February 9, 2006

Mr. Jack S. Keenan
Senior Vice President and CNO
Pacific Gas and Electric Company
Diablo Canyon Power Plant
P.O. Box 770000
San Francisco, CA 94177-0001

SUBJECT: DIABLO CANYON POWER PLANT, UNITS 1 AND 2, REQUEST FOR ADDITIONAL INFORMATION RE: RESPONSE TO GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN-BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS" (TAC NO. MC4682 AND MC4683)

Dear Mr. Keenan:

On September 13, 2004, the Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," as part of the NRC's efforts to assess the likelihood that the emergency core cooling system (ECCS) and containment spray system (CSS) pumps at domestic pressurized water reactors (PWRs) would experience a debris-induced loss of net positive suction head margin during sump recirculation. The NRC issued this GL to all PWR licensees to request that addressees (1) perform a mechanistic evaluation using an NRC-approved methodology of the potential for the adverse effects of post-accident debris blockage and operation with debris-laden fluids to impede or prevent the recirculation functions of the ECCS and CSS following all postulated accidents for which the recirculation of these systems is required, and (2) implement any plant modifications that the above evaluation identifies as being necessary to ensure system functionality. Addressees were also required to submit information specified in GL 2004-02 to the NRC in accordance with Title 10 of the *Code of Federal Regulations* Section 50.54(f). Additionally, in the GL, the NRC established a schedule for the submittal of the written responses and the completion of any corrective actions identified while complying with the requests in the GL.

By letter dated March 4, 2005, as supplemented by letters dated July 21 and September 1, 2005, Pacific Gas and Electric Company provided a response to the GL. The NRC staff is reviewing and evaluating your response along with the responses from all PWR licensees. The NRC staff has determined that responses to the questions in the enclosure to this letter are necessary in order for the staff to complete its review. Please note that the Office of Nuclear Reactor Regulation's Division of Component Integrity is still conducting its initial reviews with respect to coatings. Although some initial coatings questions are included in the enclosure to this letter, the NRC might issue an additional request for information regarding coatings issues in the near future.

Please provide your response within 60 days from the date of this letter. If you have any questions, please contact me at (301) 415-1445.

Sincerely,

/RA/

Alan Wang, Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-275
50-323

Enclosure:
Request for Additional Information

cc w/encl: see next page

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<u>**GL 2004-02 RAI Questions**</u>

Plant Materials

1. Identify the name and bounding quantity of each insulation material generated by a large-break loss-of-coolant accident (LBLOCA). Include the amount of these materials transported to the containment pool. State any assumptions used to provide this response.

2. Identify the amounts (i.e., surface area) of the following materials that are:

   (a) submerged in the containment pool following a loss-of-coolant accident (LOCA),

   (b) in the containment spray zone following a LOCA:

   - aluminum
   - zinc (from galvanized steel and from inorganic zinc coatings)
   - copper
   - carbon steel not coated
   - uncoated concrete

   Compare the amounts of these materials in the submerged and spray zones at your plant relative to the scaled amounts of these materials used in the Nuclear Regulatory Commission (NRC) nuclear industry jointly-sponsored Integrated Chemical Effects Tests (ICET) (e.g., 5x the amount of uncoated carbon steel assumed for the ICETs).

3. Identify the amount (surface area) and material (e.g., aluminum) for any scaffolding stored in containment. Indicate the amount, if any, that would be submerged in the containment pool following a LOCA. Clarify if scaffolding material was included in the response to Question 2.

4. Provide the type and amount of any metallic paints or non-stainless steel insulation jacketing (not included in the response to Question 2) that would be either submerged or subjected to containment spray.

Containment Pool Chemistry

5. Provide the expected containment pool pH during the emergency core cooling system (ECCS) recirculation mission time following a LOCA at the beginning of the fuel cycle and at the end of the fuel cycle. Identify any key assumptions.

6. For the ICET environment that is the most similar to your plant conditions, compare the expected containment pool conditions to the ICET conditions for the following items: boron concentration, buffering agent concentration, and pH. Identify any other significant differences between the ICET environment and the expected plant-specific environment.

