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ACCESSION NBR:9709030239 DOC.DATE: 97/08/26 NOTARIZED: YES DOCKET #
FACIL:50-275 Diablo Canyon Nuclear Power Plant, Unit 1, Pacific Ga 05000275
50-323 Diablo Canyon Nuclear Power Plant, Unit 2, Pacific Ga 05000323

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See Proposed change To Tech spec

SUBJECT: Forwards LAR 97-11 to licenses DPR-80 & DPR-82,requesting mod to auxiliary saltwater for installation of bypass piping.

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August 26, 1997

PG&E Letter DCL 97-150

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Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
License Amendment Request 97-11
Auxiliary Saltwater System Piping Bypass Unreviewed Safety Question

Dear Commissioners and Staff:

Enclosed is an application for amendment to Facility Operating License Nos. DPR-80 and DPR-82 in accordance with 10 CFR 50.59 and 10 CFR 50.90. This license amendment request (LAR) submits for NRC review and approval a modification to the Diablo Canyon Power Plant (DCPP) Units 1 and 2 auxiliary saltwater (ASW) system to install bypass piping. The bypass piping project was initiated due to a concern that localized corrosion was occurring in the portion of the piping buried below sea level in the tidal zone outside the Intake Structure. The ASW system provides cooling to the component cooling water system, which in turn provides cooling to engineered safety feature equipment and other plant components.

The design change on Unit 1 installed piping so that approximately 800 feet of originally installed ASW pipe was bypassed. In addition, upgraded flow and temperature instrumentation were installed. The bypass piping tie-ins to the existing Unit 1 ASW piping were completed in May 1997 during the Unit 1 eighth refueling outage. A similar modification is scheduled to be tied in to the existing ASW piping in Unit 2 during the Unit 2 eighth refueling outage (2R8), scheduled to begin in February 1998. Prior to installation of the bypass piping in Unit 1, an evaluation of the piping installation was performed in accordance with 10 CFR 50.59, 10 CFR 50.54 (p), and 10 CFR 51.22. The 10 CFR 50.59 evaluation concluded that the proposed change was not an unreviewed safety question (USQ). The 10 CFR 50.59 evaluation was reviewed and approved by the DCPP Plant Staff Review Committee.

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Since the project was a large modification, PG&E believed that the installation might be of interest to the NRC. Accordingly, PG&E, on January 27, 1997, submitted a letter to the NRC (DCL-97-010, "Auxiliary Saltwater System Piping Bypass Project") describing the ASW bypass piping project and the associated 10 CFR 50.59 evaluation. Following submittal of the 10 CFR 50.59 evaluation, a meeting was held on March 25, 1997, with NRC staff personnel to discuss the installation of the bypass piping and the features of the DCPP design.

By letter dated April 4, 1997, the NRC requested additional information regarding the installation of the bypass piping. PG&E responded to the request in a letter to the NRC dated May 15, 1997 (DCL-97-091, "Response to Request for Additional Information Concerning Auxiliary Saltwater System Piping Bypass Project"). PG&E concluded that its responses to the additional questions did not change the conclusion of the original 10 CFR 50.59 evaluation that the installation of the bypass piping was not a USQ.

On August 15, 1997, PG&E and the NRC staff in a telephone conversation discussed the technical issues related to the installation of the bypass piping. The NRC staff, based on their review of a technical report that served as part of the basis for the 10 CFR 50.59 evaluation, stated their opinion that the installation of the ASW bypass piping involved a USQ because using the conservative Seed-Tokimatsu analysis of the soil in the tidal zone in which the bypass piping was installed indicated that liquefaction of the soil was probable during a postulated Hosgri earthquake. Further, the NRC staff indicated that the potential for liquefaction at DCPP was not considered in the licensing basis of the plant.

As stated in the January 27, 1997, submittal, PG&E evaluated the potential for seismic induced liquefaction for a portion of the Unit 1 buried pipeline. PG&E's conclusion that the ASW bypass piping installation did not involve a USQ was based on the judgment that any potential liquefaction would not be significant, if it occured at all, using the latest analytical techniques; and even if it were to occur as predicted by the more conservative liquefaction analysis method any liquefaction could be accommodated by the use of standard and industry accepted seismic design and analytical methodologies. This conclusion is documented in the safety evaluation submitted on January 27, 1997.

As noted above, PG&E is aware that the NRC technical staff has reached a different judgment on whether the ASW bypass piping involves a USQ. Accordingly, in order to resolve this disagreement in an expeditious manner, while at the same time preserving PG&E's position regarding the correctness of its prior actions, PG&E is submitting this LAR for NRC review of the installation

as a USQ pursuant to the NRC staff's conclusion. PG&E has evaluated the current configuration of Unit 1 and believes that based on the design of the system, which accounts for the worst possible cases of liquefaction, the ASW system is operable and Unit 1 is not required to be shut down while this request is being reviewed by the NRC. The area analyzed for potential liquefaction is isolated to only a portion of the Unit 1 bypass piping, and does not affect the Unit 2 ASW bypass piping location.

The ASW bypass piping is completed and in operation in Unit 1. PG&E also plans to tie-in the Unit 2 ASW bypass piping during the 2R8 scheduled to begin in February 1998. Therefore, PG&E requests that this LAR be reviewed as high priority, and an approved LAR issued no later than February 15, 1997. PG&E requests that the approved license amendment be effective upon approval by the NRC.

Sincerely,

Greg Rueger

Gregory M. Rueger

cc: Donald B. Allen
Edgar Bailey, DHS
Steven D. Bloom
Ellis W. Merschoff
Kenneth E. Perkins
Diablo Distribution

Enclosures:

1. Figure 1, Drawing "Auxiliary Saltwater System Bypass Piping - Plan View Intake Hillside Areas"
2. Figure 2, Drawing "Auxiliary Saltwater System Bypass Piping - Partial Plans and Sections (Intake Area)"
3. Figure 3, Drawing "Auxiliary Saltwater System Bypass Piping - Partial Plans & Sections In Intake Access Road"
4. Figure 4, Drawing "Auxiliary Saltwater System Bypass Piping - Partial Plans, Sections, Details on Hillside"
5. Figure 5, Drawing "DCO-EP-49207, Interior Piping Isometric"
6. Report "Dresser® Style 38, 24-1/2 Inch Coupling Cyclic Displacement Qualification Test," dated November 22, 1996 (partial report)

7. Revised Report, Liquefaction Evaluation, Proposed ASW Bypass, dated August 23, 1996
8. Geotechnical Consultation, Liquefaction Evaluation, ASW Bypass Piping Unit 1, dated October 1, 1996
9. Liquefaction Evaluation, Proposed ASW Bypass, dated August 20, 1997

AUXILIARY SALTWATER SYSTEM PIPING BYPASS - UNREVIEWED SAFETY QUESTION

A. DESCRIPTION OF AMENDMENT REQUEST

This license amendment request (LAR) requests NRC review of modifications to the auxiliary saltwater (ASW) system to bypass approximately 800 feet of Unit 1 and 200 feet of Unit 2 Class 1 ASW pipe, a portion of which is buried below sea level in the tidal zone outside the Intake Structure. Upgraded flow meter and temperature instrumentation will be included. The project includes approximately 450 feet (both Units) of new pipe inside the Intake Structure, and 1,400 feet of new buried pipe between the Intake and selected tie-in points in the existing pipe. The Unit 1 modifications were completed in May 1997 during the Unit 1 eighth refueling outage (1R8). The Unit 2 modification is scheduled to be performed during the eighth refueling outage (2R8) scheduled to begin in February 1988.

B. BACKGROUND

The existing ASW piping is safety-related and provides service water to the component cooling water (CCW) heat exchangers (HX). Each unit has two 24 inch carbon steel pipes with a nominal wall thickness of 375 mils. The pipes are lined internally 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 buried piping is supported from the concrete circulating water conduits (CWCs) at intervals of approximately 20 to 40 feet. These attachments are through concrete blocks which encase the pipe flanges. The CWCs are relatively rigid and are founded directly on or embedded in rock. The piping is locally backfilled with clean, graded sand. The buried ASW piping was designed to be protected against corrosion by the use of an internal liner and the exterior coating system. The internal liner continues to be very effective as demonstrated by extensive visual inspection. The external coating system was the most effective system available at the time of installation.

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, an investigative program was initiated in late 1992. A consultant was used to assure that the expertise of the corrosion protection industry was utilized in this investigation.

The consultant conducted a system-wide (supply piping) corrosion assessment to determine the extent of electrical shorting to other structures, estimate the condition of the external coating, and project the potential for corrosion damage. Initial testing was completed in early 1994. A second consultant was retained to independently verify the testing to date and to perform additional testing necessary to quantify the condition of the ASW system.

In early 1995, the testing program noted a potential for high rates of corrosion on the Unit 1 piping located in the tidal zone near the Intake. A non-conformance report was initiated to establish and track corrective actions. The recommendation was to install a bypass around the questionable area of both Units in the tidal zone. Operability Evaluation 95-03, Revision 0, "Operability of the Auxiliary Salt Water System With Potential External Corrosion," was issued on May 5, 1995. The current Revision 4 was issued May 20, 1997.

The lack of an installed cathodic protection system over the complete length has allowed the potential for localized corrosion to occur at holidays (pinhole defects) in the coating. Measures were taken to prevent holidays at the time of installation. However, as the coating degrades due to age, holidays will allow corrosion to initiate. In estimating the current condition of the buried piping, it is felt holidays exist in the coating and that isolated corrosion pits exist. Estimates of the effective corrosion rate in the worst areas produce pits of considerable depth at any long existing holidays. Factors which assure that the ASW piping remains operable at these pits are the relatively low system pressure, the counteracting soil pressure, the expected isolated nature of the pits, the low seismic strain on the piping, and the strength and confirmed good condition of the PVC Paraliner.

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 Building area concerns were resolved 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. It is impractical to excavate for a visual inspection. Internal inspections, using a remote ultrasonic device is not practical due to the unavailability of inspection "pigs," lack of a location to launch a "pig," and the varying thickness of the Paraliner. Some corrosion, localized but not general, is

expected to have occurred on the piping located in the tidal zone and elsewhere. Cathodic protection was recently installed on the tidal zone piping, thus arresting further corrosion there.

