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March 7, 1983

ØCANØ383Ø7

Director of Nuclear Reactor Regulation
ATTN: Mr. J. F. Stolz, Chief
Operating Reactors Branch #4
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Director of Nuclear Reactor Regulation
ATTN: Mr. Robert A. Clark, Chief
Operating Reactors Branch #3
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Arkansas Nuclear One - Units 1 & 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6
Additional Information Concerning
Spent Fuel Storage Expansion

Gentlemen:

Your letter dated February 1, 1983, (ØCNAØ283Ø2) requested additional information regarding the proposed spent fuel storage expansion. Attached is our response to your request.

Very truly yours,

John R. Marshall
Manager, Licensing

JRM:JC:sl

Attachments

A001

Question 1:

How are the spent fuel storage racks designed to prevent a fuel assembly from being inserted anywhere other than in a design location?

Response:

The Region 1 racks, poison type, utilize a grid-type structure which is positioned between each storage cell and to which each cell is welded. This structure, together with the close cell-to-cell spacing prevents the insertion of a fuel assembly between storage cells.

The Region 2 racks, burnup credit, are assembled in a checkerboard pattern with each storage cell being welded directly to the adjacent cell at the corners. This close spacing prevents a fuel assembly from being inserted anywhere other than a design location.

The gaps between individual racks are less than the square size of the fuel assemblies therefore preventing the insertion of assemblies at these locations.

Question 2:

In the licensee's submittal dated November 1, 1982, the storage of control rods was not addressed. If control rods will be stored in the spent fuel pool, verify that the seismic analysis provided in the submittal represents maximum pool liner loading on the walls and floor, and the maximum interrack reactions with consideration being given to the additional weight of the control rods.

Response:

The seismic analysis was performed using the combined weights of a fuel assembly and control rod assembly in each cell location.

3. The reracking of a spent fuel pool is not considered routine and therefore is not within the scope of NUREG-0612. Concerning the moving of spent fuel storage racks, we have the following questions:

a. Verify that the special lifting devices for the removal of the existing spent fuel storage racks and the installation of the new spent fuel storage racks meet the criteria of ANSI N14.6-1978 or ANSI B30.9-1971 for non-special lifting devices.

Response:

AP&L anticipates the use of wire rope slings in the removal of the existing spent fuel storage racks and the installation of the new spent fuel storage racks. Therefore, the criteria contained in ANSI B30.9-1971 are applicable. ANO Plant Procedure #1306.24 Rev. 2 requires that all wire rope slings will be proof load tested, either by AP&L or the sling manufacturer and a permanent record of this load test will be maintained onsite at ANO. This procedure also requires a visual inspection of all slings each day that they are used and a periodic (yearly) inspection on all wire rope slings. All wire rope slings are evaluated against acceptance criteria contained in the plant procedure which is identical to that contained in ANSI B30.9-1971.

b. Verify that procedures are developed, which include the safe load paths, for the removal of existing spent fuel storage racks and installation of new spent fuel storage racks. Verify that all safe load paths for these operations are clearly marked on the floor. Provide drawings which show the load paths of the new and existing spent fuel racks and all other heavy loads associated with this modification of the spent fuel pool.

Response:

AP&L will utilize ANO Plant Procedure #1005.02 Rev. 1 "Control of Heavy Loads" as well as job specific procedures for the spent fuel reracking operations. This procedure requires that a Plant Engineering Action Request (PEAR) and a Heavy Load Lifting Permit be issued when an unexpected heavy load lift is anticipated. The Spent Fuel Pool reracking operation is considered an unexpected heavy load lift. The PEAR shall be evaluated by Plant Engineering based on the crane's lift capacity; the appropriateness of the type rigging proposed, safe load paths and that the appropriate crane operating procedure is referenced.

AP&L does <u>not</u> plan to mark all safe load paths for this operation on the floor since the marking of these paths on the floor would do very little to assist in the load handling operation.

4. The information provided in the licensee's submittal dated November 1, 1982, did not include a discussion of the capability of the component cooling water system and the service water to remove the additional heat from the spent fuel pool. 4.1 Based on the heat loads using NUREG-0800, Standard Review Plan, Section 9.1.3 and Branch Technical Position ASB 9-2, provide the results of a revised FSAR analysis of the increased heat loads from the spent fuel storage expansion on the component cooling water system and service water system. 4.2 Include information which shows the design heat load capacities and the imposed heat loads for normal operation with normal refuelings and 4.3 all design basis accident heat loads. 4.4 For each system, include an analysis of the capability of the system to remove the increased spent fuel cooling heat loads and all normal and accident heat loads while maintaining the original design margins for tube fouling and plugging. 4.5 The licensee should verify that no single failure can prevent proper spent fuel pool cooling or safe shutdown. No credit should be taken for any redundant train or component which is not properly qualified for the accident being considered, such as a safe shutdown earthquake, or which requires operator action within 20 minutes (at least 30 minutes if the single operator action is required outside of the control room).

Response:

4.1 The following are the results from the revised FSAR heat load analysis performed on both units to reflect the increase due to fuel storage expansion. An evaluation is also provided describing the effect of the increased heat loads on the component cooling water and the service water systems.

