PACIFIC GAS AND ELECTRIC COMPANY

September 28, 1973

Director
Directorate of Licensing
Office of Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

Re: Dockets 50-275, 50-323

Dear Sir:

Enclosed are three signed and twenty-five conformed copies of Pacific Gas and Electric Company's application for a Class 104b. operating license for Units 1 and 2 at its Diablo Canyon site in San Luis Obispo County, California. Seventy copies of the Final Safety Analysis Report (Exhibit B to the application) are being forwarded to you separately. In accordance with 10 CFR 2.101(b) a copy of the complete application also is being forwarded to Mr. Howard D. Mankins, Chairman, Board of Supervisors, San Luis Obispo County.

Kindly acknowledge receipt of the above material on the enclosed copy of this letter and return it to me in the enclosed addressed envelope.

Very truly yours,

F. T. Searls

Enclosures
CC w/enc.: Mr. Howard D. Mankins

DESIGN SUMMARY OF CHANGED RACKS
(Continued)

Description			Calculated Stresses or Interaction Stress Ratios	FSAR Criteria Allowables	Are Criteria Met
	5.2	Intersecting diagonal	20.9 ksi	40.8 ksi	Yes
	5.3	Modified diagonal connection at base of Rack 8	14.8 ksi	40.8 ksi	Yes
	5.4	Repaired lacing in Rack 1	16.8 ksi	40.8 ksi	Yes
6.	Strain in Liner at embeds				
	6.1	Membrane	.00021	.003	Yes
	6.2	Membrane and Bending	.00075	.010	Yes
7.	Embeds				
	7.1	Single (8"x8")			
		a. Plate bending	0.85	1.0	Yes
		b. Stud	0.61	1.0	Yes
		c. Concrete bearing	3.5 ksi	9.6 ksi	Yes
	7.2	Double (8"x13½")			
		a. Plate bending	0.85	1.0	Yes
		b. Stud	0.85	1.0	Yes
		c. Concrete bearing	3.5 ksi	9.6 ksi	Yes

DESIGN SUMMARY OF CHANGED RACKS

Description	Calculated Stresses, or load ratios, or stress ratios	Criteria Allowables	Are Criteria Met
II. Global Displacements - Relative to Pool Base			
1. Top Corner	0.38 inch	2.0 inch	Yes
2. Top Center	0.50 inch	4.1 inch	Yes

Description	Comments	FSAR Criteria Allowables	Are Criteria Met
III. Analysis			
1. Global Rack Model	216 nodes, 6 degree of freedom each (1296) 411 beam elements 32 truss elements 17 to 19 boundary elements	None	N/A
2. Individual Cell Model	37 nodes, 6 degrees of freedom except at the boundary (210) 69 beam elements	None	N/A
3. Diaphragm			
3.1 Top	140 nodes, 5 degrees of freedom each (700) 256 beam elements 4 truss elements 4 boundary elements	None	N/A

DESIGN SUMMARY OF CHANGED RACKS
(Continued)

Description			Comments	FSAR Criteria Allowables	Are Criteria Met
III. Analysis					
	3. Diaphragm (Continued)				
	3.2	Bottom	140 nodes, 5 degrees of freedom each (700) 256 beam elements 4 truss elements 8 boundary elements	None	N/A
	4. Stiffness				
	4.1	Diaphragm (in-plane bending)	530 kips/inch (EW) 700 kips/inch (NS)	None	N/A
	4.2	Fuel Cell Stiffness	13 kips/inch	None	N/A
	4.3	Rotational Stiffness of Anchor Bracket	54,000 kip-inch/radian (Accounting for the flexibility of the embed)	None	N/A

EXHIBIT B

UNITS 1 AND 2

DIABLO CANYON SITE

PACIFIC GAS AND ELECTRIC COMPANY

FINAL SAFETY ANALYSIS REPORT

(Separate Volumes)

CHAPTER 9

AUXILIARY SYSTEMS

CONTENTS

ORIGINAL FSAR

9.0 AUXILIARY SYSTEMS

9.1 FUEL STORAGE AND HANDLING

The fuel storage and handling systems provide safe and effective means of storing, transporting, and handling new and irradiated nuclear fuel. These systems mainly are located in the fuel handling areas of the Auxiliary Building, adjacent to the east walls of the containment structures. Separate facilities are provided for each unit. The Auxiliary Building is a Design Class I structure and is described in Chapter 3.

9.1.1 NEW FUEL STORAGE

New fuel will be stored in racks in vaults in the Auxiliary Building, located as shown in Figure 1.2-4 for Unit 1 and in Figure 1.2-10 for Unit 2. The racks are designed to store, protect and prevent criticality of new fuel assemblies until used within the reactor.

Design Bases

New fuel assemblies and RCC assemblies for each unit are stored in separate areas located to facilitate the unloading of new fuel assemblies and RCC assemblies from trucks. The storage vaults are designed to hold new fuel assemblies in specially constructed racks and are utilized primarily for the storage of the one-third replacement cores. The assemblies which make up the remainder of the first core are stored in the spent fuel pools which are available for this use until the first refueling.

The design bases for the new fuel storage racks are as follows: (1) Two racks provided for each unit will hold approximately one-third of a reactor core. (2) Racks are designed so that the fuel will remain subcritical (k_{eff} of less than 0.90) with the vault flooded with unborated water. (3) The racks are capable of maintaining horizontal center to center spacing of the fuel elements under maximum seismic shock (Double Design Earthquake), and of supporting the element vertically under maximum seismic shock.