To resolve the question about the exact condition of the tidal zone piping, new piping will bypass this section. The piping outside the Intake Structure will be cathodically protected.

DETAILED PROJECT DESCRIPTION

This section provides a detailed description of the design, construction, and operational aspects of the bypass.

GENERAL FEATURES

Work was initiated in May 1995 to develop a method of installing a bypass around the potentially corroded ASW pipe below sea level. The basic criteria for the pipe routing were:

- Buried pipe to be above sea level to simplify construction and improve the pipe environment.
- New pipe must not have intermediate high points that would require installation of air relief or vacuum breaker valves.
- Minimize number of bends and added length to limit reduction in flow.
- No disruptions to existing buildings or facilities.

The selected routing in the Intake Structure runs to the south end of the Intake below the -2 foot deck elevation. The pipes then rise to elevation +6.5 foot (Unit 1) and +10.5 foot (Unit 2) and exit the Intake Structure through the east wall. The pipe in this area is conventionally designed and supported. The outside pipe exits the Intake, runs below ground to the road behind the Intake, turns north, and runs north under the road. The Unit 2 pipes then turn to parallel the Unit 2 Intake conduit where the tie-in will be made. The Unit 1 pipes continue north to approximately the centerline line of the Intake where they turn to run parallel to the Unit 1 Intake conduits. Because of the configuration of the Unit 1 Intake conduits and the ASW pipe attached to them, the bypass then runs up the hill to the tie-in location in the parking lot near the Meteorological Tower. Figures 1 through 5 show the piping routing.

Pipe size selection was based on an analysis of expected pipe routing and reductions in flow caused by the additional flow resistance. Calculations were

made based on the various sizes of pipe that were available. The differences between flow losses in 24 inch and 26 inch pipe sizes were minimal, and the larger pipe sizes were not readily available. The decision was made to use 24 inch pipe, the same as the original installation.

Pipe material and interior coatings are the same as the original pipe. The interior Paraliner had shown excellent performance in the corrosive seawater environment. The original external coating is no longer available and was upgraded to a Devoe Coatings' Devguard 238 System with two coats and a fiberglass lining. The internal/external coating system should provide greater than 20 years of protection in the mild environment of the bypass. Cathodic protection is also included to assure corrosion does not become a future issue.

DESIGN INSIDE THE INTAKE

Conventional design methods were used for the piping located inside the Intake Structure. The configuration of the pipes was limited due to the possibility of maintenance activities that would require the removal of the circulating water pump (CWP) 120 inch discharge valves.

Pipe support loads are resisted by the east wall, the top deck, and the -2 foot elevation slab in the Intake. These locations have been qualified to resist all applied loads. A massive pipe anchor is designed to transfer the thrust loads to the floor and ceiling. The anchor also prevents the out-of-plane loads from pipe thrust being placed on the Intake Structure east wall.

The installation of the bypass pipes provided the opportunity to upgrade the flow and temperature measurement elements used in ASW pump surveillance tests. The existing instrumentation has limited accuracy, and results in large penalties for instrument uncertainty. The thermowells and flow metering tubes installed by this change are classified Instrument Class 1C because they are required to maintain the pressure boundary integrity of this piping. The instruments are classified as performance monitoring equipment, used for acquiring quantitative flow data in support of testing to demonstrate safety-related ASW pump operability for conformance to Technical Specifications (TS). The calibration of the flow and temperature instruments is safety-related and traceable to National Institute of Standards & Technology. The flowmeters were calibrated at Alden Laboratories using production pipe from the project. The Unit 1 temperature instruments were calibrated onsite. The Unit 2 temperature instruments will also be calibrated onsite.

Temperature measurement instruments are resistance temperature detectors (RTDs) with digital readouts. The flowmeters are ABB Kent-Taylor Magmaster magnetic flowmeters. Their location in the Intake provides a minimum of 17

diameters of straight pipe upstream and 6 diameters downstream. This is in accordance with the manufacturers recommendations.

In addition, a 2 inch diameter drain valve was added to the bypass pipe to allow drainage of the system for maintenance. A 2 inch port is installed upstream of the flow meters for camera inspection of the pipe and flow meter internal surfaces. A flange insulation kit isolates each pipe from the external cathodic protection system.

The new piping location requires a change to the security features in the Intake. The original pipes were included in a pair of vital areas accessed by card reader doors. The new pipe configuration is protected to the same level as previously. The area of the vital areas was expanded to encompass the entire pipe system in the Intake area with card reader door access, lighting, and ventilation.

DESIGN OF OUTSIDE PIPE

After the general routing of the outside pipe was determined, exploratory trenching was performed to verify the location of utilities and concrete structures. Harding Lawson Associates (HLA) performed a geotechnical evaluation including test pits, exploratory drilling, and laboratory testing. An extensive history search was made of the Intake construction records. (The entire outside pipe is in an area that was excavated and backfilled for the original Intake and CWCs.) The final excavation limits, which were to rock, were determined. The backfill compaction records were located and evaluated. A slope stability analysis was performed by HLA for the hill behind the Intake where the Unit 1 pipes will be buried.

The outside piping design is conventional buried pipe design with Design Class 1 concrete thrust blocks for seismic, dynamic system, and hydrostatic loads. The buried pipe seismic analysis included Hosgri and double design earthquake (DDE) and potential soils settlement resulting from liquefaction of a limited zone beneath a portion of the piping system. Evaluation of the Long Term Seismic Program (LTSP) loading was also performed to fulfill PG&E's commitment regarding future safety-related modifications. A seismic site response analysis was performed to determine soil displacements for use in the buried piping system analysis.

The seismic analysis showed that the movements between the thrust blocks would be beyond the strain limits of the pipe if rigidly connected joints were used. Therefore, Dresser® couplings were used to act as a "seismic expansion joint" to limit the loads in the pipes. According to the manufacturer's recommendations, Dresser® couplings gaskets can absorb only limited movement. However, Dresser® had performed a test in 1978 where a 14 inch diameter coupling,

similar to those used in the existing Diablo Canyon Power Plant (DCPP) ASW pipe, was cyclically displaced up to ± 1/2 inch.

To seismically qualify the Dresser® couplings to be used in the ASW bypass, where potential displacement demands could exceed the manufacturers recommendations, PG&E conducted a series of tests to assure the couplings would perform their safety functions. The test program used "production" pipes and couplings in a site designed test rig. The results, discussed in Figure 6, were satisfactory. The coupling met all requirements including the DCPP LTSP fragility tests, which required displacements up to nearly 3 inches and no leakage in post testing hydro tests.

The buried outside pipe requires protection against storm waves and tsunami in accordance with the design basis. PG&E contracted with Bechtel Corporation Geotechnical and Hydraulic Engineering Services to develop recommendations. Bechtel used the DCPP design basis criteria and scale model test results performed after the 1981 storm damage to the breakwater, and previous investigations of the Intake cove area, to develop storm wave energy, height, and duration. Bechtel then provided an evaluation for the potential of erosion of the soil supporting the pipe. Their report includes requirements that have been incorporated into the design for seawall reinforcement, protection of the buried pipe in the yard area with concrete and asphalt surfaces, and a gabion blanket (buried galvanized steel baskets filled with large stones) to protect the pipes where they run up the hill to the Unit 1 tie-in.

With the new pipe location above sea level, the external coating system, and the low projected corrosion rates, corrosion is expected to be very limited. PG&E will conservatively include a Non-Class 1 cathodic protection system.

CONSTRUCTION

The construction is being performed by PG&E Outage Services to approved plant procedures.

Potential flooding during construction is enveloped by the design basis flooding analysis in place for normal plant operation. The outside drainage system will prevent run-off from entering the excavation. A weather protection plan is in place to prevent flooding of the Intake in the storm season.

Security compensatory measures during construction maintain the required level of security at all stages in the construction.

The tie-in to the Unit 1 pipes was completed in May 1997 during 1R8. The Unit 2 tie-in will be done during 2R8 scheduled to begin in February 1998. It will be

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included in the regular ASW maintenance outage window. One train of ASW will remain available at all times. The pipe and all required features will be complete prior to the outage except for the tie-in spools in the Intake and at the foot of the hill. The ASW pipe will be cleared and drained. One spool at the foot of the hill will be removed, and the tie-in piece installed. In the Intake, the existing pipe will have its flanges unbolted. Two spools make up the connection between the old and new pipes. The system will then be leak tested and appropriate testing will be performed.

OPERATIONAL ISSUES

The pump surveillance testing procedures (STPs) will be revised to include new flow and temperature instrumentation. The increased accuracy of the new test equipment will result in an increase in credited flow (see Section D.2, "Auxiliary Saltwater Flow Reduction Evaluation").

The impact on operations will be minimal. The bypass has no control room functions, readouts, or alarms. The temperature and flowmeters have provision for remote readouts, but none are included in this project. The additional drain valve will be included in the ASW valve alignment procedure.

In accordance with an existing surveillance procedure, provisions for visual internal 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 tie-in.

The storm wave and tsunami protection features require no maintenance. Inspections of the features will be included in the structure portion of the Maintenance Rule. The surface of some of the Intake parking lot and road will require an engineering evaluation before any future excavation work. This information is included in the qualification list and appropriate procedures.

The cathodic protection system will be maintained with a recurring task maintenance program.

C. JUSTIFICATION

This modification to the ASW piping is required to bypass potentially corroded ASW pipe below sea level. This will assure the continued integrity of the ASW pressure boundary, and operability of the ASW system.

D. EVALUATIONS

1. SAFETY EVALUATION

The following is a summary safety evaluation which describes each important design, operation, maintenance feature, and safety consideration involved.

DESIGN FEATURES

GENERAL

Change in ASW Flow

Installation of the new bypass piping will reduce ASW flow. However, this slight reduction will not affect the ability of the ASW system to perform its intended safety function. The design basis flow is maintained with a margin and there is no significant effect on the CCW heat removal capacity. A detailed evaluation of the ASW flow reduction is provided in Section D.2.

