

RECEIVED SEP 18 1980

RELATED CORRESPONDENCE

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION



BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF RICHARD BURTON HUBBARD

CONCERNING

THE NEED FOR CLASS NINE ACCIDENT ANALYSIS

STATE OF CALIFORNIA)
COUNTY OF SANTA CLARA) ss.

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

I. INTRODUCTION

1. I am a Professional Quality Engineer, technical consultant, and a founder in 1976 and vice-president of MHB Technical Associates, technical consultants on energy and the environment, with offices at 1723 Hamilton Avenue, Suite K, San Jose, California. I have participated as an expert witness in licensing proceedings before the U.S. Nuclear Regulatory

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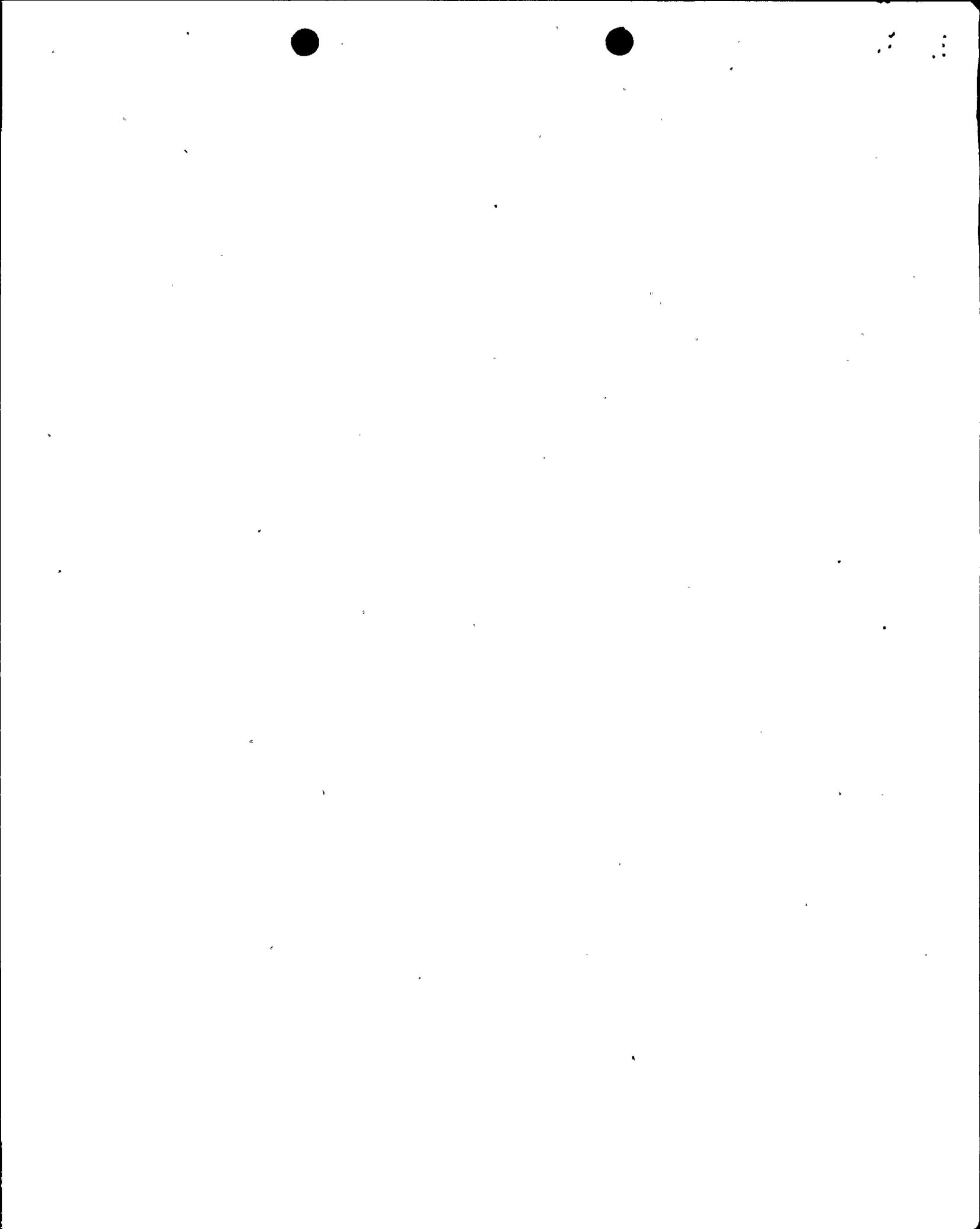


