UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NOS. 27 AND 12 TO
LICENSE NOS. DPR-53 AND DPR-69

RELATING TO MODIFICATION OF THE SPENT FUEL POOL

BALTIMORE GAS & ELECTRIC COMPANY

CALVERT CLIFFS NUCLEAR POWER PLANT UNIT NOS. 1 AND 2

1.0 INTRODUCTION

By letters dated August 5, and September 7, 1977, Baltimore Gas and Electric Company (BG&E) proposed to change the spent fuel pool (SFP) storage design for Calvert Cliffs Nuclear Power Plant Unit Nos. 1 and 2 (CCNPP) from the design which was reviewed and approved in the operating license review and described in the Final Safety Analysis Report (FSAR). The proposed change consists of increasing the existing spent fuel storage capacity for both units from 410 fuel assemblies to 1056 fuel assemblies. In response to our questions, BG&E submitted supplemental information by letters dated October 7 and 19, November 1, 4, 16 and 17, and December 7, 1977.

2.0 BACKGROUND

The present spent fuel pool at CCNPP has a nominal 18 inch center-to-center distance between fuel assemblies with a total capacity of 410 fuel assemblies. This design was based on storage capacity of nominally 1 2/3 cores (410 fuel assemblies), adequate storage of the discharge (72 assemblies per year per unit) from each unit for one year prior to its shipment off-site for reprocessing plus 217 storage locations for either unit core unloading whenever it became necessary.

The CCNPP Unit No. 1 and 2 achieved initial criticality on October 7, 1974, and November 30, 1976, respectively. CCNPP Unit No. 1 was shutdown on December 31, 1976, for a scheduled refueling and maintenance outage, at which time 72 fuel assemblies were replaced. The refueling schedule for Unit No. 1 shows next refueling in January 1978 and yearly thereafter. The first refueling for Unit No. 2 is scheduled for September 1978. Following this Unit No. 2 refueling outage, there will not be space to offload either entire reactor core should this be necessary or desirable because of operational considerations. Likewise, following the second refueling of Unit No. 2 in late 1979, the existing fuel pool storage capacity will be used up completely.

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Currently, spent fuel is not being reprocessed on a commercial basis in the United States. Thus, BG&E has requested our approval of the SFP modifications for CCNPP Unit Nos. 1 and 2 due to a lack of alternatives in the immediate future, for disposal of spent fuel.

The proposed fuel pool modification consists of replacing the old fuel racks in the Calvert Cliffs Nuclear Plant SFP with new, higher capacity fuel storage racks, which are classified as seismic Category 1 equipment. The modification consists of eleven storage racks in each side of the pool, each with forty eight (48) storage elements in a 13 X 12.5 inch center-to-center spacing. The new racks are to be fabricated from Type 304 stainless steel and will not utilize poison material for neutron absorption. Each storage tube is 8.875 inches square inside, has 3/16 inch walls and is approximately 14 feet long. Combining the spacing dimensions with the outer dimension of the fuel region, which is 8.14 inches, results in a fuel region volume fraction of 0.41 for the nominal storage lattice. The fuel assembly sits on bars across the bottom of each storage tube. The beams which form the base structure are supported by legs about seven inches above the pool floor. Each rack in turn sits on support pads on the floor. There are no connections between adjacent racks, or floor nor are there any supports to the fuel pool walls.

BG&E states in their August 5, 1977 submittal that it is responsible for the overall modification to the spent fuel storage pool with the Nuclear Services Corporation being retained to design the spent fuel racks, contract for fabrication, perform analysis pertinent to the modification, and provide installation technical assistance and with Bechtel Power Corporation providing engineering assistance in reviewing the spent fuel pool structural considerations.

3.0 DISCUSSION AND EVALUATION

In reviewing the SFP modification for CCNPP Unit Nos. 1 and 2, we considered various safety aspects of the modification. These aspects include (1) structural and mechanical design, (2) criticality analysis, (3) SFP cooling requirements (4) radioactive waste treatment, (5) method of rack installation, (6) heavy load impact analysis, (7) operational radiation exposure and (8) combined fuel shortage.