System Design

There are two racks for each unit. Each rack holds thirty-five assemblies. A rack is approximately nine feet six inches wide, thirteen feet long and thirteen feet six inches high (excluding centering cones). It is built from type 304 stainless steel.

The assemblies are in seven rows, five deep, and are spaced to have a center to center distance of twenty-two inches plus or minus one thirty-second of an inch. They are of 304 stainless steel and have a cone shaped top entrance to facilitate loading of fuel elements. They are shaped in a nine inch square (cross section) hollow beam configuration, standing upright. They have a one inch thick "plastic" bearing plate at the base.

The racks and the anchorage of racks to the floor are designed for the DDE loading condition with the racks filled with fuel assemblies. The seismic loadings are calculated assuming a 1.00g horizontal acceleration simultaneous with 0.26g vertical acceleration. Equivalent static loads are applied at the top of the racks assuming that half of the mass of racks including the assemblies is concentrated at the top of the racks.

The racks are designed to withstand a vertical (uplift) force of 4000 lb. in the unlikely event that an assembly would bind in the rack while being lifted by the Spent Fuel Bridge Crane.

The racks are located in the fuel handling area of the Auxiliary Building at elevation 125. Assembly access is from elevation 140. One third of a core can be stored for each unit. Before the first fueling, the other two-thirds will be stored in the spent fuel racks.

Safety Evaluation

The storage racks are designed in accordance with the American Institute of Steel Construction, specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings. The racks are seismic Design Class II.

Center-to center assembly spacing is held to one thirty-second of an inch to assure a k_{eff} of less than 0.90, even when the vault is flooded with unborated water. After the racks are installed, a dummy fuel element is inserted in each location and critical measurements taken to assure proper arrangement and support. A metal cap covers the top of the rack. The holes in the cap line up with the guidance cones. If a fuel assembly is accidentally dropped, it will only be able to drop into a holder and could not drop into the space between fuel assemblies. An accident analysis will be found in Chapter 15.

9.1.2 SPENT FUEL STORAGE

The spent fuel storage pool, shown in Figure 9.1-2, is the storage space for irradiated spent fuel from the reactor. This figure shows the spent fuel storage racks arrangement. This pool is not required for any plant safety-related function. Two pools are provided, one for each unit.

Design Bases

The spent fuel pools are designed to accommodate fuel assemblies in a subcritical array such that a $k_{eff} \leq 0.9$ is maintained. They are constructed of reinforced concrete as part of the Auxiliary Building structure. The design is described in Section 3.8.1. The entire structure and the spent fuel racks have been designed in accordance with Design Class I seismic requirements. Criteria set by Safety Guide 13 have been followed. Gaseous radioactivity about the spent fuel storage pool is maintained below the 10 CFR 20 limits.

System Design

The spent fuel storage pool is a reinforced concrete structure with seam-welded stainless steel plate liner. The pool volume is approximately 59,100 cubic feet. Borated water is used to fill the pool at a concentration of approximately 2,000 ppm boron.

Racks for a total of 374 spent fuel assemblies can eventually be accommodated; initially, racks for 270 will be installed. This allows for the concurrent storage of a full core of irradiated fuel assemblies, and the normal quantity of spent fuel assemblies from the reactor during a refueling operation. The spent fuel assemblies are stored in stainless steel storage racks in parallel rows having a center-to-center distance of 22 inches in both horizontal directions. Rod cluster control assemblies and burnable poison rods requiring removal from the reactor are stored in the spent fuel assemblies.

The racks and the anchorage of racks to the floor are designed for the DDE loading condition with the racks filled with fuel assemblies. The seismic loadings are calculated assuming 0.84g horizontal acceleration simultaneous with 0.26g vertical acceleration. Equivalent static loads are applied at the top of the racks assuming that half of the mass of racks including the assemblies is concentrated at the top of the racks.

The racks are designed to withstand a vertical (uplift) force of 4000 lbs. in the unlikely event that an assembly would bind in the rack while being lifted by the Spent Fuel Bridge Crane.

Adjacent to the spent fuel storage pool is the stainless steel lined fuel transfer canal which is connected to the refueling cavity (inside the containment). A leaktight door is provided between the pool and the fuel transfer canal.

All components (handling tools, new fuel elevator, etc.) in contact with the spent fuel pool water are constructed of stainless steel. Since all materials which are used in the construction of the spent fuel pool or are in contact with the pool water are stainless steel, material compatability is insured.

The borated water level in the pool is maintained to provide at least 10 ft of water above the tope of the active portion of a spent fuel assembly. This water barrier serves as a radiation shield, limiting the gamma dose rate at the pool surface.

A cooling and clean-up system for the spent fuel storage pool water is described in Section 9.1.3. This system maintains the pool water temperature below the normal design limit of 120°F when one third of a core is in the pool.

A controlled and monitored ventilation system removes any gaseous radioactivity from the atmosphere above the spent fuel storage pool and discharges it through the plant vent. This system is described in Section 9.4.2.

A spent fuel pool vent exhaust monitoring system will continuously monitor the gases in the vents from the spent fuel pool areas and alarm when the activity level of the gases reaches a preset limit. See also Chapter 6 for a discussion of the ventilation system operation in the event high activity levels are detected.

A spent fuel pool area radiation monitoring system has been provided for personnel protection and general surveillance of the spent fuel pool area. Continuous monitoring and recording readouts and high radiation level alarms in the control room, plus local audible and visual indicators, are provided.

Design Evaluation

The spent fuel storage racks are designed in accordance with Safety Guide 13 and the American Institute of Steel Construction Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings.