UNIT 1

TABLE I

DESIGN BASES FOR SPENT FUEL DISCHARGES TO SPENT FUEL POOL FOR DECAY HEAT ANALYSES

General Data

Reactor Type	Babcock & Wilcox
Reactor Core Thermal Power	2568 MWth
Number of Fuel Assemblies in Core	177
Initial Uranium Per Fuel Assembly	463 Kg

Fuel Assemblies Presently Contained in Pool

Batch	# Assemblies	Date of Discharge
1	60	January 77
2	61	February 78
3	60	March 79
4	56	January 81
5	56	January 83
6	27	January 83

Decay Heat Load Table

	To (EFPD)	Ts (Days)	Dis. Date	# Assembly	Heat Load (10^6 Btu/Hr)
Batch 1	500	6310	1/77	60	0.03
Batch 2	772	5914	2/78	56	0.05
Batch 3	1101	5489	4/79	61	0.08
Batch 4	891	4849	1/81	60	0.06
Batch 5	1074	4150	12/82	68	0.09
Batch 6	1171	3512	9/84	64	0.10
Batch 7	1198	2965	3/86	68	0.12
Batch 8	1099	2417	9/87	72	0.12
Batch 9	1068	1870	3/89	68	0.13
Batch 10	1068	1322	9/90	64	0.16
Batch 11	1068	775	3/92	64	0.30
Batch 12	1068	227	9/93	64	1.19
Batch 13	862[1]	7	4/94	64	9.19
Batch 14	506	7	4/94	64	8.87
Batch 15	150	7	4/94	64	7.53

[1]Full Core Discharge after 150 days operation into Cycle 15.

Design Evaluation

During normal operation, the Spent Fuel Cooling System serves two main functions. The first is to maintain the pool water at temperatures below 120°F. The second function is to provide purification of the spent fuel pool coolant for clarity during fuel handling operations. Under normal conditions, the pool temperature is maintained under 120°F by recirculating spent fuel cooling water from the spent fuel pool through the parallel arranged pumps and cooler and back into the pool. For maximum normal conditions, full core offload, the pool temperature is maintained at or below 150°F.

The heat load shown in Table I represents the largest heat load expected in the spent fuel pool.* The calculations are based upon an 18-month cycle.

Pool temperature is maintained below 120°F by operation of any two pump-cooler configurations for the normal heat load and at or below 150°F for the maximum heat load. Upon failure of one pump or cooler for the normal condition, sufficient cooling capacity remains to maintain bulk pool temperature below 135°F. An analysis of pool response to loss of all forced cooling is presented in Section 4.3 of this response to Question 4.

*The heat load is slightly higher for the total loss of spent fuel pool cooling.

UNIT 2

TABLE I

DESIGN BASES FOR SPENT FUEL DISCHARGES TO
SPENT FUEL POOL FOR DECAY HEAT ANALYSES

General Data

Reactor Type	Combustion Engineering PWR
Reactor Core Thermal Power	2815 MWth
Number of Fuel Assemblies in Core	177
Initial Uranium Per Fuel Assembly	4.16 Kg
Average Enrichment of U-235	3.1
Discharge Fuel Batch Size	60 Fuel Assemblies
Discharge Fuel Batch Burnup	34,000 MWD/MTU
Cycle Capacity Factor	80%

Decay Heat Load Table

	To (EFPD)	Ts (Days)	Dis. Date	# Assembly	Heat Load (10^6 Btu/Hr)
Batch 1	325	6067	3/81	60	0.03
Batch 2	612	5520	9/82	61	0.05
Batch 3	873	5155	9/83	56	0.07
Batch 4	892	4607	3/85	60	0.08
Batch 5	961	4060	9/86	52	0.08
Batch 6	1056	3512	3/88	68	0.11
Batch 7	1068	2965	9/89	68	0.12
Batch 8	1068	2417	3/91	68	0.12
Batch 9	1068	1870	9/92	68	0.14
Batch 10	1068	1322	3/94	68	0.18
Batch 11	1068	775	9/95	68	0.34
Batch 12	1068	227	3/97	68	1.39
Batch 13	862[1]	7	8/97	68	10.70
Batch 14	506	7	8/97	68	10.33
Batch 15	150	7	8/97	68	8.76

[1]Full Core Discharge after 150 days operation into Cycle 15.

Design Evaluation

During normal operation, the Spent Fuel Cooling System serves two main functions. The first is to maintain the pool water at temperatures below 120°F. The second function is to provide purification of the spent fuel pool coolant for clarity during fuel handling operations. Under normal conditions, the pool temperature is maintained under 120°F by recirculating spent fuel cooling water from the spent fuel pool through the parallel arranged pumps and cooler and back into the pool. For maximum normal conditions, full core offload, the pool temperature is maintained at or below 150°F.

The heat load shown in Table I represents the largest heat load expected in the spent fuel pool.* The calculations are based upon an 18-month cycle.

Pool temperature is maintained below 120°F by operation of any two pump-cooler configurations for the normal heat load and at or below 150°F for the maximum heat load. Upon failure of one pump or cooler for the normal condition, sufficient cooling capacity remains to maintain bulk pool temperature below 135°F. An analysis of pool response to loss of all forced cooling is presented in Section 4.3 of this response to Question 4.

*The heat load is slightly higher for the total loss of spent fuel pool cooling.

4.2 The following information describes the design heat load capacities and the imposed heat loads for normal operation with normal refuelings.