3.1 Structural and Mechanical Design

We find that the BG&E supporting arrangements for the racks, including their design, fabrication, installation, structural analysis for all loads including seismic and impact loadings, load combinations, structural acceptance criteria, quality assurance requirements for design, fabrication and installation, applicable industry codes; were

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all reviewed in accordance with the relevant parts of Section 3.7 and 3.8 of the Standard Review Plan. The licensee used seismic input in the form of floor response spectra as approved for the plant FSAR. The analytical model used for this seismic design is composed of members lumped together with the appropriate mass and structural properties to maintain the correct stiffness to insure correct structural behavior. The mathematical model interfaces with the pool floor by means of four beam elements. The fuel assemblies and fuel cell locations were coupled in this analysis. The responses (shears, moments and inertia forces), in the vertical direction and the worst horizontal direction were combined by the square root of the sum of the squares (SRSS) to produce the maximum loading on the structures. Although this procedures does not comply with the requirements of Regulatory Guide 1.92, the licensee has conservatively applied a factor of $\sqrt{2}$ to the total stress calculated and shown that the resulting stresses will have the same factor of safety as permitted by the code. In addition to this, a detailed nonlinear time history analysis explicitly including the clearance gap between the storage cell wall and the fuel assembly was performed resulting in support reactions which were compared with those of the simplified linear elastic model with no gap between the storage cell walls and the fuel assembly. We have concluded that the analytical techniques used will result in an acceptable design for the fuel storage racks.

The use of 300 series stainless steel materials for the fabrication of the new storage racks, and its requirements during the service life, were reviewed for consistency with the requirements identified in Section 9.1.2 of the Standard Review Plan.

The analysis, design, fabrication, and installation of the new spent fuel storage racks are in accordance with accepted criteria for seismic Category I equipment. We find that the subject modification proposed by the licensee is acceptable, and in part satisfies the requirements of the General Design Criteria 2, 4, and 61.

Since the possibility of long term storage of spent fuel exists, we are investigating the effects of the pool environment on the racks, fuel cladding and pool liner. Based upon our preliminary review and previous operating experience, we have concluded that at the pool temperature and the quality of the demineralized water, and taking no credit for inservice inspection, there is reasonable assurance that no significant corrosion of the racks, the fuel cladding or the pool liner will occur over the lifetime of the plant. However, if the results of the current generic review indicate that additional protective measures are warranted to protect the racks, the fuel cladding and/or the liner from the effects of corrosion, the necessary steps and/or inspection programs will be required to assure that an acceptable level of safety is maintained. Any conceivable problems which could be uncovered are of a long term nature and warrant no need for immediate concern.

3.2 Criticality Analyses

The Nuclear Services Corporation performed the criticality analyses. They used the CHEETAH computer program to obtain four energy group cross sections for diffusion theory calculations with the CITATION program. The accuracy of this diffusion theory method was checked by comparison with several series of critical experiments. The fuel pool criticality calculations are based on no burnable poison or control rods in the fuel assemblies, fresh, i.e., unirradiated fuel with 3.7 weight percent uranium 235, and no soluble boron in the water. For the present fuel assemblies, 3.7 percent enrichment corresponds to a fuel loading of 44 grams of uranium 235 per axial centimeter of fuel assembly.

Parametric calculations were made for the maximum possible reduction in storage lattice pitch, eccentric fuel assembly placement, and an increase in fuel pool water temperature to 212°F. A calculation was also made for the inadvertent placement of a fuel assembly adjacent to a filled rack, resulting in a maximum neutron multiplication factor of 0.925. This result agrees well with results of parametric calculations made with other methods for similar fuel pool storage lattices. By assuming new, unirradiated fuel with no burnable poison or control rods, these calculations yield the maximum neutron multiplication factor that could be obtained throughout the life of the nominal fuel assemblies. This includes the effect of the plutonium which is generated during the fuel cycle.