The center-to-center distance between adjacent spent fuel assemblies is sufficient to assure a $k_{eff} \leq 0.9$ even if unborated water is used to fill the pool. The design of the spent fuel handling system is such that it is impossible to insert the spent fuel assemblies in other than prescribed locations in the racks, thereby preventing any possibility of accidental criticality.

Crane operation in the fuel handling area is such that the spent fuel cask cannot traverse the spent fuel storage pool.

1. Elec·rical interlocks are installed on the fuel handling crane to prevent movement of the spent fuel cask over the spent fuel area.

2. Crane access to the cask recess in the corner of the pool is possible from the south only (Unit 1, north only for Unit 2); interlocks prevent travel of the crane hook beyo·   ·e recess borderline with the spent fuel storage section.

These limitations on the crane travel preclude the possibility of dropping heavy objects from above the spent fuel racks. The spent fuel bridge hoist is the only crane which is capable of moving objects over the spent fuel racks. The rated capacity of the hoist is 2000 pounds. An object of this weight dropped on the racks will not affect the integrity of the racks. Lighting fixtures or other components of the building above the racks are not sufficiently massive to cause damage to the racks if they are assumed to fall into the pool.

The probability and consequences of a cask tipping accident have been reviewed. Although the analysis indicates no possibility of tipping during the DDE design condition, means are provided to prevent the cask from tipping into the stored spent fuel. This restraint also would stabilize the cask in the unlikely event of a cask drop.

A cask drop in the spent fuel pool cask loading pit might result in some damage to the spent fuel pool walls and floor, however the integrity of the pool will not be affected since the walls are 6 feet thick and the 4 1/2 foot thick floor is poured directly on the underlying rock.

The path of the spent fuel cask from the spent fuel cask loading pit to the cask decontamination area, and thence to the loading area, passes over the spent fuel pool cooling system equipment. Concrete floor barriers of two foot minimum thickness between the cask and the equipment are provided. These slabs have been analysed for the extremely unlikely event of a cask drop from a height of 30 feet. The results indicated that the floor would be damaged from the fall but the cask would not penetrate the floor. Damage from any source to the spent fuel pool cooling system piping and equipment would not affect the capability of the plant to shut down safely.

Tests and Inspections

After erection of the spent fuel racks, tests will be conducted with a dummy fuel assembly by passing it into and out of each storage position to assure that no binding will occur.

9.1.3 SPENT FUEL POOL COOLING AND CLEANUP SYSTEM

The Spent Fuel Pool Cooling and Cleanup System is designed to remove the decay heat generated by stored spent fuel assemblies from the spent fuel pool water. A secondary function of the system is to clarify and purify the spent fuel pool, transfer canal, and refueling water.

Each unit has a completely independent Spent Fuel Pool Cooling and Cleanup System. The following description is for one unit with the second unit having an identical system.

Design Bases

Spent Fuel Pool Cooling and Cleanup System design parameters are given in Table 9.1-1.

Spent Fuel Pool Cooling

The cooling system is designed to remove the amount of decay heat that is produced by the number of spent fuel assemblies that are stored in the pool following a normal refueling (one-third core). When the spent fuel assemblies resulting from refueling are in the pool, the system can maintain the spent fuel pool water temperature at or below 120°F when the heat exchanger is supplied with component cooling water at the design flow and temperature.

If it is necessary to remove a complete core from the reactor while the spent fuel assemblies from the previous refueling still remain in the pool, the system can maintain the spent fuel pool water at or below 150°F.

The spent fuel cooling and cleanup system components are constructed to seismic Design Class II requirements in accordance with Safety Guide 13. The failure or maloperation of any of the components (including failures resulting from the Design Basis Earthquake) will not cause the fuel to be uncovered.

Spent Fuel Pool Dewatering Protection

System piping is arranged so that failure of any pipeline cannot drain the spent fuel pool below the water level required for radiation shielding.

Water Purification

The system's demineralizer and filters are designed to provide adequate purification to permit access to the spent fuel storage area and maintain optical clarity of the spent fuel pool water. The optical clarity of the spent fuel pool water surface is maintained by use of the system's skimmers, strainer, and skimmer filter.

System Description

The Spent Fuel Pool Cooling and Cleanup System, shown in Figure 3.2-13, removes decay heat from fuel stored in the spent fuel pool. Spent fuel is placed in the pool during the refueling sequence, and stored there until it is shipped offsite to a reprocessing facility. The system normally handles the decay heat from 1/3 of a core freshly discharged from the reactor. Heat is transferred through the spent fuel pool heat exchanger to the Component Cooling Water System.

When the Spent Fuel Pool Cooling and Cleanup System is in operation, water flows from the spent fuel pool to the spent fuel pool pump suction, is pumped through the tube side of the heat exchanger, and is returned to the pool. The suction line, which is protected by a strainer, is located at an elevation four feet below the normal spent fuel pool water level, while the return line contains an antisiphon hole near the surface of the water to prevent gravity drainage of the pool.

While the heat removal operation is in process, a portion of the spent fuel pool water may be diverted through the spent fuel pool demineralizer and the spent fuel pool filter to maintain water clarity and purity. Transfer canal water may also be circulated through the same demineralizer and filter by opening the gate between the canal and the spent fuel pool. This purification loop is sufficient for removing all anticipated fission products and other contaminants which could be introduced if a fuel assembly with defective cladding is transferred to the spent fuel pool.

