March 26, 1999

Mr. Gregory M. Rueger
Senior Vice President and General Manager
Pacific Gas and Electric Company
Diablo Canyon Nuclear Power Plant
P. O. Box 3
Avila Beach, California 93424

SUBJECT: ISSUANCE OF AMENDMENTS FOR DIABLO CANYON NUCLEAR POWER PLANT, UNIT NO. 1 (TAC NO. M97914) AND UNIT NO. 2 (TAC NO. M97915)

Dear Mr. Rueger:

The Commission has issued the enclosed Amendment No. 131 to Facility Operating License No. DPR-80 and Amendment No. 129 to Facility Operating License No. DPR-82 for the Diablo Canyon Nuclear Power Plant (DCNPP), Unit Nos. 1 and 2, respectively. The amendments approve a modification to the DCNPP, Unit Nos. 1 and 2 auxiliary saltwater (ASW) system to install bypass piping. This is in response to your application dated August 26, 1997, as supplemented by letters dated October 14 and November 13, 1997, and January 29, 1998.

These amendments revise the licensing basis as described in the Final Safety Analysis Report Update to incorporate the modification to the ASW system to install bypass piping over soil subject to liquefaction during a postulated Hosgri earthquake.

A copy of the related Safety Evaluation is enclosed. The Notice of Issuance will be included in the Commission's next regular biweekly Federal Register notice.

Sincerely,
Original Signed By

Steven D. Bloom, Project Manager
Project Directorate IV-2
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-275
and 50-323

Enclosures: 1. Amendment No. 131 to DPR-80
2. Amendment No. 129 to DPR-82
3. Safety Evaluation

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

PACIFIC GAS AND ELECTRIC COMPANY

DOCKET NO. 50-275

DIABLO CANYON NUCLEAR POWER PLANT, UNIT NO. 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 131
License No. DPR-80

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Pacific Gas and Electric Company (the licensee) dated August 26, 1997, as supplemented by letters dated October 14 and November 13, 1997, and January 29, 1998, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, by Amendment No. 131 , the license is amended to authorize revision of the Final Safety Analysis Report (FSAR) Update as set forth in the application for amendment by Pacific Gas and Electric Company dated August 26, 1997, as supplemented by letters dated October 14 and November 13, 1997, and January 29, 1998. Pacific Gas and Electric Company shall update the FSAR Update to reflect the revised licensing basis authorized by this amendment in accordance with 10 CFR 50.71(e).

3. This license amendment is effective as of its date of issuance and shall be implemented in the next periodic update to the FSAR Update in accordance with 10 CFR 50.71(e). Implementation of the amendment is the incorporation into the Final Safety Analysis Report Update, the changes to the description of the facility as described in the licensee's application dated August 26, 1997, as supplemented by letters dated October 14 and November 13, 1997, and January 29, 1998, and evaluated in the staff's Safety Evaluation attached to this amendment.

FOR THE NUCLEAR REGULATORY COMMISSION

Steven D. Bloom, Project Manager
Project Directorate IV-2
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Date of Issuance: March 26, 1999

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

PACIFIC GAS AND ELECTRIC COMPANY

DOCKET NO. 50-323

DIABLO CANYON NUCLEAR POWER PLANT, UNIT NO. 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 129
License No. DPR-82

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Pacific Gas and Electric Company (the licensee) dated August 26, 1997, as supplemented by letters dated October 14 and November 13, 1997, and January 29, 1998, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, by Amendment No. 129, the license is amended to authorize revision of the Final Safety Analysis Report (FSAR) Update as set forth in the application for amendment by Pacific Gas and Electric Company dated August 26, 1997, as supplemented by letters dated October 14 and November 13, 1997, and January 29, 1998. Pacific Gas and Electric Company shall update the FSAR Update to reflect the revised licensing basis authorized by this amendment in accordance with 10 CFR 50.71(e).

3. This license amendment is effective as of its date of issuance and shall be implemented in the next periodic update to the FSAR Update in accordance with 10 CFR 50.71(e). Implementation of the amendment is the incorporation into the Final Safety Analysis Report Update, the changes to the description of the facility as described in the licensee's application dated August 26, 1997, as supplemented by letters dated October 14 and November 13, 1997, and January 29, 1998, and evaluated in the staff's Safety Evaluation attached to this amendment.

