

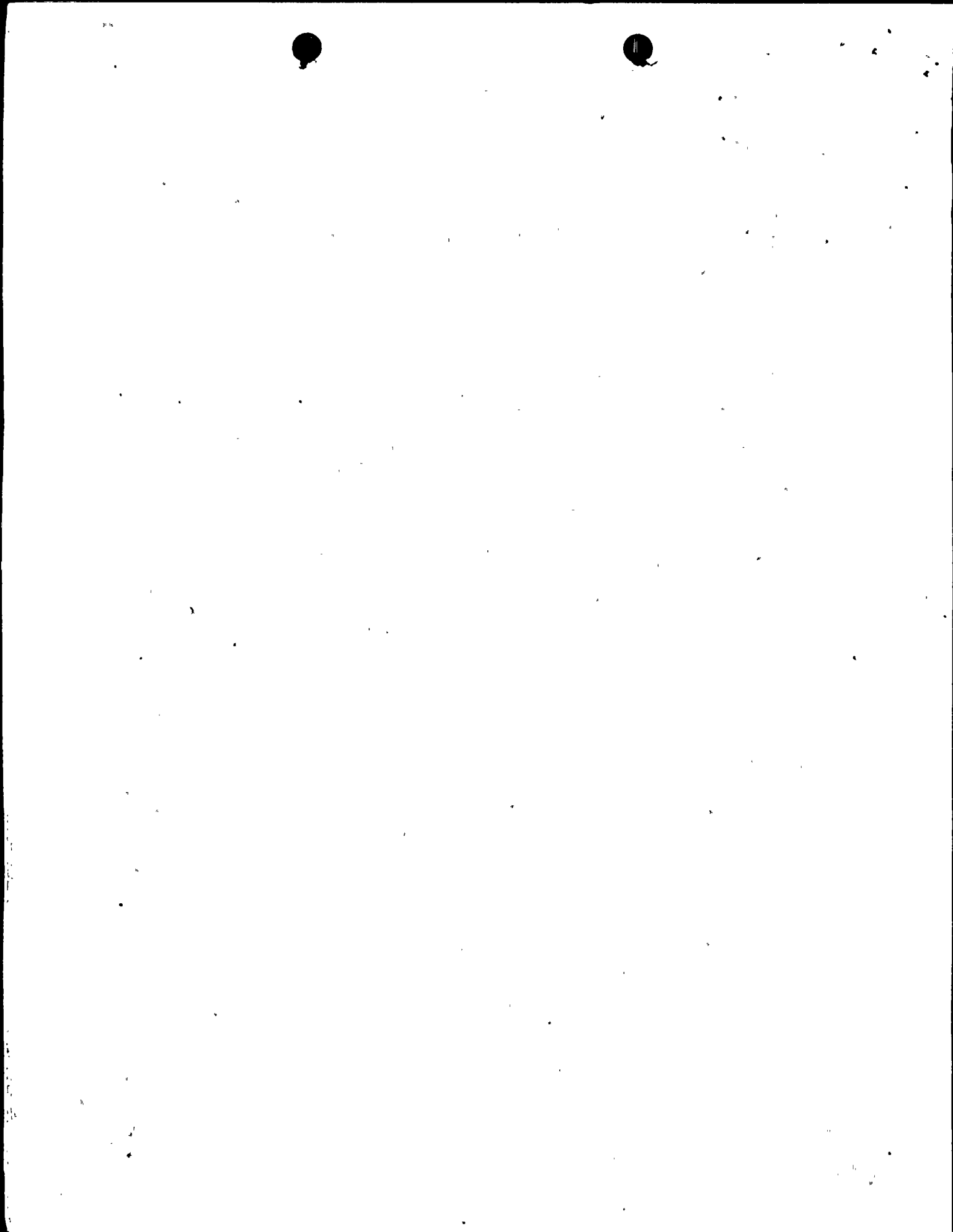
Distribution:  
Docket File ✓  
NRC PDR  
Local PDR  
NRR Reading (M. Groff)  
R. DeYoung  
V. Moore  
D. Skovholt  
D. Muller  
R. Denise  
K. Goller  
G. Lear  
W. Butler  
J. Stolz  
R. Clark  
T. Spies  
D. Vassallo  
K. Kniel  
O. Parr  
A. Schwencer  
R. Schemel  
D. Ziemann  
P. Collins  
R. Purple  
G. Knighton  
G. Dicker  
B. J. Youngblood  
W. H. Regan, Jr.  
R. Vollmer  
W. Houston  
S. Varga  
R. W. Klecker  
F. Schroeder  
K. K. Kapur

R. Tedesco  
V. Stello  
R. Maccary  
H. Denton  
V. Benaroya  
C. Long  
J. Kastner  
G. Lainas  
D. Ross  
T. Ippolito  
J. Knight  
S. Pawlicki  
L. Shao  
B. Grimes  
W. Gammill  
R. Ballard  
P. Fine  
T. Novak  
M. Spangler  
EP Project Manager - W. Ross  
Attorney, ELD  
IE (3)  
V. Wilson  
ACRS (14)  
Project Manager - T. J. Hirons  
LWR 1-3 Reading  
LWR 1-3 File  
D. P. Allison  
J. C. Stepp  
R. B. McMullen  
R. B. Hofmann  
L. G. Hulman  
M. L. Fliegel  
J. R. Tourtellotte

323  
3/18/75

*memo*

*MS*



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

MAR. 18 1975

DOCKET NOS: 50-275 AND 50-323

APPLICANT: PACIFIC GAS AND ELECTRIC COMPANY (PG&E)

FACILITY: DIABLO CANYON NUCLEAR POWER STATION, UNITS 1 AND 2

SUMMARY OF ACRS SUBCOMMITTEE MEETING HELD ON FEBRUARY 18-19, 1975

An ACRS Subcommittee Meeting regarding the Diablo Canyon Nuclear Power Station was held in San Luis Obispo, California on February 18-19, 1975. The agenda for the meeting is attached as Enclosure No. 1. A complete list of attendees is given in Enclosure No. 2.

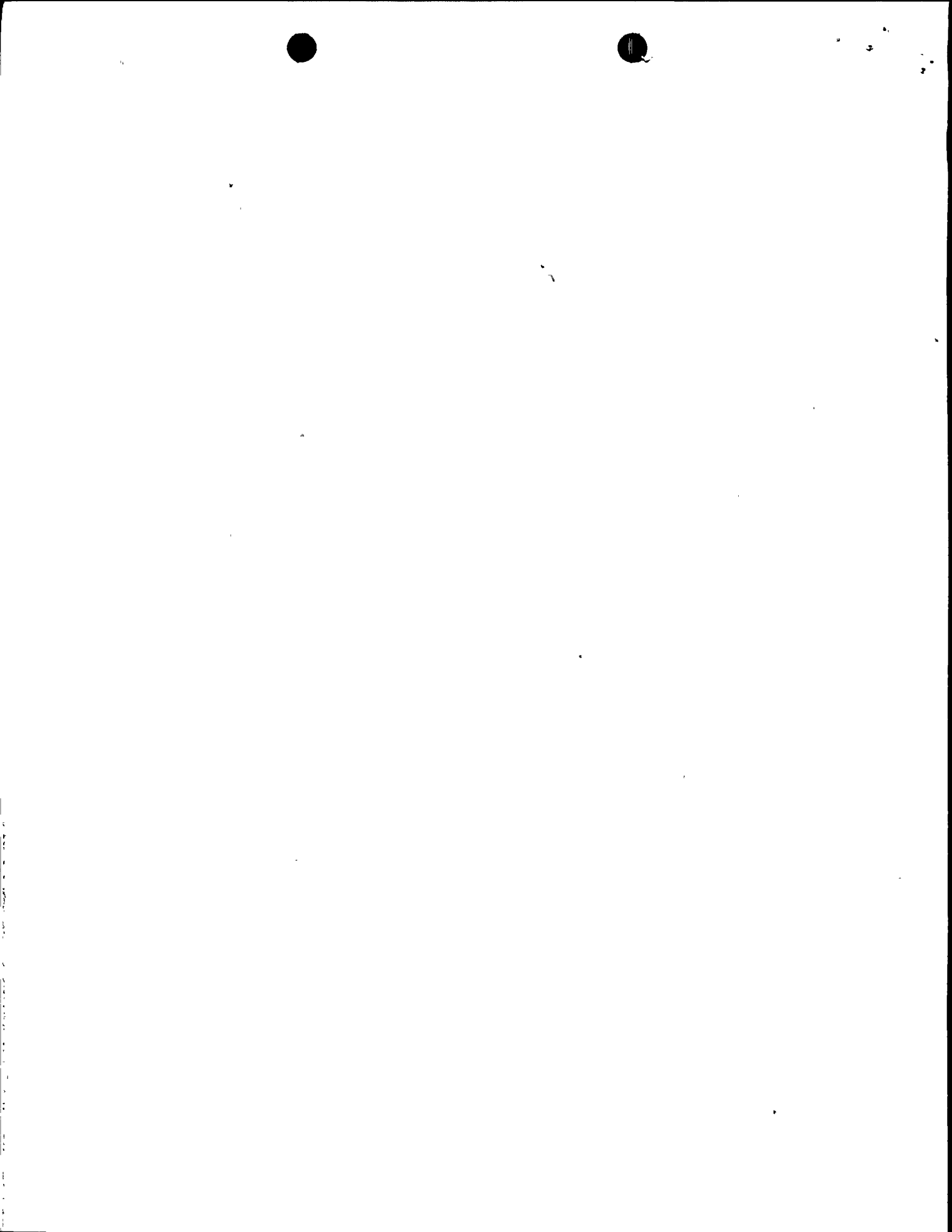
Introductory Statement by Applicant

The meeting opened with an introductory statement by the applicant which included a status report on construction and fuel load. Construction has reached approximately 90% and 50% completion on Units 1 and 2, respectively. Fuel load for Unit 1 is scheduled to begin on October 15, 1975, and Unit 2 in late summer of 1976. Shipment of fuel to the site for Unit 1 is scheduled to begin in June of 1975.

Outstanding Items in Safety Review

The staff then summarized the status of the outstanding items in the Diablo Canyon safety review. These items had been previously summarized in Section 22 of Supplement No. 1 to the Diablo Canyon SER; this Supplement was issued on January 31, 1975. Among the more important of these items are our evaluation of the earthquake potential of the Hosgri Fault, effects of tsunamis caused by near-shore generators, seismic qualification of electrical equipment, ECCS and ATWS. The status of each item was reviewed in detail, with the staff indicating where information from the applicant was outstanding and when resolution of each item was likely.