UNIT 1

Normal Operation

For normal operation, the pool is assumed to be fully loaded with 1/3 a core being loaded over a four-day period with a three-day cooling time - with the previous batch having been loaded 18 months prior to the present loading. The total heat load for the normal case is 11.67×10^6 Btu/Hr. The hottest fuel is assumed to be loaded in the center of the pit. Rack results for this case are presented below for the three inlet temperatures of 120, 150, and 180°F.

Temp. of Water at Inlet to Storage Racks	Average Cell Water Outlet Temp.	Maximum Cell Water Temp.	Maximum Clad Surface Temp. (Typical Rod)	Maximum Clad Surface Temp. (Peak Rod)	Maximum Temp. of Water in Cap Between Cells
°F	°F	°F	°F	°F	°F
120	126.9	140.0	156.8	166.9	128.0
150	156.4	168.9	186.5	197.0	157.8
180	186.4	198.1	215.0	225.5	187.6

The following comments are in order:

1) The present heat exchangers are capable of maintaining the pool water temperature below 120°F for normal refueling operations since the ΔT across the tube side of the heat exchangers.

2) All temperatures are less than saturation temperature of 242°F so the water remains subcooled.

UNIT 2

Normal Operation

For normal operation, the pool is assumed to be fully loaded with 1/3 a core being loaded over a four-day period with a three-day cooling time - with the previous batch having been loaded 18 months prior to the present loading. The total heat load for the normal case is 13.424×10^6 Btu/Hr. The hottest fuel is assumed to be loaded in the center of the pit. Rack results for this case are presented below for the three inlet temperatures of 120, 150, and 180°F.

Temp. of Water at Inlet to Storage Racks	Average Cell Water Outlet Temp.	Maximum Cell Water Temp.	Maximum Clad Surface Temp. (Typical Rod)	Maximum Clad Surface Temp. (Peak Rod)	Maximum Temp. of Water in Cap Between Cells
°F	°F	°F	°F	°F	°F
120	129.7	138.7	155	164.8	133.4
150	159	167.5	183.3	192.8	162.4
180	188.8	196.8	212	221.4	191.9

The following comments are in order:

1) The present heat exchangers are capable of maintaining the pool water temperature below 120°F for normal refueling operations since the ΔT of the first two columns is less than the 10.1°F ΔT across the tube side of the heat exchangers.

2) All temperatures are less than saturation temperature of 242°F so the water remains subcooled.

4.3 The following describes the design basis accident heat loads for both units considering the increased storage capacity.

UNIT 1

Loss of Spent Fuel Pool Cooling

Under postulated accident conditions where all non-Category 1 spent fuel pool cooling systems become inoperative, there is [illegible] alternative method for cooling the spent fuel pool water. Although it is highly unlikely that a complete loss of cooling capability could occur, the racks are analyzed to this condition.

Basis:

a. No pool cooling implies that temperature of water at inlet to spent fuel racks is 212°F, which corresponds to the saturation temperature at the pool surface.

b. The nominal water level above the top of the racks is maintained.

c. A conservative fuel loading case is assumed. The pool is completely filled with fuel with one full core discharge at one month following a normal refueling. Previous refuelings of approximately one-third core are assumed to have occurred at 18-month intervals.

d. The assemblies that are evaluated are initially placed into the pool at seven days after shutdown.

e. The peak rods are assumed to have 60% greater heat output than average rods.

f. All storage cells are filled and all downflow occurs in the peripheral gaps.

The criterion for this condition is that adequate cooling must exist so that the temperature of the fuel cladding is maintained sufficiently low so that no structural failures will occur and no safety concerns exist.

This condition (with a heat load of 31.68×10^6 Btu/Hr.) was analyzed utilizing the rack program with the maximum peak clad temperature obtained as 258.0°F. This temperature is high enough for local boiling to occur but sufficiently below the temperature of 600°F which is the approximate operating temperature in the core. So no structural damage can occur.

UNIT 2

Loss of Spent Fuel Pool Cooling

Under postulated accident conditions where all non-Category 1 spent fuel pool cooling systems become inoperative, there is an alternative method for cooling the spent fuel pool water. Although it is highly unlikely that a complete loss of cooling capability could occur, the racks are analyzed to this condition.

Basis:

a. No pool cooling implies that temperature of water at inlet to spent fuel racks is 212°F, which corresponds to the saturation temperature at the pool surface.

b. The nominal water level above the top of the racks is maintained.

c. A conservative fuel loading case is assumed. The pool is completely filled with fuel with one full core discharge at one month following a normal refueling. Previous refuelings of approximately one-third core are assumed to have occurred at 18-month intervals.

d. The assemblies that are evaluated are initially placed into the pool at seven days after shutdown.

e. The peak rods are assumed to have 60% greater heat output than average rods.

f. All storage cells are filled and all downflow occurs in the peripheral gaps.

The criterion for this condition is that adequate cooling must exist so that the temperature of the fuel cladding is maintained sufficiently low so that no structural failures will occur and no safety concerns exist.

This condition (with a heat load of 31.68 x 10^6 Btu/Hr.) was analyzed utilizing the rack program with the maximum peak clad temperature obtained as 257.1°F. This temperature is high enough for local boiling to occur but sufficiently below the temperature of 600°F which is the approximate operating temperature in the core. So no structural damage can occur.

4.4 The following is an analysis of the capability of each system to remove the increased spent fuel cooling heat loads and all normal and accident heat loads while maintaining the original design margins for tube fouling and plugging. It also verifies that no single failure can prevent proper spent fuel pool cooling of safe shutdown.

