Supplement to Safety Evaluation Report

Diablo Canyon Nuclear Power Plant

Units 1 and 2

Docket Nos. 50-275 and 50-323

2.0 Site Characteristics

2.4 Effect of Breakwater Damage on Saltwater Intake Structure

The plant obtains both its normal and emergency cooling water from the Category I Saltwater Intake Structure located on the shoreline of a cove south of Units 1 and 2. This cove is protected from storm waves by two breakwaters (east and west) with their crest constructed to elevation +20 feet Mean Lower Low Water (MLLW). Although the breakwaters are not designated as safety-related structures, they do provide flood protection to the safety-related Auxiliary Saltwater (ASW) pumps located within the Intake Structure. These ASW pumps are designed to remain functional during the design basis flood event.

As discussed in SER Supplement No. 13, April 1981, during a winter storm on January 28, 1981, the West Breakwater was damaged by storm waves. Approximately 120 feet of the seaward end of the breakwater sustained substantial damage consisting of displacement of concrete cap units, tribar armor units, and underlayer quarrystone to approximately 0 feet MLLW. Subsequent storm waves in 1981 and 1982 extended this damage to a total length of about 240 feet (as of December 1982).

As a result of the January 1981 storm, which degraded a portion of the west breakwater to a level of about Elevation 0 feet MLLW, a breakwater configuration was presented that was more severe than any condition previous postulated for the Design Basis Flood event. Based on available information, neither the staff nor the applicant were in a position to evaluate:

(a) the potential for and limits of, further breakwater degradation,

(b) the extent to which a significantly degraded breakwater would limit wave runup on the Intake Structure to a level below the design level of +30 feet MLLW during the design or lesser flooding events, and

(c) the implications of this and associated events on operation of safety-related equipment.

It was determined that if the wave runup on the Intake Structure exceeded the design level of +30 feet MLLW, the only safety-related equipment that might be affected are the Auxiliary Saltwater pumps located in the Intake Structure. The ASW pump motors are located approximately six feet (El 6.5 feet, MLLW) above the floor of the watertight ASW pump chambers. These pumps are necessary for heat transfer from the component cooling heat exchangers. The water-tight ASW pump chambers are each provided with a ventilation stack which extends through the roof of the Intake Structure to Elevation +30 feet, MLLW.

In order to preclude having to defend the safety of the plant in the future if the breakwaters were to sustain further damage or be repaired and damaged again, the applicant proposed to reanalyze the ability of the Intake Structure to withstand the effects of the Design Basis Flood event with the breakwaters severely damaged. Based on studies by Wiegel, 1982 and Seed, 1982, the applicant selected elevation 0 feet, MLLW as the postulated minimum degraded level for both of the breakwaters and conducted hydraulic model tests of the effects of the Design Basis Flood event, i.e., "Probable Maximum Tsunami" concurrent with annual storm waves (SER Supplement No. 5, September 1976). Additional model tests were conducted with "Maximum Credible Wave Events" combined with high tide and sea level anomaly. The applicant also studied the probability of vessels impacting on the Intake Structure (Kircher, Monzon-Despang and Morris, 1982). The vessels were limited to those with sufficient draft to cross over the degraded breakwater and sufficient displacement to inflict significant damage to the Intake Structure.

The hydraulic model studies utilized a laboratory testing facility measuring 80 feet by 120 feet by 4 feet deep which reproduced, at a 1:45 model to prototype scale, the Intake Structure, the breakwaters, and the adjacent nearshore and offshore bathometry. This represented a prototype area of 446 acres measuring 3600 by 5400 feet. Detailed discussion of test procedures and results of the hydraulic model studies are reported by Lillevang, Raichlen, and Case, 1982; Lillevang, 1982 and Raichlen, 1982. The application of the results of these studies on the ability of the ASW pumps to safely operate during these DBF events are reported by Matsuda, 1983.

The applicant has concluded that the SW Intake Structure, with minor modification, is capable of withstanding the effects, including wave forces, of the postulated Design Basis Flood events, thereby assuring continuous protection of the Auxiliary Saltwater (ASW) pumps. The Design Basis Flood events consist of the postulated degradation of both breakwaters to 0 feet MLLW combined with 1) the "Probable Maximum Tsunami" concurrent with storm waves of more than annual severity (estimated return period of about 41 years), or 2) the "Maximum Credible Wave Event" combined with high tide and sea level anomaly. The SW Intake Structure modifications consist of:

a) extending and reinforcing the ventilation stack for each of the AWS pump chambers to El 52.0 feet MLLW:

b) modifying manholes that provide access to the SW intake structure forbay so as to reduce venting and to withstand pressures greater than 97 feet of seawater; and

c) providing a concrete fill at the intersection of the underside of the deck slab and the rear of the curtain wall so as to mitigate slam or wave impact pressures.

The applicant concluded that extending the ASW pump ventilation shafts (stacks) preclude the ingestion of seawater to the extent that the operation of the ASW pumps would not be impaired during the postulated Design Basis Flood events (Ryan, 1982).