This design change will not impact the system design for controlling water hammer in the pipes. The ASW bypass piping for both Units will be tied into the ASW system at an elevation below that of vacuum breaker vaults. Vertical alignment of bypass pipes have no intermediate high points which would require installation of air relief or vacuum breaker valves.

Medium Energy Line Break

Bypass pipes inside the Intake conform to piping design criteria and are analyzed for the ASW service conditions. Per Design Criteria Memorandum T-12, "Flooding, Missiles, HELB, MELB," a medium energy line break (MELB) review was performed for the bypass pipes. The bypass pipes are within security enclosures which can protect nearby equipment from damage due to spray.

The evaluation of MELB effects determined that the only concern was flooding potential. However, even though there is a significant increase in piping inside the Intake, a MELB associated with the bypass pipes remains bounded by the current MELB analysis. There are no flooding effects on ASW pumps or essential equipment. The ASW bypass pipes run below the pump deck and pass through a hatch to exit the Intake Structure. The piping runs are above the invert/sump area and grate covered hatches in the pump deck. Floor drains are also located in the vicinity. Class I-E circuits entering the Intake Structure through the East wall are encased in metal conduits.

Abandoned Unit 1 pipes were cut off and sealed at the Intake Structure east wall to preclude future leakage of ground water into the Intake.

Effect of flooding on the bypass piping and supports is judged to be enveloped by normal deadload, seismic, and internal pressure loads.

Heavy Loads

Circulating water butterfly valves and their respective hatch covers are the only heavy loads lifted during maintenance activities near the bypass pipe routes.

Maintenance Procedure MP-M17.4, "Circulation Water Discharge Valve Handling," will be revised to require an engineering evaluation prior to any heavy load movements related to these valves, including at the Unit 2 Flow Control Valve (FCV)-491 hatch. The Unit 2 FCV-492 hatch at elevation 17.5 feet, near the southeast corner of the Intake will be semi-permanently sealed and will not normally be used for moving materials or equipment into or out of the Intake.

The restriction/exclusion area shown in MP-MA1.ID14, "Control of Heavy Loads," (Appendix 6.8) was revised to incorporate changes to the load restriction areas.

Pipe Materials and Coatings

The new bypass pipes and Dresser® couplings are lined with Paraliner suited for saltwater service. The existing ASW pipes are lined with Paraliner. The exterior coating will be more resistant to abrasion, holiday tested, and placed in a bedding with a relatively high resistivity sand. Because of the shallower piping alignment, the bypass pipes are not below sea level as are existing pipes. A Non-Class I cathodic protection system will also protect bypass pipes.

Exterior coatings for pipe supports are applied over a near white surface and will be suitable for service inside the Intake Structure.

Sleeves located where the four bypass pipes exit the Unit 2 Intake exterior wall are coated and the annular space between the sleeves and spools sealed to protect them from corrosion. The sealer also functions as a moisture barrier.

The flow elements are lined to protect the metal tubes and flanges from corrosion by saltwater. The metal surfaces on the outside of the flow tubes are painted. In addition, the same coating that is applied to the pipe will be applied to the flow element external metal surfaces.

The thermowells and flow element grounding rings are Hastelloy, which resists saltwater corrosion.

Internal Missile Analysis

Inside the Intake Structure, bypass pipes will be adequately supported and will not become missiles. Components adjacent to bypass pipes inside the Intake, including the CWPs and motors, have been reviewed and will not become or generate missiles which could damage the ASW bypass pipes. The new security enclosures have been seismically qualified and will not become missiles.

Seismically Induced Systems Interaction Issues

Pipes mounted inside the Intake Structure that are potential seismically induced systems interaction sources are supported by seismically qualified supports. The only targets located in the vicinity of the pipes are these ASW bypass pipes.

The security enclosures/separation barriers which are constructed to restrict access to the bypass pipes are lightweight structures which are supported from the adjacent concrete walls and slabs of the Intake Structure, and have been seismically qualified.

The panels for the flow transmitters and temperature indicators are lightweight (approximately 75 lbs) and are anchored in such a way that they will not detach from the wall and affect any targets.

The thermowells are small, lightweight components bolted to 2 inch diameter branch connections on the ASW pipes. The capability of the 2 inch pipe to support the thermowells is greatly in excess of their weight.

Fire Protection

Combustible loading for the Intake Structure above elevation -2 feet will be increased by approximately 13 pounds of glass fiber reinforced plastic instrument housings for the flow transmitters and temperature indicators. The combustible loading for the Intake Structure below the -2 feet elevation has been increased by approximately 93 pounds for the new flow element magnetic coil housings which are glass fiber reinforced plastic filled with foam. The increased combustible loading does not decrease the level of fire protection.

INSIDE INTAKE DESIGN

Interior Pipe Design and Supports

Response spectra have been developed for piping and attachments inside the Intake Structure. Pipes and their supports have been designed for Hosgri and

DDE loading in accordance with the existing licensing and design basis.

Drain Valves (upgrade)

The addition of new drain valves in the bypass piping will have no adverse impact on system flow and operation; the new drain valves will simplify draining of ASW pipes for maintenance or internal inspection.

Flow Elements Pipe (upgrade)

Piping flow elements are installed for each train inside the Intake Structure to facilitate testing of the ASW system operation. The bypass will be tested when it is connected to the ASW system. The addition of the new flow elements will have no adverse impact on system flow and operation.

Flow Metering Tubes and Thermowells (upgrade)

Magnetic flow metering tubes and thermowells containing RTDs are installed in each bypass train. The commercial grade thermowells and flow metering tubes are classified as Instrument Class IC and are dedicated for this installation by the replacement parts equivalency program. The flow metering tubes are located in-line and are connected to bypass pipes by flanges. The safety-related function of the flow elements (flow metering tubes) and thermowells is to maintain the integrity of the pressure boundary of the Design Class I bypass piping. These flowmeters will be used instead of the annubars presently used to measure the ASW flows. This design change package (DCP) will leave annubars in place and unchanged. The purpose of the replacement is to improve the accuracy of flow measurements of pump and system performance. The RTDs and flow indicating transmitters provided by the modification have no safety-related function but will be added to the Plant Monitoring Equipment Program.

The flow instrument calibration range (0-15,000 gpm) encompasses the minimum and maximum values of the ASW pump capacity. The temperature indicator range (32 - 90°F) encompasses the range of seawater temperatures at the site.

No alarms are required since the instrumentation is not required for operation. The instrumentation provides local indication only and there are no control functions.

The flow metering tubes and thermowells meet the existing design and licensing basis.

Qualification of Intake Structural Elements for Class 1 Piping Induced Loads

The Intake Structure walls and floors have been qualified to resist applied loads from the bypass system. The structure is capable of resisting all support and anchor reactions resulting from the bypass piping.

The condition of the Intake Structure interior east wall concrete and reinforcing steel has been tested and evaluated. The local condition of the concrete and rebar for the Unit 2 Intake wall was tested during installation of pipe spools and sleeves through the east wall. Inside the Intake, the condition of concrete and rebar was tested near the penetrations. Outside the wall, the portion of the wall exposed by the excavation was tested.

The holes made where bypass pipes for both Units exit the Intake will be repaired with concrete and reinforced with additional reinforcing steel placed around the pipes and sleeves inserted in walls. The annular space between pipe spools and sleeves was filled with a sealer on the east end of the sleeve. Pipes will be allowed to move in response to axial loads. The Intake Structure east wall will support in plane loads; a new structural steel pipe support will support both lateral and axial load.

Security Barrier Modifications

The security enclosures/separation barriers constructed to restrict access to the bypass pipes are lightweight structures which are supported from the adjacent concrete walls and slabs of the Intake Structure, and have been seismically qualified. The security barriers are Non-Class 1 structures. These security modifications will not reduce the effectiveness of the existing security plan.

Natural Events

Tornado analysis

ASW bypass piping inside the Intake Structure is protected by the Intake Structure. At access openings in the top deck, protection where required is provided by reinforced concrete covers and steel. DCP C-49323 will provide modifications to the Intake facilities related to tornado and tornado missiles.

Tsunami evaluation

Intake Structure compartments with the exception of the ASW pump compartments, are not watertight and are subject to external flooding under tsunami conditions. Such flooding would not adversely affect the bypass pipelines. ASW pumps and vents for pump compartments will not be affected by

this design change.

Effect of flooding on the bypass piping and supports is judged to be enveloped by normal deadload, seismic, and internal pressure loads.

OUTSIDE INTAKE DESIGN

Buried Piping Seismic Analysis

The buried piping system was designed for seismic loading conditions in accordance with applicable design basis requirements. The analysis addresses the seismic responses and other effects of support by the soil on the buried bypass piping. Section D.4, "Analysis of Buried Piping System," provides a detailed discussion.

Dresser® Coupling Usage

Flexible couplings (i.e., Dresser® couplings) have been provided to limit axial stresses which could be induced in pipelines by a seismic event. Use of suitable proprietary couplings is allowed by the design basis for the ASW system piping (paragraph 118 of ASME B31.1). Estimated axial movements and lateral deflections are enveloped by the allowable movement and rotation capabilities for the couplings as provided by the manufacturer and prescribed by American Water Works Association C219 and testing performed by PG&E. Manufacturer's data and PG&E's testing demonstrate: (1) the couplings are suitable for maximum system water pressures, (2) they can retain a watertight seal after a seismic event, and (3) the suitability of seal materials for the functional lifetime of the pipelines.

Couplings also: (1) limit stresses due to differential displacement between the pipes, structure, thrust blocks, etc., (2) facilitate fit-up of pipe spools, and (3) limit seismic forces transmitted to the east wall of the Intake Structure and existing ASW pipes and the CWC at the tie-in locations.

See enclosed Figure 6 regarding "Dresser® Style 38, 24-1/2 Inch Coupling Cyclic Displacement Qualification Test."

Buried Piping Restraints (Thrust Blocks)

Thrust blocks for the ASW pipes are classified as Design Class I. Pipe envelope material is classified as Graded Quality Item (Class S), and soil backfill is classified as Design Class II. Concrete thrust blocks are provided at all changes in direction to offset hydraulic and seismic forces. Limiters (harness restraints) are installed at some locations to limit maximum movement at the couplings.