ANO-1

Single Failure Analysis for the ANO-1 Spent Fuel Pool Cooling System

The ANO-1 spent fuel cooling system was originally designed to maintain the spent fuel pool water at approximately 120°F with a heat load based on removing the decay heat generated from one-third of the core fuel assemblies as described in Section 9.4.1 of the FSAR. In addition, the system has the capability to maintain the spent fuel pool at approximately 150°F with one and one-third core assemblies in the fuel pool as also described in Section 9.4.1 of the FSAR. The spent fuel cooling system was designed to provide adequate capacity and component redundancy to assure the cooling of stored spent fuel, even when unexpectedly large amounts of fuel are in storage. The system was designed to allow ample time to assure cooling can be effected even in the event of multiple component failures or complete cooling loss.

Since the spent fuel cooling system is designed with redundant components, it is considered highly unlikely that a loss of cooling would occur. If this does occur, maintenance work begins as quickly as possible to restore cooling. While the maintenance is being performed, connections or valve lineups are performed for makeup water to be supplied from the most readily available source.

Makeup water for the spent fuel pool can be supplied from the Seismic Category 1 Borated Water Storage Tank (BWST) through either Decay Heat Removal (DHR) pump. If the BWST is not available, a temporary hose

connection is provided on the Seismic Category 1 service water piping near the spent fuel pool. In addition, hose connections are available from the condensate tank and demineralized water supply. This design meets the intent of Safety Guide 13 (i.e., the Borated Water Storage Tank is a Seismic Category 1 vessel; all connecting piping is located in a Seismic Category 1 structure; a backup system for supplying water to the pool is provided through a temporary connection to the Seismic Category 1 service water system; and, there is sufficient time to rig a temporary makeup water supply to the pool in the event of failure of the normal source).

Under the original design, failure of a single component in this system does not permit uncovering of the stored spent fuel under normal operating conditions since the system is designed with redundant components to prevent loss of cooling, and subsequent evaporation loss of coolant due to failure of a single component. In the event of such a failure, the loop containing the component would be isolated and cooling continued with the other loop. Cooling loss due to boiling in the unlikely event of a complete loss of cooling would not be significant under the original design because of the considerable time required to raise the pool to boiling temperature.

The original design was based on a heat load 28.0×10^6 BTU/hr (FSAR, Fig. 9.44). The expected heat load after re-racking is expected to be 28.02×10^6 BTU/hr (Table 5-1 of the NRC Licensing Submittal). This is an increase of less than one-tenth of one percent. Because of the consideration above, and those mentioned in the attached Single Failure Analysis chart for the ANO-1 spent fuel pool cooling system, it is expected that the additional heat load due to re-racking of the spent fuel pool should not be significant enough to alter the cooling capabilities of the existing spent fuel pool cooling system.

SINGLE FAILURE ANALYSIS - SPENT FUEL POOL COOLING SYSTEM

Component	Failure	Compensating Methods of Cooling
1. Spent Fuel Coolers	One not available	a. Cooling via the redundant cooler using either spent fuel pump. (Under the original design conditions as explained in Section 9.4.1 of the FSAR of storing 1-1/3 cores, the temperature would rise to approximately 200°F after a considerable period of time if a pump and a cooler are assumed to be unavailable (FSAR Sec. 9.4.2.1.2). Using a higher heat load that re-racking would be expected to bring, the temperature could approach boiling, whereby makeup would be available to compensate for evaporation.)
		b. Makeup from the Seismic Category 1 BWST via the DHR pumps. (The rated capacity of the DHR pumps is 3,000 gpm; therefore its capacity to deliver the required makeup to the fuel pool should not be affected greatly by any increase of makeup requirements due to re-racking of the spent fuel pool.)
		c. Makeup via temporary connection to the Seismic Category 1 Service Water System. (Because of the very large total flow capacity of the service water system, any increase of makeup requirement due to re-racking of the spent fuel pool should not affect the capability of the service water system to deliver adequate makeup to the fuel pool.)
		d. Makeup via temporary connections to the condensate tank or demineralized water supply.

2. Spent Fuel Pumps	One not available	a. Cooling via either cooler using the redundant pump.
		b. Makeup from the BWST via the DHR pumps.
		c. Makeup from the Service Water System via temporary connections.
		d. Makeup via temporary connections to the condensate tank or demineralized water supply.
3. BWST	Not available	a. Makeup from the Service Water System via temporary connections.
		b. Makeup via temporary connections to the condensate tank or demineralized water supply.
4. Decay Heat Removal Pumps	One not available	a. Makeup from the BWST via the redundant DHR pump.
		b. Makeup from the Service Water System via temporary connections.
		c. Makeup via temporary connections to the condensate tank or demineralized water supply.
5. Offsite Power	Not available	a. Makeup from the BWST via the DHR pumps.
		b. Makeup from the Service Water System via temporary connections.

ANO-2

Single Failure Analysis for the ANO-2 Spent Fuel Pool Cooling System

The ANO-2 fuel pool cooling system was originally designed to limit fuel pool temperature to 150°F with 2-3/4 cores in the pool as described in Section 9.1.3.2 of the FSAR. The cooling portion of the fuel pool system is a closed loop system consisting of two half capacity pumps for normal duty and one full capacity heat exchanger. With two and three quarter cores in the fuel pool, both fuel pool pumps and the heat exchanger are normally in service.

