HLWYM NPEmails

From: Albert Wong
Sent: Tuesday, March 20, 2007 3:13 PM
To: George Adams; Oleg Povetko; Razvan Nes; Fernando Ferrante; Tina Ghosh; Susan Cooper; Christopher Ryder
Cc: Robert Johnson (NMSS); Jim Pearson; Rosemary Reeves; Sheena Whaley
Subject: Fwd: Reference for Engineered controls - fuel lifts
Attachments: 9-1 Fuel Storage and Handling.pdf

Rosemary found the following reference from the Shearon Harris FSAR, FYI.

I talked to people in NRR after the PCSA Phase II exercise mtg last week. They told me different NPPs have different ways to prevent fuel assemblies from being over withdrawn. The controls range from limit switches at Calvert Cliffs to positive mechanical up-stop at St. Lucie Unit 1 (from St. Lucie Unit 1 FSAR). At Calvert Cliffs, the limit switch is set by the fuel handling machine operator. The travel length of the fuel handling machine can be adjusted by the operator. The operator follows a plant procedure when adjusting the setting. There are other secondary indicators (e.g., tape measure) around the pool to help the operator maintain safe water level above the fuel. Additionally, there are rad alarms in the facility to warn operators when radiation is detected.

A third plant (N. Anna) withdraws the fuel into a mast (sort of like a telescoping rod) and that mast can't be lifted out of water. I think it's similar to what Chris found out from reading the Columbia (?) FSAR. N. Anna's fuel handling machine is incapable of lifting the fuel out of water due to the physical limit of how far the machine can travel. Obviously all safety controls can be defeated. For instance, at N. Anna, one can use a different bridge crane (w/ longer lifting capability) to forcefully pull the fuel out of water.

I'm trying to get some info from one of the fuel handling machine manufacturer to see how modern machines are configured. Different NPPs were built in different times. The level of sophistication of the equipment varies depending on when it was built. When evaluating this issue, we should keep one thing in mind (as Chris pointed out): the age of YM fuel and the additional water available for shielding, which in theory should make the YM pool ops safer.

So far we have gaither info from the SH FSAR, Jim Pearson, Sheena and the conversations I had with NRR. When we meet tomorrow, I'd like to spend a few min to discuss how we proceed from here if we finish the main topic early. Of course the main topic of the discussion will be event sequence #3 (tipping of the cask).

>>> Rosemary Reeves 03/20/2007 12:42 PM >>>
Albert,

I finally found a statement that refers to a design of engineered controls for fuel lifts. The statement is "The hoist travel and tool length are designed to limit the maximum lift of a fuel assembly to a safe shielding depth."

It is in Shearon Harris FSAR. Refer to page 36 of the attached file.

So far in my reading, the FSAR does not specify a code requirement, but I think this is part of their adherence to Criterion #61 of Appendix A to Part 50, which says "[fuel storage and handling systems] shall be designed with suitable shielding for radiation protection."

Please send to the PCSA Phase II team.

Rosemary

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9.0 NEW AND SPENT FUEL STORAGE AND HANDLING

The design of the Shearon Harris Nuclear Power Plant as shown on Figures 1.2.2-55 through 1.2.2-59 incorporates the use of three spent fuel pools and one new fuel pool, as well as a cask loading pool. All of these pools are interconnected by the main fuel transfer canal and the fuel transfer canal.

Should the need exist, the SHNPP is designed such that spent fuel from Carolina Power & Light's Brunswick and Robinson Nuclear Power Plants could be stored in addition to the spent fuel from the SHNPP. The design of the fuel pools and storage racks allow for the storage of new and spent fuel in any applicable fuel pool. New fuel storage is not limited to the pool designated as the new fuel pool. The new and spent fuel pools will also have the capability to accept spent fuel storage racks for CP&L fuel other than the PWR fuel to be used by the SHNPP. A discussion of these racks is presented in Sections 9.1.1 and 9.1.2. The fuel handling devices are discussed in Section 9.1.4.

9.1 Fuel Storage and Handling

9.1.1 New Fuel Storage

9.1.1.1 Design Bases. New fuel storage is provided by applicable wet fuel pools, as well as the new fuel dry storage racks in the new fuel inspection pit. The PWR racks in Pool A are designed to store both new and spent fuel. PWR fuel storage is provided by 6x10 cell rack modules. The pool may accommodate a maximum of eight of this style rack for a storage capacity of 480 assemblies. However, there are currently only six of this type of storage rack module installed in Pool A, for a total storage capacity of 360 new or spent fuel PWR assemblies. The new fuel dry storage racks within the new fuel inspection pit provide dry storage for new fuel assemblies. The cells of the new fuel dry storage racks are identical to the PWR racks used in Pools A and B. However, the new fuel racks are arranged differently and all cells may not contain fuel assemblies. On four of the 6x10 cell new fuel dry storage racks, two of the sides common to one of the corners are restricted and the remaining space is arranged in a checkerboard pattern. The pattern is the same for the fifth new fuel rack but all four corners are restricted.

When storing fuel, these rack modules provide safe storage in either a wet or dry pool environment and are designed for underwater installation and removal. The new fuel inspection pit, which contains the new fuel dry storage racks, is maintained in a dry condition and Pool A is maintained in a flooded condition.

The fuel racks consist of individual vertical cells fastened together through top and bottom supporting grid structures to form integral modules. Boraflex is encapsulated into the stainless steel walls of each storage cell for neutron absorption. Certain PWR rack modules have designated cells that do not contain the neutron absorbing material in one cell wall. These cells are utilized for an absorber material coupon surveillance program. The PWR rack modules have a center-to-center spacing of 10.5 inches between cells. These free-standing, self-supporting modules are sufficient to maintain a subcritical array even in the event the fuel pool is flooded with unborated water. Tables 9.1.2-1 and 9.1.2-2 show the parameters for the SHNPP spent fuel racks, which are located in Pool A.

In the event that additional space is needed for the storage of spent fuel from other nuclear plants in the CP&L system, Pool A is designed for the storage of both PWR and BWR fuel. Spent BWR fuel will be stored in 11x11 BWR rack modules, which are designed for underwater installation and removal. The BWR rack modules have a center-to-center spacing of 6.25 inches between cells. There are currently three 11x11 BWR rack modules installed in Pool A.

The storage racks shall maintain the allowable stored fuel assemblies in a sub-critical array such that: (1) The k-effective calculated assuming maximum fuel assembly reactivity and flooded with unborated water is less than 0.95, at a 95 percent probability, 95 percent confidence level. (2) The k-effective corresponding to optimum moderation (low density or heterogeneously distributed water) is less than 0.98, at a 95 percent probability, 95 percent confidence level.

9.1.1.2 Facilities Description. Pool A is located in the south end of the Fuel Handling Building, as shown on Figures 1.2.2-55 through 1.2.2-59. Pool A is interconnected with the other three spent fuel pools by means of a transfer canal which runs the length of the Fuel Handling Building. These pools can be isolated by means of removable gates.

The Pool A is a concrete structure with a stainless steel liner for compatibility with the pool water. There is no built-in drain connection in pool A, thus eliminating the possibility of draining the pool when spent fuel is being stored. Provisions are made to limit and detect leakage from the fuel pools through the use of liner leak detection channels which are placed in various locations outside the stainless steel liner and pool gates. These channels funnel any leakage to drain lines which are checked periodically to determine the structural integrity of the pools and gates. A description of the pool liner is given in Section 9.1.3.

The new fuel inspection pit, which contains the new fuel dry storage racks, is a concrete structure located in the north end of the Fuel Handling Building at Elevation 261'. It has a concrete floor with no steel liner. It is not usable for wet storage, due to an open stairwell leading down to the 216' elevation, with a non-waterproof door into the pit.

9.1.1.3 Safety Evaluation. The Fuel Handling Building is designed in accordance with Regulatory Guide 1.13, Rev. 1, "Spent Fuel Storage Facility Design Basis," and provides protection to the fuel racks and other pieces of equipment against natural phenomena such as tornadoes, hurricanes, and floods as discussed in Sections 3.3, 3.4, and 3.5.

The design and safety evaluation of the fuel racks is in accordance with the NRC position paper, "Review and Acceptance of Spent Fuel Storage and Handling Applications."

The racks, being ANS Safety Class 3 and Seismic Category I structures, are designed to withstand normal and postulated dead loads, live loads, loads due to thermal effects, and loads caused by the operating bases earthquakes and safe shutdown earthquake events in accordance with Regulatory Guide 1.29, and stress allowables defined by ASME Code, Section III. The racks can withstand an uplift force equal to the maximum uplift capability of the spent fuel bridge crane.

The design of the PWR fuel racks is such that with a maximum core geometry K-infinity less than or equal to 1.470 at 68°F, and the pool flooded with unborated water at optimum moderation, K_{eff} is ≤ 0.95.

The design of the BWR spent fuel racks is such that with reactivity bounded by the 8 x 8R, 3.2 w/o U235 assembly, the K_{eff} for the racks will not exceed 0.95 with the spent fuel pool flooded with unborated water. With this limit on assembly reactivity, all fuel assemblies loaded in BSEP Unit 1 through reload 5 and all fuel assemblies located in BSEP Unit 2 through reload 6 are conservatively bounded and may be stored at SHNPP.

Consideration is given to the inherent neutron absorbing effect of the materials of construction. Fuel handling accidents will not alter the rack geometry to the extent that the criticality acceptance criteria is violated. The criticality safety analysis is discussed in Section 4.3.2.6.

Materials used in construction are compatible with the storage pool environment, and surfaces that come in contact with the fuel assemblies are made of annealed austenitic stainless steel.

TABLE 9.1.1-1 WAS DELETED BY AMENDMENT NO. 43.

9.1.2 Spent Fuel Storage

9.1.2.1 Design Bases. Spent fuel storage is provided by the New Fuel Storage Pool (Pool A) and the three spent fuel pools commonly referred to as Pool B, C, and D. The maximum storage capacity of these three pools is dependent on the type of storage racks and assemblies chosen for installation. The actual number and type of assemblies being stored will vary depending on future storage requirements. The currently licensed storage capacity of each pool is provided in Table 9.1.2-1. The four pools are licensed to include 3,080 PWR storage cells and 5,304 BWR storage cells, for a total storage capacity of 8,384 fuel assemblies.

Pool B is located adjacent to Pool A at the Unit 1 (south) end of the Fuel Handling Building and provides storage for spent fuel assemblies using a combination of various rack modules sizes. Pools C and D are located in the north end of the Fuel Handling Building and provide additional storage for spent fuel assemblies using a combination of various rack modules sizes. Storage racks are to be added on an as needed basis. Rack modules are designed for underwater installation and removal, should rack rearrangement be desired. Module arrangement may vary, based on changing fuel storage needs, provided the structural analysis shows the proposed module arrangement to be acceptable. Rearrangement of the racks would have no effect on maximum stored fuel criticality.

To accommodate the storage of spent fuel from other nuclear plants in the CP&L system, Pools A, B, and C are designed for the storage of both PWR and BWR fuel. The 9x9 PWR racks designed for Pool C are dimensionally interchangeable with the 13x13 BWR rack modules designed for Pool C. Table 9.1.2-1 provides a listing of the various rack sizes.

The fuel racks consist of individual vertical cells fastened together through top and bottom supporting grid structures, or intermittent welds along the corners of adjacent fabricated cell boxes, to form an integral of storage cells. The bottom of the storage cell array is connected to a baseplate, which provides additional rigidity and also serves to support the fuel assemblies in storage. The rack modules are free-standing and self-supporting. A neutron absorbing material is encapsulated into the stainless steel walls of each storage cell. Certain PWR rack modules in Pools A or B have designated cells that do not contain neutron-absorbing material in one cell wall. These cells are utilized for an absorber material coupon surveillance program.

The PWR rack modules located in Pools A and B have a center-to-center spacing (pitch) of 10.5 inches between cells. The PWR rack modules designed for Pools C and D have a center-to-center spacing (pitch) of 9.0 inches between cells. The BWR rack modules located in Pools A, B, C, and D have a center-to-center spacing (pitch) of 6.25 inches between cells. Table 9.1.2-2 provides other basic dimensional parameters for the SHNPP spent fuel racks.

The modules are designed to maintain a subcritical array of $K_{eff} \leq 0.95$ even in the event that the pools are flooded with unborated water. Insertion of a BWR fuel assembly into a rack designed to store PWR fuel will result in a subcritical array of $K_{eff} \leq 0.95$. Conversely, a PWR fuel assembly will not fit into a BWR spent fuel rack storage cell, thus, mislocation is not a concern.

The PWR storage modules located in Pools A and B are "Region 1" style racks, which are designed with a gap between adjacent storage cells, commonly referred to as a flux trap. This type of rack design places no fuel characteristic (i.e., enrichment and/or burnup) restrictions on stored fuel. Therefore, the design of these racks precludes insertion in other that prescribed locations, thereby preventing any possibility of accidental criticality.

The gap between cells in the PWR storage modules located in Pools A and B also allow lead-in openings to be included at the top of the storage ells to guide the fuel during insertion. The BWR racks design for all four pools do not require or contain flux traps, since subcriticality of all fuel is ensured by considering storage of fuel with the highest reactivity. BWR storage locations do not have a lead-in, since the fuel lower nozzle design facilitates insertion into the storage cell.

The PWR storage modules designed for Pools C and D are maximum density "Region 2" style racks, which do no include a flux trap between adjacent cells. These racks ensure subcriticality under normal storage conditions by placing burnup enrichment limitations on stored fuel.

Subcriticality in PWR racks designed for Pools C and D under accident conditions, except for fuel misloading, is also ensured by the design of the storage module without taking credit for soluble boron. The inadvertent misloading of a fresh fuel assembly into a Pool C or D PWR storage cell is highly unlikely, primarily due to the distance from the new fuel handling areas. Nevertheless, this condition has been considered and it has been determined that this accident will result in a subcritical array of $K_{eff} \leq 0.95$, if credit is taken for soluble boron. Administrative procedures to assure the presence of soluble poison during fuel handling operations will preclude the possibility of the simultaneous occurrence of the loss of all soluble boron and a misloaded PWR fuel assembly. The largest reactivity increase would occur if a new fuel assembly of the highest reactivity (i.e., fresh, unburned) were to be positioned within an otherwise fully loaded PWR storage rack module. Under this accident condition, credit for the presence of soluble boron is permitted by NRC guidelines[1], and it has been determined that a minimum soluble boron concentration of about 400 ppm would be adequate to assure that the limiting $K_{eff} \leq 0.95$ is not exceeded. This concentration is much lower than the 2,000 ppm concentration required by administrative controls. Therefore, subcriticality is assured under all accident conditions.

<u>9.1.2.2 Facilities Description</u>. The spent fuel storage facility is located in the Fuel Handling Building as shown in Figures 1.2.2-55 through 1.2.2-59. The spent fuel is transferred from Containment to the Fuel Handling Building through the fuel transfer tube. The spent fuel bridge crane is used to transfer the spent fuel between the storage racks, fuel pools, transfer canals, and the spent fuel cask. This procedure is carried out with the spent fuel assemblies totally submerged.

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[1] Double contingnecy principle of ANSI N16.1-1975, as specified in Section 1.2 of the NRC OT Postion Paper (Reference 9.1.2-1).

There are three spent fuel pools. The spent fuel pool at the south end of the FHB is referred to as Pool B or Spent Fuel Pool Unit 1. The north end of the FHB contains two additional spent fuel pools. The larger of these two pools is referred to as Pool C or Spent Fuel Pool Unit 2. The smaller north end pool is referred to as Pool D, Spent Fuel Pool, or New Fuel Pool Unit 2. These pools are interconnected by means of the main fuel transfer canal which runs the length of the Fuel Handling Building. These pools can be isolated by means of removable gates.

The spent fuel pools are concrete structures with a stainless steel liner for compatibility with the pool water. Provisions are made to limit and detect leakage from the fuel pools through the use of liner leak detection channels which are placed in various locations outside the stainless steel liner and pool gates. These channels funnel any leakage to drain lines which are checked periodically to determine the structural integrity of the pools and gates. A description of the pool liner is given in Section 9.1.3.

9.1.2.3 Safety Evaluation. The Fuel Handling Building is designed in accordance with Regulatory Guide 1.13, Rev. 1, "Spent Fuel Storage Facility Design Basis," and provides protection to the fuel racks and other pieces of equipment against natural phenomena such as tornadoes, hurricanes, and floods, as discussed in Sections 3.3, 3.4, and 3.5.

The design and safety evaluation of the fuel racks is in accordance with the NRC position paper, "Review and Acceptance of Spent Fuel Storage and Handling Applications," dated April 14, 1978 (Reference 9.1.2-1).

The racks, being ANS Safety Class 3 and Seismic Category I structures, are designed to withstand normal and postulated dead loads, live loads, loads due to thermal effects, loads caused by the operating bases earthquakes, and safe shutdown earthquake events in accordance with Regulatory Guide 1.29, and stress allowables defined by ASME Code, Section III.

Consideration is given to the inherent and fixed neutron absorbing effect of the materials of construction. The design of the racks is such that $K_{eff} \leq 0.95$ under all conditions, including fuel-handling accidents. Due to the close spacing of the cells, it is impossible to insert a fuel assembly in other than design locations. Inadvertent insertion of a fuel assembly between the rack periphery and the pool wall is considered a postulated accident and, as such, realistic initial conditions such as boron in the water can be taken into account. This condition has an acceptable $K_{eff} \leq 0.95$. A discussion of the criticality analysis is provided in Section 4.3.2.6.

The racks are also designed with adequate energy absorption capabilities to withstand the impact of a dropped fuel assembly from the maximum lift height of the spent fuel bridge crane. Handling equipment capable of carrying loads heavier than a fuel assembly is prevented by interlocks or administrative controls, or both, from traveling over the fuel storage area. When such loads must travel over the spent fuel storage area, redundant holding systems as described in Table 9.1.4-1 are used. The racks can withstand an uplift force equal to the maximum uplift capability of the spent fuel bridge crane.

NUREG-0800, Section 9.1.4 Acceptance Criterion 5 requires that, "The maximum potential kinetic energy capable of being developed by any load handled above the stored fuel, if dropped, is not to exceed the kinetic energy of one fuel assembly and its associated handling tool when dropped from the height at which it is normally handled above the spent fuel storage racks."

Analysis performed by Westinghouse showed that the maximum kinetic energy that can be developed by the BPRA tool is 6677 ft. lbs. while that developed by a fuel assembly and its handling tool is only 4961 ft. lbs.

Analysis of potential fuel damage due to this situation was performed by Westinghouse. This analysis showed that although the kinetic energy for the dropped handling tool is 35 percent greater than the kinetic energy for a combined fuel assembly and tool drop accident, that latter case is more limiting from a fuel rod damage potential. In previous accident analyses it was assumed the the dropped fuel assembly fractures a number of fuel rods in the impacted (stationary) assembly and subsequently falls over and ruptures the remaining rods in the dropped assembly. In the case of a dropped tool accident, it is postulated that the handling tool directly impacts a stationary fuel assembly which can cause fuel rods to be fractured in the impacted assembly. However, no additional fuel rods are fractured due to the tool fallover after impact.

The analytical procedure for assessing fuel damage is to conservatively assume that the total kinetic energy of the dropped assembly is converted to fuel clad impact fracture energy. The energy required to break a fuel rod in compression is estimated to be 90 ft. lbs. If the total kinetic energy for the dropped tool, 6677 ft. lbs., is absorbed by fracturing the fuel rod, a total of 74 fuel rods would be broken.

This value is substantially less than the number of fuel rods that could be potentially fractured by a dropped fuel assembly and subsequent fallover. Based on this analysis, it is concluded that the dropped tool accident is not limiting.

Following this analysis, the potential for damage to the fuel racks was analyzed. Five different locations on the top of a standard PWR poison rack assembly were analyzed for straight drop BPRA tool impact.

In addition, the effect of dropping the BPRA tool at an angle such that it ended up lengthwise on the top of the rack was analyzed. However, since the energy is applied to a larger number of cells during the inclined drop, the damage to an individual cell is not as great as that of a straight drop.

The different scenarios analyzed indicate that it may be possible for the cell to drop 1/2-inch to the base or deflect laterally as much as .459-inch. It is possible that the cells located in the drop zone may be damaged enough to obstruct the insertion or removal of fuel. However, in no case does the fuel rack grid structure fail nor is the poison material damaged. Thus, an increase in reactivity between adjacent cells is not considered likely. This is also supported by the fact that the soluble boron in the pool water counteracts any postulated reactivity increase.

Thus, it has been demonstrated that this situation would have no adverse safety impact on the SHNPP stored fuel.

Tool drop accidents involving the RCCA change tool, BPRA tool, thimble plug tool, PWR spent fuel handling tools, the BWR spent fuel handling tool, refueling trash baskets and items carried by the spent fuel handling tools (vendor supplied refueling trash basket, failed fuel rod storage basket and dummy spent fuel assembly) have been evaluated. If the consequences of dropping a tool from the maximum height which the tool can be raised by the spent fuel bridge crane is not acceptable, then a tool lift limit is indicated on the tool. Tool lift limit marks are placed on tools, and are only applicable when the tools are located in pools A and B. During tool operation, verification that tool lift limits have not been exceeded, is determined by observing that the lift limit marks on the tools are not raised above the upper hand rail of the spent fuel bridge crane. If the thimble plug tool, a fuel pool trash basket (including the specimen basket) with its handling tool or the failed fuel rod storage basket with its handling tool is dropped from the full height that can be achieved by the spent fuel bridge crane; or the other tools are dropped from their lift limits, the consequences will be less severe than for a dropped spent fuel assembly and its handling tool. PWR spent fuel racks have been evaluated for a tool drop which develops 6677 ft-lbs of kinetic energy. BWR spent fuel racks have been evaluated for tool drop which develops 3800 ft-lbs of kinetic energy.

Materials used in construction are compatible with the storage pool environment, and surfaces that come into contact with the fuel assemblies are made of annealed austenitic steel. The materials are corrosion resistant and will not contaminate the fuel assemblies or pool environment.

Shielding considerations are discussed in Section 12.3. Radiological conditions associated with the fuel handling accident are discussed in Section 15.7.

