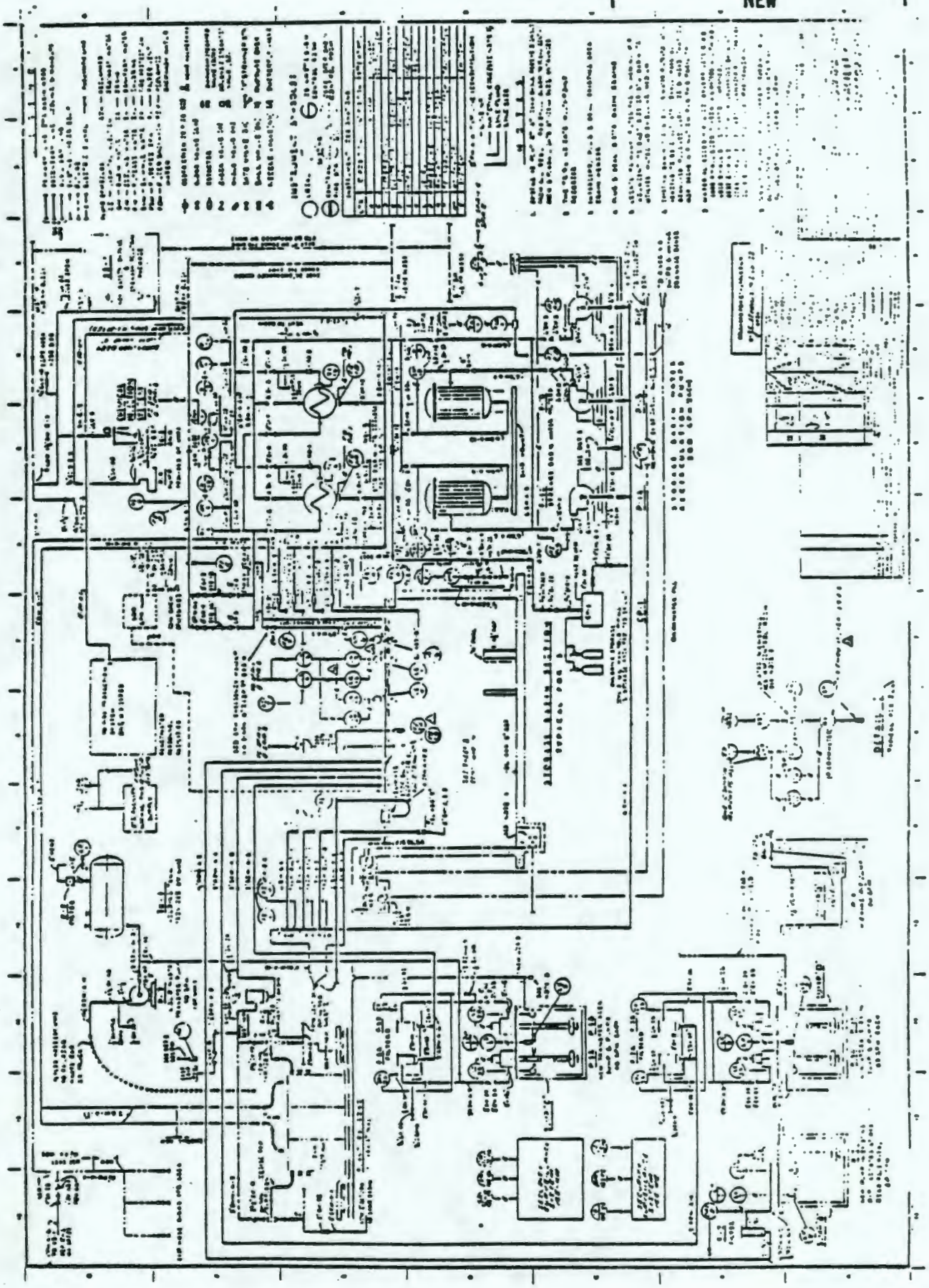


FIGURE 5.3

ENGINEERING FLOW DIAGRAM PT 2

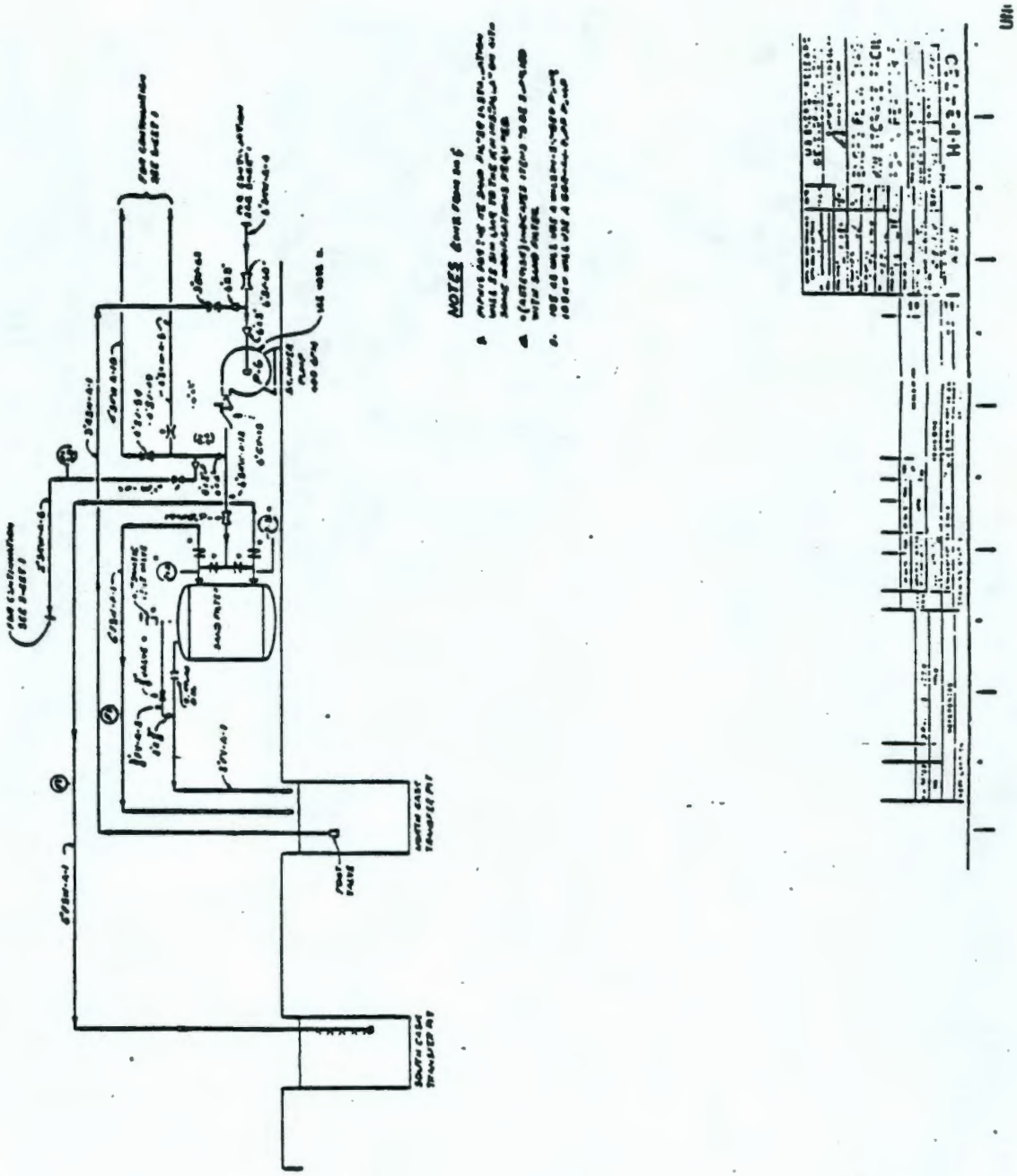


FIGURE 5.4
COOLING POOL RECIRCULATION PUMP

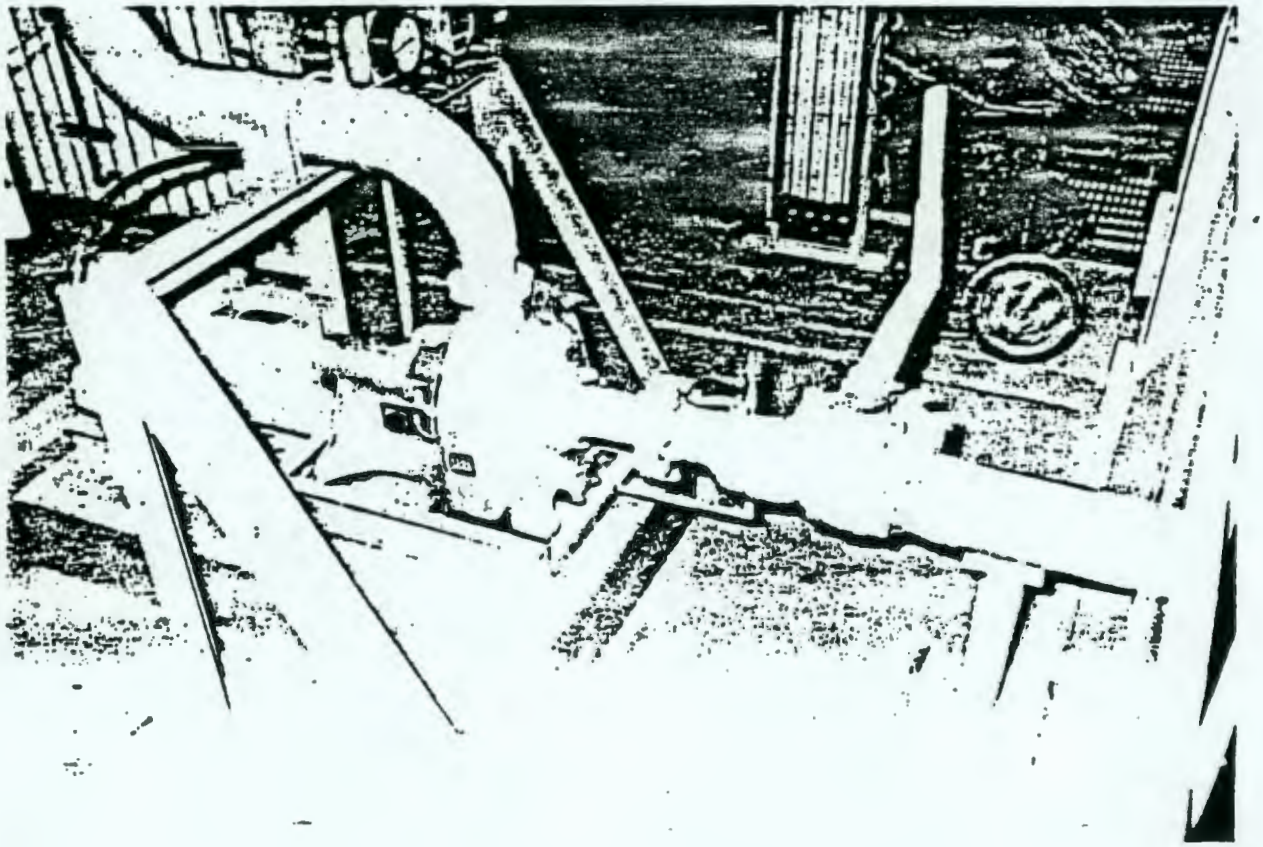


FIGURE 5.5

COOLING POOL RECIRCULATION FILTERS

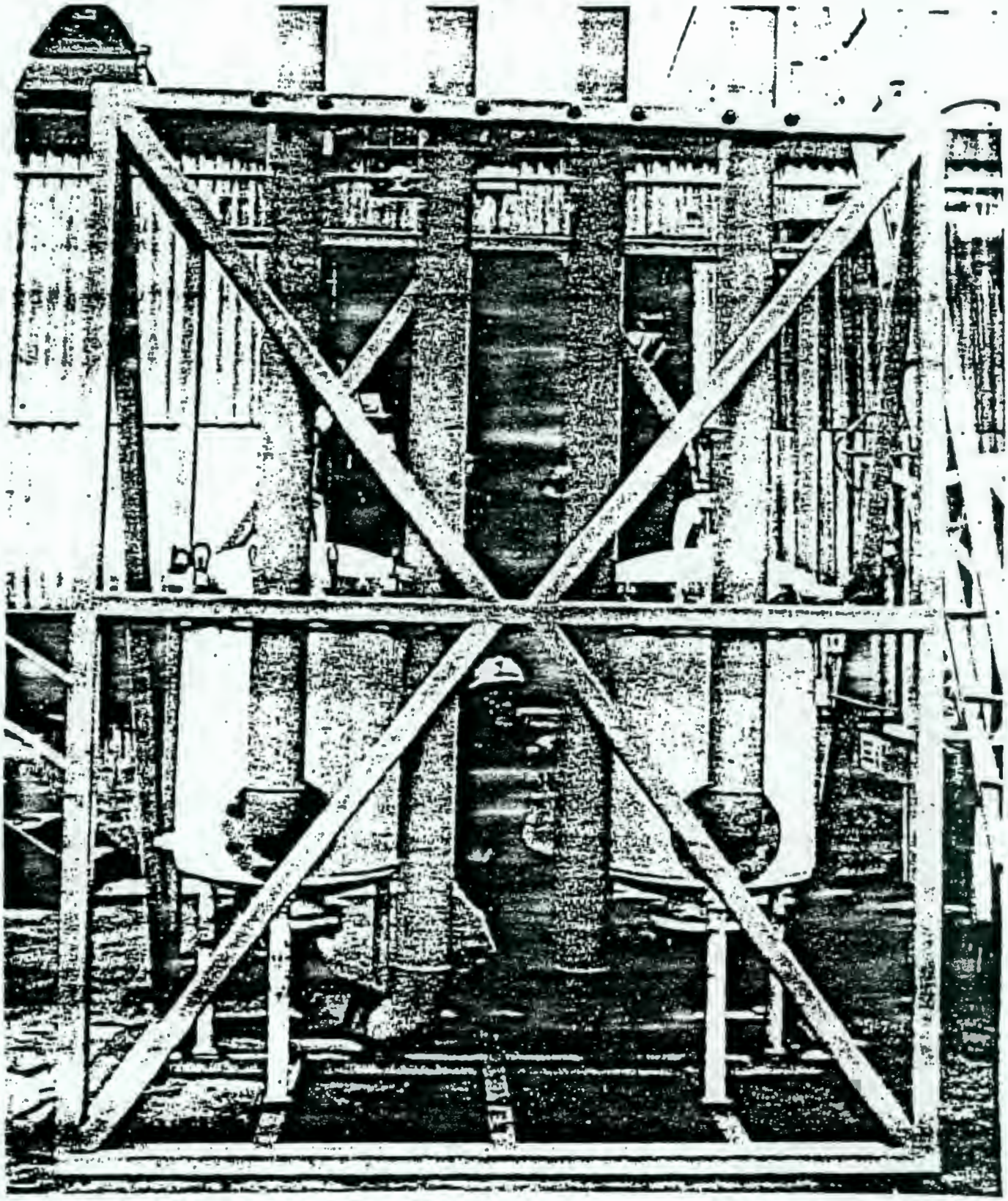


FIGURE 5.6

COOLING POOL HEAT EXCHANGERS

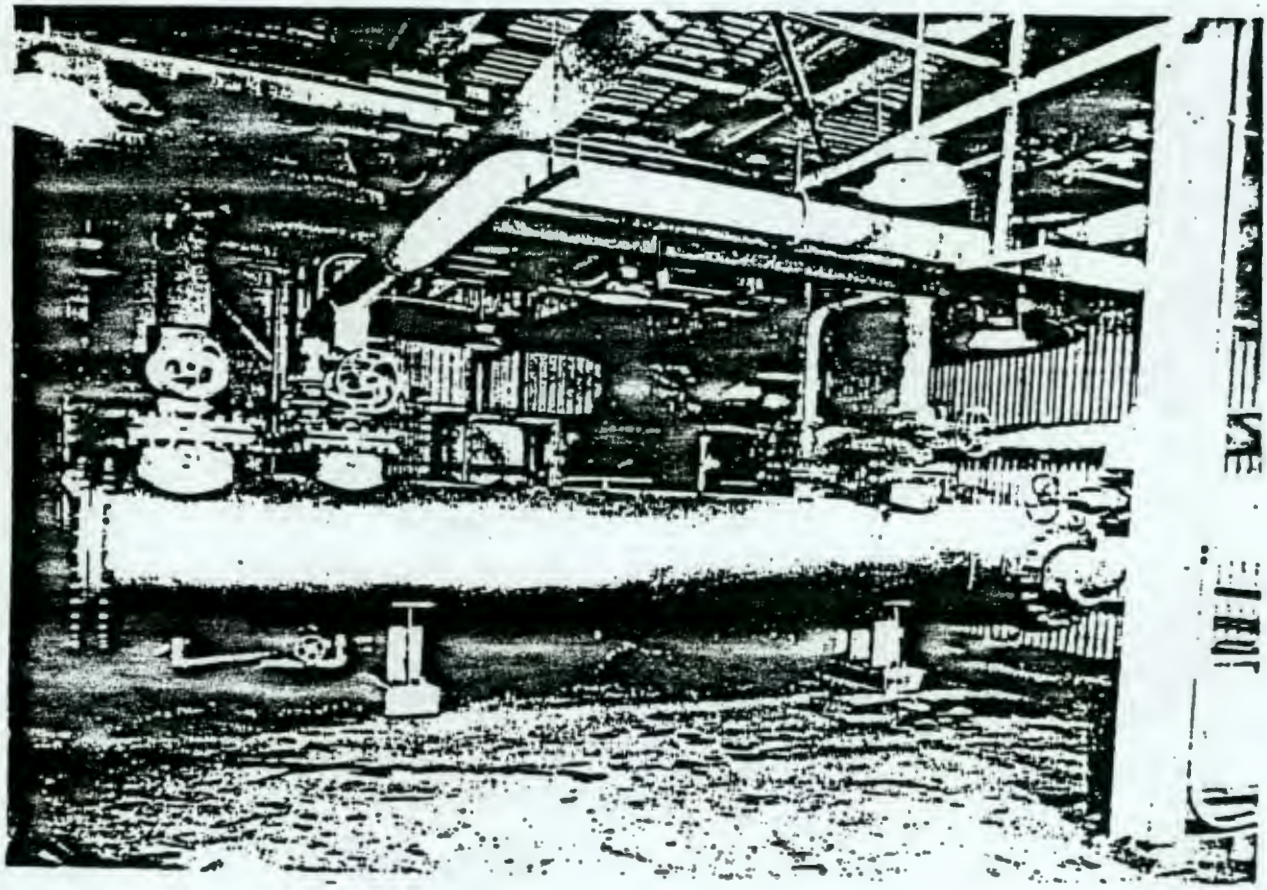