Additionally, cooling is provided to the spent fuel pool by allowing the pool to boil and supplying adequate makeup to maintain spent fuel pool level.

Normal makeup to the spent fuel pool is from the refueling water tank via the fuel pool purification pump. In addition to normal makeup, the boric acid makeup tanks via the boric acid makeup pumps are available for makeup and/or boration of the spent fuel pool. Makeup from the service water system via two redundant paths is also provided to ensure that makeup is available to the spent fuel pool under all operating or accident conditions. This design satisfies the requirement of Regulatory Guide 1.13 for a Seismic Class 1 makeup system and backup source of makeup water.

In the unlikely event of loss of normal fuel pool cooling under the original design basis of two and three quarter cores stored in the pool, the temperature would rise from 150°F to boiling in 4.1 hours. In the unlikely event makeup was unavailable for 12 hours under these conditions and the spent fuel temperature was 212°F, the pool water level would only decrease approximately nine feet. As a result, the fuel would still be covered by approximately 16 feet of water. These calculations were based on the heat load from two and three quarter cores in the pool of 28.97×10^6 BTU/hr (see Section 9.1.3.3.1 FSAR). It is expected that the new design heat load after re-racking will be 32.5×10^6 BTU/hr (Table 5-2 of the NRC Licensing Submittal). This heat load is approximately 12.2 precent higher than the original design heat load of 28.97×10^6 BTU/hr. To maintain adequate cooling in the spent fuel pool system, the energy added to the system due to the higher heat load must be equal to the additional energy that must be removed from the system. Therefore, a 12 percent increase in heat added to the system should result in a 12 percent increase in the boil-off rate assuming that all the additional heat due to re-racking will be removed by boiling. It follows that after 12 hours of allowing the water in the spent fuel pool to boil assuming the higher heat load due to re-racking, the water level should decrease by approximately 12 percent more than 9 ft. as under the original design conditions. This would leave an adequate amount of water covering the fuel, even after a period of 12 hours of boiling assuming the higher heat load that would result from re-racking the fuel.

Because of the above mentioned time factor, proper spent fuel pool cooling and safe shutdown should not require any operator action within thirty minutes. In addition, provisions could be made for makeup water to be supplied to the spent fuel pool from sources not mentioned elsewhere in this evaluation. For example, offsite capabilities (e.g. fire truck) could be utilized to provide makeup to the spent fuel pool under existing Emergency Plan agreements, or hose connections could be made to supply makeup from other ANO-2 or ANO-1 components.

A Single Failure Analysis chart for the ANO-2 spent fuel pool cooling system is attached.

SINGLE FAILURE ANALYSIS - SPENT FUEL POOL COOLING SYSTEM

Component	Failure	Compensating Methods of Cooling
1. Fuel Pool Heat Exchanger or any component of the normal fuel pool cooling system (i.e. fuel pool pumps, spent fuel pool cooling piping and service water lines to and from the heat exchanger.	Out of service	a. Makeup from the Seismic Category 1 Boric Acid Makeup Tank or the non-seismic Boric Acid Makeup Tank via the Seismic Boric Acid Makeup Pumps. (The Boric Acid Makeup Pumps should provide adequate flow as their rated capacity is 143 pgm (FSAR, Table 9.3-17) each, and the maximum required makeup rate before re-racking was approximately 66 gpm (FSAR, Sec. 9.1.3.3.1)). b. Makeup from the Seismic Category 1 Service Water System via one of two redundant paths from each of the service water heaters. (The relatively small expected increase in maximum required makeup rate should not effect the capability of the service water system to provide adequate flow as the service water pumps are designed to a total flow of 12,000 gpm (Table 9.2-3).)
2. Service Water Makeup Path	Not available due to failure of any of the components of the makeup path	a. Makeup from the Boric Acid Makeup Tanks via the Boric Acid Makeup Pumps. b. Makeup from the redundant Service Water Makeup path.
3. Boric Acid Makeup Tank	One not available	a. Makeup from the Service Water System b. Makeup from the other Boric Acid Makeup Tank via the Boric Acid Makeup Pumps.
4. Boric Acid Makeup Pump	One not available	a. Makeup from the Boric Acid Makeup Tank via the Boric Acid Makeup Pump b. Makeup from the Service Water System.

5. Offsite Power	Not available	a. Makeup from the Boric Acid Makeup Tank via the emergency diesel generator powered (FSAR, p. 9.3-29) Boric Acid Makeup pumps. b. Makeup from the Service Water System.

5. The licensee's submittal dated November 1, 1982 stated that the spent fuel pool temperature would be maintained below 120°F for normal refueling operations. The licensee should verify that this pool temperature was calculated using the heat load based on NUREG-0800 and the worst single active failure. Describe this failure and any effect on the operation of the remaining portion of the system.