TABLE 9.1.2-1
NEW AND SPENT FUEL RACK DESIGN ATTRIBUTES

POOL	Fuel Type	Storage Array Size (Cells)	Rack Dimensions (Inches)	Licensed Number of Racks	Total Licensed Storage Capacity
A	PWR	6x10	62.4 x 104.0	6	360
	BWR	11x11	69.0 x 69.0	3	363
B	PWR	6x10	62.4 x 104.0	5	300
		7x10	72.8 x 104.0	6	420
		6x8	62.4 x 83.2	1	48
	BWR	11x11	69.0 x 69.0	18	2178
C	PWR	9x11	81.5 x 99.5	2	198
		9x9	81.5 x 81.5	9	729
	BWR	13x13	81.5 x 81.5	9	1,521
		11x13	69.0 x 81.5	6	858
		8x13	50.5 x 81.5	2	208
		8x11	50.5 x 69.0	2	176
D	PWR	8x10	72.5 x 90.5	6	480
		8x11	72.5 x 99.5	2	176
		9x10	81.5 x 90.5	3	270
		9x11	81.5 x 99.5	1	99
Total[1]				80	8,384

[1] Upon installation of all racks in all four pools.

TABLE 9.1.2-2
HARRIS SPENT FUEL RACK DIMENSIONS *

Pools A and B Rack Design Parameter	PWR	BWR
C-C SPACING	10.50	6.250
CELL I.D.	8.750	6.050
POISON CAVITY	0.090	0.060-0.080
POISON WIDTH	7.500	5.100
CELL GAP	1.330	___
POISON THICKNESS	0.075	0.045-0.075
CELL WALL THICKNESS	0.075	0.075
WRAPPER THICKNESS	0.035	0.035
POISON (^{10}b GM/CM^2	0.020	0.0103-0.015

Pools C and D Rack Design Parameter	PWR	BWR
C-C SPACING	9.0	6.25
CELL I.D.	8.8	6.06
POISON CAVITY: Inner Box	0.107	0.082
Rack Periphery	0.106	0.110
POISION WIDTH: Inner Box	7.5	5.0
Rack Periphery	7.5	3.5
CELL GAP	N/A	___
POISON THICKNESS	0.098	0.075-0.101
CELL WALL THICKNESS	0.075	0.075
WRAPPER THICKNESS: **		
Inner Box	0.035	0.035
Rack Periphery	0.075	0.075
POISON (^{10}B gm/cm^2	0.0302	0.0162

* All dimensions are nominal and units are in inches, unless noted otherwise

** Neutron absorbing material is not needed or used on the exterior walls of modules facing non-fueled regions, i.e., the pool walls. However, at least one panel is used between storage racks.

9.1.3 Fuel Pool Cooling and Cleanup System

9.1.3.1 Design Basis. The Fuel Handling Building (FHB) is split into two storage facilities. The storage facility on the south end of the FHB consists of two spent fuel pools, also referred to as Pool A and Pool B. The storage facility on the north end of the FHB consists of spent fuel pools, also referred to as Pool C and Pool D. By design, the pools in the FHB may accommodate both new and spent fuel as described in Section 9.1.1 and 9.1.2. The design bases for the Fuel Pool Cooling and Cleanup System (FPCCS) are as follows:

a) The North and South fuel storage facilities each consist of two 100 percent cooling systems in addition to cleanup equipment for removing the particulate and dissolved fission and corrosion products resulting from the spent fuel.

b) Fuel can be transferred within the operational storage facility as shown on Figure 1.2.2-55. Fuel handling is described in detail in Section 9.1.4.

c) The FPCCS is designed to maintain water quality in the fuel storage pools and remove residual heat from the spent fuel.

d) The current and typical refueling practice at SHNPP of transferring the entire core to the storage facility is referred to herein as the Full Core Offload Shuffle. The refueling practice of transferring only that portion of the core to be discharged to the storage facility is referred to herein as the Incore Shuffle. Both of these practices are reported as Normal Cases when meeting the requirements of the Standard Review Plan. The Abnormal Case is reported as the transfer of the entire core to the storage facility following startup of the next operating cycle. This case is referred to herein as the Post Outage Full Core Offload.

e) The cooling system serving the South fuel storage facility (Pools A and B) has been designed to remove the heat loads generated by the quantities of fuel to be stored in the pools.

The cooling system serving the North fuel storage facility (Pools C and D) has been designed to remove heat load of no more than 7.0 Mbtu/hr.

f) The Standard Review Plan pool temperature requirement for the Normal Case, assuming a single active failure, is 140°F. The minimum decay time prior to movement of irradiated fuel in the reactor vessel will address both radiological and decay heat considerations. Administrative controls are placed on the minimum cooling time before transfer of spent fuel to the pools, to limit the fuel pool temperature to less than or equal to 150°F. The pool temperature requirement for the Abnormal Case is to be below boiling. The pool concrete design temperature is 150°F, but has been evaluated to 160°F.

g) Calculations of the maximum amount of thermal energy to be removed by the spent fuel cooling system are made using the ORIGEN2 computer code. The ORIGEN2 calculation will include a reactor power uncertainty value of 2%.

h) The fuel pool heatup rates were calculated using the following assumptions:

1) No credit for operation of the FPCCS.

2) No evaporative heat losses.

3) No heat absorption by concrete or liner.

4) No heat absorption by spent fuel racks or fuel in pool.

i) The cleanup loop pumps have the capacity to provide makeup water at a rate greater than the loss of water due to normal system leakage and evaporation.

j) Safe water level (and thus sufficient radiation shielding) is maintained in the new and spent fuel pools since the cooling connections are at the tops of the pools.

k) Components and structures of the system are designed to the safety class and seismic requirements indicated in Table 3.2.1-1.

l) The FPCCS will perform its safety related function assuming a single active failure (Reference 9.1.3-1).

9.1.3.2 System Description. The Fuel Pool Cooling and Cleanup Systems are provided as shown on Figures 9.1.3-1, 9.1.3-2, 9.1.3-3 and 9.1.3-4. Each FPCCS is compirsed of two fuel pools (Pools A and B - south end, Pools C and D - north end); a Fuel Transfer Canal (south and north); two fuel pool heat exchangers; two fuel pool cooling pumps; two fuel pool strainers; a fuel pool demineralizer; a fuel pool demineralizer filter; and two fuel pool and refueling water purificaiton pumps; a fuel pool skimmer pump; a fuel pool skimmer strainer, and a fuel pool skimmer filter. The common Cask Loading/Unloading Pool and the Main Fuel Transfer Canal are supported by both the south and north FPCCSs. The FPCCS fuel pool skimmer systems have provisions for skimmer connections as follows: three fuel Pool A and D skimmers; five Pool B and C skimmers; south and north transfer canal skimmers; two main transfer canal skimmers, one cask loading/unloading pool skimmer.

The new fuel pool, Pool A, and the spent fuel pool, Pool B, are interconnected by the south Fuel Transfer Canal. The Cask Loading/Unloading Pool, Pool C, and Pool D are interconnected by the north Fuel Transfer Canal. The Main Fuel Transfer Canal connects the south and north Fuel Transfer Canals. Gates are provided to isolate the pools, as needed. Spent fuel is placed in the pools during refueling or from shipments of off-site fuel and stored until it is shipped to a reprocessing facility or otherwise disposed. Fuel handling is discussed in detail in Section 9.1.4. The overall arrangement of the pools is shown on Figure 1.2.2-55. Cooling of spent fuel is accomplished by the fuel pool cooling systems. The location of the inlet and outlet connections to the pools precludes the possibility of coolant flow "short circuiting" the pool.

The Fuel Handling Building is designed to Seismic Category I requirements and to the tornado criteria as stated in Section 3.3.

The fuel pools in the Fuel Handling Building will not be affected by any loss of coolant accident in the Containment Building. The water in the pools is isolated from that in the refueling cavity during most of the refueling operation. Only a very small amount of interchange of water will occur as fuel assemblies are transferred during refueling.

The FPCCS is designed for the removal of sensible heat from the fuel pools. For this mode of operation, the equilibrium temperatures are as shown in Table 9.1.3-2.

The FPCCS serving Pools C and D has been designed to remove a decay heat load no greater that 7.0 Mbtu/hr. This limited heat load can be from spent fuel assemblies acquired from HNP, H. B. Rosinson Unit 2 and/or Brunswick Units 1 and 2.

The clarity and purity of the fuel pool water is maintained when desired or necessary by passing approximately five percent of the cooling system flow through a cleanup loop consisting of two filters and a demineralizer. The fuel pool cooling pump suction line, which can be used to lower the pool water level, penetrates the fuel pool wall approximately 18 ft. above the fuel assemblies. The penetration location precludes uncovering the fuel assemblies as a result of a postulated suction line rupture.

Piping in contact with fuel pool water is austenitic stainless steel. The piping is welded except where flanged connections are used at the pumps, heat exchangers and control valves to facilitate maintenance.

Control Room and local alarms are provided to alert the operator of high and low pool water level, and high temperature in the fuel pool. A low flow alarm, based on measured flow to the fuel pool, is provided to warn of interruption of cooling flow.

Each Fuel Pool Cooling and Cleanup System (North and South) is comprised of the following components. The component parameters are presented in Table 9.1.3-2.

a) Fuel Pool Heat Exchanger - Two fuel pool heat exchangers are provided. The fuel pool heat exchangers are of the shell and straight tube type. Component cooling water supplied from the Component Cooling Water System (Section 9.2.2) circulates through the shell, while fuel pool water circulates through the tubes. The installation of two heat exchangers assures that the heat removal capacity of the cooling system is only partially lost if one heat exchanger fails or becomes inoperative.

b) Fuel Pool Cooling Pump - Two horizontal centrifugal pumps are installed. The use of two pumps installed in separate lines assures that pumping capacity is only partially lost should one pump become inoperative. This also allows maintenance on one pump while the other is in operation.

c) Fuel Pool Demineralizer - One demineralizer is installed. The demineralizer is sized to pass approximately five percent of the loop circulation flow to provide adequate purification of the fuel pool water and to maintain optical clarity in the pool.

d) Fuel Pool Demineralizer Filter and Fuel Pool and Refueling Water Purification Filter - Two filters are installed - one fuel pool demineralizer filter and one fuel pool and refueling water purification filter. The filters remove particulate matter from the fuel pool water.

e) Fuel Pool Cooling and CLeanup System Skimmers - The provisions for the following skimmers are installed: three for fuel Pools A and D, five for Pools B and C, one each for the south and north transfer canals; two for the main transfer canal (one for each FPCCS), one for the cask loading/unloading pool.

f) Fuel Pool and Refueling Water Purification Pumps - Two fuel pool and refueling water purification pumps are provided. Each pump can take suction from and return fluid to the refueling water storage tank via the Safety Injection System, the transfer canal, the fuel pools, or the refueling cavity. Fluids from these systems are purified by the fuel pool demineralizer and filter. Each pump can also take suction from the demineralized water storage tank for make-up to the fuel pools and line flushing.

g) Fuel Pool Cooling and Cleanup System Valves - Manual stop valves are used to isolate equipment and lines and manual throttle valves provide flow control. Valves in contact with fuel pool water are of austenitic stainless steel or of equivalent corrosion resistant material.

h) Fuel Pool Cooling and Cleanup System Piping - All piping in contact with fuel pool water is of austenitic stainless steel construction. The piping is welded except where flanged connections are used at the pumps, heat exchanger, and control valve to facilitate maintenance.

i) Fuel Pool Gates - The vertical steel gates on the new fuel pool, spent fuel pools, fuel transfer canals, main fuel transfer canal and cask loading pools allow the spent fuel to be immersed at all times while being moved to its destination. They also allow each area to be isolated for drainage, if necessary, and enable new fuel to be stored dry in the new fuel pool.

Fuel Pool water chemistry limits and guidelines are specified in plant chemistry procedures. These procedures insure the fuel pool water chemistry is consistent with current specifications and guidelines established by the NSSS vendor, fuel manufacturer and EPRI standards. The plant Chemistry subunit routinely monitors the fuel pools water by chemical and radiochemical analysis of grab samples. When chemistry exceeds plant procedure limits, appropriate corrective actions are implemented to restore the parameter within its limit. The performance of the Fuel Pool Demineralizer is routinely monitored and when the ion exchange media is depleted, the resin is replaced.

The Spent Fuel Pool fission and corrosion product activities are discussed in FSAR Section 11.1.7. Design and normal operating specific activities are given in FSAR Table 11.1.7-1.

Radiological monitoring of the various samples for the subject system is described in detail in FSAR Sections 11.5.2.5 and 11.5.2.6.

The differential pressure across the flushable filter is measured with on line instrumentation. Before the differential pressure approaches 60 psig, the filter being deposited with maximum amount of crud requires a back-flushing treatment.

9.1.3.3 Safety Evaluation. All fuel pools are cooled by two independent cooling loops, either of which can remove the decay heat loads generated. For Pools A and B, this heat removal capacity is sufficient to remove the decay heat loads generated by the quantities of fuel through operation to the end of Cycle 9. For Pools C and D, a total decay heat load of no more than 1.0 Mbtu/hr can be removed by either loop.

Table 9.1.3-2 provides the fuel pool heat load, equilibrium temperature, and water heat inertia for the Normal Operation, Incore Shuffle, Full Core Offload Shuffle and Post Outage Full Core Offload cases. The combined decay heat load for Spent Fuel Pools A and B is based on an evaluation of equilibrium heat load that will occur subsequent to several cycles of operation with a core power level of 2900 Mwt. The evaluation is based on the assumption that just prior to a refueling outage SFP A/B have all of the spaces filled with previously discharged fuel with the exception of the spaces required for the reload batch and full off load. During the subsequent cycle discharge HNP fuel will be stored in the SFP A/B for several years and older fuel will be moved from SFP A/B to SFP C/D to make space available for the subsequent refueling. The heat load assumed in SFP A/B is based on decay of the discharge batch that would occur during the refueling outage and build up of decay heat in the reactor core in the subsequent cycle. The evaluation is based on refueling outage duration of 15 days. For cases assuming a single active failure, a single CCW train supplies both essential and non-essential loads, resulting in reduced CCW flow to the fuel pool cooling system heat exchanger.

Administrative controls are placed on the minimum cooling time prior to transfer of irradiated fuel from the core to the storage facility in order to maintain the pools at less than or equal to 150°F (Reference 9.1.3-2). The minimum cooling time prior to movement of irradiated fuel in the reactor vessel addresses both radiological and decay heat considerations. The most conservative of these two are used in determining the actual required cooling time.

In the event of a single failure in one of these Spent Fuel Cooling Loops, the other loop will provide adequate cooling. The pool temperature with one Fuel Pool Cooling Loop in operation will be equal to or less than 150°F.

The maximum normal heat load which would exist in the A and B fuel pools concurrent with a LOCA would be 18.31 MBTU/hr. The maximum heat load values given in FSAR Table 9.1.3-2 for the Incore Shuffle, Full Core Offload Shuffle and the Post Outage Full Core Offload are not used because a LOCA is not required to be considered concurrent with these conditions.

When the Emergency Core Cooling System is aligned to recirculate from the containment sump to the Reactor Coolant System, the CCW trains are separated from each other and from the nonessential header to maintain protection against single passive failure and to provide sufficient flow to their respective RHR trains. Once separated, each train provides flow to its respective essential header composed of heat loads from the RHR pump and RHR Heat Exchanger.

The containment analysis for SI recirculation assumes that the Non-essential CCW header is isolated from the initiation of SI recirculation to 5 hours after the initiation of the postulated LOCA. Cooling to the spent fuel pools is assumed to be interrupted at the start of the LOCA. Using the heat load listed for normal operations, the limiting spent fuel pool (A/B) is predicted to reach 160°F in 7.2 hours after the accident is initiated. This provides 2.2 hours to complete the manipulations to restore the nonessential CCW header flow from the available CCW pump(s). The heatup rate is conservatively based on the decay heat that is present in the spent fuel pools early in a fuel cycle. The starting temperature of the spent fuel pool is conservatively taken as 125.7°F. This temperature is based on a CCW supply temperature of 105°F and the listed heat load for the Normal Operations case.

All local manual manipulations are performed in areas which are accessible subsequent to a LOCA. Applicable procedures identify the minimum flow rates to be maintained to the RHR heat exchangers and the spent fuel pool heat exchangers. The total time of 7.2 hours is sufficient to prepare and implement the restoration of the cooling to the spent fuel pool heat exchangers.

To assure reliability, each of the fuel pool cooling pumps is powered from separate buses so that each pump receives power from a different source. If a total loss of offsite power should occur, the operator has the option of transferring the pumps to the emergency power source.

In addition, emergency cooling connections are provided in the loops to permit the installation of portable pumps to bypass the fuel pool cooling pumps should they become inoperable when cooling is required in either pool.

As shown on Figure 9.1.3-2, valving and blind flange connections are provided at the suction and discharge side of the fuel pool cooling pumps for emergency connection of a spare cooling pump.

Compliance of the Fuel Pool Cooling and Cleanup System to the guidance of NRC Regulatory Guide No. 1.13, "Fuel Storage Facility Design Basis," is addressed in Section 1.8.

The cooling loop piping and components are designed to Seismic Category I criteria. The cleanup loop is not designed to Seismic Category I criteria; however, suitable valving is provided between the cooling loop and the cleanup loop to permit isolation of the cleanup loop. The cooling loop portion of the FPCCS is protected against externally generated missiles. The fuel pool cooling pumps and associated piping are located in an area of the plant where there are no postulated internally generated missiles. The fuel pool cooling pumps have not been considered credible sources of internally generated missiles. The no-load speed of the pumps is equal to the synchronous speed of the electric motors; consequently, there are no pipe-break plus single failure combinations which could result in a significant increase in pump suction or discharge header. In addition, the FPCCS is protected against the effects of high energy and moderate energy fluid system piping failures (Section 3.6).

The FPCCS is manually controlled and may be shut down safely for reasonable time periods for maintenance or replacement of malfunctioning components.

Whenever a leaking fuel assembly is transferred from the fuel transfer canal to a fuel pool, a small quantity of fission products may enter the fuel pool cooling water. The cleanup loop is provided to remove fission products and other contaminants from the water.

The cleanup loop will normally be run on an intermittent basis as required by fuel pool water conditions. It will be possible to operate the purification system with either the ion exchanger or filter bypassed. Local sample points are provided to permit analysis of ion exchanger and filter efficiencies.

In the event of a high radiation alarm in the Fuel Handling Building, the purification system will be manually started. The cleanup loop is not started automatically since the short delay to manually initiate purification would not significantly speed the reduction of contamination in the pool.

The skimmer system for the new and spent fuel pools consists of surface skimmers, a fuel pool skimmer pump, a fuel pool skimmer pump suction strainer and a fuel pool skimmer filter. The surface skimmers float on the water surface and are connected via flexible hose to the pump suction piping at various locations on the perimeter of the pools. Flow from the pump is routed through the skimmer filter and returned to the fuel pools below the water level.

Siphoning of the pools is prevented by limiting the skimmer hose length to approximately five (5) feet. In addition the skimmer system return piping enters the pool at a point five (5) feet below the normal pool water level and terminates flush with the pool liner. Therefore, water loss due to failures in the skimmer system piping would be limited to five (5) feet.

A failure of the skimmer system piping would not uncover spent fuel nor interrupt fuel pool cooling since the fuel pool cooling water suction connections are located more than five (5) feet below the normal water level.

Draining or siphoning of the spent and new fuel pools via piping or hose connections to these pools or transfer canals is precluded by the location of the penetrations, limitations on hose length, and termination of piping penetrations flush with the liner. Hoses connected to temporary equipment used in the new and spent fuel pools are administratively controlled to prevent siphoning. The fuel pool cooling water return piping terminate at elevation 279 ft., 6 in. The spent fuel pool suction piping exists at 278 ft., 6 in. and the new fuel pool exits at 277 ft., 6 in.. Normal pool water level is 284 ft., 6 in, with the top of the spent fuel at approximately 260 ft. Skimmer suction piping exits the pools at elevation 285 ft., 3 in.

The reduction of the normal pool water level by approximately 5 ft. due to any postulated pipe failure will have no adverse impact on the capability of the cooling system to maintain the required temperature and it does not effect the required shield water depth for limiting exposures from the spent fuel. The slow heatup rate of the fuel pool would allow sufficient time to take any necessary action to provide adequate cooling using the backup provided while the cooling capability for the fuel pool is being restored.

Technical Specification 3.9.11 requires a minimum amount of water coverage in the fuel pools to reduce the potential doses resulting from a fuel handling accident. This minimum water depth provides sufficient iodine removal capability to maintain both the whole body and thyroid doses well within the acceptable limits of 10CFR50.67 which forms the basis for this Technical Specification and the fuel handling accident doses described in Chapter 15. Technical Specification 3.9.11 requires all movement of fuel assemblies and crane operations with loads in the affected pool area be suspended and the water level restored to within its limit within four hours if the water level falls below the minimum required.

The fuel handling accident described in Section 15.7.4 was evaluated with a dropped PWR fuel assembly impacting a stored PWR fuel assembly and ultimately coming to rest in a horizontal position on top of BWR fuel assemblies seated in the BWR fuel storage racks. This scenario results in the minimum water depth above the dropped fuel assembly, which is utilized to determine conservative decontamination factors used for the removal of iodines assumed in the accident evaluation. Assumptions and inputs supporting the fuel handling accident evaluation are located in Section 15.7.4. Maintaining water level in accordance with Technical Specification 3.9.11 assures that water coverages and decontamination factors used in the Chapter 15 fuel handling accident analysis remain bounding.

Alarms are provided for the indication of fuel pool water levels. Alarms for both high and low water levels indicate changing conditions in the pools. The fuel pool low level alarm indicates the minimum required water depth. An additional alarm set at a lower fuel pool water level indicates degraded pool water capacity conditions. The high level alarm provides equipment protection as well as inventory control during pool makeup and water transfer activities.

Normal makeup for evaporative losses and small amounts of system leakage from the fuel pools is accomplished using the Demineralized Water System (DWS), although other sources, such as from the reactor makeup water storage tank or the recycle holdup tank, may also be used. The DWS connects to the fuel pools and refueling water purification pumps, spent fuel pools cooling pumps, and fuel pools skimmer pumps to permit makeup to the fuel pools, or may be directly added to the pools via hoses. The seismic Category I Refueling Water Storage Tank (RWST) may also be aligned to provide borated makeup water to the fuel pools, and a seismic Category I source of emergency makeup water is available from the Emergency Service Water (ESW) system, by connecting flexible hoses to connections on the ESW and fuel pool cooling and cleanup system piping.

Floor and equipment drain sumps and pumping systems are provided to collect and transfer FPCCS leakage to the Waste Management System. High level alarms are annunciated in the Control Room when high sump level is reached.

Fuel handling equipment is designed such that the equipment cannot fall into the pool under SSE conditions (Section 9.1.4). In addition, the Fuel Handling Building is tornado missile resistant (Section 3.5).