FIGURE 5.7

ION EXCHANGE SYSTEM

A - ION EXCHANGE SYSTEM CONTAINER WITH THREE ION EXCHANGE TANK WELLS

B - INDIVIDUAL ION EXCHANGE TANK WELL

FIGURE 5.8
LIQUID WASTE TRANSFER PUMP

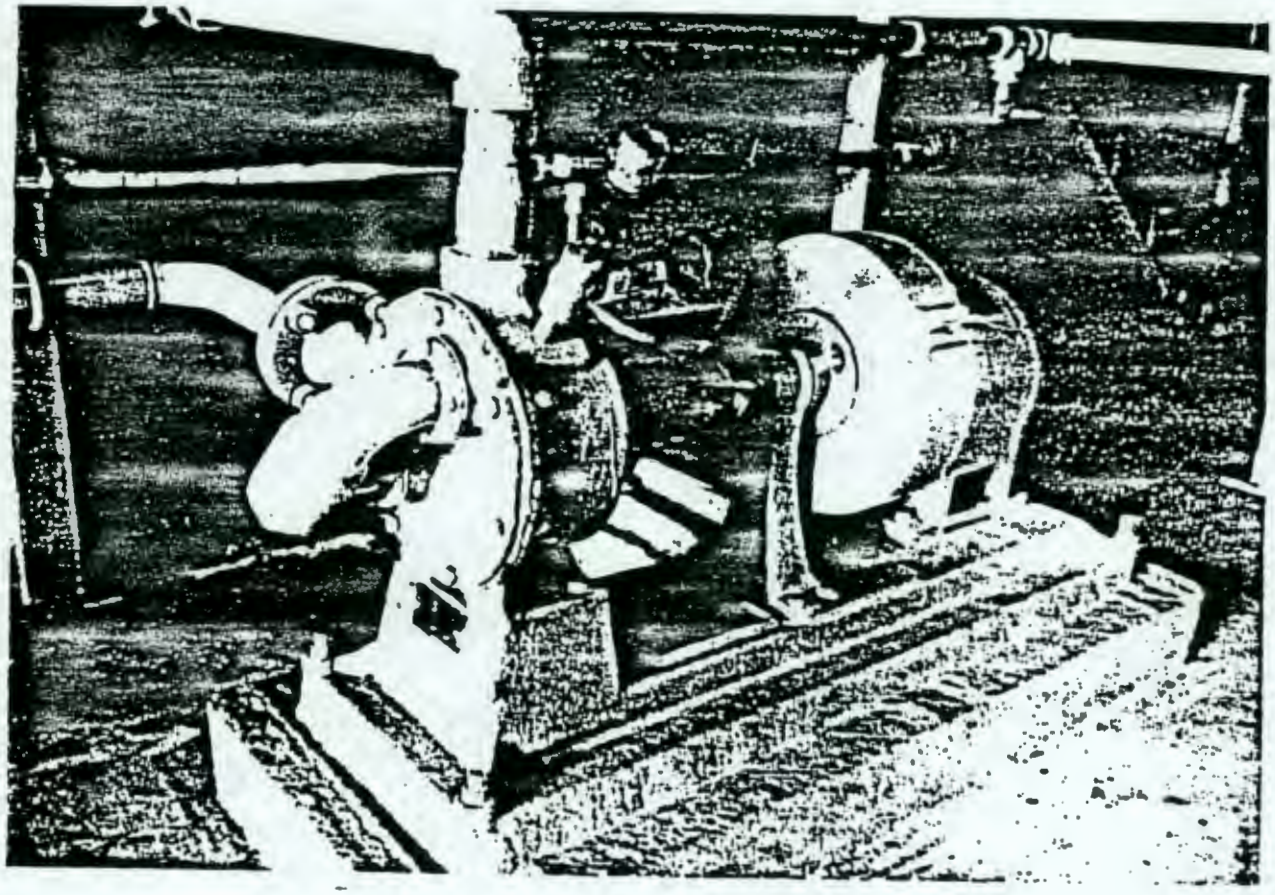


FIGURE 5.9

CATCH TANK PUMPS

FIGURE 5.10

IRRADIATED FUEL CASK TRANSFER AREA SUMPS

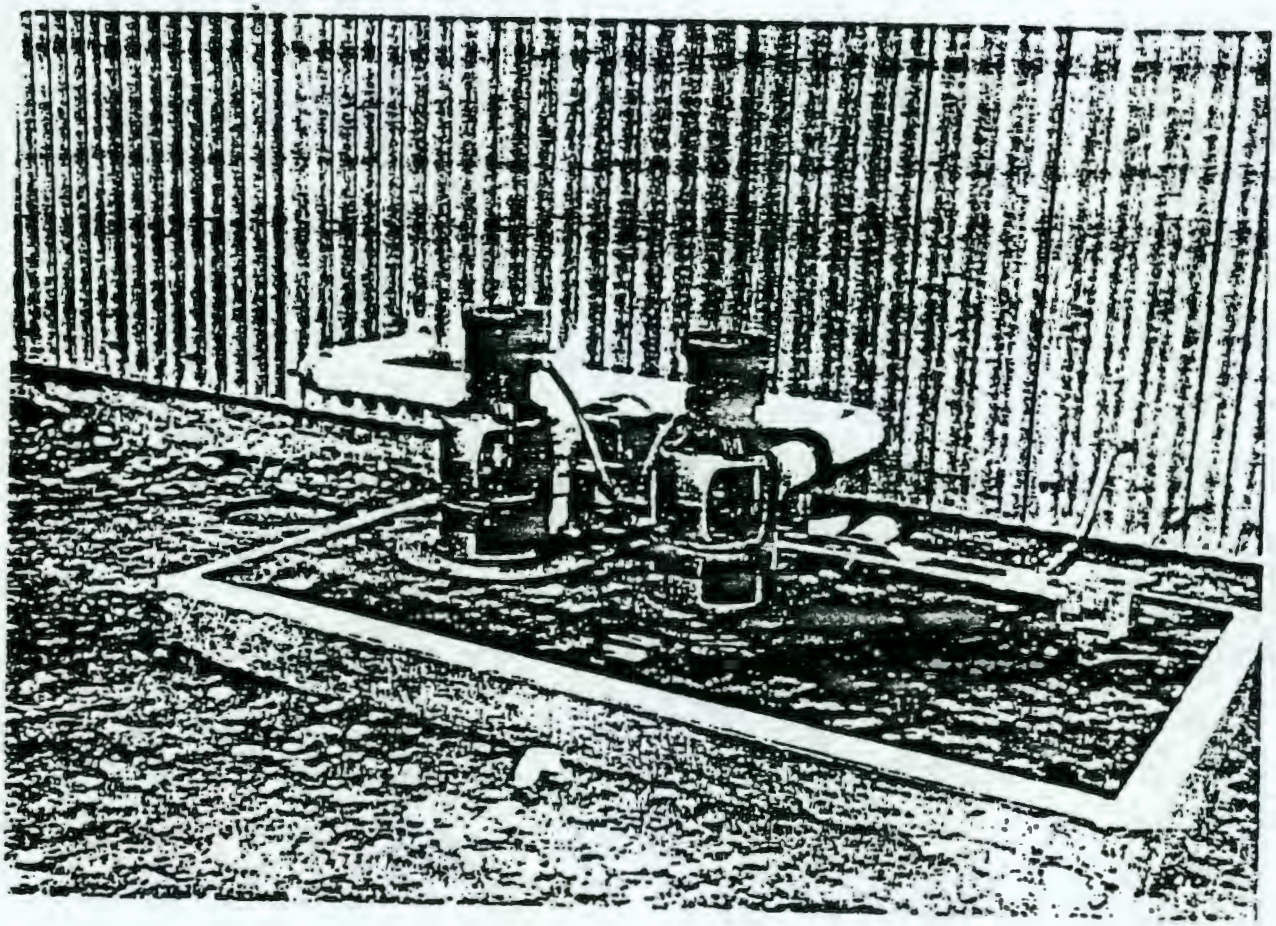