FOR THE NUCLEAR REGULATORY COMMISSION

Steven D. Bloom, Project Manager
Project Directorate IV-2
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Date of Issuance: March 26, 1999

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 131 TO FACILITY OPERATING LICENSE NO. DPR-80

AND AMENDMENT NO. 129 TO FACILITY OPERATING LICENSE NO. DPR-82

PACIFIC GAS AND ELECTRIC COMPANY

DIABLO CANYON NUCLEAR POWER PLANT, UNITS 1 AND 2

DOCKET NOS. 50-275 AND 50-323

1.0 INTRODUCTION

By letter dated August 26, 1997, as supplemented by letters dated October 14 and November 13, 1997, and January 29, 1998, Pacific Gas and Electric Company (PG&E) submitted a license amendment request for the review and approval of a modification to the Diablo Canyon Nuclear Power Plant (DCNPP), Units 1 and 2 auxiliary saltwater (ASW) system to install bypass piping. The bypass piping installation project was initiated due to a concern that localized corrosion was occurring in the portion of the ASW piping buried below sea level in the tidal zone outside the intake structure. The ASW system provides cooling to the component cooling water (CCW) system, which in turn provides cooling to engineered safety feature (ESF) equipment and other plant components. The modifications involve bypassing approximately 800 feet of Unit 1 and 200 feet of Unit 2 safety-related piping, a portion of which is buried below sea level. Upgraded flow and temperature instrumentation will be included as part of the modification.

The October 14 and November 13, 1997, and January 29, 1998, supplemental letters provided additional clarifying information, did not expand the scope of the application as originally noticed, and did not change the staff's original proposed no significant hazards consideration determination published in the Federal Register on September 9, 1997 (62 FR 48677).

The existing ASW piping is safety-related and provides cooling water to the CCW heat exchangers (HXs) located inside the turbine building of Units 1 and 2. Each unit has two 24-inch carbon steel pipes with a nominal wall thickness of 375 mils. The pipes are lined with Paraliner, a modified polyvinyl chloride (PVC) with a nominal thickness of 1/8 inch. The piping exterior is coated with coal tar epoxy reinforced with fiberglass. The piping exits the intake structure between elevation 9.67 feet and 16.55 feet below sea level. The pipes remain below sea level for approximately 200 feet in Unit 1 and 80 feet in Unit 2. The existing ASW piping system is anchored to the circulating water conduits (CWCs) at intervals of 20 to 40 feet through concrete blocks which encase the pipe flanges, which are founded on, or embedded in, rock. The new ASW bypass piping is routed such that it is supported by the soil and is generally buried at a shallower depth than the existing piping.

In 1992, a 4-inch diameter annubar (above ground) piping access port in the ASW piping, adjacent to the turbine building, developed a hole due to external corrosion. Subsequent investigations identified pitting corrosion on the buried main ASW piping below the annubars. In order to better quantify the aging aspects of the buried ASW piping, the licensee initiated an investigative program to assess the extent of problem. In early 1995, testing programs, which were part of the investigative program, noted a potential for high rates of corrosion on the Unit 1 piping located in the tidal zone near the intake structure. As a result of the investigative/testing programs, the licensee decided to install a bypass around the questionable area of both units' ASW piping in the tidal zone.

Considering the factors of environment, electrical shorting of the piping sections, the potential for damage to the coating, and the lack of cathodic protection, the worst corrosion is expected to have occurred on the piping near the turbine building annubars and the Unit 1 tidal zone. The turbine area concerns were resolved by the licensee in 1992 by the addition of cathodic protection and repair of the coating. The tidal zone piping is buried up to 17 feet below sea level and 35 feet below the surface. Therefore, it was impractical for the licensee to excavate for a visual inspection. Internal inspections were also not very practical for various reasons. To resolve the question about the exact condition of the piping located in the tidal zone, the licensee elected to install new ASW piping that would bypass that section of piping.

To resolve the concern regarding the potential corrosion of the buried piping in the tidal zone, PG&E decided to bypass the potentially affected piping, by installing an ASW bypass system consisting of two trains of 24-inch diameter Schedule 20 piping for each unit. The pipes in each train are connected by 125 psi concrete-encased bolted flanges, 150 psi uncased flanges, and flexible joint couplings designed by the Dresser Corporation. The bends, where the pipes change direction, are also encased in concrete thrust blocks, which serve as anchor points where differential soil displacements are prescribed. The piping and the concrete thrust blocks are buried in the soil up to a depth of 12 feet, except for two blocks, which rest on rock. The bypass system bypasses approximately 800 feet of the existing Unit 1 piping and 200 feet of the Unit 2 piping. The project includes approximately 450 feet of new piping in the intake structure, and 1400 feet of new buried piping located between the intake building at one end, and tie-in joints with the existing piping at the other end. The tie-in joints are also encased in concrete blocks. The pipe materials and interior coatings are also the same as the original pipe. The original external coating is no longer available so it was upgraded to a Devoe Coatings' Devguard 238 System with two coats and a fiberglass lining. The internal/external coating system is intended to provide at least 20 years of protection in the expected environment of the bypass piping. Cathodic protection is also included to minimize the possibility of corrosion becoming a future issue.

