EXHIBIT I

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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| In The Matter Of: | ) | |
| | ) | |
| PACIFIC GAS AND ELECTRIC COMPANY | ) | Docket Nos. 50-275 OL |
| | ) | 50-323 OL |
| (Diablo Canyon Nuclear Power | ) | |
| Plant, Units 1 and 2) | ) | |

AFFIDAVIT OF RICHARD BURTON HUBBARD

CONCERNING

PUBLIC RISK ASSOCIATED WITH PROPOSED LOW-POWER TEST PROGRAM

STATE OF CALIFORNIA )
) ss.
COUNTY OF SANTA CLARA )

## I. INTRODUCTION

RICHARD B. HUBBARD, being of legal age and duly sworn, deposes and says as follows:

1. My name is Richard B. Hubbard. I am a Professional Quality Engineer licensed by the State of California, a technical consultant, and a founder (in 1976) and vice president of MHB Technical Associates, a corporation engaged in the business of technical consulting on energy and environmental issues and having its principal office at 1723 Hamilton Avenue, San Jose, California, 95125. I hold a B.S. in Electrical Engineering from the University of Arizona (1960) and an M.B.A. from the University of Santa Clara (1969). I have sixteen



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years experience in nuclear power plant electronics, instrumentation, and controls, including eleven years experience in responsible managerial positions in the Nuclear Instrumentation Department (1965-1971), Atomic Power Equipment Department (1971-1975), and Nuclear Energy Control and Instrumentation Department (1975-1976) of General Electric Company. I am a member of the IEEE Nuclear Power Engineering standards subcommittee responsible for the preparation of Quality Assurance standards for safety-related aspects of nuclear power facilities. I have testified on safety-related aspects of nuclear power facilities as an expert witness before the Nuclear Regulatory Commission Atomic Safety and Licensing Boards; before (and at the request of) the NRC's Advisory Committee on Reactor Safeguards; before the Joint Committee on Atomic Energy of the United States Congress; and before various State legislative and administrative bodies. I am thoroughly familiar with the safety analyses of the Diablo Canyon license Applicant (Pacific Gas and Electric Company), the Nuclear Steam Supply System supplier (Westinghouse), and the NRC Staff (Staff) as a result of my service as a technical consultant since the fall of 1976 to the Center for Law in the Public Interest, attorneys for the Joint Intervenors in the Diablo Canyon Operating License proceeding.

2. For the past four years, I, along with my co-founders of MHB Technical Associates, have conducted numerous technical and economic evaluations of nuclear power plants. Examples of my recently completed projects directly related to various aspects of the subject addressed in this affidavit--nuclear plant risk assessment--are as follows:

a. Critique of WASH-1400:

The Union of Concerned Scientists (UCS) prepared a critique of the U.S. Reactor Safety Study (WASH-1400). The UCS Critique was released in November, 1977, and was the culmination of over a year's effort

by about a dozen technical people. The UCS Critique was edited by MHB partners Gregory Minor and me, and I also contributed to a number of the chapters. Further, I presented sections of the summary of the UCS Critique to the NRC's Risk Assessment Review Group.

b. Swedish Reactor Safety Study:

As a part of Sweden's re-evaluation of the role of nuclear power, MHB was contracted by the Swedish Energy Commission to conduct a $200,000 risk study of a Swedish nuclear plant (Barseback). This study was completed in January of 1978, and the results were presented by me and others to the Swedish Parliament in April, 1978. Subsequently, I conducted a follow-up study for the Swedish Nuclear Power Inspectorate. The study addressed uncertainties in risk assessment (follow-up to the NRC's Risk Assessment Review Group Report).

c. Italian Reactor Safety Study:

In 1980, MHB completed a site-specific risk assessment for reactor accidents at an Italian reactor site (Caorso) utilizing the WASH-1400 techniques. Accident consequences were calculated with a modified and updated version of the WASH-1400 consequence model--the CRAC Code. Preliminary results of the MHB study were presented by me to the Italian government at a meeting in Venice on January 25 through 27, 1980. The final report was presented by Dale Bridenbaugh and me in a forum in Rome on May 16 and 17, 1980.

3. I have also provided technical consultation to the West German government concerning risk assessments of nuclear plants. My experience and qualifications are further described in Attachment A, which is appended to this affidavit.

## II. PURPOSE

4. The purpose of this affidavit is to:

   a. Describe the potential risk to public health and safety associated with the proposed Diablo Canyon Low-Power Test Program (LPTP), and

   b. To assess the need for emergency planning measures to mitigate the consequences of any radioactive releases which might occur during the LPTP.

## III. SUMMARY

5. This affidavit assesses the public risk associated with the proposed Low-Power Test Program (LPTP) at Diablo Canyon. My opinion is that while the risk associated with a 5% power test program at Diablo Canyon will be significantly reduced from that at full power operation, the risks may never the less be significant and thus effective off-site emergency response planning is necessary before the low-power testing may be authorized. Specific matters discussed hereafter which provide the basis for this opinion include:

   a. The Staff's probability analysis of the LPTP risks is based on an extrapolation of WASH-1400. Thus, Diablo-specific analyses have not been performed and the serious shortcomings of WASH-1400 have been ignored. Further, the Staff's risk estimates never address the meteorological conditions at Diablo Canyon.

   b. At 5% power, significant radionuclide inventories will be developed. Indeed, at 5% power, the short-lived isotopes of iodine and tellurium, the significant contributors to prompt public health consequences, approach 95% of their equilibrium condition (5% of their full power value) in 8 to 40 days, depending

on the radionuclide. The inventory of radionuclides, while reduced from the full power level, still poses a substantial prompt health hazard.

c. At 5% power, Diablo Canyon will be the equivalent of a 54.2 megawatt-electrical or 166.9 megawatt-thermal power reactor. The NRC is requiring detailed off-site emergency planning for small reactors of comparable size, as well as at test reactors. There is clear NRC precedent for requiring off-site emergency planning measures to mitigate the consequences of potential releases which might occur during the Diablo Canyon LPTP.