The new fuel pool and spent fuel pools are furnished with stainless steel liners. Although they are classified as non-Nuclear Safety, the fuel pool liners are designed and constructed to the applicable portions of the ASME Code, Section III and they are subject to the Quality Assurance Criteria of 10 CFR 50, Appendix B. Other portions of the fuel transfer system in the Fuel Handling Building which are in communication with the new and spent fuel pools; namely, the fuel transfer canal, the main fuel transfer canal and the fuel cask loading pit, are also furnished with stainless steel liners.

Although these liners are qualified to the same requirements as the fuel pool liners, it is impossible for leakage in these portions of the fuel transfer system to jeopardize the inventory of cooling water in the fuel pools due to a difference in floor elevation. These areas may also be isolated from the fuel pools by gates.

A Permanent Cavity Seal Ring (PCSR) has been installed in the annulus of the reactor cavity adjacent to the refueling cavity. The PCSR is furnished with eight hatch covers which are closed and tested prior to flood-up for refueling. The PCSR is classified as nuclear safety related, subject to the quality assurance provisions of 10CFR50 Appendix B. It is designed and constructed to the applicable portions of the ASME Code Section III, Subsection ND, but is not code stamped by an ANI.

Piping and components of the Fuel Pool Cooling and Cleanup System are designed to the applicable codes and standards listed in Section 3.9. Those portions of the FPCCS required to ensure cooling of the fuel pool are Safety Class 3, since their prolonged failure could result in the release to the environment of normally retained gaseous radioactivity. Piping in contact with fuel pool water is austenitic stainless steel.

Fuel pool nozzles shall be stainless steel Seismic Category I designed and fabricated to ASME Section III, Subsection No. ND. However, they are classified as NNS.

9.1.3.4 Inspection and Testing Requirements. Provisions are incorporated in the layout of the system to allow for periodic inspection, using visual and monitoring instrumentation. Equipment is arranged and shielded to permit inspection with limited personnel exposure.

Preoperational and startup tests as described in Section 14.2.12 were conducted in the FPCCS. Periodic tests are required as described in the Technical Specifications. Inservice inspection requirements are described in Section 6.6 and pump and valve testing will be performed as described in Section 3.9.6.

Prior to initial fill, vacuum box testing was performed on the major liner field joints normally exposed to water.

Components of the system were cleaned and inspected prior to installation. Demineralized water was used to flush the entire system. Instruments were calibrated and alarm functions checked for operability and setpoints during testing. The system was operated and tested initially with regard to flow points, flow capacity and mechanical operability.

Data will be taken periodically during normal system operation to confirm heat transfer capabilities, purification efficiency, and differential pressures across components.

Table 9.1.3-1A deleted by Amendment No. 48

Table 9.1.3-1A deleted by Amendment No. 48

Table 9.1.3-1B deleted by Amendment No. 48

Table 9.1.3-1B deleted by Amendment No. 48

Table 9.1.3-1C deleted by Amendment No. 48

TABLE 9.1.3-2

FUEL POOL COOLING AND CLEANUP SYSTEM PARAMETERS

Fuel Pool Heat Load, Equilibrium Temperature and Heat Inertia*	
Fuel Pool Heat Load (A/B)	
Incore Shuffle	22.17×10^6 Btu/hr
Full Core Offload	40.56×10^6 Btu/hr
Normal Post Outage Full Core Offload (Emergency Core Offload)	46.23×10^6 Btu/hr
Maximum Heat Load During Normal Operations***	18.31×10^6 Btu/hr
Fuel Pool Heat Load (C/D)	7.0×10^6 Btu/hr
Fuel Pool Equilibrium Temperature**	
Incore Shuffle	≤150°F
Full Core Offload Shuffle	≤150°F
Post Outage Full Core Offload	≤150°F
Combined Spent and New Fuel Heat Pool Heat Inertia	
Normal Operation	4.73°F/hr
Incore Shuffle	5.75°F/hr
Full Core Offload Shuffle	10.56°F/hr
Post Outage Full Core Offload	11.98°F/hr
Fuel Pool Heat Exchanger	
Quantity (per FPCCS)	2
Type	Shell and Two Pass Straight Tube
UA (Design per Heat Exchanger), Btu/hr.-F	21.1×10^5

TABLE 9.1.3-2 (Continued)

FUEL POOL COOLING AND CLEANUP SYSTEM PARAMETERS

Shell Side (Component Cooling Water) - Design	
Inlet temperature, F	105
Outlet temperature, F	110
Design flowrate, lb./hr.	2.68×10^6
Design pressure, psig	170
Design temperature, F	200
Material	Carbon Steel

*Based on Equilibrium PUR cycle and accumulation in pools A/B of fuel with burnups from PUR. The C/D inventory is based on the license amendment request for 1×10^6 Btu/hr of storage.

**Administrative controls are placed on the minimum cooling time prior to transfer of irradiated fuel from the core to the storage facility to maintain the pools at less than or equal to 140°F. The minimum decay time prior to movement of irradiated fuel in the reactor vessel will address both radiological and decay heat considerations.

***This heat load is consistent with a refueling outage duration of 15 days or greater.

TABLE 9.1.3-2 (Continued)

Tube Side (Fuel Pool Water) - Design	
Inlet temperature, F	120
Outlet temperature, F	113
Design flowrate, lb.	1.88×10^6
Design pressure, psig	150
Design temperature, F	200
Material	Stainless Steel
Fuel Pool Cooling Pump	
Quantity (per FPCCS)	2
Type	Horizontal Centrifugal
Design flowrate, gpm	4560
TDH, ft. H20	98
Motor horsepower	150
Design pressure, psig	150
Design temperature, °F	200
Material	Stainless Steel
New Fuel Pool (Pool A or New Fuel Pool Unit 1)	
Volume, gallons (at normal level, elevation 284.5 feet)	142,272
Boron concentration, ppm (minimum)*	2,000
Liner material	Stainless Steel
Spent Fuel Pool (Pool B or Spent Fuel Pool Unit 1 or Pool C)	
Volume, gallons, (at normal level, elevation 284.5 feet)	388,800
Boron concentration, ppm (minimum)*	2,000
Liner material	Stainless Steel
Spent Fuel Pool (Pool C or SPent Fuel Pool Unit 2)	
Volume, gallons, (at normal level, elevation 284.5 feet)	388,800
Boron concentration, ppm (minimum)*	2,000
Liner material	Stainless Steel

*The actual boron concentration will be determined by the plants' Technical Specifications for Refueling.

TABLE 9.1.3-2 (Continued)

Spent Fuel Pool (Pool D or Spent Fuel Pool Unit 2)	
Volume, gallons, (at normal level, elevation 284.5 feet)	184,307
Boron concentration, ppm (minimum)*	2,000
Liner material	Stainless Steel
Fuel Pool Demineralizer Filter	
Quantity (per FPCCS)	1
Type	Back Flushable
Design pressure, psig	400
Design temperature, °F	200
Flow, gpm	325
Maximum differential pressure across filter element at rated flow (clean filter), psi	5
Maximum differential pressure across filter element prior to backflush, psi unit 1/unit 2	60/15
Fuel Pool Demineralizer	
Quantity (per FPCCS)	1
Type	Flushable
Design pressure, psig	400
Design temperature, F	200
Design flowrate, gpm	325
Volume of resin (each), ft^3	85
Fuel Pool and Refueling Water Purification Filter	
Quantity (per FPCCS)	1
Type	Back Flushable
Design pressure, psig	400
Design temperature, F	200
Design flowrate, gpm	325
Maximum differential pressure across filter element at rated flow (clean filter), psi	5
Maximum differential pressure across filter element prior to backflush, psi unit 1/unit 2	60/15

*The actual boron concentration will be determined by the plants' Technical Specifications for Refueling.

TABLE 9.1.3-2 (Continued)

Fuel Pool Strainer (per FPCCS)	
Quantity	1
Type	Basket
Design flowrate, gpm	4560
Design pressure, psig	150
Design temperature, F	200
Maximum differential pressure across the strainer element above flow (clean), psi	1.4
Mesh	40
Fuel Pool Skimmer Pump Suction Strainer (per FPCCS)	
Quantity	1
Type	Duplex Basket
Design pressure, psig	150
Design temperature, F	200
Design flowrate, gpm	385
Maximum differential pressure across strainer element at rated flow (clean), psi	5
Maximum differential pressure across strainer element prior to removing, psi	60
Mesh	100
Fuel Pool Skimmer Filter (per FPCCS)	
Quantity	1
Type	Back Flushable
Design pressure, psig	400
Design temperature, F	200
Design flowrate, gpm	400
Maximum differential pressure across filter element at rated flow (clean), psi	5
Maximum differential pressure across filter element prior to removing, psi unit 1/unit 2	60/15

TABLE 9.1.3-2 (Continued)

Fuel Pool Skimmer Pump		
Quantity (per FPCCS)	1	
Design flowrate, gpm	385	
TDH, ft. H20	210	
Motor horsepower	40	
Design pressure, psig	150	
Design temperature, F	200	
Material	Stainless Steel	
Fuel Pool and Refueling Water Purification Pump		
Quantity (per FPCCS)	2	
Type	Vertical In-line Centrifugal	
Design flowrate, gpm	325	
TDH, ft. H20	320	
Motor horsepower	60	
Design pressure, psig	150	
Design temperature, F	200	
Material	Stainless Steel	
Fuel Pool Cooling and Cleanup System Piping and Valves		
Material	Stainless Steel	
Design pressure, psig	150	
Design temperature, F	200	
Fuel Pool Skimmers	Quantity	gpm each
Spent Fuel Pool (Pool B and C)	5	35
New Fuel Pool (Pool A and D)	3	30
Fuel Transfer Canal (2 each canal - south and north)	4	25
Main Fuel Transfer Canal (per FPCCS)	1	20
Cask Loading Pool	1	50

Table 9.1.3-3 Deleted by Amendment No. 43

9.1.4 Fuel Handling System

9.1.4.1 Design Bases. The Fuel Handling Building contains one new fuel pool and three spent fuel pools with a transfer canal system that permits transfer of fuel between pools and the reactor cavity in the Containment Building. The Fuel Handling System (FHS) is designed in conformance with Regulatory Guide 1.13 as detailed in Section 1.8.

The Fuel Handling System will provide the following services on SHNPP:

a) provides the means for safely moving the fuel as necessary to accomplish receipt and storage of new and spent fuel, refueling, receiving shipments of offsite spent fuel, and shipment of spent fuel to offsite locations.

b) provides the means for safely preparing the plant facilities for fuel movement, such as placement of fuel transfer canal gates in appropriate positions, dismantling and replacing reactor vessel components to allow for refueling and placement of portable barriers for safe spent fuel cask handling.

c) provides the means for safely transferring spent fuel among all fuel pools.

d) provides shielding for protection of personnel from excessive radiation exposure during refueling, inspection, and fuel storage.

e) provides that either:

1) a load drop resulting from a single electrical or lifting cable failure is precluded, or;

2) the consequences of a load drop can be accommodated without affecting the ability to bring the plant to a safe shutdown condition or to control the release of significant amounts of radioactive material.

f) is designed such that maximum design load on the wire rope hoisting cables shall not exceed 1/5 ultimate strength of the cables.

g) provides appropriate containment isolation boundaries for containment penetration.

h) is designed such that lifting devices have appropriate administrative controls, interlocks and stopping capability.

i) is designed such that fuel lifting and handling equipment and structures will not fail in such a manner as to damage Seismic Category I equipment or structures in the event of an SSE.

Structures, systems, and components designed as Seismic Category I are shown in Table 3.2.1-1. Structures, systems, and components which could damage safety-related equipment upon failure are designed to withstand an SSE event without causing such damage. Components that are designed for Safety Class 1, 2, or 3 are shown in Table 3.2.1-1.

9.1.4.1.1 Fuel transfer decay heat. The refueling water provides a reliable and adequate cooling medium for spent fuel transfer. The operable fuel pools are connected to the pool cooling and clean-up systems, which are discussed in detail in Section 9.1.3.

9.1.4.1.2 Fuel transfer radiation shielding. Adequate shielding from radiation is provided during reactor refueling by transferring and storing spent fuel underwater and maintaining a safe shielding depth of water above the fuel assemblies during refueling. This permits visual control of the operation at all times while maintaining acceptable radiation levels for periodic occupancy of the area by operating personnel.

9.1.4.2 <u>System Description</u>.

9.1.4.2.1 System. The Fuel Handling System consists of the equipment and associated structures used to handle fuel from the time of receipt until it leaves the plant and the handling equipment used to prepare the reactor to discharge and receive fuel.

The equipment consists of:

a) Containment building overhead polar crane.

b) Manipulator crane.

c) Spent fuel bridge crane.

d) Spent fuel cask handling crane.

e) Auxiliary crane.

f) Fuel handling tools and fixtures.

g) Fuel transfer system.

h) Fuel racks.

i) New fuel elevator.

The following areas are associated with the fuel handling equipment:

a) Refueling cavity.

b) Fuel pools and fuel transfer canal system.

c) New fuel storage area.

d) Spent fuel cask loading pool and decontamination area.

Refer to Figures 1.2.2.55 through 1.2.2-59 for general arrangements of the Fuel Handling Building.

The associated fuel handling structures may be divided into two areas:

a) The refueling cavity which is flooded only during shutdown for refueling.

b) The new and spent fuel pools and fuel transfer canal system.

9.1.4.2.2 Components.

9.1.4.2.2.1 Reactor vessel head lifting device. The reactor vessel head lifting device consists of a welded and bolted structural steel frame which enables the overhead polar crane to lift the head and store it during refueling operations. This device is part of the Integrated Reactor Vessel Head (IRVH).

9.1.4.2.2.2 Reactor internals lifting device. The reactor internals lifting device is a structural frame mechanism which provides the means of gripping the upper and lower internal packages to transmit the lifting load to the crane (refer to Figure 9.1.4-1). By the use of auxiliary brackets, the assembly is guided onto the internal packages. Attachment is accomplished by manually connecting the assembly to the internals with handling tools operated from the internals lifting rig platform. The upper internals are stored in the flooded refueling cavity during refueling. Although their removal is not required for refueling, the lower internals may be stored in the flooded refueling cavity when required.

9.1.4.2.2.3 Manipulator crane. The manipulator crane is a rectilinear bridge and trolley crane with a vertical mast extending down into the refueling water (refer to Figure 9.1.4-2). The bridge spans the refueling cavity. The bridge and trolley motions are used to position the vertical mast over a fuel assembly in the core. A long tube with a pneumatic gripper on the end is lowered out of the mast to grip the fuel assembly. The gripper tube is long enough so the upper end is still contained in the mast when the gripper end contacts the fuel. A winch mounted on the trolley raises the gripper tube and fuel assembly up into the mast tube. The fuel is transported while inside the mast tube to its new position.

Controls for the manipulator crane are mounted on a console on the trolley. The bridge and trolley are positioned by a combination of a video position indication system and visual observation.

This system consists of the following: two video cameras, (one mounted on the bridge truck and the other on the trolley), two sets of position plates, (one set mounted near the guide rail for bridge position and the other on the bridge for the trolley position), a CRT monitor and selector switch, (both mounted in the control console). The drives for the bridge, trolley, and hoist are variable speed and include separate slow speed jog switches for each.

The manipulator crane will not collapse nor become disengaged as a consequence of an SSE.

9.1.4.2.2.4 Spent fuel bridge crane. The spent fuel bridge crane, as shown on Figure 9.1.4-3, is a wheel-mounted walkway spanning the width of the Fuel Handling Building, which carries an electric monorail hoist on an overhead structure. The monorail hoist has access to all spent and new fuel pools, as well as interconnecting transfer canals. The fuel assemblies are moved within the fuel pools by means of a long-handled tool (refer to Figure 9.1.4-4) suspended from the hoist. The hoist travel and tool length are designed to limit the maximum lift of a fuel assembly to a safe shielding depth. The spent fuel bridge crane will not drop its load nor leave the rails as a consequence of an SSE. The capacity of the crane is 2,500 lbs; the approximate weight of the handling tool and a fuel assembly is 2,000 lbs. The capacity of the spent fuel bridge crane precludes excessive loads from being carried over spent fuel storage area.

The spent fuel bridge crane hoist is equipped with a load monitor preset to prevent hoist operation at a load of 200 lbs above the weight of a fuel assembly with RCCA and handling tool. Changing of the set points to lift heavier loads will be under administrative control.

9.1.4.2.2.5 Fuel Transfer System. The Fuel Transfer System includes an underwater conveyor car running on tracks extending from the refueling cavity through the transfer tube and into the fuel transfer canal and an upending frame at each end of the transfer tube (refer to Figure 9.1.4-5). To remove a fuel assembly from the reactor, the upending frame in the refueling cavity receives a fuel assembly in the vertical position from the manipulator crane. The fuel assembly is then lowered to a horizontal position for passage through the transfer tube and raised to a vertical position by the upending frame in the fuel transfer canal. The hoist on the spent fuel bridge then takes the fuel assembly to a position in the spent fuel racks via the fuel transfer canals.

To seal the reactor Containment during Unit operation, a blind flange is bolted on the end of the transfer tube in the refueling cavity inside containment, and a manually operated valve is locked closed in the fuel transfer canal in the Fuel Handling Building (Section 6.2.4). The transfer tube and the blind flange are designed to Seismic Category I requirements.

9.1.4.2.2.6 Rod cluster control assembly (RCCA) changing fixture. The following description applies when performing incore shuffles. If the complete core is off-loaded to the Fuel Handling Building, this equipment is not utilized. An RCCA changing fixture is mounted on the refueling cavity wall for transferring RCCA's from fuel assemblies removed from control positions and inserting RCCA's into the fuel assemblies to be placed in the control positions (Figure 9.1.4-6). The fixture consists of two main components: a guide tube mounted to the wall for containing and guiding the RCCA and a wheel-mounted carriage for holding the fuel assemblies and positioning fuel assemblies under the guide tube. The guide tube contains a pneumatic gripper on a winch which grips the RCCA and lifts it out of the fuel assembly. By repositioning the carriage, another fuel assembly is brought under the guide tube; and the gripper lowers and releases the RCCA. The manipulator crane loads and removes the fuel assemblies into and out of the carriage.

9.1.4.2.2.7 Spent fuel cask handling crane and auxiliary crane. The spent fuel cask handling crane (150-ton) transfers the spent fuel cask between the railroad car and the spent fuel cask loading pool, (refer to Figures 1.2.2-55 through 1.2.2-59). Design of the Fuel Handling Building and the spent fuel cask handling crane prevents the possibility of the cask passing over or falling into any fuel pool. Permanent mechanical stops, which will withstand the impact of the crane at maximum operating speed, are provided to limit the crane movement so that travel of the center of the main hook is limited to 12 in. south of the centerline of the cask loading pool. Additionally, only the micro drives will be functional in the last 5 ft. of crane travel in the southerly direction as controlled by limit switch. In the unlikely event that the crane comes in contact with the mechanical stops while at maximum operating speed, the maximum swing of the bottom of the cask from its normal position in the vertical plane will be 14.5 inches in the southerly direction. When the cask reaches this deflected position, it is still entirely over the cask pool. Therefore, if dropped while in this extended position, the cask will not come in contact with spent fuel in the fuel pools.

The spent fuel cask handling crane is equipped with limit switches which limit main hook vertical travel to ensure the shipping cask could never fall more than 30 feet through air to any load-bearing surface and will not be raised more than 6 in. above the operating floor.

Two independent systems are provided to prevent the centerline of the main hook of the spent fuel cask crane from coming within 10 ft. 6 in. of the west edge and 15 ft. of the north edge of the nearest spent fuel pool. A combination of limit switches and mechanical stops restrict the crane from the spent fuel pool area. Travel of the center line of the main hook on the cask crane is restricted to the shaded area as shown on Figure 9.1.4-7 by a combination of limit switches and mechanical stops. During cask handling, the center line of the main hook is further restricted under administrative control to the path cross hatched on the figure. A removable barrier is provided with its west face in line with the east edge of the cask unloading pool on top of the dividing wall between that pool and the cask head storage area. The function of the removable barrier is to prevent the cask, in the remote chance of being dropped on top of the dividing wall between the cask loading pool and cask head and yoke storage area, from toppling over and falling into a currently inoperable fuel pool. The dropping cask, after landing on the dividing wall, may start to topple over and strike the barrier. The barrier is designed to withstand the striking force, thus preventing the cask from falling into a currently inoperable fuel pool. The removable barrier is 21 feet 6 inches in overall height. It is set in place by being lowered into a 4 feet deep recess in the concrete floor; therefore, the installed height is 17 feet 6 inches measured from the operating floor. The removable barrier is not used as a mechanical stop.

The auxiliary crane will be used for the installation and re-removal of this barrier.

Figures 9.1.4-7 through 9.1.4-12 show the envelope of travel of the main hook of the spent fuel cask handling crane as controlled by design and administrative control of the crane, and within the main hook envelope, the area to which cask travel will be restricted by administrative control.

There is no safety-related equipment within the possible area of main hook (and, therefore, fuel cask) travel, either on the operating floor level or on floors beneath.

Additionally, a review for the consequences on the building structure due to dropping of the cask crane load block has been performed. The floors within the load block travel envelope will withstand a postulated drop of the load block from the maximum height to which it can be raised with the following exceptions:

a) The stairs near column line 73 will fail, but no safety-related components will be affected.

b) The floor at elevation 286.00 ft. north of column line 73Z and the floor at elevation 261.00 ft. in the new fuel containers storage area will sustain damage, however, the effect is considered to be local. Only non-safety related components will be affected by a load drop in this vicinity.

The auxiliary crane (design capacity of 12 tons) operates on the same runway as the spent fuel cask handling crane as shown in Figures 1.2.2-55 through 1.2.2-59. Two independent systems are provided to prevent the two cranes from coming in contact with each other. Design of each system provides that the auxiliary crane can operate in the common operating area only when the cask crane is in its parking position which is at a safe distance away from the end of travel of the auxiliary crane. While the cask crane is operating, the auxiliary crane is limited to operate at a safe distance away from the common area.

A redundant supporting system is provided on the auxiliary crane in regard to hook, reeving, and braking mechanisms. Provisions are made to manually move the crane to a laydown area for emergency manual lowering of the load. A detailed description of the auxiliary crane is given in Table 9.1.4-1.

Both cranes are capable of retaining the maximum load during an SSE although the crane may not be operable after the seismic event. The bridge and trolley are provided with means for preventing them from leaving their runways with or without hook load during operation or under any postulated seismic event. There is no other lifting device that can carry excessive loads over the fuel storage areas.

9.1.4.2.2.8 Containment Circular Bridge Crane

The overhead crane in the Containment (250 ton/50 ton) used for reactor servicing operations is of the polar configuration, and is seated on a girder bracketed off the containment wall. The crane is capable of retaining a 177.5-ton lifted load (weight of integrated reactor vessel head with lifting rig, which is the weight used by Westinghouse in the head drop analysis and is the heaviest component to be lifted during refueling operations) during an OBE or SSE, although the crane may not be operable after the seismic event. The bridge and trolley are prevented from leaving their runways with or without the 177.5 ton lifted load during operation or under any seismic event.