- 2 -

Statement by Sandra A. Silver

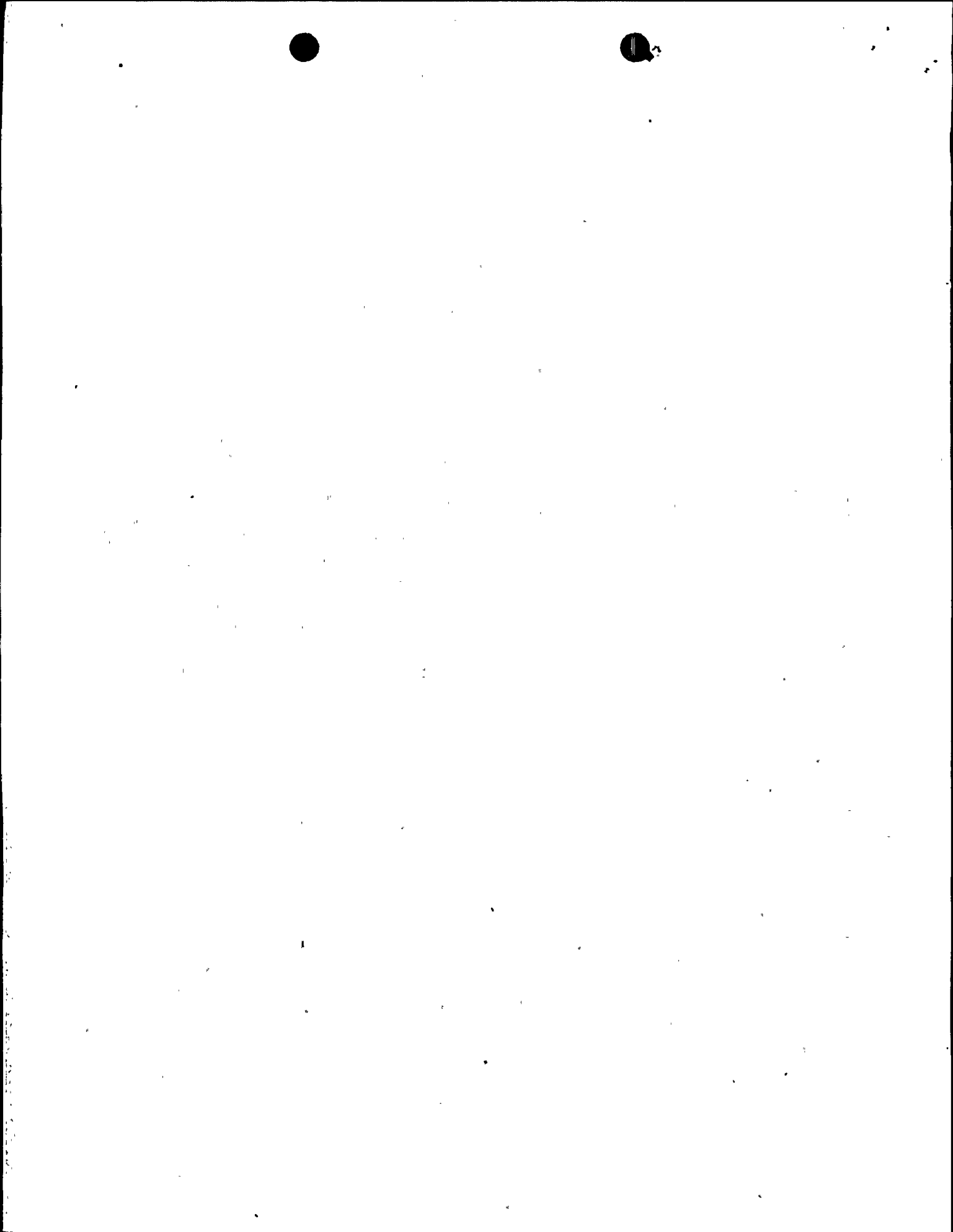
At this point, a statement was read into the record by Sandra A. Silver, a resident of San Luis Obispo County and an intervenor in the Diablo Canyon proceedings. Ms. Silver commented on several issues involved in the Diablo Canyon safety review, and expressed strong objections to the location of the plant in San Luis Obispo County. Dr. Okrent indicated that her comments would be passed on to the Full ACRS Committee.

Geology and Seismology

The applicant then began his presentation on Geology and Seismology. This presentation consisted of four separate talks by PG&E consultants:

- (1) Dr. Richard Jahns, principal geologist since the beginning of the project, discussed the geological background and the development of the geology report for the site. He emphasized the general regionalization of the site and its location in California geology.
- (2) Mr. Douglas Hamilton, geology consultant, dealt specifically with the offshore seismic interpretation programs.
- (3) Dr. Stewart Smith, the seismologist of record, discussed existing seismic data and a determination of the postulated earthquakes that should be considered in the design of the plant.
- (4) Dr. John Blume, structural engineering consultant in the area of earthquake engineering, discussed the methods used for development of seismic input on events into vibratory ground motion.

Dr. Jahns concentrated on two areas in his presentation: (1) a brief summary of the early geologic investigations at the site, with emphasis on the problem of potential surface faulting; and (2) a summary of regional tectonic characteristics of Southern California that are pertinent to appraisals of the site. The exploration of the site as far as artificial exposures were concerned was aimed at a detailed appraisal of the sub-horizontal contact between the wave cut bedrock surface and the overlying marine terrace deposits. Since these deposits can be dated, it would then be possible to demonstrate that if faults were found in the bedrock, and these faults did not disturb the overlying dated material, then an age ceiling could be imposed on the latest

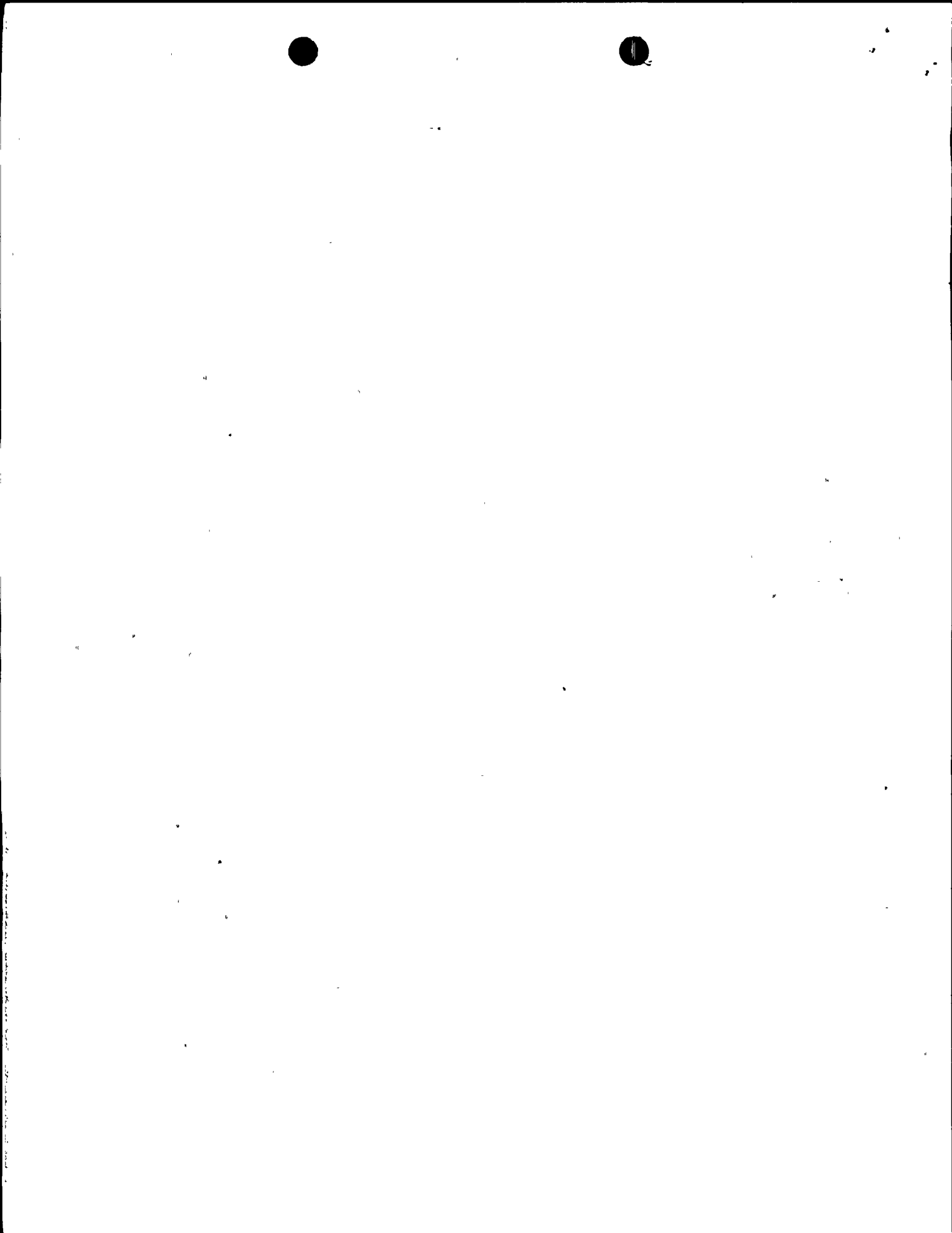


movement of these faults. As a result of the extensive trenching and excavation program which was conducted, it was concluded that potential surface faulting need not be considered in the plant design. With regard to the regional situation, Jahns emphasized that the different major faults must be evaluated in the context of their own physical characteristics, continuity, segment length, etc., and also with regard to their positions and behavior throughout different parts of geologic time. He indicated that the San Andreas Fault was clearly the dominant feature involved, but also discussed the importance of the Sur Nacimiento fault zone. He concluded by stating that for the faults in this regional setting, it would seem significant in considering the respective roles and orders of significance to consider them most specifically in the context of the past five million years since that is basically what is involved in appraising their present and potential future activity.

Doug Hamilton began his presentation by discussing some of the work that has been done in surveying the offshore geology. He indicated that there are two elements of this surveying: (1) seismic reflection profiling; and (2) gravity survey and mapping program. There have been four different surveys applicable to the region offshore from the Diablo Canyon site:

- (1) USGS Bartlett cruise in 1972 under the direction of Ely Silver;
- (2) USGS Kelez survey in 1973 under the direction of Holly Wagner;
- (3) PG&E sponsored work in 1973-1974 by the firm of Bolt, Beranek and Newman of Houston;
- (4) PG&E sponsored work in 1974 by the firm of Aquatronics, Inc., of Houston.

Hamilton used detailed maps and track charts to indicate the areas of coverage by each of these surveys; he stated that the interpretation of the offshore profiling involved integration of data from all four of these surveys. These data were discussed in considerable detail; the discussion also included a detailed interpretation of the Hosgri Fault. He described the Hosgri Fault as continuing as either one or a group of two or three breaks, and traced the fault from near Point Sal northward to the vicinity of Cape San Martin where the breaks die out. The plant site is about two and a half miles to the inner breaks of the Hosgri Fault at its nearest point of approach. Hamilton





then turned his attention to the compilation of the gravity survey data. The map gave gravity anomaly values for the offshore area ranging from Point Conception up the coastline to a point around Cape San Martin. He emphasized the importance of this map, in that it gives definite indications of major structural features that have been mapped independently by other means, e.g., the Santa Lucia Bank and Hosgri Faults. Hamilton concluded his discussion by summarizing the major features of the area, including the large offshore Santa Maria Basin, the lesser or folded basins, including San Luis Obispo syncline, the Pismo syncline, the area of the Santa Maria Valley and the onshore Santa Maria Basin which lies generally south of the Santa Maria Valley down to where the transverse ranges come up south of Lompoc. The structural disturbance of these includes very large faults which have very pronounced gravity expression. These include the Santa Lucia Bank and San Simeon Faults, the Faults of Rinconada and the Sur Nacimiento system, and to the south, the faults of the transverse ranges system including the Santa Ynez and a system of faults which has no specific name that branches off from the Santa Ynez and then heads up toward Point Sal. Lesser faults are also shown in this gravity expression, including the Hosgri Fault which does have local gravity expression, but clearly not expression which is comparable either to the Santa Lucia Bank or San Simeon Faults and to other faults mapped onshore which include the Edna, the Pismo, and related faults in the ground east of the San Luis Range area.

Several questions were asked regarding Hamilton's presentation. Dr. Page asked whether there was firm evidence that the Hosgri and San Simeon Faults are not connected? Hamilton discussed the data in the region of the proposed connection; he felt that the evidence is good that they are not all one continuous system, although he qualified the statement by saying that both faults have to be considered part of the system of faults on the eastern boundary of the Santa Maria Basin. Dr. Trifunac asked what Hamilton's speculations would be regarding the general sense of motion, the amplitude of motion, and the effects of these motions on the major faults that were discussed? Hamilton responded in light of the Hosgri Fault, and indicated that the Hosgri might be considered capable of a few feet of movement, although he did not specify whether that movement would be vertical or lateral.