## IV. DISCUSSION OF ISSUES

6. The term "risk" can be defined in several ways. In this affidavit, as in WASH-1400, risk is defined as the probability of the accident occurring times its consequences. Risk assessment involves two major tasks; the first is to identify and determine the likelihood of possible reactor accidents, and the second is to calculate the consequences. The risks for the Diablo Canyon LPTP described herein are for operation of an initially unirradiated core at 5% power for 6 months. For Diablo Canyon Unit 1, 5% power corresponds to approximately 54.2 megawatts-electrical or 166.9 megawatts-thermal.*

7. The Staff has concluded that if an accident were to occur during low-power testing, off-site doses would be insignificant and no off-site protective actions would be anticipated.** Further, the Staff has concluded that because of low

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* Diablo Canyon FSAR, page 1.1-2.

** NRC Response to Joint Intervenors Interrogatories, March 16, 1981, pages 9 and 10.

risk, evacuation is not of significant concern during low-power testing* and, therefore, the evacuation of a partial distance or the entire 360 degree circumference of the reactor is not a significant requirement for low-power testing.** The conclusion is apparently drawn from the Staff's "Introduction" in Supplement 10 of the Diablo Canyon Safety Evaluation Report (SER)*** since the Applicant has presented no plant-specific or site-specific risk assessment for the LPTP in the Diablo Canyon FSAR.**** Likewise, the Staff risk estimates in the SER appear to be based on a qualitative extrapolation of the WASH-1400 results for the Surry PWR at a generic site, rather than on a detailed quantitative assessment of the specific Diablo Canyon design, operation, and site factors.

8. WASH-1400 represents one of the most comprehensive inquiries into nuclear safety ever carried out by the NRC. Even if one questions the validity of the absolute values of the WASH-1400 results for the Diablo Canyon LPTP as we do here, it is still clear that WASH-1400 produced a body of useful analysis that significantly advances the technical understanding of nuclear power reactor safety. Equally clearly, there is still a range of technical views on the absolute probabilities and the uncertainty error bounds associated with the conclusions of WASH-1400-type risk assessments. Nuclear power regulators must not uncritically accept the absolute numbers resulting

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* NRC Response to Joint Intervenors' Interrogatories, March 16, 1981, as modified by the March 25, 1981 Errata, page 15.

** NRC Response to Joint Intervenors' Interrogatories, March 16, 1981, as modified by the March 25, 1981 Errata, page 18.

*** NUREG-0675, Supplement 10, pages 1 to 4.

**** The Diablo Canyon Seismic Risk Analysis (Amendment 52 of the FSAR) sets forth the public risk from possible earthquake-induced damage to the Diablo Canyon plant. Staff review of the seismic Risk Analysis was never completed, nor were the results of the preliminary review ever documented by the Staff in any Supplement to the Diablo Canyon SER.

from generic reactor risk assessments. Victor Gilinsky, one of the five NRC Commissioners, cautioned in a November 15, 1979 presentation as follows:

> ".....the truth is that for all the elaborate reviews, computer accident scenarios and the extensive regulatory requirements so onerous to the utilities, most of the regulatory technicians--along with their industry counterparts--believed, deep down, they were only gilding the lily with their safety rules, that accidents were remote, that nuclear power plants did not pose serious risks, that the important possibilities had been covered.....The basic flaw in the system, then, was the secondary priority assigned to questioning and improving safety, an attitude legitimized by the astronomically small risk estimates of the Rasmussen Report. The complacency, and ultimately the sheer sloppiness, of the nuclear enterprise which so appalled the Kemeny Commission and led it to call for a 'fundamental change in attitude' was the result. Three Mile Island shattered that complacency." (emphasis added)

9. Within the last few years, studies of uncertainty in the absolute values in nuclear risk assessment have been conducted. For example, a recent and very thorough review of WASH-1400 was conducted by the Risk Assessment Review Group (RARG), set up by the NRC and chaired by Dr. Harold Lewis. Their report, entitled Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission, NUREG/CR-0400, was published in September of 1978. The RARG held a dozen public meetings in 1977 and 1978 and received numerous presentations of data and viewpoints, both supportive and critical of the WASH-1400 methodology and results. The data presented at these meetings (several thousand pages) represent one of the largest and most recent sources of information on reactor accident probability and consequences covering a wide range of viewpoints and opinions. One relevant deficiency in WASH-1400 that the RARG identified in Disjoint Item 6 was that the subject of earthquake-initiated accidents, one of the key potential accident initiators at Diablo Canyon, deserves more attention than it received in WASH-1400.

10. The RARG report does not quantify accident probability uncertainties, but does include the following observation:

> "We are unable to determine whether the absolute probabilities of accident sequences in WASH-1400 are high or low, but we believe that the error bounds on those estimates are, in general, greatly understated."

In regard to the uncertainties in the accident consequences identified in WASH-1400, the Review Group made these observations:

> "There is much disagreement about the details of the estimates made by the WASH-1400 team charged with making the disease and mortality estimates. For example, although all the members of the WASH-1400 team contributed their full and honest efforts to the task, the spectrum represented by that team was not broad enough to encompass the full range of scholarly opinion on the subject. This led the WASH-1400 team to make estimates with a narrower range of stated 'uncertainty' than would otherwise have been the case."