FIGURE 5.11

RAILROAD CASK CAR

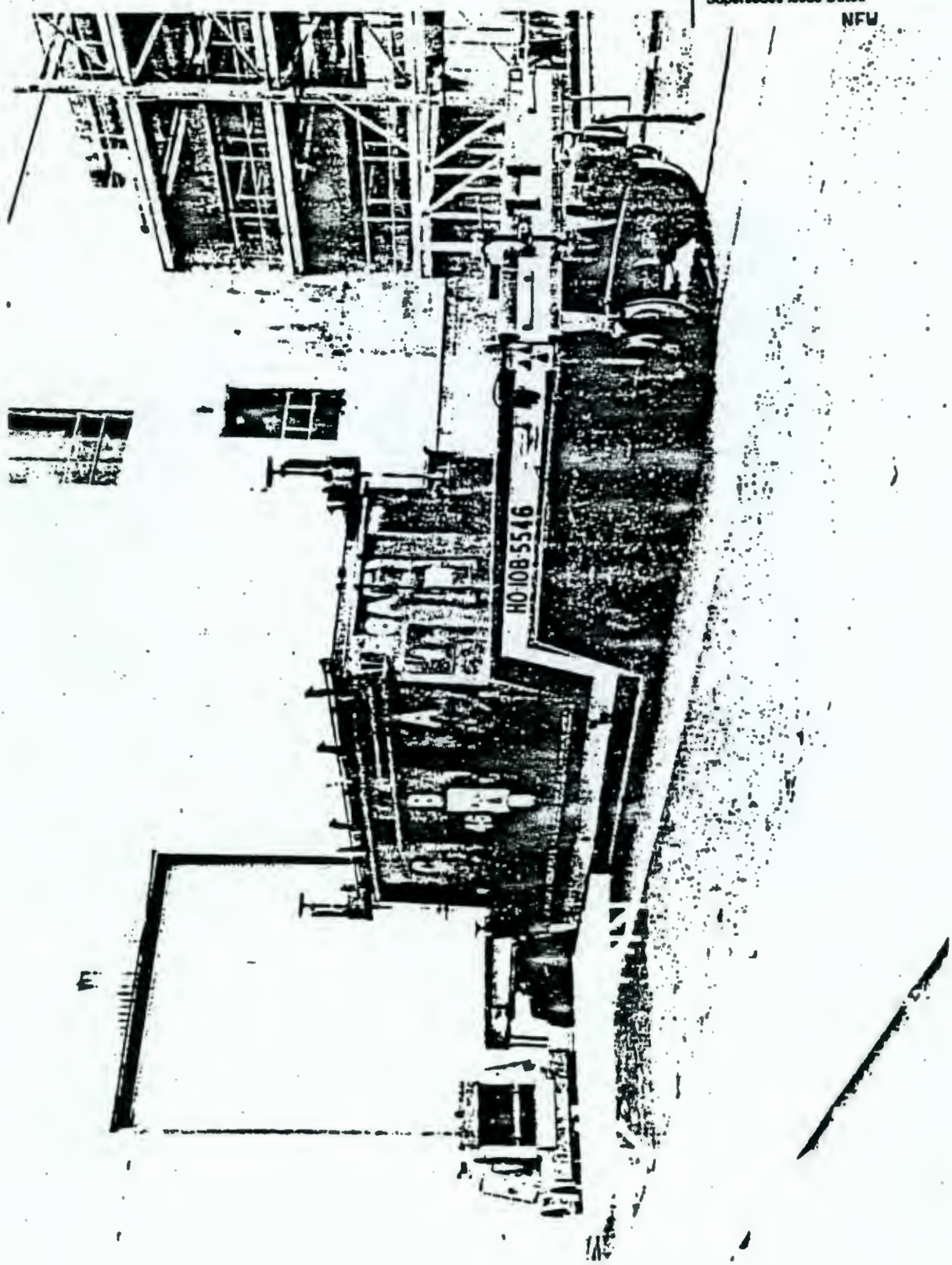


FIGURE 5.12

CASK CRANE - 105 KW FACILITY

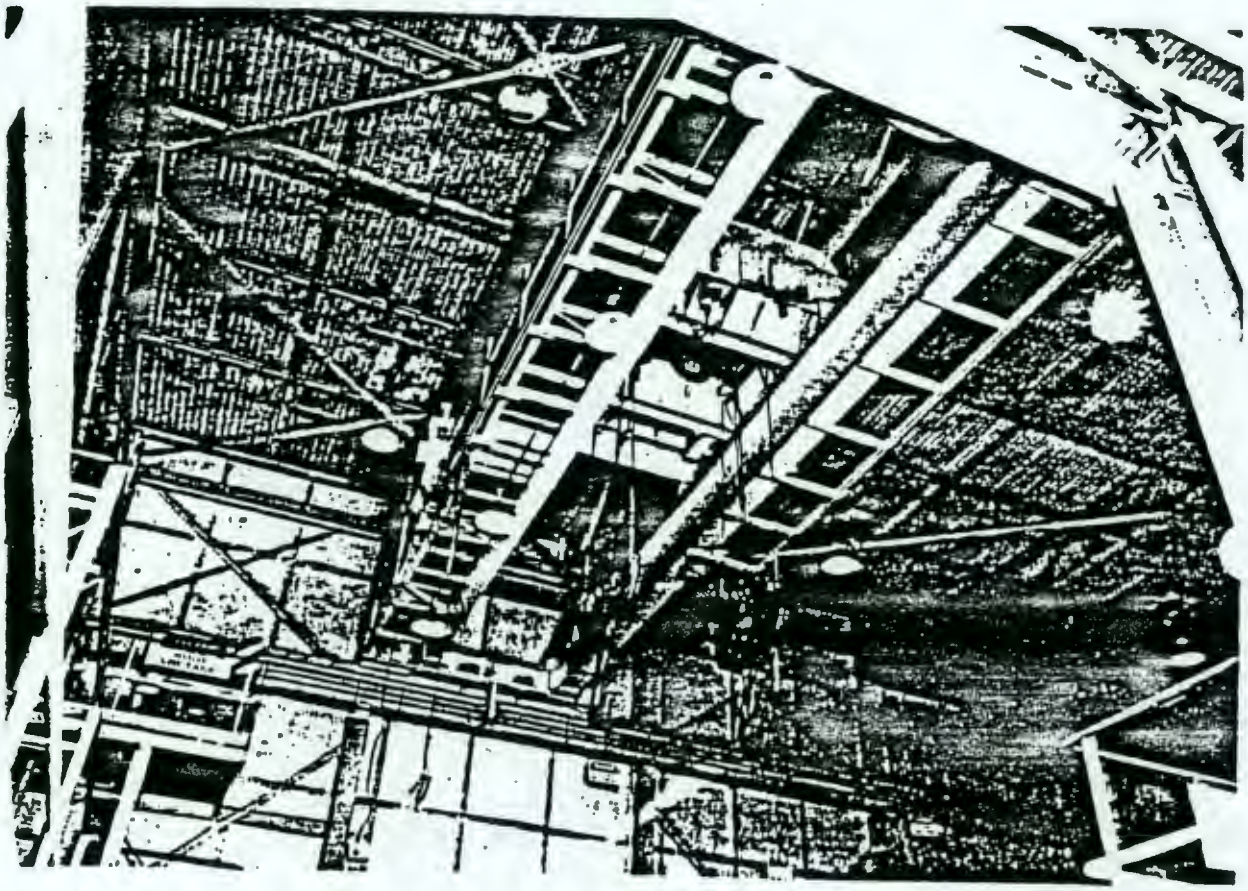


FIGURE 5.13

STORAGE CANISTER HOISTS

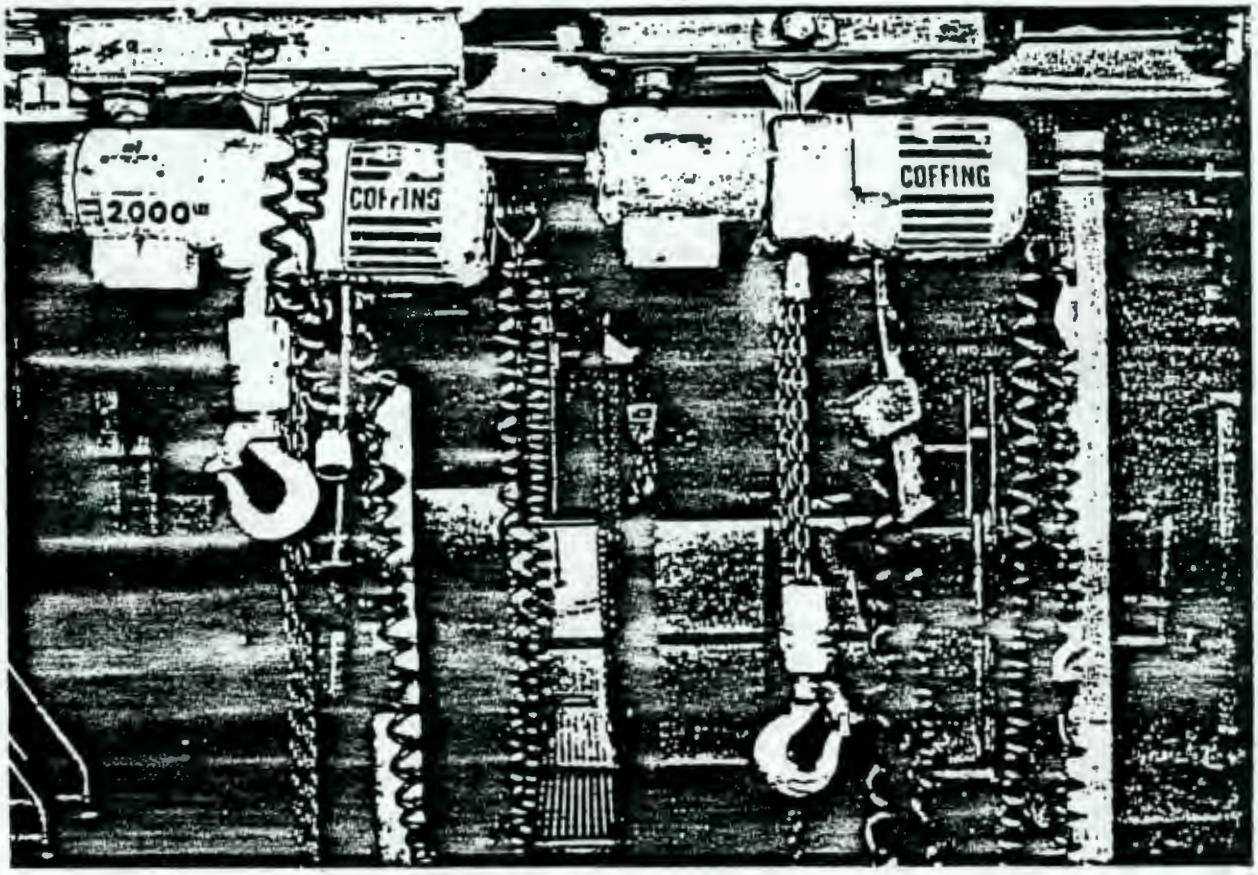


FIGURE 5.14

FUEL CANISTER HOOK (STRAIGHT TYPE)

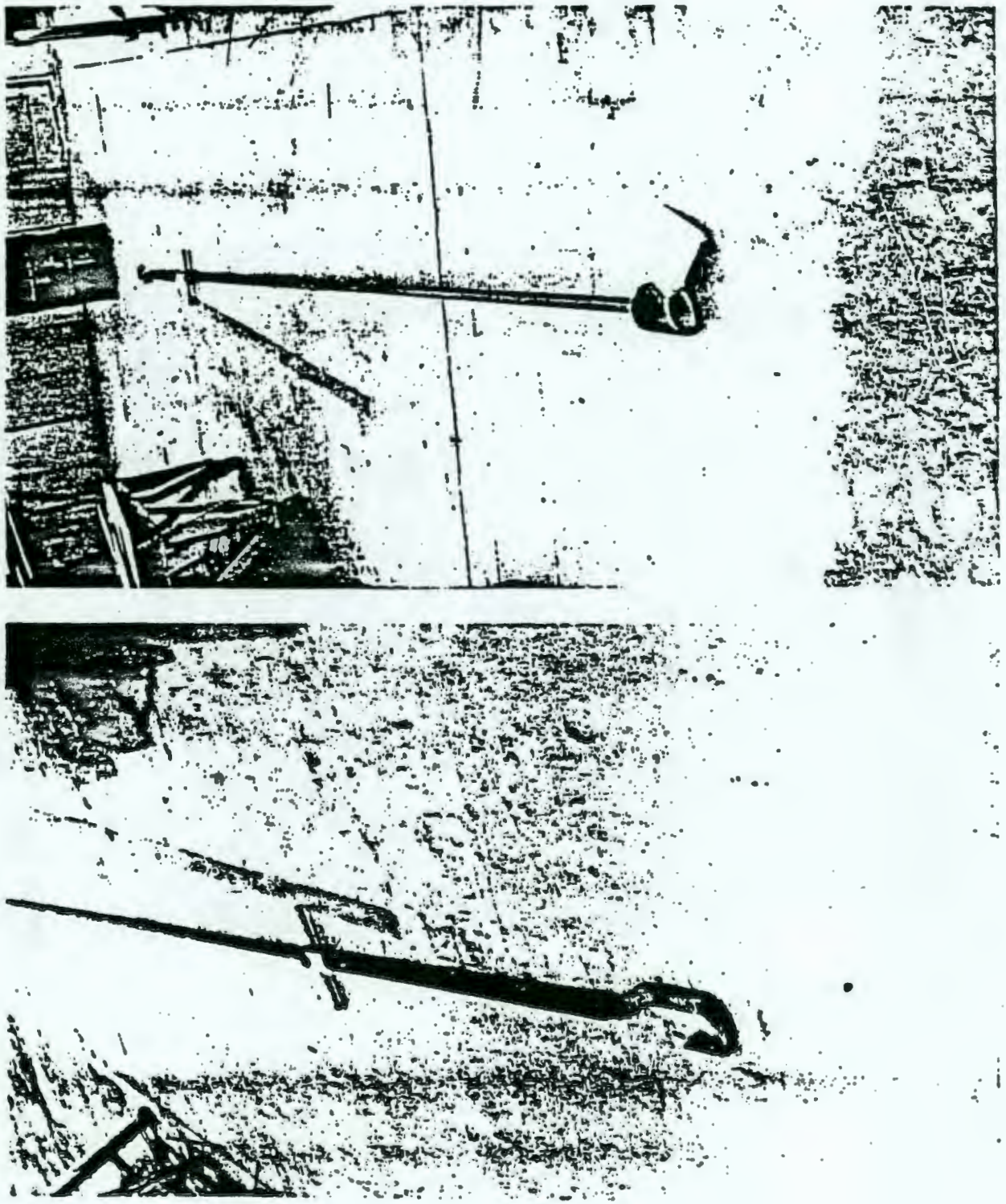
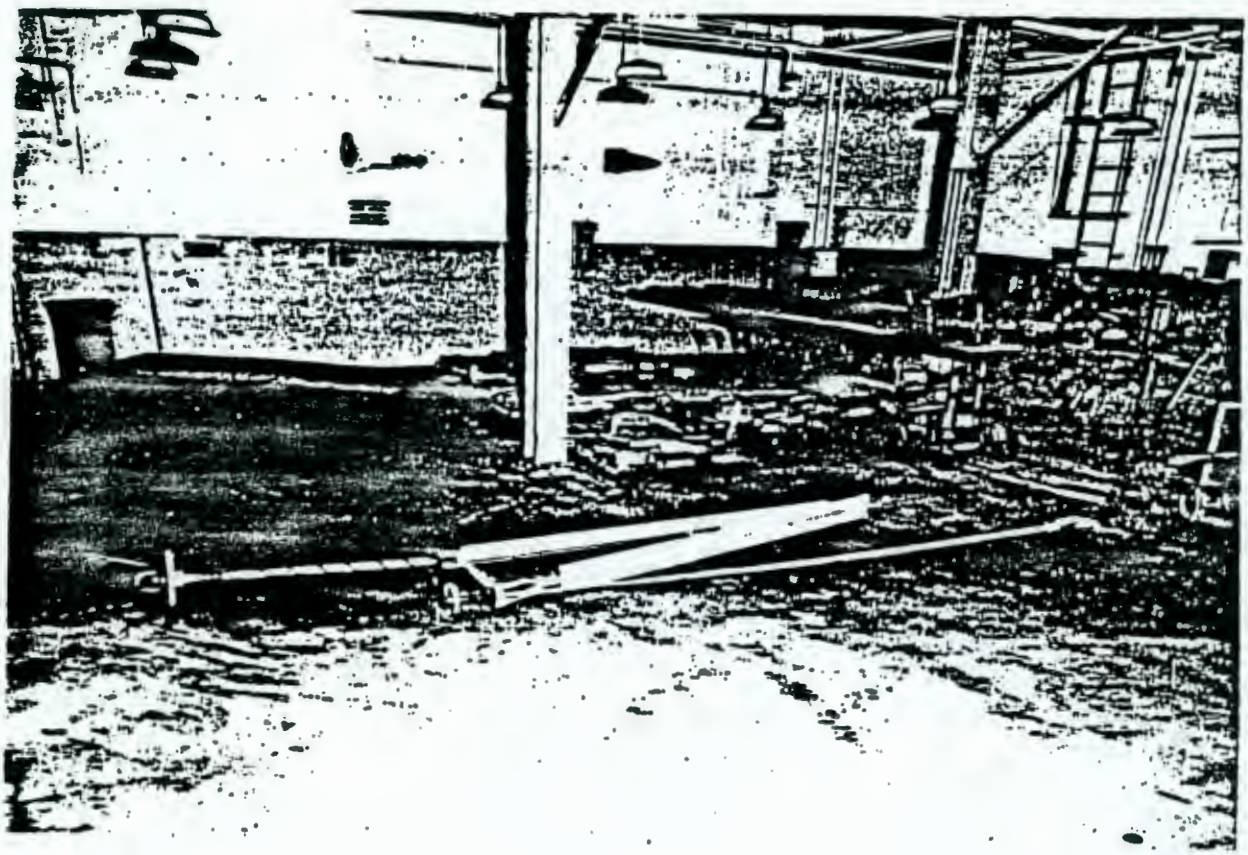


