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Docket No. 50-155

NOVEMBER 0 5 1980

MEMORANDUM FOR: J. P. Knight, Assistant Director for Components & Structures Engineering Division of Engineering

FROM: G. C. Lainas, Assistant Director for Safety Assessment Division of Licensing

SUBJECT: ASSISTANCE TO ORB #5 REGARDING THE BIG ROCK POINT FUEL POOL STORAGE EXPANSION SER AND HEARING

Operating Reactors Branch #5 requires assistance in finalizing the structural, mechanical and materials engineering portion of the SER for the Big Rock Point spent fuel pool storage expansion. Assistance is also required in providing testimony, including appearances as needed at the hearings for this contested case.

A draft SER was written covering these topics; however, we were recently informed that we will be unable to obtain the services of the previous reviewer to follow-through on this case. Accordingly, I request that you provide thennecessary assistance.

We request that you pomplete your review by December 15, 1980. ORB #5 estimates that it would require about two weeks to review the correspondence and draft SER for the above topics. A copy of the draft SER is enclosed for your information. It is estimated that an additional three man-weeks of effort through early next year will be required to prepare testimony, review licensee and intervenor responses to interrogatories, prepare and answer interrogatories, and to testify at the hearing in those areas covered by the enclosed SER. The schedule for the hearing has not yet been specified by the Board.

Please let me know by November 12, 1980, whether you can meet the proposed schedule.

This matter was discussed with D. Jeng, Acting Chief, Structural Engineering Branch on November 3, 1980. W. Paulson, ORB #5 Project Manager for Big Rock Point, will provide the licensee submittals, admitted contentions, and responses to interrogatories. There are two TACs numbers for this effort; 11823 for work on the SER and 12234 for work related to the hearing. Please contact Mr. Paulson (Ext. 27214) if you have any questions.

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Original signed by

Gus C. Lainas, Assistant Director
for Safety Assessment
Division of Licensing

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DATE	11/5/80	11/5/80			11/5/80

Enclosure:
Draft SER

cc w/enclosure:
F. Schauer
D. Crutchfield
W. Paulson

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ENCLOSURE

CONSUMERS POWER COMPANY
BIG ROCK POINT PLANT (DOCKET #50-155)
SPENT FUEL STORAGE POOL MODIFICATION
REQUEST FOR LICENSE CHANGE AND TECHNICAL SPECIFICATION CHA' .E

SAFETY EVALUATION REPORT
ENGINEERING BRANCH
DIVISION OF OPERATING REACTORS

DESCRIPTION OF PROPOSAL

By letter dated June 26, 1979, Consumers Power Company requested a change to the Big Rock Point License DPR-6 and Appendix A Technical Specifications. The proposed modification concerns increasing the storage capacity in the spent fuel pool from 193 to 441 fuel assemblies, by addition of new storage racks.

Three independent fuel assembly storage racks are to be installed in the pool, and the existing failed fuel storage rack will be removed. The new rack assemblies consist of one 8 X 11 array, an 8 X 13 array, and a 9 X 9 array of storage locations. Each new rack consists of an array of square storage cans, or tubes, fabricated from one-quarter (1/4) inch thick type 304 stainless steel, with a nominal 9.0 inch center-to-center spacing. The cans are welded to one-half (1/2) inch thick base plates. The storage cans have ~~lea~~ LEAD-in surfaces at the top to provide guidance for insertion of the fuel assemblies. Openings at the top and in the base plate provide a flow path for convective cooling of the fuel assemblies through natural circulation. The storage cans are welded to a grided base, and are structurally tied at the top with an over-under stainless steel grid system. Both the bottom and top grid systems will be comprised of a lattice of stainless steel beams.

Each storage rack is self-supporting, and is supported by adjustable leveling legs. Four leveling legs are provided for the 8 X 11 and 9 X 9 racks, while the 8 X 13 racks are supported on six leveling legs. Except at the leveling legs, all welded construction is used in the fabrication of the spent fuel rack assembly. The racks are not supported laterally by the fuel pool walls. Load transfer to the pool structure from the fuel racks occurs only at the base of the racks at the pool floor/leveling legs interface.

Horizontal seismic loads are transmitted through the cans and grid systems to the floor of the fuel pool via the leveling legs. Vertical seismic and deadweight loads are transmitted through the cans and baseplates to the grid beams, to the gussets and bosses into which the leveling legs are screwed. The loads are then transmitted to the pool floor via the leveling legs.

Each rack is provided with four lifting lugs which will be welded to the upper grid beam system. Lifting forces will be transmitted through the lifting lugs, to the upper grid beams, to the cans, and into the lower grid beam system and base plates.

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Further details of the spent fuel pool and the racks are illustrated in the applicant's submittals, including proprietary drawings.