11. In response to the conclusions of the RARG study, in January, 1979, even before the TMI-2 accident, the NRC Commissioners, in a Policy Statement, concluded that accident probabilities estimated in WASH-1400 were not reliable and acknowledged shortcomings in the methods by which WASH-1400 was prepared and issued. The Diablo Canyon extrapolations by the Staff for the LPTP suffer the same infirmities, some of which are briefly summarized in the following:

> a. Specific Diablo Canyon fault-trees and event-trees necessary to quantify the accident sequence numerical conclusions have not been developed. In addition, for one of the potential dominant accident contributors, small break LOCA's, the LOCA evaluation is being revised by Westinghouse (see Item F in Applicant's February 13, 1981 letter to the NRC). Detailed plant-specific fault-tree and

event-tree assessment has repeatedly been suggested by the ACRS* and is recognized as potentially useful in plant licensing in the Task II.C programs in the TMI Action Plan (NUREG-0660). Unfortunately, the Diablo Canyon specific quantitative assessments described in TMI Task II.C have not yet been prepared by the Applicant or reviewed by the NRC (an exception is the partial systems interaction study conducted by the Applicant and reviewed by the NRC in Supplement 11 of the SER).

b. The time available before fuel failure following LOCA will be increased because of the reduced decay heat level occurring following the LPTP. However, because of the increased numbers of shutdowns likely to occur at a new plant during the LPTP, as compared to sustained full-power operation, accident sequences

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* See letter from Milton S. Plesset, ACRS Chairman to John F. Ahearne, NRC Chairman entitled "ACRS Report on Near Term Operating License Items From Draft 3 of NUREG-0660," March 11, 1980 which states in part that:

"The Committee wishes to comment at this time on two items in the Action Plans in order to recommend the initiation of actions which relate to the NTOL plants. In the Committee's opinion, the issuance of an operating license should not be contingent on completion of these matters.

1. In its letter of December 13, 1979 on the TMI-2 Lessons Learned Task Force Report, the ACRS supported the Integrated Reliability Evaluation Program (IREP). However, the ACRS went on to state, 'the Committee does not agree that the proposed IREP will fully satisfy the need. The ACRS recommends that the NRC develop a program in which licensees, acting individually or jointly, develop reliability assessments of their plants in addition to the NRC IREP, which would be performed concurrently.'

   The ACRS believes that, on an expedited but practical schedule, the NTOL plant owners, as well as current licensees, should be required to perform studies of the type referred to above.

2. In its letter of December 13, 1979, the ACRS supported the recommendation of the Lessons Learned Task Force concerning design features for core-damage and core-melt accidents. The ACRS further recommended that design studies of possible hydrogen control and filtered-venting systems for containment be required from licensees."

Thus, contrary to the fact set forth by Brunot for PG&E in his affidavit at page 7, PG&E has been on notice for over a year that a plant-specific accident probability analysis should be conducted.

involving maintenance activities during shutdown conditions (with reactor head removed and/or containment inadvertently open, for example) may reduce the barriers delaying radioactive releases. Also, during a start-up test program, one would expect an increased frequency of operator errors, particularly from operators of a plant owner similar to PG&E who have not had recent operating experience with a large PWR.

c. There will be increased reliance on operators during the LPTP. For example, PG&E has determined that close operator surveillance of parameters and suitable action points in the event of significant deviation from test conditions are required in order to minimize the risk. It is also recognized by PG&E that in order to perform these tests some automatic safety functions, reactor trips and safety injection, will be defeated. Further, it is recognized that several technical specification requirements will not be met while either preparing for or performing these tests.*

d. The Staff conclusions, like those in WASH-1400, assume that public risk can be reduced to simply the mathematical product of "probability" and "consequences." However, it must be emphasized that both probability and consequences may be significantly affected by the effectiveness of implementation by licensees, the NRC and local and state governments of safety assurance measures. Thus, the implementation of such measures as operational procedures, operator training, quality assurance, regulatory oversight, resolution of generic issues, and feedback of operating experience all may significantly impact both probability and consequences and thus the overall risk. The TMI-2 experience has sharply focused concerns regarding these qualitative aspects of risk assessment. The Staff risk analysis in SER, Supplement 10, does not address this matter and thus there is no basis for concluding that the risks discussed therein are conservative.

e. A re-evaluation by the NRC Staff of the failure rate data used in WASH-1400 in the light of new, more extensive data, suggests an increase by about a factor

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* Affidavit of James A. Schiffer for PG&E, April 2, 1981, Attachment II, page 1-1.

of three in the core melt frequencey due to this effect alone.*

f. Significant losses in safety system availability have occurred in operating plants. The 1980 Browns Ferry partial failure to scram has added further uncertainty to claims of very high reliability of such safety systems.**

g. It appears that while some systems interactions were considered in the WASH-1400 study, and some have been examined for Diablo Canyon specifically (see SER Supplement 11), the scope of this assessment was inadequate. Similarly, the effects of control systems and other non-safety systems on accidents, including seismically induced accidents, may not have received adequate attention.***

h. WASH-1400 indicates that much of the nuclear plant risk is due to human failures of several kinds. The WASH-1400 authors assumed for those cases where there were not well-defined sequences of operator's actions, that the operator took no action. There is little or no way for the WASH-1400 methodology to incorporate the ingenuity of a human during an accident. Thus, human response may be an intrinsic conservatism in the risk calculations. However, as the experience during the TMI-2 accident indicates, the operators could also unintentionally initiate accidents or cause matters to worsen.

i. Sabotage was not included in the WASH-1400 estimates. Sabotage remains difficult to quantify, but there appears to be little basis for justifying it

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* Advisory Committee on Reactor Safeguards, U.S. NRC, letter to Hon. Morris K. Udall, from Milton S. Plesset, subject: (Actual Component Failure Experience) February 20, 1980.