The new piping will result in a reduction in flow because of the additional length of piping needed to bypass the existing piping. The following evaluation addresses the system functional aspects of the ASW piping modification including the resultant reduction in flow.

By letter dated January 27, 1997, PG&E initially submitted an analysis of the design change in accordance with 10 CFR 50.59, and determined that it did not involve an unreviewed safety question (USQ). By letter dated May 15, 1997, PG&E provided additional information in response to a request for additional information (RAI) dated April 4, 1997 from the staff. However, a preliminary review of PG&E's geotechnical consultant's report, "Revised Report, Liquefaction Evaluation, Proposed ASW Bypass, Diablo Canyon Power Plant," indicated that there was a high probability of liquefaction of the medium dense sands on which a portion of the Unit 1 ASW piping is founded. During a teleconference with PG&E, the staff pointed out that locating safety-related equipment or structures on liquefiable soil is not part of the licensing basis for DCNPP, and therefore it is a USQ. By letter dated August 26, 1997, PG&E submitted License Amendment Request (LAR) 97-11 for NRC approval of an ASW system modification to install bypass piping. By letter dated November 13, 1997, PG&E provided additional information in its response to a RAI dated October 14, 1997 from the staff. The NRC documented its determination of the USQ by letter dated December 3, 1997, to PG&E.

2.0 EVALUATION

2.1 Plant Systems Evaluation

The ASW bypass modification changed the routing and increased the length of the ASW supply piping. This change will increase the pressure drop in this piping and reduce the flow of ASW to the CCW HX by approximately 352 gallons per minute (gpm), or approximately 3 percent. The ASW system design criteria is to supply sufficient cooling water to the CCW HXs to support normal operation and mitigate design basis accidents (DBAs) without exceeding the CCW design temperature limits. The current licensing basis requirement is to provide sufficient flow to the CCW HXs to ensure that the maximum CCW temperature does not exceed 120 degrees fahrenheit (°F) with a one time allowable transient to 140°F for 6 hours.

The reduction in actual flow created by the bypass modification does not have any significant safety impact on the design and licensing basis for the system. As part of the ASW bypass modification, ASW flow and temperature instruments were replaced with more accurate instrumentation. In addition, the correction factors which were used to account for variations in tide level and HX differential pressure (dP) were determined to be very conservative and have been revised by the licensee. As a result of these changes, the corrections to the measured ASW flow will be smaller. Based on the licensee's calculations, the required corrections to the flow will decrease by more than the reduction in flow caused by the bypass modification.

The licensee's Surveillance Testing Procedure (STP) M-26, "ASW Flow Monitoring," is used to demonstrate that the ASW system provides the required cooling to the CCW HXs. The STP measures the ASW flow and then subtracts instrument accuracy and corrects for potential variations in tide level and CCW heat exchanger dP. The corrected ASW flow is then compared to the acceptance criteria. The acceptance criteria for STP M-26 has not changed as a result of the bypass modification. To demonstrate adequate flow margin still exists with the modifications, the licensee compared the margin that would exist with the modifications to the margin that existed using actual STP results. With the new correction factors for the flow and temperature instrumentation, and the recalculated tide and HX dP correction factors, it is expected that the test would pass the STP acceptance criteria with greater flow margin following the modifications. The staff has reviewed the licensee's projected test results and concurs with the licensee's conclusions that the ASW system will still perform within its design and licensing basis and that there will be no reduction in safety margin as a result of the piping modifications. In NRC Inspection Report Nos. 50-275/97-202 and 50-323/97-202, the staff also determined that the head loss due to the additional length of piping was not significant, and the ASW system design flow would still be maintained after the modifications. Based on these conclusions, the bypass piping modifications will not affect the ability of the ASW system to meet the requirements of General Design Criterion (GDC) 44, "Cooling water," with respect to providing adequate heat removal from safety-related structures, systems, and components.