ASPECTS OF REVIEW

Structural and Mechanical

The supporting arrangements for the racks, including their restraints, design, fabrication, and installation ~~procedures~~ CRITERIA; the structural design and analysis procedures for all loadings, including seismic and impact loadings; the load combinations; the structural acceptance criteria; the quality assurance requirements for design, fabrication, and installation; and applicable industry codes were all reviewed in accordance with the applicable portions of the current Position for Review and Acceptance of Spent Fuel Pool Storage and Handling Applications, April 1978, including modifications, January 1979. The allowable stresses for the stainless steel racks are in accordance with Part 1 of the AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings." Yield strengths at appropriate temperatures are obtained from Table I-2.2 of Section III of the ASME B&PV Code.

The spent fuel pool is located in the Reactor Building. The seismic analysis of the racks was a time history analysis, using structural damping values which conform to the positions in Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants." The 8 X 11 rack was used in the analysis to determine loads, stresses, and deflections, since this rack has the greatest potential for tipping and will develop the greatest internal forces due to seismic and deadweight loadings. ~~These~~ Three models were used in the analysis of the fuel rack. A nonlinear model is used in a tipping analysis to determine rack forces resulting from horizontal seismic excitation at the rack supports. A three-dimensional finite element model is used to determine stresses in the rack resulting from seismic, thermal, and deadweight loading. And a one-dimensional three mass model is used to determine maximum rack sliding distances during a DBE.

The analytical model used to determine rack loads allows tipping, but conservatively restrains sliding, to obtain a conservative value for the structural loading of the rack members.

The seismic input used was a displacement time history of the fuel pool floor, obtained from a seismic time history analysis of the plant. In addition to the weight of the rack and fuel assemblies, hydrodynamic masses were accounted for. Fuel can interaction was accounted for by explicitly modeling the gaps and the hydrodynamic coupling between a fuel assembly and the can which encloses it.

In the three dimensional analytical model used to determine rack stresses, N-S and E-W equivalent seismic loading was represented by uniform forces applied along the length of the cans. The magnitude of this equivalent loading was determined by equating the maximum bending moment at the base of the can (from the peak response of the time history tipping analysis) to the bending moment at the base in a model subjected to a uniform horizontal loads. In the vertical direction, the seismic analysis consisted of a static analysis using the maximum vertical floor acceleration. This is acceptable based on a frequency analysis of the rack which showed that its fundamental frequency was greater than 33Hz, indicating a rigid response in the vertical direction. The responses of the rack in the three component directions were combined using the square root of the sum of the squares (SRSS) procedure, in accordance with Regulatory Guide 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analyses." Thermal stress resulting from the differential heating effect between a full and an empty can were added to the stresses resulting from the seismic and deadweight loadings, using an absolute sum method.

A time-history sliding analysis was performed to determine any potential impacting bewteen adjacent fuel racks, and between the racks and the spent fuel pool structure. The coefficient of friction between the stainless steel liner and the rack leveling legs used in the analysis was conservatively chosen to be 0.2, based on information provided in a report by E. Rabinowicy to Boston Edison Company, "Friction Coefficients of Water-Lubricated Stainless Steels", November 5, 1976. The results of the time history analysis indicate that during a DBE, the racks slide less than 0.5 inch, based on the absolute sum of the displacements of two adjacent racks. The minimum available gaps between adjacent racks, between racks and pool walls, and between racks and other pool equipment are approximately 1.75, 3.0, and 2.0 inches, respectively.

The loads and load combinations considered in the analysis of the spent fuel storage racks are in accordance with Regulatory Guide 3.8.4. Results of the seismic analysis show that the racks are capable of withstanding the loads associated with all the design loading conditions without exceeding allowable stresses.

Seismic floor time histories used in the analysis were taken from a report by D'Appolonia Consulting Engineers, Inc., entitled, "Derivation of Floor Responses Reactor Building," dated June 1978. These floor responses were determined using ground acceleration time histories compatible with smooth design response spectra which conform to the positions in Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," and scaled to peak zero period horizontal and vertical accelerations of 0.12g and 0.08g, respectively. This document is currently under staff review, and has been submitted in support of the full term operating license application.

Two postulated fuel assembly drops were considered in the analysis of the racks. Energy methods were used to determine the effects of the impact of a fuel assembly dropped from a maximum height of 43'-3" above the bottom of the fuel pool, based on the upper limit of travel of the auxiliary hook. The worst case drop, where the fuel assembly is postulated to drop into an empty fuel can and impacts the baseplate at the bottom of the rack, results in a kinetic energy at impact of 195,000 inch-pound. The second case postulates the drop of the fuel assembly onto the top of the fuel rack lead-in guides. In both cases, the impact energy is dissipated by local yielding or crushing, however gross stresses in the rack remain below allowable and the overall structural integrity of the rack is maintained.