** U.S. NRC, Facility: Tennessee Valley Authority, Browns Ferry Unit 3, Docket No. 50-296, Athens, Alabama; subject: Failure of Control Rods to Insert During a Scram, U.S. NRC Preliminary Notification of Event or Unusual Occurrence PNO-II-80-119, June 30, 1980.

*** Board Notification BN-80-15, November, 1980, Differing Professional Opinion Board Notification, "Safety Implications of Control Systems and Plant Dynamics."

as small compared to a frequency of one in 10,000 per reactor year for a core damage accident.

j. The WASH-1400 evaluation that the seismic contribution to LWR risk is negligible has been shown to be in serious error.* In addition, review of specific plant designs including Diablo Canyon has turned up a wide range of design errors and other seismic deficiencies. Furthermore, estimates of the return frequency of the safe shutdown earthquake have become progressively larger with time so that they may now exceed those used in the WASH-1400 analysis.**

12. In summary, since issuance of the final version of WASH-1400 in 1975 with the core melt frequency of about one in 20,000 per reactor year (median value), a considerable number of events have occurred which tend to support a thesis that the WASH-1400 estimate of the frequency of core melt (or at least core damage severe enough to threaten containment and a major release of radioactive materials) may be too low. While operation of nuclear power plants at less than rated conditions, as proposed for the Diablo Canyon LPTP, has historically been accepted as a method for reducing the probability of accidents, I believe that the numerical findings and conclusions developed in WASH-1400, and extrapolated by the Staff to the Diablo Canyon LPTP in Supplement 10 of the SER, do not provide a documented scientific basis sufficient to justify the conclusion that the probabilities of off-site releases during the LPTP are low enough to preclude the need for off-site consequence mitigation measures.

13. The second major factor in the Diablo Canyon LPTP risk assessment is the quantification of accident consequences. The beginning point of the WASH-1400 consequence calculation is the specification of the postulated accident in terms of

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* Hsieh, T.M., Okrent, D., "On Design Errors and System Degradation in Seismic Safety," Structural Mechanics in Reactor Technology (Trans. 4th Int. Conf. San Francisco, 1977) Vol. K(b), paper K 9/4.

** Okrent, D., "New Trends in Safety Design and Analysis," IAEA-CN-39/6.4, Stockholm, October 20-24, 1980.

the quantity of radioactive material that could be released to the environment, the amount of energy associated with the release, the duration of the release, the time of release after accident initiation, the warning time for evacuation, the elevation of the release and the probability of the accident occurrence. The description of the range of radioactive releases from a potential accident is set forth in WASH-1400. Data for nine (9) potential PWR release categories are described. The release data represent the basic input to the consequence model.

14. A consequence model was developed for WASH-1400 which utilized a progression of mathematical and statistical models. These models describe the release of radionuclides from the reactor containment, calculate the movement of the material in the areas surrounding the power plant, and determine the interaction with the influence upon man and his environment. The Calculations of Reactor Accident Consequences (CRAC) computer model was developed to perform these tasks in a manner which would "realistically" predict the consequences from postulated accidents. The WASH-1400 models were chosen with the objective of quantifying societal risk. Therefore, the WASH-1400 consequence estimates are not based on the conservative approaches normally taken in the regulatory process and thus WASH-1400 should not be directly extrapolated to the proposed licensing of the Diablo Canyon LPTP.

15. The consequences from the release of a specific amount of radioactive material can range from slight to catastrophic, depending upon the following key elements:

a. the amount of radioactive material released to the atmosphere,

b. the number of people exposed to the contamination, and

c. the meteorological conditions following the release.

CRAC calculates sets of consequences from all of the combinations of release magnitudes, population groupings and samplings of actual meteorological conditions.* Each consequence set has a probability of occurrence associated with it which is defined by the probability of the release magnitude times the probability of the population group times the probability of the meteorological condition. With all combinations generated, a distribution function for a consequence is formed with the associated statistics. In this manner, a full range of results is obtained with associated probabilities.

16. Accident consequences are directly related to the fission product inventory. The radionuclides which are significant contributors to the dominant exposure modes for prompt public health consequences are the short-lived isotopes of Iodine and Tellurium. At 5% power, these radionuclides will approach approximately 95% of their equilibrium condition (5% of their full power value) in 5 half-lives which corresponds to between approximately 8 and 40 days depending upon the radionuclide. We agree with the Staff and PG&E that the available inventory attributable to prompt health effects would be reduced by approximately a factor of 20 for operation from initial starting at 5% power for six months compared to continuous full power operation.** Any further reduction in this term for the proposed LPTP, as suggested by the NRC, is not conservative or prudent because of the inherent uncertainties in any such testing program. Thus, should a release occur, the inventory of radionuclides, while reduced from the full power level, still poses a substantial prompt health hazard.

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* Appendix VI of WASH-1400 describes the "Calculations of Reactor Accident Consequences" which is the basis for this computer code. WASH-1400 references in this section, unless otherwise specified, are to WASH-1400, Appendix VI, Calculations of Reactor Accident Consequences.