7. For a LBLOCA, provide the time until ECCS external recirculation initiation and the associated pool temperature and pool volume. Provide estimated pool temperature and

pool volume 24 hours after a LBLOCA. Identify the assumptions used for these estimates.

Plant-Specific Chemical Effects

8. Discuss your overall strategy to evaluate potential chemical effects including demonstrating that, with chemical effects considered, there is sufficient net positive suction head (NPSH) margin available during the ECCS mission time. Provide an estimated date with milestones for the completion of all chemical effects evaluations.

9. Identify, if applicable, any plans to remove certain materials from the containment building and/or to make a change from the existing chemicals that buffer containment pool pH following a LOCA.

10. If bench-top testing is being used to inform plant-specific head loss testing, indicate how the bench-top test parameters (e.g., buffering agent concentrations, pH, materials, etc.) compare to your plant conditions. Describe your plans for addressing uncertainties related to head loss from chemical effects including, but not limited to, use of chemical surrogates, scaling of sample size and test durations. Discuss how it will be determined that allowances made for chemical effects are conservative.

Plant Environment Specific

11. Provide a detailed description of any testing that has been or will be performed as part of a plant-specific chemical effects assessment. Identify the vendor, if applicable, that will be performing the testing. Identify the environment (e.g., borated water at pH 9, deionized water, tap water) and test temperature for any plant-specific head loss or transport tests. Discuss how any differences between these test environments and your plant containment pool conditions could affect the behavior of chemical surrogates. Discuss the criteria that will be used to demonstrate that chemical surrogates produced for testing (e.g., head loss, flume) behave in a similar manner physically and chemically as in the ICET environment and plant containment pool environment.

12. For your plant-specific environment, provide the maximum projected head loss resulting from chemical effects (a) within the first day following a LOCA, and (b) during the entire ECCS recirculation mission time. If the response to this question will be based on testing that is either planned or in progress, provide an estimated date for providing this information to the NRC.

ICET 1 and ICET 5 Plants

13. (Not Applicable).

Trisodium Phosphate (TSP) Plants

14. (Not Applicable).

15. (Not Applicable).

16. (Not Applicable).

Additional Chemical Effects Questions

17. The aluminum and other submerged metallic coupons in ICET #4 experienced little corrosion. In this test, the calcium silicate appeared to produce a beneficial effect by contributing to the protective film that formed on the submerged samples. Given that individual plants have less calcium silicate insulation than was represented by the ICET and that a given plant LOCA could result in little or no calcium silicate in the containment pool, discuss how you are confirming your plant materials will behave similar to ICET #4 for your plant-specific conditions.

18. (Not Applicable).

19. (Not Applicable).

20. (Not Applicable).

21. (Not Applicable).

22. (Not Applicable).

23. (Not Applicable).

24. (Not Applicable).

Coatings

Generic - All Plants

25. Describe how your coatings assessment was used to identify degraded qualified/acceptable coatings and determine the amount of debris that will result from these coatings. This should include how the assessment technique(s) demonstrates that qualified/acceptable coatings remain in compliance with plant licensing requirements for design-basis accident (DBA) performance. If current examination techniques cannot demonstrate the coatings' ability to meet plant licensing requirements for DBA performance, licensees should describe an augmented testing and inspection program that provides assurance that the qualified/acceptable coatings continue to meet DBA performance requirements. Alternatively, assume all containment coatings fail and describe the potential for this debris to transport to the sump.

Plant Specific

26. Provide test methodology and data used to support a zone of influence (ZOI) of 5.0 L/D. Provide justification regarding how the test conditions simulate or correlate to actual plant conditions and will ensure representative or conservative treatment in the amounts

of coatings debris generated by the interaction of coatings and a two-phase jet. Identify all instance where the testing or specimens used deviate from actual plant conditions (i.e., irradiation of actual coatings vice samples, aging differences, etc.). Provide justification regarding how these deviations are accounted for with the test demonstrating the proposed ZOI.

27. (Not Applicable).

28. (Not Applicable).

29. (Not Applicable).