Commission (NRC) including the Diablo Canyon seismic hearings; have testified at the request of the NRC's Advisory Committee on Reactor Safeguards; have appeared before various committees of the U.S. Congress; and have testified in various state licensing and regulatory proceedings. I am thoroughly familiar with the safety analyses of the Diablo Canyon license Applicant (Pacific Gas and Electric Company) and the Nuclear Steam Supply System supplier (Westinghouse) as a result of my service as a 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. I received a B.S. in electrical engineering from the University of Arizona in 1960 and an MBA from the University of Santa Clara in 1969. From 1964 to February 1976 I was employed in the Nuclear Power Division of the General Electric Company, with the final eleven of the twelve years working in increasingly responsible management positions.

2. Samples of my recently completed projects directly related to various aspects of 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). 1/ The UCS Critique^{2/} 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 do a \$200,000 risk study of a Swedish nuclear plant (Barsebäck). This study was completed in January of 1978, and the results were presented by me and others to the Swedish Parliament in April, 1978.^{3/} 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:

MHB recently 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 to 27, 1980. The final report was presented by Dale Bridenbaugh and me in a forum in Rome on May 16, 1980.

My qualifications and experience are further described in detail in the testimony I presented during the Diablo Canyon seismic hearings in 1979.

II. STATEMENT OF ISSUES

3. Neither the Applicant nor the NRC has conducted a plant-specific and site-specific Class Nine accident analysis



for the Diablo Canyon nuclear station. The purpose of this affidavit is to identify present state-of-the-art safety features which have not been evaluated for Diablo Canyon and which have the potential for significant risk reduction. These additional safety features, both preventive and mitigative, include such features as filtered vented containment, molten core retention, hydrogen control systems, and groundwater interdiction. In addition, as described in this affidavit, the Applicant has not conducted a plant-specific system reliability analysis using event-tree and fault-tree logic techniques, the methodology utilized in WASH-1400 for a generic plant risk assessment, to identify design weaknesses and possible system modifications that should be implemented at the Diablo Canyon station to improve the capability and reliability of reactor systems under various transient and LOCA events, including seismically induced accidents. Further, this affidavit identifies the need to conduct the Class Nine and reliability analyses prior to the granting of an Operating License, either low power or full power, in order to assure that radioactive contamination of the reactor will not preclude the installation of additional safety features or increase substantially their economic and health costs.