Limiters do not contribute to the qualification of the buried piping system to Hosgri and DDE design requirements. Limiters are Non Design Class 1 and are added to improve the seismic margin in LTSP evaluations.

Geotechnical Evaluation

Geotechnical evaluations were performed in support of the buried bypass piping design to investigate the site along the route of the piping and established inputs for the seismic and site response analysis. Stability of the slope where the Unit 1 bypass piping was buried and potential for liquefaction were also evaluated. Section D.3, "Geotechnical Evaluation," provides a detailed discussion.

Cathodic Protection

A cathodic protection system is included for the new bypass piping outside the Intake Structure, existing ASW piping, and the piping abandoned as a result of the bypass. It is a Non-Class 1 system that provides additional assurance of minimum corrosion attack on the pipe.

Storm Protection Evaluation

The effects of tsunamis and storm waves that could affect the bypass piping were evaluated in accordance with the design basis. Wave effects were established from records of and results from previous scale model testing.

Protective measures for the buried piping were designed to mitigate the effects of tsunamis and storm waves. Section D.5, "Tsunami and Storm Wave Protection Evaluation," provides a detailed discussion.

Tornado Protection

The bypass piping located outside of the Intake Structure is protected against tornado effects by burial under at least 5 feet of soil, or a reinforced concrete slab where the burial depth is less than 5 feet.

CONSTRUCTION ISSUES

There will be no appreciable impact on environmental quality. Existing pipes were drained and saltwater returned to the Intake cove per existing DCPP procedures prior to installation of removable spools near the Unit 1 tie-in locations and again when the Unit 1 bypass pipes are connected to the ASW system. Buried portions of the bypass pipes were installed in previously disturbed areas. No drainage paths were modified and no new discharge points will be added. Siltation and dust were controlled during construction and the

work areas were cleaned up after work is complete. During relocation of the rental seawater reverse osmosis (SWRO) brine line, the current practice of discharging brine into the Intake Structure was maintained.

Flooding During Excavation

Normal construction practices were utilized to minimize storm run-off entering the excavation and Intake. Flooding of the Intake during construction is bounded by the MELB analysis discussed above.

Fire Protection

This DCP has installed a new fire hydrant at the Intake while the 6 inch asbestos cement pipe firewater line is temporarily removed. Jumpers were provided to supply firewater inside the Intake. Intake facilities and surrounding areas are still accessible for emergency vehicles via the roadway on top of the Intake Structure. The work did not affect any other fire protection system, barriers, or enclosures.

Increased fire loading during construction was controlled by existing plant procedures for temporary and transient combustibles.

Tie-in to Existing Pipe

Existing Unit 1 pipes were exposed within an excavation twice. Unit 1 pipes were first exposed during cutting of existing pipes for installation of the removable spools during the Unit 1 seventh refueling outage (1R7). Pipes were again exposed prior to and during tie-in of the bypass piping.

The existing pipe spools modified during 1R7 are straight and level at the tie-in location and attached at each flange and intermediate locations to the CWC by reinforced concrete encasements. The flange encasements remained buried and undisturbed. The pipes were cut between the intermediate encasements. One train was cut at a time; the other train remained operational. The concrete encasements and restraint on pipes from soil bearing and friction adequately supported pipes against dead loads, loading due to water flow, and possible seismic loads while the pipes were exposed in the excavation. Such support is adequate until the bypass tie-ins are completed. The pipes were temporarily backfilled after the removable spools were installed.

Cutting of existing pipes and tie-in of the Unit 1 bypass pipes took place during the tie-in operation for the underground pipes. All new/replacement for Units 1 and 2 ASW bypass supply pipes, except their associated tie-ins, along with all their associated pipe supports were/will be installed prior to the start of any Unit

2 tie-ins inside the Intake Structure.

Construction Security:

Appropriate physical security compensatory measures will be established to protect the ASW piping consistent with physical security plan (PSP) commitments during construction activities that may have the potential to affect existing measures.

2. AUXILIARY SALTWATER FLOW REDUCTION EVALUATION

COMPARISON TO PREVIOUS DESIGN

The ASW bypass project changed the routing and increase the length of the ASW supply piping. This change will increase the pressure drop in this piping and will reduce the flow of ASW to the CCW HX by approximately 352 gpm, approximately 3 percent.

DESIGN CRITERIA

The ASW system design criteria is to supply sufficient cooling water to the CCW HXs to support normal operation and mitigate design basis accidents without exceeding the CCW design basis temperature limits.

LICENSING BASIS

The ASW system licensing basis requirement is to provide sufficient flow to the CCW HXs to ensure that the maximum CCW temperature does not exceed 120°F with a one time allowable transient to 140°F for 6 hours.

DESIGN EVALUATION

STP M-26, "ASW Flow Monitoring," is used to demonstrate that the ASW system provides adequate cooling to the CCW HX. The STP measures the ASW flow and then subtracts instrument inaccuracy and corrects for potential variations in tide level and CCW HX differential pressure (dP). The corrected ASW flow and temperature are then compared to the acceptance criteria. The acceptance criteria in STP M-26 have not changed as a result of the bypass project.

There is not a safety significant issue associated with the reduction in flow caused by the bypass. As part of the ASW bypass project, ASW flow and temperature instruments were replaced with more accurate instruments. In addition, the correction factors which are used to account for variations in tide

level and HX dP were found to be very conservative and have been revised. As a result of these changes, the corrections to the measured ASW flow will be smaller. Based on Calculation M-988, the required corrections to the flow will decrease by more than the reduction in flow caused by the bypass. In addition, the current STP results show that flow margin exists.

The following example using actual STP values illustrates the projected results:

- A tide level of +1 foot
- A CCW HX dP of 105 inches of water
- Saltwater temperature of 63°F
- CCW HX outlet temperature of 71°F
- Measured flow rate of 12377 gpm

STP M-26 specifies the methodologies for calculating flow correction factors. In accordance with the current revision of the STP, 446 gpm would be subtracted to account for the low tide conditions and 255 gpm would be subtracted to account for the maximum permissible CCW HX dP prior to HX cleaning. Next, the STP would subtract 220 gpm to account for the accuracy of the flow instruments. Thus, the "corrected" flow would be 12337 - 446 - 255 - 220 = 11,416 gpm. The required ASW flow rate depends on the actual ASW and CCW temperatures. After accounting for 1.5°F instrument inaccuracy, an ASW temperature of 64.5°F is credited. Similarly, a CCW temperature of 71 + 4 = 75°F is credited. Using these temperatures, in accordance with STP M-26, a flow of 10,987 gpm is required. Therefore, for this example, the test would have passed with 11416 - 10987 = 429 gpm of margin. At colder, more typical ASW temperatures, more margin exists than this example shows.

For the same values above, the estimated reduction in flow due to the bypass project is 352 gpm. Thus, a measured flow of 12337 - 352 = 11985 gpm is expected. Since the tide and CCW HX dP correction factors have been recalculated to more accurately reflect actual plant conditions, 357 gpm for tide and 227 gpm for HX dP are subtracted from the measured flow, and 180 gpm would be subtracted to account for the accuracy of the new flow instruments. This results in a "corrected" flow of 11221 gpm. The more accurate ASW temperature indication would allow the ASW temperature of 63.8°F to be credited. Along with a credited CCW temperature of 75°F, the required ASW flow would be 10572 gpm. Therefore, the test would pass with 649 gpm of margin.

STP M-26 has been revised for Unit 1 and will be revised for Unit 2 to incorporate these new correction factors and accuracies.

The reduction in actual ASW flow will not impact the results of previous CCW HX performance testing. Performance test calculations (to compute apparent fouling) use the flow rates which are measured during the test. The test determines the overall heat transfer coefficient (U), which includes film coefficients that are a function of flow and also includes a fouling factor, which does not depend on flow (fouling is constant). Design basis accident analyses compute U using design flows and fouling.

CONCLUSIONS

The design and licensing basis requirements of the ASW system continue to be met. In addition, the calculation demonstrates that the ability of the ASW system to pass STP M-26 will not be affected.

REFERENCES

1. Mechanical Calculation M-988

2. STP M-26

3. GEOTECHNICAL EVALUATION

COMPARISON TO PREVIOUS DESIGN

The existing ASW buried piping system was anchored to the CWCs, which are founded on or embedded in rock. The ASW bypass piping, in contrast has been rerouted such that it is supported by the soil and is generally buried at a shallower depth than the existing buried piping. These differences necessitated several different geotechnical evaluations that were not required in the design of the existing buried piping system. These geotechnical evaluations are described in this section.

DESIGN EVALUATION

SITE INVESTIGATION AND TESTING

The original construction of the Intake Structure and CWCs involved excavation and filling of the area to the east of the Intake Structure, and took place in 1970-1971. In 1980-1981, electrical ductbanks located above the Intake CWCs for both Units were repaired. Fill placement records for these construction activities

were reviewed. Excavation drawings and construction photographs were examined to determine the depth of fill and rock locations in the vicinity of the route of the bypass piping. Review of these records indicates that backfill material was placed and compacted in accordance with specifications during initial construction and later repairs to electrical duct banks.

Previous geotechnical investigations, which included a variety of borings and trenches, were also reviewed. These data were used in conjunction with site investigations performed specifically for the ASW bypass project described in this section.

PG&E contracted with HLA to perform soil sampling and testing along the route for the bypass pipes. This was in order to confirm geotechnical inputs for the seismic site response analysis of the ASW bypass buried pipeline and for the analysis of slope stability for the Unit 1 piping.

HLA performed field testing involving test pits, borings, and sample collection in December of 1995 and January of 1996; and subsequently prepared the reports "Geotechnical Field and Laboratory Investigation, ASW System Bypass," and "Dynamic Soil Properties for Analysis of ASW Piping System Bypass," addressing shear wave velocities, soil modulus reduction, and damping curves for use in the seismic site response analysis. HLA contracted with a soil testing laboratory to perform laboratory tests. The data resulting from these investigations were also used to support slope stability and liquefaction evaluations for the site.

A commercial grade dedication of the soil testing work done by HLA and their contractor was accomplished by PG&E's Geosciences Department, working under the Nuclear Quality Assurance (QA) Program of PG&E's Technical and Ecological Services.