The centerline of the crane is offset from the reactor vessel centerline to assure the alignment of lifting devices with all possible loads and to provide clearance for containment spray header piping risers which run vertically along the containment liner.

The consequences of dropping the Integrated Reactor Vessel Head (IRVH) during preparation for or after completion of fuel handling has been analyzed. A summary of the assumption and results of the analysis follows:

The worst case drop scenario is evaluated; normally this is the concentric drop of the IRVH onto the vessel. It is pointed out that the fuel in the RPV will not suffer significant impact damage affecting the integrity of the fuel rods in this event. Also, it is determined that the RPV and primary shield wall (PSW) supporting the RPV (see Section 3.8.3.4.1) would remain intact, the reactor vessel primary nozzles would not be stressed above allowable limits and the reactor coolant loop piping and the essential auxiliary piping connected thereto remain capable of continued circulation of borated water at the specified flow rate. Therefore, the offsite doses would not approach 1/4 of the 10 CFR 100 limits in the concentric drop scenario and would be characteristically less for a non-concentric drop since the refueling cavity concrete floor would absorb part of the load.

During preparation for, and after completion of fuel handling, the IRVH will be transported to and from the laydown area in accordance with the pre-determined load path. The lifting of the IRVH to and from the laydown area is limited by administrative controls to a maximum of 12 in. above the operating floor. (In the laydown area the IRVH is raised above 12 in. to be placed upon its stand.) A drop from this strictly limited height onto the massive concrete and steel structure is not likely to have any serious consequences. Nevertheless, additional protection for required safe shutdown equipment is afforded by redundancy since the dropped IRVH could only damage the limited amount of equipment which is directly below it.

In all of the IRVH drops scenarios considered, the integrity of the vessel was never jeopardized nor was adequate make up water and cooling capacity interrupted such that the fuel could be uncovered. Furthermore, rapid containment isolation is provided with prompt automatic actuation on high radiation so that any unexpected releases result in doses well below 1/4 of the 10 CFR 100 limits taking into account delay times in detection and actuation.

9.1.4.2.2.9 Spent fuel basket and crud collection vessel storage. The north fuel transfer canal (former Unit No. 2 and No. 3 fuel transfer canal) is utilized as a permanent storage area for spent fuel shipping baskets. The baskets are inserted into the IF 300 cask for shipping spent fuel assemblies. Maximum number of baskets to be stored in the canal is 3 PWR and 4 BWR. The baskets will be stored under water and may be positioned anywhere within the canal except during movement of fuel assemblies anywhere within through the canal. At which time the baskets will be stored east of 4'-6" east of column Line M. Storage of the basket within the canal will be freestanding. If the baskets topple over during a seismic event, no damage to the structure or liner will result. The fuel baskets may be damaged as a result of toppling over. However, when stored in the transfer canal, the baskets do not perform any safety-related function. The auxiliary crane will be utilized to transfer the baskets between the cask loading pool and fuel transfer canal and anywhere within the canal. The north fuel transfer canal is also utilized as a storage location for stainless steel vessels used for collection and retention of spent fuel pool crud (see Section 11.1.7 for discussion of crud). These small (2' diameter, 60" high) steel tanks may also be stored in the "D" Spent Fuel Pool in the interim period prior to that pool being racked for storage of spent fuel, but any crud storage vessels there must be removed prior to racking. A total of no more than 10 of these vessels will be stored in these areas.

9.1.4.2.3

New fuel assemblies received for refueling may, if found acceptable by inspection, be stored either dry in racks in the new fuel inspection area or in racks in any operational fuel pool.

Should the need exist in the future, spent fuel from other nuclear plants in the CP&L system would be brought to the SHNPP site in an approved shipping cask. The cask would be placed in the flooded shipping cask pool. The spent fuel would then be removed from the cask and transported to the storage racks. This procedure would be carried out with the spent fuel assemblies totally submerged.

The fuel handling equipment handles the spent fuel assemblies underwater from the time they leave the reactor vessel until they are placed in a container for shipment from the site. Underwater transfer of spent fuel assemblies provides an effective, economic, and transparent radiation shield, as well as a reliable cooling medium for removal of decay heat.

The associated fuel handling structures are generally divided into two areas: the refueling cavity which is flooded only during a plant shutdown for refueling, and the fuel pools and fuel transfer canals. The refueling cavity and the Fuel Handling Building are connected by a fuel transfer tube which is fitted with a blind flange on the Containment end and a gate valve on the Fuel Handling Building end. The blind flange is in place except during refueling to ensure containment integrity. Fuel is carried through the tube on an underwater transfer car.

Fuel is moved between the reactor vessel and the refueling cavity by the manipulator crane. A rod cluster control changing fixture is located in the refueling cavity for transferring control elements from one fuel assembly to another. The fuel transfer system is used to move fuel assemblies between the Containment Building and the Fuel Handling Building. After a fuel assembly is placed in the fuel upender, the lifting arm pivots the fuel assembly to the horizontal position for passage through the fuel transfer tube. After the transfer car transports the fuel assembly through the transfer tube, the lifting arm at the end of the tube pivots the assembly to a vertical position so that the assembly can be lifted out of the fuel upender.

In the Fuel Handling Building, fuel assemblies are moved about by the spent fuel bridge crane or (new fuel only) the auxiliary crane. When lifting irradiated fuel assemblies, the spent fuel bridge crane uses a long-handled tool to ensure that sufficient radiation shielding is maintained. Initially, a short tool is used to handle new fuel assemblies, (see Figure 9.1.4-13) but the new fuel elevator is used to lower the assembly to a depth at which the bridge crane, using the long-handled tool, can place the new fuel assemblies into the storage racks.

Administrative procedures will ensure that no irradiated fuel (outside of sealed casks) will be handled or transported inside the FHB unless the operating floor equipment hatch to the unloading area is in place.

Decay heat, generated by the spent fuel assemblies in the fuel pools, is removed by the Spent Fuel Pool Cooling and Cleanup System, which is described in Section 9.1.3.

After a sufficient decay period, the spent fuel assemblies may be removed from the fuel racks and loaded into the spent fuel shipping cask for removal from the site.

9.1.4.2.4 New Fuel Receiving and Inspecting Procedure

a) New fuel arrives at the north end of the Fuel Handling Building on truck or rail car.

b) The airtight door is opened to admit the carrier and closed behind it.

c) The equipment hatch cover is removed.

d) The new fuel containers are lifted from the carrier by the auxiliary crane or the cask crane and placed on the operating level or in the new fuel inspection area. If the outside airtight door is to be open at any time, the equipment hatch cover will be replaced first.

e) The new fuel container lids are unbolted and removed by the auxiliary crane and stored. This may be performed on the operating level or in the new fuel inspection area.

f) The fuel assemblies are prepared for upending.

g) The fuel assemblies are upended using the auxiliary crane and lifted with the spent fuel bridge crane or auxiliary crane to the operating level and inspected.

h) After inspection, acceptable new fuel assemblies are transported to any fuel pool, or stored dry in rack(s) in the new fuel inspection area.

i) Unacceptable new fuel may be temporarily stored dry in a rack/racks in the new fuel inspection area or returned to the shipping containers and stored in the new fuel inspection area until corrective action is taken.

j) The new fuel container lids are returned to the containers by the auxiliary crane and bolted.

k) The equipment hatch cover is removed.

l) The empty new fuel containers are lifted by the auxiliary crane and loaded back on the carrier. The equipment hatch cover is replaced.

m) The airtight door is opened and the carrier, loaded with empty new fuel containers, leaves the building and the airtight door is closed.

9.1.4.2.5 Offsite Spent Fuel Receiving Procedure

a) Offsite spent fuel arrives at the north end of the Fuel Handling Building in approved shipping containers by truck or railcar.

b) The airtight door is opened to admit the vehicle and closed behind it.

c) The equipment hatch cover is removed.

d) The cask is prepared for lifting.

e) The cask is lifted by spent fuel cask handling crane and transported to the decontamination or work area. The equipment hatch cover is replaced.

f) Cask is prepared for pool entry.

g) Cask loading pool is flooded and the gate removed.

h) Removable barrier is put in place by the FHB auxiliary crane, or verified to be in place. The removable barrier is designed to withstand DBE seismic loads in accordance with Positions C.2 and C.4, Regulatory Guide 1.29.

i) Cask is transported and lowered into the cask loading pool.

j) Cask head is removed and stored in an appropriate location.

k) Move all fuel baskets that are being stored in the north fuel transfer canal to a position 4'-6" east of column line 'M'.

l) Fuel is removed from the cask using the appropriate long-handled spent fuel tool (PWR or BWR).

m) The spent fuel is transported, using the spent fuel bridge crane, to its pre-assigned storage location.

n) After the cask is emptied the head is returned to the cask and replaced.

o) Cask is lifted by the spent fuel cask handling crane and placed in the decontamination area.

p) Removable barrier is placed in storage, or left in place.

q) Cask is prepared for shipment and decontaminated to acceptable levels.

r) The equipment hatch cover is removed.

s) Cask is lifted from the decontamination area and returned to the truck or railcar for removal and the equipment hatch cover is replaced.

t) The airtight door is opened and the vehicle, loaded with the empty cask, leaves the building and the airtight door is closed.

9.1.4.2.6 Spent fuel shipping procedure.

a) A truck or railcar arrives at the north end of the Fuel Handling Building carrying an empty approved spent fuel shipping container.

b) The airtight door is opened to admit the vehicle and closed behind it.

c) The equipment hatch cover is removed.

d) The cask is prepared for lifting.

e) The cask is lifted by spent fuel cask handling crane and transported to the decontamination or work area. The equipment hatch cover is replaced.

f) Cask is prepared for pool entry.

g) Cask loading pool is flooded and the gate removed.

h) Removable barrier is put in place by the FHB auxiliary crane, or verified to be in place.

i) Cask is transported and lowered into the cask loading pool.

j) Cask head is removed and stored in an appropriate location.

k) Move all fuel baskets that are being stored in the north fuel transfer canal to a position 4'-6" east of column Line 'M'.

l) Spent fuel is loaded into the cask using the appropriate long-handled spent fuel tool (PWR or BWR) and the spent fuel bridge crane.

m) After cask is loaded, the head is returned to the cask and replaced.

n) Cask is lifted by the spent fuel cask handling crane and placed in the decontamination area.

o) Removable barrier is placed in storage, or left in place.

p) Cask is prepared for shipment and decontaminated.

q) The equipment hatch cover is removed.

r) Cask is lifted from the decontamination area and returned to the truck or railcar for removal and the equipment hatch cover is replaced.

s) The airtight door is opened and the vehicle, loaded with the full cask, leaves the building and the airtight door is closed.

9.1.4.2.7 Refueling procedure.

9.1.4.2.7.1 Preparation.

a) The reactor is shut down and cooled to ambient conditions with a final $K_{eff} \leq 0.95$.

b) A radiation survey is made and if the levels are sufficiently low, the containment is entered.

c) The reactor vessel coolant level is lowered slightly below the reactor vessel flange.

d) IRVH cables are disconnected and removed to storage.

e) Reactor vessel head insulation and instrument leads are removed.

f) The fuel transfer tube blind flange is removed and the refueling cavity drain valves are closed.

g) Checkout of the fuel transfer system and manipulator crane is started.

h) The reactor vessel head nuts are loosened with the hydraulic tensioner.

i) The rector vessel head studs and nuts are removed to storage. (Stuck studs are a possible exception.) (See Section 1.8)

j) Guide studs are installed in at least two and typically three reactor vessel flange holes, and the remainder of the holes are plugged.

k) The refueling cavity underwater lights are installed.

l) The reactor vessel permanent cavity seal ring hatch covers are closed and tested.

m) Final preparation of tools is made. Checkout of the fuel transfer system is completed. Manipulator crane is parked.

n) The reactor vessel head is unseated, raised approximately one inch, and checked for levelness.

o) The reactor vessel integrated head is lifted slowly clear of the refueling pool cavity.

p) The refueling cavity is filled.

q) The control rod drive shafts are unlatched from the spider.

r) The reactor vessel internals lifting rig is lowered into position and latched to the upper internals package.

s) The reactor vessel upper internals package and drive shafts are lifted out of the vessel and placed in the underwater storage rack.

t) Checkout of manipulator crane is complete (Core Index).

u) The core is now ready for refueling.

9.1.4.2.7.2 Refueling reassembly. The refueling sequence is now started with the manipulator crane. Refueling may be accomplished either by the transfer of the entire core to the storage facility, referred to herein as the Full Core Offload Shuffle or the transfer of only that portion of the core to be discharged to the storage facility, referred to herein as the Incore Shuffle. For the Full Core Offload, some partially spent fuel assemblies and the new fuel assemblies are added to the core. For the Incore Shuffle, some partially spent fuel assemblies have their positions changed and new assemblies are added to the core.

For fuel assemblies containing rod cluster control assemblies (RCCA), the refueling sequence is modified as required. For the Incore Shuffle, if a transfer of the RCCA between fuel assemblies is necessary, the assemblies are taken to the RCCA changing fixture for the exchange. For the Full Core Offload Shuffle, if a transfer of the RCCA between fuel assemblies is necessary, the assemblies are placed in storage racks in the fuel pools and the RCCA is exchanged using the portable RCCA change fixture attached to the spent fuel bridge crane. Such an exchange may be required whenever a spent fuel assembly containing an RCCA is removed from the core and whenever a fuel assembly is placed in or taken out of a control position during refueling rearrangement.

9.1.4.2.7.3 Reactor reassembly.

a) The fuel transfer conveyor car is parked, and the refueling cavity is isolated from the fuel transfer canal by closing the manual gate valve on the FHB side.

b) The manipulator crane is parked.

c) The reactor vessel upper internals package is placed in the vessel. The reactor vessel internals lifting rig is unlatched and removed to storage.

d) The full-length control rod drive shafts are relatched to the RCCA spiders.

e) The old seal rings are removed from the reactor vessel head, the grooves cleaned, and new rings installed.

f) The water level in the refueling cavity is lowered just below the flange.

g) The flange surface is cleaned.

h) The reactor cavity is drained.

i) The reactor vessel head is positioned and seated onto the vessel flange.

j) The guide studs are removed to their storage rack. The stud hole plugs are removed.

k) The head studs are placed and retorqued.

l) The refueling cavity drain holes are opened, and the flange for the fuel transfer tube is replaced.

m) Electrical leads are reconnected to the IRVH.

n) Vessel head insulation and instrumentation leads are replaced.

o) The permanent cavity seal ring hatch covers are opened.

p) A hydrostatic test is performed on the reactor vessel.

q) Control rod drives are checked.

r) Pre-start-up tests are performed.

9.1.4.2.8 Codes and standards.

a) Cranes - Crane Manufacturers Association of America (CMAA) Specification No. 70 and/or AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.

b) Structures - ASME Code, Section III, Appendix XVII.

c) Electrical - Applicable standards and requirements of the National Electric Code, NFPA 70, and NEMA Standards MAI and ICS for design installation and manufacturing.

d) Materials - Main load-bearing materials to conform to the specifications of the ASTM, ASME, or AISC Standards.

e) Safety - i -OSHA Standards, 29CFR1910 and 29CFR1926, including load-testing requirements.

ii - ANSI N18.2

iii - Regulatory Guide 1.29 and GDC 61 and 62.

iv - ANSI B30.2, "Safety Standards for Overhead and Gantry Cranes."

f) Fuel Transfer Tube: ASME Section III, Code Class 2.

9.1.4.3 Safety Evaluation. The extent of compliance of the fuel handling system with Regulatory Guide 1.13 is discussed in Section 1.8.

Movement of heavy loads over safety-related equipment is controlled in accordance with plant procedure MMM-020 "Operation, Testing, Maintenance and Inspection of Cranes and Special Lifting Equipment." This procedure was reviewed as part of the requested actions for NRC Bulletin 96-02 "Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment" (Reference 9.1.4-1) to confirm that the program continues to be implemented within the licensing basis.

9.1.4.3.1 Fuel handling equipment. Electrical interlocks and limit switches on the bridge and trolley drives of the manipulator crane protect the equipment. In an emergency, the bridge, trolley, and winch can be operated manually using a hand-wheel on the motor shaft. Manual operation of the bridge and trolley, with appropriate administrative controls in place, is also acceptable when used to move fuel to and from open water to avoid fuel assembly interaction and possible damage. (See Westinghouse Specification F-5, "Instructions, Precautions, and Limitations for Handling New and Partially Spent Fuel Assemblies.")

The manipulator crane design includes the following provisions to ensure safe handling of fuel assemblies.

Safety Interlocks

Operations which could endanger the operator or damage the fuel are prohibited by mechanical or fail-safe electrical interlocks or by redundant electrical interlocks. All other interlocks are intended to provide equipment protection and may be implemented either mechanically or by electrical interlock, not necessarily fail-safe.

Fail-safe electrical design of a control system interlock may be applied according to the following rules.

a) Fail-safe operation of an electrically operated brake is such that the brake engages on loss of power.

b) Fail-safe operation of an electrically operated clutch is such that the clutch disengages on loss of power.

c) Fail-safe operation of a relay is such that the de-energized state of the relay inhibits unsafe operation.

d) Fail-safe operation of a switch, termination, or wire is such that breakage or high resistance of the circuit inhibits unsafe operation. The dominant failure mode of the mechanical operation of a cam-operated limit switch is sticking of the plunger in its depressed position. Therefore, use of the plunger-extended position (on the lower part of the operating cam) to energize a relay is consistent with fail-safe operation.

e) Fail-safe operation of an electrical comparator or impedance bridge is not defined.

Those parts of a control system interlock required to be fail-safe which are not or cannot be operated in a fail-safe mode as defined in these rules, may be supplemented by a redundant component or components to provide the requisite protection.

a) When the gripper is engaged, the machine shall not traverse unless the guide tube is either in its full up position or jog permissive have been selected. Then the machine is allowed to traverse in a controlled manner when used to avoid fuel assembly interaction and possible damage as described above.

b) When the gripper is disengaged, the machine shall not traverse unless the gripper is withdrawn into the mast.

c) Vertical motion of the guide tube shall be permitted only in a controlled area over the reactor (avoiding the vessel guide studs), a fuel transfer system, or rod cluster control changing fixture.

d) Traverse of the trolley and bridge shall be limited to the areas of item c and a clear path connecting those areas.

e) A key-operated interlock bypass switch shall be provided to defeat interlocks a through d to allow operation of an inspection camera on the gripper.

f) The gripper shall be monitored by limit switches to confirm operation to the fully engaged or fully disengaged position. An audible and a visual alarm shall be actuated if both engaged and disengaged switches are actuated at the same time or neither is actuated. A time delay may be used to allow for recycle time of normal operation.

g) The loaded fuel gripper shall not release unless it is in its down position in the core, or in the fuel transfer system or rod cluster control changing fixture, and the weight of the fuel is off the mast.

h) Raising of the guide tube shall not be permitted if the gripper is disengaged and the load monitor indicates that it is still attached to the fuel assembly.

i) Raising of the guide tube shall not be permitted if the hoist loading exceeds the allowable limit.

j) Lowering of the guide tube shall not be permitted if slack cable exists in the hoist.

k) The guide tube shall be prevented from rising to a height where there is less than the safe shielding depth of water over the fuel assemblies.

l) The guide tube shall travel only at a controlled speed of about 2 fpm when: 1) the bottom of the fuel begins to enter the core, and 2) the gripper approaches the top of the core. In addition, just above those points, the guide tube shall automatically stop lowering, and shall require acknowledgement from the operator before proceeding.

m) The fuel transfer system upender shall be prevented from moving unless the engaged gripper is in the full up position or the disengaged gripper is withdrawn into the mast, or unless the manipulator crane is out of the fuel transfer zone. An interlock shall be provided from the refueling machine to the fuel transfer system to accomplish this.

Suitable restraints are provided between the bridge and trolley structures and their respective rails to prevent derailing due to the SSE. The manipulator crane prevents disengagement of a fuel assembly from the gripper during an SSE.

The following safety features are provided for in the fuel transfer system:

1. Transfer car permissive switch - The transfer car controls are located in the Fuel Handling Building; and conditions in the Containment are, therefore, not visible to the operator. The transfer car permissive switch allows a second operator in the Containment to exercise some control over car movement if conditions visible to him warrant such control.

Transfer car operation is possible only when both lifting arms are in the down position as indicated by the limit switches. The permissive switch is a backup for the transfer car lifting arm interlock. Assuming the fuel container is in the upright position in the Containment and the lifting arm interlock circuit fails in the permissive condition, the operator in the Fuel Handling Building still cannot operate the car because of the permissive switch interlock. The interlock, therefore, can withstand a single failure.

2. Lifting arm (transfer car position) - Two redundant interlocks allow lifting arm operation only when the transfer car is at the respective end of its travel and therefore can withstand a single failure.

Of the two redundant interlocks which allow lifting arm operation only when the transfer car is at the end of its travel, one interlock is a position limit switch in the control circuit. The backup interlock is a mechanical latch device on the lifting arm that is opened by the car moving into position.

3. Deleted by Amendment No. 46.

4. Transfer car (lifting arm) - The transfer car lifting arm is primarily designed to protect the equipment from overload and possible damage if an attempt is made to move the car when the fuel upender is in the vertical position. This interlock is redundant and can withstand a single failure. The basic interlock is a position limit switch in the control circuit. The backup interlock is a mechanical latch device that is opened by the weight of the fuel upender when in the horizontal position.

5. Lifting arm (refueling machine) - The refueling cavity lifting arm is interlocked with the manipulator crane. Whenever the transfer car is located in the refueling cavity, the lifting arm cannot be operated unless the engaged gripper is in the full up position or the disengaged gripper is withdrawn into the mast, or the manipulator crane is over the core.

6. Lifting arm (fuel handling machine) - The lifting arm is interlocked with the spent fuel bridge crane. The lifting arm cannot be lowered unless the spent fuel bridge crane is not over the lifting arm area.

9.1.4.3.2 Overhead cranes. Overhead cranes used in refueling and fuel handling operations include the 250/50-ton overhead polar crane, the 150-ton spent fuel cask handling crane, and the 12-ton (design load) auxiliary crane. These cranes are classified as non-nuclear safety (NNS) since they neither provide nor support any safety system function.

a) Overhead Polar Crane

The crane is used for removal of the Integrated Reactor Vessel Head and the upper internals package during the refueling shutdown. This crane is provided with seismic restraints to prevent derailment in the event of an SSE or OBE.