** NUREG-0675, Supplement 10, page 3, and affidavit of William K. Brunot, page 6, April 2, 1981 for PG&E.

17. Accident consequences are also directly related to the number of people exposed to the radioactive contamination. The Diablo Canyon site is better than the average U.S. site for population density in the 0-10 mile radius. For example, in 1970 in the 10-mile ring, there were 6,300 people* living in the area surrounding the Diablo Canyon site while the median value for the first 111 U.S. sites was 24,000.** However, the potential benefit of this low population density could be lost for accidental releases occurring during the LPTP if effective off-site emergency planning measures are not implemented and operational.

18. The introductory mention of the evacuation aspect of emergency planning in WASH-1400 states:

> "In the case of a potentially serious accidental release, it is assumed that people living within about 25 miles of the plant, and located in the direction of the wind, would be evacuated....."

Other references to evacuation are in WASH-1400, Appendix VI, where it is explained that credit is taken for evacuation in all directions to 5 miles and in a downwind 45° sector to 25 miles in order to concentrate evacuation facilities where they will do most good. After the TMI-2 experience, the NRC and FEMA, in NUREG-0654, selected for large power reactors, a Plume Exposure Pathway Emergency Planning Zone (EPZ) with about a 10-mile radius and an Ingestion Pathway EPZ with about a 50-mile radius.

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* NUREG-0348, Demographic Statistics Pertaining to Nuclear Power Reactor Sites, October 1979, pages T2 and T21A.

** The resident population does not include transient population such as seasonal residents or visitors to the recreational areas. Near the Diablo Canyon site are recreational areas including public beaches and state parks.

19. The FEMA/NRC Steering Committee further concluded that small water-cooled power reactors (less than 250 MTt) and the Fort St. Vrain gas-cooled reactor may use a Plume Exposure EPZ of about 5 miles and an Ingestion Pathway EPZ of About 30 miles. This conclusion is based on the lower potential hazard from these facilities (lower radionuclide inventory and longer times to release significant amounts of activity for many scenarios). The radionuclides to be considered in planning were determined to be the same as recommended in NUREG-0396.* Diablo Canyon at 5% power has a thermal rating equivalent to the small power reactors cited above. Therefore, it is clear based on this precedent, that effective off-site emergency planning measures must be instituted for the Diablo Canyon LPTP.

20. Following the TMI accident, upgraded emergency preparedness has also been required for non-power test reactors in accordance with the new emergency planning regulations.** Currently, the NRC has a contractor doing a detailed study of fission product releases based on credible accident scenarios for a test reactor. The study is now in the review cycle. Until the preceding study is completed, the NRC's Chief of the Emergency Preparedness Branch would arbitrarily assign an EPZ of 1 mile for plume exposure and 3 miles for ingestion for non-power reactors larger than 1 megawatt-thermal.*** Again, as in Item 17, there is clear NRC precedent for requiring off-site emergency planning measures to mitigate the consequences of potential releases which might occur during the Diablo Canyon LPTP.

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* Letter, Dennis Crutchfield of the NRC to David Hoffman, Consumers Power Company, June 13, 1980.

** Letter, Tedesco, NRC, to All Non-Power Reactor Licensees, November 6, 1980.

*** Telephone conversation between Richard Hubbard and Steve Ramos of the NRC, March 25, 1981.

21. One additional matter bears mention with respect to emergency preparedness during the proposed Diablo Canyon LPTP. Neither the Staff* nor PG&E** dispute that on-site and off-site emergency preparedness is a necessary prerequisite to the licensing of Diablo Canyon, even at low power. Indeed, PG&E concludes that a six-mile off-site planning zone for plume exposure and a 10-mile zone for ingestion pathways are appropriate at low power.***

22. Consideration of worst case meteorological conditions is also an integral part of emergency action planning and of determining potential accident consequences. Atmospheric transport is important because hazardous radionuclides may be carried long distances in relatively short times. No mention of Staff consideration of the Diablo Canyon-specific meteorology is included in the Staff's risk estimates in Supplement 10 of the SER. This appears to be a significant omission.

23. Waterborne transport of radionuclides is of lesser importance in most events, and is generally slow moving for rock sites such as Diablo Canyon, thereby providing time to invoke interdiction measures. However, the Staff fails to discuss methods to assess and interdict liquid pathway releases though the liquid release may be the most probable pathway.****

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* NUREG-0675, Supplement 10, pages II.A-1 to II.B-3.

** PG&E's Memorandum of Points and Authorities in Support of Motion for Summary Disposition, April 3, 1981, pages 3, 6, 7, and 8.

*** Affidavit of William K. Brunot for PG&E, April 2, 1981, page 5.

**** NUREG/CR-1596, an unpublished report prepared by Sandia Laboratories, sets forth the general effect of liquid pathways on the consequences of core melt accidents.

## V. CONCLUSION

24. Based on the foregoing, I conclude there is inadequate and incomplete Diablo Canyon-specific risk assessments based on the specific design, operation, and site conditions to enable detailed quantification of the public risk associated with the accidental radioactive releases which might occur during the proposed Diablo Canyon LPTP. Clearly there will be some yet unquantified reduction in risk if the Diablo Canyon plant is operated at 5% power for six months as compared to full power operation. The probability of a radioactive release will be reduced because the decay heat level is reduced, as compared to the heat following sustained full power operation, which allows greater time to correct malfunctions. Potential prompt consequences will also be reduced due to the reduced fission product inventory and the low population density near the plant. However, because of the relatively fast buildup of the isotopes which dominate prompt consequences, even at 5% power the fission products available for release pose a major hazard. Further, uncertainties in the absolute values of the results of any such probability analysis are substantial. Effective off-site emergency planning by local authorities including measures such as sheltering and evacuation, is therefore, both necessary and prudent to ensure the safety and health of the public.