FIGURE 5.15

FUEL CANISTER HOOK (OFFSET TYPE)



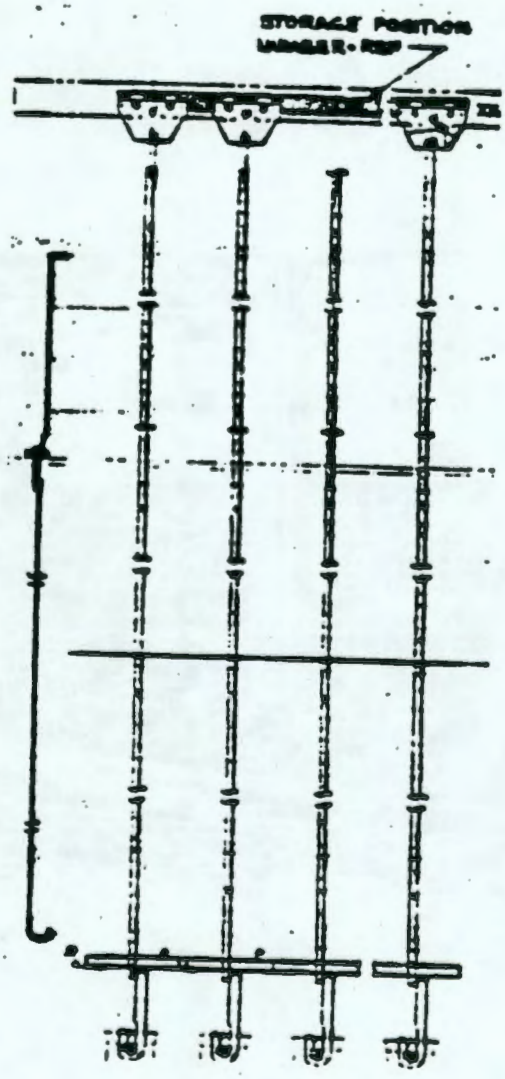
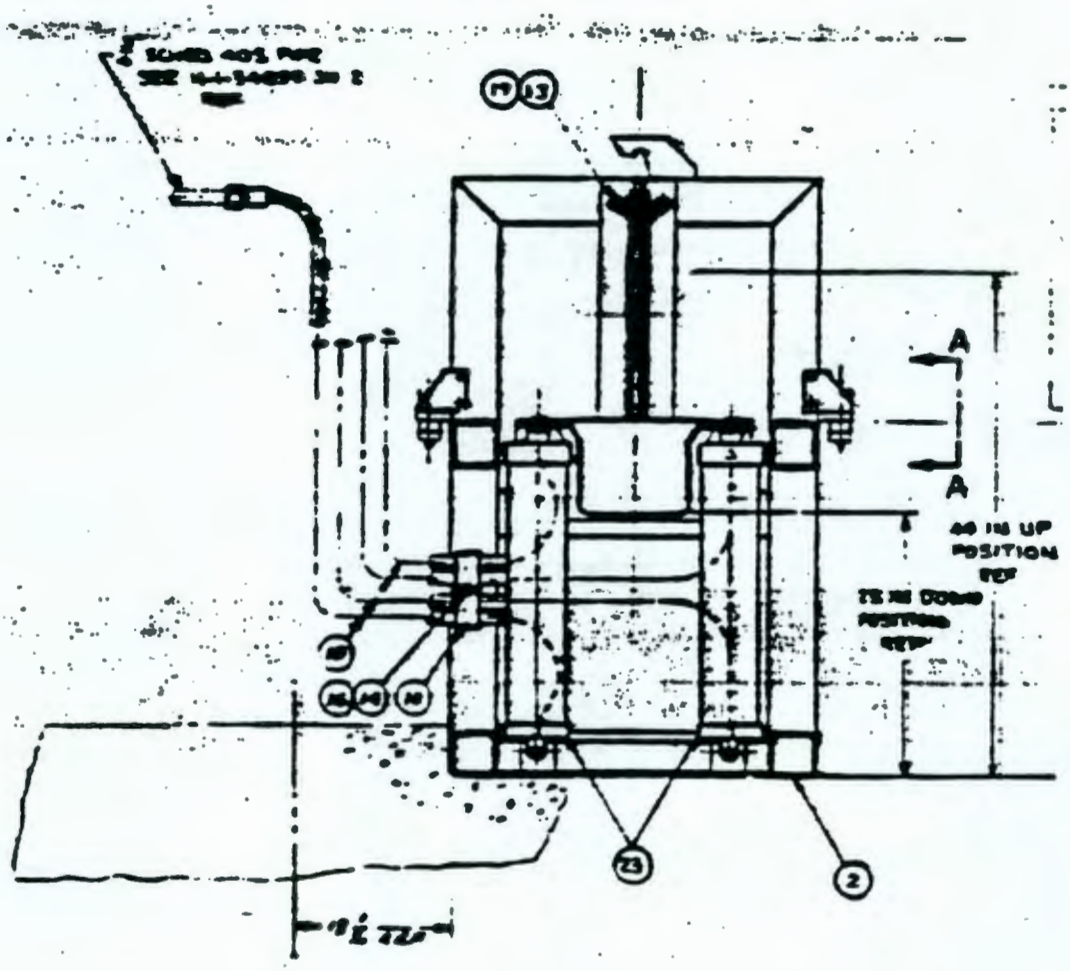