A discussion of consequences from dropping the Integrated Reactor Vessel Head is noted in Section 9.1.4.2.2.8. The consequences of various postulated accidents involving the dropping of the reactor vessel upper internals are discussed in Appendix 9.1A, Heavy Loads Analysis.

b) Spent Fuel Cask Handling Crane

This 150-ton crane is provided for handling the spent fuel shipping cask. Crane design and building arrangement preclude travel of this crane hook over the fuel pools. This crane will maintain its structural integrity and hold its load under the dynamic loading conditions of the SSE as described in Section 9.1.4.2.2.7. A postulated drop of the fuel cask will not cause damage to spent fuel and safety-related equipment.

The consequences of load dropping is noted in Section 9.1.4.2.2.7.

c) Auxiliary Crane

The auxiliary crane is used for handling of the removable barrier, pool gates, fuel racks and other miscellaneous items weighing less than 10 tons.

The handling of loads weighing more than 10 tons but less than 12 tons are administratively controlled.

The auxiliary crane, a single failure proof crane, is fed from a 3-pole circuit breaker located in a motor control center. With this type of scheme, loss of one phase on the power cable to the cranes is not feasible due to the nature of the circuit protective devices. If an overload or short circuit exists on the feed to the cranes, the circuit breaker would open all three phases.

Reversal of two phases is not a credible event at the power source since the power cables are connected directly to a circuit breaker. The SHNPP power system design precludes loss of a single phase or reversal of any two phases on the power feeds to the plant crane systems.

Kranco, the manufacturer of the auxiliary crane, stated that in the event of a phase loss before drive operations the crane drives cannot operate. In the event of a phase loss while the hoist is operating, the overspeed switch will disconnect the drive automatically at 140 percent of drive rated speed to set the holding brake and stop the load.

In the unlikely event of a phase reversal, a time-delay reverse phase relay actuates such that the crane drives cannot operate. In the event of a phase reversal during hoist motor operation, the time-delay reverse phase relay will operate to shut down the hoist drive, set the holding brake, and stop the load.

The crane is designed to maintain its structural integrity and hold its load under the dynamic loading conditions of the SSE. Load drop is precluded due to its redundant supporting system as described in Section 9.1.4.2.2.7 and Table 9.1.4-1.

9.1.4.4 Inspection and Testing Requirements. As part of normal plant operations, fuel-handling equipment to be used during the refueling outage is inspected prior to the refueling operations. During the operational testing, procedures are followed to affirm the correct performance of the fuel handling system interlocks.

The test and inspection requirement for the equipment in the fuel handling system are:

1. Manipulator crane, spent fuel bridge crane, rod cluster control changing fixture (if used), and new fuel elevator.

The minimum acceptable initial test shall include the following:

a. Manipulator Crane and Spent Fuel Bridge Crane shall be load tested at 125 percent of the rated load.

b. The equipment shall be checked for proper functional and running operation.

The following maintenance and checkout tests are recommended to be performed prior to using the equipment:

a. Visually inspect for loose or foreign parts. Keep free of dirt and grease.

b. Lubricate exposed gears with proper lubricant.

c. Inspect hoist cables for worn or broken strands.

d. Perform operational checks of limit switches and limit switch actuators for proper functional operation.

e. Check the equipment for proper functional and running operation.

2. Reactor vessel head lifting device and reactor internals lifting device.

The minimum acceptable test shall include the following:

a. The devices shall be load tested to 125 percent of the rated load.

b. The devices shall be assembled to ensure proper component fit up.

The following maintenance and checkout tests are recommended to be performed prior to using the tools:

a. Visually inspect for loose or foreign parts or damaged surfaces.

b. Visually inspect all engagement surfaces and lubricate with proper lubricant.

c. On the reactor internals lifting device, check for the proper functioning of the engagement and protective rig operators.

3. New fuel assembly handling tool and spent fuel assembly handling tool

The minimum acceptable test shall include the following:

a. The tools shall be load tested to 125 percent of the rated load.

b. The tools shall be checked for proper functional operation.

The following maintenance and checkout tests are recommended to be performed prior to using the tools.

a. Visually inspect the tools for dirt, loose hardware, and for any signs of damage such as nicks and burns.

b. Check the tools for proper functional operation.

4. Fuel transfer system

The minimum acceptable test shall include the following:

a. The system shall be checked for proper functional and running operation.

The following maintenance and checkout tests are recommended to be performed prior to using the tools.

a. Visually inspect for loose or foreign parts. Keep free of dirt and grease.

b. Lubricate exposed gears with proper lubricant.

c. Perform operational checks of limit switches and limit switch actuators for proper functional operation.

d. Check the system for proper functional and running operation.

5. Reactor vessel stud tensioner

The minimum acceptable test shall include the following:

a. The tensioner shall be checked for proper functional and running operation.

The following maintenance and checkout tests are recommended to be performed prior to using the equipment.

a. Visually inspect for loose or foreign parts.

b. Inspect hydraulic lines for wear or damage.

c. Check the hydraulic unit for proper pressurization and if any leaks occur at operating pressure.

9.1.4.5 Instrumentation Requirements. Instrumentation requirements of equipment, including interlocks, are discussed in Sections 9.1.4.2 and 9.1.4.3.

TABLE 9.1.4-1

FHB AUXILIARY CRANE

a) The crane is designed, fabricated, installed, inspected, tested, and operated in accordance with the requirements of ANSI B30.2, "Safety Standards for Overhead and Gantry Cranes", and CMAA Specification No. 70, "Specifications for Electric Overhead Traveling Cranes", as applicable.

b) Design, fabrication, workmanship, materials, and construction of the crane structure is in accordance with the AISC, "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" except that permissible unit stresses in welds are as contained in Table 9.3-1 and Paragraph 9.3 of AWS D1.1, "Structural Welding Code", or CMAA Specification No. 70, "Specifications for Electric Overhead Traveling Cranes," whichever is more restrictive.

1) Allowable Stresses and Safety Factors

The following allowable stresses and factors of safety are used unless greater strength requirements are specified in CMAA Specification No. 70 for Class A Cranes. Factors of safety are based on the loading combinations and the ultimate strength of the materials.

(a) Hoist rope has a factor of safety of six based on the lead line stress computed from the rated load, modified by a factor representing the efficiency of lifting tackle, but excluding impact load.

(b) All parts subject to dynamic strains such as gears, shafts, drums, blocks, and other integral parts have a factor of safety of five.

(c) Bending stress combined with torsional stress in pins and axles does not exceed 20 percent of the yield stress of material used.

(d) Normal torsional deflection in bridge drive shaft is limited to 0.08 degrees per foot at two thirds of rated motor torque or a total movement at wheel circumference of 1/2 in., whichever is more restrictive.

(e) Hook stresses do not exceed 1/5 of the ultimate strength or 1/3 of the yield strength of the material used, whichever is smaller.

2) Design and Loading Conditions

All structural and mechanical parts of the crane are designed to resist dead and live loads, seismic loads and the forces produced by impact and thrust. Fatigue analysis is considered for load bearing components for a usage factor of 20,000 to 100,000 full load cycles.

(a) The crane structures, components and subsystems essential to retaining and holding the load in a stable or immobile safe position, and means provided for safely moving the crane manually with load and emergency lowering of the load are designed to sustain an SSE event.

Structures, components and subsystems other than those covered above are designed such that they will not fall off from the crane during a seismic event and the failure of which will not damage the seismically qualified items covered above.

(b) Bridge trucks and trolley are provided with restraints to prevent them from leaving their runways with or without the design load during normal operation or under any seismic excursions.

(c) The portions of the vertical hoisting system components, which include the head block, rope reeving system, load block and dual load-attaching device are each designed to support a static load of 200 percent of the design rated load, using allowable stresses and safety factors specified above.

(d) All parts of the crane are designed to resist any of the following conditions of loading, using allowable stresses and safety factors specified above and those specified herein:

(1) Dead load plus live load plus impact

(2) Dead load plus live load, plus the lateral or longitudinal thrust

(3) Dead load plus live load plus SSE plus pendulum and swinging load effects.

(4) Rated breakdown torque of motors

(5) Collision with bumper stops with no load

For conditions (1), (2), and (5), members are designed in accordance with basic allowable stresses of CMAA Specification No. 70, AISC Code, or AWS D1.1, whichever governs.

For condition (3), members are designed for 1.6 times the allowable stresses. Local overstressing is permitted for condition (3) provided it can be demonstrated that the crane retains the design load and does not fall from the runway. Ability of the crane for emergency manual transferring and lowering of the load is maintained after the seismic event.

For condition (4) stresses do not exceed 90 percent of the elastic limit of the material.

c) During the construction phase of the project the use of the crane shall be controlled to assure that the lift capacity and other operating limitations are not exceeded as required in the applicable specifications. Following completion of the construction use and prior to movement of spent fuel in the 37
fuel handling building, the crane shall be refurbished, tested and inspected in accordance with applicable specifications to assure compliance with performance requirements.

d) Minimum operating temperature of the crane is 50 F.

e) All ferritic material which is used in load bearing structural members are impact-tested to determine fracture toughness of the material. Load bearing structural members are defined as structural members stressed in the process of transferring hook loads (vertical or horizontal) through the crane to the main runway. ASTM A-514 material is not used in any load bearing structural members; other low alloy steel may be used with CP&L's (or it's agent's) written approval.

Either drop weight test per ASTM E-208 or Charpy tests per ASTM A-370 may be used for impact testing. The minimum operating temperature, as obtained by following procedures in Subarticle NC-2300 or ND-2300 of ASME B&PV code, Section III, Div. 1, based on the drop weight test or the Charpy V-notch impact test respectively, are not higher than 50 F.

f) Welding is performed by using welding procedures, welders, welding
operators, and tackers qualified in accordance with AWS D1.1. 37

g) Postweld heat treatment of welded assemblies is performed, if necessary, when an assembly is under restraint during welding, when machining is to be performed, or for welded steel greater than 1-1/2 in. in thickness at the welded joint. Welds on all load bearing structural members are Postweld
heat-treated in accordance with Subarticle NF-4620 of ASME B&PV Code, 37
Section III, Div. 1, or other requirements as approved by CP&L (or its agent).

h) Where practical, weld joint designs susceptible to laminar tearing are not used. Weld joints susceptible to laminar tearing are ultrasonically tested for soundness of base metal and weld metal of the completed weld joint.

i) Full penetration butt welds on all load-bearing structural members are 100 percent radiographed for soundness of weld metal and base metal where accessible. Full penetration tee welds on all load-bearing structural members and full penetration butt welds on all load-bearing structural members which cannot be radiographed are tested as follows:

1) Magnetic particle or liquid penetrant test of root pass and final weld layer.

2) Ultrasonic test of completed weld joint for soundness of weld metal and base metal.

All fillet welds and partial-penetration welds are visually inspected in accordance with and to the acceptance criteria of AWS D1.1 Paragraph 9.25. Fillet welds and partial-penetration welds joining load-bearing structural members are inspected by liquid penetrant or magnetic particle methods after the final weld layer is applied.

j) The automatic and manual controls for all motions are designed such that a malfunction in the control system will not prevent the load from being maintained at a safe, holding position.

k) The hoisting system is designed to provide two completely independent load paths such that the failure of any single component in either load path system will result in the other assuming the full load and retaining it in a safe, stable position.

The following basic load path components are provided with redundant counterparts or otherwise protected against subsystem or component failure:

1) Hook

2) Load block

3) Reeving

4) Head block

5) Drum

6) Braking system

7) Gear train

Hoist cable redundancy is achieved by the provision of two balanced reeving systems consisting of two separate load-sharing wire ropes reeved in such a manner that the breakage of one rope will result in its share of the load being immediately transferred, without development of slack, to the other.
1 The centers of lift of the two independent cable systems are coincident so as to minimize the swinging or twisting motion imparted to the load block when load transfer occurs following a cable break.

Each load path is designed to resist the full load as specified in Paragraph b) 2).

1 An equalizer system of the beam type is provided whose main functions are as follows:

1) Continually adjust the hook load during normal hoisting operations so that the load will be shared equally by all parts of the reeving system.

2) Transfer the shock of a cable break in a safe dynamic fashion to the remaining cable by means of a shock absorbing arrangement permitting load transfer from one side of the equalizer system to the other without the imparting of unacceptably large dynamic impact to the cable or crane.

The equalizer system is provided with a set of proximity limit switches actuated by an exaggerated displacement of the equalizer assembly such as would be experienced in the event of a cable break. Limit switches so actuated will set the holding brakes to stop and retain the load in a safe, stable position.

The equalizer assembly is attached to the trolley frame by means of a redundant system of supports.

Following the failure of a component or subsystem, means are provided to safely move and lower the load to a laydown area to allow the failed component(s) or subsystem(s) to be repaired, adjusted or replaced as required to return the crane to service.

An electronic load indicating device is provided to monitor both load paths and will set the holding brakes in the event of a cable break or rope load unbalance.

1) Dual load attaching points of redundant design are provided as part of the load block assembly for the support of the redundant subcomponents of the hook. Each hook subcomponent and attaching point is capable of supporting three times the rated load, statically applied, without permanent deformation of any part of the hook and load block assembly other than that due to localized stress concentrations in areas where additional material has been provided for wear.

A 200 percent static load test is performed on each redundant sub-component of the hook. Measurements of the geometric configurations are made before and after the load test. Nondestructive examination is performed before and after the load test, consisting of magnetic particle and ultrasonic testing in accordance with the following:

(a) The hook forging is ultrasonically examined in accordance with ASTM A-388. The results of the ultrasonic examination are analyzed and documented.

(b) Hook shank and load areas are magnetic-particle examined by the longitudinal method in accordance with ASTM E-109, Appendix A1, Paragraph A1.2.1.3. Other magnetic particle examination methods may be used provided care is taken to prevent local overheating, burning or arcing of the surface to be tested. All cracks are unacceptable and all linear indications or aligned porosity exceeding 1/4 in. in length are unacceptable. All repairs require approval of CP&L (or its agent).

The load block is nondestructively examined by surface and volumetric techniques.

m) Crane motions have the following maximum speeds with full rated load:

1) Hoist: 5 fpm

2) Bridge Travel: 100 fpm

3) Trolley Travel: 50 fpm

Slow speeds for precise handling and setting are provided by inching drives at five percent of the full rated speed for bridge and trolley travel and between 6 to 12 in. per minute for the hoist.

n) The maximum fleet angle does not exceed 3-1/2 degrees at any point during hoisting, except that for the last three ft. of maximum lift elevation, the fleet angle may increase slightly.

Use of reverse bends for running wire ropes are limited so that disproportionate reduction in wire rope fatigue life would not be expected.

Pitch diameter is at least 24 times the diameter of rope for the drums and sheaves, and at least 12 times the diameter of rope for equalizer sheaves. (Ropes are stainless cable ASTM A-492, type 304 with independent wire rope core having six strands of 37 wires per strand.)

o) A limit switch activated by the hook block and a gear type limit switch are provided to prevent the hoisting system from "two blocking".

p) An overload protection device of redundant design is provided for the hoisting system which will be actuated by a load in excess of 110 percent of the hook rating, thereupon opening the main hoist circuit and setting the holding brakes.

q) Brakes are as follows:

1) Bridge Travel: Electrically released, spring-set, friction-shoe type with capacity at least equal to full operating torque of the bridge drive. Brake will operate when motor controller is in OFF position, when main power supply switch is in OFF position, or in the event of power failure, or an overspeed or overload condition.

2) Trolley Travel: Electrically released, spring-set, friction-shoe type brake with capacity at least equal to full operating torque of the trolley drive. Brake will operate when motor controller is in OFF position, when main power supply switch is in OFF position, or in the event of a power failure, or an overspeed or overload condition.

3) Bridge and trolley braking systems are designed to be Single Failure Proof and capable of manual operation for emergency service.

4) Hoist: Two electric stopping and holding brakes, and one electrical hoist-control device as further specified in sub-paragraphs (a) and (b) following:

(a) Electric stopping and holding brake for the hoist operates automatically and is of the electrically released, spring-set, friction-shoe type capable of stopping and holding 1-1/2 times the full rated load when the power is off. Brakes are mounted on the motor shafts extending from opposite sides of the motor. When the power is off, or tripped by overspeed or overload devices, or activated by one of the limit switches described elsewhere, the brake is capable of stopping and holding the load.

(b) Electrical hoist control devices are of the eddy current type. They are capable of controlling the lowering speed under all conditions with up to 1-1/2 times the rated load on hook. No lowering of load occurs unless power is applied to hoist motor in a lowering direction.

5) Two hoist holding brakes are capable of operation for emergency lowering after a single failure. Provisions are made for manual operation of the holding brakes in this event by means of alternate lowering and holding to provide time for adequate heat dissipation. Design for manual brake operation during emergency lowering includes features to indicate and control the lowering speed.

r) The drum is provided with structural and mechanical devices to prevent it from dropping, rotating or disengaging from its holding brake system should failure occur in the drum shaft, bearing, or bearing support.

The hoist drum is provided with an overspeed switch which will cut power to the hoist and set the holding brakes should the drum attain 40 percent overspeed.

s) Design of the crane limits the torque during jogging and plugging to acceptable values.

t) Drift point in the electrical power system for bridge or trolley movement is provided only for the lowest operating speeds.

u) The crane is radio controlled for remote operation. The crane can also be pendant controlled from the operating floor. The pushbutton pendant control is suspended from the bridge and supported from a motorized messenger track so that the pendant can be placed at any position along the length of the bridge. The pushbuttons are spring loaded to ensure automatic return to "OFF" position when buttons are released. The pendant control cable is mounted to an electric hoist system to enable the operator to vary the height of the control.

An additional control station, mounted on the building wall near the storage position of the crane, is provided to control the movements of the crane bridge and the pendant station in an area within 50 ft. from the storage position of the crane. Once the pendant station takes control of the crane, the wall station will be inoperative until the main switch on the pendant is switched to the OFF position.

Purpose of the wall mounted station is to bring the crane in and out of the storage position only. Handling of loads is not controlled by the wall-mounted station.

v) The bridge and trolley are provided with accessible enclosed limit switches, which, when the bridge or trolley has traveled to within nine in. of its end stop, will interrupt the current to the drive motor. Reversing the motion of the bridge or trolley will reset the switch. A bypass control is provided to allow the bridge or trolley to approach end stops.

Also provided are two independent methods to prevent Auxiliary Crane from coming in contact with the Cask Crane as described in Section 9.1.4.2.2.7.

w) A capacity plate showing both design rated load capacity (12 ton) and maximum working load capacity (10-ton) of the hoist is placed on each crane girder and is easily legible from the operating deck.

x) Instruction manuals are provided by the manufacturer for each component covering installation, operation and maintenance instructions in accordance with Ebasco Instruction Manual Guidelines, General Instructions (Form 567-A), Mechanical Equipment Including Major Heating, Ventilating and Air Conditioning Equipment (Form 567-C) and Electrical Equipment (Form 567-E).

Instruction manual also includes the following:

1) Qualification requirements for crane operators

2) Procedure for emergency manual operations for moving the crane and lowering the load, and locations of manual controls

3) Field test procedures

Maintenance instructions are based on maintaining the crane at design rated load capacity.

y) The manufacturer is required to provide a competent, experienced representative, on completion of crane installation, to check and certify that the crane has been properly erected; instruct CP&L in the crane operation, lubrication, and periodic maintenance adjustments; and also direct CP&L in the initial crane operation to demonstrate it's satisfactory performance for acceptance by CP&L.

The crane system is static load tested at 125 percent of the design rated load. The test includes all positions generating maximum strain in the bridge and trolley structures and other positions as recommended by the manufacturer. After satisfactory completion of the 125 percent static test and adjustments required as a result of the test, the crane is full performance tested with 100 percent of the design rated load for all speeds and motions for which the system is designed. This will include verifying all limiting and safety control devices.

The features provided for manual lowering of the load and manual movement of the bridge and trolley during an emergency are tested with the maximum working load attached to demonstrate their ability to function as intended.

The protective overload devices are tested to ensure proper functioning of the devices by a test procedure recommended by the manufacturer.

Above tests are run within temperature range as specified for the plant operation phase.

z) The crane manufacturer has an accepted quality assurance program consistent with the pertinent provisions of Appendix B to 10CFR Part 50.

REFERENCES: SECTION 9.1

9.1.2-1 USNRC, "OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications," dated April 14, 1978, and Addendum dated January 18, 1979.

9.1.3-1 ESR 9600217, "Single Failure Analysis for the Spent Fuel Pool Cooling System."