SELECTION OF GEOTECHNICAL DESIGN INPUTS FOR SEISMIC AND SITE RESPONSE ANALYSIS

This section summarizes the important design inputs to the seismic and site response analysis resulting from geotechnical investigations. The use of these parameters is described in more detail in Section D.4.

The median (low-strain) shear wave velocity of the soil was taken as 800 feet/second based upon geotechnical investigations described above. Uncertainty in the shear wave velocity was considered by using lower bound and upper bound shear wave velocities of 650 feet/second and 1200 feet/second, respectively.

Modulus reduction and damping curves described in "Guidelines for Determining Design Basis Ground Motions," (EPRI TR-102293, Project 3302) corresponding to a reference strain of 0.1 percent, were used in the site response analyses. These curves are very similar (G/Gmax and damping curves vary only a few percent from Seed and Idriss curves) to the upper bound curve for modulus reduction, and the lower bound curve for damping of sands developed by Seed and Idriss. This combination of the Seed and Idriss curves has been widely accepted for estimating modulus reduction and damping in low plasticity soils such as those present at the site. Sensitivity of the site responses to variability in the modulus and damping reduction curves was considered by studying the effect of applying curves corresponding to a reference strain of 0.2 percent, in accordance with recommendations of HLA.

Sensitivity studies were also performed for three cases of seismic incidence angle: 0°F vertical incidence body waves and ±36°F inclined incidence body waves. The ±36°F wave incidence angles used were based upon the results of site specific studies performed by PG&E during the LTSP.

POTENTIAL LIQUEFACTION OF SOILS

During the review of the results from soil borings beneath a portion of the proposed Unit 1 buried pipeline, an area of medium dense sand was noted. This zone of medium dense sand was identified by blow count data from penetration tests in two borings at a depth of about 25 feet. In both borings, the zone of medium dense sand was confined by high density material both above and below. From the depth of the borings and the moisture in the sand at these locations, it was concluded that the groundwater table is nearby.

These conditions suggested that liquefaction of the medium dense sand following a major earthquake may occur.

Data from other borings made as part of the ASW bypass project as well as from previous site investigations were gathered. Construction photographs and excavation and backfill records for the circulating water tunnels and the Intake Structure were also reviewed. This information suggests that the zone of potential liquefaction is limited in size, and covers an area of about 10 to 20 feet by 100 feet with a thickness of about 5 feet. The zone lies at a depth of about 25 feet below the ground surface, and is confined on all sides by high-density materials that are not susceptible to liquefaction. All available data indicates that high density material exists at all other locations along the bypass buried pipeline.

To address the liquefaction issue, an analysis of the susceptible zone was performed by HLA. This analysis included consideration of a large seismic event

having a magnitude of 7.5, and a peak ground acceleration (PGA) of 0.83 g, as well as a magnitude 6.0 event, having a smaller PGA of 0.35 g. The smaller event was intended to provide an indication of the effects resulting from an operating basis earthquake type event, while the larger represents a Hosgri or LTSP event.

The HLA analysis was based upon the Seed-Tokimatsu method for estimating settlements due to liquefaction. In this analysis, it was assumed that the entire 5 feet thick zone would liquefy. The slope stability evaluations performed by HLA, discussed in a subsequent section, also considered the low strength materials found in this study and potential failure planes through them.

Using these conventional and conservative methods of analysis, HLA concluded that the liquefaction effects would be limited to (vertical) settlement of the soil; lateral spreading was precluded because of the limited size of the liquefiable zone and the high-density materials surrounding it. Due to arching effects, HLA estimated that upper bound settlements would vary from about 1 inch in the liquefiable zone to about 0.5 inch near the ground surface for the Hosgri or LTSP event. For the smaller seismic event, the upper bound displacements in the liquefiable zone and at the surface are estimated to be 1/2 inch and 1/4 inch, respectively. Application of scale factors (i.e., seismic margin factors) to the LTSP input motion would result in small increases to the predicted settlement, since the Seed-Tokimatsu curves are dependent mainly on earthquake magnitude. The LTSP earthquake has a maximum magnitude of 7.2.

More recent data and methods on liquefaction effects from large earthquakes suggest that the Seed-Tokimatsu approach is quite conservative, and that liquefaction would not occur at the ASW bypass site, or would have effects that are considerably less severe. These new data have increased the database of liquefaction effects observed in soils that have standard penetration test blowcounts in the range of those identified at the ASW bypass site (References 8, 9, 10, and 11). These data were not available when the methods used in the ASW bypass analysis were developed. However, no credit was taken in the evaluation for those methods, and liquefaction was conservatively assumed to occur for the purpose of design analysis only. The basis for this is as follows (from Enclosure 9):

> *It should be noted that the value of 15 was not measured in a true penetration test but was obtained by converting the blowcounts measured using a larger diameter sampler and is likely conservative. Also, the inferred value of 15 was obtained just below the water table and it may have resulted from a temporary imbalance of water pressures inside and outside the drill pipe. The previous sample in the same boring in similar material had an inferred blowcount in the order of 100. Regardless, for*

the purposes of the slope stability evaluation it was assumed that there was a zone of saturated, medium dense sand bounded by the CWI conduit, the adjacent rock slope and the intake structure with a depth of 5 feet, a width of 10 to 20 feet, and a length of 100 feet. It is clearly stated in the Harding Lawson report that "this is a conservative assumption, given that the fill was reportedly compacted to at least 95 percent relative compaction. It is more likely that the sands range from being medium dense to dense within the zone defined above." Making this assumption, and then, very conservatively, using normalized blowcounts in the range of 15 to 19 in conjunction with the procedures of Seed et al. (1985), even though it is now generally accepted that the Seed et al. procedure is not based on lowest blowcounts in a profile but rather some kind of "conservative average," it was determined, again for the purposes of the slope stability evaluation, that there was a high probability of liquefaction of this zone and that a residual undrained shear strength should therefore be used in the slope stability evaluation. Even when those conservative assumptions were made, failure through this zone that was assumed to be susceptible to liquefaction was found to be even less likely than other potential modes of failure as shown in Plate 3 of the Harding Lawson report.

While the slope stability evaluation had not suggested that there was any real possibility of liquefaction, even in this restricted zone, PG&E subsequently asked Harding Lawson if they could estimates the total and differential settlements that would accompany dissipation of excess pore pressures in this zone if the same conservative assumptions were made for the purposes of design of the ASW bypass piping. These estimates are presented in the second Harding Lawson report.

Because there was some concern that the conservative assumptions made in these evaluations might be construed as implying that there was a real possibility of liquefaction occurring at the site, a section headed "Comments Regarding Predicted Settlements" was added to the second Harding Lawson report. This section makes three points which can be summarized as follows:

1. *Recent research indicates there is no evidence of liquefaction in sand deposits with minimum normalized SPT blowcounts exceeding 15;*

2. *The zone under the ASW bypass that was assumed, for the purposes of the analysis, to be subject to liquefaction, would, if it exists, be a soft inclusion that would not feel the same stresses and strains in an earthquake as a semi-infinite horizontal layer, and therefore standard analysis procedures are additionally conservative for this geometry;*

3. *The zone in question may not be fully saturated and, even if it is, the drainage path for dissipation of excess pore pressures is very short.*

The predicted settlements from liquefaction were applied directly to the bypass piping subgrade model as discussed in Section D.4. Because settlements from liquefaction can only occur after the dissipation of pore pressures in the sand induced by earthquake motions, the displacements resulting from liquefaction were not applied concurrently with seismically-induced soil displacements. Instead, liquefaction-induced settlements alone were applied in a separate load case as discussed in Section D.4.

Evaluation and conclusions from the soil liquefaction analysis are described in the HLA reports "Liquefaction Evaluation, Proposed ASW Bypass, Diablo Canyon Power Plant," dated August 23, 1996; and "Liquefaction Evaluation, ASW Bypass Piping, Unit 1, Diablo Canyon Power Plant," dated October 1, 1996, and in a letter from Dr. Robert Pyke dated August 20, 1997.

SLOPE STABILITY ANALYSIS

The Unit 1 bypass buried piping ascends a 2:1 (horizontal : vertical) slope to the parking area near the Meteorological Tower. To ensure the stability of the slope in which the bypass piping is buried, an evaluation was performed by HLA. The evaluation considered normal and seismic conditions. Geotechnical data gathered from previous investigations was used to support the evaluation.

A static slope stability evaluation was performed using standard limit equilibrium methods to determine the factor of safety using both circular and noncircular slip surfaces. The most critical slip surface passed through the toe of the slope, and provided a factor of safety of 3.2, far in excess of the minimum value of 1.5 required by the design basis.

A pseudo-static slope stability analysis was performed to assess stability under a design basis seismic event. For this analysis, only the Hosgri earthquake was used, since its PGA is significantly higher than the double design earthquake (0.75 g vs.0.40 g), and has a longer duration. In this analysis, the horizontal yield coefficient that reduces the factor of safety to unity is determined and compared with the input time history. Estimates of slope displacement may also be computed by considering the peaks in the input time history that exceed the yield coefficient. HLA determined from the pseudo-static slope stability analysis, that the yield coefficient of 0.67 g is sufficient to conclude that the displacement of the slope will be insignificant in response to a Hosgri earthquake.

HLA also performed a pseudo-static slope stability evaluation using a LTSP

earthquake input motion (0.83 g PGA), with conclusions similar to the Hosgri case. Even with a scale factor of 1.4 applied to the LTSP input motion (i.e., a seismic margin factor of 1.4), HLA concluded that the slope displacements would be insignificant. This is due to the limited number of peaks exceeding the yield level, and their relatively high frequency, which do not significantly contribute to the accumulation of displacements.

Slope stability evaluations are described in the HLA report, "Geotechnical Slope Stability Evaluation, ASW System Bypass Unit 1, Diablo Canyon Power Plant," dated July 3, 1996.

ENGINEERING QA

Engineering work performed by HLA was covered by PG&E's Nuclear QA Program, in accordance with procedural requirements. Since the computer code (UTEXAS3, Version 1.204-(C)) used by HLA to perform the slope stability evaluations did not fully meet PG&E's Nuclear QA Program requirements, results generated by this code were verified by Bechtel's Geotechnical Engineering Group, using the SLOPEW code. Bechtel's SLOPEW code has been certified, and engineering work performed in accordance with their QA program. Bechtel's Nuclear QA Program has been certified by PG&E, and appears on the qualified suppliers list.