Response:

UNIT 1

TABLE I

DESIGN BASES FOR SPENT FUEL DISCHARGES TO SPENT FUEL POOL FOR DECAY HEAT ANALYSES

General Data

Reactor Type	Babcock & Wilcox
Reactor Core Thermal Power	2568 MWth
Number of Fuel Assemblies in Core	177
Initial Uranium Per Fuel Assembly	463 Kg

Fuel Assemblies Presently Contained in Pool

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1	60	January 77
2	61	February 78
3	60	March 79
4	56	January 81
5	7	January 81
6	4	January 81

Decay Heat Load Table

	To (EFPD)	Ts (Days)	Dis. Date	# Assembly	Heat Load (10^6 Btu/Hr)
Batch 1	500	6310	1/77	60	0.03
Batch 2	772	5914	2/78	56	0.05
Batch 3	1101	5489	4/79	61	0.08
Batch 4	891	4849	1/81	60	0.06
Batch 5	1074	4150	12/82	68	0.09
Batch 6	1171	3512	9/84	64	0.10
Batch 7	1198	2965	3/86	68	0.12
Batch 8	1099	2417	9/87	72	0.12
Batch 9	1068	1870	3/89	68	0.13
Batch 10	1068	1322	9/90	64	0.16
Batch 11	1068	775	3/92	64	0.30
Batch 12	1068	227	9/93	64	1.19
Batch 13	862[1]	7	4/94	64	9.19
Batch 14	506	7	4/94	64	8.87
Batch 15	150	7	4/94	64	7.53

[1]Full Core Discharge after 150 days operation into Cycle 15.

Design Evaluation

During normal operation, the Spent Fuel Cooling System serves two main functions. The first is to maintain the pool water at temperatures below 120°F. The second function is to provide purification of the spent fuel pool coolant for clarity during fuel handling operations. Under normal conditions, the pool temperature is maintained under 120°F by recirculating spent fuel cooling water from the spent fuel pool through the parallel arranged pumps and cooler and back into the pool. For maximum normal conditions, full core offload, the pool temperature is maintained at or below 150°F.

The heat load shown in Table I represents the largest heat load expected in the spent fuel pool.* The calculations are based upon an 18-month cycle.

Worst Single Active Failure
(Loss of ore pump or cooler)

Pool temperature is maintained below 120°F by operation of any two pump-cooler configurations for the normal heat load and at or below 150°F for the maximum heat load. Upon failure of one pump or cooler for the normal condition, sufficient cooling capacity remains to maintain bulk pool temperature below 135°F. An analysis of pool response to loss of all forced cooling is presented in Section 4.3 of this response to Question 4.

*The heat load is slightly higher for the total loss of spent fuel pool cooling.

UNIT 2

TABLE I

DESIGN BASFS FOR SPENT FUEL DISCHARGES TO
SPENT FUEL POOL FOR DECAY HEAT ANALYSES

General Data

Reactor Type	Combustion Engineering PWR
Reactor Core Thermal Power	2815 MWth
Number of Fuel Assemblies in Core	177
Initial Uranium Per Fuel Assembly	4.16 Kg
Average Enrichment of U-235	3.1
Discharge Fuel Batch Size	60 Fuel Assemblies
Discharge Fuel Batch Burnup	34,000 MWD/MTU
Cycle Capacity Factor	80%

Decay Heat Load Table

	To (EFPD)	Ts (Days)	Dis. Date	# Assembly	Heat Load (10^6 Btu/Hr)
Batch 1	325	6067	3/81	60	0.03
Batch 2	612	5520	9/82	61	0.05
Batch 3	873	5155	9/83	56	0.07
Batch 4	892	4607	3/85	60	0.08
Batch 5	961	4060	9/86	52	0.08
Batch 6	1056	3512	3/88	68	0.11
Batch 7	1068	2965	9/89	68	0.12
Batch 8	1068	2417	3/91	68	0.12
Batch 9	1068	1870	9/92	68	0.14
Batch 10	1068	1322	3/94	68	0.18
Batch 11	1068	775	9/95	68	0.34
Batch 12	1068	227	3/97	68	1.39
Batch 13	862[1]	7	8/97	68	10.70
Batch 14	506	7	8/97	68	10.33
Batch 15	150	7	8/97	68	8.76

[1]Full Core Discharge after 150 days operation into Cycle 15.

Design Evaluation

During normal operation, the Spent Fuel Cooling System serves two main functions. The first is to maintain the pool water at temperatures below 120°F. The second function is to provide purification of the spent fuel pool coolant for clarity during fuel handling operations. Under normal conditions, the pool temperature is maintained under 120°F by recirculating spent fuel cooling water from the spent fuel pool through the parallel arranged pumps and cooler and back into the pool. For maximum normal conditions, full core offload, the pool temperature is maintained at or below 150°F.

The heat load shown in Table I represents the largest heat load expected in the spent fuel pool.* The calculations are based upon an 18-month cycle.

Worst Single Active Failure
(Loss of ore pump or cooler)

Pool temperature is maintained below 120°F by operation of any two pump-cooler configurations for the normal heat load and at or below 150°F for the maximum heat load. Upon failure of one pump or cooler for the normal condition, sufficient cooling capacity remains to maintain bulk pool temperature below 135°F. An analysis of pool response to loss of all forced cooling is presented in Section 4.3 of this response to Question 4.

*The heat load is slightly higher for the total loss of spent fuel pool cooling.

6. The ANO-2 spent fuel pool cooling system consists of two pumps and a single heat exchanger. Provide a discussion of the capability and procedure to remove the spent fuel pool cooling heat exchanger from service for tube cleaning, tube plugging or retubing. Include a discussion of the time available to perform these tasks without exceeding any pool temperature alarm setpoint.

Response:

The capability to remove the spent fuel pool cooling heat exchanger from service for tube cleaning, tube plugging or retubing is discussed in detail in the response to question 4.