In accordance with an existing surveillance procedure, provisions for visual inspection of the new bypass pipe are included. A 2-inch inspection port is located near the flowmeters and pumps for camera access to inspect the pipe interior. In addition, a spool piece inside the intake may be removed for internal piping camera insertions to view the pipe between the intake and the bypass tie-in. The cathodic protection system will be maintained with a recurring task maintenance program. Thus, the new bypass piping, with the new instrumentation, has adequate inspection and testing capability in accordance with GDC 45, "Inspection of cooling water system," and GDC 46, "Testing of cooling water system."

The new piping will also be designed to seismic Category I requirements, and will be adequately protected from the effects of other natural phenomena such as tornadoes and tsunamis and, therefore, the new bypass piping meets the requirements of GDC 2, "Design bases for protection from natural phenomena."

The licensee also performed an evaluation of the pipe break effects of the new bypass piping and determined that they are bounded by the existing medium [moderate] energy line break (MELB) analysis associated with the originally installed piping. Given that the new bypass piping is the same size and will operate under the same pressure, the staff concurs with the licensee's findings with regards to the MELB analysis. Thus, the requirements of GDC 4, "Environmental and dynamic effects design bases," with respect to adequate protection against pipe breaks, should continue to be met after the modifications.

Based on its review, as described above, the staff concludes that the planned modifications to add new ASW bypass piping is in accordance with the requirements of GDCs 2, 4, 44, 45, and 46 with respect to protection against natural phenomena, protection against the effects of pipe breaks, the capability to remove heat from safety-related components, and with respect to providing adequate inspection and testing capability, respectively. The staff, therefore, concludes that the planned modifications regarding the ASW bypass piping are acceptable.

2.2 Mechanical Evaluation

2.2.1 Materials

The bypass piping is fabricated from A106, Grade B carbon steel, the same as the existing piping. The interior of the bypass piping is also lined with Paraliner. The outside surface is coated with an abrasion resistant epoxy coating, except at ends connected by sleeve-type mechanical connections, which are also coated with Paraliner. Cathodic protection is also included along the entire length of the piping. Since the bypass piping is buried above sea level, it is located in a more benign environment to preclude corrosion. PG&E stated that this internal/external coating system, together with the cathodic protection, is expected to provide more than 20 years of protection in this environment. The staff finds this reasonable and acceptable.

2.2.2 Design Codes

The bypass piping is considered a modification of an existing system, and not a new design. The design of this piping was performed in accordance with applicable provisions of ANSI B31.7-1969 with 1970 Addendum, for Class III piping and related provisions and acceptance criteria of ANSI B31.1b-1973, supplemented by ASME Boiler and Pressure Vessel (B&PV) Section III, Winter 1972 Addenda, Subsection NC-3650 criteria, with an additional requirement for buried piping. This requirement consists in the absolute addition of the axial and bending stresses to determine the maximum axial stress in the pipe.

The flanges are standard B16.5 flanges (ASME/ANSI B16.5, Steel Pipe Flanges and Flanged Fittings, 1973). The design of the buried piping flanged joints was based on acceptance criteria from ASME B&PV Section III, 1989 Edition, Subsection ND 3658.1, and Appendix XI methods, modified for buried piping.

The concrete thrust blocks were designed by using the strength design method, based on ACI 318-71, "Building Code Requirements for Reinforced Concrete."

The piping and the concrete thrust blocks were designed for various load combinations which include dead load, soil settlement loads, liquefaction load, internal pressure, thermal expansion, tsunami loads, and seismic loads due to the Double Design Earthquake (DDE), the Hosgri earthquake, and the DCPP Long Term Seismic Project (LTSP) earthquake motion. However, the LTSP is not within the design basis for the DCPP, and is therefore outside the scope of this evaluation. An evaluation was also performed for Hosgri earthquake aftershock loads.

The staff has reviewed the load combinations and the acceptance criteria, and finds these acceptable and in conformance with the design basis of the DCPP.

2.2.3 Design of the Piping in the Intake Structure

The seismic analysis of the new piping in the intake structure was based on response spectrum analysis methods. The seismic loads were combined with dead weight, internal pressure and thermal expansion loads in determining the maximum piping stresses, in accordance with the existing licensing and design basis.

PG&E also performed missile and medium energy line break reviews for the bypass piping in the intake structure, and determined that there would not be adverse effects on surrounding equipment, since the bypass piping system is enclosed within security enclosures.