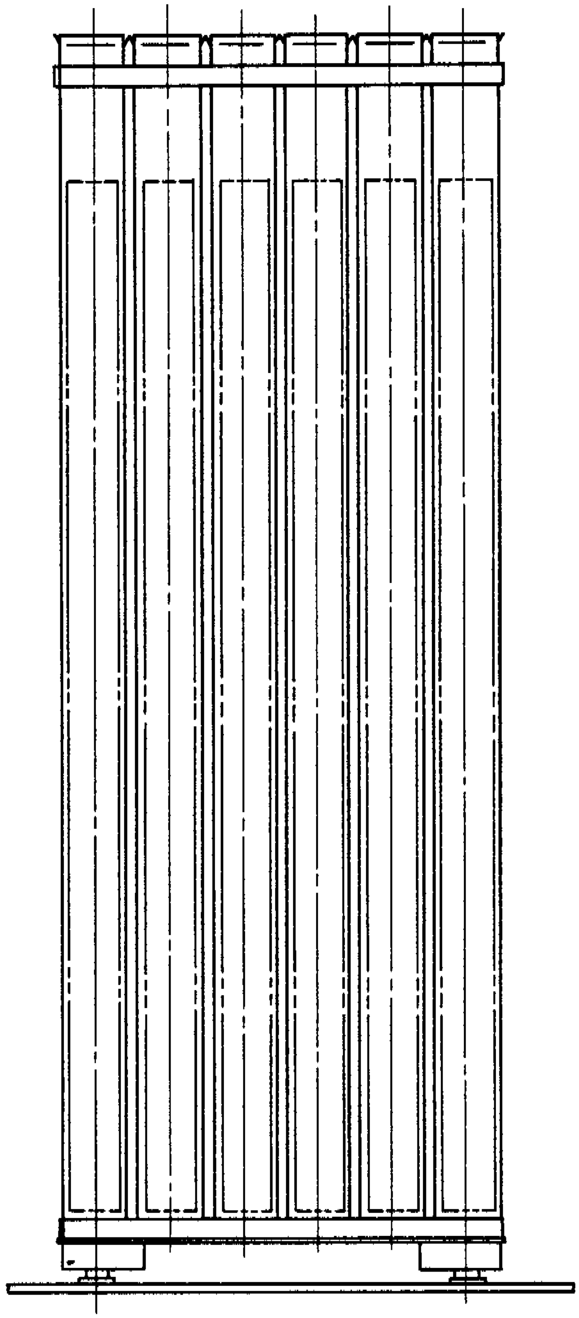
9.1.3-2 Deleted by Amendment No. 51

9.1.3-3 ESR 9500425, "Harris SFP "C" and "D" Activation Project--SFP pools"

9.1.3-4 ESR 9800219, "Harris SFP "C" and "D" Activation Project--CCW connect"

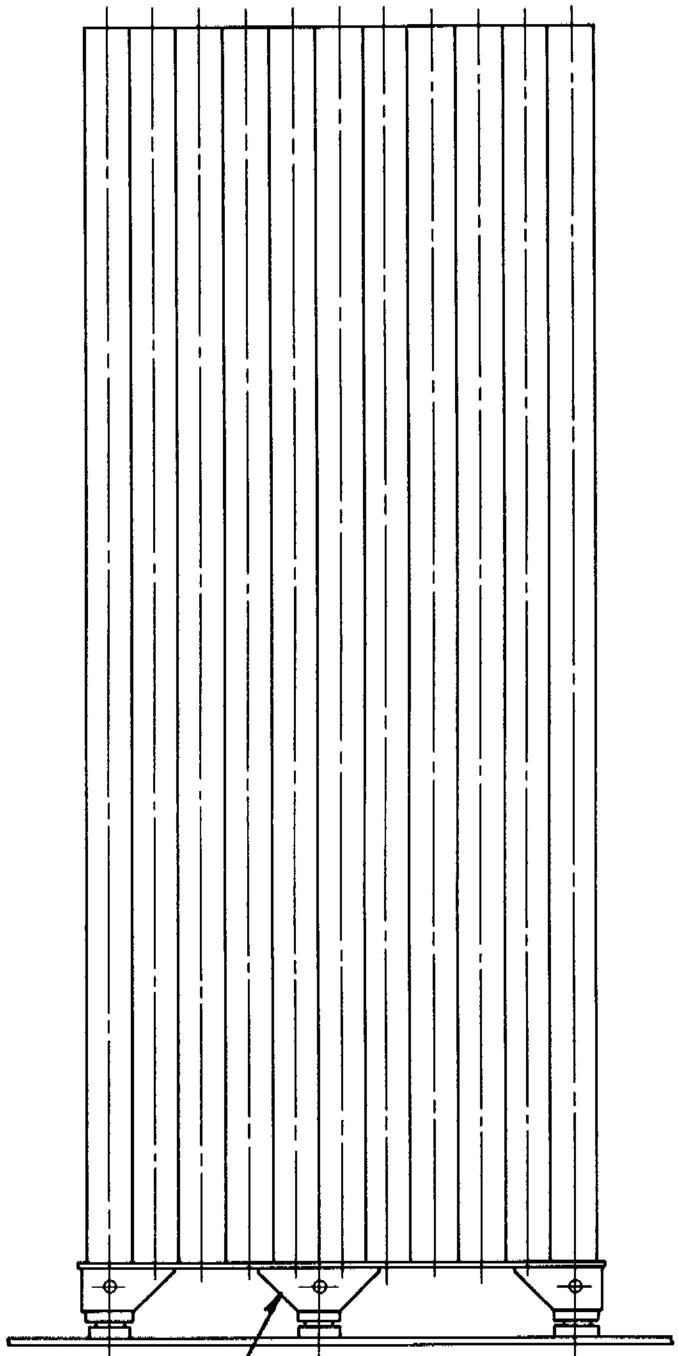
9.1.3-5 ESR 0000286, "SFP Heatload Analysis for RFO-10 and Cycle 11"

9.1.4-1 "NRC Bulletin 96-02 "Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment, 30 Day Response." Serial: HNP-96-086, Dated May 13, 1996.



Amendment No. 7

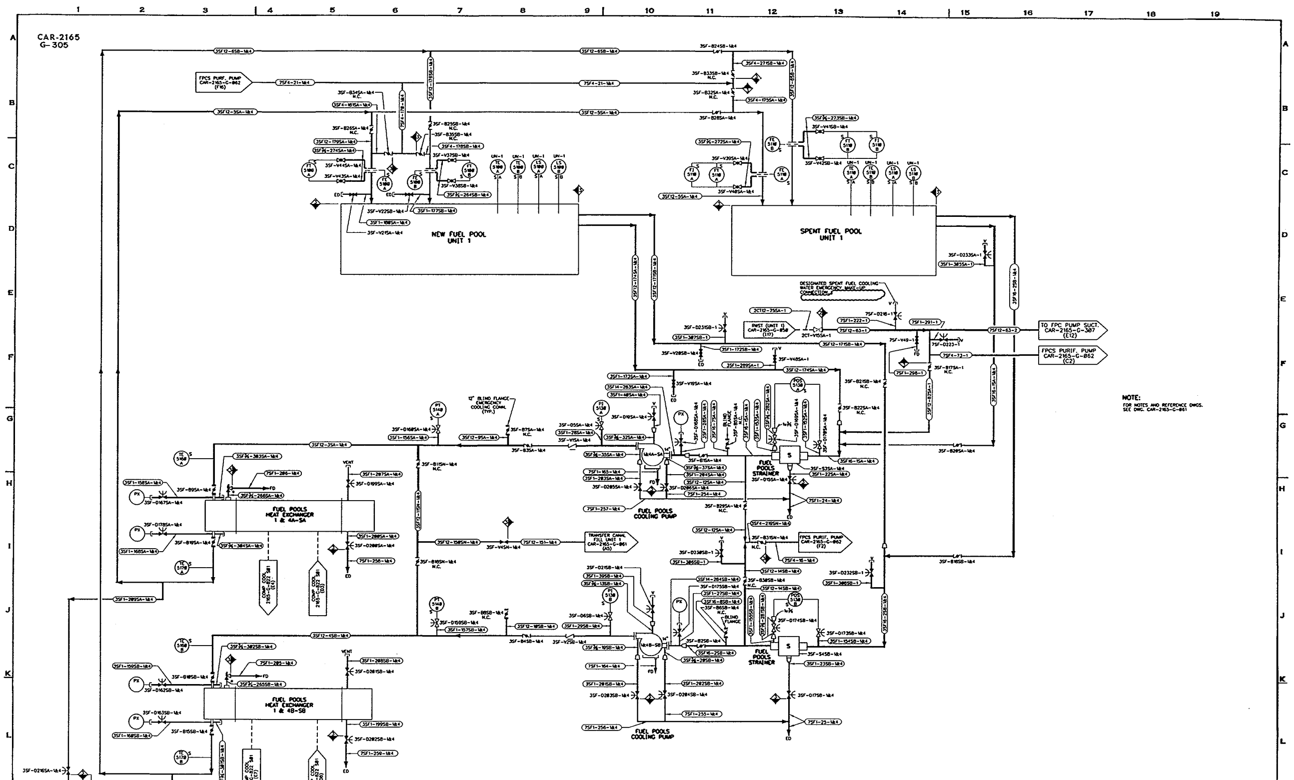
SHEARON HARRIS NUCLEAR POWER PLANT Carolina Power & Light Company FINAL SAFETY ANALYSIS REPORT	PWR FUEL RACK	Figure 9.1.1-1.



MIDDLE PADS ARE NOT REQUIRED
FOR SOME RACKS

Amendment No. 49

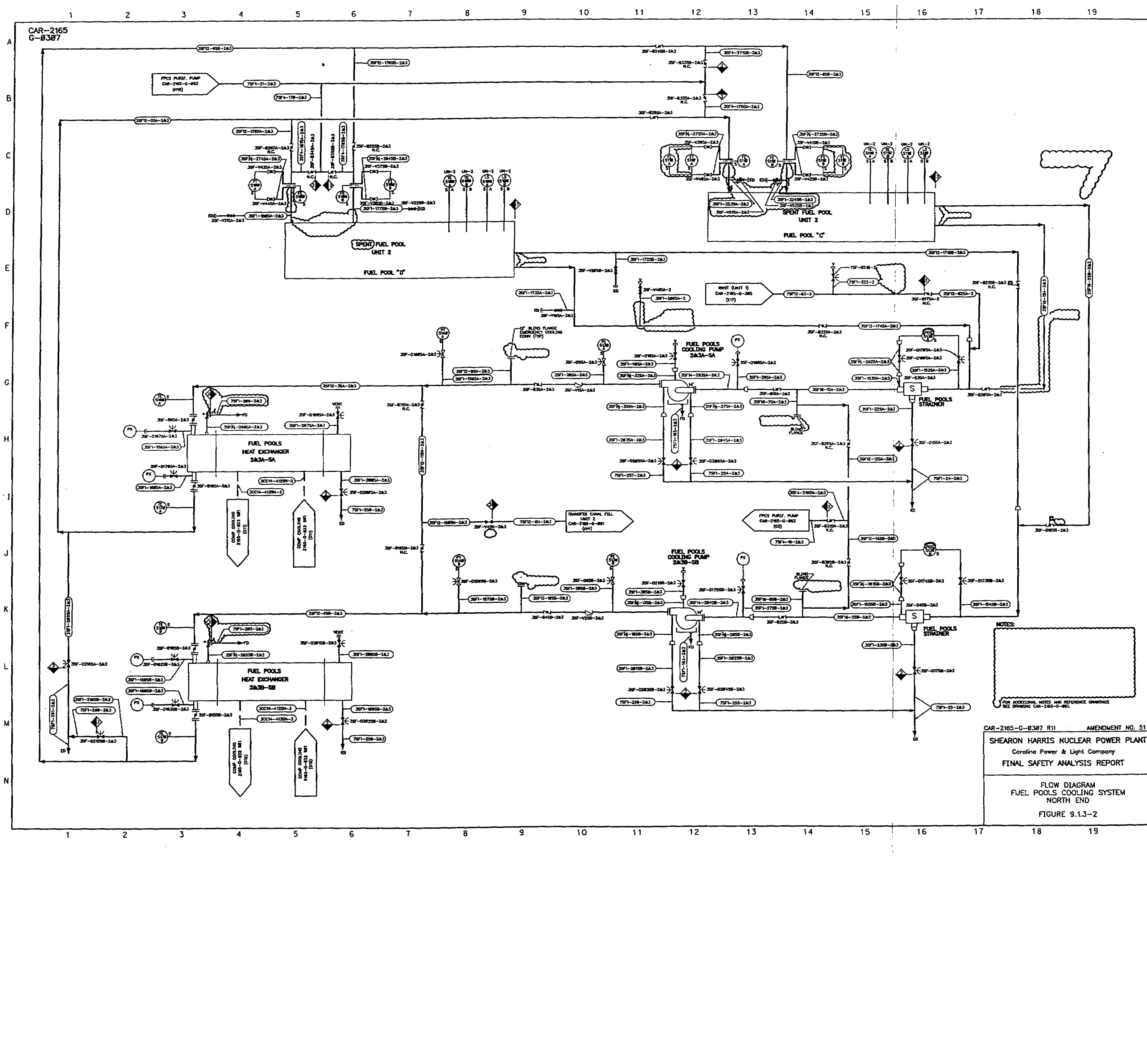
SHEARON HARRIS NUCLEAR POWER PLANT Carolina Power & Light Company FINAL SAFETY ANALYSIS REPORT	BWR FUEL RACK	Figure 9.1.1-2.



CAR-2165-G-0305 R16 AMENDMENT 53

SHEARON HARRIS NUCLEAR POWER PLANT
Carolina Power & Light Company
FINAL SAFETY ANALYSIS REPORT

FLOW DIAGRAM
FUEL POOLS COOLING SYSTEM
SOUTH END
FIGURE 9.1.3-1

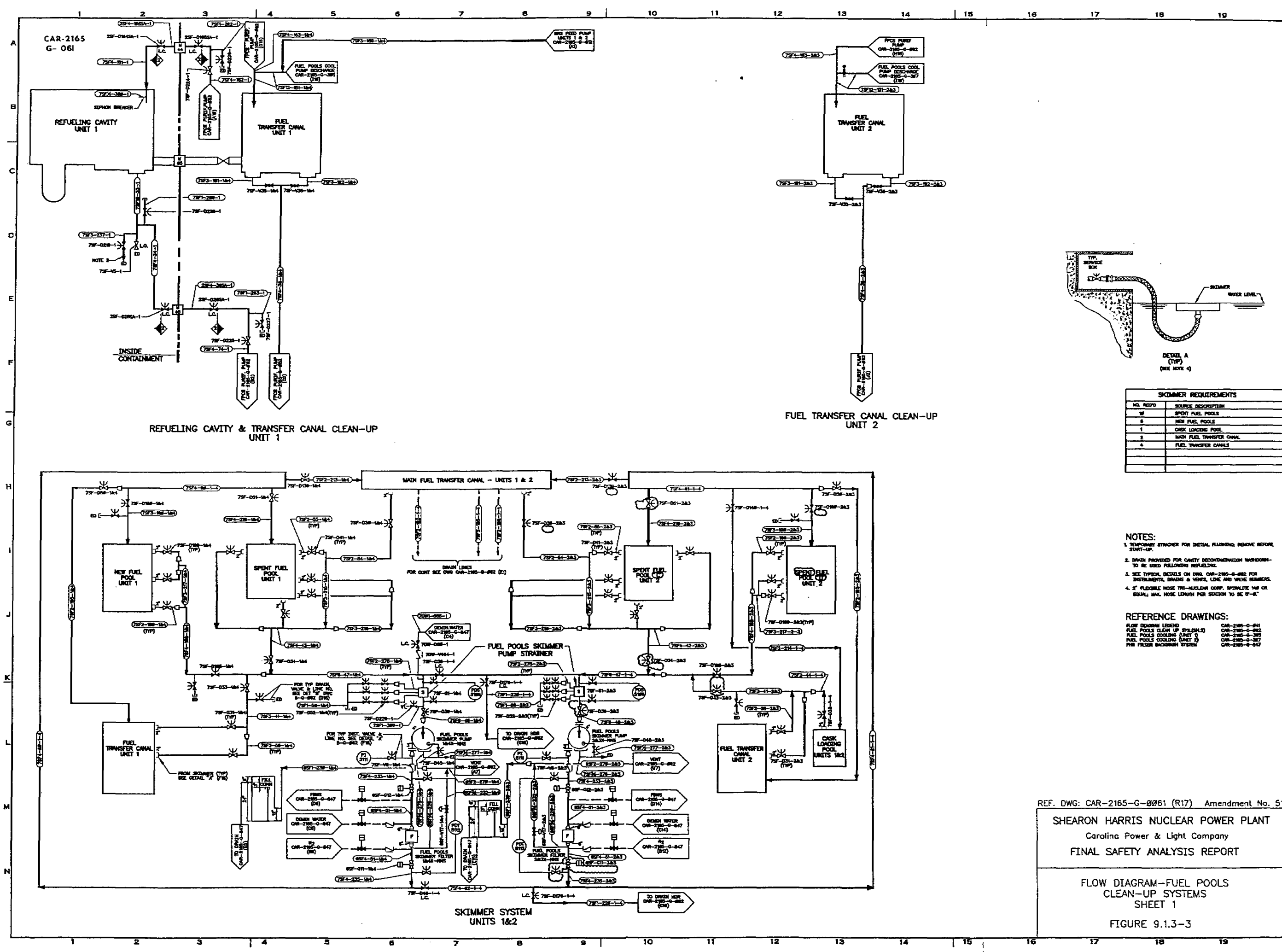


CAR-2165-G-0307 R11 AMENDMENT NO. 51

SHEARON HARRIS NUCLEAR POWER PLANT
Carolina Power & Light Company
FINAL SAFETY ANALYSIS REPORT

FLOW DIAGRAM
FUEL POOLS COOLING SYSTEM
NORTH END

FIGURE 9.1.3-2



SKIMMER REQUIREMENTS	
NO. REQ'D	SOURCE DESCRIPTION
10	SPENT FUEL POOLS
6	NEW FUEL POOLS
1	CASK LOADING POOL
2	MAIN FUEL TRANSFER CANAL
4	FUEL TRANSFER CANALS

NOTES:

1. TEMPORARY STRAINER FOR INITIAL FLUSHING; REMOVE BEFORE START-UP.
2. DRAIN PROVIDED FOR CAVITY DECONTAMINATION WASHDOWN-TO BE USED FOLLOWING REFUELING.
3. SEE TYPICAL DETAILS ON DWG. CAR-2165-G-002 FOR INSTRUMENTS, DRAINS & VENTS, LINE AND VALVE NUMBERS.
4. 2" FLEXIBLE HOSE TRI-NUCLEAR CORP. SPIRALITE 140 OR EQUAL; MAX. HOSE LENGTH PER STATION TO BE 5'-0."

REFERENCE DRAWINGS:

FLOW DIAGRAM LEGEND	CAR-2165-G-041
FUEL POOLS CLEAN UP SYS.(SH.2)	CAR-2165-G-062
FUEL POOLS COOLING (UNIT 1)	CAR-2165-G-305
FUEL POOLS COOLING (UNIT 2)	CAR-2165-G-307
PHB FILTER BACKWASH SYSTEM	CAR-2165-G-047

REF. DWG: CAR-2165-G-0061 (R17) Amendment No. 51

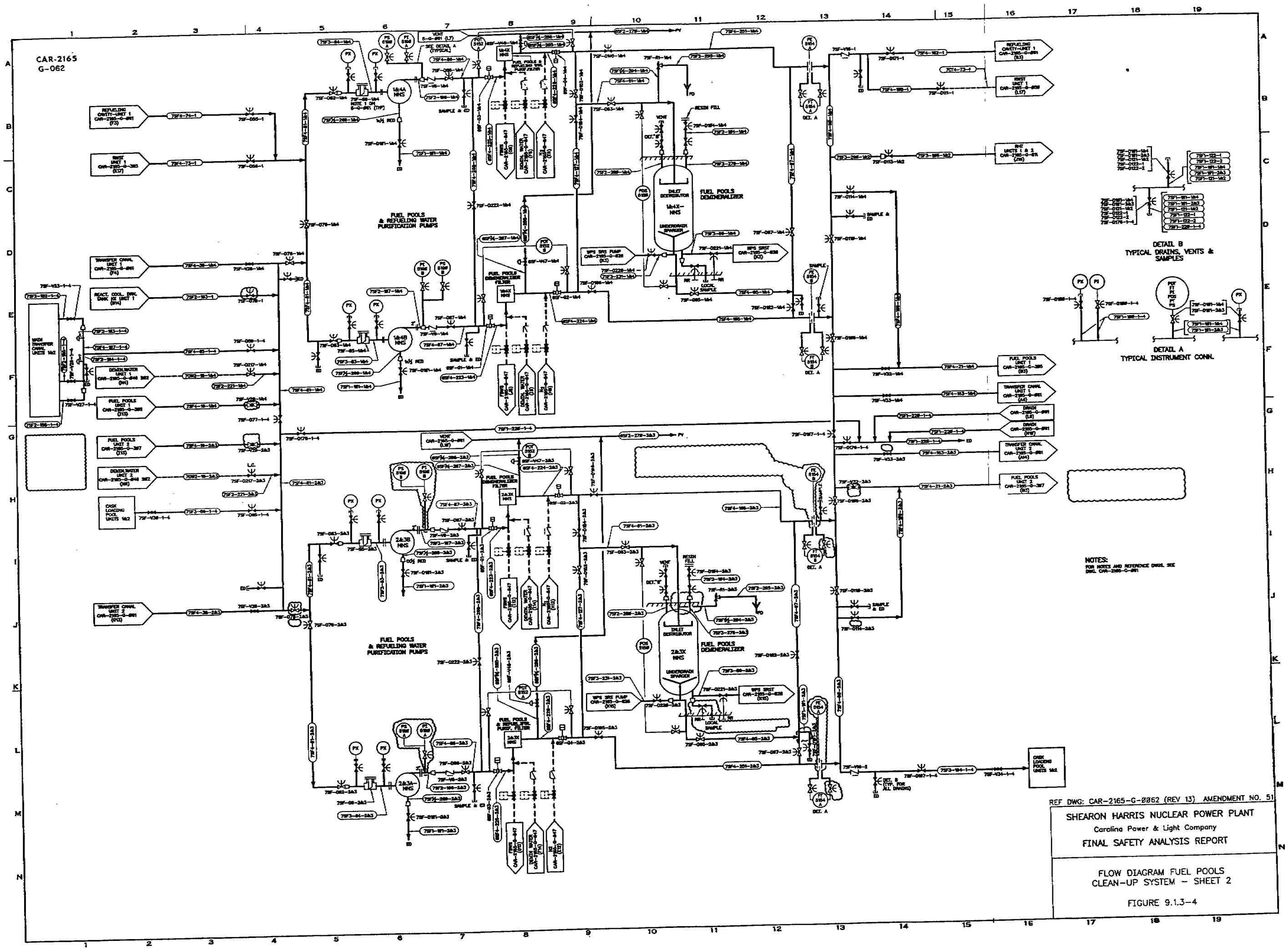
SHEARON HARRIS NUCLEAR POWER PLANT

Carolina Power & Light Company

FINAL SAFETY ANALYSIS REPORT

FLOW DIAGRAM-FUEL POOLS
CLEAN-UP SYSTEMS
SHEET 1

FIGURE 9.1.3-3

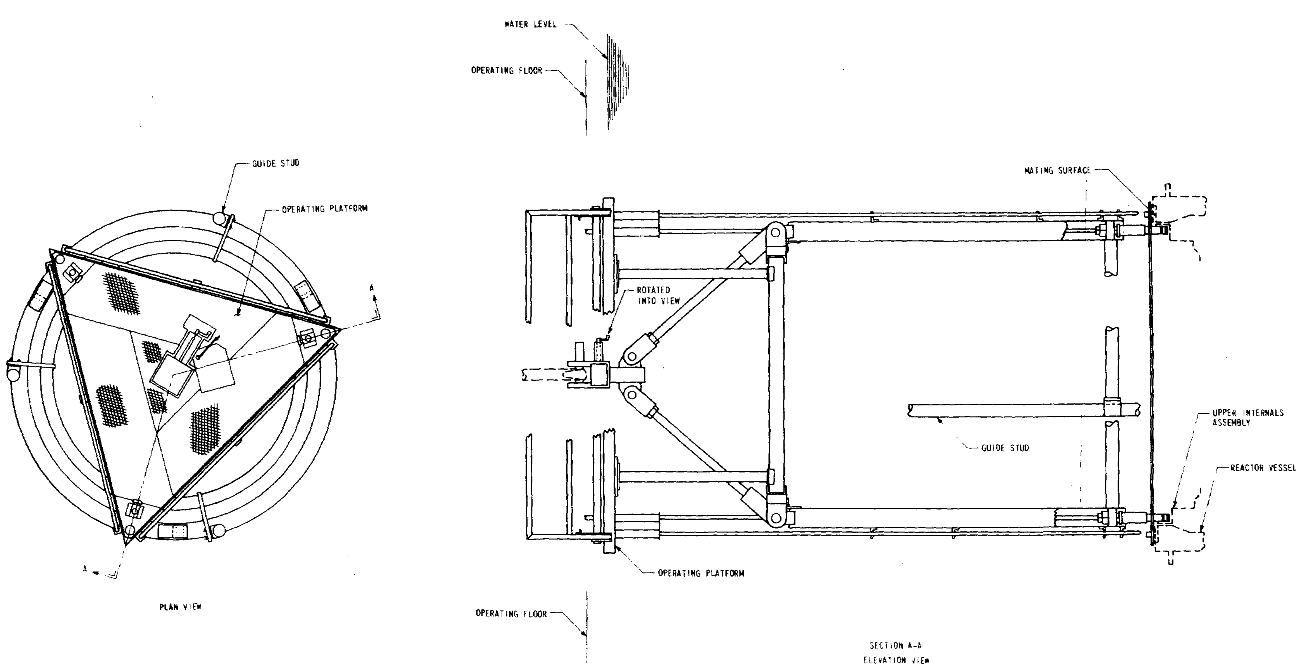


REF DWG: CAR-2165-G-Ø062 (REV 13) AMENDMENT NO. 51

SHEARON HARRIS NUCLEAR POWER PLANT
Carolina Power & Light Company
FINAL SAFETY ANALYSIS REPORT