I have read the foregoing and swear that it is true and accurate to the best of my knowledge.

Richard B. Hubbard

RICHARD B. HUBBARD

Subscribed and sworn to before me this 16th day of April, 1981.

Karen L. Engels

NOTARY PUBLIC

My commission expires: 1-13-84

OFFICIAL SEAL
KAREN L. ENGELS
Notary Public California
Principal Office in
Santa Clara County
My commission expires Jan. 13, 1984

ATTACHMENT A Ex. L. p. 49

# PROFESSIONAL QUALIFICATIONS OF RICHARD B. HUBBARD

RICHARD B. HUBBARD
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## EXPERIENCE:

9/76 - PRESENT

Vice-President - MHB Technical Associates, San Jose, California. Founder, and Vice-President of technical consulting firm. Specialists in independent energy assessments for government agencies, particularly technical and economic evaluation of nuclear power facilities. Consultant in this capacity to Oklahoma and Illinois Attorney Generals, Minnesota Pollution Control Agency, German Ministry for Research and Technology, Governor of Colorado, Swedish Energy Commission, Swedish Nuclear Inspectorate, and the U.S. Department of Energy. Also provided studies and testimony for various public interest groups including the Center for Law in the Public Interest, Los Angeles; Public Law Utility Group, Baton Rouge, Louisiana; Friends of the Earth (FOE), Italy; and the Union of Concerned Scientists, Cambridge, Massachusetts. Provided testimony to the U.S. Senate/House Joint Committee on Atomic Energy, the U.S. House Committee on Interior and Insular Affairs, the California Assembly, Land Use, and Energy Committee, the Advisory Committee on Reactor Safeguards, and the Atomic Safety and Licensing Board. Performed comprehensive risk analysis of the accident probabilities and consequences at the Barseback Nuclear Plant for the Swedish Energy Commission and edited, as well as contributed to, the Union of Concerned Scientist's technical review of the NRC's Reactor Safety Study (WASH-1400).

2/76 - 9/76

Consultant, Project Survival, Palo Alto, California. Volunteer work on Nuclear Safeguards Initiative campaigns in California, Oregon, Washington, Arizona, and Colorado. Numerous presentations on nuclear power and alternative energy options to civic, government, and college groups. Also resource person for public service presentations on radio and television.

5/75 - 1/76

Manager - Quality Assurance Section, Nuclear Energy Control and Instrumentation Department, General Electric Company, San Jose, California.
Report to the Department General Manager. Develop and implement quality plans, programs, methods, and equipment which assure that products produced by the Department meet quality requirements as defined in NRC regulation 10 CFR 50, Appendix B, ASME Boiler and Pressure Vessel Code, customer contracts, and GE Corporate policies and procedures. Product areas include radiation sensors, reactor vessel internals, fuel handling and servicing tools, nuclear plant control and protection instrumentation systems, and nuclear steam supply and Balance of Plant control room panels. Responsible for approximately 45 exempt personnel, 22 non-exempt personnel, and 129 hourly personnel with an expense budget of nearly 4 million dollars and equipment investment budget of approximately 1.2 million dollars.

11/71 - 5/75

Manager - Quality Assurance Subsection, Manufacturing Section of Atomic Power Equipment Department, General Electric Company, San Jose, California.
Report to the Manager of Manufacturing. Same functional and product responsibilities as in Engagement #1, except at a lower organizational report level. Developed a quality system which received NRC certification in 1975. The system was also successfully surveyed for ASME "N" and "NPT" symbol authorization in 1972 and 1975, plus ASME "U" and "S" symbol authorizations in 1975. Responsible for from 23 to 39 exempt personnel, 7 to 14 non-exempt personnel, and 53 to 97 hourly personnel.

3/70 - 11/71

Manager - Application Engineering Subsection, Nuclear Instrumentation Department, General Electric Company, San Jose, California.
Responsible for the post order technical interface with architect engineers and power plant owners to define and schedule the instrumentation and control systems for the Nuclear Steam Supply and Balance of Plant portion of nuclear power generating stations. Responsibilities included preparation of the plant instrument list with approximate location, review of interface drawings to define functional design requirements, and release of functional requirements for detailed equipment designs. Personnel supervised included 17 engineers and 5 non-exempt personnel.

12/69 - 3/70

Chairman - Equipment Room Task Force, Nuclear Instrumentation Department, General Electric Company, San Jose, California.
Responsible for a special task force reporting to the Department General Manager to define methods to improve the quality and reduce the installation time and cost of nuclear power plant control rooms. Study resulted in the conception of a factory-fabricated control room consisting of signal conditioning and operator control panels mounted on modular floor sections which are completely assembled in the factory and thoroughly tested for proper operation of interacting devices. Personnel supervised included 10 exempt personnel.

12/65 - 12/69

Manager - Proposal Engineering Subsection, Nuclear Instrumentation Department, General Electric Company, San Jose, California.
Responsible for the application of instrumentation systems for nuclear power reactors during the proposal and pre-order period. Responsible for technical review of bid specifications, preparation of technical bid clarifications and exceptions, definition of material list for cost estimating, and the "as sold" review of contracts prior to turnover to Application Engineering. Personnel supervised varied from 2 to 9 engineers.