The demineralizer may be isolated by manual valves from the heat removal portion of the Spent Fuel Pool Cooling and Cleanup System. By so doing, the demineralizer may be used in conjunction with the refueling water purification pump and filter and resin trap to clean and purify the refueling water while spent fuel pool heat removal operations proceed. Connections are provided such that the refueling water may be pumped from either the refueling water storage tank or the refueling cavity, through the filter, demineralizer, and resin trap and discharged to either the refueling cavity or the refueling water storage tank. To further assist in maintaining spent fuel pool water clarity, the water surface is cleaned by a skimmer loop. Water is removed from the surface by the skimmers, pumped through a strainer and filter, and returned to the pool surface at three locations remote from the skimmers.

The spent fuel pool is initially filled with water that is at 2,000 ppm boron concentration. Borated water may be supplied from the refueling water storage tank via the refueling water purification pump connection, or by running a temporary line from the boric acid blender, located in the Chemical and Volume Control System, directly into the pool.

Demineralized makeup water can be added from the condensate storage tank using the makeup water transfer pumps (Sections 9.2.4 and 9.2.5) to replace evaporated losses. The pumps, tanks and piping are constructed to seismic Design Class I in accordance with Safety Guide 13.

The gate is installed between the spent fuel pool and the transfer canal so that the transfer canal may be drained to allow maintenance of the fuel transfer equipment. The water in the transfer canal is first pumped using a

[illegible] removal operation is in process, a portion of the [illegible] portable pump, into the spent fuel pool and then is transferred to a holdup tank in the Chemical and Volume Control System by the spent fuel pool pump. When maintenance on the fuel transfer equipment is completed, the water is returned directly to the transfer canal by the holdup tank recirculation pump.

Component Description

Spent Fuel Pool Cooling and Cleanup System codes and classifications are given in Table 9.1-2. Equipment design parameters are given in Table 9.1-3.

Spent Fuel Pool Pump - The pump is a horizontal, centrifugal unit, with all wetted surfaces being stainless steel or an equivalent corrosion-resistant material. The pump is controlled manually from a local station.

Spent Fuel Pool Skimmer Pump - The spent fuel pool skimmer pump is a horizontal centrifugal unit, with all wetted surfaces being stainless steel or an equivalent corrosion-resistant material. The pump is controlled manually from a local station.

Refueling Water Purification Pump - The refueling water purification pump is a horizontal centrifugal unit, with all wetted surfaces being stainless steel or an equivalent corrosion-resistant material. The pump is operated manually from a local station.

Spent Fuel Pool Heat Exchanger - The spent fuel pool heat exchanger is of the shell and U-tube type with the tubes welded to the tube sheet. Component cooling water circulates through the shell, and spent fuel pool water circulates through the tubes. Construction is carbon steel on the shell side and stainless steel on the tube side.

Spent Fuel Pool Demineralizer - The spent fuel pool demineralizer is a flushable, mixed bed demineralizer. The demineralizer is designed to provide adequate fuel pool water purity.

Spent Fuel Pool Filter - The spent fuel pool filter is designed to improve the pool water clarity by removing particles 5 microns or larger.

Spent Fuel Pool Skimmer Filter - The spent fuel pool skimmer filter is used to remove particles which are not removed by the strainer. It is designed to remove particles 5 microns and larger.

Refueling Water Purification Filter - The refueling water purification filter is designed to improve the clarity of the refueling water in the refueling canal or in the refueling water storage tank by removing particles 5 microns and larger.

Spent Fuel Pool Strainer - A strainer is located in the spent fuel pool pump suction line for removal of relatively large particles which might otherwise clog the spent fuel pool demineralizer or damage the spent fuel pool pump. It is slotted screen design and stainless steel construction.

Spent Fuel Pool Skimmer Strainer - The spent fuel pool skimmer strainer is designed to remove debris from the skimmer process flow. It is an in-line basket strainer of stainless steel construction.

Spent Fuel Pool Skimmers - Two spent fuel pool skimmers are provided to remove water from the surface of the spent fuel pool. The skimmer heads are manually positioned to take water from any elevation from the water surface to four inches below the surface. The skimmer, pipe and supports are of stainless steel construction.

Valves - Manual stop valves are used to isolate equipment and manual throttle valves provide flow control. Valves in contact with spent fuel pool water are austenitic stainless steel or equivalent corrosion-resistant material.

Piping - All piping in contact with spent fuel pool water is austenitic stainless steel. The piping is welded except where flanged connections are used to facilitate maintenance.

Safety Evaluation

Availability and Reliability

The Spent Fuel Pool Cooling and Cleanup System has no emergency function during an accident. This manually controlled system may be shut down for limited periods of time for maintenance or replacement of malfunctioning components. Redundancy of the Spent Fuel Pool Cooling and Cleanup System components is not required because of the large heat capacity of the pool and the slow heat-up rate. In the unlikely event that the spent fuel pool pump should fail for an extended period, a portable pump can be connected for circulation of the pool water through the spent fuel pool heat exchanger. The heat generated by the spent fuel (1-1/3 cores) assemblies, in the spent fuel pool during pump failure, will not increase the spent fuel pool water temperature beyond 180°F during the period required to install the portable pump. If a failure should occur that would prevent the use of the spent fuel pool heat exchanger for cooling the spent fuel pool water (e.g. - severance of the piping which constitutes the cooling recirculation path), natural surface cooling would maintain the water temperature at or below the boiling point. A Class I backup makeup water source is provided to assure that the water level in the spent fuel pool can be maintained.

Spent Fuel Pool Dewatering

The most serious failure of this system would be complete loss of water in the storage pool. To protect against this possibility, the spent fuel pool cooling suction connection enters near the normal water level so that the pool cannot be gravity-drained. The cooling water return line contains an anti-siphon hole to prevent the possibility of gravity draining the pool.