<u>Standard Review Plan</u>

Geotechnical investigations performed for the ASW bypass buried piping system generally conform to the applicable portions of the Standard Review Plan, Sections 2.5.4, "Stability of Subsurface Materials and Foundations," and 2.5.5, "Stability of Slopes." Additional investigations were performed specifically for the ASW bypass project to augment data collected during original construction and previous site investigations conducted during licensing of the plant. The ASW bypass buried piping will be located in areas that were excavated and backfilled during the construction of the Intake Structure and CWCs. Sources of the backfill are known, and controls on its placement were implemented. Dynamic soil properties were based upon the results of soil sampling and testing along the route of the buried bypass piping.

Geologic features of the site and earthquake design bases were previously investigated during plant licensing. Both of these areas were extensively investigated as part of the LTSP.

Potential liquefaction at the site was investigated and addressed using conventional methods as described in this section.

CONCLUSION

Based on the soils test data and the application of standard engineering principles and practices, the dynamic soils properties used for the analysis of the ASW bypass piping are consistent with the licensing commitments set forth in the Final Safety Analysis Report (FSAR).

Potential soil liquefaction effects resulting from the Hosgri and LTSP input motions have been evaluated and are considered in the buried piping system analysis.

The slope stability analysis demonstrated that the slope in which the Unit 1 ASW bypass piping is routed, is stable with a large factor of safety under static conditions. The slope remains stable under the Hosgri and LTSP input motions, with margin.

REFERENCES

1. Geotechnical Field and Laboratory Investigation, ASW System Bypass, Units 1 and 2, Diablo Canyon Power Plant, May 8, 1996, Harding Lawson Associates.

2. Pyke, R., Dynamic Soil Properties for Analysis of ASW Piping System Bypass, Diablo Canyon Power Plant, May 28, 1996.

3. Liquefaction Evaluation, Proposed ASW Bypass, Diablo Canyon Power Plant, August 23, 1996, Harding Lawson Associates.

4. Liquefaction Evaluation, ASW Bypass Piping, Unit 1, Diablo Canyon Power Plant, October 1, 1996, Harding Lawson Associates.

5. Geotechnical Slope Stability Evaluation, ASW System Bypass Unit 1, Diablo Canyon Power Plant, July 3, 1996, Harding Lawson Associates.

6. Seed, H.B., K. Tokimatsu, L.F. Harder, and R.M. Chung, Influence of SPT Procedures and Liquefaction Resistance Evaluations, American Society of Civil Engineers, Journal of Geotechnical Engineering, Vol. 111, No. 12, December 1985.

7. Tokimatsu, K. and H.B. Seed, Evaluation of Settlement of Sands Due to Earthquake Shaking, American Society of Civil Engineers, Journal of Geotechnical Engineering, Vol. 113, No. 8, August 1987.

8. Bartlet, S.F., and T.L. Youd, Empirical Prediction of Liquefaction-Induced Lateral Spread, American Society of Civil Engineers, Journal of Geotechnical Engineering, Vol. 121, No. 4, April 1995.

9. Baziar, M.H. and R. Dobry, Residual Strength and Large-Deformation Potential of Loose Silty Sands, American Society of Civil Engineers, Journal of Geotechnical Engineering, Vol. 121, No. 12, December 1995.

10. Fear, C.E., and E.C. McRoberts, Reconsideration of Initiation of Liquefaction in Sandy Soils, American Society of Civil Engineers, Journal of Geotechnical Engineering, Vol. 121, No. 3, March 1995

11. Pyke, R., Practical Aspects of the Evaluation of Liquefaction Potential, First International Conference on Earthquake Geotechnical Engineering, Tokyo, Japan, Nov. 14-16, 1995.

4. ANALYSIS OF BURIED PIPING SYSTEM

COMPARISON TO PREVIOUS DESIGN

DESCRIPTION OF EXISTING ASW PIPING SYSTEM

The ASW piping system is comprised of two trains for each unit originating at the two ASW pumps, located in the Intake Structure, and terminating in the CCW HXs located in the Turbine Building. As the piping exits the Intake Structure, it is rigidly attached to the CWCs at intervals not exceeding 40 feet. The CWCs are large reinforced concrete structures that have been placed directly on or embedded in rock. As a result, the original piping analysis assumed that the entire length of piping run is founded in rock.

DESCRIPTION OF BURIED PORTIONS OF ASW BYPASS PIPES

There are four trains of ASW bypass piping, one for each of the ASW pumps in each unit. Each bypass line exits through the east wall of the Intake Structure and extends underground eastwards and uphill, to a point near the top of the hillside east of the Intake Structure, adjacent to the CWC, where the line ties into the existing buried ASW line. The bypass piping is supported in soil, and thrust blocks are located at changes in direction of the piping system.

The new bypass piping system consists of 24 inch diameter schedule 20 pipes connected by 125 psi bolted flanges (encased in concrete), heavy weld-neck 150 psi flanges (unencased), and Dresser® couplings. The Dresser® couplings are provided for improved flexibility of the piping system due to the high seismic

demands. Tie rods or displacement "limiters" are installed at selected Dresser® coupling locations to limit the slip displacement of couplings to a pre-determined limit. These limiters are Non Design Class I and are installed as a redundant component to provide additional assurance that the coupling ends will not separate in the LTSP evaluation. They are not credited in the qualification of the coupling against design basis effects.

The buried piping system will be constructed by trenching, placing the pipe on compacted bedding material, placing an envelope of compacted material around and a short distance above the pipe, and backfilling the trench with compacted material. Pipe sections are connected by bolted flanges, or by bolted sleeve-type (Dresser®) couplings where joint flexibility is required.

DESIGN EVALUATION

As discussed above, the analysis of the existing ASW buried piping considered the piping to be supported on rock and assumed that the piping would move with the ground under the propagation of seismic shear and compressional waves. Stresses in the piping system, therefore, are directly proportional to the rock strains, which are low.

The installation of the bypass piping results in a buried configuration that is fundamentally similar to the existing configuration. The major variance from the original design is that the piping is now supported in soil instead of anchored to rock.

The bypass piping is a modification of an existing system, not a new design. Design of the piping is performed in accordance with applicable provisions of ANSI B31.7-1969 with 1970 Addendum, for Class III piping, and related provisions of ANSI B31.1-1973 (FSAR, Table 3.2-3). Since these codes are intended for the design of above ground piping, modifications, or additional requirements have been developed for the ASW bypass buried piping design.

LOADS

Design basis demands on the buried ASW bypass pipes include axial forces, shear forces, bending moments, torsional moments, displacements, and rotations which may result from each of the loads discussed below.

In order to adequately characterize the behavior of buried piping, the stress contributions from axial forces are combined with stresses described in ANSI B31.1-1973, since this reference was originally intended for use in above-ground piping.

[illegible]

[illegible]

Loads considered in the evaluation include dead, live, internal pressure (normal and abnormal), thermal (normal and abnormal), seismic (Hosgri earthquake and DDE), and tsunami/storm wave. Tsunami and storm wave effects are discussed in Section D.5, "Tsunami and Storm Wave Evaluation."

NORMAL LOAD COMBINATION

The normal combination includes loads that are part of the normal operation at the power plant on a daily basis and include dead, live, design pressure and temperature, and soil settlement loads. The load combination and acceptance criteria are consistent with ANSI B31.1-1973, augmented to suit buried piping.

ABNORMAL LOAD COMBINATIONS

Abnormal combinations include combinations which include DDE and Hosgri seismic events. These combinations include normal operating conditions and abnormal loads that are not likely to occur during the life of the plant, but are considered credible. ASW operating modes with a short duration are excluded from these combinations. Sustained plus thermal load effect combinations are also considered. The load combination and acceptance criteria are consistent with ANSI B31.1-1973, supplemented by ASME B&PV Code, Section III, Winter 1972 Addenda, Subsection NC-3650, augmented to suit buried piping.

BOLTED SLEEVE-TYPE (DRESSER®) COUPLINGS

The bolted sleeve type couplings are subject to the same loads and load combinations as those given for the buried piping. Coupling acceptance criteria for the normal combination are based on manufacturer's recommended capacities, developed in accordance with applicable industry standards (ANSI/American Water Works Association Standard C219-91, "Standard for Bolted, Sleeve-Type Couplings for Plain-end Pipe"). For abnormal load combinations, capacities used are substantiated by tests or analysis.

FLANGED JOINTS

Neither ANSI B31.7 nor ANSI B31.1 provide sufficient guidance specific to buried piping flanged joints. Consequently, acceptance criteria for the flanged joints are developed from the ASME B&PV Code, Section III, 1989 Edition, Subsection ND 3658.1, using Appendix XI methods, modified to be consistent with the characteristics of the buried piping flange and gasket construction.

CONCRETE THRUST BLOCKS

Concrete thrust blocks are provided to resist hydraulically and seismically induced loads associated with changes in direction of the piping, loads associated with discontinuities resulting from the presence of bolted sleeve-type couplings, and soil displacements.

<u>ANALYSIS OF BURIED PIPES</u>

METHODOLOGY

A soil/structure interaction (SSI) analysis using the SHAKE and SASSI computer codes is performed to determine the displacements imposed on the buried piping system. The SSI analysis is made necessary by site conditions, where the piping will be buried in a region previously excavated and backfilled with soil during construction of the Intake Structure and CWCs. The SASSI analyses provide differential displacements in the soil at various points along the route of the buried piping system. Inputs to the SHAKE and SASSI analyses were obtained from geotechnical investigations (Section D.3). The SSI analyses included a number of sensitivity studies to examine the effects of variability in wave incidence angle, soil modulus reduction, and shear wave velocity. Calculated soil displacements from the SSI analysis were based upon the lower bound shear wave velocity, which produces the largest predicted soil displacements (Reference 6).

The differential displacements due to P-waves and SV-waves from the SASSI analysis are adjusted and combined to yield horizontal and vertical displacements of the soil that supports the piping system, at various points. Hosgri, DDE, and LTSP inputs are considered.