We find that when the number of the fuel assemblies described in the BG&E submittals, having no more than 44 grams of uranium 235 per axial centimeter of fuel assembly, are loaded into the proposed racks, the neutron multiplication factor will be less than 0.95.

3.3 SFP Cooling Requirements

The maximum heat load for the expanded capacity in the pool was calculated on the assumption of a 314-day refueling cycle for each unit with Unit No. 2 being refueled sixty days after Unit No. 1. A cooling time of seven days was assumed after reactor shutdown before the completion of the transfer of both the normal, one-third core refueling and full core offloads into the spent fuel pool. On this basis, BG&E calculated the maximum heat load for the normal refueling to be 14.5×10^6 BTU/hr plus 2.8×10^6 BTU/hr for uncertainties or 17.3×10^6 BTU/hr total.

The cooling system for the spent fuel pool has two pumps and two heat exchangers. These are cross connected so that any combination of a pump and heat exchanger can be used to cool the spent fuel pool for either Unit Nos. 1 or 2. There is also additional cooling available from valving the shutdown cooling system of either unit to the spent fuel pool cooling system. Each spent fuel cooling pump is designed to pump 1390 gallons of water per minute. With both pumps and heat exchangers in operation, the spent fuel cooling system is designed to remove 20×10^6 BTU/hr while maintaining the fuel pool outlet water temperature at 127°F with 95°F service water cooling the heat exhangers. The shutdown cooling system, when connected to the spent fuel pool, is designed to remove 27×10^6 BTU/hr while maintaining the fuel pool outlet temperature at 130°F with 95°F service water cooling the heat exchanger.

In its submittal of August 5, 1977, BG&E stated that there are alarms which will annunciate unsatisfactory water levels in the pool or an excessive fuel pool water temperature.

Based on a comparison of the spent fuel pool's heat loads, which BG&E reported in its submittal of September 7, 1977, with those obtained by using the method given on pages 9.2.5-8 through 14 of the NRC Standard Review Plan (with the uncertainty factor, K equal to 0.1), we find the licensee's calculated values for the heat load to be acceptable.

Assuming a full array of 1056 stored fuel assemblies, the maximum incremental heat load that will be imposed on the plant by this proposed modification will be that due to nine annual refuelings, all of which will have had more than two years of cooling. This maximum incremental heat load will be 2.64×10^6 BTU/hr. Since this is only 1.1 percent of the heat rejection capacity of the Service Water System, which has a total heat removal capability of 240×10^6 BTU/hr, we find that the incremental heat load will have a negligible effect on the service water temperature and that the capacity of the present Service Water System is adequate for removing the incremental heat load associated with the proposed modification.

We find that with both spent fuel pool loops operating, the fuel pool outlet temperature for any normal refueling will be less than the 127°F design temperature stated in the FSAR. We also find that in the case of a postulated single failure, which effectively shuts down one loop immediately after any normal refueling offload, the fuel pool outlet water temperature will not exceed 155°F. For the full core offload with the safety related Shutdown Cooling System connected to the spent fuel pool, we find that the fuel pool outlet water temperature will not exceed 140°F, which we find to be acceptable.

3.4 Radioactive Waste Treatment

The plant contains waste treatment systems designed to collect and process the gaseous, liquid and solid wastes that might contain radioactive material from both units. The waste treatment systems were evaluated in the Safety Evaluation Report (SER) for both units dated August 1972. There will be no change in the waste treatment systems or in the conclusions of the evaluation of these systems as described in Section 3.1.7 of the SER because of the proposed modification.

3.5 Method of Fuel Rack Installation

The first refueling for Unit No. 2 is scheduled for September, 1978; consequently, the licensee plans to modify the Unit No. 2 side before storing any spent fuel assemblies in it. There will be no movements of racks over the spent fuel during this portion of the modification. After the Unit No. 2 side has been modified, the licensee plans to move the spent fuel stored in the Unit No. 1 side to the Unit No. 2 side by using the fuel pool service platform in its design mode as described in the FSAR. The fuel is passed through the opening in the common dividing wall in the pool. The gate would then be installed in the slots on the Unit No. 2 side to cover the opening. As the Unit No. 1 side is drained, the differential pressure holds the gate against a rubber gasket providing a leak tight seal. The licensee can then modify the Unit No. 1 side of the pool without moving racks over spent fuel.