FIGURE 5.16
TROLLY & HANGER ASSEMBLY
WITH DISENGAGING TOOL

FIGURE 5.17

CANISTER ELEVATOR



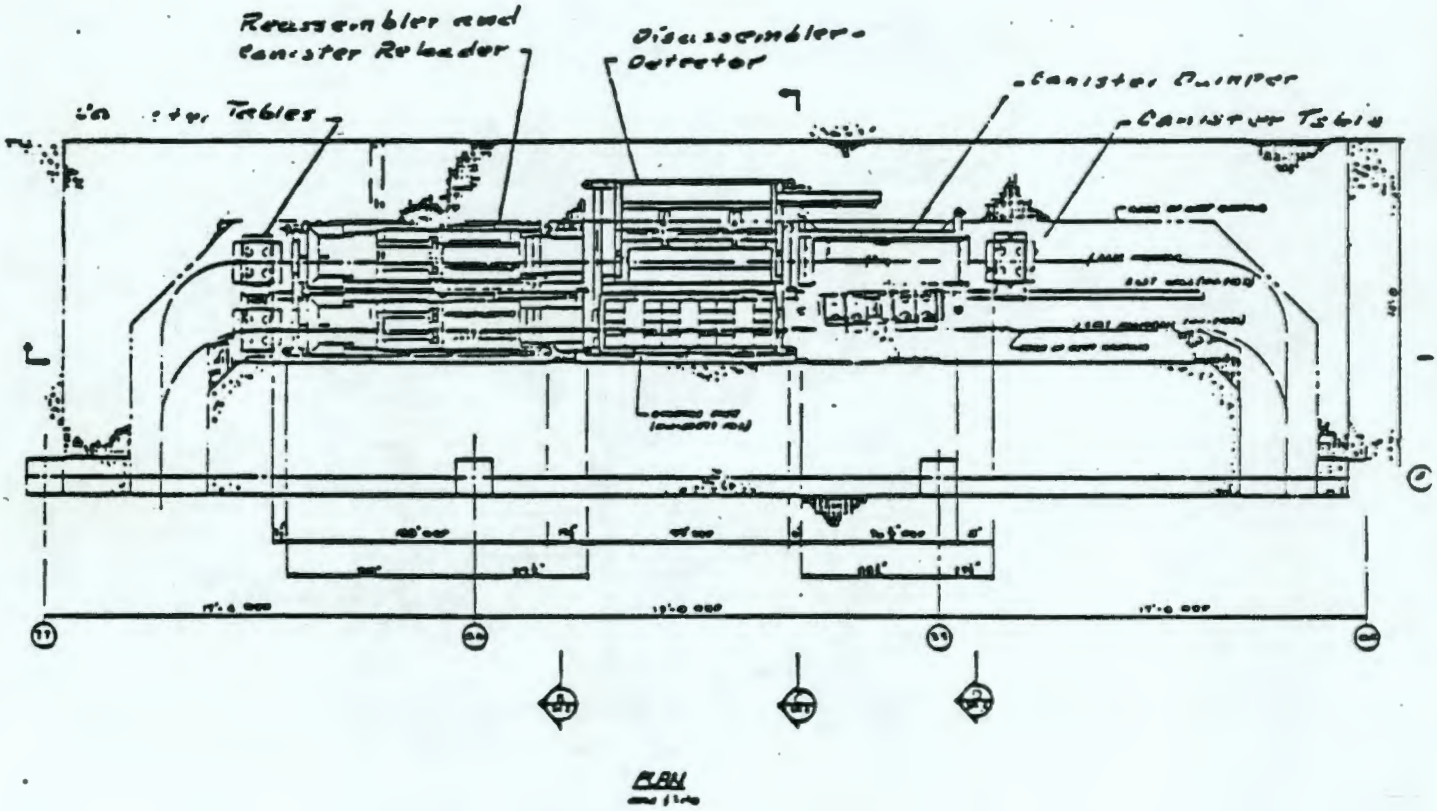


FIGURE 5.18
SEGREGATION EQUIPMENT LAYOUT

FIGURE 5.19

CANISTER DUMPER

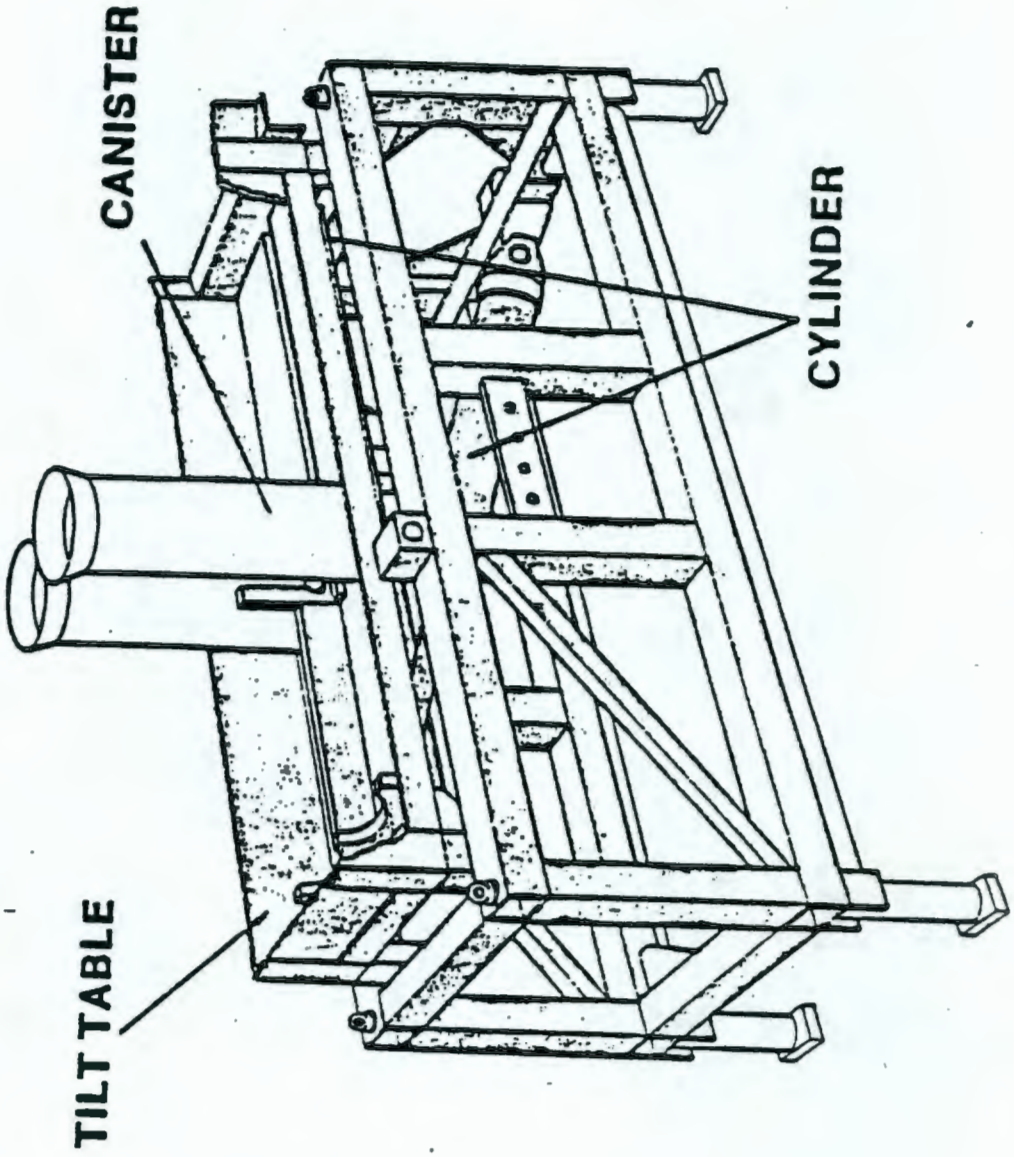


FIGURE 5.20

FUEL ELEMENT DETECTOR SYSTEM

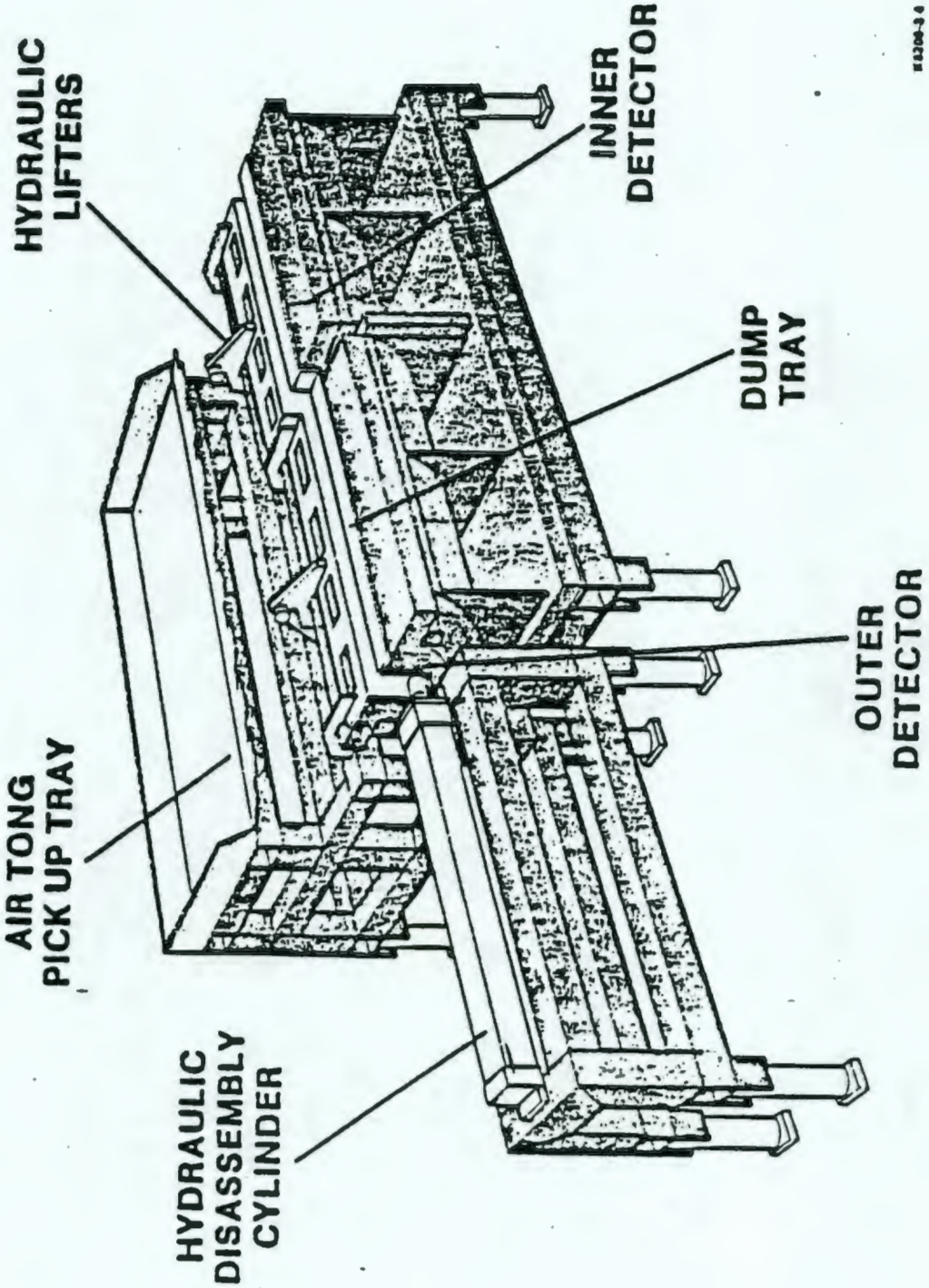


FIGURE 5.21

REASSEMBLER AND REPACKAGING SYSTEM

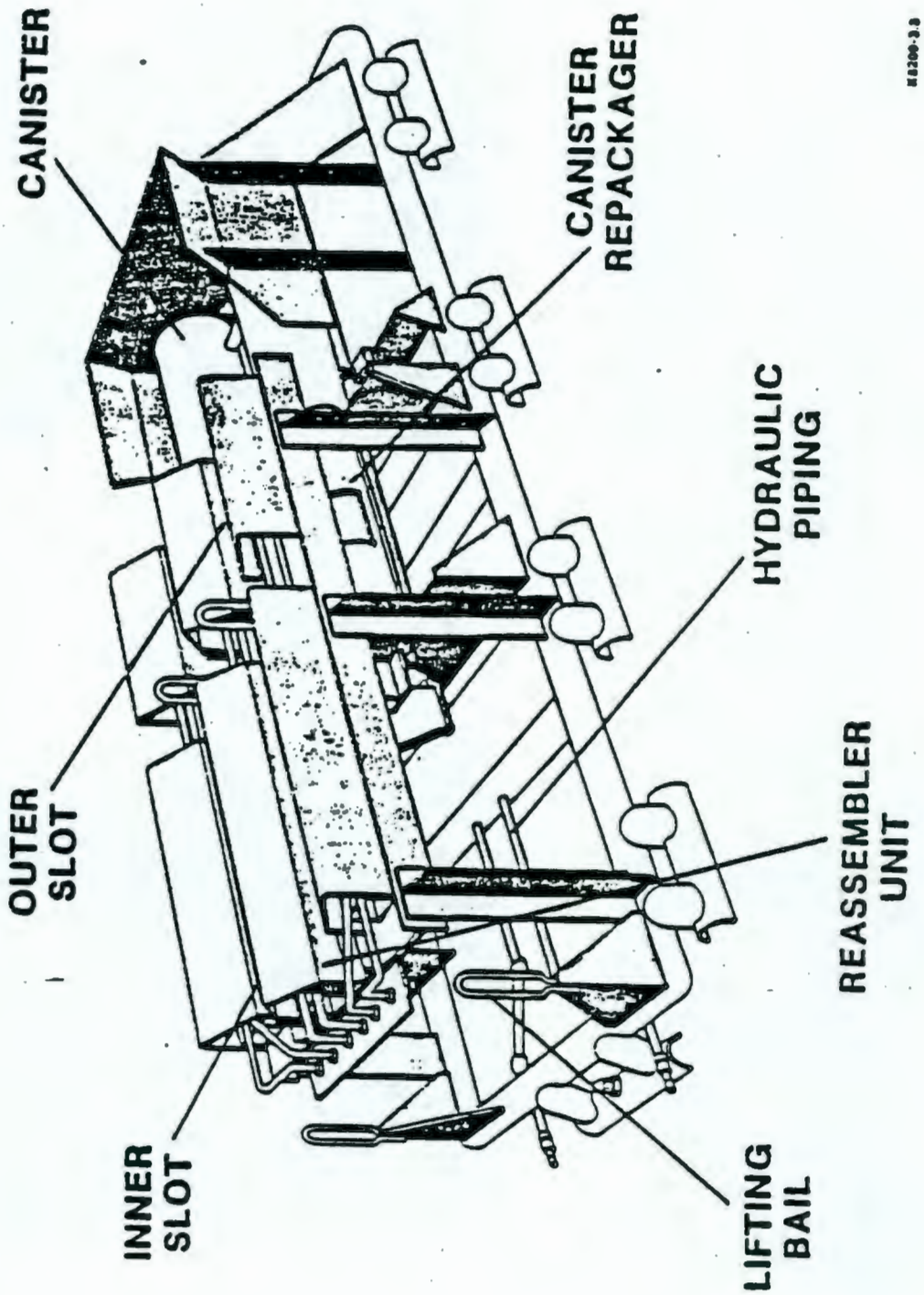
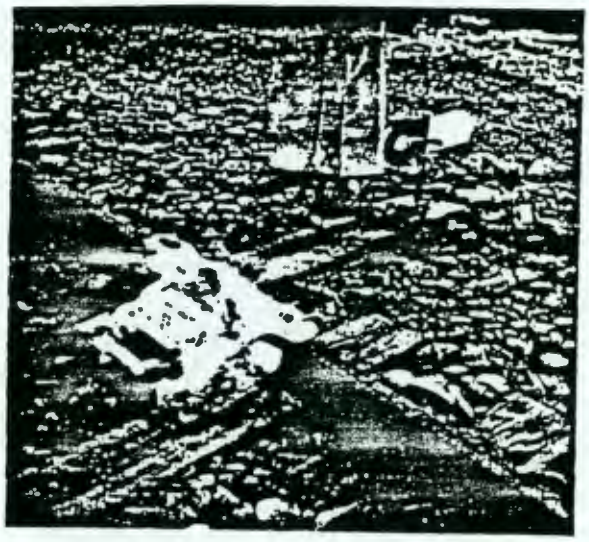


FIGURE 5.22

KE DERAILER



KW DERAILER

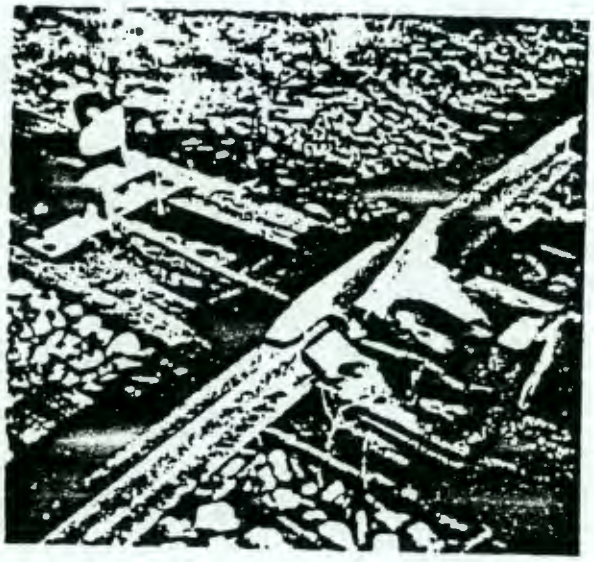
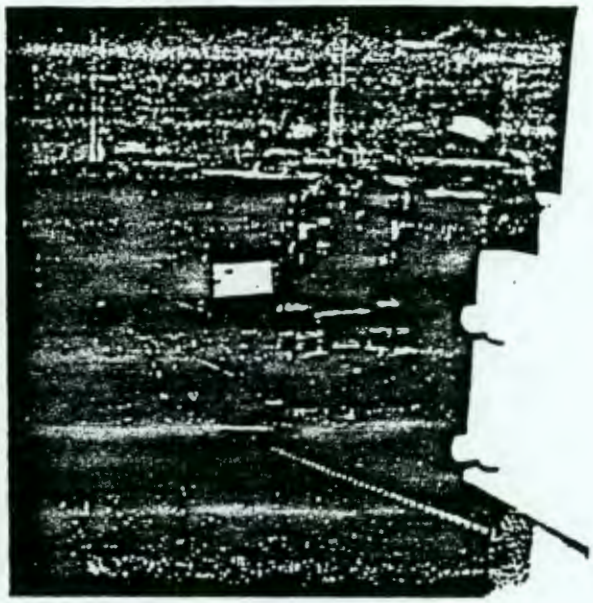


FIGURE 5.23

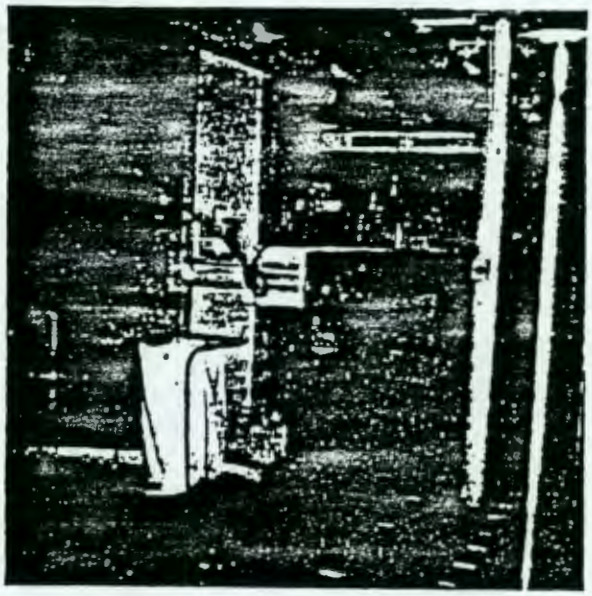
K BASIN RAILSTOP

FIGURE 5.24

K BASIN SHOCK ABSORBER



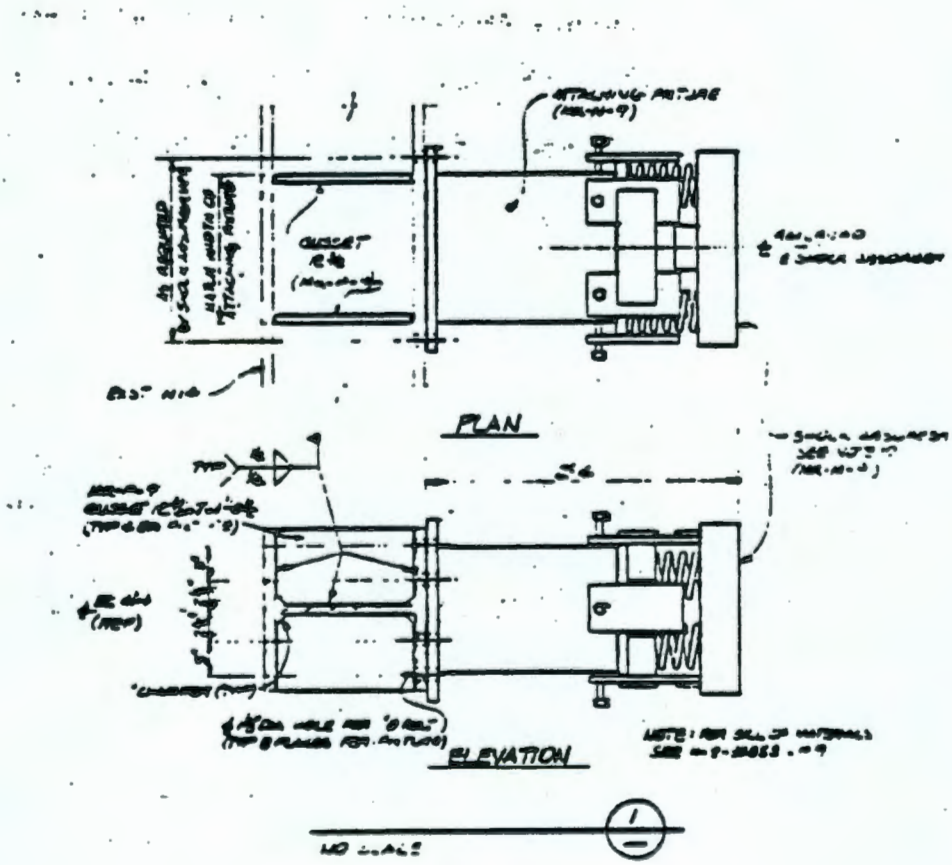
SHOCK ABSORBER - FRONT



SHOCK ABSORBER - REAR

FIGURE 5.25

RAIL CAR SHOCK ABSORBER



6.0 CONDUCT OF OPERATIONS

6.1 Organizational Structure and Responsibilities

The Operations Division of UNC Nuclear Industries is responsible for the operation of the 100K fuel storage facilities, N Reactor and other related facilities under terms of Department of Energy contract Number EY-76-C-06-1857.