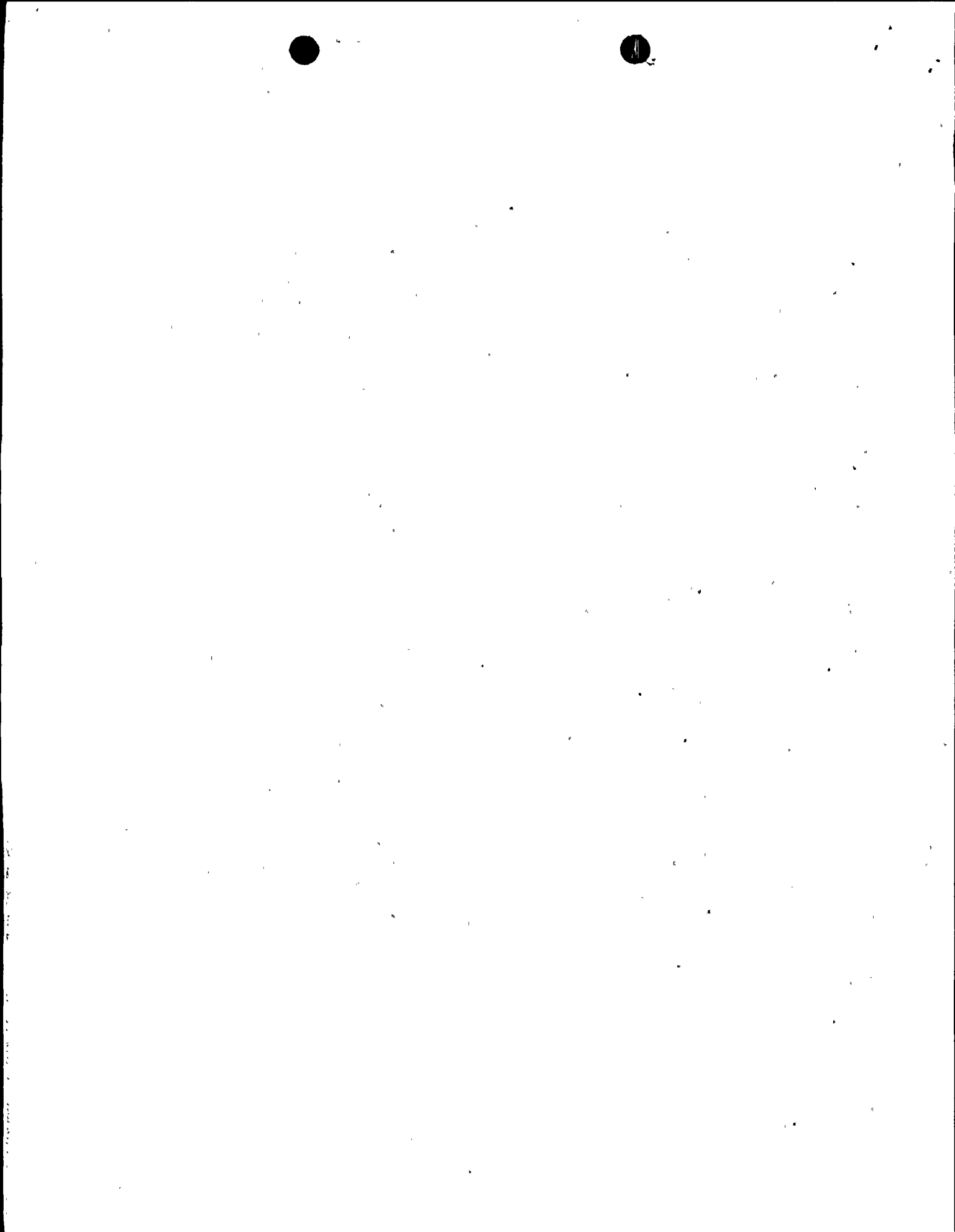
Dr. Stepp of the NRC staff then commented on the information presented. He indicated that the staff had reviewed the material presented, and that additional information on the subject had been requested from the applicant. This request included questions on the relationship



of the Hosgri and San Simeon Faults, a more detailed documentation of the structural relationship of these faults in their assumed area of approach, and a discussion of the structural relationship of the Hosgri Fault to the transverse ranges faults. The staff also asked for a discussion of the magnitude of earthquakes that one might expect on faults within the San Andreas Fault System that have different orders of structural significance. Finally, additional documentation was requested regarding the location of the 1927 earthquake that occurred off Point Conception. Stepp indicated that the staff hoped to complete its review of this material in May of this year. F. McKeown of USGS concurred with the staff's comments, and emphasized that the relationship of the southern end of the Hosgri Fault to the transverse ranges could be extremely important in locating the 1927 event.

Dr. Okrent then asked how much of the offshore information that is reported now was available in sufficient scope in 1967 to prompt someone to look for the structures now being reported and discussed? Dr. Jahns indicated that the potential existence of the Hosgri Fault was suspected in 1967, but that no detailed offshore sub-bottom data were available. The applicant emphasized that the geological studies performed prior to the construction permit review were quite extensive, and that there was no question in their mind that a very complete state of the art investigation of the site had been performed.

Dr. Smith began his presentation by discussing the earthquakes which had been postulated as design basis events for the plant; he emphasized the levels of conservatism that had been employed at the construction permit stage, e.g., the assumption of an earthquake unassociated with a fault occurring directly beneath the plant. Smith indicated that the discovery of offshore faults in recent years was not really a surprise, and that events subsequent to the initial analysis at the CP stage have borne out the wisdom of the very conservative approach that was taken in considering that earthquakes of the size postulated could occur as close to the plant site as was assumed. He further stated that, based on Hamilton's interpretation of possible motion on the Hosgri Fault, the ground motion produced by an event of this size, at a distance of three to five miles at closest approach would certainly fall within the envelope of the kinds of ground motion that have been proposed for the site. With regard to earthquakes on the offshore faults that have been analyzed, Smith indicated that these events have contained a large component of vertical slip. He then discussed specifically the 1927 earthquake that was centered

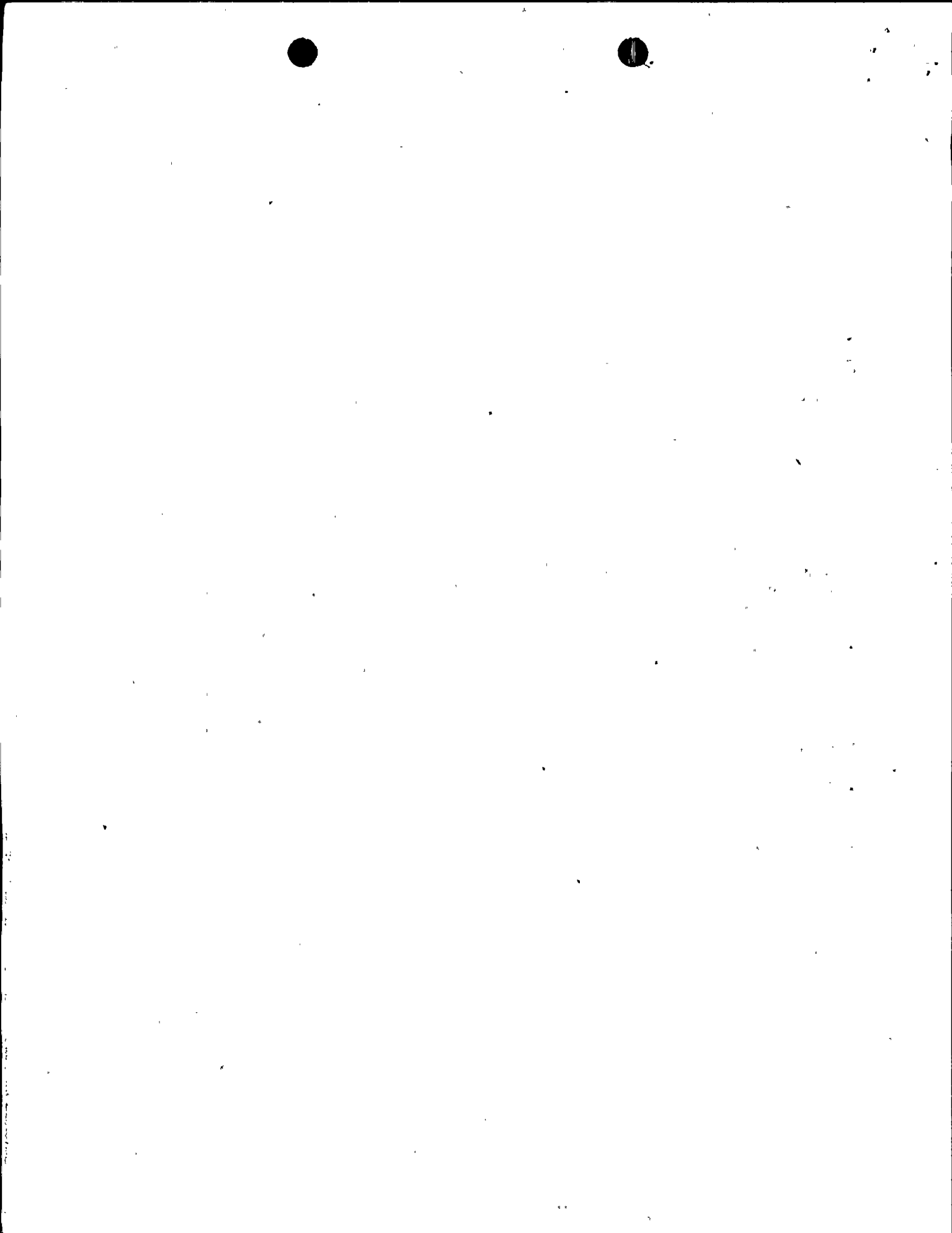


- 6 -

off Point Conception; analysis of the data indicates that the aftershock region had to be substantially closer to the shore than the main shock location given by Byerly in 1930. However, Smith stated that he cannot clearly associate this event with one of the presently mapped faults, although it is his opinion that the most likely association is with the transverse range structures.

After several questions from the ACRS consultants regarding location and depth of the 1927 event, and postulated earthquakes on the Hosgri Fault, Dr. Blume began his presentation by reviewing the four specific fault-earthquake situations which were postulated for the design of the plant. He emphasized that, at the CP stage, very few methods were available for converting magnitude and distance into site acceleration, and that site or peak acceleration was only one consideration that was used in the design. Other equally important considerations were the damping factors assumed for various structures and systems, the duration of the shaking, the probability of peak acceleration, given a certain earthquake, and the probability of the spectral response diagram, given that peak acceleration. Blume discussed in detail the methods that were used for estimating site acceleration; he indicated that the principal one employed was the Site Acceleration Magnitude (SAM) or Blume Method. After a detailed discussion of the SAM method as applied to the four earthquake situations mentioned above, Blume stated that he is pleased with the fact that the methods used nearly 8-10 years ago at the CP stage compare extremely well with those in use today, e.g., those proposed by Snauble & Seed, Cloud & Coress, and Donovan. Blume then discussed the recent analysis that was performed based on components of the Parkfield-5, 1966 and Castaic, 1971 earthquakes, each normalized to a peak ground acceleration of 0.5g, rather than the 0.4g that was used in the original design. He also mentioned the Koyna transverse earthquake in India as being close to the situation at the Diablo Canyon site; an acceleration of 0.49g was observed from this event.

Dr. Trifunac asked a question regarding the SAM method as described in Dr. Blume's paper in the 1965 World Conference Proceedings. Trifunac indicated that the use of this method by Blume appears to result in accelerations which underestimate all present available data by a factor of 0.5 to 0.8 on the logarithmic scale. After a lengthy discussion, Blume agreed to get together with Trifunac in an attempt to resolve this apparent discrepancy.



- 7 -

Dr. Kapur of the NRC staff emphasized the part played by damping values in the determination of response spectra. He indicated that the damping values used by the applicant were very conservative, and that the staff considers the response spectra calculated by the applicant to be quite conservative.

Dr. Okrent then asked the USGS to elaborate on their statement that a design acceleration value of 0.5g is not adequate? James Devine of USGS indicated that this statement was meant to leave the issue open because he did not feel that all questions had been answered at this point. Devine stated that recent work by Dr. Smith concerning the location of the 1927 event, along with some unpublished work by the USGS, indicate that there is still profitable information available concerning that earthquake which could alter the obligation to put it on the Hosgri. He also emphasized the importance of the ranking of faults with regard to the resolution of this question. Okrent then asked what approach the USGS would take regarding the nature of the Hosgri structure if the 1927 event had never occurred? Frank McKeown of USGS responded that there is no definitive evidence to tie the Hosgri and San Simeon Faults together, but that the possibility cannot be ruled out entirely. He indicated that it is very difficult to assign a given size earthquake to the fault because you are not dealing with a single continuous break; it consists of many, many breaks. Dr. Trifunac asked whether the applicant's four proposed design basis earthquakes could be considered reasonable if the 1927 event were eliminated? Devine replied that he felt that all four were reasonable at the time of the CP, and that he still feels that they are reasonable with a proviso on earthquake D (the event unassociated with a fault), that being that the Hosgri be examined more carefully after the applicant responds to the staff's recent request for additional information. He indicated that this information will help to better estimate the maximum earthquake that could occur on the Hosgri Fault which in effect now controls the undesignated earthquake D.