By taking advantage of the split-pool concept, the licensee can install the new racks without having to move a rack close to or over spent fuel. After the new racks are installed, the fuel handling procedures in and around the pool will be the same as those that were in effect prior to the proposed modifications. We find this method of fuel rack installation to be acceptable.

3.6 Heavy Load Impact Analysis

The NRC staff has under way a generic review of load handling operations in the vicinity of spent fuel pools to determine the likelihood of a heavy load impacting fuel in the pool and, if necessary, the radiological consequences of such an event. Because the Calvert Cliffs STS for both units prohibit the movement of loads in excess of 1600 pounds over fuel assemblies in the SFP, we have concluded that the likelihood of a heavy load handling accident is sufficiently small that the proposed modification is acceptable. No additional restrictions on load handling operations in the vicinity of the SFP are necessary while our review is under way.

The consequences of fuel handling accidents in the spent fuel pool area are not changed from those presented in the SER for both units dated August 1972.

3.7 Occupational Radiation Exposure

We have estimated the increment in onsite occupational dose resulting from the proposed increase in stored fuel assemblies on the basis of information supplied by the licensee and by utilizing realistic assumptions for occupancy times and for dose rates in the spent fuel area from radionuclide concentrations in the SFP water. The spent fuel assemblies themselves contribute a negligible amount to dose rates in the pool area because of the depth of water shielding the fuel. The occupational radiation exposure resulting from the proposed action represents a negligible burden. Based on present and projected operations in the spent fuel pool area, we estimate that the proposed modification will add less than one percent to the total annual occupational radiation exposure burden at this facility. The small increase in radiation exposure will not affect the licensee's ability to maintain individual occupational doses to as low as is reasonably achievable and within the limits of 10 CFR 20. Thus, we conclude that storing additional fuel in the SFP will not result in any significant increase in doses received by occupational workers.

3.8 Combined Fuel Storage

In the September 7, 1977 submittal, BG&E states that they plan to store spent fuel from either reactor in either side of the Spent Fuel Storage Pool. At CCNPP, the SFP is a common pool divided in two sides by a wall containing a removable gate. This SFP design was presented in the Calvert Cliffs Unit Nos. 1 and 2 FSAR as a single shared SFP for both CCNPP units and approved as such when the operating licenses were issued. We, therefore, conclude that the BG&E proposal to store spent fuel from either CCNPP unit in any location of the common SFP continues to be acceptable provided appropriate fuel assembly inventory control is maintained.

4.0 TECHNICAL SPECIFICATIONS

As indicated, in the criticality analysis of this safety evaluation, the Standard Technical Specifications (STS) must be modified to incorporate a limit of 44 grams of uranium 235 per axial centimeter of fuel assembly. Since the allowed center-to-center distance between fuel assemblies and the acceptable k_{eff} is different for spent fuel storage and new fuel storage, new Specifications (5.6) for each type of storage were imposed. The requirements are consistent with those used in STS for other plants.

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Specification 5.6 as related to the capacity of the combined stor
is limited to 1056 fuel assemblies.

A specification required to prevent heavy load impact by prohibit
the movement of loads in excess of 1600 pounds over fuel assembli
in the SFP is already in Sepcifications 3.9.6 for each unit.

5.0 SAFETY CONCLUSION

We have concluded, based on the considerations discussed above, t
(1) there is reasonable assurance that the health and safety of t
public will not be endangered by operation in the proposed manner
and (2) such activities will be conducted in compliance with the
Commission's regulations and the issuance of this amendment will r
be inimical to the common defense and security or to the health ar
safety of the public.

Date: January 4, 1978