



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE INSERVICE TESTING PROGRAM

PACIFIC GAS AND ELECTRIC COMPANY

DIABLO CANYON POWER PLANT, UNIT NOS. 1 AND 2

DOCKET NOS. 50-275 AND 50-323

1.0 INTRODUCTION

The Code of Federal Regulations, 10 CFR 50.55a, requires that inservice testing (IST) of certain American Society of Mechanical Engineers (ASME) Code Class 1, 2, and 3 pumps and valves be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel Code and applicable addenda, except where relief has been requested and granted or proposed alternatives have been authorized by the Commission pursuant to 10 CFR 50.55a (f)(6)(i), (a)(3)(i), or (a)(3)(ii). In order to obtain authorization or relief, the licensee must demonstrate that: (1) conformance is impractical for its facility; (2) the proposed alternative provides an acceptable level of quality and safety; or (3) compliance would result in a hardship or unusual difficulty without a compensating increase in the level of quality and safety. Guidance related to the development and implementation of IST programs is given in Generic Letter (GL) 89-04, "Guidance on Developing Acceptable Inservice Testing Programs," issued April 3, 1989, and its Supplement 1, issued April 4, 1995. Also, NUREG-1482, "Guidelines for Inservice Testing at Nuclear Power Plants," was promulgated by GL 89-04, Supplement 1.

Section 50.55a authorized the Commission to grant relief from ASME Code requirements or to approve proposed alternatives upon making the necessary findings. The NRC staff's findings with respect to granting or not granting the relief requested or authorizing the proposed alternative as part of the licensee's IST program are contained in this Safety Evaluation (SE).

By letter dated November 19, 1997, Pacific Gas and Electric Company (licensee) submitted a revised relief request, P-RR2, for Diablo Canyon Power Plant (DCPP) Units 1 and 2, second ten-year interval program for IST of pumps. This revised relief request was submitted in response to an NRC safety evaluation dated June 24, 1997, which authorized the alternative testing for an interim period of six months in order for PG&E to provide additional information to justify the proposed alternative. The DCPP Units 1 and 2 IST Program was developed to the 1987 Edition of ASME Section XI, with addenda through OMa-1988, for the second ten-year interval that began on January 1, 1996, for Unit 1 and on June 1, 1996 for Unit 2.

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## 2.0 REVISED RELIEF REQUEST P-RR2

P-RR2 requests relief from the Code requirements for vibration monitoring of the turbine-driven auxiliary feedwater pumps 1-1 and 2-1. Table 3a of OM-6 specifies, in part, that the pump testing frequency be doubled from every three months to every six weeks whenever the measured vibration levels fall within the alert range. P-RR2 requests that the lower limit on the alert range be relaxed from 0.325 in/sec to 0.450 in/sec for the pump bearing vibration testing on recirculation.

### 2.1 Licensee's Basis for Request

The licensee provided the following basis:

The auxiliary feedwater (AFW) system provides a backup source of feedwater to the secondary side of the steam generators (SGs) when the main feedwater system is unavailable. This maintains the heat removal capability of the steam generators. The system also functions as a source of feedwater during plant startups and shutdowns. The turbine-driven AFW pumps are used as an emergency back up to the motor-driven auxiliary feedwater pumps. The turbine-driven AFW pumps are tested on recirculation flow in accordance with ASME/ANSI OMa-1988 and Technical Specification 4.7.1.2.1.

Baseline testing and subsequent quarterly testing of the turbine-driven AFW pumps are performed while on recirculation because the only other available flow path is into the steam generator which could result in thermal cycling of FW/AFW nozzles. The baseline vibration levels for the outboard pump bearings were measured at 0.312 in/sec for pump 1-1 and 0.316 in/sec for pump 2-1 in February 1992. The baseline vibration levels were investigated and the pumps were found to be operating acceptably. Subsequent testing on a monthly basis has shown that there is no increasing trend in vibration levels. Some data scatter occurs which occasionally results in vibration readings in the alert range of 0.325 in/sec to 0.700 in/sec. The upper limit of the observed vibration data scatter is approximately 0.400 in/sec. An alert level of 0.450 in/sec will prevent normal vibration from putting the pump on alert, yet it will still provide sufficient warning if the pump trends toward the action limit.

Per the ASME Code, any vibration level greater than 0.325 in/sec is within the alert range and requires doubling the pump's testing frequency. Since these pumps were baselined, subsequent tests have yielded vibration levels averaging 0.248 in/sec for Unit 1 and 0.317 in/sec for Unit 2. To further investigate this vibration issue, vibration readings were taken on Pump 2-1 at full flow condition. The vibration levels dropped from >0.300 in/sec on recirculation to 0.099 in/sec at full flow.



Vibration spectral analysis indicates that the predominant frequency is five times pump speed which correlates with the pump vane pass frequency because the pump impellers have five vanes each. When the pumps are operated at low flow during surveillance testing, the relative flow to the impeller is not aligned with the impeller vane. This causes vibration at vane passing frequency (5X). The operating design flow of these pumps is 870 gpm. Due to thermal fatigue and plant transient concerns, the surveillance test is run with the pump on recirculation flow of approximately 50 gpm.