30. The NRC staff's safety evaluation (SE) addresses two distinct scenarios for formation of a fiber bed on the sump screen surface. For a thin bed case, the SE states that all coatings debris should be treated as particulate and assumes 100% transport to the sump screen. For the case in which no thin bed is formed, the staff's SE states that the coatings debris should be sized based on plant-specific analyses for debris generated from within the ZOI and from outside the ZOI, or that a default chip size equivalent to the area of the sump screen openings should be used (Section 3.4.3.6). Describe how your coatings debris characteristics are modeled to account for your plant-specific fiber bed (i.e. thin bed or no thin bed). If your analysis considers both a thin bed and a non-thin bed case, discuss the coatings' debris characteristics assumed for each case. If your analysis deviates from the coatings debris characteristics described in the staff-approved methodology, provide justification to support your assumptions.

31. Your submittal indicated that you had taken samples for latent debris in your containment, but did not provide any details regarding the number, type, and location of samples. Please provide these details.

32. Your submittal indicated that you plan to use a debris interceptor as a method to impede transport of debris to the ECCS sump screen. What is the amount (in either volume or percentage) of debris that is expected to be captured by the interceptor? Is there an evaluation for potential to overload the debris interceptor?

33. What structural analysis was performed on the debris interceptor design?

34. You indicated that you would be evaluating downstream effects in accordance with WCAP 16406-P. The NRC is currently involved in discussions with the Westinghouse Owner's Group (WOG) to address questions/concerns regarding this WCAP on a generic basis, and some of these discussions may resolve issues related to your particular station. The following issues have the potential for generic resolution; however, if a generic resolution cannot be obtained, plant-specific resolution will be required. As such, formal RAIs will not be issued on these topics at this time, but may be needed in the future. It is expected that your final evaluation response will specifically address those portions of the WCAP used, their applicability, and exceptions taken to the WCAP. For your information, topics under ongoing discussion include:

ee. Wear rates of pump-wetted materials and the effect of wear on component operation
ff. Settling of debris in low flow areas downstream of the strainer or credit for filtering leading to a change in fluid composition
gg. Volume of debris injected into the reactor vessel and core region
hh. Debris types and properties
ii. Contribution of in-vessel velocity profile to the formation of a debris bed or clog
jj. Fluid and metal component temperature impact
kk. Gravitational and temperature gradients
ll. Debris and boron precipitation effects
mm. ECCS injection paths
nn. Core bypass design features
oo. Radiation and chemical considerations
pp. Debris adhesion to solid surfaces
qq. Thermodynamic properties of coolant

35. Your response to GL 2004-02 question (d)(viii) indicated that an active strainer design will not be used, but does not mention any consideration of any other active approaches (i.e., backflushing). Was an active approach considered as a potential strategy or backup for addressing any issues?

36. You did not provide information on the details of the break selection, ZOI and debris characteristics evaluations other than to state that the Nuclear Energy Institute (NEI) and SE methodology were applied. Please provide a description of the methodologies applied in these evaluations and include a discussion of the technical justification for deviations from the SE-approved methodology.

37. Please discuss the break selection process used to identify the limiting Region I "debris generation break" and the limiting Region II break. Where are these break locations?

38. Were secondary side breaks (e.g., main steam, feedwater) considered the break selection analyses? Would these breaks rely on ECCS sump recirculation?

39. You stated that a series of containment walkdowns were performed for Units 1 and 2 during the spring 2002 and spring 2003 outages, respectively. Were these walkdowns performed in accordance with NEI 02-01 methodology?

40. You acknowledged that use of the alternate evaluation methodology requires that mitigative capability be demonstrated for the Region II breaks (up through the double-ended guillotine break (DEGB) of the largest reactor coolant system piping). Please provide information to demonstrate this mitigative capability in their supplemental GL response.

41. You stated that testing to support other than 100% fines generation for calcium silicate (Cal-Sil) and Marinite insulation fragments will be completed in September 2006. Please provide a description of this test plan including purpose for this testing. Please provide information to justify the plant-specific application for the Cal-Sil and Marinite debris size distribution that results from such testing.

42. You stated that studies for inorganic zinc transport will be performed to justify less transport. Please provide a description of this plan including any testing to be performed. Please provide information to justify the plant-specific application of a reduced transport fraction that results from such testing.