Capability of Removing the ANO-2 Spent Fuel Heat Exchanger From Service

Upon isolation of the Spent Fuel Heat Exchanger from service for any reason (e.g. tube cleaning, tube plugging, retubing), the normal closed loop fuel pool cooling via the heat exchanger is lost. When this takes place, cooling is provided to the spent fuel pool by allowing the pool to boil and supplying adequate makeup to maintain spent fuel pool level. Under the original design basis of two and three quarter cores stored in the pool as described in Section 9.1.3.2 of the FSAR, the temperature would rise from the design temperature of 150°F to boiling in 4.1 hours following isolation of the heat exchanger (FSAR, Sec. 9.1.3.3.1). The fuel pool alarm setpoint is 160°F (M-2517, Rev. 14; instrument 2TIS 5413). An estimate of the time from heat exchanger isolation to the time the fuel pool temperature alarm setpoint is reached under these conditions can be made by assuming the ratio of temperature rise to time from 150°F to 212°F equals the ratio of temperature rise to time from 150°F to 160°F as follows:

$$\frac{\Delta T_1}{\Delta t_1} = \frac{\Delta T_2}{\Delta t_2} \qquad \text{where}$$

$$\frac{\Delta T_1}{\Delta t_1} = \frac{\text{change in temp. from design condition of 150 F to 212 F}}{\text{change in time}} = \frac{62\text{ F}}{4.1\text{ hrs}}$$

and

$$\frac{\Delta T_2}{\Delta t_2} = \frac{\text{change in temp. from design condition of 150 F to 160 F}}{\text{change in time}} = \frac{10\text{ F}}{\Delta t_2}$$

therefore,

$$\Delta t_2 = \frac{(\Delta T_2)(\Delta t_2)}{\Delta T_1} = \frac{(10^\circ F)(4.1\text{ hrs})}{(62^\circ F)} = .66\text{ hrs.} = \underline{\text{approx. 40 min.}}$$

With the higher heat load that should result from re-racking the fuel pool, the fuel pool temperature alarm setpoint would be reached in less than 40 minutes. Under these considerations it should not be assumed that the fuel pool heat exchanger could be put back into service before the fuel pool temperature alarm setpoint is reached or even before

boiling occurs. However, the spent fuel pool is designed to give adequate cooling to the pool by allowing the pool to boil and supplying adequate makeup to maintain spent fuel pool level.

The attached Single Failure Analysis chart for the ANO-2 Spent Fuel Cooling System shows the compensating methods of cooling for a failure of the fuel pool heat exchanger.

SINGLE FAILURE ANALYSIS - SPENT FUEL POOL COOLING SYSTEM

Component	Failure	Compensating Methods of Cooling
1. Fuel Pool Heat Exchanger or any component of the normal fuel pool cooling system (i.e. fuel pool pumps, spent fuel pool cooling piping and service water lines to and from the heat exchanger.	Out of service	a. Makeup from the Seismic Category 1 Boric Acid Makeup Tank or the non-seismic Boric Acid Makeup Tank via the Seismic Boric Acid Makeup Pumps. (The Boric Acid Makeup Pumps should provide adequate flow as their rated capacity is 143 pgm (FSAR, Table 9.3-17) each, and the maximum required makeup rate before re-racking was approximately 66 gpm (FSAR, Sec. 9.1.3.3.1)). b. Makeup from the Seismic Category 1 Service Water System via one of two redundant paths from each of the service water heaters. (The relatively small expected increase in maximum required makeup rate should not effect the capability of the service water system to provide adequate flow as the service water pumps are designed to a total flow of 12,000 gpm (Table 9.2-3).)
2. Service Water Makeup Path	Not available due to failure of any of the components of the makeup path	a. Makeup from the Boric Acid Makeup Tanks via the Boric Acid Makeup Pumps. b. Makeup from the redundant Service Water Makeup path.
3. Boric Acid Makeup Tank	One not available	a. Makeup from the Service Water System b. Makeup from the other Boric Acid Makeup Tank via the Boric Acid Makeup pumps.
4. Boric Acid Makeup Pump	One not available	a. Makeup from the Boric Acid Makeup Tank via the Boric Acid Makeup Pump b. Makeup from the Service Water System.

5. Offsite Power	Not available	a. Makeup from the Boric Acid Makeup Tank via the emergency diesel generator powered (FSAR, p. 9.3-29) Boric Acid Makeup pumps. b. Makeup from the Service Water System.

7. It is not clear from the licensee's November 1, 1982 submittal or from any previous docketed information whether the spent fuel pool liner plate is designed and constructed to seismic Category I requirements. Verify that the liner plate is seismic Category I, or that the seismic loads imposed on the fuel pool liner due to the increased number of fuel bundles to be stored in the pool, do not result in any damage to the liner so as to cause any of the following:

   a. Significant releases of radioactivity due to mechanical damage to the fuel;

   b. Significant loss of water from the pool which could uncover the fuel and lead to release of radioactivity due to heatup;

   c. Loss of ability to cool the fuel due to flow blockage caused by a portion or one complete section of the liner plate falling on top of the fuel racks;

   d. Damate to safety-related equipment as a result of the pool leakage; and

   e. Uncontrolled release of significant quantities or radioactive fluids to the environs.