6.1.1 K Facility Operations

The K facilities are operated by the Fuels Processing Branch of the Reactor Plant Department under the direction of the Vice President for Reactor Operations of the Operations Division. See the organizational chart Figure 6.1.

The K-Basin Operations Subsection Manager is the onsite manager overseeing each facility operations supervisor, and the shift supervisors at KE. The supervisors are responsible for operating and maintaining the facilities in accordance with the operation and maintenance procedures, References 46 and 47.

The operators are supplied by the Fuel Processing Section, the radiation and chemical technologists are supplied by the Radiation and Water Quality Section, and the craft services (instrument, electrical, millwright, etc.) required to maintain the facilities are supplied by Facility Services.

The Manager, Fuel Processing, is directly responsible for the training, safety, and conduct of all personnel involved in handling and storage of the irradiated N Reactor fuel elements at the facilities. The manager is also responsible for the accountability of the fuel after it arrives at the facilities as well as operating and emergency procedures for the facilities. The manager has the responsibility to ensure that all personnel assigned duties involving the handling of irradiated fuel are qualified to perform that work.

The Manager, Facility Services, is responsible for providing written maintenance procedures for the facilities.

The N Reactor Shift Managers have the responsibility for taking immediate action on all facility alarms received when the facilities are not manned. They will dispatch qualified personnel to take corrective action as outlined in the Operating and Emergency Procedures. Also, they will notify facility personnel of any condition of a serious nature.

6.1.2 Technical Support to the 105-K Facilities

6.1.2.1 Nuclear Criticality Operating Limits

Process Standards[48] are issued by the Process Standards Subsection in conformance with the facility Operational Safety Requirements.

6.1.2.2 Environmental and Radiological Control Limits

The Environmental and Occupational Safety Section develop and issue controls, procedures, and practices which establish the operational radiation and environmental protection program.

6.1.2.3 Changes in Plant Systems Design

Design changes to the facilities or related equipment are accomplished under UNI-M-91, "Changes in Reactor Plant Systems Design as Specified in CPG 5.3, Reactor Plant Systems Design Changes".

6.1.3 Quality Assurance Programs

Audits for conformance to established quality assurance practices set forth in UNI-M-73, "UNC Quality Assurance Manual"[20], are conducted by the Quality Assurance and Control Division. These audits will include periodic checks to determine compliance with Process Standard C-303.[48]

6.2 Training Program

Listed below is an outline for a training program containing nuclear topics and other subjects important to safety that will ensure that personnel working in the facilities are qualified to perform assignments for storage of N Reactor irradiated fuel elements.

The Training Subsection will provide assistance in the criticality training of employees as requested and maintain records on criticality safety training as outlined in DOE-RL 5480.1 Ch-5. Operators, Radiation and Chemical Technologists and other craftsmen attend training programs that are applicable to handling and storage of irradiated fuels and emergencies that could occur through equipment failure. Records of this training are maintained.

Qualifications and training requirements for managers and supervisors will be specified in the facility Operations Safety Requirements.

The UNC training plan[49] outlines the education, experience, training and retraining requirements for operators, supervisors, and managers. The training and retraining source of material are described in the "UNC Technical Training Program", Reference 50. In addition, career development short courses, seminars, etc. are provided on a non scheduled basis.

6.2.1 Nuclear Criticality Safety Training

The purpose of the Nuclear Criticality Safety Training Program[51] is to ensure that operators, supervisors and managers involved in the control, handling, storage, processing or transferring of fissile materials in quantities that could support a chain reaction possess the knowledge and experience commensurate with the responsibility for their assigned tasks and that they are aware of the risks involved with a nonreactor nuclear facility criticality. Formal class-room training is required every two years. In addition, operators are required to have an on-the-job instruction by their supervisor every six months. The Nuclear Criticality Safety Training Program fulfills the requirements set forth in DOE Order chapter 5480.1A.

6.2.1.1 Basic Program

Training is performed formally in the classroom on a quarterly basis and on the job on a continuing basis. General topics covered in formal training are:

- Standard and Emergency Procedures
- Emergency Actions and Unit Procedures
- Administrative Controls
- Process Standards and Bases
- Basic Criticality Principles

In addition to reviewing the topics outlined above, time is allowed in each session for the discussion of unusual occurrences and work-oriented problems. Changes in procedures and Process Standards are reviewed. Over an 18-month cycle, complete review is made of Process Standards, Technical Specifications, Company Policy Guides, Emergency Procedures, Standard and Mandatory Procedures and Radiation Work Permits pertinent to nuclear criticality safety.

In addition to the quarterly formal training sessions, each supervisor responsible for handling of nonreactor fissile materials is responsible for on-the-job training of assigned personnel. The supervisors not only train workers in the use of procedures and Process Standards but also in the actual use of equipment to perform the various jobs. Training in evacuation procedures through the use of periodic practice plant evacuations is also provided.

6.2.1.2 Record Keeping and Testing

A Nuclear Criticality Safety Training Program presentation is available each month. Personnel handling fissile material are required to attend one training program every two years. Each person signs the attendance sheet when attending formal training sessions.

A written test is given at the end of each monthly training session. A summary check sheet contains the names of the personnel in the training program, the dates attended, and their pass-fail test grades. Records are maintained in the Training office.

Each person must receive a minimum score of 70 percent on the written test to successfully complete each session. Retraining and retesting are given to those who fail the test.

6.2.2 Radiation Zone Worker Training

Before an employee enters a Radiation Zone (except when escorted), radiological training is required. The Radiological Training Program is summarized below.

Employees who work in Radiation Zones receive several hours of training on radiation protection that includes: Radiation Zone rules, radiation work procedures, respiratory protection, personnel dosimeters, emergency signals, radiation controls, contamination control, radiation effects, and as low as reasonably achievable (ALARA) principles.

Each supervisor provides on-the-job training for assigned personnel who work in Radiation Zones. Each supervisor also holds staff and safety meetings in which radiation control and radiation safety topics are covered.

Information letters concerning radiation protection topics are furnished periodically to Company Workers.

Radiation and Water Quality Control furnishes information on radiological conditions in Radiation Zones to employees prior to their entering a Radiation Zone.

Radiation Zone workers are required to attend a Radiation Zone worker retraining session every 2 years.

6.3 Monitoring Equipment

6.3.1 Radiation Instrumentation

6.3.1.1 High Level Gamma Instrumentation

High level gamma instrumentation has been provided to actuate visual and audible alarms located in each facility work area, both facility control rooms, and the facility entrances upon actuation of a high level gamma alarm. The alarm signal will be transmitted and annunciated in the N Reactor control room. The high radiation alarm set point is controlled and is kept locked.

6.3.1.2 Nuclear Criticality Instruments

Criticality dosimeters are located within the fuel basin areas to provide data in the event of a nuclear criticality accident.

6.3.1.3 Gamma Radiation Monitors

Instrumentation is provided to monitor the radiation levels in the recirculation equipment areas, in the railroad car cask loadout transfer areas, and at several locations within the cooling pool work areas. The instruments are equipped with adjustable high radiation setpoints. Radiation data will be transmitted and recorded in the K facility control rooms. A radiation alarm will actuate a visual alarm located in each cooling pool work area and actuate annunciators in both facility control rooms. The alarm signal will also be transmitted and annunciated in the N Reactor control room.

6.3.1.4 Ion Exchange Tank Radiation Monitors

The installed ion exchange tank radiation monitoring system is inoperable. The ion exchange tank radiation level is monitored with portable instruments.

6.3.2 Water Level Instrumentation

Redundant electrode operated alarms have been provided to monitor each cooling pool water level. Any high or low level trip provide annunciation in both facility control rooms, and the N Reactor control room. The alarm system is functionally tested routinely. In addition, a 24-hour drawdown test of each cooling pool is performed monthly to determine leak rates.

6.3.3 Water Temperature Instrumentation

The cooling pool water temperatures are monitored and recorded in the facility operations offices. A high temperature alarm is set to annunciate in both facility control rooms. A high temperature alarm will annunciate in the N Reactor control room. This system is functionally tested routinely.

6.3.4 Corrosion Monitoring

There are two areas in which corrosion may become a factor. The cooling system is a concern because the piping used is made of carbon steel. Periodic inspections of this piping ensure its integrity. The other area of concern is the aluminum canisters and encapsulation components. It is not known what effect the pool environment will have on the aluminum or how long the canisters will last.

The aluminum components are subject to pitting corrosion. Extensive pitting would initially cause leakage of radioactive material into the pool and eventually reduce the ability of the canister to hold the fuel.

A program has been developed to track the integrity of piping to ensure that enough lead time is available to take corrective action should corrosion become a problem.

6.3.5 Testing and Calibration

All instrumentation discussed in this section is functionally tested routinely and is periodically calibrated in accordance with UNC procedures.

6.4 Operating Procedures

Listed below are the primary procedures that will be in effect at the facilities for handling and storage of irradiated fuel.

- Cask unloading at K facility irradiated fuel storage basin.
- Cask loading and well car loading for returning fuel to N Plant for repackaging.
- Cask loading and well car loading for fuel shipment to PUREX.
- Changing and disposal of primary coolant filters.
- Fuel segregation (KE only).
- Operation of secondary coolant system.

- o Operation of the liquid waste pump and disposal of waste from the liquid waste holding tank.
- o Operation of the auxiliary exchange modules.
- o Canister decapping.
- o Addition of water to primary coolant system.
- o Operation of 181-KE raw water submersible pumps, 183 filters, and 190 service water pumps.
- o Functional test of all cooling pool monitoring systems.
- o Functional test of Transfer Area cranes and electric hoists.
- o Operation and functional test of electric boiler for glycol heating system.
- o Operation and functional check of air monitoring system.
- o Response to critical monitoring annunciations at N Reactor.
- o Primary and secondary cooling water sampling program.

6.5 Emergency Procedures

The Emergency Response Guides UNI-M-2 VOL4, include the following emergency guides for the KE and KW Facilities.

1-K 100-K Area Emergency Plans
2-K High Radiation or criticality - 105-KE and 105-KW
3-K Loss of Primary Cooling Water Pumps to 100-K Fuel Storage Basins
4-K Loss of Secondary Cooling Water to 100-K Area Fuel Storage Basins
5-K Fuel Storage Basin Rupture - 100-K Area
6-K Dropped Fuel Shipping Cask in a K Transfer Area - 100-K Area
7-K Operational Fire Control 100-K
8-K Chlorine Release 100-K
9-K Terrorist Threats or Acts (bomb threats, sabotage, unauthorized entry)
10-K K Storage Basin Monitoring - Power Loss
11-K Practice Evacuation Procedure
12-K Hazards From Sage Fire
13-K Upstream Dam Failure and Loss of River Water Response for Shutdown Areas and Facilities
14-K Volcanic Ashfall
2-O Chemical Release

Copies of these Emergency Guides will be available in the N Reactor control room for their use in the event they are needed when the facilities are not manned.

6.6 Fuel Inventory Control and Accountability

Special Nuclear Material (SNM) and inventory control records will be handled in accordance with instructions issued by the Manager, Basin Planning, at N Reactor prior to each transfer campaign. It is essential that the fuel handlers maintain absolute control over material received from N Reactor for storage at the facility, transferred from one basin to the other, or transferred to PUREX.

Any discrepancies noted when loading or unloading canisters from the casks will be resolved before another canister is unloaded, or any cask movement is made.

The facilities' irradiated fuel storage accountability and bucket summary records will be routinely checked against the cooling pool pin map and against stored canisters in the cooling pool.

6.7 Fire Protection

A wet sprinkler system is installed in the facility control rooms, offices, lunchrooms, and clothing change rooms; and any operation of this system annunciates at the 100 Area Fire Station. Fire alarm boxes are located inside and outside the building, as well as telephones located at several locations inside the building which are available for contacting the Fire Department.

The normal water supply to the facility fire protection systems, to both the sprinklers and outside hydrants, is the same filtered water sources (1500 gpm), that provides emergency water to the cooling pools. In the event this normal supply is interrupted, a raw water source can be made available by manually valving open lines that tie into the fire water piping from the 181-KE river pumps. This raw water emergency supply is at least equal to the 1500 gpm normal supply.