These recirculation vibration levels do not warrant doubling the testing frequency. In addition, industry experience has shown that extended or frequent operation at minimum pump flow can cause pumps to degrade. In the case of the turbine-driven AFWPs, vibration at an alert level of 0.325 in/sec when tested on recirculation is not indicative of a potential pump problem.

Operation of the pumps at vibration levels of up to 0.450 in/sec for short periods of time during quarterly pump testing will not cause the pump to degrade. When the pumps are operated for normal and emergency operations, the flows will be higher and the vibration is significantly reduced.

The Unit 1 turbine-driven auxiliary feedwater pump (TDAFWP) had extensive repair/replacement activities during a refueling outage in October 1995, including turbine shaft replacement, coupling replacement, alignment, and pump bearing fan replacement. Vibration levels at recirculation flow did not decrease significantly after the maintenance. Unit 1 pump's vibration levels have not exceeded 0.325 in/sec since November 1994.

Unit 2 TDAFWP had extensive maintenance during a refueling outage in April 1996, including turbine removal and inspection, coupling inspection, and alignment. Vibration levels at recirculation flow did not decrease significantly after the maintenance. During the last three years, Unit 2 vibration level has exceeded 0.325 in/sec on 13 of 39 pump tests performed on recirculation flow.

In June 1994, both units had a steel vibration pickup plate added to the outboard pump bearing to aid in taking of more consistent data. The addition of the vibration pickup plates did not significantly change vibration readings.

The vendor, BW/IP International, Inc., Pump Division, stated in a letter [dated, August 27, 1997] that operating the pumps at this vibration level for short periods of time on recirculation flow during quarterly testing will not cause the pumps to degrade. An analysis has not been performed to demonstrate that the pump is capable of continued operation at higher vibration levels; however, the pumps do not normally operate at low flow other than for testing. PG&E's alternative test will demonstrate that the pump vibration is reduced below 0.325 in/sec when the pump is operated at full flow.



The pump vendor agrees that it is permissible to raise the alert level to 0.450 in/sec peak for the pump bearing during quarterly testing while the pumps are tested on recirculation flow. The vendor recommended that during full flow performance testing and continuous operation on recirculation flow, the vibration levels should be evaluated to the present alert limit of 0.325 in/sec peak. The vendor also recommended that PG&E periodically review performance and vibration data for any adverse trends or other indication of pump distress. PG&E program meets all of the vendor recommendations.

PG&E has taken several vibration spectra on both pumps during the last five years. Spectral analysis of the vibration signature consistently indicates that the most prominent vibration frequency is at five times pump running speed. This corresponds to pump vane-pass frequency because the pump impellers have five vanes each. The pump vendor has reviewed the spectral data for the TDAFWPs and stated that the vibration is due to vane passing frequency caused by testing the pump at low flows.

## 2.2 Proposed Alternate Testing

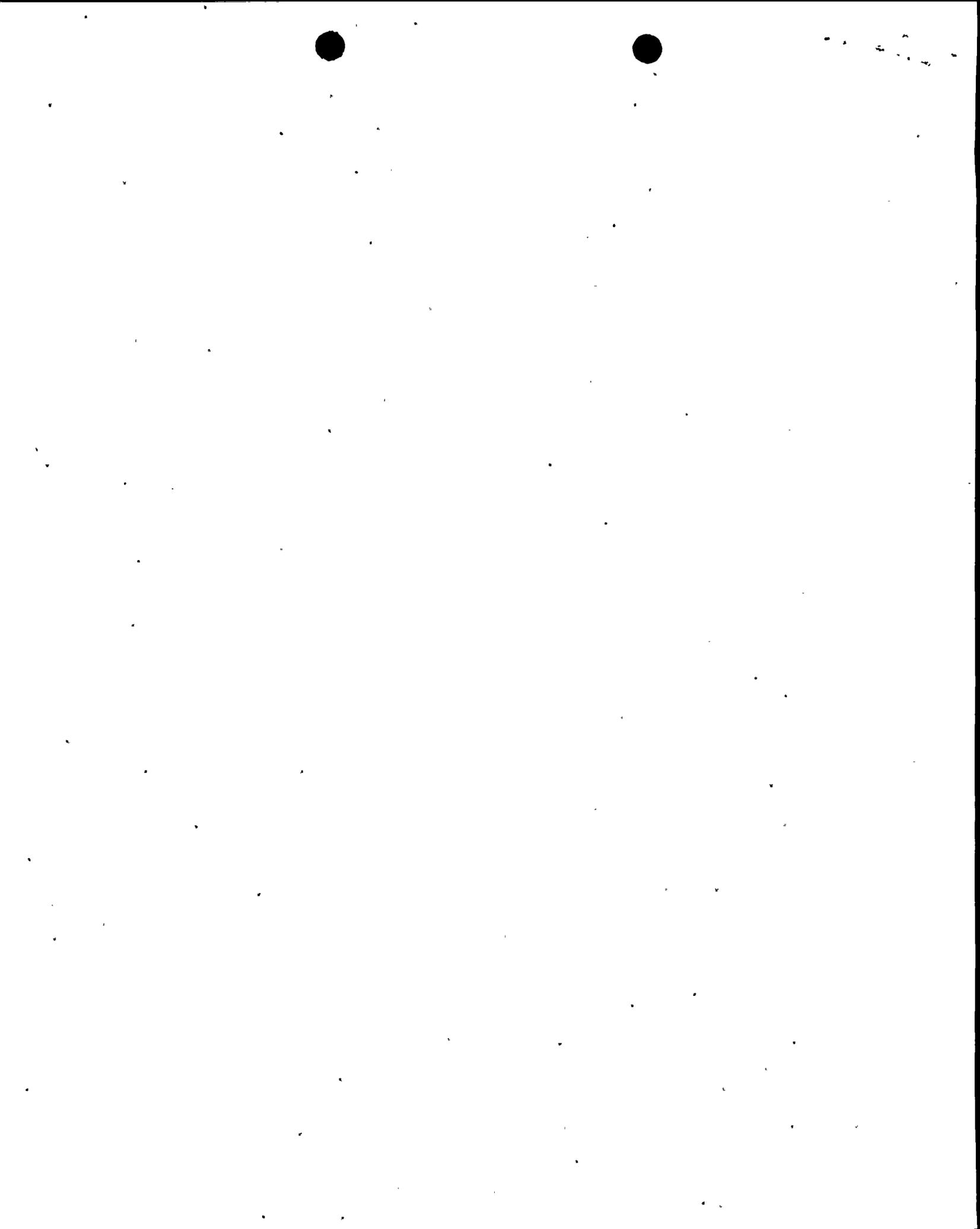
The licensee proposed the following:

PG&E will set the vibration alert level to 0.450 in/sec for the turbine driven AFW pump bearing for pump testing on recirculation flow. The current action level of 0.700 in/sec will remain unchanged. The vibration levels will continue to be evaluated to the 0.325 in/sec alert levels during full flow testing.

Full flow vibration testing will be performed on a cold shutdown frequency not to exceed once per 92 days. The test will be performed in Modes 1, 2, or 3 when adequate steam flow is available. During the test, only the bearing which had vibration levels greater than 0.325 in/sec during the quarterly test will be monitored, in order to decrease the length of time that cold water is injected into the steam generators.

## 3.0 EVALUATION

OM-6 requires that pumps with vibration levels between 0.325 in/sec and 0.700 in/sec be classified in the alert range and that the testing frequency be doubled (from quarterly to every six weeks) until the cause of the vibration in the alert range is determined and the condition corrected. The turbine-driven AFW pumps are used as an emergency backup to the motor-driven AFW pumps, which are used to provide feedwater to the secondary side of the steam generator when the main feedwater system is not available and during plant startup and shutdown. The licensee believes that because of hydraulic instabilities associated with running the pumps on recirculation, the lower limit on the vibration alert level of 0.325 in/sec would not be indicative of a potential pump problem. In order to reduce unnecessary vibration testing, the licensee proposes to relax the alert level from 0.325 in/sec to 0.450 in/sec during quarterly recirculation tests. The required action level would not be affected by the relief. For the bearings with vibration levels greater than 0.325 in/sec during the quarterly test, the



0.325 in/sec alert level will be applied during full flow testing on a cold shutdown frequency not to exceed once per 92 days.

The additional information provided by the licensee in a letter dated November 19, 1997, indicated that historical data on the spectral analysis of the vibration signature show that the prominent vibration frequency is at five times pump running frequency, corresponding to pump vane-pass frequency. The vendor, BW/IP International, Inc., stated in a letter dated, August 27, 1997 that it is permissible to raise the alert level to 0.450 in/sec peak for the pump bearing during quarterly testing on recirculation flow and that operating the pumps at this vibration level for short periods of time will not cause the pumps to degrade. The vendor recommended that PG&E periodically review performance and vibration data for pump degradation. The licensee states that its program meets all of the vendor's recommendations. The NRC staff believes that the periodic review of pump vibration data should include a comparison of the current vibration spectrum with the baseline vibration spectrum, an evaluation of the trend of available overall vibration amplitudes and spectra, and the determination of the need for corrective action. It appears that the licensee has included these elements in its analysis. The analysis and data supporting the basis would be subject to NRC inspection.

Increasing the test frequency when the alert limit is exceeded would result in additional testing of the pump that could cause accelerated wear. The licensee and the pump vendor have determined the cause of the vibration in question and have found that raising the alert level to 0.450 in/sec during testing on recirculation flow would not compromise the operational readiness of the pumps in question. Under these conditions, there is reasonable assurance that the degradation mechanism will not cause further degradation such that before the next pump test or before repairs can be made, the pump would fail.

#### 4.0 CONCLUSION

The proposed alternative testing is approved pursuant to 10 CFR 50.55a(a)(3)(i) based on the finding that the proposed alternative would provide an acceptable level of quality and safety.

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Date: March 19, 1998

