9.4 SPENT FUEL POOL COOLING SYSTEM

9.4.1 DESIGN BASIS

The SFPC system is common to both units. The pool contains water with the proper dissolved concentration of boron and has the capacity to store 1830 fuel assemblies.

The SFPC system is designed to remove the maximum decay heat expected from 1613 fuel assemblies, not including a full core off-load. The maximum pool temperature in this case is 120°F. The system is also capable of being used in conjunction with the SDC system to remove the maximum expected decay heat load from 1830 fuel assemblies, including a full core discharge. The maximum SFP temperature in this case is 130°F.

The maximum decay heat load expected from 1613 fuel assemblies, not including a full core off-load, is a function of decay time. For a limiting decay time of 3.5 days, which results in an initial core alteration time of 3.0 days after reactor shutdown, the decay heat load is 22.33×10^6 Btu/hr. The fuel is assumed to have undergone steady-state burnup at 2738 MWt for an average of 1562.4 days for an 100 assembly batch reload. The total SFP decay heat load as a function of decay time is compared to the heat removal capacity from the two SFP heat exchangers as a function of SRW temperature to show what time after shutdown is acceptable for each SRW temperature condition to maintain the pool at a temperature of 120°F. A maximum SRW temperature of 65°F is required to support a minimum decay time of 3.5 days. In the event that one SFP cooling loop is lost, the remaining loop can remove the heat load while maintaining the pool temperature at 155°F.

The maximum decay heat rate for 1830 fuel assemblies stored in the SFP is a function of decay time. For a limiting decay time of 4.5 days, which results in an initial core alteration time of 3.0 days after reactor shutdown, the decay heat load is 45.96×10^6 Btu/hr based upon the following hypothetical sequence of events:

1. Eighty-four fuel assemblies are removed from Unit 1 after an average of 1860 days of reactor operation at 2738 MWt, and are replaced with fresh fuel. Unit 1 is then returned to full power.
2. Three-hundred-sixty-five days after the Unit 1 refueling, 84 fuel assemblies are removed from Unit 2 after an average of 1860 days of irradiation and are replaced with fresh fuel. Unit 2 is then returned to full power.
3. Three-hundred-sixty-five days after the Unit 2 refueling, 84 fuel assemblies are removed from Unit 1 after an average of 1860 days of irradiation and are replaced with fresh fuel. Unit 1 is then returned to full power.
4. This refueling cycle continues until the pool contains 1613 fuel assemblies at the end of a Unit 2 refueling. It has been conservatively assumed that the 67 oldest assemblies have been removed from the pool to allow for complete filling of the racks with newer fuel.
5. Unit 1 is then shutdown 60 days after the previous Unit 2 shutdown and the entire core is offloaded after a minimum of 4.5 days of decay. At this point, it is conservatively assumed that the fuel has completed its current cycle, and is therefore at maximum irradiation.

Upon completion of the last operation, the pool will contain 1830 fuel assemblies, with each discharge subjected to different periods of irradiation and decay, in accordance with the table below assuming the minimum decay time of 4.5 days:

	Number of Assemblies	Irradiation Period (Days)	Decay Period (Days)
a.	17	1860	6964.5
b.	84	1860	6599.5
c.	84	1860	6234.5
d.	84	1860	5869.5
e.	84	1860	5504.5
f.	84	1860	5139.5
g.	84	1860	4774.5
h.	84	1860	4409.5
i.	84	1860	4044.5
j.	84	1860	3679.5
k.	84	1860	3314.5
l.	84	1860	2949.5
m.	84	1860	2584.5
n.	84	1860	2219.5
o.	84	1860	1854.5
p.	84	1860	1489.5
q.	84	1860	1124.5
r.	84	1860	759.5
s.	84	1860	394.5
t.	84	1860	64.5
u.	217	1860	4.5

The total SFP decay heat load as a function of decay time is compared to the heat removal capacity from both loops of SFPC as a function of SRW temperature, supplemented with one loop of SDC to show what time after shutdown is acceptable for each SRW temperature condition to maintain the pool at a temperature at 130°F. A maximum SRW temperature of 75°F is required to support a minimum decay time of 4.5 days.

9.4.2 SYSTEM DESCRIPTION

The SFPC System shown in Table 9-16 and Figure 9-7 is a closed-loop system consisting of two half-capacity pumps and two half-capacity heat exchangers in parallel, a bypass filter that removes insoluble particulates, and a bypass demineralizer that removes soluble ions. The SFPC heat exchangers are cooled by service water (SRW).

Skimmers are provided in the SFP to remove accumulated dust from the pool. The clarity and purity of the water in the SFP, refueling pool, and the RWT are further maintained by passing a portion of the flow through the bypass filter and/or demineralizer. The SFP filter and demineralizer removes fission products from the cooling water in the event of a leaking fuel assembly.

Connections are provided for tie-in to the SDC system to provide for additional heat removal in the event that 1830 fuel assemblies are contained in the pool. When the pressure in the SDC system is greater than the design pressure of the SFPC system, the SFPC system is isolated from the SDC system via two manual isolation valves. Although not required by the design code, double valve isolation is provided at this system interface to meet the original FSAR design basis (FCR 90-87).

The entire SFPC system is tornado-protected and is located in a Seismic Category I structure. Borated makeup water comes from the RWT. Non-borated makeup water comes from the demineralized water system.

9.4.3 COMPONENTS

9.4.3.1 Functional Description

A description for the spent fuel pool cooling system is contained in Table 9-16.