Water Quality

Only a very small amount of water is interchanged between the refueling canal and the spent fuel pool while fuel assemblies are transferred in the refueling process. Whenever a leaking fuel assembly is transferred from the fuel transfer canal to the spent fuel storage pool, a small quantity of fission products

may enter the spent fuel cooling water. The purification loop provided removes fission products and other contaminants from the water, by maintaining radioactivity concentration in the spent fuel pool water at 5×10^{-3} μc/cc (β and γ) or less.

Tests and Inspections

Active components of the Spent Fuel Pool Cooling and Cleanup System are either in continuous or intermittent use during normal system operation. Periodic visual inspection and preventive maintenance are conducted using normal industry practice.

Instrumentation Applications

The instrumentation provided for the Spent Fuel Pool Cooling and Cleanup System is discussed below. Alarms and indications are provided as noted.

Temperature

Local instrumentation is provided to measure the temperature of the water in the spent fuel pool and give local indication as well as annunciation in the control room when normal temperatures are exceeded.

Local instrumentation is also provided to give indication of the temperature of the spent fuel pool water as it leaves the spent fuel pool heat exchanger.

Pressure

Local instrumentation is provided to measure and give indication of the pressures in the spent fuel pool pump and refueling water purification pump suction and discharge lines. Instrumentation is also provided to measure pressure differential on the spent fuel pool filter and the refueling water purification filter.

Flow

Local instrumentation is provided to measure and give indication of the flow in the outlet line of the spent fuel pool filter.

Level

Instrumentation is provided to give an alarm in the control room when the water level in the spent fuel pool reaches either the high or low level setpoint.

9.1.4 FUEL HANDLING SYSTEM

The Fuel Handling System, shown in Figure 9.1-3, consists of equipment and structures utilized for handling new and spent fuel assemblies in a safe manner during refueling and fuel transfer operations.

Design Bases

The following design bases apply to the Fuel Handling System:

1. Fuel handling devices have provisions to avoid dropping or jamming of fuel assemblies during transfer operation.

2. Fuel lifting and handling devices are capable of supporting maximum loads under double design earthquake conditions. The fuel handling equipment will not fail so as to cause damage to any fuel elements should the double design earthquake occur during a refueling operation.

3. The fuel transfer system, where it penetrates the containment, has provisions to preserve the integrity of the containment pressure boundary.

4. Cranes and hoists used to lift spent fuel assemblies have a limited maximum lift height so that the minimum required depth of water shielding is maintained.

System Description

The Fuel Handling System consists of the equipment needed for the refueling of the reactor core. Basically this equipment is comprised of cranes, handling equipment, and a fuel transfer system. The structures associated with the fuel handling equipment are the refueling cavity, the refueling canal, the spent fuel storage pool, and the new fuel storage area.

The reactor is refueled with fuel handling equipment designed to handle the spent fuel underwater from the time it leaves the reactor vessel until it is placed in a cask for shipment from the site. Underwater transfer of spent fuel provides an effective, economic and transparent radiation shield as well as a reliable cooling medium for removal of decay heat. Boric acid is added to the water to insure subcritical conditions.

The associated fuel handling structures may be generally divided into three areas: (1) the refueling cavity and refueling canal which are flooded only during plant shutdown for refueling, (2) the spent fuel pool which is kept full of water and is always accessible to operating personnel, and (3) the new fuel storage area which is separate and protected for dry storage. The refueling canal and the spent fuel pool are connected by the fuel transfer tube. This tube is fitted with a blind flange on the canal end and a gate valve on the spent fuel pool end. The blind flange is in place except during refueling to ensure containment integrity.

The new fuel containers are unloaded from the shipping vehicle and placed on the 5' elevation using the fuel handling crane. New fuel assemblies are removed one at a time from the shipping containers using the new fuel handling tool and the spent fuel bridge hoist. The assemblies are stored in the new fuel storage racks in the fuel storage area.

Each assembly is inspected for possible shipping damage prior to insertion into the reactor core. The spent fuel bridge hoist is used to transfer the assemblies between the new fuel storage racks and the adjacent inspection facility.

New fuel is delivered to the reactor by first transferring the fuel with the spent fuel bridge hoist to the new fuel elevator. The fuel is lowered into the spent fuel pool where the spent fuel handling tool is interchanged with the new fuel tool. The assembly is then transferred to the upender using the spent fuel bridge hoist.

The upender at either end of the fuel transfer tube is used to pivot a fuel assembly to the horizontal position for passage through the transfer tube. Fuel is carried through the tube on an underwater transfer car. After the transfer car transports the fuel assembly through the transfer tube, the upender at that end of the tube pivots the assembly to a vertical position so that it can be lifted out of the fuel container.

Fuel is moved between locations in the reactor vessel and the transfer mechanism by the manipulator crane.

In the spent fuel pool, fuel assemblies are moved about by the spent fuel pool bridge hoist. When lifting spent fuel assemblies, the bridge hoist and a long-handled tool are used to prevent lifting fuel assemblies any closer than 9.4 feet from the spent fuel pool surface assuring that sufficient radiation shielding is maintained. A shorter tool is used to handle new fuel, but the new fuel elevator must be used to lower the assembly to a depth at which the hoist, using the long-handled tool, can place the new assembly into the fuel transfer container in the upending device.

Decay heat, generated by the spent fuel assemblies in the spent fuel pool, is removed by the Spent Fuel Pool Cooling and Cleanup System. After a sufficient decay period, the fuel is removed from the racks and loaded into a shipping cask for removal from the site.