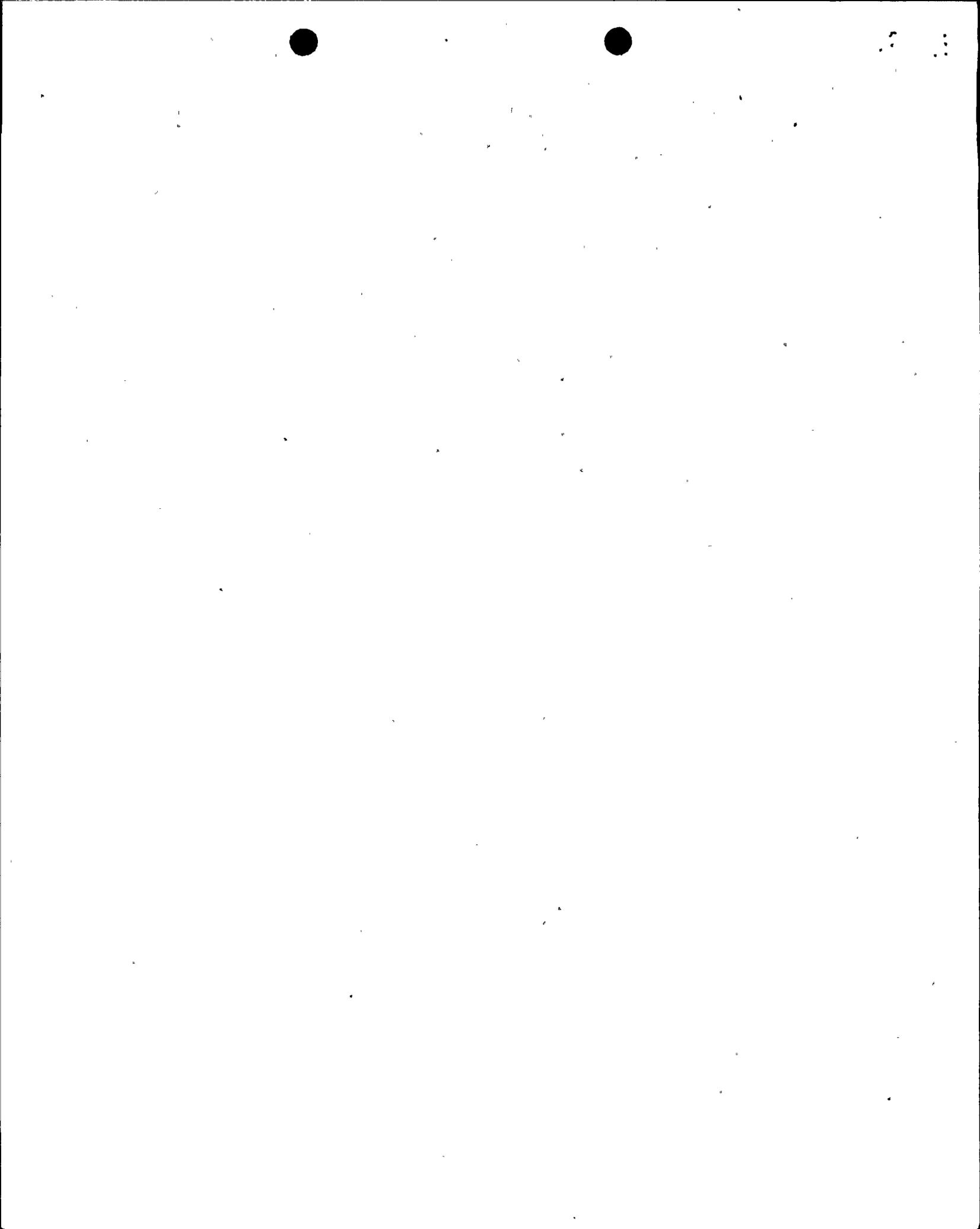


III. BACKGROUND

4. Following the enactment of the National Environmental Policy ACT (NEPA), the NRC issued guidance on the treatment of accidents in environmental reports of light water reactors in the form of a proposed Annex to 10 CFR Part 50, Appendix D. In that guidance (36 FR 2285, December 1, 1971) it is noted that consequences of accidents beyond the design basis (called Class Nine accidents) could be severe, but that the probability of their occurrence is so small that their environmental risk is extremely low.^{4/}

5. The Annex stated that the consequences of Class Nine accidents need not be analyzed and, accordingly, the NRC's NEPA environmental reviews have not included calculations of the consequences of Class Nine accidents. Rather, NRC Environmental Statements have discussed these accidents only in a qualitative sense by restating the conclusions in the proposed Annex and by briefly referencing the existence of a more quantitative analysis in WASH-1400. The basis for the NRC's failure to consider the risk to the public of Class Nine accidents for Diablo Canyon is discussed in Section 7 of the Diablo Environmental Statement^{5/} and on page ii* of the Addendum to the Final Environmental Statement.^{6/} Employee risk, on the

* The NRC concluded that "the risk of accidental radiation exposure has been addressed in depth in the Commission's Reactor Safety Study (WASH-1400, NUREG-75/014) and found to be acceptably low."