In addition to soil displacements induced directly by earthquake, displacements resulting from the liquefaction of a pocket of sand located about 25 feet below a portion of the bypass piping have been considered. Liquefaction was determined to result only in ground settlement, and affects only a limited portion of the bypass piping system. LTSP and smaller magnitude events were considered. These analyses are described in Section D.3.

Geotechnical evaluation of the slope (Section D.3) in which the Unit 1 pipes are buried demonstrates that no significant deformation due to instability will occur. Therefore, no displacements associated with slope stability were considered in the analysis. LTSP and Hosgri earthquake events provide the maximum demands, and were considered in the analysis.

The displacements that are computed in the SASSI analyses are used in the

analysis of the buried piping system. The buried piping system evaluation is divided into two main parts: (1) analysis for lateral effects, and (2) analysis for axial effects. These two analyses are uncoupled and the results of each are combined for the evaluation of piping components. The two effects can be uncoupled due to the use of several Dresser® couplings along the piping system, which serve to practically isolate the various pipe segments from one another, and prevent the transfer of axial forces and moments.

Analysis for lateral effects is performed by using conventional methods, such as those described in References 1 and 2 of this section. This analysis consists of a finite element model of the piping system. Subgrade reactions from the soil are represented by Winkler springs that are provided at close intervals. Other restraints such as at thrust blocks anchored to bedrock, are also provided. The differential displacements from the SASSI analysis are used to displace the supports of the Winkler springs. This analysis results in bending moments in the piping system and rotational demands for the Dresser® couplings. Displacements resulting from liquefaction were applied in a manner similar to the seismic soil displacements. Since these displacements do not occur concurrently with earthquake, they are treated as a separate load case, as discussed in Section D.3.

The largest calculated soil displacements result from the softest soil (lowest shear wave velocity), while the internal forces in the buried piping system result from the stiffest soil springs (highest shear wave velocity). To account for variability in input parameters, a conservative combination of spring stiffness and imposed displacement inputs were used in the buried piping model.

The analysis of the buried piping for axial effects is accomplished by considering the friction forces and displacements along the pipe. Dresser® coupling slip displacement demands are determined by imposing the displacements from the SASSI analyses at anchor points, combined with other effects such as from temperature and other operating conditions. Other piping system components have demand axial forces imposed from soil friction, Dresser® coupling slip resistance, earth pressure, and fluid pressure.

The axial and lateral effects from the buried piping model and axial effects calculations are combined for the evaluation of the various piping components and thrust blocks. Dresser® couplings are evaluated for slip displacement demands considering the load combinations stated previously. Piping system components are also evaluated for the stated load combinations.

In addition to the design basis evaluations for Hosgri and DDE load combinations, an evaluation for LTSP loads has also been performed. This evaluation uses load combinations and acceptance criteria that are based upon

the guidelines provided by EPRI NP-6041 (Reference 3), which are quite similar to the design basis. These evaluations showed substantial margins, in excess of 50 percent.

ENGINEERING QA

PG&E utilized the services of a consultant (International Civil Engineering Consultants) to perform the site response and SSI analyses. The same personnel who performed the SSI analysis for the LTSP also performed the SSI work for the ASW bypass piping. Engineering work performed by their personnel was covered by PG&E's Nuclear QA Program. Computer codes used by consultants were either certified under PG&E's QA Program, or independently verified by a vendor on PG&E's qualified suppliers list.

A technical expert panel was also utilized by the project to provide technical guidance and expert advice on important engineering issues that arose. This panel was composed of Robert Kennedy (RPK Structural Mechanics Consulting), Evans C. Goodling (consulting engineer), Robert Pyke (Harding Lawson Assoc.), and Henry Thailer (PG&E). The function of the panel was to review important engineering decisions made by the project, and provide input or suggestions on possible approaches or methods that might be used by the project to solve or address certain technical issues. Design authority for the engineering of the ASW bypass modifications was completely retained by the project.

STANDARD REVIEW PLAN

Analyses performed for the ASW bypass buried piping system generally conform to the applicable portions of the SRP, Sections 3.7.2, "Seismic System Analysis," 3.7.3. "Seismic Subsystem Analysis," and 3.9.2 "Dynamic Testing and Analysis of Systems, Components, and Equipment."

SSI analyses were performed to establish site response and soil displacement inputs for the analysis of the buried piping. Control motions used in the analyses are consistent with the design and licensing bases. Low-strain soil properties were established as described in Section D.3; nonlinear soil behavior was considered by using strain-dependent linear soil properties calculated from analysis of a free field soil column. Uncertainty in the low-strain shear modulus was considered by median and bounding values as described above. Additional variability in modulus reduction and damping curves was also considered by performing sensitivity studies. Limitations on strain-compatible soil moduli were generally satisfied, although the maximum damping used in the lowest soil strata slightly exceeded the SRP limit in some cases. These exceedences are not expected to have any important effect because of their small magnitude and

limited area of application. SSI analyses were performed by qualified individuals (the same personnel who performed the SSI analyses for PG&E's LTSP), using a certified computer code.

Relative soil displacements determined from the site response and SSI analyses were used in a buried piping analysis as discussed in SRP 3.7.3 and 3.9.2. Soil resistance (including uncertainty in soil properties), differential movement of piping anchors, and geometry of the buried piping system were considered in the buried piping model. The buried piping model was treated as a beam-on-elastic-foundation problem, as described above. Upper bound local soil settlements resulting from potential soil liquefaction consistent with those described in Section D.3 were also considered.

CONCLUSIONS

The evaluations described above verified that the ASW bypass piping is capable of performing its required function under all design conditions, with margin. The analysis addresses the effects of a LTSP seismic event in addition to the design basis events.

The design variables and analytical methods utilized are consistent with the commitments set forth in the FSAR and the safety evaluation report, and follow conventional engineering methods. Adequate margin against seismically induced stresses assures that the system will continue to function within the design requirements after a design basis seismic event.

REFERENCES

1. Guidelines for the Seismic Design of Oil and Gas Pipeline Systems, American Society of Civil Engineers, 1984.
2. Seismic Design and Evaluation Guidelines for the Department of Energy High-Level Waste Storage Tanks and Appurtenances, Banyopadhyay, et al, Brookhaven National Lab., BNL-52361 (Rev 10/95), October 1995.
3. A Methodology for Assessment of Nuclear Power Plant Seismic Margin (Revision 1), EPRI NP-6041-SL, Electric Power Research Institute, August 1991.
4. ANSI B31.1 Power Piping Code, 1973.
5. ANSI B31.7 Nuclear Power Piping, Class III, 1969 with 1970 Addendum
6. Site Response Analyses for Developing Seismic Inputs for Seismic Qualification of the Buried Portions of the Auxiliary Saltwater Bypass Piping System, Diablo Canyon Power Plant, International Civil Engineering Consultants, June 1996.

7. Design Criteria Memorandum S-17B, Saltwater Systems, Pacific Gas and Electric.

5. TSUNAMI AND STORM WAVE PROTECTION EVALUATION

COMPARISON TO PREVIOUS DESIGN

The ASW bypass project will change the alignment of the ASW piping between the ASW pump vaults at the Intake Structure and tie-in points upstream of the vacuum breaker vaults near Parking Lot No. 5. The bypass piping outside of the Intake Structure is buried at a more shallow depth in the soil than the existing piping and is not anchored to the concrete CWC. This installation could potentially result in a risk of exposure, without the other design features, of the piping due to tsunami or storm-induced wave action, erosion, and potential loss of support. Consequently, protective measures have been included in the design as described in this section.

DESIGN CRITERIA

The safety-related ASW piping is designed to withstand the effects of the design basis tsunami and storm wave loading conditions. The design basis tsunami and storm wave loading conditions for Diablo Canyon Power Plant, as defined in Design Criteria Memorandum (DCM) T-9, "Wind, Tornado, and Tsunami," includes the following effects:

- A probable maximum tsunami combined with storm waves of annual severity, high tide, and storm surge.
- A maximum credible wave event, combined with high tide.
- A probable maximum distantly-generated tsunami combined with high tide and storm surge.

In this section, tsunami means the combination of tsunami, design basis storm, and tide storm surge effects, unless otherwise noted.

Since the ASW piping, in and adjacent to the Intake Structure, is within the zone of influence of the tsunami loading conditions it must be protected from tsunami induced damage. The buried ASW piping above the maximum wave run-up elevation stated in DCM T-9 need not consider tsunami conditions.

DESIGN EVALUATION

Since the alignment of the buried piping was modified under the ASW bypass piping project, it is necessary to review the impact of the new alignment on the vulnerability of the ASW piping to tsunami induced damage. (Elevations used in the following discussion are referenced to mean sea level, except as noted.)

In its existing configuration, the buried ASW piping is protected from tsunami induced damage by the following:

- The piping has approximately 26 feet of cover (it exits the Intake Structure at or below elevation -9.7 feet, the finished grade is at elevation +17.5 feet, and the piping is 2 feet in diameter). This cover protects the piping from being exposed through tsunami induced erosion or scouring.

- The piping is attached to the massive Intake CWCs that are anchored in the underlying bedrock. This assures that, even if the piping is partially exposed, it will remain supported.

The alignment of the ASW bypass piping, in the vicinity of the Intake Structure is as follows:

- The piping exits the east wall of the Intake Structure, near the southeast corner, at or below elevation +10.5 feet. With the finished grade at elevation +17.5 feet, the piping will have approximately 6 feet of cover.

- The piping ascends the slope to the Intake Structure service road. At the service road, the piping centerline will be at elevation +22.5 feet and the finished grade will be at elevation +26.0 feet, resulting in approximately 2.5 feet of cover. A reinforced concrete slab provides protection for the piping in this area.

- The piping ascends the slope to Parking Lot No. 5. Along the slope, the cover varies, but will be a minimum of approximately 5 feet. A reinforced concrete slab provides protection for the piping in areas with soil cover less than this value.

- The piping will be supported by the surrounding soil and by concrete thrust blocks at all changes in direction, which are also supported by the surrounding soil.

As a result of the reduction in burial depth (cover) and the absence of support from the CWCs, the vulnerability of the ASW bypass piping to tsunami induced damage would be increased without engineered storm wave protection.