9.4.3.2 Codes and Standards

The following codes and standards were used in the design of the SFPC System components:

Pump	Standards of: ASME (III, VIII, IX, PTC8.2), ASTM, NEMA, ANSI
Heat Exchanger	Standards of: Tubular Exchanger Manufacturers Association (TEMA), ASME (III, VIII, IX), ASTM, ANSI
Filter	ASME III C and ASME VIII paragraph UW-2(a)
Ion Exchanger	ASME III C and ASME VIII paragraph UW-2(a)
Valves, Piping, Fittings	ANSI B31.7 Class III

9.4.3.3 Tests and Inspections

Each component is cleaned and inspected before installation and the assembled systems flushed with demineralized water. The flow paths, flow capacity and mechanical operability are tested by operation. The head and capacity of the pumps are also tested.

Instruments are calibrated prior to tests. Alarm functions are checked for operability and limits during preoperational testing. During normal operation, periodic tests will be made to confirm design criteria.

9.4.4 SYSTEM OPERATION AND RELIABILITY

In the normal case (i.e., with no full-core off load), if one SFPC loop is lost, the remaining loop can remove decay heat while maintaining the pool temperature at 155°F. In the case of total loss of SFPC with 1613 fuel assemblies in the pool, it would take more than 8 hours to raise the pool temperature from 155°F to 210°F. The case of total loss of SFP cooling is only discussed to demonstrate the time available to take appropriate action in such an event to preclude boiling, and the resulting loss in pool water level. The design of the SFPC System and pool structural components (e.g., pool liner plate, SFPC piping and pumps) for total loss of cooling is not part of the system's design basis.

The most serious failure to the system is the loss of SFP water. This is avoided by routing all SFP piping connections above the water level and providing them with siphon breakers to prevent gravity drainage.

The SFP is designed to preclude the loss of structural integrity. Section 5.6.1 describes the analysis made to verify that the structural integrity cannot be impaired. Additional design and quality control requirements for the SFP are given in Section 6.3.5.1. However, if a leak from the SFP is postulated, the capabilities for controlling the leak are as follows:

Makeup water can be supplied indefinitely to the SFP at a rate of at least 150 gpm. It can usually be supplied at a greater rate for a period of many days, but this depends upon plant conditions. The makeup water flow path is as follows:

a. Source - Well water
b. Portable Makeup Demineralizers
   - Typical capacity 150 gpm or more
c. Demineralized Water Storage Tank
   - Storage capacity 350,000 gallons
d. Four Reactor Coolant Makeup Pumps (Normally run one per unit)
   - Capacity 165 gpm each, less the amount required for reactor coolant makeup
e. Two RWTs (One per unit)
   - Storage capacity 420,000 gallons
   - Required to have 400,000 gallons during operation
   - During refueling this water has been transferred to the refueling pool where it is also available for pumping if conditions permit
f. Two Spent Fuel Cooling Pumps (One per RWT)
   - Capacity 1390 gpm each
g. Spent Fuel Pool

The two halves of the SFP can be isolated from each other and 830 fuel assemblies, as a minimum, can be stored in the non-leaking half.

The four Emergency Core Cooling System (ECCS) equipment rooms on the lowest level of the Auxiliary Building (Figure 1-5) can be prevented from flooding by shutting their watertight doors. In addition, each ECCS pump room is also drained by an 80 gpm sump pump. The remainder of this level is drained by two sump pumps at a rate of 160 gpm. The sump pumps discharge to the Miscellaneous Waste Processing System (MWPS), which has storage capacity of 8000 gallons and can process 128 gpm.

TABLE 9-16

SPENT FUEL POOL COOLING SYSTEM COMPONENT DESCRIPTION

Pump	
Type	Horizontal, centrifugal with mechanical seals
Number	2
Capacity (each)	1390 gpm
TDH	200 feet
Materials	
Casing	American Society for Testing and Materials (ASTM) A296, Gr CA-15 or ASTM A217, Gr CA-15
Stuffing Box Extension Assy. (Backhead)	ASTM A296, Gr CA-15, ASTM A217, Gr CA-15, ASTM A487 Gr CA-15, or ASTM A487 Gr CA6NM Class A
Motor	100 hp, 460 Volt, 60 Hz, 3 phase, 3550 RPM
Heat Exchanger	
Type	Horizontal counter flow Straight tube rolled and seal welded into tube sheets
Number	2 in parallel
Heat Transfer area (each)	1920 ft^2
Materials	
Shells	C.S. SA-285-C
Tubes	SS-304, SA-213
Tube Sheets	SS-304, SA-240
Shell side relief valve setpoint	150 psig
Fuel Pool Filter	
Type	Cartridge
Number	1
Design/Operating Flow	128/120 gpm
Design Pressure	175 psig
Design Temperature	250°F
Material	ASTM SA240, Type 304
Fuel Pool Demineralizer	
Type	Mixed bed, non-regenerable
Number	1
Design/Operating Flow	128/120 gpm
Design Pressure	200 psig
Design Temperature	250°F
Resin	Mixed (anion, cation)
Materials	ASTM SA240, Type 304

TABLE 9-16

SPENT FUEL POOL COOLING SYSTEM COMPONENT DESCRIPTION

SFP Piping, Fittings, Valves	
Material	Stainless Steel 304
Design Pressure	160 psig
Design Temperature	150°F/155°F[(a)]
Joints 2-1/2" and Larger	Butt-welded except at flanged equipment
Joints 2" and Smaller	Socket weld except at flanged equipment
Valves 2-1/2" and Larger	Stainless steel, butt weld-ends, 150 psi
Valves 2" and smaller	Stainless steel, socket weld ends, 150 psi
Relief valve setpoint	150 psig (on tube side of spent fuel pool cooling heat exchanger)
Butterflies 3" and larger	Rubber seated carbon steel lug type, 150 psi

(a) Portions of the SFP Cooling System are designed for a maximum postulated temperature of 155°F [Section 9.4.4, Doc. No. 92-769(M601)].