The licensee has stated that the heaviest load that will be transported over the stored spent fuel is the 24-ton spent fuel transfer cask. The use of this fuel transfer cask, was previously reviewed and found acceptable in the staff's Safety Evaluation Report on the cask drop analysis published February 6, 1976. The fuel transfer cask is provided with safety slings which have been found acceptable, and preclude its drop. Analyses performed by the licensee for casks smaller than the 24-ton fuel transfer cask indicate that they even, if they drop on the fuel pool liner, it will not result in a loss of pool water in excess of the 200 gpm makeup capability. In addition, the licensee has stated that administrative controls, for casks other than the fuel transfer cask, will be established to ensure that: (a) no cask is moved over or near stored spent fuel, (b) all cask handling operations are limited to the south west corner of the spent fuel pool, and (c) no spent fuel is stored in the two existing "A" racks adjacent to the cask handling area during caks handling operations.

The effects of a postulated stuck fuel assembly have been considered and accounted for by examining the case where an upward force of 2000 lbs. is exerted on a rack due to attempted assembly withdrawal. A mechanical trip switch is set to actuate below this load.

The spent fuel pool is contructed of concrete walls and floor, lined with a 3/16 inch thick stainless steel plate. The fuel pool concrete, reinforcing steel, and liner were analyzed to account for the additional loadings imposed by the new and existing racks. The more conservative load combinations of Section 9.3 of ACI 349-76 or Standard Review Plan Section 3.8.4 were used in the analysis. The allowable stress/load limits were taken from ACI 318-77 and the American Iron and Steel Institute "Stainless Steel Cold-Formed Structural Design Manual."

DOUBLE PUMP FAILURE TEMP. LOADS

Results of the analysis for the most severe loading conditions indicate that the maximum stresses are within the allowables, and that the structural members of the fuel pool are adequate to withstand the additional loads imposed by the new racks and additional fuel.

Detailed written installation procedures will be prepared by the installation contractor and approved by the licensee prior to commencement of rack installation. We have reviewed the acceptance criteria for the detailed written procedures, and find that they provide an acceptable means for ensuring that any deleterious impact on safety-related structures, systems and components or additional risk to the health and safety of the public is precluded. In addition, the licensee has agreed to provide the staff with a copy of the detailed written installation sequence and procedures for our review prior to the commencement of any movement of racks in the spent fuel pool.

Materials

The spent fuel pool storage racks, their associated hardware and support frame components, and the pool liner are constructed almost entirely of Type 304 stainless steel. The only exception is the leveling legs which are ASTM A276 UNSS 21-800 stainless steel. All rack materials are compatible with the storage pool environment, which is demineralized, unborated water controlled to a temperature less than the design value of 95°F. The licensee has stated that the fuel pool water chemistry is maintained at a pH of 6.9 and the conductivity typically of 0.3 μmho. This corresponds to extremely pure neutral water. Based on our review of previous operating experience with similar materials approved and in use, we have concluded that at the pool temperature and water quality, 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.

EVALUATION AND CONCLUSION

The analysis, design, fabrication, and criteria for establishing installation procedures of the proposed new spent fuel racks are in conformance with accepted codes, standards and criteria. The structural design and analysis procedures for all loadings, including seismic, thermal, and impact loading; the acceptance criteria for the appropriate loading conditions and combinations; and the applicable industry codes are in accordance with appropriate portions of the NRC Staff Position for Review and Acceptance of Spent Fuel Storage and Handling Applications.

Allowable stress limits for the combined loading conditions are in accordance with AISC specifications. Yield stress values at the appropriate temperature were obtained from Section III of the ASME B&PV Code. The quality assurance codes and criteria for the materials, fabrication and installation of the new racks are in accordance with the accepted requirements of 10 CFR 50 Appendix B, and ANSI.

The effects of the additional loads on the existing pool structure due to the new fuel racks, existing fuel racks, and equipment have been examined. The pool structural integrity is assured by conformance with the Standard Review Plan criteria and with all FHSR acceptance criteria.

Results of the seismic and structural analyses indicate that the racks are capable of withstanding the loads associated with all design loading conditions. Also, impact due to fuel assembly/cell interaction has been considered, and will result in no damage to the racks or fuel assemblies themselves.

Results of the dropped fuel assembly analyses show that local rack deformation will occur, but indicate that gross stresses meet the applicable allowables and that the integrity of the racks is maintained. In addition, the licensee has stated that a drop of the heaviest load planned for transport over the spent fuel racks (i.e. the 24 ton spent fuel transfer cask) is precluded by the use of safety slings, and that the drop of smaller casks will not result in a loss of pool water in excess of the 200 gpm makeup capability.

Results of the stuck fuel assembly analysis show that the stresses are below those allowed for the applicable loading combination.

There is no evidence at this time to indicate that corrosion of the fuel assemblies, the stainless steel rack structures, or the fuel pool liner will occur over the lifetime of the plant, at the temperatures and quality of the demineralized water to be maintained in the pool.

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We find that the subject modification proposed by the licensee is acceptable and satisfies the applicable requirements of the General Design Criteria 2, 4, 61, and 62 of 10 CFR, Part 50, Appendix A.

THE FINDINGS AND CONCLUSIONS IN THIS SER ARE BASED ON
~~The results of the seismic analyses performed are for~~ specific response spectra, as specified in the D'Appolonia Consulting Engineers Report previously referenced in this SER.