Dr. Okrent asked the staff whether the acceptable seismic design criteria for Diablo Canyon 1 and 2 would be the same for additional units, if such were proposed? Dr. Stepp indicated that the staff's seismic design criteria have constantly been upgraded as our understanding of the problems of earthquakes and earthquake spectra properties change. He stated that we would always consider the probable maximum earthquake for the site in our evaluation, regardless of whether the plant was partially built or not. Dr. Shao emphasized that the





staff will consider all steps in going from the g value to response spectra and damping values, including the methods used, and then a decision would be made regarding the adequacy of the seismic design. After more discussion, Shao indicated that if the g value holds at 0.5, and the applicant has employed the criteria and methods which have been stated, then the plant is probably adequately designed for seismic loads. Dr. Okrent then asked what probability per year of safely shutting down the reactor in the event of an earthquake, that the staff is seeking for Diablo Canyon? Dr. Denton replied that the staff does not use a probability approach in selecting safe shutdown earthquakes (SSE). He stated that the Commission's criteria, as set forth in Appendix A to Part 100, provide a framework to work in to arrive at an SSE; we then have to couple that with the design approach and the design of structures and components in order to arrive at an evaluation of adequacy of the seismic design.

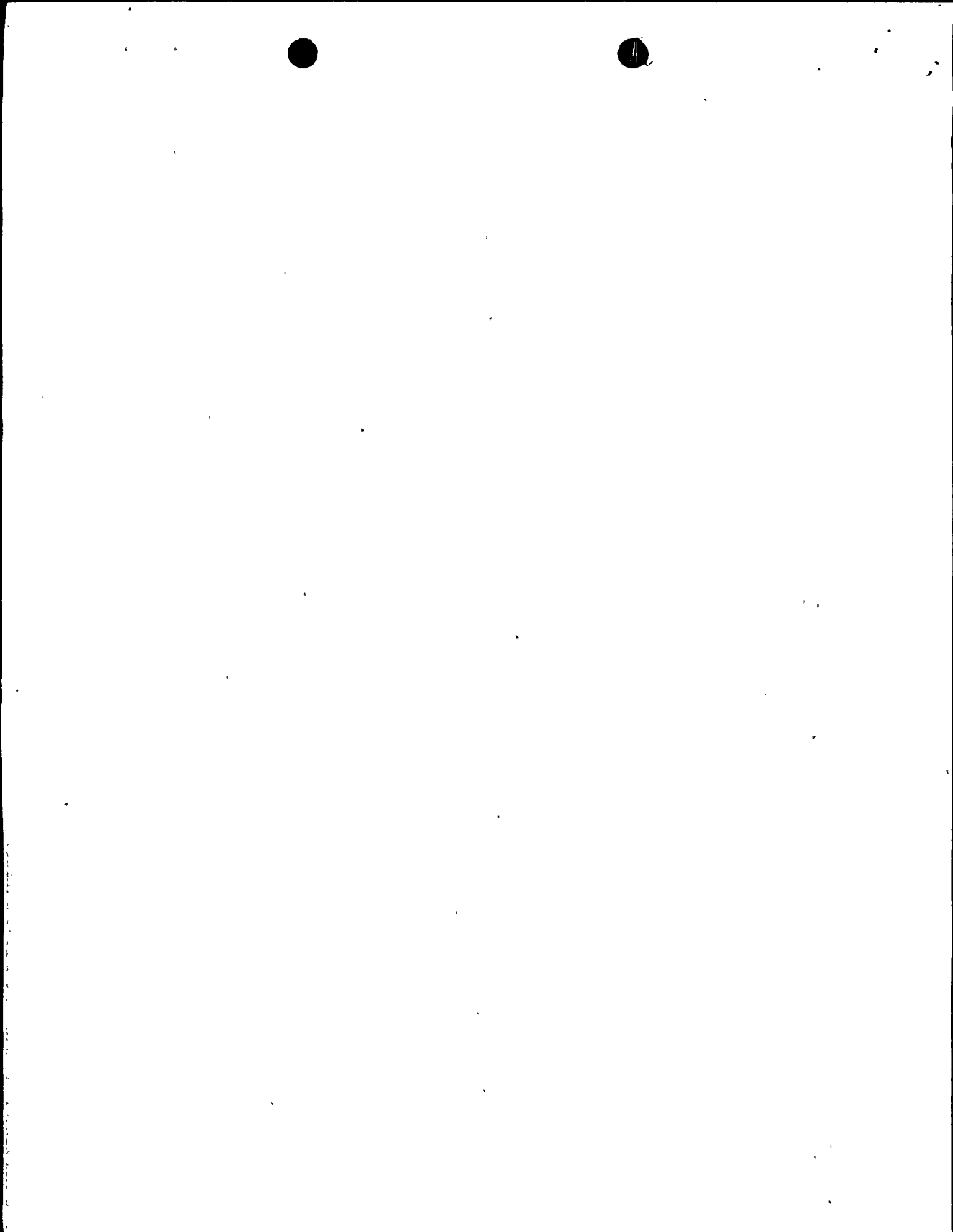
Dr. Thompson pointed out that, after all the discussion that had transpired, the question of whether the Hosgri Fault would be expected to exhibit predominant strike or dip slip had not really been answered. Holly Wagner of USGS commented in detail on the findings of his survey, but did not reach any firm conclusions regarding the preference for strike or dip slip.

### Seismic Design

Mr. Wollak of PG&E began the session on seismic design with a presentation on the design criteria for the major components, and how Dr. Blume's criteria have been implemented. Wollak stated that the seismic analysis of Seismic Category I structures, systems, and components is based on the input free field ground motions and the resulting response spectra for the operating basis and safe shutdown earthquakes. Four dynamic methods of seismic analysis were used:

- (1) Time history modal superposition;
- (2) Response spectrum modal superposition;
- (3) Response spectrum single degree of freedom; and
- (4) Method for rigid equipment and piping.

After discussing design procedures in detail, Wollak commented on some recent work which was done to compare the safe shutdown earthquake response of typical Category I structures, systems, and components to that which would be induced using modified input response spectra and

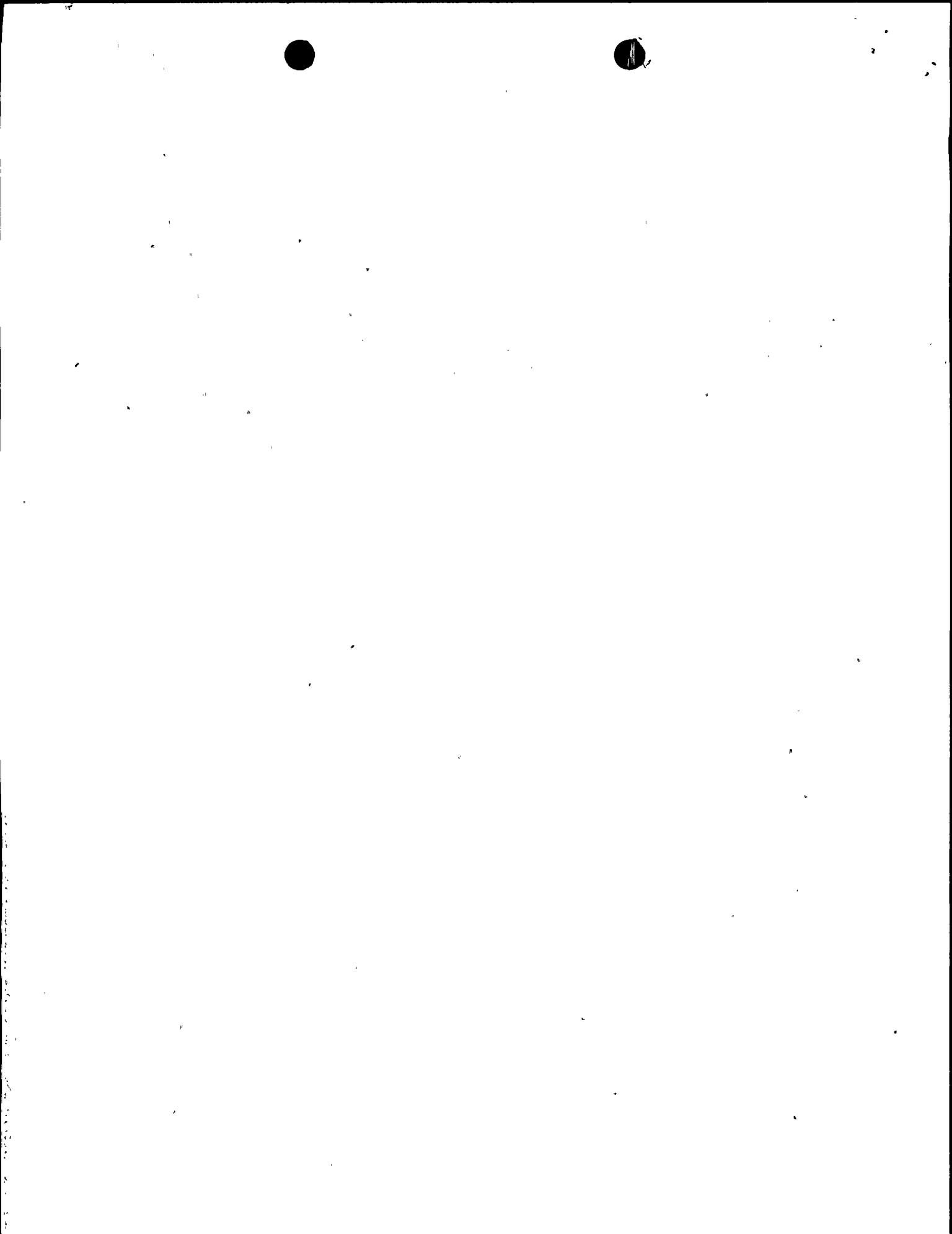


the damping values given in Regulatory Guide 1.61. These modified input response spectra were derived from acceleration time histories for components of the Parkfield-5, 1966 and Castaic, 1971 earthquakes, each normalized to 0.5g. The spectral content of these records is considered representative of the vibratory ground motion expected at a site with foundation material similar to Diablo Canyon, and generated from a nearby source. A comparison of these modified spectra with the spectra and damping used in the SSE design confirms the seismic design adequacy of typical Category I structures, systems, and components. Wollak concluded his presentation by stating that the seismic design basis for major plant structures and components includes significant conservatism in the form of design spectra (unusually rich in high frequencies), very low assumed damping values, and an acceptance criteria based on overall elastic behavior under seismic loadings.

Dr. Okrent asked whether a calculation had been done using 0.5g peak acceleration and the response spectra and damping values of Regulatory Guide 1.60? Wollak replied that they had not done this. The staff then commented on the applicability of the response spectra in 1.60, and also on the reasoning behind the selection of the Parkfield and Castaic earthquakes as comparisons for the Diablo Canyon site.

Dr. Okrent emphasized the importance of knowing, with some degree of assurance, that all safety related structures, systems, and components will be able to survive an earthquake of given acceleration, e.g., 0.5g. Mr. Lindblad stated that once seismic design criteria were chosen for the plant, all structures, systems and components were designed to meet these criteria. He indicated that he feels that there is conservatism in the overall design.

After additional discussion on loading factors and the different seismic design situations where the OBE and SSE control the design, Dr. T. C. Esselman of Westinghouse presented the seismic design criteria that were used for the primary loop components and piping. He reviewed the methods used for each component and for piping, and indicated the margins that resulted from the analysis. Dr. Okrent asked whether the staff reviewed the seismic modeling of various components in the primary loop. Dr. Kapur replied that Westinghouse has documented many codes involving this modeling, and that the staff has reviewed these codes in some detail. The possibility of failure of the turbine building (a non-seismic Category I structure), and the effect of such a failure on Category



- 10 -

I systems was discussed. The staff stated that all such systems in the turbine building had been adequately protected against such a failure. With regard to this item, Dr. Bush asked about the supports on the valves, that in the event of loss of power during an earthquake, what is the reliability regarding closure of the valves? Westinghouse agreed to provide information in response to this question at some later date.