8/64 - 12/65

Sales Engineer, Nuclear Electronics Business Section of Atomic Power Equipment Department, General Electric Company, San Jose, California.
Responsible for the bid review, contract negotiation, and sale of instrumentation systems and components for nuclear power plants, test reactors, and radiation hot cells. Also responsible for industrial sales of radiation sensing systems for measurement of chemical properties, level, and density.

10/61 - 8/64

Application Engineer, Low Voltage Switchgear Department, General Electric Company, Philadelphia, Pennsylvania.
Responsible for the application and design of advanced diode and silicon-controlled rectifier constant voltage DC power systems and variable voltage DC power systems for industrial applications. Designed, followed manufacturing and personally tested an advanced SCR power supply for product introduction at the Iron and Steel Show. Project Engineer for a DC power system for an aluminum pot line sold to Anaconda beginning at the 161KV switchyard and encompassing all the equipment to convert the power to 700 volts DC at 160,000 amperes.

9/60 - 10/61

GE Rotational Training Program

Four 3-month assignments on the GE Rotational Training Program for college technical graduates as follows:

a. Installation and Service Eng. - Detroit, Michigan. Installation and startup testing of the world's largest automated hot strip steel mill.

b. Tester - Industry Control - Roanoke, Virginia. Factory testing of control panels for control of steel, paper, pulp, and utility mills and power plants.

c. Engineer - Light Military Electronics - Johnson City, New York. Design of ground support equipment for testing the auto pilots on the F-105.

d. Sales Engineer - Morrison, Illinois. Sale of appliance controls including range timers and refrigerator cold controls.

EDUCATION:

Bachelor of Science Electrical Engineering, University of Arizona, 1960.

Master of Business Administration, University of Santa Clara, 1969.

PROFESSIONAL AFFILIATION:

Registered Quality Engineer, License No. QU805, State of California.

Member of Subcommittee 8 of the Nuclear Power Engineering Committee of the IEEE Power Engineering Society responsible for the preparation and revision of the following 4 national Q.A. Standards:

a. IEEE 498 (ANSI N45.2.16): Supplementary Requirements for the Calibration and Control of Measuring and Test Equipment used in the Construction and Maintenance of Nuclear Power Generating Stations.

PROFESSIONAL AFFILIATION: (Contd)

b. IEEE 336 (ANSI N45.2.4): Installation, Inspection, and Testing Requirements for Instrumentation and Electric Equipment during the Construction of Nuclear Power Generating Stations.

c. IEEE 467 (ANSI 45.2.14): Quality Assurance Program Requirements for the Design and Manufacture of Class IE Instrumentation and electric Equipment for Nuclear Power Generating Stations.

d. IEEE Draft: Requirements for Replacement Parts for Class IE Equipment Replacement Parts for Nuclear Power Generating Stations.

PERSONAL DATA:

Birth Date: 7/08/37
Married; three children
Health: Excellent

PUBLICATIONS AND TESTIMONY:

1. In-Core System Provides Continuous Flux Map of Reactor Cores, R.B. Hubbard and C.E. Foreman, Power, November, 1967.

2. Quality Assurance: Providing It, Proving It, R.B. Hubbard, Power, May, 1972.

3. Testimony of R.B. Hubbard, D.G. Bridenbaugh, and G.C. Minor before the United States Congress, Joint Committee on Atomic Energy, February 18, 1976, Washington, DC. (Published by the Union of Concerned Scientists, Cambridge, Massachusetts.) Excerpts from testimony published in Quote Without Comment, Chemtech, May, 1976.

4. Testimony of R.B. Hubbard, D.G. Bridenbaugh, and G.C. Minor to the California State Assembly Committee on Resources, Land Use, and Energy, Sacramento, California, March 8, 1976.

5. Testimony of R. B. Hubbard and G.C. Minor before California State Senate Committee on Public Utilities, Transit, and Energy, Sacramento, California, March 23, 1976.

6. Testimony or R.B. Hubbard and G.C. Minor, Judicial Hearings Regarding Grafenrheinfeld Nuclear Plant, March 16 & 17, 1977, Wurzburg, Germany.

PUBLICATIONS AND TESTIMONY: (Contd)

7. Testimony of R.B. Hubbard to United States House of Representatives, Subcommittee on Energy and the Environment, June 30, 1977, Washington, DC, entitled, Effectiveness of NRC Regulations - Modifications to Diablo Canyon Nuclear Units.

8. Testimony of R.B. Hubbard to the Advisory Committee on Reactor Safeguards, August 12, 1977, Washington, DC, entitled, Risk Uncertainty Due to Deficiencies in Diablo Canyon Quality Assurance Program and Failure to Implement Current NRC Practices.

9. The Risks of Nuclear Power Reactors: A Review of the NRC Reactor Safety Study WASH-1400, Kendall, et al, edited by R.B. Hubbard and G.C. Minor for the Union of Concerned Scientists, August, 1977.

10. Swedish Reactor Safety Study: Barsebäck Risk Assessment, MHB Technical Associates, January 1978 (Published by Swedish Department of Industry as Document DSI 1978:1).

11. Testimony of R.B. Hubbard before the Energy Facility Siting Council, March 31, 1978, in the matter of Pebble Springs Nuclear Power Plant, Risk Assessment: Pebble Springs Nuclear Plant, Portland, Oregon.

12. Presentation by R.B. Hubbard before the Federal Ministry for Research and Technology (BMFT), August 31 and September 1, 1978, Meeting on Reactor Safety Research, Risk Analysis, Bonn, Germany.