The Geotechnical and Hydraulic Engineering Services division of Bechtel Corporation was contracted to perform an evaluation of the potential for tsunami induced erosion along the alignment of the ASW bypass piping and provide recommendations for protective measures.

Because of the limited duration of tsunami run-up compared to storm waves, it was concluded that the maximum credible wave event (storm waves) would present the controlling case for the design of protective measures. This is true because a tsunami event is combined with storm waves of annual severity, which are less severe than the maximum credible wave event. Storm wave effects were developed from the results of scale model testing previously performed for the Intake Structure cove. From a review of test results and high speed film, maximum water velocities, run-up, wave incidences, and other pertinent data were developed. In accordance with the design basis, a breakwater degraded to mean lower low water level was assumed in model tests.

The results of Bechtel's evaluation are summarized in the report, "Diablo Canyon Power Plant - Auxiliary Seawater Cooling System Erosion Protection for New Bypass Piping," dated October 1996.

Protective measures for the buried bypass piping includes the following:

- pattern-grouting to protect the soil mass in the vicinity of where the bypass piping exits the Intake Structure.
  Reinforcement of the revetment southeast of the Intake Structure with
- Pavement of the area east of the Intake Structure with additional thickness of asphalt.

- Concrete reinforcement of the service road embankment.

- Reinforced concrete slab over the service road, below which the bypass pipes are routed, and additional thickness of asphalt pavement over the parking area at the toe of the slope.

- Gabion mattress extending from the toe of the slope up the hill where the Unit 1 bypass pipes are routed. The gabion mattress is extended up to an elevation sufficient to protect the buried piping against maximum wave run-up.

STANDARD REVIEW PLAN

Evaluation of storm wave and tsunami effects for the ASW bypass buried piping system generally conforms to the applicable portions of the SRP, Sections 3.4.1, "Flood Protection," and 3.4.2, "Analysis Procedures."

The highest water levels and velocities associated with storm waves and tsunami were established from design basis inputs described in this section. Protective measures discussed above, are specified for portions of the buried piping system that are susceptible to wave attack. The specified measures were selected based upon their performance in other conventional applications.

CONCLUSION

Implementing the protective measures will prevent the buried portions of the ASW bypass piping from being exposed to damage as a result of tsunami and severe storm induced erosion. The existing design criteria and licensing basis are satisfied for the proposed alignment of the buried ASW bypass piping.

REFERENCES

1. Diablo Canyon Power Plant - Auxiliary Seawater Cooling System Erosion Protection for New Bypass Piping," October 1996, Bechtel Corporation.

2. DCM T-9, "Wind, Tornado, and Tsunami

E. NO SIGNIFICANT HAZARDS EVALUATION

PG&E has evaluated the no significant hazards considerations (NSHC) involved with the proposed amendment, focusing on the three standards set forth in 10 CFR 50.92(c) as set forth below:

> *"The commission may make a final determination, pursuant to the procedures in paragraph 50.91, that a proposed amendment to an operating license for a facility licensed under paragraph 50.21(b) or paragraph 50.22 or for a testing facility involves no significant hazards considerations, if operation of the facility in accordance with the proposed amendment would not:*
>
> *(1) Involve a significant increase in the probability or consequences of an accident previously evaluated; or*

(2) *Create the possibility of a new or different kind of accident from any accident previously evaluated; or*

(3) *Involve a significant reduction in a margin of safety.*

The following evaluation is provided for the NSHCs.

1. *Does the change involve a significant increase in the probability or consequences of an accident previously evaluated?*

The auxiliary saltwater (ASW) system is not identified as the cause, or involved in the initiating event of, any Final Safety Analysis Report (FSAR) analyzed accidents. Thus, activities addressed herein will not increase the probability of occurrence of any FSAR evaluated accident.

During the construction of the ASW bypass piping, the integrity and performance of the ultimate heat sink will not be affected, nor will the ability of any safety-related system, structure, or component (SSC) to perform their function be compromised. Approved, written procedures are used during construction to assure the functioning of these SSCs (e.g., heavy load procedures, security procedures, tie-in procedures). The system unavailability due to construction is managed in accordance with Technical Specification (TS) limiting conditions for operation (LCO).

The ASW system is a moderate energy system. Since the bypass modification does not significantly change the operating parameters of the system, there is no change in the Medium Energy Line Break (MELB) analysis methodology for this system, and no increase in the probability of occurrence of a pipe crack.

The ASW pipes are required to mitigate consequences of FSAR analyzed accidents.

The initial work for the ASW bypass project involved installation of Design Class I removable spool pieces in the existing ASW piping. The spool pieces removed were modified and reinserted into the existing ASW piping. The modifications to the spool pieces did not affect their flow characteristics or structural integrity. Therefore, the removable spool pieces did not cause ASW operating parameters to exceed their design basis, did not change any system interfaces, had no impact on ASW system capability to perform its function, and did not change the system's

operation.

The work for this project was performed in a series of steps. For each step, the added work scope was incorporated in a design change package revision and a revised safety evaluation was performed.

The tie-in of the piping to the ASW system is done during separate system clearances during a refueling outage for each train; one train will remain in service during the outage at all times. The cross-tie between the two Units will be available during the work.

When all the work associated with the ASW bypass project is completed, including pipe and pipe support installation, structural modifications, and external protective features; the ASW system will perform its safety function as described in the FSAR. The flow in ASW pipes will not be significantly affected by this work. Per Mechanical Calculation M-988, the increase in head loss for bypass piping is not significant; the design basis flow is maintained with a margin and there is no significant effect on the Component Cooling Water (CCW) heat removal capacity.

The newly installed piping has been designed to withstand the appropriate design basis seismic loading and to withstand the effects of external events including flooding, tsunami, and tornadoes. The newly installed piping and associated support components have been evaluated, and where appropriate, designed to withstand system interactions including pipe breaks, internal flooding, seismic interaction, internally generated missiles, and fires.

Since the ASW system design bases parameters are maintained and the newly configured piping has been evaluated and designed to meet established licensing basis considerations, the consequences of an accident previously evaluated in the FSAR are not increased.

Therefore, the proposed changes do not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. *Does the change create the possibility of a new or different kind of accident from any accident previously evaluated?*

The design and installation sequence for bypass pipes and connection to the Unit 1 ASW system were developed and sequenced so as not to affect the integrity of the pressure boundary or Paraliner of operating ASW trains. Removable spool pieces were installed during Unit 1 seventh refueling outage (1R7). Plant procedures and proper sequencing of

removal of the removable spool pieces and installation of tie-ins of bypass pipes will ensure adequate ASW is available for supporting the refueling and plant shutdown requirements. Tie-ins of Unit 1 bypass pipes will be done during separate system clearances during a refueling outage for each train; one train will remain in service during the outage at all times. The cross-tie between the two Units will be available during the work.

Piping layout and supports, design features for natural events, and evaluations and design features for systems interaction assure that the integrity of the ASW system for each unit is maintained.

The conservative analyses used in the piping design indicates there is a potential for soil liquefaction in some areas during certain seismic events (Hosgri earthquake). Liquefaction of soil is not considered in the licensing basis for the plant. Analyses using more recent methods indicate that actual settlements will be much less than predicted by the analyses used in the design, and that the piping will maintain its integrity.

Therefore, the proposed changes do not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. *Does the change involve a significant reduction in a margin of safety?*

TS 3.7.4.1 and 3.7.12, pertinent to the ASW system, are applicable for Modes 1 (Power Operation), 2 (Startup), 3 (Hot Standby), and 4 (Hot Shutdown). The installation of the Unit 1 ASW removable spool pieces were done during the 1R7 outage. During the refueling outage, the ASW trains were made inoperable one at a time for installation of a spool piece and were sequenced and scheduled to support TS 3.4.1.4.1 and 3.4.1.4.2 for residual heat removal (RHR) in Mode 5 (Cold Shutdown), and TS. 3.9.8.1 and 3.9.8.2 for RHR in Mode 6 (Refueling) as applicable. Modification of two existing supports for Unit 2 Pipe 687 was done when the line was out-of-service during the Unit 2 seventh refueling outage. Tie-ins will occur during a refueling outage and during separate system clearances. The cross-tie between the two Units will be available during the work.

The TS basis for the ASW system is to provide sufficient cooling capacity for the continued operation of safety-related equipment during normal and accident conditions (TS Bases 3/4.7.4). This equates to providing sufficient cooling water for the CCW heat exchangers (HXs) to ensure CCW design basis temperature limits are not exceeded. Although the change in ASW pipe routing causes an increase in the pressure drop in the ASW piping, and therefore a decrease in ASW flow by approximately

3 percent (352 gpm), the design and licensing basis requirements of the ASW system will continue to be met.

Surveillance Test Procedure (STP) M-26, "ASW Flow Monitoring," demonstrates that the ASW system provides adequate cooling to the CCW HX. The STP measures the ASW flow and then subtracts instrument inaccuracy and corrects for potential variations in tide level and CCW HX differential pressure (dP). The corrected ASW flow and temperature are then compared to the acceptance criteria. The acceptance criteria in STP M-26 have not changed as a result of the bypass project.

There will not be a safety significant issue associated with the reduction in flow caused by the bypass. As part of the ASW bypass project, ASW flow and temperature instruments are being replaced with more accurate instruments. In addition, the correction factors which are used to account for variations in tide level and HX dP were found to be very conservative and have been corrected. As a result of these changes, the corrections to the measured ASW flow will be smaller. Based on Calculation M-988, the required corrections to the flow will decrease by more than the reduction in flow caused by the bypass. In addition, the current STP results show that flow margin exists.

Therefore, none of the proposed changes involves a significant reduction in a margin of safety.

F. NO SIGNIFICANT HAZARDS DETERMINATION

Based on the above safety evaluation, PG&E concludes that the changes proposed by this LAR satisfy the NSHC standards of 10 CFR 50.92(c), and accordingly a no significant hazards finding is justified.

G. ENVIRONMENTAL EVALUATION

PG&E has evaluated the proposed changes and determined the changes do not involve: (I) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed changes meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), an environmental assessment of the proposed change is not required.