PG&E also upgraded the flow and temperature measurement elements used in ASW pump surveillance tests. The thermowells and flow metering tubes installed by this change were classified Instrument Class 1C because they are required to maintain the pressure boundary integrity of this piping.

2.2.4 Design of the Buried Bypass Piping

2.2.4.1 Geotechnical Parameters and Input Ground Motions

The design of the buried bypass piping included Hosgri, DDE and potential liquefaction of a limited zone beneath a portion of the piping system during an earthquake. Loads due to dead weight and soil settlement were not included, since these loads are insignificant for shallow buried piping.

To determine the input ground motion into the piping model, PG&E performed a seismic site response analysis, using the free-field computer program SHAKE (SHAKE - A Computer Program for Earthquake Response Analysis of Horizontally Layed Sites, Report EERC-72-12, University of California, Berkeley, December 1972) and the soil/structure interaction computer program SASSI (System Analysis for Soil Structure Interaction) (SASSI - A System for Analysis of Soil Structure Interaction, Report UCB/GT/81-02, University of California, Berkeley, April 1981). This program was used in the LTSP work that was accepted in Supplemental Safety Evaluation Report 34 (NUREG–0675, Supplement 34). The SASSI analysis generates the differential soil vertical and horizontal displacements at the concrete blocks and along the buried piping. The analysis was performed for the DDE, the Hosgri earthquake, and the LTSP earthquake.

2.2.4.2 Analysis

Analyses performed for the ASW bypass buried piping systems generally conform to applicable portions of the Standard Review Plan Section 3.7.2, Seismic System Analysis, Section 3.7.3, Seismic Subsystem Analysis, and Section 3.9.2, Dynamic Testing and Analysis of Systems Components, and Equipment.

The analysis of the buried bypass piping was based on beam-on-elastic-foundation type modeling. The piping and the concrete thrust blocks are assumed to rest on Winkler-type springs, representing the soil, except for two blocks and the Intake structure, which rest on rock. One end of the piping is assumed to be rigidly anchored to the Intake structure. The pipe is modeled by a series of flexible and rigid beams (representing the blocks), and by closely spaced foundation springs. The concrete encased pipe bends were considered rigid. The piping segments between anchors were connected by flanges, some encased in concrete, and by Dresser type couplings. These couplings permit free relative motion in the axial direction, and act as hinges in the lateral direction, thus eliminating moment transfer across a coupling and reducing the bending stresses in the piping.

The stiffness properties of the Winkler springs and the differential soil displacements depend on the shear velocity in the soil, which in turn depends on the assumed soil properties. Using the SASSI program, PG&E performed a parametric study to determine the largest soil stiffness, corresponding to a high shear velocity, and the largest displacements, corresponding to a low shear velocity. This is a conservative approach which the staff finds acceptable.

The responses of the system were determined from quasi-static analyses using the general purpose linear elastic finite element program SAP90 (Structural Analysis Program). The largest horizontal and vertical differential soil displacements from the SASSI analysis were prescribed at the concrete thrust blocks and at the soil springs. These differential displacements induce pipe deformation, and axial forces and bending moments. The analysis of the buried system was divided in two parts, one for determining the axial effects, and the other for determining the lateral effects. The uncoupling of the axial and lateral effects is permissible because the piping consists essentially of straight runs, as a result of encasing the pipe bends in the concrete thrust blocks. The analysis for axial effects considered soil friction forces and axial differential displacements. It was based on manual calculations, in accordance with conventional engineering practice. The results of the two analyses were later combined by absolute sum in the evaluation of the stresses in the piping and the concrete thrust blocks. This methodology is in accordance with current industry practice as reflected in ASME Guidelines for the Seismic Design of Oil and Gas Pipeline Systems, 1984 and Brookhaven National Laboraty Report BNL-52361, "Seismic Design and Evaluation Guidelines for the Department of Energy High-Level Waste Storage Tanks and Appurtenances, October 1995 . The staff concurs with this approach, and finds it reasonable and acceptable.