13. Testimony by R.B. Hubbard, D.G. Bridenbaugh, and G.C. Minor before the Atomic Safety and Licensing Board, September 25, 1978, in the matter of the Black Fox Nuclear Power Station Construction Permit hearings, Tulsa, Oklahoma.

14. Testimony of R.B. Hubbard before the Atomic Safety and Licensing Board, November 17, 1978, in the matter of Diablo Canyon Nuclear Power Plant Operating License Hearings, Operating Basis Earthquake and Seismic Reanalysis of Structures, Systems, and Components, Avila Beach, California.

15. Testimony of R.B. Hubbard and D.G. Bridenbaugh before the Louisiana Public Service Commission, November 19, 1978, Nuclear Plant and Power Generation Costs, Baton Rouge, Louisiana.

16. Testimony of R.B. Hubbard before the California Legislature, Subcommittee on Energy, Los Angeles, April 12, 1979.

PUBLICATIONS AND TESTIMONY: (Contd)

17. Testimony of R.B. Hubbard and G.C. Minor before the Federal Trade Commission, on behalf of the Union of Concerned Scientists, Standards and Certification Proposed Rule 16 CFR Part 457, May 18, 1979.

18. ALO-62, Improving the Safety of LWR Power Plants, MHB Technical Associates, prepared for U.S. Department of Energy, Sandia National Laboratories, September, 1979, available from NTIS.

19. Testimony by R.B. Hubbard before the Arizona State Legislature, Special Interim House Committee on Atomic Energy, Overview of Nuclear Safety, Phoenix, AZ, September 20, 1979.

20. "The Role of the Technical Consultant," Practising Law Institute program on "Nuclear Litigation," New York City and Chicago, November, 1979. Available from PLI, New York City.

21. Uncertainty in Nuclear Risk Assessment Methodology, MHB Technical Associates, January, 1980, prepared for and available from the Swedish Nuclear Power Inspectorate, Stockholm, Sweden.

22. Italian Reactor Safety Study: Caorso Risk Assessment, MHB Technical Associates, March, 1980, prepared for and available from Friends of the Earth, Rome, Italy.

23. Development of Study Plans: Safety Assessment of Monticello and Prairie Island Nuclear Stations, MHB Technical Associates, August, 1980, prepared for and available from the Minnesota Pollution Control Agency.

24. Affidavit of Richard B. Hubbard and Gregory C. Minor before the Illinois Commerce Commission, In the Matter of an Investigation of the Plant Construction Program of the Commonwealth Edison Company, prepared for the League of Woman Voters of Rockford, Illinois, November 12, 1980, ICC Case No. 78-0646.

25. Systems Interaction and Single Failure Criterion, MHB Technical Associates, November, 1980, prepared for and available from the Swedish Nuclear Power Inspectorate, Stockholm, Sweden.

ENCLOSURE 2 (CONTINUED)

| Clarification Item | Shortened Title | Description | Implementation Schedule | Plant Applicability | Requirements Issued | Clarification Issued | Tech Spec. Req. | Remarks |
|---|---|---|---|---|---|---|---|---|
| II.K.3 | Final recommendations, B&O task force (continued) | c. New analyses | In accordance with review schedule | All | * | Encl. 3 | No | |
| | | 31. Plant-specific analysis | 1/1/83Δ | All | * | Encl. 3 | No | |
| | | 44. Evaluate transients with single failure | 1/1/81Δ | BWR | * | Encl. 3 | As required | |
| | | 45. Manual depressurization | 1/1/81Δ | BWR | * | Encl. 3 | No | |
| | | 46. Michelson concerns | Fuel load | BWR | * | Encl. 3 | No | |
| III.A.1.1 | Emergency preparedness, short term | Short-term improvements | Fuel load | All | 8/19/80 | NUREG-0654 | No | Use NUREG-0654 until Rev. 1 is issued (due out 10/80). |
| III.A.1.2 | Upgrade emergency support facilities | 1. Establish TSC, OSC, EOF (interim basis) | TBD | All | 9/27/79 | 11/9/79 | No | |
| | | 2. Design | TBD | TBD | TBD | TBD | TBD | |
| | | 3. Modifications | TBD | TBD | TBD | TBD | TBD | |
| III.A.2 | Emergency preparedness | 1. Upgrade emergency plans to App E, 10 CFR 50 | Fuel load | All | 8/19/80 | NUREG-0654 | No | |
| | | 2. Meteorological data | Fuel load | All | 6/26/80 | NUREG-0654 | No | |
| III.D.1.1 | Primary coolant outside containment | Measure leak rates & establish program to keep leakage ALARA | Full power | All | 9/27/79 | 11/9/79 Encl. 3 | Yes | |
| III.D.3.3 | Inplant $I_2$ radiation monitoring | 1. Provide means to determine presence of radioiodine | Fuel load | All | 9/27/79 | 11/9/79 Encl. 3 | Yes | |
| | | 2. Modifications to accurately measure radioiodine | 1/1/81 or prior to licensing | All | 9/27/79 | 11/9/79 Encl. 3 | Yes | |
| III.D.3.4 | Control-room habitability | 1. Identify and evaluate potential hazards | Full power | All | 6/26/80 | Encl. 3 | No | |
| | | 2. Schedule for modifications | Full power | All | 6/26/80 | Encl. 3 | No | |
| | | 3. Modifications | Full power | All | 6/26/80 | Encl. 3 | Yes | |

Δ Four months before operating license is issued or 4 months before date indicated.

* Requirement formally issued by this letter.



EXHIBIT J