basis of occupational radiation exposure for the two-unit station, was estimated to be 450 man-rem per year per unit.^{7/} Finally, background information describing Class Nine Accident analyses and past NRC practices, is summarized in the "Description of Problem" portion of NRC Task Action Plan A-33.^{8/}

6. A recent and thorough critical review of WASH-1400 was conducted for the NRC by the Risk Assessment Review Group (RARG).^{9/} In light of the criticisms and limitations of WASH-1400 revealed by the RARG, the NRC Commissioners concluded, in part, that "...the Commission does not regard as reliable the Reactor Safety Study's numerical estimate of the overall risk of reactor accidents." (Page 3 of NRC Statement on Risk Assessment and the Reactor Safety Study Report in Light of the Risk Assessment Review Group Report.) Thus, the NRC Staff has little or no theoretical basis to exclude the consideration of Class Nine accidents for Diablo Canyon. In addition, the NRC Staff has concluded that the accident at TMI-2 was a Class Nine accident, even though the release of radioactive material to the off-side population was very small.^{10/}

7. The Council on Environmental Quality (Council or CEQ) is directed by NEPA "...to review and appraise the various programs and activities of the federal government....for the purpose of determining the extent to which such programs and



activities are contributing to the achievement of the policy of NEPA...." Last year, as part of the Council's overall effort to meet this responsibility, the Council initiated a study of the NRC's regulations and policy on the environmental analysis of possible nuclear accidents, including Class Nine events, under NEPA. The results of the Council's conclusions, documented in a March 20, 1980, letter to the NRC Chairman, are presented in an Attachment to this affidavit. The Council concluded in part that:

"The results of our review of impact statements prepared by the NRC for nuclear power reactors are very disturbing. The discussion in these statements of potential accidents and their environmental impacts was found to be largely perfunctory, remarkably standardized, and uninformative to the public. Despite the broad diversity of size, design, and location of the nuclear reactors licensed by the Commission over the years, virtually every EIS contains essentially identical, 'boilerplate' language written in an unvarying format. The typical EIS does not consider or analyze the possibility of a major accident even though it is these 'Class 9' accidents which have the potential for greatest environmental harm and which have led to the greatest public concern. Moreover, for those accidents which are typically discussed in an EIS, the potential impacts on human health and the environment are presented in a cursory and inadequate manner with little attention to public understanding.

Each EIS relies on the NRC accident analysis policy, which has remained essentially unchanged and in interim form since 1971, asserting that 'correct manufacture, design, operation and quality assurance' will provide 'a high degree of protection' against the occurrence of



postulated accidents. A limited range of accidents with varying consequences are discussed. Estimates of materials released from such accidents or 'release fractions,' are provided. However, based on the conclusion that it is highly improbable that serious accidents will occur, the policy prohibits the discussion of certain severe accidents, the Class 9 events."

8. The Council recommended a new NRC policy on Class Nine events as follows:

"We believe that the new policy should be based on the sensible approach of discussing the environmental and other consequences of the full range of accidents that might occur at nuclear reactors, including accidents now classified as Class 9. This should include core melt events. In addition, EIS's should present the best estimates of the likelihood of such events. In order to comply with the disclosure requirements of NEPA, the NRC should include in the analyses the likely range of environmental and other consequences from severe and other accidents. In describing reactor accidents and their possible effects in impact statements, the NRC should follow closely the relevant provisions of the Council's NEPA regulations, including the provision on 'worst case' analysis.

We also urge the Commission to broaden its range of variables (e.g., radiation pathways) in determining accident impacts, and expand its discussions in EIS's of the impacts of nuclear accidents on human health, the natural environment and local economies. Site specific treatment of data should be substituted for 'boilerplate' assessment of accident initiating events and potential impacts, and EIS's should be comprehensible to non-technical members of the public."