2.2.4.2.1 Dresser Couplings

The bypass piping contains components designed to accommodate and reduce potentially high axial loads. The initial seismic analysis of the buried piping showed that the relative movements between the concrete thrust blocks would induce axial loads and strains beyond the axial load capacity of the piping, if only rigidly connected flanges were used. To absorb the relative axial movements and limit the axial loads in the pipes and the moment demand on the concrete thrust blocks, PG&E installed bolted sleeve-type (Dresser type 24½ inch diameter, Style 38) mechanical couplings, to act as pipe expansion joints near the thrust blocks and at intermediate locations in the piping. To qualify these couplings, PG&E conducted a series of cycling tests to assure the couplings would perform their safety function. The tests were conducted using production pipes and couplings in a test rig installed at the DCPP site. A description of the coupling and the qualification testing was provided in PG&E letters dated January 27, 1997, and August 26, 1997.

A coupling consists of a 7-inch long, 24¼-inch inside diameter, 3/8-inch thick slightly bulged tube into which the pipe ends are inserted, with a 1½ inch gap in between. Leak tightness is provided by wedge shaped rubber gaskets, clamped at each tube end. All metal contact surfaces are covered with Paraliner. During an event, the pipe ends move relative to each other. Free operation is obtained by applying, during assembly, a silicone-based lubricant to the pipe surfaces and the gaskets, thus reducing the friction between the pipe coating and the gaskets to near zero. The determination of the proper lubricant for this application was also part of the qualification testing.

Although the pipes are postulated to be subjected to simultaneous internal pressure and seismic soil motion, the tests were conducted in the "dry" condition, where sinusoidal cycling motion was imposed first, followed by a hydrostatic test to check for gasket leakage. Due to the size of the piping involved, it was impractical to conduct the tests with simultaneous internal pressure and cyclic motion. This, however, was acceptable since the pressure retaining capability of the coupling does not depend on the internal pressure to seal.

The test sequence consisted of one OBE followed by one Hosgri, a hydrostatic test, then 4 more OBEs, another hydrostatic test, then 3 fragility tests (beyond Hosgri) and the final hydrostatic test. This sequence is considered to meet the intent of IEEE 344-87, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations." The maximum peak-to-peak relative axial displacement expected under Hosgri seismic conditions is 1.1 inches, under an operating pressure of 102 psig. The minimum required peak- to-peak relative displacement for Hosgri qualification was specified as 1.5 inches at 4.5 Hz-5.5 Hz, and the subsequent hydrostatic test was conducted at 150 psig. A cyclic fragility test, performed after the Hosgri test, found that the couplings could experience a maximum relative peak-to-peak displacement of nearly 3 inches at 5 Hz, without damage to the gaskets. None of the hydrostatic tests indicated post-test leakage, but a visual examination of the mating surfaces at the end of the tests indicated some wear of the Paraliner.

In addition to the tests, PG&E also provided past Dresser data on tests of a 14-inch, Style 38 coupling, which were conducted under simultaneous axial cycling for 30 seconds at 10 Hertz with 1 inch amplitude, and internal pressure of 225 psig. There was no visible evidence of water leakage from the coupling during or after the test. PG&E also provided the manufacturer's recommended maximum joint rotation under internal pressure of the attached pipes, before detection of leakage, as 4 degrees. PG&E specified this rotation as the coupling capacity under normal and abnormal conditions.

The staff has evaluated PG&E's qualification of the 24½-inch Dresser-type mechanical couplings and finds it reasonable and acceptable.

2.2.4.3 Evaluation in the Liquefaction Zone

PG&E also evaluated the response to soil settlement of Unit 1 bypass piping passing through the soil liquefaction zone. Liquefaction induced settlement displacements occur after the termination of a seismic event, due to the dissipation of pore pressures in the soil which are maximized during the strong shaking phase of an earthquake. As a result, the soil spring stiffnesses are based upon "at rest" soil properties, instead of the dynamic soil properties.

Based on the extent of the liquefiable zone, PG&E demonstrated that only vertical ground settlements due to liquefaction could occur after an earthquake event. PG&E postulated the maximum surface ground settlement to be the same as the absolute maximum surface ground vertical displacement due to a Hosgri earthquake. The staff accepted this estimate of liquefaction-induced settlement, as it is based on reasonable assumptions related to the soil properties.

2.2.4.4 Slope Stability

Because the Unit 1 ASW bypass piping, in one section, descends at a 2:1 slope, PG&E performed a static slope stability analysis, and a pseudo-static stability analysis under a design basis seismic event, based on the Hosgri and LTSP earthquakes.

Based on these analyses, PG&E determined a factor of safety under static loading of 3.2 at the most critical slip plane, in excess of the design basis minimum of 1.5. PG&E also concluded that the slope displacements are insignificant for both Hosgri and LTSP earthquake ground motions and therefore, the stresses resulting from these displacements are also insignificant. The staff finds these conclusions reasonable and acceptable.