Response:

The spent fuel pool liner plates for Unit 1 and 2 are <u>not</u> Seismic Category I structures. Reference FSAR pages 1.10-9 and 3.13-23. Their original design basis was governed by construction loading generated by concrete placements. No original plant calculations are available to document their ability to withstand seismic loads imposed on the liner. As a part of this rerack effort, Structural Dynamics Technology has prepared an evaluation of the liners to withstand loads due to the increased fuel bundles to be stored in the pool. The results of these analyses is documented in reports APL-02-013 dated November 24, 1982 and APL-01-014 dated January 15, 1983. Section 7.1 of each report is attached for your information. This report indicated that the liner will be able to adequately support new horizontal fuel rack reactions when fully loaded with fuel assemblies.

Table 1-2 (continued)

1. CIVIL STRUCTURAL SECTION

Civil-structural items within the scope of the Nuclear Quality Assurance Program are limited to the following:

Reactor building

Auxiliary building housing the engineered safeguard systems, emergency diesel generators, control room and radioactive materials.

Diesel fuel storage facilities

Enclosures for service water pumps

Supports for Class 1 system components

Emergency reservoir and pipelines

* Spent fuel pool (excluding liner plate)

Only those portions of the Civil-structural work which are within the areas listed above are within the scope of the Nuclear QA Program.

Q Number	Description	Spec #	Remarks
1.1	PRESTRESSED AND REINFORCED CONCRETE		
1.11	Reinforcing Steel	C-29	
1.111	Cadwelds	C-32	
1.12	Concrete Including Protective Mat	C-26 C-302 C-28 C-19	
1.131	Prestressing System (Excluding Tendon Sheathing)	C-34	
1.132	Sheathing Filler	C-36	
1.2	LINER PLATE		
1.21	Reactor Building Structure Liner Plate (Excluding leak chase piping system not mating with liner plate and tie nuts)	C-30/C-58	
1.22	Locks and Hatch	C-31	
1.3	FUEL RACKS		
1.31	New Fuel Racks		

7.0 MISCELLANEOUS LOADINGS AND OTHER EFFECTS

This section discusses the evaluation of the pool liner plate and horizontal reinforcing in the pool walls, and addresses miscellaneous loading conditions.

7.1 Liner Plate Evaluation

Reference 7 discusses the calculations carried out to evaluate the adequacy of the liner plate. This evaluation considered the effect of differential coefficient of thermal expansion of the liner plate versus the concrete for the accident thermal load case. It has been shown by experience that this loading is, by far, the controlling load on the liner plate.

The evaluation in Reference 7 was carried out considering the load-deflection characteristics of the anchors, and the interaction between the stiffnesses of the liner plate panels and these anchors. This evaluation also addressed the possibility that there is a buckled liner plate in series with the unbuckled liner plates being evaluated. Based on the evaluation, it was determined that a factor of safety of 4.3 exists for the liner plate. Additional loads associated with the new horizontal fuel rack reactions are negligible when compared to the thermal effects, and in view of the substantial safety factor involved, are not of concern.

7.0 MISCELLANEOUS LOADINGS AND OTHER EFFECTS

This section discusses the evaluation of the pool liner plate and horizontal reinforcing in the pool walls, and addresses miscellaneous loading conditions.

7.1 Liner Plate Evaluation

Reference 12 discusses the calculations carried out to evaluate the adequacy of the liner plate for ANO-2. This evaluation considered the effect of differential coefficient of thermal expansion of the liner plate versus the concrete for the accident thermal load case. It has been shown by experience that this loading is, by far, the controlling load on the liner plate. The liner plate in ANO-Unit 1 is very similar in detail and anchorage as that in the Unit 2 pool.

The ANO-2 evaluation was carried out considering the load-deflection characteristics of the anchors, and the interaction between the stiffnesses of the liner plate panels and these anchors. This evaluation also addressed the possibility that there is a buckled liner plate in series with the unbuckled liner plates being evaluated. Based on the evaluation, it was determined that a factor of safety of 4.3 exists for the liner plate. Additional loads associated with the new horizontal fuel rack reactions are negligible when compared to the thermal effects, and in view of the substantial safety factor involved, are not of concern. Based on the similarity in anchorage and liner plate details between the pools of Unit 1 and Unit 2, it is concluded that the Unit 1 pool liner plate is adequate.

Table 3.2-6 (continued)

1. CIVIL STRUCTURAL SECTION

Civil-Structural items required to be within the scope of the Nuclear Quality Assurance Program are limited to the following:

Containment

Auxiliary building housing the engineered safety features, emergency diesel generators, control room and radioactive materials.

Emergency diesel fuel tank vaults.

Intake structure housing service water pumps.

Supports for Seismic Category 1 system components.

Emergency Pond and pipelines.

* Spent Fuel Pool (Excluding Liner Plate)

Q Number	Description	Spec. No.	Remarks
21.1	PRESTRESSED & REINFORCED CONCRETE		
21.11	Reinforcing Steel	C-2029	
21.111	Cadwelds	C-2032	
21.121	Furnish & Deliver Concrete	C-2026	
21.122	Forming, Placing, Finishing and Curing of Concrete	C-2302	
21.123	Off-Site Supplied Concrete	C-2060	
21.124	Installation of Concrete Expansion Type Shell or Stud Anchors	C-2305	
21.125	Limitations on Installing Grouted and/or Expansion Anchor Bolts	C-2316	
21.126	Attachment to and Opening in Concrete Unit Masonry Walls	C-2317	
21.127	Fabrication of Cold Leg Restraint Block Impact Pads	C-2320	
21.131	Prestressing System (Excluding Tendon Sheathing)	C-2034	
21.132	Tendon Sheathing Filler	C-2036	