9. Subsequently, the NRC Commissioners, in a June 13, 1980, policy statement adopted a statement of interim policy which withdrew the proposed Annex to Appendix D and temporarily



..

suspended the rule-making which was initiated in 1971 (45 Fed. Reg. 40101). The Interim Policy indicates that consideration of the environmental consequences of severe reactor accidents might warrant the need "for additional features or other actions which would prevent or mitigate the consequences of serious accidents." (45 Fed. Reg. at 40103). Consideration of such information might indicate, among other things, the need to modify plant design, implement emergency preparedness measures, or reconsider a construction permit altogether. In this regard, the CEQ in an August 14, 1980, letter stated that:

"....the Council strongly disapproves of the Commission majority's statement that such new NEPA reviews will lead to conclusions regarding the environmental risks of accidents similar to those that would be reached by a continuation of current practices....45 Fed. Reg. at 40103. Two members of the Commission disagreed with the majority on this point and concluded that that position is "absolutely inconsistent with an even-handed reappraisal of the former erroneous position on Class 9 accidents." 45 Fed. Reg. at 40103. The Council agrees." 11/

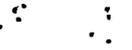
10. In summary, the NRC's NEPA environmental reviews have not included an evaluation of the consequences of Class Nine accidents either generically or for Diablo Canyon. As a result of the Class Nine accident at TMI-2, and the RARG's conclusion that estimates of the absolute probabilities of accidents in WASH-1400 are not reliable, the NRC has no



theoretical or practical basis to continue to justify excluding the safety and environmental assessment of Class Nine accidents for Diablo Canyon.

IV. DISCUSSION OF ISSUES

11. The special circumstances required to justify a Class Nine environmental and safety analysis and a system reliability analysis are present at Diablo Canyon. Construction of both units was underway when the existence of the Hosgri fault offshore and running within four miles of Diablo Canyon was confirmed. Further, the ability of nuclear power plants to withstand earthquake damage is undeniably crucial in California, where seismic phenomena are not unknown.^{12/} As concluded by the Appeal Board in ALAB-519: "We have here a nuclear plant designed and largely built on one set of seismic assumptions, an intervening discovery that those assumptions underestimated the magnitude of potential earthquakes, a re-analysis of the plant to take the new estimates into account, and a post hoc conclusion that the plant is essentially satisfactory as is -- but on theoretical bases partly untested and previously unused for these purposes. We do not have to reach the merits of those findings to conclude that the circumstances surrounding the need to make them are exceptional in every sense of that word." (emphasis added)^{13/}