FLOW DIAGRAM FUEL POOLS
CLEAN-UP SYSTEM - SHEET 2

FIGURE 9.1.3-4



SHEARON HARRIS NUCLEAR POWER PLANT
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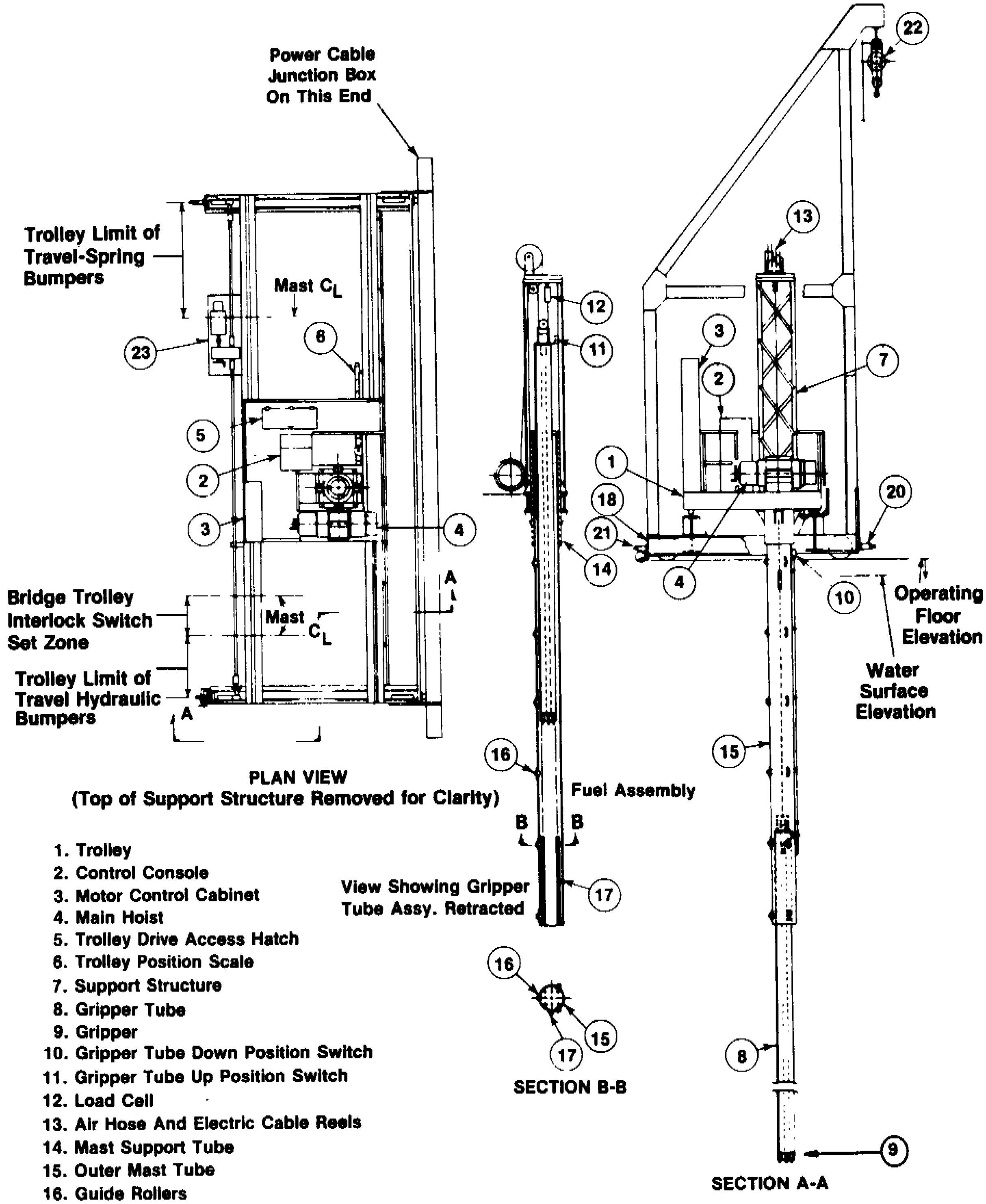
FINAL SAFETY ANALYSIS REPORT

REACTOR INTERNALS LIFTING DEVICE

FIGURE 9.1.4-1

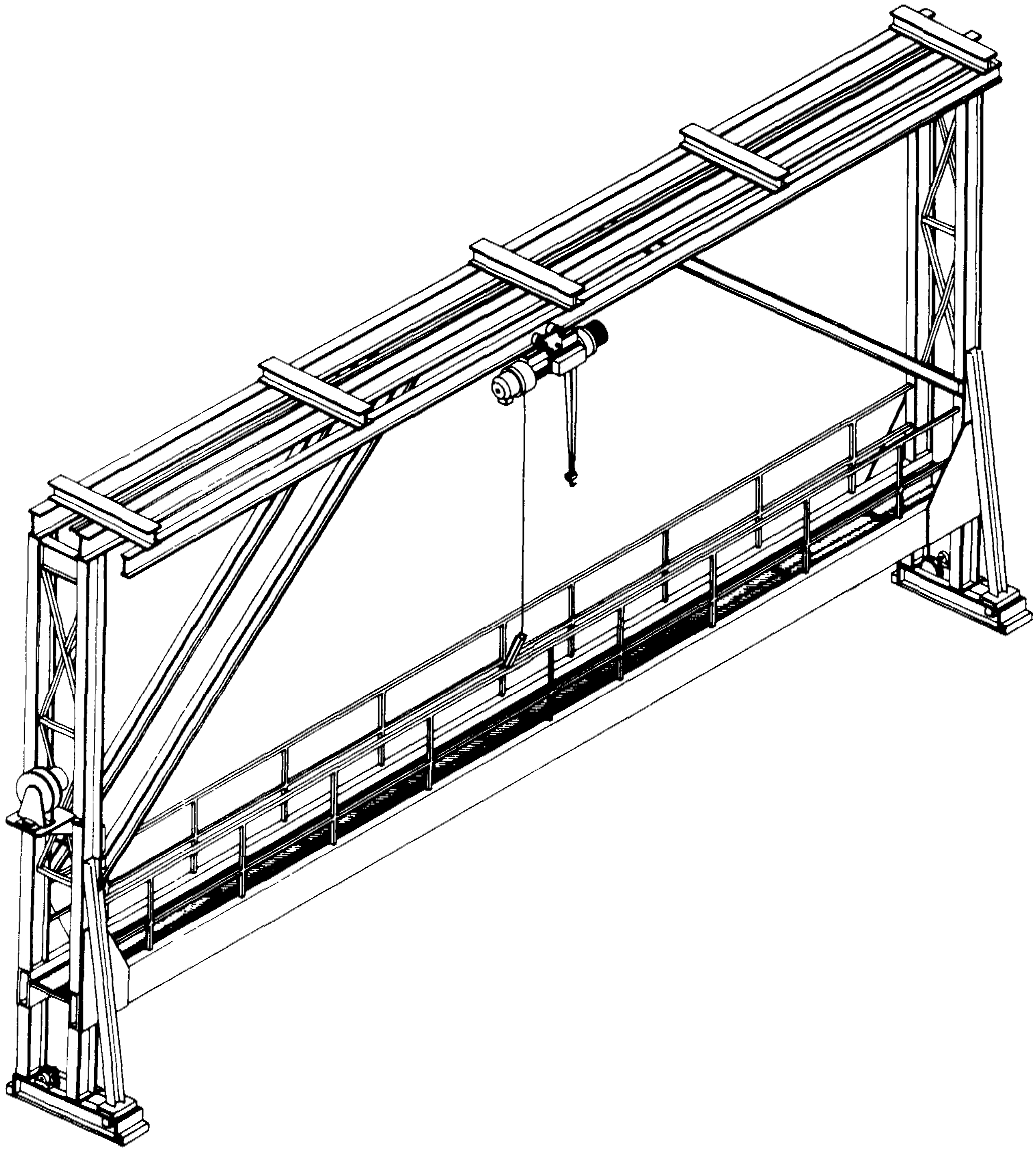


1. Trolley
2. Control Console
3. Motor Control Cabinet
4. Main Hoist
5. Trolley Drive Access Hatch
6. Trolley Position Scale
7. Support Structure
8. Gripper Tube
9. Gripper
10. Gripper Tube Down Position Switch
11. Gripper Tube Up Position Switch
12. Load Cell
13. Air Hose And Electric Cable Reels
14. Mast Support Tube
15. Outer Mast Tube
16. Guide Rollers
17. Fuel Assy. Guide Bars
18. Bridge

20. Hydraulic Bumper
21. Spring Bumper
22. Monorail Hoist
23. Bridge Drive

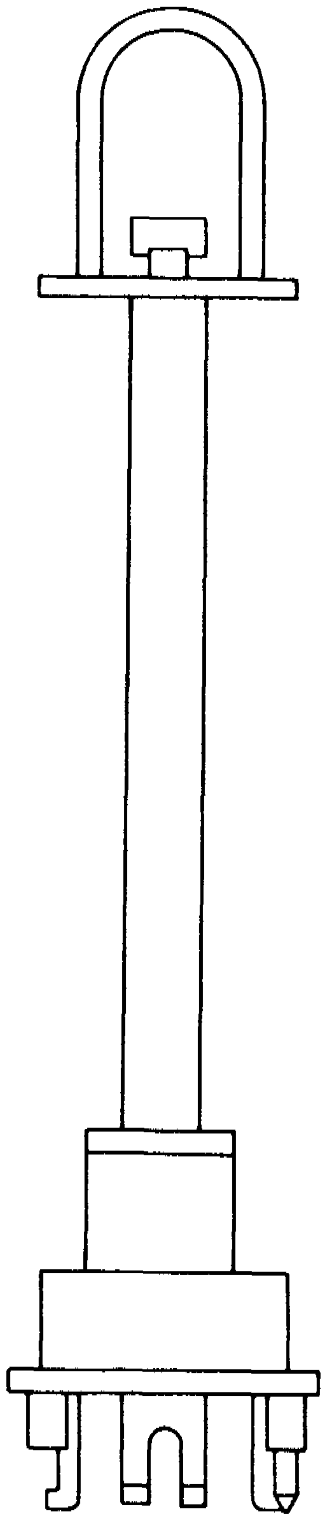
AMENDMENT NO. 43

SHEARON HARRIS NUCLEAR POWER PLANT Carolina Power & Light Company FINAL SAFETY ANALYSIS REPORT	MANIPULATOR CRANE	FIGURE 9.1.4-2

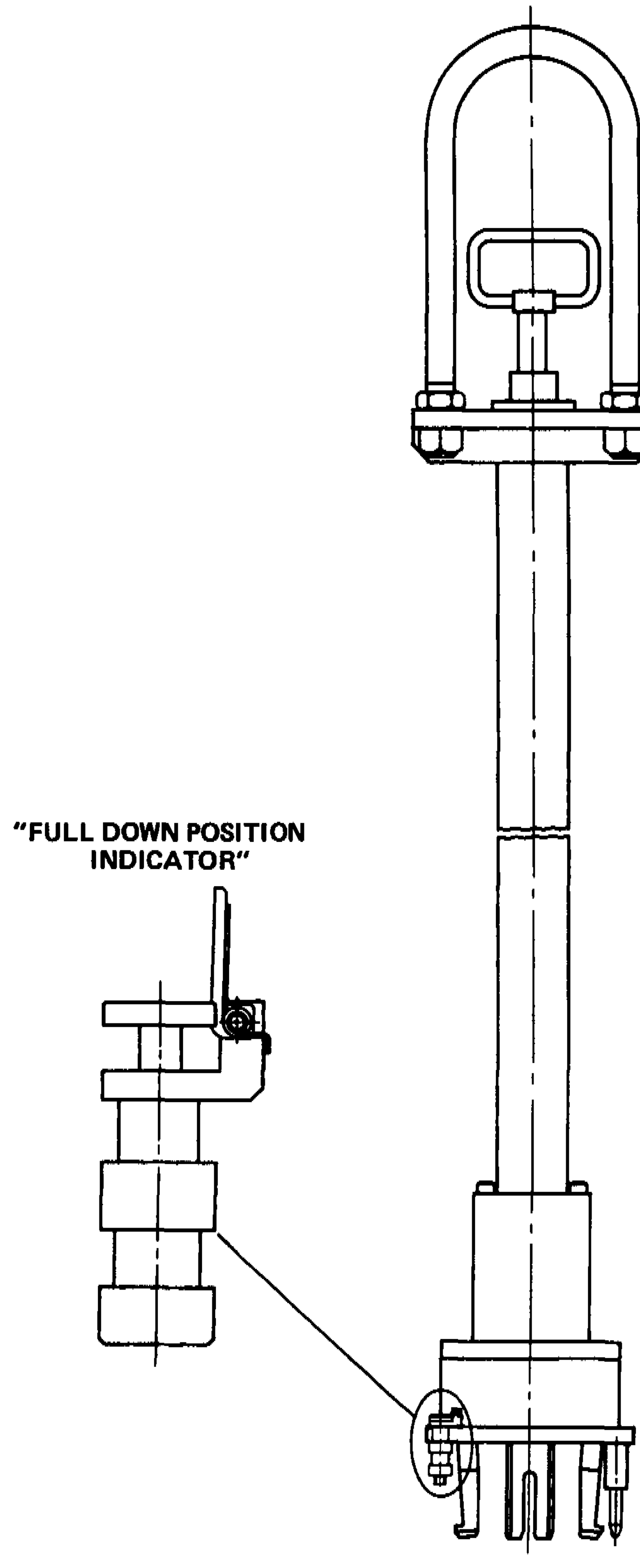


Amendment No. 44

SHEARON HARRIS NUCLEAR POWER PLANT Carolina Power & Light Company FINAL SAFETY ANALYSIS REPORT	SPENT FUEL BRIDGE CRANE	FIGURE 9.1.4-3

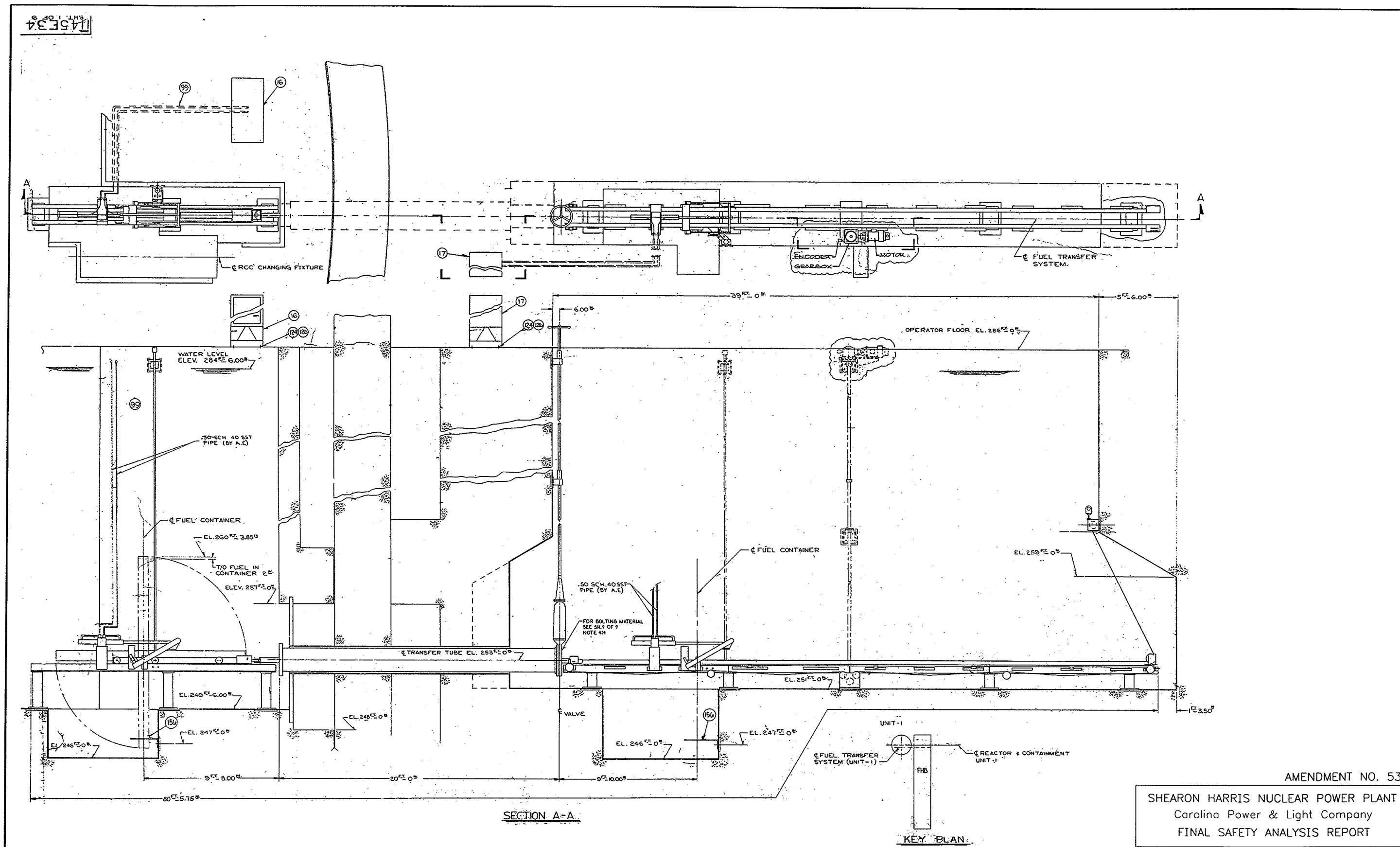


SHEARON HARRIS NUCLEAR POWER PLANT Carolina Power & Light Company FINAL SAFETY ANALYSIS REPORT	PWR LONG HANDLED TOOL	FIGURE 9.1.4-4



AMENDMENT NO. 2

SHEARON HARRIS NUCLEAR POWER PLANT Carolina Power & Light Company FINAL SAFETY ANALYSIS REPORT	PWR LONG HANDLED TOOL	FIGURE 9.1.4-4a



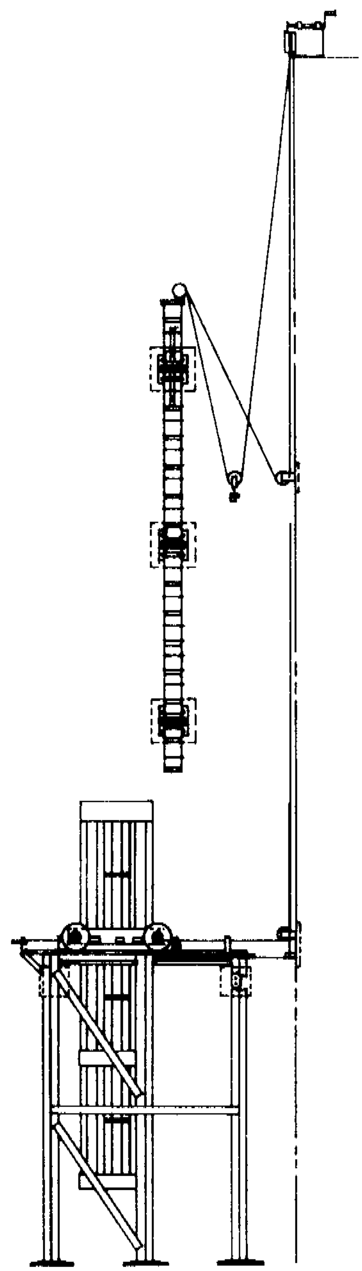
AMENDMENT NO. 53

SHEARON HARRIS NUCLEAR POWER PLANT
Carolina Power & Light Company
FINAL SAFETY ANALYSIS REPORT

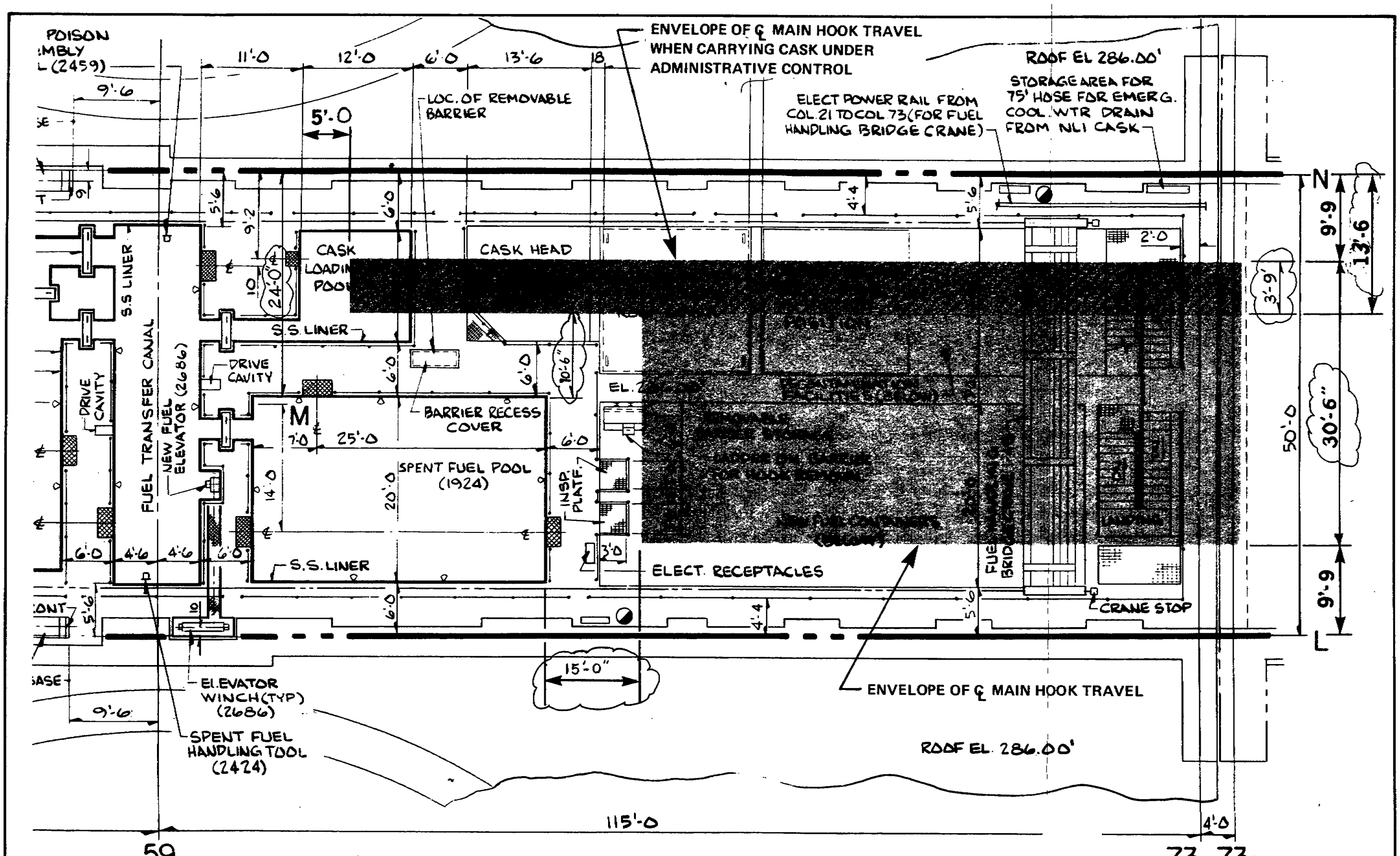
FUEL TRANSFER SYSTEM

FIGURE 9.1.4-Ø5

1364-ØØ2642 (REV 6)



SHEARON HARRIS NUCLEAR POWER PLANT Carolina Power & Light Company FINAL SAFETY ANALYSIS REPORT	Rod Cluster Control Change Fixture	FIGURE 9.1.4-6



[redacted]

PLAN AT EL. 286.00'

THIS FIGURE REPRESENTS THE SPENT FUEL CASK CRANE, MAIN HOOK AND CASK TRAVEL ENVELOPES. FOR THE LATEST BACKGROUND DRAWING REFER TO FIGURE 1.2.2-55.