The spent fuel cask is lowered into the spent fuel pool with the fuel handling crane. The assemblies are loaded into the cask with the spent fuel bridge hoist. The cask is then transferred to the adjacent decontamination area using the fuel handling crane. The outside surfaces of the cask are decontaminated prior to shipment by using steam, water, detergent solutions and manual scrubbing to the extent required. The decontamination area has a

stainless steel lined base and a curb is provided around it to prevent the water and solvents used during decontamination from spreading over the building floor. Drains in the floor of the area remove the decontaminants to the Waste Disposal System for processing.

Component Description

Manipulator Crane - The manipulator crane is a rectilinear bridge and trolley crane with a vertical mast extending down into the refueling water. The bridge spans the refueling cavity and runs on rails set into the edge of 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 down out of the mast to grip the fuel assembly. The gripper tube is long enough so that 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 while inside the mast tube is transported to its new position.

All controls for the manipulator crane are mounted on a console on the trolley. The bridge is positioned on a coordinate system laid out on one rail. The electrical readout system on the console indicates the position of the bridge. The trolley is positioned with the aid of a scale on the bridge structure. The scale is read directly by the operator at the console. The drives for the bridge, trolley, and winch are variable speed and include a separate inching control on the winch. Electrical interlocks and limit switches on the bridge and trolley drives prevent damage to the fuel assemblies. The winch is also provided with limit switches plus a mechanical stop to prevent a fuel assembly from being raised above a safe shielding depth should the limit switch fail. In an emergency, the bridge, trolley, and winch can be operated manually using handwheels on the motor shafts.

Spent Fuel Pool Bridge - The spent fuel pool bridge is a wheel-mounted walkway, spanning the spent fuel pool, which carries an electric monorail hoist on an overhead structure. The bridge, trolley and the hoist are electrically driven. The fuel assemblies are moved within the spent fuel pool by means of a

long-handled tool 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 pool bridge is also used in transfer of new fuel assemblies to and from the new fuel storage area.

Fuel Handling Crane - The fuel handling crane is an overhead traveling crane located in the fuel handling area above elevation 140'. It consists of two parallel structural guides bridged by a trolley and moves on four double-flanged wheels. The crane has a 125-ton capacity main hook for handling spent fuel casks and a 15-ton capacity auxiliary hook for handling new fuel shipping containers. The travel of both hooks over the spent fuel pool is restricted by electrical interlocks and administrative controls to preclude the possibility of dropping heavy objects on the spent fuel. Crane hook access is restricted to the cask recess in the corner of the pool. The integrity of the crane hooks is assured by the following measures: 1) shop testing of both hooks, 2) the main hook is radiographed and liquid penetrant tested, the auxiliary hook is radiographed and magnetic particle inspected, and 3) both hooks are field tested for 10 minutes at 1/2, 3/4, 1 and 1-1/4 times the rated loads.

The fuel handling crane was designed in accordance with seismic Class I requirements. It was designed for accelerations of 0.93g horizontal and 0.13g vertical - acting simultaneously - for the D.E. loading condition, with no increase in allowable stress. In addition, the design of the crane is adequate to assure against exceeding the yield strength of any part of the crane when the DDE loading condition is applied. (Accelerations during DDE are twice those during DE).

Although the vertical acceleration due to an earthquake is not large enough to overcome the crane's gravity load, a vertical "stop" is provided along the entire length of the runway to prevent uplift and derailing.

Structural design is in accordance with Standard No. 6 of the Association of Iron and Steel Engineers (AISE) where applicable. All members not covered by that standard are designed and fabricated in accordance with the current

Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings by the American Institute of Steel Construction (AISC), except that stresses do not exceed 90 percent of the allowable values stated in this AISC specification.

New Fuel Elevator - The new fuel elevator consists of a box-shaped elevator assembly with its top end open and sized to house one fuel assembly. Depth of the structure is slightly less than the overall length of the fuel assembly which rests on the bottom plate.

The new fuel elevator is used exclusively to lower a new fuel assembly to the bottom of the spent fuel pool where it is transported to the fuel transfer system by the spent fuel pool bridge hoist.

Fuel Transfer System - The fuel transfer system (Figure 9.1-3) includes an underwater air-motor driven transfer car that runs on tracks extending from the refueling canal through the transfer tube into the spent fuel pool and an upender lifting frame at each end of the transfer tube. The upender in the refueling canal receives a fuel assembly in the vertical position from the manipulator crane. The fuel assembly is then pivoted to a horizontal position for passage through the transfer tube and pivoted to a vertical position by the upender in the spent fuel pool. The spent fuel pool bridge hoist takes the fuel assembly to a position in the spent fuel storage racks.

A blind flange is bolted on the refueling canal end of the transfer tube to seal the reactor containment. The terminus of the tube outside the containment is closed by a gate valve.

Rod Cluster Control Changing Fixture - Rod cluster control (RCC) elements are transferred from one fuel assembly to another by the RCC changing fixture. The five major subassemblies of the changing fixture are: frame and track structure, carriage, guide tube, gripper, and drive mechanism. The carriage is a movable container supported by the frame and track structure. The tracks provide a guide for the four flanged carriage wheels and allow horizontal movement of the carriage during changing operations. Positioning stops on both the carriage and frame locate each of the three carriage compart[illegible] directly

below the guide tube. Two of these compartments hold individual fuel assemblies while the third supports a single RCC element. The guide tube, situated above the carriage and mounted on the refueling canal wall, provides for the guidance and proper orientation of the gripper and RCC element as they are being raised or lowered. The pneumatically actuated gripper engages the RCC element. Two flexure fingers can be inserted into the top of the RCC element when air pressure is applied to the gripper piston. Normally, the fingers are locked in a radially extended position. Mounted on the operating deck, the drive mechanism assembly includes: manual carriage drive mechanism, revolving stop operating handle, pneumatic selector valve for actuating the gripper piston, and electric hoist for elevation control of the gripper.