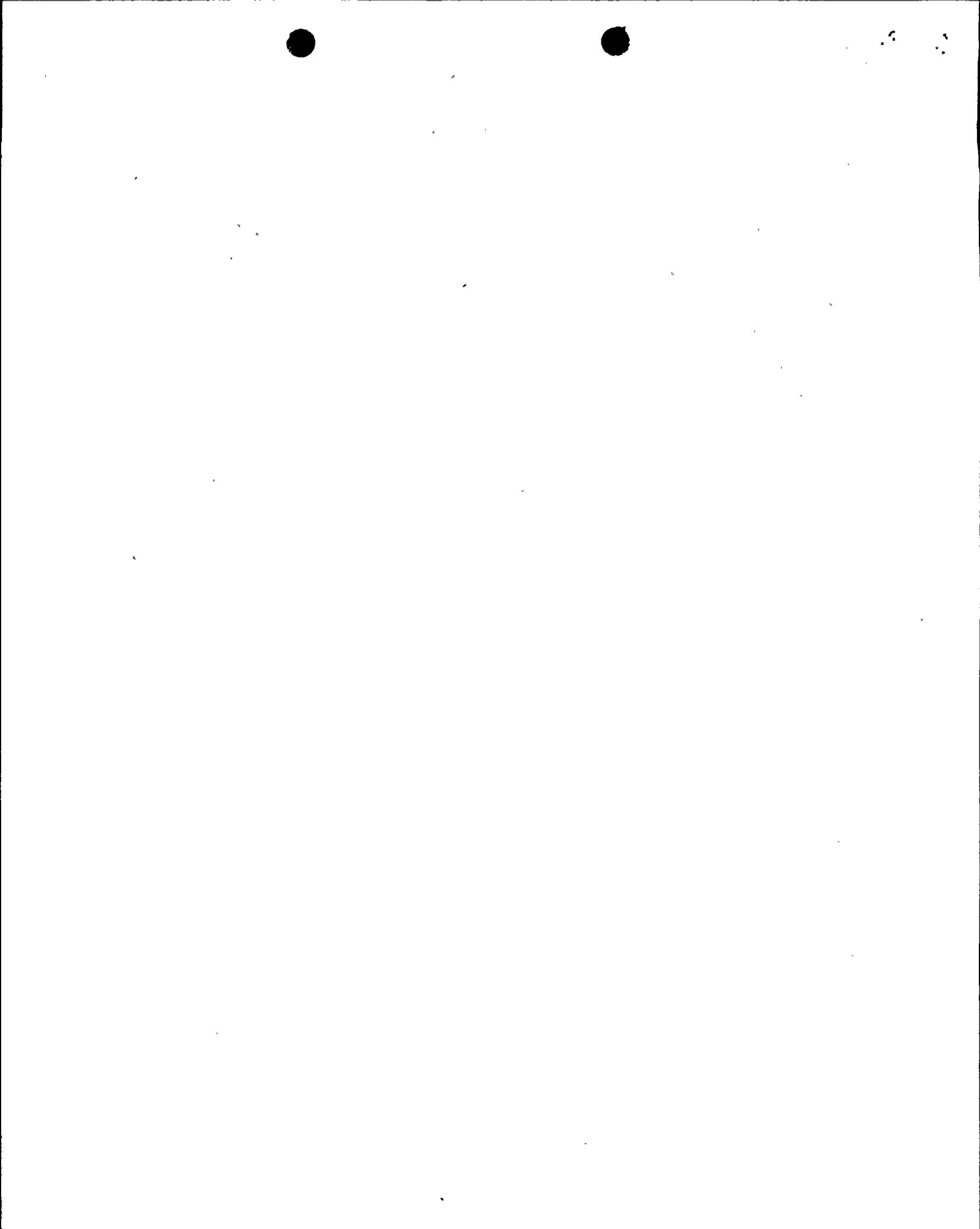
12. The accident at Three Mile Island, Unit 2 (TMI-2) demonstrated that serious reactor core damage accidents are a possibility and that consideration of core degradation and melting beyond the design basis accident should be conducted.^{14/} Such an evaluation has not been conducted for Diablo Canyon. Further, the issuance of an Operating License may foreclose or preclude the modification of the Diablo Canyon facility to accommodate the additional safety features, both preventive and mitigative, which have the potential for significant risk reduction. These additional safety features include items such as filtered vented containment, molten core retention, hydrogen control systems, and groundwater interdiction.

13. A current in-depth safety re-review of two operational nuclear stations, Indian Point 2 and 3 and Zion 1 and 2, has been initiated by the NRC. The review includes, in part, the consideration of severe accident mitigation features such as filtered containment venting, core retention systems, full-pressure residual heat removal system, bunkered emergency decay-heat removal system, and hydrogen control measures. The Licensee is examining and performing conceptual design studies to determine if any of these features or a combination of them could be employed in these plants to mitigate the effects of core degradation and core melt accidents. In parallel to the Licensee effort, the NRC is studying and examining these



features in order to establish design criteria and bases, as well as performance or reliability requirements.^{15/}

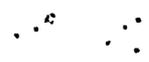
14. In addition, in response to the studies of the TMI-2 accident, the NRC is planning to initiate a long-term rulemaking on consideration of degraded or melted cores. The schedule for the rulemaking and the application to Diablo Canyon are yet to be determined. The rulemaking will include consideration of (a) the use of filtered-vented containment systems to mitigate the consequences of core-degraded and core-melt accidents, (b) hydrogen control measures to deal with accident conditions involving large amounts of hydrogen generation, (c) core-retention devices, (d) reexamination of design criteria for decay heat removal, radwaste and other related systems, such as the makeup and purification systems, so that they can perform their functions under degraded-core conditions, (e) plans and other preparation for postaccident recovery, (f) criteria for locating highly radioactive systems (e.g., should they be in isolated buildings), and (g) effects of an accident in a reactor plant on an adjacent plant in a multiple reactor site. In addition a number of other TMI-related studies will be coordinated, and, as appropriate, factored into this long-term rulemaking activity. These other studies are (a) evaluation of radwaste system design features to aid in accident recovery and decontamination, (b) provision of a ventilation



system outside the containment structure, (c) large-volume noble-gas recovery or delay systems, and (d) liquid-pathway radiological control.^{16/} Because of the special circumstances of Diablo Canyon, I believe that the plant-specific evaluations discussed in Items 13 and 14 should immediately be initiated by the Staff and Applicant for Diablo Canyon.