AMENDMENT NO. 48

REF DWG: CAR-2165-G-022

SHEARON HARRIS NUCLEAR POWER PLANT
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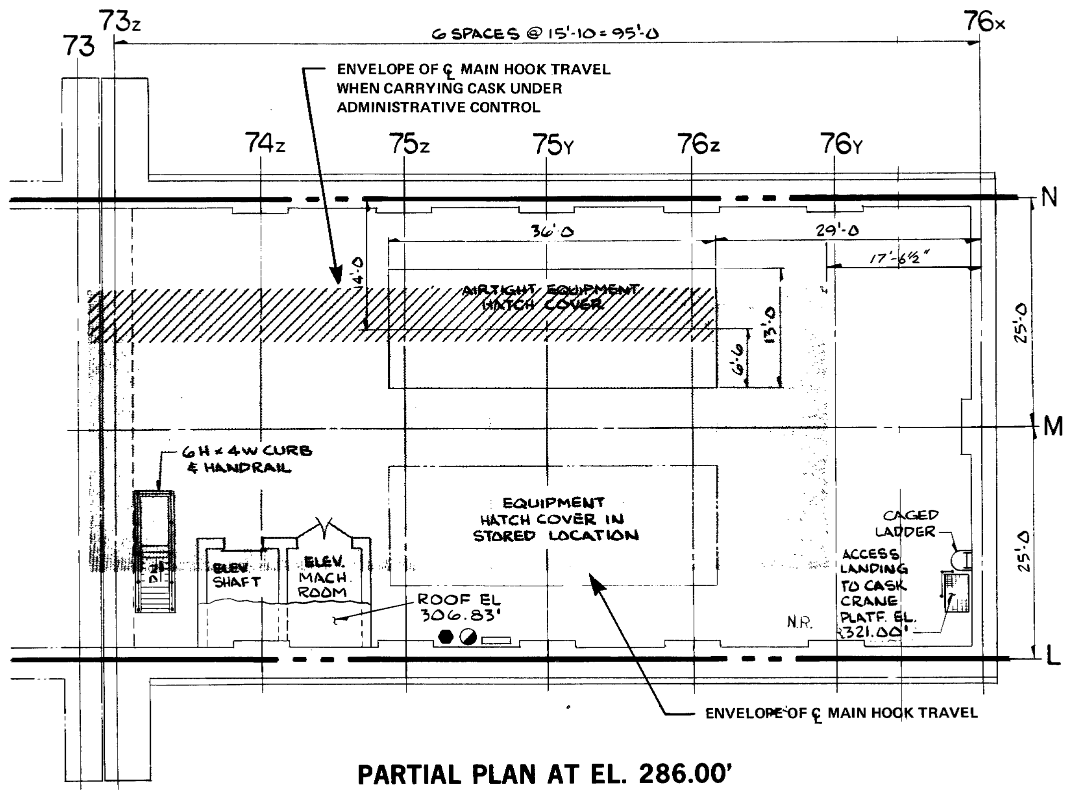
FINAL SAFETY ANALYSIS REPORT

SPENT FUEL CASK CRANE
MAIN HOOK AND CASK TRAVEL
ENVELOPES – SHEET 1
FIGURE 9.1.4-7



PARTIAL PLAN AT EL. 286.00'

FOR DIMENSIONS SEE SHEET 1

THIS FIGURE REPRESENTS THE SPENT FUEL CASK CRANE, MAIN HOOK AND CASK TRAVEL ENVELOPES. FOR THE LATEST BACKGROUND DRAWING REFER TO FIGURE 1.2.2-55.

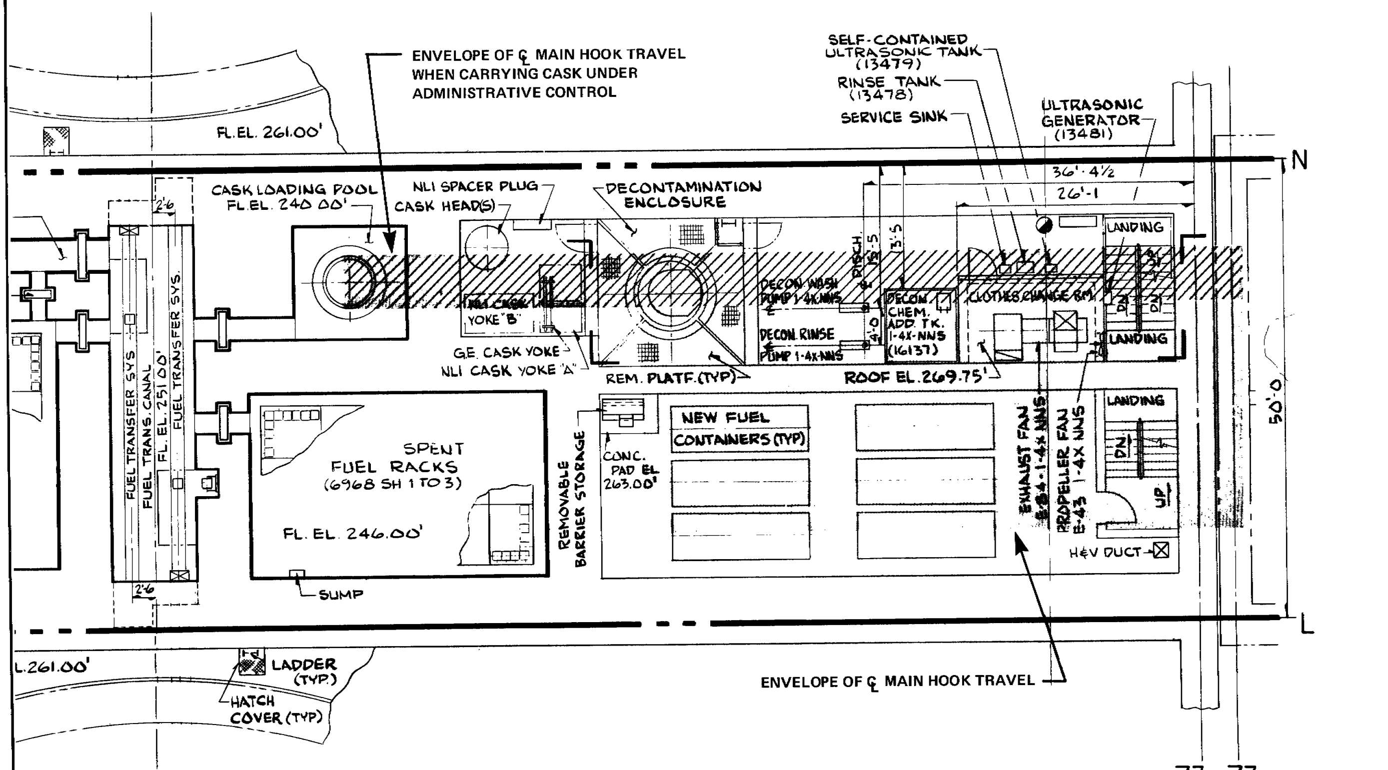
AMENDMENT NO. 40

SHEARON HARRIS NUCLEAR POWER PLANT
Carolina Power & Light Company
FINAL SAFETY ANALYSIS REPORT

SPENT FUEL CASK CRANE
MAIN HOOK AND CASK TRAVEL
ENVELOPES – SHEET 2

FIGURE 9.1.4-8

REF DWG: CAR2165-G-022



PLAN AT EL. 261.00'

FOR DIMENSIONS SEE SHEET 1

THIS FIGURE REPRESENTS THE SPENT FUEL CASK CRANE, MAIN HOOK AND CASK TRAVEL ENVELOPES. FOR THE LATEST BACKGROUND DRAWING REFER TO FIGURE 1.2.2-55.

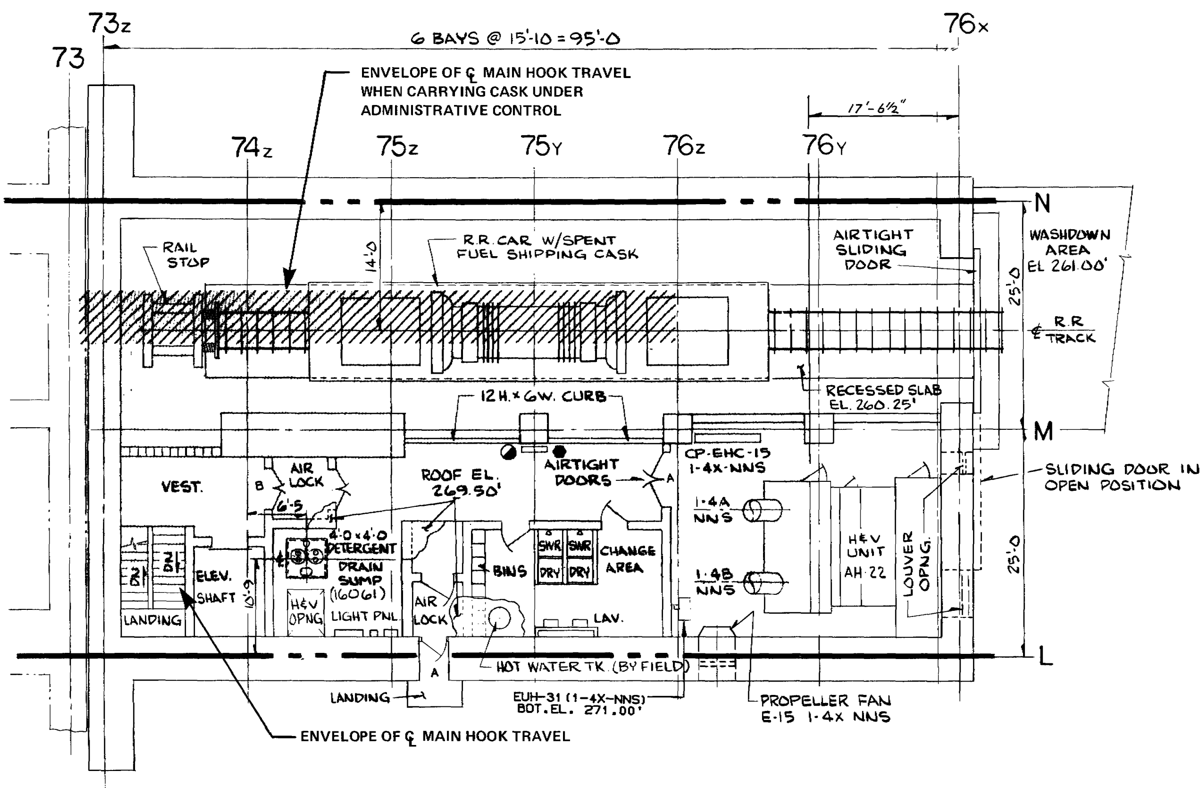
REF DWG: CAR2165-G-022

AMENDMENT NO. 40

SHEARON HARRIS NUCLEAR POWER PLANT
Carolina Power & Light Company
FINAL SAFETY ANALYSIS REPORT

SPENT FUEL CASK CRANE
MAIN HOOK AND CASK TRAVEL
ENVELOPES – SHEET 3

FIGURE 9.1.4-9



PARTIAL PLAN AT EL. 261.00'

FOR DIMENSIONS SEE SHEET 1

THIS FIGURE REPRESENTS THE SPENT FUEL CASK CRANE, MAIN HOOK AND CASK TRAVEL ENVELOPES. FOR THE LATEST BACKGROUND DRAWING REFER TO FIGURE 1.2.2-55.

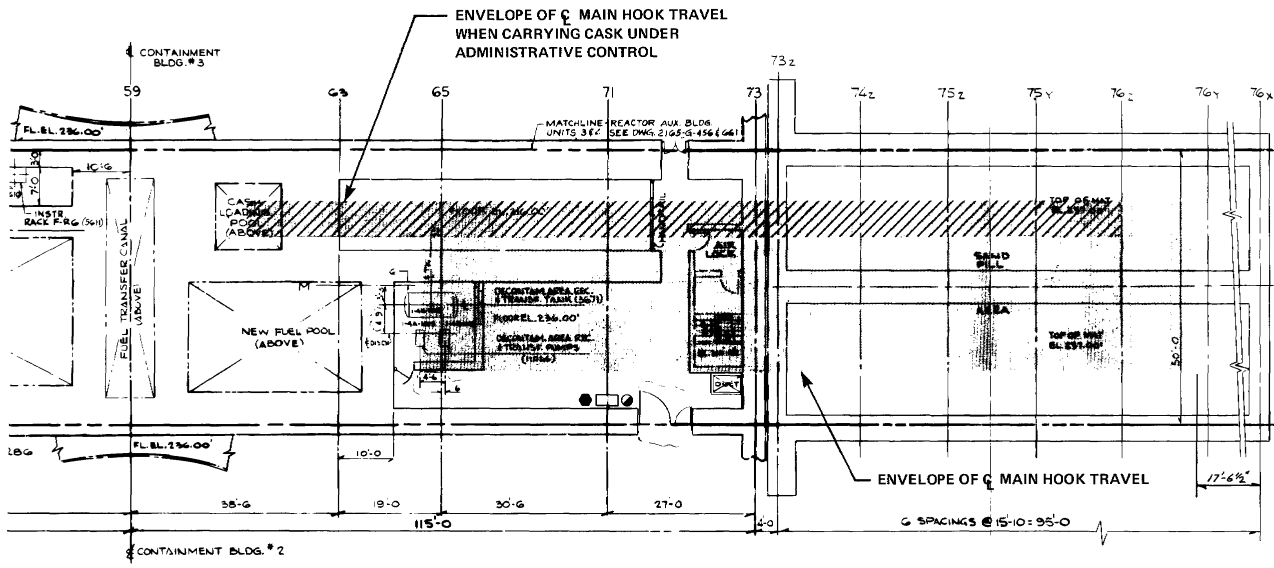
AMENDMENT NO. 40

SHEARON HARRIS NUCLEAR POWER PLANT
Carolina Power & Light Company
FINAL SAFETY ANALYSIS REPORT

SPENT FUEL CASK CRANE
MAIN HOOK AND CASK TRAVEL
ENVELOPES – SHEET 4

FIGURE 9.1.4-10

REF DWG: CAR2165-G-022



PLAN AT EL. 236.00'

FOR DIMENSIONS SEE SHEET 1

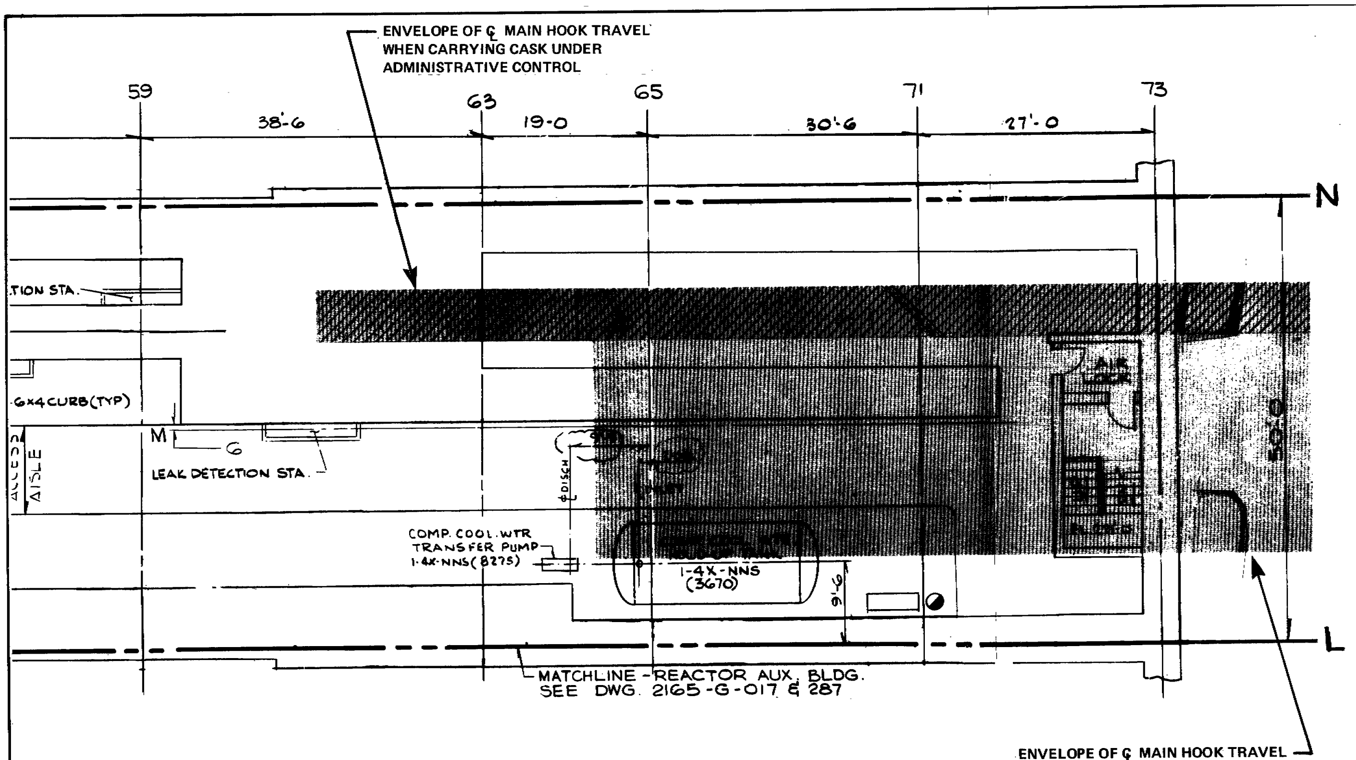
Amendment No. 19

SHEARON HARRIS NUCLEAR POWER PLANT
Carolina Power & Light Company
FINAL SAFETY ANALYSIS REPORT

SPENT FUEL CASK CRANE
MAIN HOOK AND CASK TRAVEL
ENVELOPES – SHEET 5

FIGURE 9.1.4-11

REF DWG: CAR2165-G-023 (REV 6)



PLAN AT EL. 216.00'

FOR DIMENSIONS SEE SHEET 1

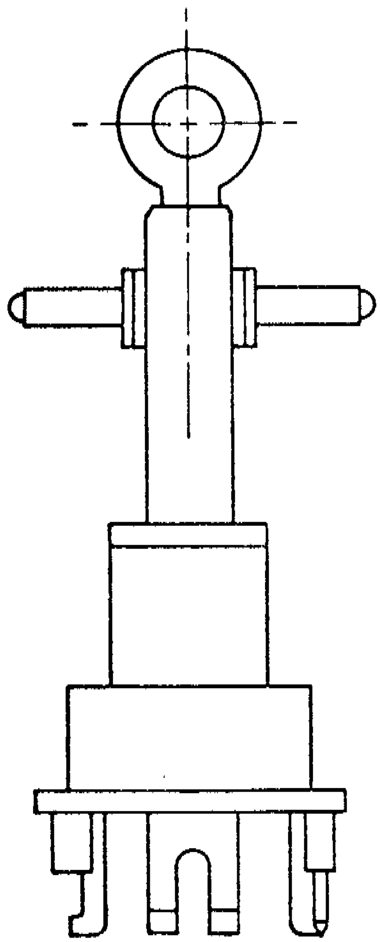
AMENDMENT NO. 27

SHEARON HARRIS NUCLEAR POWER PLANT
Carolina Power & Light Company
FINAL SAFETY ANALYSIS REPORT

SPENT FUEL CASK CRANE
MAIN HOOK AND CASK TRAVEL
ENVELOPES – SHEET 6

FIGURE 9.1.4-12

REF DWG: CAR2165-G-023 (REV 10)



SHEARON HARRIS NUCLEAR POWER PLANT Carolina Power & Light Company FINAL SAFETY ANALYSIS REPORT	PWR SHORT HANDLING TOOL	FIGURE 9.1.4-13