The fire protection alarm system is part of the Central Fire Station electrical power loop. All the detectors at the facility are in series and tied into the loop. The power supply is dc (batteries) located in 1720-K building equipped with ac rectifier charging units. The batteries are rated for 72 hours and if they drop below 85 percent of full charge an appropriate alarm will sound in the Central Fire Station alerting people in this continuously manned area of this condition.

The Central Fire Station is located about three miles away. Operation of this station and its equipment is the responsibility of the Rockwell Hanford Co. Rockwell personnel periodically inspect and test the fire protection systems and equipment provided in each facility. Techniques for fighting small fires and the use of hand held equipment are periodically demonstrated by Rockwell for UNC employees.

General housekeeping for fire prevention and training for those individuals involved in fire risk work is provided in accordance with UNI-M-38 "Industrial Safety Manual" Reference 52.

6.8 Review and Appraisal

DOE Order 5480.1A "Environmental Protection, Safety, and Health Protection Program for DOE Operations" (Reference 2) requires the establishment and maintainence of an internal independent review and appraisal system. Three formally chartered groups, the Company Nuclear Review Board, the Nuclear and Environmental Safety Committee, and the Safety Assessment and Analysis Section conform to this requirement. The duties, responsibilities, and authority for these groups are provided in UNI-250 REV6 "Charters for UNC Nuclear Industries, Inc. Nuclear and Environmental Safety Review System", Reference 53.

These groups have the responsibility to participate in an ongoing review of the facility from conceptual Design through facility modification into operations.

6.9 Effects of Normal Operation

6.9.1 Effluents

6.9.1.1 Liquids

Beneath each basin is an asphalt membrane which was installed during the original construction. This membrane was intended to collect any basin leakage and divert it to a tile drainage field. The diversion line has been intercepted and connected to a sump. Since repair of a leak in the discharge pit area at KE, now used for the segregation activity, no leakage has been detected in this system at either facility.[54] An additional check for leakage is provided by seven monitoring wells around each basin quarterly sampling from these wells also indicate no leakage. Any leakage collected would be pumped from the sump back into the basin.

Filtered water is pumped through the heat exchanger or chiller to cool the basin water, then discharged directly back to the river. This discharge is covered by the DOE NPDES permit for outfall No. 004. At the rated capacity of one heat exchanger at each basin and the river at its minimum flow rate the thermal discharge could increase the river temperature by 0.002F.

6.9.1.2 Gaseous Waste

Ventilation is provided by four powered roof vents, two over the basin rated at 10,000 cfm each and two over the transfer area rated at 7500 cfm each. The basin vents operate as needed. The discharge is provided with a continuous air monitor. The radiological emission totals approximately 1.00 mCi per year and is composed primarily of ^{60}Co, ^{137}Cs, ^{155}Eu, and ^{90}Sr.[54] This very small emmission provides an insignificant offsite or onsite dose.

6.9.1.3 Solids

The water filter cartridges are changed out about every 6 months and shipped to the 200 areas for burial. The ion exchange tanks are changed out approximately every 6 weeks. The spent resins are shipped to the 200 areas for burial.

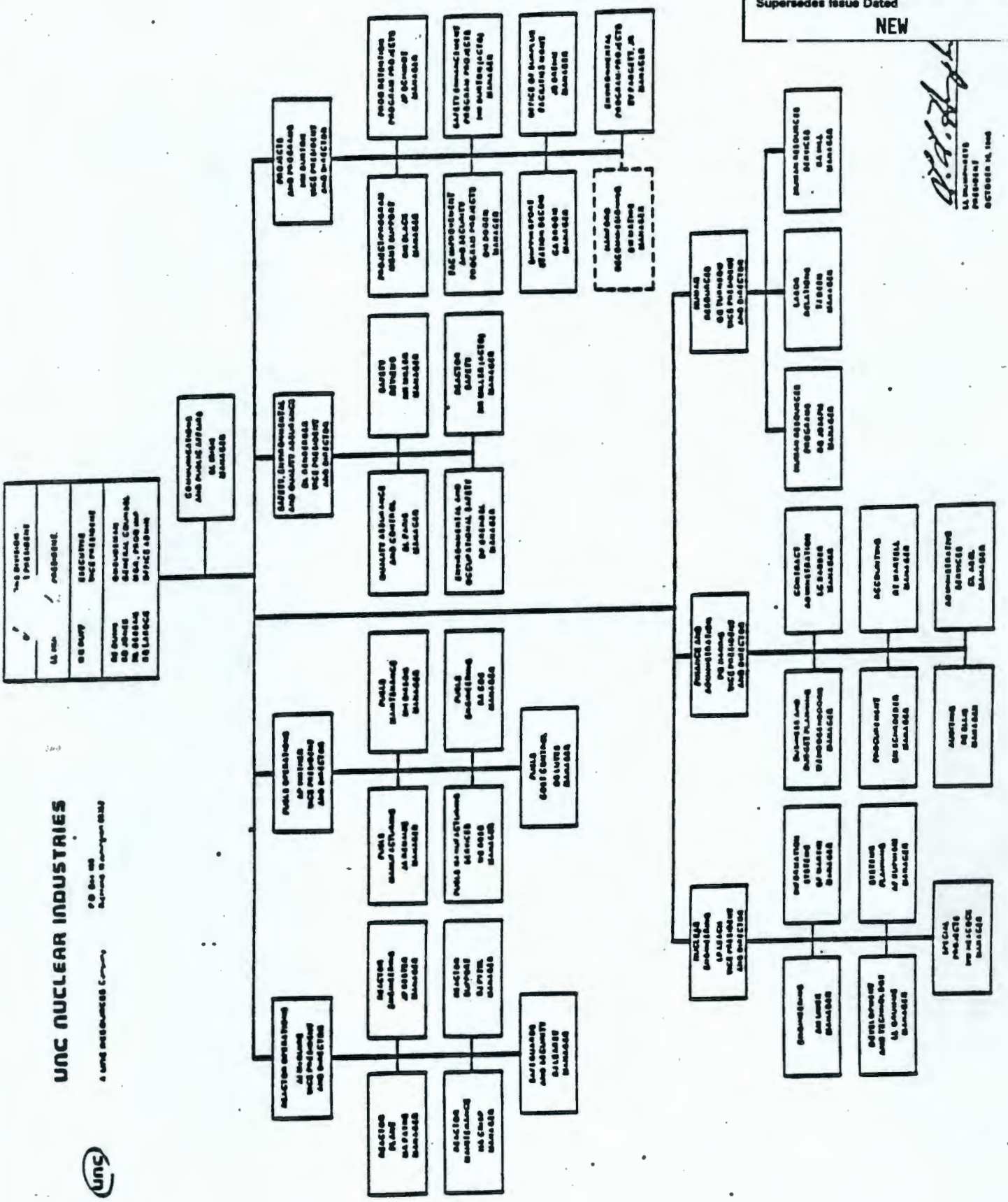
6.9.2 Personnel Radiation Exposure

All operations within the facilities will be conducted in accordance with UNC procedures and practices developed specifically to assure that occupational radiation exposures are kept as low as reasonably achievable (ALARA).

Personnel working in the facilities will be exposed to radiation from the spent fuel during unloading, transfer and segregation operations. The maximum dose rate expected at the operating floor level from these operations is 50 mrem per hour at the transfer and segregation stations in KE. Personnel in most of the rest of the KE facility will experience lower dose rates on the order of 20 mrem per hour. The dose rates at the KW facility are less than 1 mrem per hour. The UNC radiation exposure control program records and tracks all personnel dosimetry results to ensure that all individual exposures are maintained as far below the quarterly and annual limits as possible. The collective radiation exposure to the work force is also minimized.

Area radiation monitors and air particulate activity monitors will continuously operate in the facilities to provide warning of high radiation conditions. Regular surveys by radiation monitoring personnel and posting of high radiation or contamination areas will help reduce or eliminate unplanned exposures. Internal exposures to operating personnel are expected to be negligible since, effectively, the only radionuclides evolved from the storage basin water are noble gases, which are given minor contributions to the external dose rate. All other radionuclides of significance after 150 days of cooling remain in the water and are removed by the filters and ion exchangers.

FIGURE 6.1



Organization Chart

7.0 CRITICALITY SAFETY ANALYSIS

The storage of irradiated N Reactor fuel in the KE and KW Fuel Storage Facilities has been evaluated for potential nuclear criticality accidents and found to be safe and within the nuclear criticality safety criteria and limits established for the fuel storage basins segregation activity.[3,4,6,7] The basis of the nuclear safety limit is that the neutron multiplication factor, or k-effective, will remain below 0.98 for all postulated accidents. The fuel storage configuration used in the analysis is shown in Figures 1.2 and 1.3 and consists of full density storage of fuel stored on the basin floor. This fuel can be any combination of the various enrichments used at N Reactor. The hanging fuel, hung at a ratio of one canister over three floor storage canisters, may also be of a single enrichment or any combination of irradiated N Reactor fuel. However, no hanging fuel canister storage of 1.25wt % scrap is allowed. Hanging canisters of any kind over canisters containing 1.25wt % of scrap is not allowed.[7]

The criticality analysis supporting the fuel storage configurations is based on calculations assuming use of unirradiated Mark IA fuel in the storage arrangements and postulated accident conditions. The assumption of unexposed Mark IA fuel in these calculations is the most conservative and most limiting basis for the calculations from a standpoint of nuclear criticality safety. Further conservatism in the calculations was achieved by assuming use of only aluminum canisters. The use of stainless steel canisters would provide additional safety margins as discussed in Reference 55.

The calculational models of fuel stored in the unique fuel storage geometry were compared to the measured data in PT-N-506[4]. The results of this test confirmed that the calculational models would adequately ensure that the postulated accident conditions would not exceed nuclear safety limits.

Additional criticality evaluations were made regarding the accumulation of dissolved fissile isotopes[7,8] in various pieces of equipment (ion exchange tanks, sand filter, cartridge filter, etc.). The criticality analysis for the decapping design change[7] identified several criticality concerns for the Decapping/Recanning Project. Some of these concerns require that administrative controls be applied to this operation, while others require modification to equipment to implement physical constraints to supplement administrative controls.

Criticality control limitations and procedural requirements, including routine samples for fissile isotope concentrations, will be specified in the facility process control document.

8.0 ACCIDENT ANALYSIS

The postulated accidents associated with this facility are discussed in this section. Also included are the potentials for and the consequences of radioactive releases associated with the accidents. Administrative procedures and specific equipment design limit the potential frequency of accidents considered from "infrequent" to "not expected to occur during the lifetime of the facility". Reference 1 provides the bases for these frequency classification. The potential consequences of the accidents considered were minimal.

8.1 Criticality Related Accidents[3,4,5]

A series of incidents with a potential for accidental nuclear criticality were evaluated. In all instances, more than one unusual independent and simultaneous event would have to take place to exceed the storage basin safety limit. The accidents analyzed are summarized below. All criticality safety analyses of storage configurations considered the highest enrichment fuel currently used (Mark IA).

8.1.1 Railroad Car Fuel Spill

Transport of irradiated fuel from N Reactor basin to the facility is the responsibility of the Rockwell Hanford Company. Their safety analysis concludes that in a railroad well car accident the fuel casks could be thrown from the wells. The casks could lose their coolant but contain the fuel.[38,39] Even if it is assumed that the fuel spills from the casks and into a hemispherical configuration, criticality could not occur, since a well car carries only 126 fuel elements, 42 in each of the wells. A minimum of 169 Mark IA fuel elements are required for a criticality to occur in an optimally moderated and reflected hemispherical configuration.[56]

A railroad car fuel spill accident is judged to fall within the category of "not expected to occur during the lifetime of the facility."

8.1.2 Cask Fuel Spill

The minimum number of Mark IA fuel elements needed to form a hemispherical critical mass is 169.[56] Consequently, spilling a cask (which contains only 42 fuel elements) will present no criticality problem.

A cask spill is judged to fall in the category of infrequent.

8.1.3 Canister Drop

Dropping multiple canisters containing spike fuel from the one over three storage configuration onto a full density storage array of spike fuel, is a minimal perturbation. Such an incident would not raise the k-effective above 0.833. This value is significantly below the k-effective safety limit value of 0.98.

Special criticality concerns associated with capped canister (Mark I and II) storage were evaluated in Reference 3. Based on the analysis in that document, limits on the amount of fuel suspended above a full density array was established at a ratio of 1 over 3.

Equipment design limits the suspended fuel storage to the 1 over 3 configuration, therefore a 2 over 3 or 3 over 3 configuration is not possible. Administrative controls prevent hanging fuel in the west bay of each basin, so that a railcar accidently entering the basin could not drop its contents and the hanging fuel onto the fuel stored on the floor.

A canister drop accident is judged to have an occurence frequency of "infrequent."

8.1.4 Broken Fuel Elements

Some of the fuel elements shipped to the facility for storage will be broken and cracked. An estimated quantity of such elements is approximately five percent of the total fuel in storage. Calculations have assumed that one percent of the fuel has gone into solution and remains in the water immediately surrounding the fuel elements. This is a conservative assumption since the water circulates and passes through filters and ion exchangers for removal of radionuclides.

N Reactor spent fuel elements destined for storage in the KW basin will be encapsulated in either:

(1) The standard N Reactor fuel storage canisters (designated Mark 0) modified by welding a plate on the bottom and installing a sealing cap on the top of the canister to become a Mark I canister, or

(2) The Mark II, a canister of improved design and made entirely of stainless steel. See Figure 2.1.

The KE facility storage racks currently store fuel in the open Mark 0 canisters. However, fuel in Mark I or Mark II canisters, with or without encapsulation, may also be stored in KE.

Encapsulation of the spent fuel elements in the Mark I and II canisters is intended to prevent the escape of solid and dissolved radionuclides into the K facility basins. Gaseous fission products are vented from the fuel loaded canisters and dissipated through the building ventilation system. Release of non-gaseous radionuclides into the storage basin water can take place only through a leak in a canister or the cap assembly.

At the KE facility approximately five percent of the fuel is damaged, however the release of the uranium and plutonium is very gradual. Any suspended particulate uranium and plutonium are continually being removed by the filters and ion exchange tanks. The presence of dissolved fissile isotopes in the cooling pool should not present any potential criticality problems as these are being constantly removed by the ion exchangers. The fuel segregation activity is not expected to significantly increase radioactivity release to the coolant since all the fuel being processed is already in open canisters. See section 5.7 for a discussion of the effect of decapping operations. Decapping 1.25 wt% fuel will require administrative limits on sludge buildup (see table 5.4).