#### ACRS Questions Regarding Geology-Seismology and Seismic Design

Following a short executive session, the meeting reconvened, and the following questions were raised by several of the ACRS members and consultants:

##### Dr. Trifunac

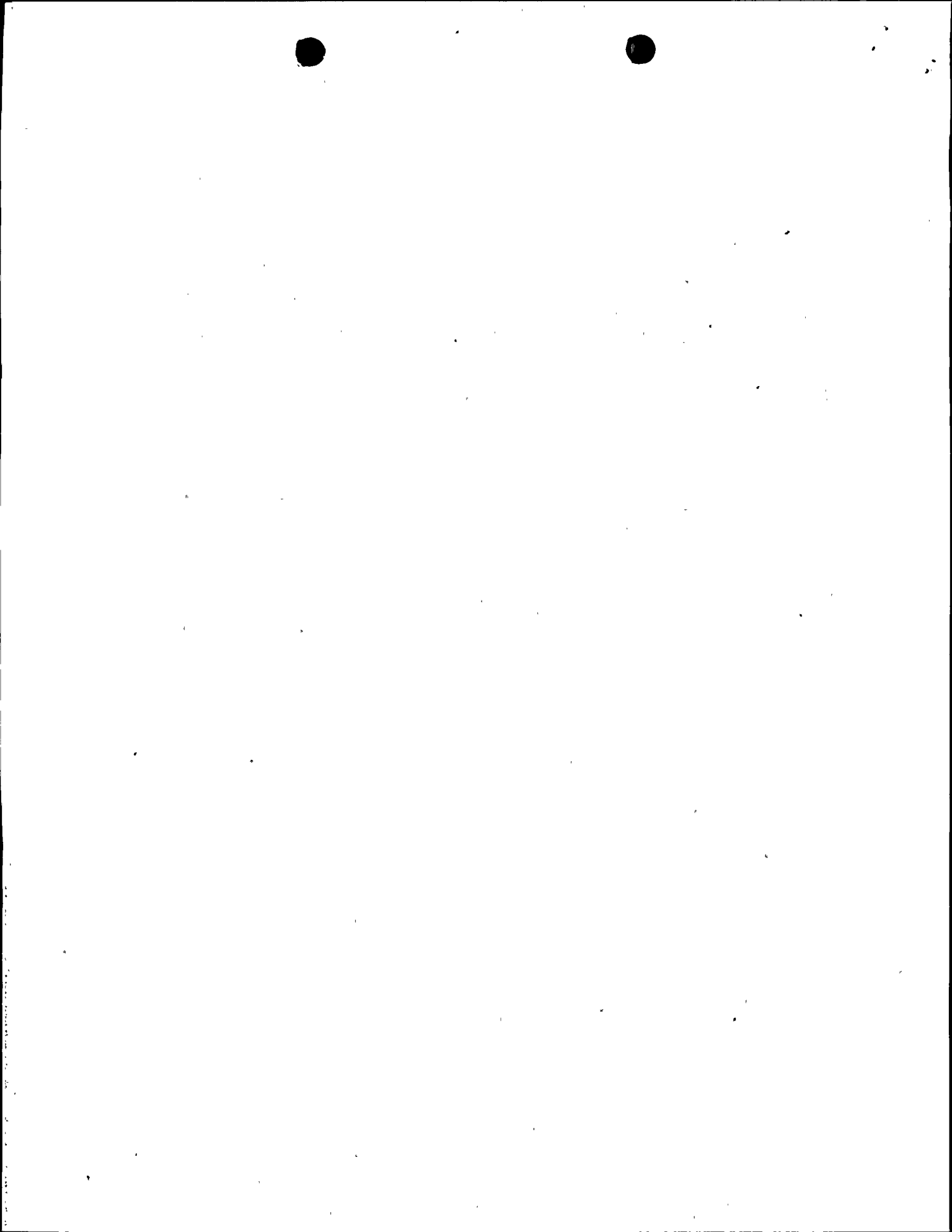
- (1) In light of previous discussions with John Blume, justify the apparent discrepancies in the relationships used.
- (2) Referencing question 1, what would be the calculated peak acceleration using other currently available methods?
- (3) What would be the effect on the response of the plant of a small magnitude earthquake which produces very high peak accelerations?
- (4) When this peak acceleration has been derived, would it be possible to calculate confidence levels on this value?
- (5) What is the maximum historic, as well as predicted, modified Mercalli intensity at the site due to any earthquake any place, and what would be the peak acceleration resulting from it?

##### Dr. Thompson

- (1) He inquired about copies of USGS Open File Report 74-272. Mr. Devine of USGS agreed to provide several copies of this report.

##### Dr. White

- (1) Provide additional evidence to demonstrate that the Castaic and Parkfield earthquakes (normalized to 0.5g) really have lesser effects on the Diablo Canyon structures than the original design earthquake.



- 11 -

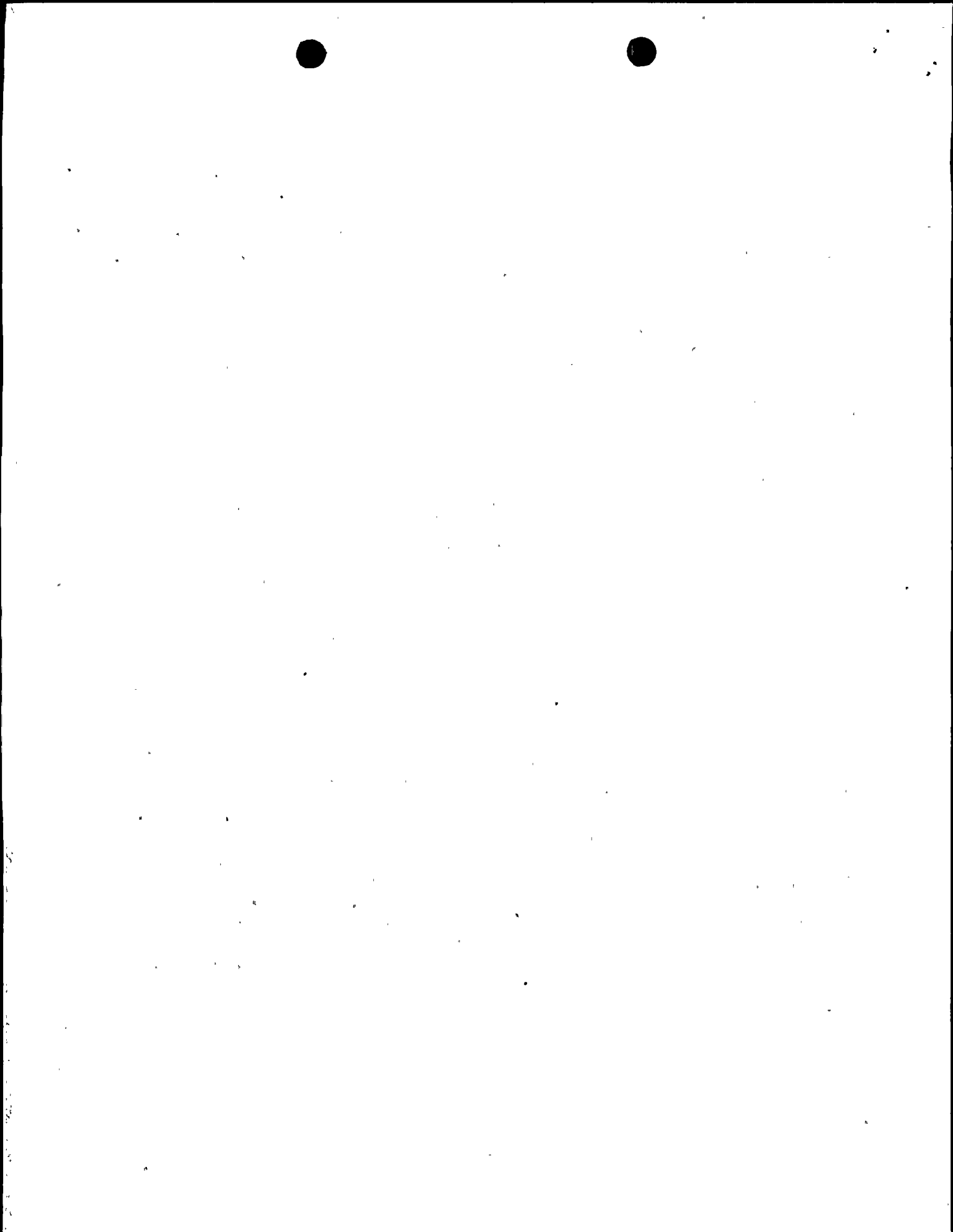
Dr. Okrent

- (1) What kind of errors can arise in the seismic design analysis?
- (2) What are the sources of error in going from the earthquake itself via a one-dimensional seismic model to the finite element model?
- (3) Assuming that some peak g value is adopted by the staff as adequate, justify that the calculations based on the Castaic and Parkfield spectra provide the necessary assurance.
- (4) How does the staff decide what constitutes an adequate audit of the seismic design analysis? (Reference the Appendix to Draft WASH-1400 which includes a partial design check).

Dr. Okrent asked the applicant and staff to be prepared to discuss these questions at the next Diablo Canyon Subcommittee Meeting. (The last question is for the staff only).

Seismic Design (continued)

Mr. Dorrycott of Westinghouse then presented the design criteria and qualification requirements for safety related instrumentation. He listed the instrument control electrical equipment that had been qualified in testing programs; this equipment was tested in full-scale testing programs and qualified to design acceleration levels. Dr. Okrent asked if an earthquake with a larger higher frequency component than the one analyzed would appreciably affect the performance of the instrumentation? After some discussion regarding the effects of damping, etc., Okrent asked the applicant and Westinghouse to look into this matter. Dr. Kapur commented that equipment at higher elevations in the plant does not experience the very high frequency component, and so the problem is not so severe. Mr. Ebersole pursued the discussion with regard to possible contact chatter in switches, etc. Dorrycott responded that Westinghouse is pursuing a failure mode and effects analysis with regard to the resolution of this problem. The staff indicated that they hoped to have the issue of seismic qualification resolved prior to completion of the Diablo Canyon review by ACRS. With regard to qualification, Dr. Bush brought up the possible interactive effects of seismic and environmental qualification; he asked if any work had been done in this area? After some discussion, it was agreed that this problem had not really been addressed.



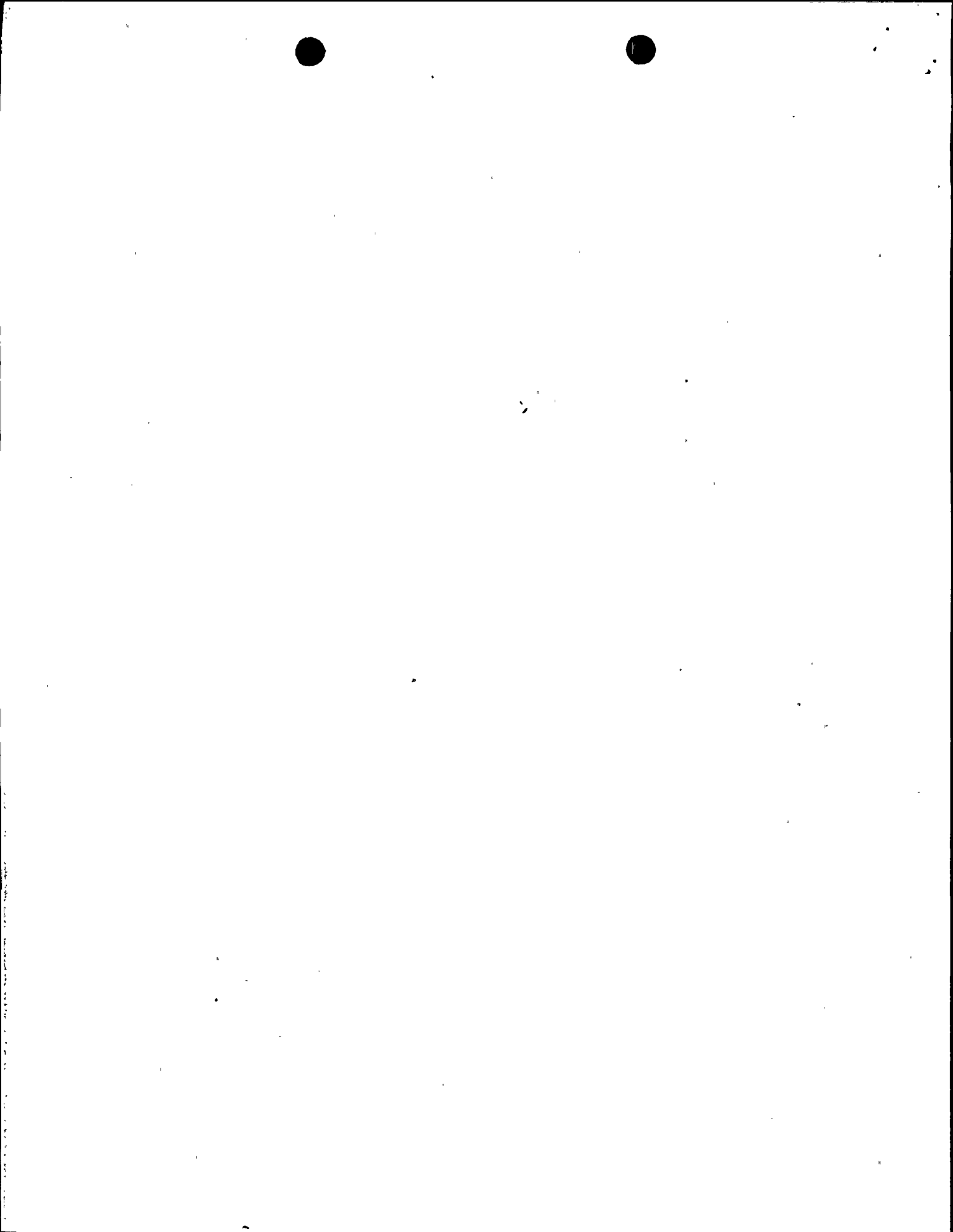


- 12 -

Dr. Bush then brought up the subject of experimental confirmation of vibration characteristics of major reactor components, and the response of safety instrumentation to seismic loadings. This was an agenda item for this meeting as well as having been cited in the ACRS CP letters for both Units 1 and 2. Mr. Lindblad indicated that a number of programs have been instituted in response to this concern:

- (1) Equipment qualification dynamic tests, as discussed by Mr. Dorrycott.
- (2) Dynamic tests of expansion anchors (tests sponsored by PG&E at the University of California).
- (3) Component tests conducted at Indian Point 2 and San Onofre on components similar to those which will be used at Diablo Canyon. With regard to item 3, Dr. Lin of Westinghouse discussed the applicability of these component tests to Diablo Canyon. He first discussed in detail the seismic qualification of instrumentation, in response to earlier questions. He then indicated that vibration testing of the reactor coolant loop and steam generator had been performed at Indian Point 2. He indicated that data were available from San Onofre, both from shake tests and from effects of the San Fernando earthquake. Lin also discussed some full-scale testing on a Westinghouse reactor in Japan.
- (4) Testing of models of pipe and pressure vessels for seismic damping characteristics (tests sponsored by PG&E at UCLA).
- (5) Installation of plant seismic instrumentation to record the small earthquakes that may occur during the coming years of operation.

Dr. Okrent asked whether PG&E had any plans for full-scale shaking of the Diablo Canyon Plant? Mr. Lindblad replied that they did not, and that they felt that the conservative damping assumed in the design provided sufficient margin such that full-scale shaking to reproduce the natural period of vibration was not really necessary. The staff added that unless one could simulate accelerations close to the SSE, e.g., 0.4 to 0.5g, the benefits of such testing would be small. The point was also made that artificial testing to such large accelerations would be extremely difficult.



### Seismic Scram

The last agenda item of the day involved a discussion of seismic scram. Mr. Lindblad indicated that PG&E had reviewed the recent Livermore report on this subject; he stated that the report leaves many questions open, and that at the present time, PG&E believes that an automatic trip of the reactor at the onset of an earthquake does not necessarily improve the safety situation. Dr. Okrent asked whether the applicant had prepared some kind of list detailing the good and bad features of a seismic scram? Mr. Lindblad stated that they had done this at various times, and that on the bad side, such a scram introduces a non-standard condition for the reactor, a transient involved in shutdown, loss of one of the sources of power, and an additional need to monitor a changing operation in the plant on top of the stress of the earthquake itself. Dr. Okrent then asked whether PG&E had evaluated the plant to see what level earthquake would lead to trip, whether you wanted it or not? Lindblad said they had not, but that he would estimate something of the order of a 0.1g acceleration value. This could be a reactor trip, turbine trip, or perhaps some other component, and would not necessarily initiate an automatic reactor shutdown. He added that he did not feel that it was good practice to shut the plant down for any earthquake, only for those which are potentially damaging to the plant; he did not think that PG&E should tolerate spurious trips of the reactor for small earthquakes. Okrent asked about the possible merits of an early scram for an earthquake which is going to cause a loss of coolant accident (LOCA). Dr. Kapur stated that the most important reason for having a seismic scram is that if the earthquake is accompanied by a LOCA, the peak clad temperature could be significantly reduced. He then considered various postulated earthquakes. For earthquakes of the order of the OBE, e.g., slightly greater than or equal to the OBE, the operator is required to shut down the plant. For earthquakes much greater than the OBE, some damage will be incurred, but within the SSE, the plant is still designed to be safely shut down. For earthquakes in this range, there are other monitoring systems which will trip the plant. Kapur also cited the problems of spurious signals and unwanted transients in concluding that he did not feel that a seismic scram was desirable at this time.

Mr. Ebersole raised the question of d-c power supplies with regard to breaker closure or trip in the event of an earthquake where one has generator trip. Then, what are the seismic qualifications of the switchgear and power supplies? Mr. Herrera of PG&E indicated that the batteries for the switchyards have earthquake bracing and are designed to withstand accelerations of at least 0.2g.



- 14 -

Dr. Okrent asked whether one can engineer a seismic scram system with a high degree of reliability, e.g., a reliability such that one has a probability of spurious scram no larger than one in a 100 or one in a 1000 per year? Considerable discussion ensued on this item, with the general conclusion being reached that such reliability could probably be achieved if the threshold level were set far enough above the acceleration for the OBE.

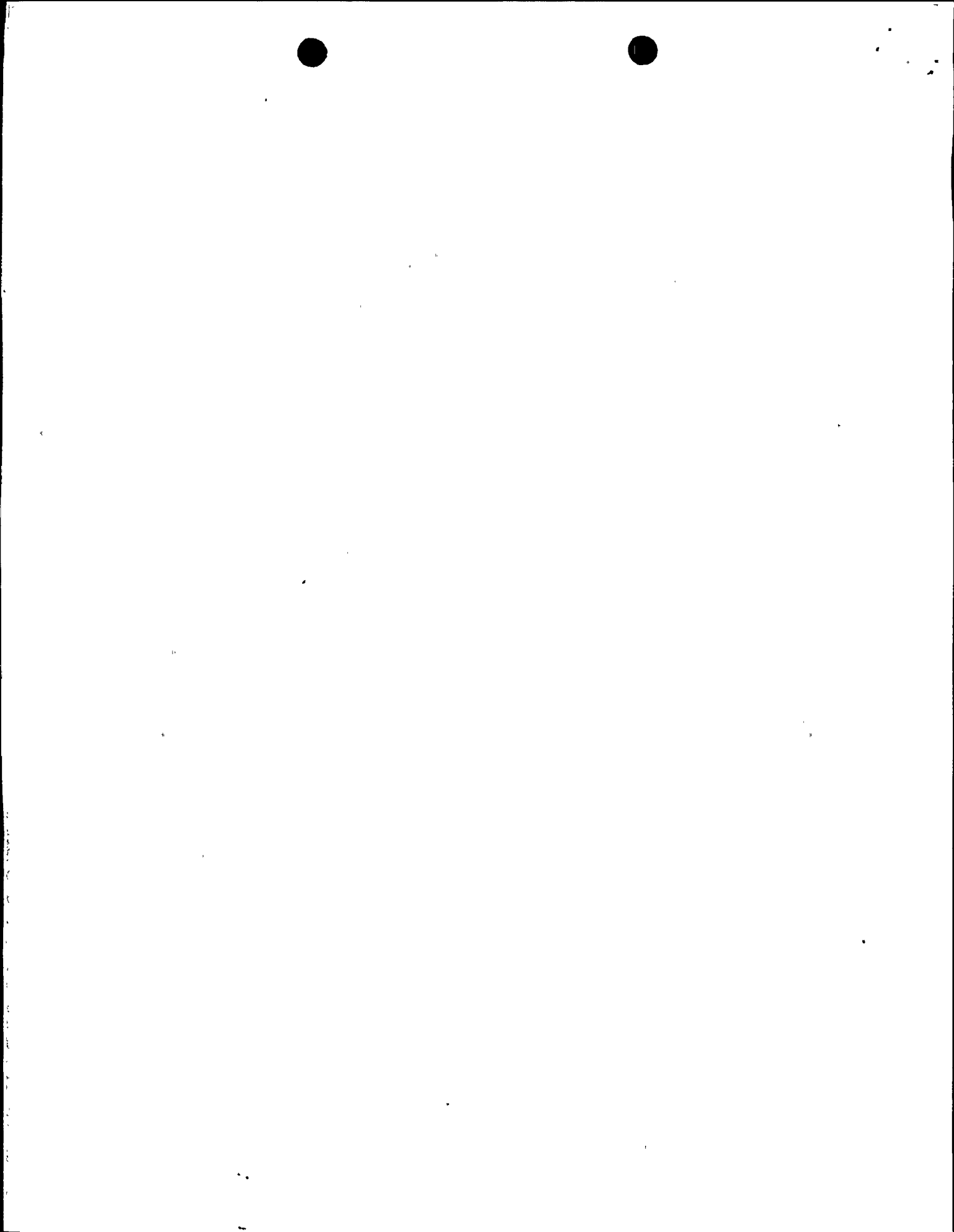
After additional discussion of this item, the meeting adjourned for the day.

### Systems Interactions

The meeting for the second day began with the subject of systems interactions. The reference for this discussion was an ACRS letter from Dr. Stratton to Mr. Muntzing (dated November 8, 1974) titled, "Systems Analysis of Engineered Safety Systems". In this letter, the Committee indicated that attention to the evaluation of safety systems and associated equipment from a multi-disciplinary point of view to identify potentially undesirable interactions between systems is becoming increasingly desirable and important. The letter then contains several examples to illustrate this theme.

After some general comments by Mr. Lindblad regarding the nature of the letter and its applicability to Diablo Canyon, Mr. Ebersole posed a series of questions and situations regarding the applicability of this letter to the Diablo Canyon Plant. Ebersole had visited the plant the previous day. These questions and situations are summarized below:

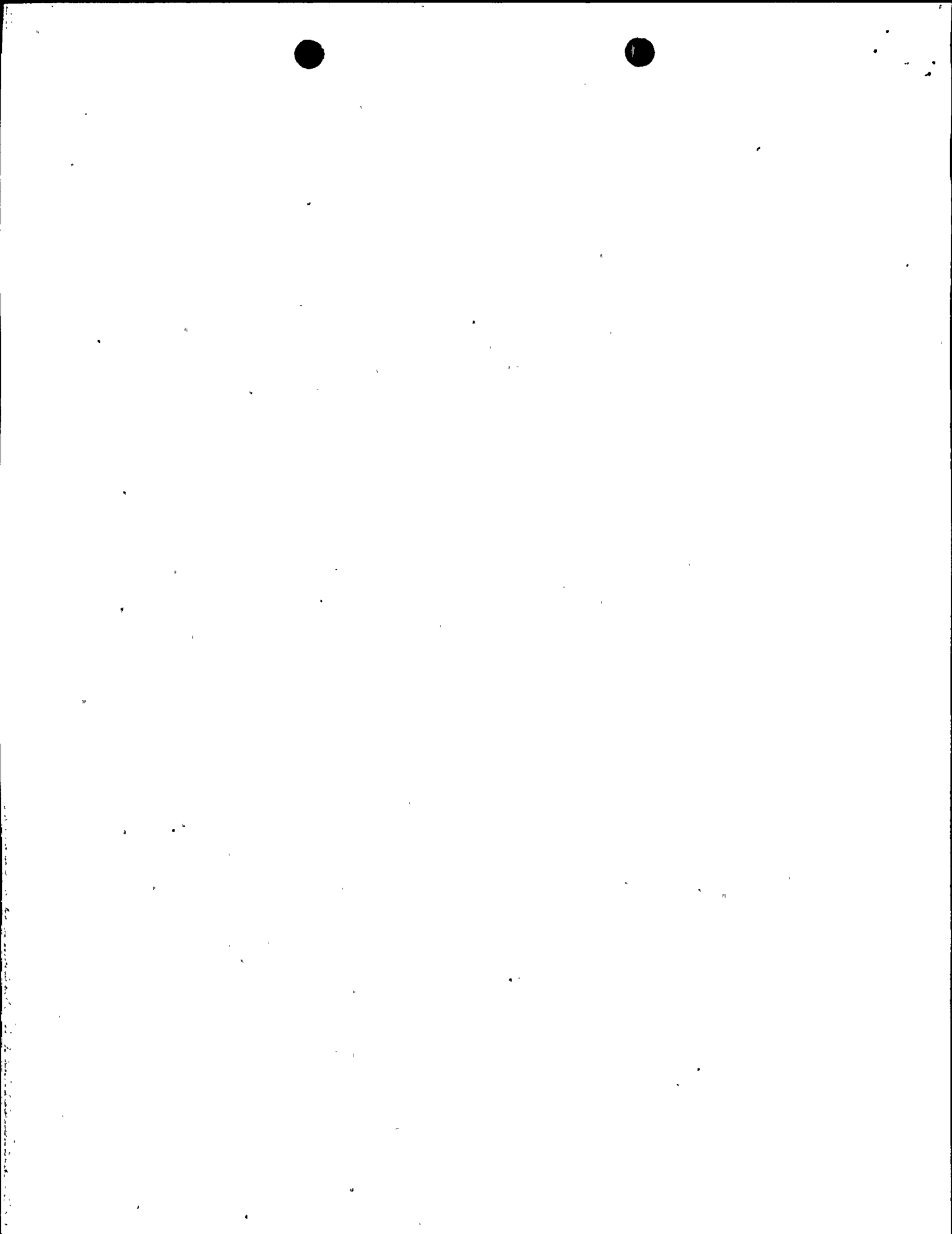
- (1) In the event of fire in the turbine building, it appears that there could be ventilation problems in the 4 kV vital switchgear rooms and also in the diesel generator compartments. For the switchgear rooms, there is common atmospheric coupling between these rooms, and it appears then that there would be communication between these rooms in the event of a fire in one of them. In the case of the diesel generator compartments, if the generator end of the diesel is isolated, i.e., the roll-down doors are closed, one would have a situation where the generator could receive very little cooling, causing a temperature rise in that part of the room and a possible overload condition and resultant a-c power outage.
- (2) The plant has many pairs of rotating shafts of various sorts serving different functions. These are typical redundant configurations of services which are on line at all times (not engineering safety feature designs). Now, suppose one postulates the failure of one