Spent Fuel Handling Tool - This manually actuated tool is used to handle new and spent fuel in the spent fuel pool. It is mounted on the end of a long pole suspended from the spent fuel pool bridge hoist. An operator on the spent fuel pool bridge guides and operates the tool.

New Fuel Assembly Handling Fixture - This short-handled tool is used to handle new fuel on the operating deck of the fuel storage area, to remove the new fuel from the shipping container, and to facilitate inspection and storage of the new fuel and loading of fuel into the new fuel elevator.

Reactor Vessel Head Lifting Device - The reactor vessel head lifting device consists of a welded and bolted structural steel frame with suitable rigging to enable the crane operator to lift the head and store it during refueling operations. The lifting lugs are permanently attached to the reactor vessel head.

Reactor Internals Lifting Device - The reactor internals lifting device is a structural frame suspended from the overhead crane. The frame is lowered onto the guide tube support plate of the internals, and is manually bolted to the support plate by three bolts. Bushings on the frame engage guide studs in the vessel flange to provide guidance during removal and replacement of the internals package.

Reactor Vessel Stud Tensioner - Stud tensioners are employed to secure the head closure joint at every refueling. The stud tensioner is a hydraulically operated device that uses oil as the working fluid. The device permits pre-loading and unloading of the reactor vessel closure studs at cold shutdown conditions. Stud tensioners minimize the time required for the tensioning or unloading operations. Three tensioners are provided and are applied simultaneously to three studs located 120 degrees apart. A single hydraulic pumping unit operates the tensioners, which are hydraulically connected in series. The studs are tensioned to their operational load in two steps to prevent high stresses in the flange region and unequal loadings in the studs. Relief valves on each tensioner prevent overtensioning of the studs due to excessive pressure.

Refueling Procedure

The refueling operation follows a detailed procedure which provides a safe, efficient refueling operation. The following significant points are assured by the refueling procedure:

1. The refueling water and the reactor coolant contains approximately 2,000 ppm boron. This concentration, together with the negative reactivity of control rods, is sufficient to keep the core approximately 10 percent $\Delta k/k$ subcritical during the refueling operations. It is also sufficient to maintain the core subcritical if all of the rod cluster control assemblies were removed from the core.

2. The water level in the refueling cavity is high enough to keep the radiation levels within acceptable limits when the fuel assemblies are being removed from the core. This water also provides adequate cooling for the fuel assemblies during transfer operations.

The refueling operation is divided into four major phases: 1) preparation; 2) reactor disassembly; 3) fuel handling; and 4) reactor assembly. A general description of a typical refueling operation through the four phases is given below:

1. Phase I - Preparation

The reactor is shut down and cooled to cold shutdown conditions with a final $k_{eff} < 0.9$ (all rods in). Following a radiation survey, the containment is entered. At this time, the coolant level in the reactor vessel is lowered to a point slightly below the vessel flange. Then the fuel transfer equipment and manipulator crane are checked for proper operation.

2. Phase II - Reactor Disassembly

All cables, air ducts, and insulation are removed from the vessel head. The refueling cavity is then prepared for flooding by sealing off the reactor cavity; checking of the underwater lights, tools, and fuel transfer system; closing the refueling canal drain holes; and removing the blind flange from the fuel transfer tube. With the refueling cavity prepared for flooding, the vessel head is unseated and raised approximately one foot above the vessel flange. Water from the refueling water storage tank is pumped into the Reactor Coolant System by the residual heat removal pumps causing the water to overflow into the refueling cavity. The vessel head and the water level in the refueling cavity are raised simultaneously, keeping the water level just below the head. When the water reaches a safe shielding depth, the vessel head is taken to its storage pedestal. The control rod drive shafts are disconnected and, with the upper internals, are removed from the vessel. The fuel assemblies and rod cluster control assemblies are now free from obstructions, and the core is ready for refueling.

3. Phase III - Fuel Handling

The refueling sequence is started with the manipulator crane. As determined by the refueling procedure which is prepared before each refueling, spent fuel assemblies are removed from the core. The positions of partially spent assemblies are changed, and new assemblies are added to the core.

The general fuel handling sequence is:

a. The manipulator crane is positioned over a fuel assembly in the most depleted region of the core.

b. The fuel assembly is lifted by the manipulator crane to a predetermined height to clear the reactor vessel and still leave sufficient watercoverir. to eliminate any radiation hazard to the operating personnel.

c. If the removed assembly contains a rod cluster control, the assembly is placed in the rod cluster control changing fixture by the manipulator crane. The rod cluster control is removed from the spent fuel assembly and put in a new fuel assembly or in a partially spent fuel assembly also placed in the changing fixture.

d. The fuel transfer car is moved into the refueling canal from the spent fuel pool.

e. The fuel assembly container is pivoted to the vertical position by the upender.

f. The manipulator crane is moved to line up the fuel assembly with the fuel transfer system.

g. The manipulator crane loads a fuel assembly into the fuel assembly container of the fuel transfer car.

h. The container is pivoted to the horizontal position by the upender.

i. The fuel container is moved through the fuel transfer tube to the spent fuel pool by the transfer car.

j. The fuel assembly container is pivoted to the vertical position. The fuel assembly is unloaded by the spent fuel handling tool attached to the spent fuel pool bridge hoist.

k. The fuel assembly is placed in the spent fuel storage rack.

l. A new fuel assembly is brought from dry storage, lowered into the spent fuel pool with the new fuel elevator, and loaded into the fuel assembly container by the spent fuel pool bridge hoist.

m. The fuel assembly container is pivoted to the horizontal position and the transfer car is moved back into the refueling canal.

n. Partially spent fuel assemblies are relocated in the reactor core, and new fuel assemblies are added to the core.

o. Any new assembly or transferred fuel assembly that is placed in a control position is first placed in the rod cluster control changing fixture to receive a rod cluster control from a spent fuel assembly.

p. This procedure is continued until refueling is completed.