2.2.4.5 Tsunami Loading

PG&E has provided storm wave protective measures to protect the bypass piping from scouring effects of tsunami conditions. Therefore, the only tsunami load that PG&E considered was due to design basis submergence level over the buried pipes. The resulting hydrostatic pressure loading is enveloped by the Hosgri earthquake loading combination. The staff finds this reasonable and acceptable.

2.2.4.6 Hosgri Aftershock Loading

By letter dated November 13, 1997, PG&E provided the results of an evaluation of the bypass piping system to a postulated aftershock from a Hosgri earthquake, concurrent with Hosgri-induced liquefaction effects. PG&E postulated that the aftershock from a Hosgri earthquake produces the same effects as the Hosgri main shock. The staff concurs with this loading combination, and finds it acceptable.

2.2.5 Results of Analyses

In response to a staff request for additional information, dated October 14, 1997, PG&E provided in the November 13, 1997, letter, details and results of the analyses under the loading conditions listed above. PG&E determined the response of the piping, unencased flanges, concrete thrust blocks and Dresser type couplings, and demonstrated, for all loading combinations, that the largest stresses in the piping satisfied the design allowables by substantial margins. PG&E also demonstrated that the slip displacement and rotational demands of the Dresser couplings were well within the maximum specified capacities.

The highest loaded concrete thrust blocks are three blocks located in the liquefaction zone. PG&E demonstrated that the moment and thrust demand under the liquefaction effects loading combination, is well within the moment capacities and slide resistance capacities of the blocks. This loading combination also included abnormal internal pressure, resulting from simultaneous start-up of all ASW pumps.

The staff has reviewed these results and finds them reasonable and acceptable.

Based on the review of PG&E's submittals, the staff finds within its scope of review, that the design calculations performed by PG&E for the Diablo Canyon ASW System Piping Bypass Project under Hosgri earthquake, Hosgri aftershock, potential Hosgri soil liquefaction, slope stability and tsunami conditions are reasonable and acceptable, and conform with the Diablo Canyon licensing basis and generally accepted engineering practices.

2.3 Geotechnical Evaluation

2.3.1 Evaluation

Geotechnical Parameters

The construction area of the ASW bypass buried pipeline consists of engineered backfill over bedrock with soil depths to bedrock ranging from five to 30 feet. The licensee had contracted with a consulting firm to conduct soil sampling and testing for the bypass route to obtain geotechnical inputs for the seismic and site response analysis of the ASW bypass piping and for the analysis of slope stability for the Unit 1 piping (which passes through the liquefiable soil zone). Based on these geotechnical investigations, the median (low-strain) shear wave velocity of the soil was taken as 800 feet per second, and uncertainty in the shear wave velocity was considered by using upper bound and lower bound velocities of 1,220 and 650 feet per second, respectively. The modulus reduction and damping values for the site were also calculated in accordance with accepted geotechnical engineering practices. In addition, PG&E performed sensitivity studies for three cases of seismic wave incidence angles based upon the results of site specific studies performed during the Diablo Canyon Long Term Seismic Program (LTSP). PG&E's calculations and uncertainty analyses for the estimation of the geotechnical parameters for the project site are considered acceptable because the procedures for their estimation follow generally accepted engineering practices and previous procedures accepted by the staff for the Diablo Canyon LTSP.

Input Ground Motion and Soil/Structure Interaction (SSI) Analysis

The design basis seismic input for the Diablo Canyon Power Plant is based on the input ground motion applied to rock. However, the ASW bypass piping is not founded on the bedrock. It has been rerouted such that it is supported by the soil and is generally buried at a shallower depth than the original ASW piping. Therefore, PG&E performed a seismic site response analysis for different earthquakes, i.e., LTSP, Hosgri, and Double Design Earthquake (DDE) using the SHAKE program. An SSI analysis was also performed using the SASSI computer program to determine the displacements imposed on the buried piping system. In this analysis, PG&E considered the effects of variability in shear wave velocity, wave incidence angles, and soil modulus reduction. The staff considers the procedures used by PG&E in these analyses acceptable, as they are based on the current state of the art and conform to the relevant SRP section.