- 15 -

of a pair (say train A) which serves some specific function. Has the applicant examined the consequences if the alternate service, say train B, does not respond properly as a function of time? Examples might be service functions which control ventilating systems, water supplies, etc. In other words, the interest here is the thesis of non-response of backup trains of active services, and a consideration of the time delay involved that might be an abnormal delay rather than normal. An extension of this might be, if the backup service does not respond, what time is available to repair the service or else pursue an alternate course of action?

- (3) The Rasmussen Report discussed the total loss of all a-c power, and included some probabilities on the length of time before power might be restored. With regard to this situation, has the applicant considered this loss of power in light of the stoppage of rotating shafts and a possible temperature excursion in the containment to values of the order of 400-500°F? Mr. Lindblad indicated that they had reviewed this general type of situation, and that the containment would not exceed its design temperature. He further added that with loss of a-c power, the containment heat input is reduced by about 85% because of the loss of the normal heat loads from the reactor and the reactor coolant pumps.
- (4) In the case of small LOCA conditions (larger than the charging pump capacity), one has depressurization of the primary system. For this situation, can the applicant describe the heat transport paths to the ultimate heat sink? Possible paths are the residual heat removal system (but there is probably not sufficient flow here), the component cooling water system (which passes through the containment fan coolers) coupled with the auxiliary saltwater system, or natural convection in the steam generators. As a function of break size, what fractions of the heat are carried along these various transport paths to the ultimate heat sink? An additional question raised was, what will be the ambient temperature surrounding the auxiliary feedwater pumps, as a function of time, in the absence of cooling and ventilation in these pump rooms?
- (5) For the auxiliary saltwater system, one of the auxiliaries is a common pair of sump pumps in the intake structure to pump out leakage, if necessary. These pumps would be submerged under a high wave condition. What are the criteria for the design of these sump pumps? In addition, the piping for the saltwater pumps is supported by connection to a non-seismic structure,





- 16 -

namely the condenser discharge conduits. The idea of a seismic piping system anchored to a non-seismic structure appears to deserve some clarification. The coupling of the auxiliary saltwater piping to the earthen fill and the building foundation was also discussed.

- (6) Again with respect to the sump pumps for the auxiliary saltwater system, it was mentioned that these pumps would be flooded under very high waves. Under this condition, would the integrated intake of water into the louvres be such that the sump pumps would not be required in the short-term following this flooding?
- (7) The cable link that supplies power to these sump pumps is an example of cabling which is intermittently subjected to fresh-and salt-water flooding. What qualification of this cable has been performed to ensure its function under the conditions of alternate drying and submergence in either fresh-or salt-water?
- (8) With regard to the hot shutdown panel, is there a possibility that in providing this auxiliary function, you really have not recreated a new scene for common vulnerability of damage? In other words, is there really independence from the control room with regard to this panel being a center of active functions?

Each of the items raised by Mr. Ebersole was discussed in considerable detail. Dr. Okrent asked both the applicant and staff to be prepared to discuss and resolve any outstanding questions on these items at the next Subcommittee Meeting.

Dr. Bush then raised the following two questions:

- (1) Has the applicant considered the problem of phosphate build-up with regard to closure of valves on the turbines? This question is related to the response of non-seismic valves under severe seismic shaking. Are there any reliability statistics regarding closure of such valves under seismic loadings (when generator load has been dropped)? Mr. Lindblad indicated that the Earthquake Engineering Research Institute does collect information of this sort. With regard to contacting the above-mentioned Earthquake Institute, Bush suggested that data from Alaska also be obtained, e.g., data from the 1964 Alaskan earthquake.



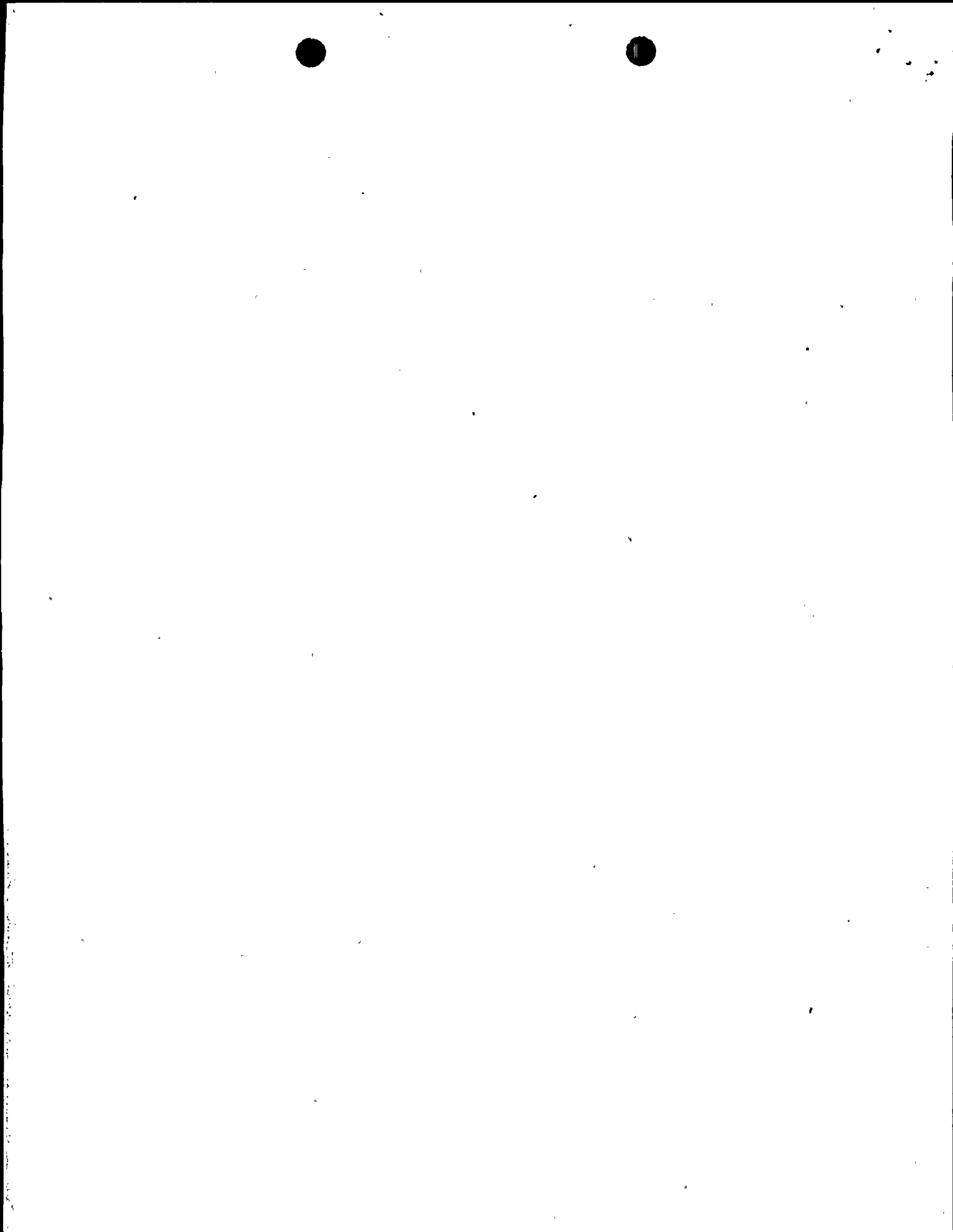
- 17 -

- (2) If you assume a failure of one of the inlet lines to the steam generator so that you have the full impact of the jet forces, as well as the jet forces from the exhaust from the steam generator, and then impose a seismic loading as well, does this situation fall within the design envelope?
- (3) Dr. Okrent asked that the staff reexamine in detail the modeling of the primary coolant pump under a seismic loading, to be assured that this modeling has been done properly.
- (4) Mr. Koffman asked what accelerations might be experienced in the control room for the design SSE acceleration of 0.4g? Mr. Lindblad estimated between 1.6 and 2.0g, but indicated that they would look further into this item. Koffman stated that this could be an additional argument for having a seismic scram.

As a concluding remark to the general subject of Systems Interactions, T. Hirons indicated that the staff has had some preliminary discussions with ACRS as to how some of these situations should be handled. It is planned that many of them can be incorporated into various sections of the Standard Review Plan. A special ACRS Subcommittee, with Dr. Bush as chairman, has been set up to begin reviewing some of these items with the staff.

#### Electric Power Systems

Mr. Herrera of PG&E opened this subject with a presentation on the offsite power system for Diablo Canyon. He stated that the interconnected PG&E 230 and 500 kV electric transmission systems will serve as a two-system source of offsite power for the Diablo Canyon Units. The two generating units will be connected to the transmission system by means of two 230 kV and three 500 kV lines emanating from their respective switchyards. These yards are physically separated and independent of each other. Each of the 230 and 500 kV lines supplying the Diablo Canyon switchyards have primary and backup protective relaying systems and automatic closing features. This will ensure fast and proper clearing of all electrical faults, and will permit automatic restoration of power from the system if all conditions are proper. Stability studies which have been conducted on the system indicate that the loss of any single generator in the system, including that for either Diablo Canyon Unit, while operating at full load, will not adversely affect the stability of the remainder of the transmission grid. He concluded by stating that the design of the offsite power system meets the intent of General Design Criteria 17 and 18, IEEE Standard 308-1971, and Regulatory Guide 1.32.