15. In any melt-through accident at Diablo Canyon, massive quantities of radioactive materials may leach into the groundwater and eventually migrate into the ocean. Models to assess the consequences of the possible massive contamination of water by radioactive releases on health, water supplies, costs, or interdiction techniques have not been adequately addressed in WASH-1400 or by the Diablo Canyon Applicant. This may be a significant omission. Little or no preparations have been made to interdict the flow of contaminated groundwater from beneath the reactor containment buildings should a melt-down occur. A description of potential interdiction systems and the potential safety improvements should be developed for Diablo Canyon.

16. Timing of the implementation of the safety features resulting from the preceding evaluations is a significant consideration. Radioactive contamination of the reactor system may preclude the modification or addition of equipment within



the reactor core to prevent, monitor, or control a degraded core. Likewise, radioactive contamination will increase the worker occupational exposures resulting from modifications to the reactor system. The additional security measures instituted once fuel is loaded will also increase the time and costs of any post fuel-load construction (time delay is also very expensive). Thus, modifications or additions of safety features installed after the granting of an Operating License may be precluded or will result in an increase in the economic costs and health risks associated with the implementation.

17. The need for plant-specific assessment of accident probabilities, including Class Nine events, at all U.S. reactors has been recognized following the TMI-2 accident by a number of groups, including the NRC's Advisory Committee on Reactor Safeguards (ACRS).^{17/} In response, the Integrated Reliability Evaluation Program (IREP) has now been instituted by the Probabilistic Analysis Staff of the NRC. IREP has as its charter the evaluation of the probabilities of accident sequences leading to core meltdown and (to a limited extent) the assessment of the consequences associated with the specific sequences for each U.S. operating reactor. Techniques developed in WASH-1400 (i.e., event-tree and fault-tree techniques, accident radioactive release categorization), are being used on the individual plants in conjunction with data compiled in



WASH-1400 and in data collection projects begun since its release. To date, the IREP study has concentrated on one reactor, Crystal River, Unit 3 by the Babcock & Wilcox Company.*

18. Because of the special circumstances, the Diablo Canyon Applicant should perform simplified system reliability analysis for the following systems: subcriticality systems, emergency feedwater systems, ECCS injection and recirculation systems, shutdown cooling system, containment cooling and spray systems, safety features actuation systems, and auxiliary systems upon which these depend (alternating and direct current, compressed air, essential service water or cooling systems, and heating, ventilating and air conditioning systems). These analyses should use event-tree and fault-tree logic techniques to identify design weaknesses and possible system modifications that would be made to improve the capability and reliability of the above systems under various transient and LOCA events. Particular emphasis should be given to determining potential failures that could result from human errors, common causes, single point vulnerabilities, and test and maintenance outages. The results of such studies should be factored into the final design of Diablo Canyon prior to the granting of an Operating License.

* Zion/Indian Point risk studies are also being conducted at this time by the Licensees along the lines of WASH-1400 with a number of refinements. Significant aspects of this study include refined modeling for plume trajectory, a more extensive containment event-tree and modeling, utilization of plant data, and consideration of external events. For additional details the reader is referred to the meeting summary of a June 25, 1980, presentation on this subject to the NRC by S. Israel of the NRC.

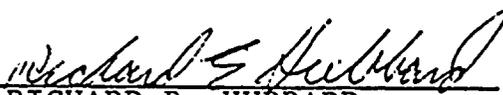


19. In summary, the accident at TMI-2 demonstrated the reality of the risk, previously only theoretically assessed, of accidents that result in substantial degradation and melting of the core.