Liquefaction

There is a five-foot thick section of medium dense sand (located below the ground water table) at a depth of 25 feet (beneath the ASW piping bypass route) with low standard penetration test blow count data. PG&E's consultant evaluated the liquefaction potential of this sandy layer and found it susceptible to liquefaction during a major seismic event. The 5-foot thick liquefiable layer is, however, surrounded by highly-dense materials which are not susceptible to liquefaction. Therefore, the important question is the areal extent of the liquefiable soil layer and the consequences of liquefaction of this layer. In response to a staff question on this subject, PG&E has stated that the engineered backfill placed previously in the intake structure area (including portions of the sandy soils area) is dense to very dense, and that only localized zones (pockets) of liquefiable medium dense sand are present. However, PG&E conservatively assumed, for purposes of analysis, a larger area of liquefiable zone (approximately 10 to 20 feet wide and 120 feet long). The staff has reviewed the boring log data in this area and accepts PG&E's characterization of the liquefiable zone.

After defining the areal extent of the liquefiable zone, PG&E evaluated the possible settlement of the susceptible area using the LTSP earthquake peak ground acceleration (PGA) of 0.83g and assuming that the entire five feet of sand liquefied. The maximum vertical settlement calculated was 1.0 inch at the liquefiable depth to about 0.5 inch at the ground surface for the LTSP event. Differential settlement of the ASW bypass piping could occur during an earthquake event because the pipeline crosses over the liquefiable zone of soils. PG&E has taken the maximum differential settlement to be the same as the maximum absolute ground surface settlement of 0.5 inch; and the staff agrees with this assumption. Horizontal spreading was not considered due to the highly dense nature of the surrounding soils which would contain the liquefied soils. The staff considers the estimate of liquefaction-induced settlement acceptable, as it is based on reasonable assumptions related to the soil properties, and conforms to the recommendations of SRP Section 2.5.4, "Stability of Subsurface Materials and Foundations."

Slope Stability

Because the Unit 1 ASW bypass piping, in one section, descends at a 2:1 slope, PG&E performed a static slope stability analysis, and a pseudo-static stability analysis under a design basis seismic event. For the latter analysis, PG&E used the Hosgri earthquake which has a higher PGA than the DDE, i.e., 0.75g vs 0.40g, and a longer duration. PG&E also performed a pseudo-static slope stability evaluation using the LTSP earthquake (0.83g PGA). In the seismic stability analyses, PG&E utilized the residual shear strength of the medium dense sands assuming that they may liquefy under a seismic event. In response to a question about the basis for the value of the residual shear strength assumed in its analysis, PG&E has cited data based on post-earthquake field measurements. The staff has verified the data and found that the value of residual shear strength (700 pounds per square foot) used in the analysis is reasonable.

Based on its stability analyses, PG&E found that the static analysis yielded a factor of safety of 3.2 at the most critical slip plane, in excess of the design basis minimum of 1.5. PG&E further determined that the pseudo-static analyses yielded results sufficient to conclude that the slope displacements are insignificant for both Hosgri and LTSP earthquake ground motions. Because the licensee utilized the stability analysis procedures that generally conform to the SRP 2.5.5, "Stability of Slopes", and used the appropriate earthquake ground motions, the licensee's conclusions concerning the safety of the slope along the ASW Bypass route are acceptable to the staff.

Based on the review of PG&E's submittals, the staff concludes that the geotechnical investigations performed by the licensee for the Diablo Canyon ASW System Piping Bypass Project are adequate and acceptable. The staff further concurs with PG&E's determination that the probable liquefaction of the 5-foot thick medium dense sand layer will induce a maximum vertical settlement of about 1.0 inch at the liquefiable depth and about 0.5 inch at the ground surface for the LTSP earthquake event. The staff also concurs with PG&E's estimation of the maximum differential settlement of the pipelines as 0.5 inch (which is equal to the maximum ground surface settlement) for the purpose of pipe stress analysis. Furthermore, the geotechnical input parameters (such as the earthquake ground motion and liquefaction-induced settlements of the buried pipes) used by PG&E in its pipe stress analysis as well as the slope stability analysis are reasonable and acceptable. In general, the licensee's analyses are considered acceptable to the staff as they conform to the requirements of the NRC Standard Review Plan Sections 2.5.4 and 2.5.5 and the Diablo Canyon licensing bases.

3.0 STATE CONSULTATION

In accordance with the Commission's regulations, the California State official was notified of the proposed issuance of the amendments. The State official had no comments.

4.0 ENVIRONMENTAL CONSIDERATION

These amendments change a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (62 FR 48677). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

5.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

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