4. Phase IV - Reactor Assembly

Reactor assembly, following refueling, is essentially achieved by reversing the operations given in Phase II - Reactor Disassembly.

Safety Evaluation

Conformance with the requirements of Safety Guide Number 13 assures safety under normal and postulated accident conditions.

Safe Handling

The manipulator crane design includes the following provisions to assure safe handling of fuel assemblies:

1. Bridge, trolley, and winch drives are mutually interlocked, using redundant interlocks, to prevent simultaneous operation of any two drives.

2. Bridge and trolley drive operation is prevented except when both gripper tube up position switches are actuated.

3. An interlock is supplied which prevents the opening of a solenoid valve in the air line to the gripper except when zero suspended weight is indicated by a force gauge. As backup protection for this interlock, the mechanical weight actuated lock in the gripper prevents operation of the gripper under load even if air pressure is applied to the operating cylinder.

4. An excessive suspended weight switch opens the hoist drive circuit in the up direction when the loading is in excess of 110 percent of a fuel assembly weight.

5. An interlock of the hoist drive circuit in the up direction permits the hoist to be operated only when either the open or closed indicating switch on the gripper is actuated.

6. An interlock of the bridge and trolley drives prevents the bridge drive from traveling beyond the edge of the core unless the trolley is aligned with the refueling canal centerline. The trolley drive is locked out when the bridge is beyond the edge of the core.

7. Restraints are provided between the bridge and trolley structures and their respective rails to prevent derailing due to the double design earthquake. The manipulator crane is designed to prevent disengagement of a fuel assembly from the gripper under the double design earthquake.

8. The main and auxiliary hoists are equipped with two independent braking systems. A solenoid release - spring set electric brake is mounted on the motor shaft. This brake operates in the normal manner to release upon application of current to the motor and set when current is interrupted. The second brake is a mechanically actuated load brake internal to the hoist gear box that sets if the load starts to overhaul the hoist. It is necessary to apply torque from the motor to raise or lower the load.

In raising, the motor cams the brake open; in lowering, the motor slips the brake allowing the load to lower. This brake actuates upon loss of torque from the motor for any reason and is not dependent on any electrical circuits. On the main hoist the motor brake is rated at 350 percent operating load and the mechanical brake at 300 percent.

The working load of fuel assembly plus gripper is approximately 2,500 pounds.

The gripper itself has four fingers gripping the fuel, any two of which will support the fuel assembly weight.

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

1. Transfer car operation is possible only when both upenders are in the down position as indicated by the limit switches.

2. The remote control panels have a permissive switch in the transfer car control circuit that prevents operation of the transfer car in either direction when either switch is open; i.e., with two remote control panels, one in the refueling canal and one in the spent fuel pool, the transfer car cannot be moved until both "go" switches on the panels are closed.

3. An interlock allows upender operation only when the transfer car is at either end of its travel.

4. Transfer car operation is possible only when the transfer tube gate valve position switch indicates the valve is fully open.

5. The refueling canal upender is interlocked with the manipulator crane. The upender cannot be operated unless the manipulator crane gripper tube is in the fully retracted position or the crane is over the core.

Seismic Considerations

The maximum design stress for the structures and for all parts involved in gripping, supporting or hoisting the fuel assemblies is 1/5 ultimate strength of the material. This requirement applies to normal working load and emergency pullout loads, when specified, but not to earthquake loading. To resist double design earthquake forces, the equipment is designed to limit the stress in the load bearing parts to 0.9 times the ultimate stress for a combination of normal working load plus double design earthquake forces.

Containment Pressure Boundary Integrity

The fuel transfer tube which connects the refueling canal (inside the containment) and the spent fuel pool (outside the containment) is closed on the refueling canal side by a blind flange at all times except during refueling operations. Two seals are located around the periphery of the blind flange with leak-check provisions between them. The spent fuel pool side containment integrity is maintained by a gate valve.

Radiation Shielding

During all phases of spent fuel transfer, the gamma dose rate at the surface of the water is limited by maintaining a minimum of 9.4 feet of water above the top of the fuel assembly during all handling operations.

The two cranes used to lift spent fuel assemblies are the manipulator crane and the spent fuel pool bridge hoist. The manipulator crane contains positive stops which prevent the top of a fuel assembly from being raised to within 9.4 feet of the normal water level in the refueling cavity. The hoist on the spent fuel pool bridge moves spent fuel assemblies with a long-handled tool. Hoist travel and tool length likewise limit the maximum lift of a fuel assembly to within 9.4 feet of the normal water level in the spent fuel pool.

Tests and Inspections

As part of normal plant operations, the fuel handling equipment is inspected for operating conditions prior to each refueling operation. During the operational testing of this equipment, procedures are followed that will affirm the correct performance of the fuel handling system interlocks.

ENCLOSURE 7

NRC LETTER TO PG&E
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(Item 14)