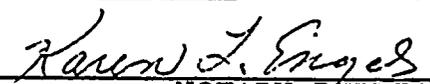
V. CONCLUSIONS

20. Based on the foregoing discussion and background information, I conclude that a Class Nine accident analysis and system reliability analysis of the Diablo Canyon plant should be performed by the Applicant and reviewed by the NRC. The Class Nine and reliability analyses should be performed prior to the granting of any Operating License for Diablo Canyon, either low power or full power, because radioactive contamination of the reactor will either foreclose or increase the economic costs and health risks associated with such engineering safety features as filtered vented containment, molten core retention, hydrogen control systems, and groundwater interdiction that have the potential for preventing or mitigating accidents.

21. All of the matters herein are known to me of my personal knowledge or of my personal opinion based on my education and experience. If called as a witness, I am competent and would testify thereto.


RICHARD B. HUBBARD

Subscribed and sworn to before
me this 17th day of September, 1980


NOTARY PUBLIC



My commission expires: January 11, 1984



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LIST OF REFERENCES

- 1/ WASH-1400 (NUREG-75/014), Reactor Safety Study - An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, U.S. Nuclear Regulatory Commission, Washington, D.C., October, 1975. We refer hereinafter to the study and the draft report as "WASH-1400".
- 2/ Kendall, Henry W., et al, The Risks of Nuclear Power Reactors: A Review of the NRC Reactor Safety Study WASH-1400 (NUREG-75/014), Union of Concerned Scientists, Cambridge, Massachusetts, August, 1977.
- 3/ DsI 1978: 1, Swedish Reactor Safety Study: Barsebäck Risk Assessment, prepared for the Swedish Energy Commission by MHB Technical Associates, San Jose, California, January, 1978.
- 4/ SECY-78-137, Memorandum to the NRC Commissioners on Assessments of Relative Differences in Class Nine Accident Risks in Evaluations of Alternatives to Sites with High Population Densities, March 7, 1978.
- 5/ Final Environmental Statement - Diablo Canyon, Units 1 and 2, U.S. Atomic Energy Commission, Washington, D.C., May, 1973.
- 6/ Addendum to the Final Environmental Statement for the Operation of the Diablo Canyon Nuclear Plant, Units 1 and 2, U.S. Nuclear Regulatory Commission, Washington, D.C., May, 1976.
- 7/ Ibid 6, page 14-1.
- 8/ NUREG-0371, Task Action Plans for Generic Activities - Category A, U.S. Nuclear Regulatory Commission, Washington, D.C., November, 1978, pages A-33/1 and A-33/2.
- 9/ NUREG/CR-0400, Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission, U.S. Nuclear Regulatory Commission, Washington, D.C., September, 1978.
- 10/ Docket No. 50-272, Salem Unit 1, "NRC Staff Response to Board Question No. 4 Regarding the Occurrence of a Class Nine Accident at TMI," by B.H. Smith, August 24, 1979.



- 11/ Letter, Gus Speth, CEQ Chairman, to John Ahearne, NRC Chairman, August 14, 1980, NRC Public Document Room, Washington, D.C., comments on proposed rule PR 50.51.
- 12/ ALAB-519, January 23, 1979, page 8.
- 13/ Ibid 12.
- 14/ NUREG-0660, NRC Action Plan Developed as a Result of the TMI-2 Accident, Vol. 1, U.S. Nuclear Regulatory Commission, Washington, D.C., May, 1980, Page II-1.
- 15/ Ibid 14, page II.B-8
- 16/ Ibid 14, pages II.B-11 and II.B-12.
- 17/ Letter, Plesset, Milton S., ACRS Chairman, to Ahearne, John F., NRC Chairman, entitled "ACRS Report on Near Term Operating License Items from Draft 3 of NUREG-0660," dated March 11, 1980, NRC News Release 80-56.

LIST OF ATTACHMENTS

<u>Attachment</u>	<u>Description</u>
A	Letter, Speth to Ahearne, March 20, 1980.