The applicant concluded that the probability of large vessels (i.e. greater than 250 tons displacement) crossing the degraded breakwater and impacting the intake structure is acceptably low (storm-independent case is 6.7×10^{-6} events per year, Kircher, Monzon-Despanz, and Morris, 1982). With respect to the safety-related function of the ASW pumps, the impact of vessels displacing less than 250 tons on the intake structure would be inconsequential.

The applicant is in the process of reconstructing and strengthing the damaged portion of the west breakwater.

The staff and its consultant, the U.S. Army Coastal Engineering Research Center (CERC), were actively involved in the planning, monitoring and evaluation of the hydraulic model studies. The staff has determined that the licensee, during the progress of the physical hydraulic studies, has complied with the guidance provided in Regulatory Guide 1.125. Additionally, because the breakwaters, even in their assumed degraded condition, will provide a degree of wave protection to the Intake Structure, they are considered flood protection barriers, as defined in Regulatory Guide 1.102. The staff, with the assistance of CERC have reviewed the applicant's reports and has drawn the following conclusions:

a. Although sufficient evidence has been provided to indicate that breakwater degradation below the level of 0 feet MLLW is rare, the information provided by the applicant does not substantiate the assumption that a rubble-mound breakwater cannot degrade below that level.

b. The applicant has applied the most critical wave height, period, and direction of wave approach associated with both the "Probable Maximum Tsunami Annual Storm Wave Event" and the "Maximum Credible Wave Event". The staff concludes that there are appropriate design basis and are in concordance with Regulatory Guide 1.59.

c. Extending the ventilation stack for each of the Auxiliary Saltwater pump chambers on the Intake Structure to elevation +52 feet, MLLW will prevent significant ingestion of wave runup and spray and will allow unimpaired operation of the ASW pumps during the Design Basis Flood event.

d. The applicant has conservatively determined the wave pressures on the Saltwater Intake Structure and the ventilation stacks associated with the Design Basis Flood event with both breakwaters degraded to 0 feet MLLW level. The structural ability of the SW Intake Structure and the ventilation stacks to resist impact forces associated with the DBF event and other design events is discussed in the Section 3.4 of this SSER.

e. The applicant has conservatively determined the best estimate of the frequency of a vessel crossing the degraded breakwater and impacting on the Saltwater Intake Structure for the storm-independent case as 6.7×10^{-6} per year. The analysis was limited to those types of vessels with a draft shallow enough to cross over the breakwater and displacing more than 250 tons. Vessels displacing less than 250 tons will not inflict significant damage to the Intake Structure.

The staff therefore concludes that the Auxiliary Saltwater pumps would be flood protected for events up to and including the "Probable Maximum Tsunami Event" and the "Maximum Credible Wave Event" even if the entire length of both breakwaters were degraded to the level of 0 feet MLLW. Because there is no assurance that the breakwater will not degrade below the level of 0 feet MLLW, the staff will require, and the licensee has agreed to, a technical specification to:

a) monitor the condition of the breakwater,

b) implement timely corrective action when limited damage is sustained, and

c) identify the limiting condition for operation relative to the ~~MLLW~~ configuration of the breakwaters.

Based on its review and analysis, and the implementation of the technical specification, the staff concludes that the plant meets the guidance of Regulatory Guides 1.59, 1.102 and 1.125. The staff further concludes that the plant meets the requirements of General Design Criteria 2 and 10 CFR Part 100, Appendix A with respect to tsunami and wave induced flooding.

References

1. Lillevang, Omar J., Fredric Raichlen, and Jack Cox "The Height Limiting Effect of Sea Floor Terrain Features and of Hypothetically Extensively Reduced Breakwaters on Wave Action at Diablo Canyon Sea Water Intake" - Report on a Three-Dimensional Physical Model Study for Pacific Gas and Electric Company, March 15, 1982.

2. Wiegel, Robert L., "Breakwater Damage by Severe Storm Waves and Tsunami Waves," March 5, 1982.

3. Seed, H. Bolton, "Evaluation of Seismic Stability of Breakwaters at Diablo Canyon NPS." September 22, 1981 (Revised April 6, 1982).

4. Raichlen, Fredric, "The Investigation of Wave-Structure Interactions for the Cooling Water Intake Structure of the Diablo Canyon Nu lear Power Plant, December 1982.

5. Kircher, Charles A., Hector Monzon-Despang, and Richard J. Morris, "Frequency of Vessel Impact with the Diablo Canyon Intake Structures," December 10, 1982.

6. Lillevang, Omar J., "Criteria for Selection of Critical Wave Direction," November 2, 1982.

7. Matsuda, E. N., "Wave Effects on the Intake Structure at Diablo Canyon, Units 1 and 2," January 1983.

8. Ryan, P.J., "Investigation of Seawater Ingestion into the Auxiliary Salt Water Pump Room Due to Splash Runup During the Design Flood Events at Diablo Canyon," January 1983.