43. The GL response did not appear to describe how erosion is handled for large and small pieces of fibrous and particulate debris. Table 1 of the GL response suggests that erosion might not be modeled for these types of debris. Please provide further information concerning how erosion is handled for these debris size categories and justify this treatment.

44. From the September 2005 response to GL 2004-02, debris settling upstream of the sump strainer (i.e., the near-field effect) appears to be credited to support both the sizing and analytical design basis for the proposed replacement strainers. Please confirm whether this observation is true. In addition, if applicable, please estimate the fraction of debris that settled and describe the analyses that were performed to correlate the scaled flow conditions and any surrogate debris in the test flume with the actual flow conditions and debris types in the plant's containment pool.

45. The NRC staff understands that vents or other penetrations might be present which connect the volume internal to the strainer to the containment atmosphere above the containment minimum water level. As a result, a water seal over the entire strainer is not assured. According to Appendix A to Regulatory Guide 1.82, Revision 3, without a water seal across the entire strainer surface, the strainer should not be considered to be "fully submerged." Therefore, the NRC staff requests that you explain what sump strainer failure criteria (i.e., in terms of differential pressure across the strainer) are being applied for the failure method of insufficient flow through the strainer (i.e., insufficient flow compared to the requirements of the pumps taking suction on the recirculation sump).

46. What is the basis for concluding that the refueling cavity drain(s) would not become blocked with debris? What are the potential types and characteristics of debris that could reach these drains? In particular, could large pieces of debris be blown into the upper containment by pipe breaks occurring in the lower containment, and subsequently drop into the cavity? In the case that large pieces of debris could reach the cavity, are trash racks or interceptors present to prevent drain blockage? In the case that partial/total blockage of the drains might occur, do water hold-up calculations used in the computation of NPSH margin account for the lost or held-up water resulting from debris blockage?

47. The September 2005 response to GL 2004-02 indicated that flume tests for which debris was added in batches over short periods of time resulted in a greater degree of settling than those earlier tests in which debris was added over longer periods of time. The response stated that the earlier tests did not allow sufficient time for debris to settle, but it is not clear to the NRC staff how reducing the period between additions of debris batches would increase the available time for debris to settle. Please provide additional information to explain the observed increase in debris settling for the later tests when debris was introduced in batches over short periods of time (i.e., less than a minute).

48. What is the minimum strainer submergence during the postulated LOCA? At the time that the re-circulation starts, most of the strainer surface is expected to be clean, and the strainer surface close to the pump suction line may experience higher fluid flow than the rest of the strainer. Has any analysis been done to evaluate the possibility of vortex formation close to the pump suction line and possible air ingestion into the ECCS pumps? In addition, has any analysis or test been performed to evaluate the possible accumulation of buoyant debris on top of the strainer, which may cause the formation of an air flow path directly through the strainer surface and reduce the effectiveness of the strainer?

49. Your September 2005 GL response noted that of 8460 lbs of unqualified coating chips, 15% and 0% would transport onto the sump screen without and with a debris interceptor, respectively. PG&E noted that the bases for the transport fraction with a debris interceptor of 0% were computational fluid dynamics analysis, interceptor design, and qualification testing. Please explain.

50. The September 2005 GL response noted that you are planning to perform testing to determine the transport capability of calcium silicate and Marinite insulation fragments, and their potential for erosion in a transport pool flow stream. If the testing is used to design the sump screen, please summarize the basis, results, and conclusions of the testing and how you apply testing for the design.

51. In GL 2004-02, item 2.d.iv, the NRC requested licensees to provide the basis for concluding that the water inventory required to ensure adequate ECCS or Containment Spray System (CSS) recirculation would not be held up or diverted by debris blockage at choke-points in containment recirculation sump return flowpaths. Diablo Canyon responded that as part of the upstream effects evaluation performed, various locations were found that have the potential to hold up water inventory. These potential hold up points will be evaluated and Diablo Canyon will revise the calculations that estimates the minimum sump water level that would exist at the start of recirculation. Please provide the NRC with the results of this evaluation.