8.1.5 Water Loss and Partial Moderation

The nuclear interaction between adjacent fuel canisters is reduced by the water separating them. Reducing the density of water could increase the reactivity of the storage array. During normal operating conditions, water density will vary with temperature. The changes are small and will have an insignificant effect on the reactivity of the storage array. However, upon loss of the basin water and during the process of reestablishing it, the fuel could go through stages of partial moderation. Calculations using the KENO computer code were carried out to evaluate partial moderation and reflection of fuel.

The results are contained in References 3, 4, and 5. Calculations in Reference 4 indicate that the k-effective value for a partially moderated storage array will not exceed that of a fully moderated storage array. For spike fuel, the k-effective value for the full density array with one-over-three hanging fuel array is within the k-effective safety limit of 0.98 for all normal and credible single contingency accident situations. It is apparent that even during a loss of coolant, multiple events would have to take place for a criticality to occur.

The loss of coolant in the facilities is judged to fall within the category of "not expected to occur during the lifetime of the facilities."

8.1.6 Loss of Storage Array Geometry

Collapse of the support structure with fuel stored in a one-over-three array would cause a fuel concentration of 443.4 lbs. uranium/sq. ft. on the basin floor. For unirradiated Mark IA fuel with optimum moderation and reflection, the minimum critical mass of fuel would be 401 pounds of uranium per square foot. Thus, for unirradiated Mark IA fuel in the one-over-three configuration, a loss of storage array geometry accident would pose a potential criticality problem. However, unirradiated fuel will not be stored that way. The minimum critical mass for Mark IA exposed to 6% Pu-240 is approximately 25% greater than for unexposed Mark IA[5]; consequently, the minimum critical floor loading for 6% Mark IA is about 500 lbs./sq. ft. basin floor. Thus, for one-over-three storage, the loss of storage array geometry accident does not pose a criticality problem for exposed fuel.

A 2-over-3 or 3-over-3 configuration of spike fuel is not safe, however, hanging storage facility design is intended to prevent this configuration.

For a criticality to occur with lower enriched Mark IV fuel, the fuel would have to be removed from the canisters and then be configured in an optimum hemispherical array.

Dropping a loaded cask car into the basin has been considered. It has been determined that only one car could enter the basin.[57] If the car could drop the suspended fuel and its own load (of all spike fuel) in the same 1-over-3 configuration of spike fuel, criticality would be a possibility. The possibility of a criticality is prevented by authorizing only the lower enriched MKIV fuel to be stored in the first (west) bay of each facility's basin. Also, storage by hanging fuel in the west bay of each basin is prohibited.

A cask car dropping into the west bay of either basin would not cause a criticality in the east and middle bays because of the 3 foot thick concrete wall divider between bays.

Collapse of the hanging fuel support structure is judged to fall within the category of "not expected to occur during the lifetime of the facilities."

8.1.7 Well Car Drop Into the Fuel Storage Basin

The possibility of a well car accidentally dropping into a K facility basin has been effectively eliminated. The measures taken to ensure that it does not occur are discussed in section 8.2.8. In addition, criticality from such an event is prevented by fuel storage restrictions as discussed in Section 8.1.6.

8.2 Noncriticality Related Accidents

8.2.1 Loss of Monitoring Instrumentation

The loss of a critical monitoring instrumentation would cause an annunciation in the K facility control rooms and at the N Reactor control room. Procedures are provided for immediate response and corrective action.

8.2.2 Liquid Waste Car Accident

A review of possible impact accidents at railroad crossings indicates that in all cases there is a possibility of a spill.[58] The severity of any spill will depend on the mode or combination of modes of accidents postulated. The analysis referenced indicates the probability and consequences of an accidental spill from this cause are at an acceptable level. See Reference 58 for details.

8.2.3 Crane Failure and Cask Dropped Into the Fuel Loadout Pit[16]

A fully loaded transfer cask, dropped accidentally onto the floor of the transfer pit through a vertical distance of 25 feet, would fracture the pit floor slab. However, the extent of slab failure and accompanying cracking would not permit water to leak from the pit at a very fast rate (25 gpm).[30] There would be a minimum environmental release from such an accident because of the underbasin collection membrane and tile field. A cask drop into the fuel loadout pit is judged to have a frequence classification of "infrequent".

8.2.4 Crane Failure and Cask Dropped onto the Floor of Transfer Area (Maximum Credible Accident)

A fully loaded transfer cask, dropped accidently on to the floor of the transfer area from a height of 15 feet or more and overturning would result in the cask lid coming off and the irradiated fuel spilling out of the cask. The maximum temperature of the fuel elements would be less than 910 F as shown by water loss fuel heatup calculations for fuel in canisters in the cooling pool.[14] An analysis of the radiological consequences from the gaseous release of volatile solids involving a fully loaded cask (42 elements) of irradiated fuel in such an accident was evaluated.[15] The resultant population exposure at the site basin boundary is calculated to be 7×10^{-6} mrem whole body and 1.5×10^{-3} mrem thyroid.

A cask containing three canisters of broken fuel segments dropped onto the transfer area floor would be expected to release about 30 times more radioactivity than a cask of all unbroken fuel elements. The original analysis covering unbroken fuel assumed that three fuel elements were broken during the cask drop and spill.[15] The breaks were assumed to be at a 45

degree angle, with radioactive release predicted on resultant exposed surface and 100% of the broken fuel noble gas inventory. A canister of broken fuel segments is estimated to have a factor of 30 more exposed uranium surface. Consequently the offsite population exposure would be about 2×10^{-5} mrem - whole body and 4.5×10^{-2} mrem thyroid. These are well within the DOE limits of 500 mrem whole body and 1500 mrem thryoid.

Such a cask drop as described above could result in unshielding the fuel and cause a high radiation alarm requiring immediate evacuation of personnel. In an incident at N Reactor, reported in Abnormal Occurrence Report AO No. 2-77, personnel were exposed to fuel as it was being discharged from the reactor. The quick response (evacuation) of the affected personnel resulted in individual doses of 4 to 15 rem. The radiation levels for fuels stored 150 days, as in the cask drop situation, is much lower than freshly discharged fuel. Based on this experience, personnel exposed to unshielded irradiated fuel from a cask drop would receive a radiation dose not exceeding the 5 rem annual limit recommended by the International Council for Radiation Protection. The personnel dose following evacuation would be higher but comparable to the offsite dose and well within the limit.

A cask drop is judged to have a classification of "infrequent". Such a drop containing all broken fuel segments is judged to have a classification of "not expected to occur during the lifetime of the facility" because of the small quantity of broken fuel segments (5% of the total).

8.2.5 Loaded Canister Dropped from a Lifting Hoist to the Pool Floor

A fully loaded canister, accidentally dropped onto the floor of the fuel storage basin from a height of 3.5 feet, would not fracture the bottom floor slab, and would not result in an environmental release.[16]

8.2.6 Fire and Explosion Hazards

The three modification projects (Projects H-501, H-508, and H-558) required only minor alterations and additions to the facility storage pool areas or other parts of the 105-K buildings. None of these should affect the fire or explosion risk to the facilities. The facilities are of noncombustible construction and no additional combustible or explosive materials are required for the operation of the facilities. An adequate supply of water will be available for fire protection needs. The existing fire sprinkler systems in the lunch rooms and change rooms were extended to cover all the shop and office locations which are in service in the facilities. The fire and sanitary water systems have been reactivated including the fire hydrants around the 105-K buildings.

The use of the ion exchange systems will not present any hazard of explosion since there will be no attempts to regenerate the ion exchange material. A mixed cation and anion organic resin may also be used in the ion exchange tanks, if necessary, to reduce the radionuclide concentraton in the basin water. If a mixed organic resin is used, the residence time will be administratively limited to prevent a possible degradation of the resin.

8.2.7 Loss of Pool Coolant

Early in the development of the KE-SAR the complete loss of storage pool coolant was considered as the maximum credible accident. However, with the issuance of UNI-287, "Extreme Load Analysis of the 100-K Fuel Storage Basins and Clearwells", (Ref. 16), the complete loss of water from the storage pool due to an earthquake or an accidental drop of the fuel shipping cask into the transfer pit is no longer considered credible. A railroad well car falling into the basin is also considered not credible as explained in Section 8.2.8. The maximum credible accident is now defined as a cask drop in the transfer area that results in spilled fuel outside of a transfer cask. Further discussion of the maximum credible accident is provided in Section 8.2.4.

However, two analyses have been made of a hypothetical loss of coolant. The first study, Reference 14, is based on a full floor loading of 150 day stored (decayed or aged) fuel. This study determined a maximum fuel temperature of 910°F. At this temperature the fuel cladding will remain intact. There would be release of volatile solids from damaged fuel as discussed in Section 8.2.4. With less than 5% of the fuel damaged the release would be less than 200 times the release from a cask drop. The second analysis[31] was based on heat generation of the fuel as actually stored in the nearly filled KE facility. This fuel has been stored or aged much longer than 150 days. The maximum fuel temperature would be 781°F for a full floor load with 16 1/2 rows of hanging fuel.

8.2.8 Uncontrolled Railroad Train

A hypothetical accident involving a runaway train has been identified. It is postulated that the train engineer becomes physically incapacitated as the train approaches or enters the facility. Unlike the N Reactor facility, the rails at the K facilities line up directly with the fuel storage pool and terminate approximately 6 feet from the edge of the fuel storage pool. The weight of one loaded cask car is approximately 120 tons and it is not inconceivable that a car could enter the pool in this kind of accident. Without specifically calculating the effects, it was determined that the weight of one cask car would be well in excess of the amount necessary to damage the floor.[29] Based on these determinations, it was concluded that to

prevent such a hypothetical accident from becoming a reality, protective devices and procedures should be in place to prevent a runaway or uncontrolled train from entering the facility.

Derailers, railstops, and bumpers are utilized as protective devices. The combined weight of the heaviest loaded cask car and locomotive is 470,000 pounds. The kinetic energy of this combination at 2 mph is 63,100 ft-lbs, at 4 mph 252,000 ft-lbs. The rail stops on the southern-most rail spur coming into each basin can absorb 31,500 ft-lbs, the bumpers 59,000 ft/lbs for a total capacity of absorbing 90,500 ft-lbs. This is sufficient to stop a train traveling 2 mph, but clearly is inadequate for a train with a velocity of 4 mph. The bumping posts used to protect the northern-most rail spur coming into each facility are designed to absorb 252,000 ft-lbs, which is adequate to stop a one-car train going 4 mph. Derailers capable of derailing trains traveling at speeds up to 5 mph are located 520 ft from the end of the track. The derailers are double locked in the active position with a UNC lock and a Rockwell lock. These are unlocked after the train has uncoupled all but one cask car and stopped adjacent to the derailer. The locks from the derailer are then removed, one by the Rockwell train crewman and one by the UNC Supervisor or other qualified person.* The UNC representative then rides in the locomotive cab while the locomotive is within the derailer location.

The older (ALCO) locomotives are provided with a throttle return and throttle position limiting device. The UNC representative applies a lock to the throttle limiting its position to the 2 mph setting. However a finely tuned engine can propel the locomotive at speeds up to 4 mph at the 2 mph throttle setting. There is an emergency stop switch available if the locomotive speed exceeds 2 mph. Excessive speed is determined by engine noise.

The newer (GM) locomotives are provided with a Pace Setter electronic controller (see Section 5.6.4) which can be accurately set for any low speed. In this locomotive the UNC representative ensures that the Engineer properly sets and activates the Pace Setter. An emergency stop switch is also available on these locomotives. Excess speed is determined by an electronic speedometer reading in one mph increment.

There are a number of protective features in place to prevent an out of control train from entering the facilities. The track switch which allows trains to enter KW is kept in the closed position, routing any out of control train to KE. The entrance to KE is protected either by a crash car with locked brakes or the switch which will route trains to the auxiliary siding. Both KE and KW have locked derailers which must be removed before trains can

*As defined in the Facility Operational Safety Requirements.

enter. A throttle lock or Pace Setter, the emergency stop switch, and the presence of the UNC representative in the cab of the locomotive ensures that the train will remain under control as it approaches the basin.

WP #1013U

9.0 QUALITY ASSURANCE

9.1 Construction Phase

Projects H-501, H-508, H-558, DC-82180, DC-82121 and DC 82223 were completed in accordance with a documented quality assurance program plan which encompases project activities from the issuance of design criteria through acceptance of the completed facilities. This plan defined the requirements applicable to UNC, Vitro, (now Kaiser,) the architect-engineer and the J.A. Jones Construction Company the construction contractor. In defining these requirements, the plan incorporated appropriate elements of the quality assurance programs which were already in place for DOE sponsored work at Hanford by these three organizations.

Compliance with the quality assurance program plan for Projects H-501, H-508, H-558, DC-82180, DC-82121 and DC-82223 was verified by the UNC Quality Assurance Department through auditing and review and approval of (1) documents which defined the specific quality assurance measures to be applied, (2) project design criteria, drawings, specification documents and acceptance test procedures, (3) procurement documents for engineered items, and (4) inspection plans. Audits consisted of reviewing the adequacy and findings of the audits conducted by the architect-engineer and the construction contractor of their activities, as well as auditing for compliance with the requirements applicable to UNC.

Quality records in the form of properly approved plans, procedures and instructions; design and procurement documents; manufacturer's certifications; reports of inspections, tests and audits; and other quality related documents are available for review in the project files.

9.2 Operating Phase

The operation and maintenance of the facilities, as modified by Projects H-501, H-508, H-558, and equipment installed under DC-82180, DC 82223 and DC-82121 will be governed by the quality assurance program document.[20] The program encompasses all applicable elements of the N Reactor program that relate to operation, maintenance, and any future modification of the facilities.

The quality assurance program document has been reviewed with the appropriate management of the facility to assure the implementation of the requirements. The Quality Assurance Division will conduct periodic audits to assure compliance with all requirements of the program and to determine the effectiveness of the program.

WP #1014U

10.0 Operations Safety Requirements

Limits, operating conditions and other requirements have been established to assure that the K Area Fuel Storage Facilities are operated in a manner that provides for the protection of the health and safety of the public. The requirements are included in the latest issue of the Operations Safety Requirements UNC Nonreactor Nuclear Facilities KE and KW Fuel Storage Basins, UNI-M-139 Vol 1.[59]

WP #1014U

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