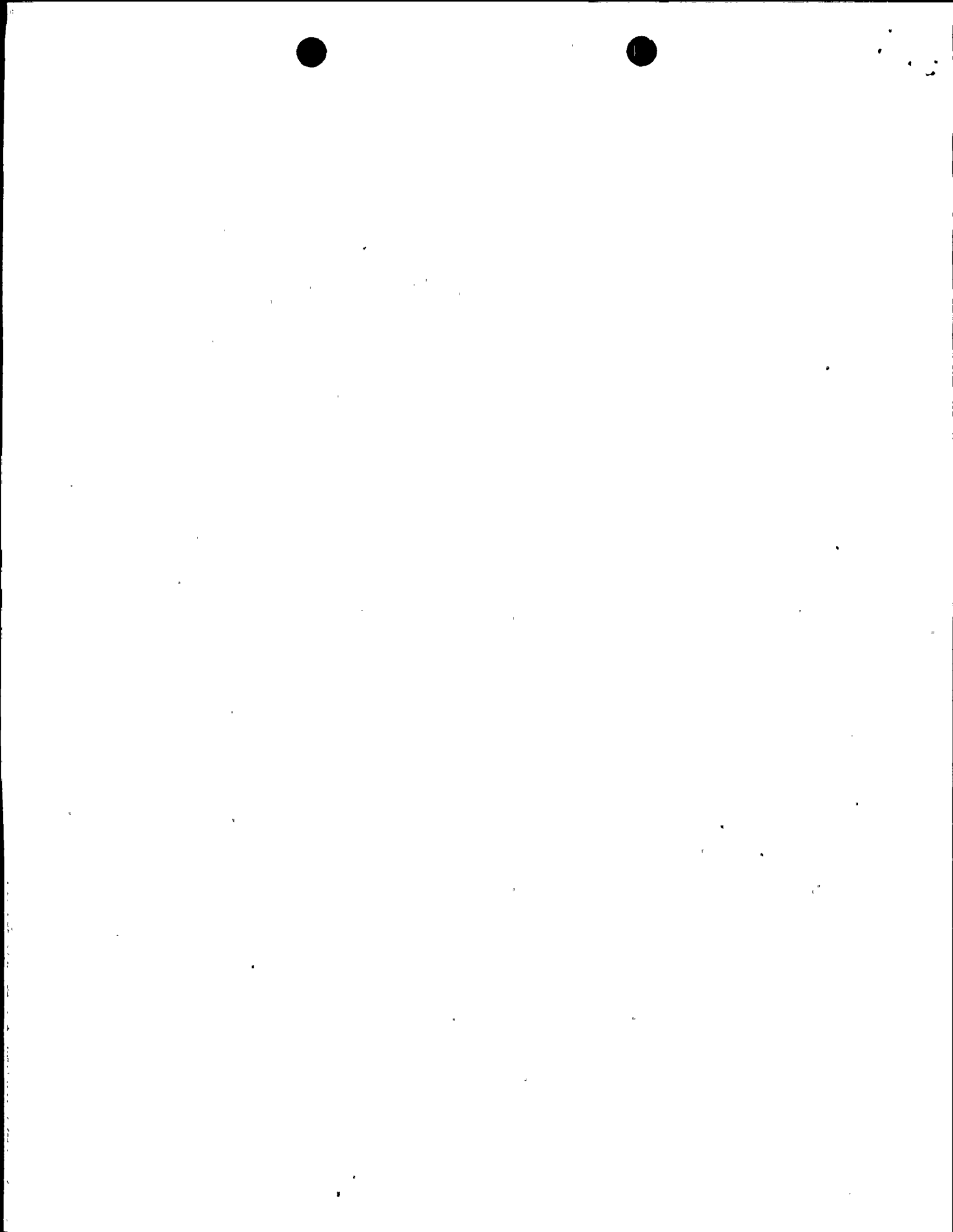


- 18 -

Several questions were raised regarding the presentation on offsite power. Dr. Okrent asked if figures were available on system reliability that would provide a basis for judging the probability per year of losing all offsite power to the Diablo Canyon site? Mr. Herrera indicated that specific figures were not available. Mr. Ebersole asked if PG&E was taking any steps to upgrade the load rejection logic to prevent cascade as the nuclear units come on to the system? Mr. Herrera indicated that they were. Dr. Bush asked if, under a seismic loading, can you bootstrap yourself to the turbine from a startup condition, as contrasted to a load rejection continuing operation? Mr. Lindblad responded that they could.

Mr. Nielsen of PG&E then made a presentation on the onsite power system for Diablo Canyon. This system consists of the output from the main generator and an auxiliary power system composed of 12,000, 4160, and other low voltage systems. All auxiliary system buses can be fed from either the main generating unit or from the standby-startup offsite source. The emergency power system can also be supplied by the diesel generators. The engineered safety features and other emergency services are fed from three 4160 volt buses, each supplied by a diesel generator as well as by the normal offsite and main unit sources. ESF loads have been grouped to meet single failure criteria. Two diesel generators are sufficient to carry the emergency loads that are required for safe operation under normal and accident conditions. One diesel generator is common to both Units and is automatically transferred to the Unit which requires actuation of safety features. The onsite d-c power system consists of a 125 volt system. The system is divided into 3 groups, and each battery has its own battery chargers and switchgear. The batteries have the capacity to supply their loads for the time duration required, even without allowance for the diesels immediately relieving some of the load.

Dr. Okrent asked what happens if, in a seismic event, both reactors indicate that there is a LOCA? Nielsen indicated that whichever Unit receives its accident signal first will obtain the load from the swing diesel. After additional discussion, Okrent asked if anyone has looked at the reliability of this situation, and does one have the necessary reliability? He further stated that he felt that the staff should look in detail at the design of everything that one needs to function in order to get onsite power (both a-c and d-c), given an earthquake large enough to have a reasonable chance of losing offsite power. Finally, Okrent asked if the staff had considered the possibility of sequential effects due to earthquakes, e.g., offsite power going off and on. Nielsen indicated, for the example cited, that once the diesels



- 19 -

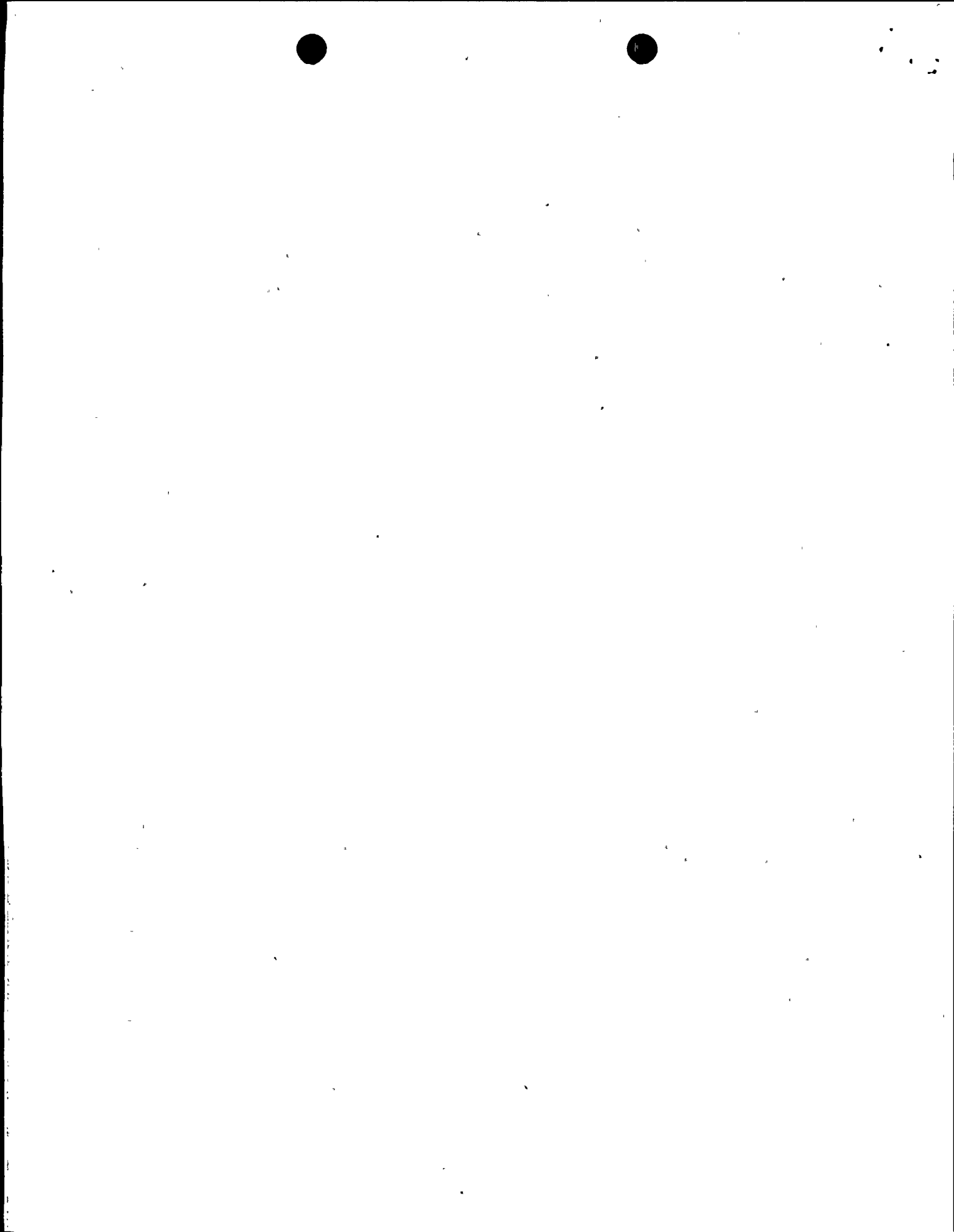
come up to full speed (10 to 12 seconds), the offsite power source would be locked out. Mr. Ebersole raised some additional questions regarding the change-over from offsite power to the diesels, e.g., valve actuation. Nielsen responded to these questions for PG&E. Finally, Ebersole raised the concern that the day tanks for all five diesels are supplied through a two-tank, two-pipe, two-electrical pump fuel oil system, and that the state of the entire fuel oil system depends on getting power to these two small pumps which must cycle on and off frequently. Mr. Lindblad responded that the system meets the single failure criterion, and that he feels that it is adequately designed to perform its intended function.

#### Lockout of Power to Motor-Operated ESF Valves

A letter on this subject from Dr. Kerr of ACRS to Mr. Muntzing (dated January 14, 1975) had been distributed earlier in the meeting to the applicant and staff. The letter raised some questions regarding the proposed lockout of power to the above-mentioned valves. T. Hirons of the staff indicated that the position stated in the Diablo Canyon Safety Evaluation Report was unchanged at this time. Mr. Lindblad stated that PG&E's position is that they prefer to maintain operability of the valves from the control room.

Mr. Gormly of PG&E then began his presentation on this subject. He used a piping diagram to indicate the nine valves which the staff had flagged with regard to lockout of power. The most important of these are the single valves from the refueling water storage tank to the safety injection and RHR pumps. Several questions were asked during the presentation regarding the size of the valves, valve operators, annunciation of valve position in the control room, etc. Gormly detailed the information that would be available to the operator to indicate that one of these valves was closed, and the steps that the operator could take to open them. He indicated that they had made no comprehensive evaluation of the probability of spurious closure of one of these valves.

Several of the questions in the ACRS letter on this subject were then discussed in light of the Diablo Canyon design. These included an evaluation of the probability of a spurious signal, time interval required for reactivation of valve operator after loss of power, question of whether signal lights are lost when the circuit breaker is opened, reliability of valve indicators, etc. The discussion concluded with Mr. Lindblad stating that the applicant would like additional time to consider some of the questions in the letter. The staff also indicated that they would respond later to these questions.





### Miscellaneous Questions

- (1) Mr. Ebersole commented that the plant contains various hydrogen storage systems and lines throughout the plant. He brought up the general subject of hydrogen release and accumulation. Mr. Gornly responded that they had taken this problem into account in designing the plant. With regard to hydrogen evolution out of the battery rooms, Mr. Nielsen stated that they had studied this problem in detail (partly at the request of the staff), and that the analysis showed that it would take 28 days to accumulate enough hydrogen to approach the minimum explosive limit, assuming complete loss of ventilation.
- (2) With regard to inservice inspection (baseline), Dr. Bush stated that the Units apparently meet the criteria set forth in ASME Section 11-1971; in this regard, he asked how this compares with the 1974 code? Mr. Lindblad replied that the areas of non-compliance with Section 11 of the 1974 Code are very limited in nature. This question will be discussed in greater detail at a future meeting.
- (3) Dr. Okrent asked if in the routing of electrical systems, are seismic Category I and non-seismic Category I lines ever placed in the same cable tray or penetration? Mr. Nielsen replied that they are not. Okrent then asked if there are possible modes of overheating for the non-seismic lines which could lead to a loss of penetration integrity? After some discussion, Okrent asked the applicant and staff to be prepared to discuss this item at the next meeting.

### Emergency Plan

Mr. Shiffer of PG&E discussed the emergency plan for the Diablo Canyon Units. He indicated that in the development of the plan, primary consideration was given to the December 1970 AEC guide for the preparation of emergency plans for production and utilization facilities. The plan includes provisions for primary and alternate emergency control centers, notification of offsite state and federal agencies with responsibilities during an emergency, onsite first aid and decontamination facilities, and emergency radiological monitoring equipment. Shiffer indicated that the plan describes a spectrum of accidents and the specific action levels to be taken for protective measures. In the event of an emergency, the San Luis Obispo County Sheriff's Department is responsible for coordination of any initial offsite protective measures which may be required.

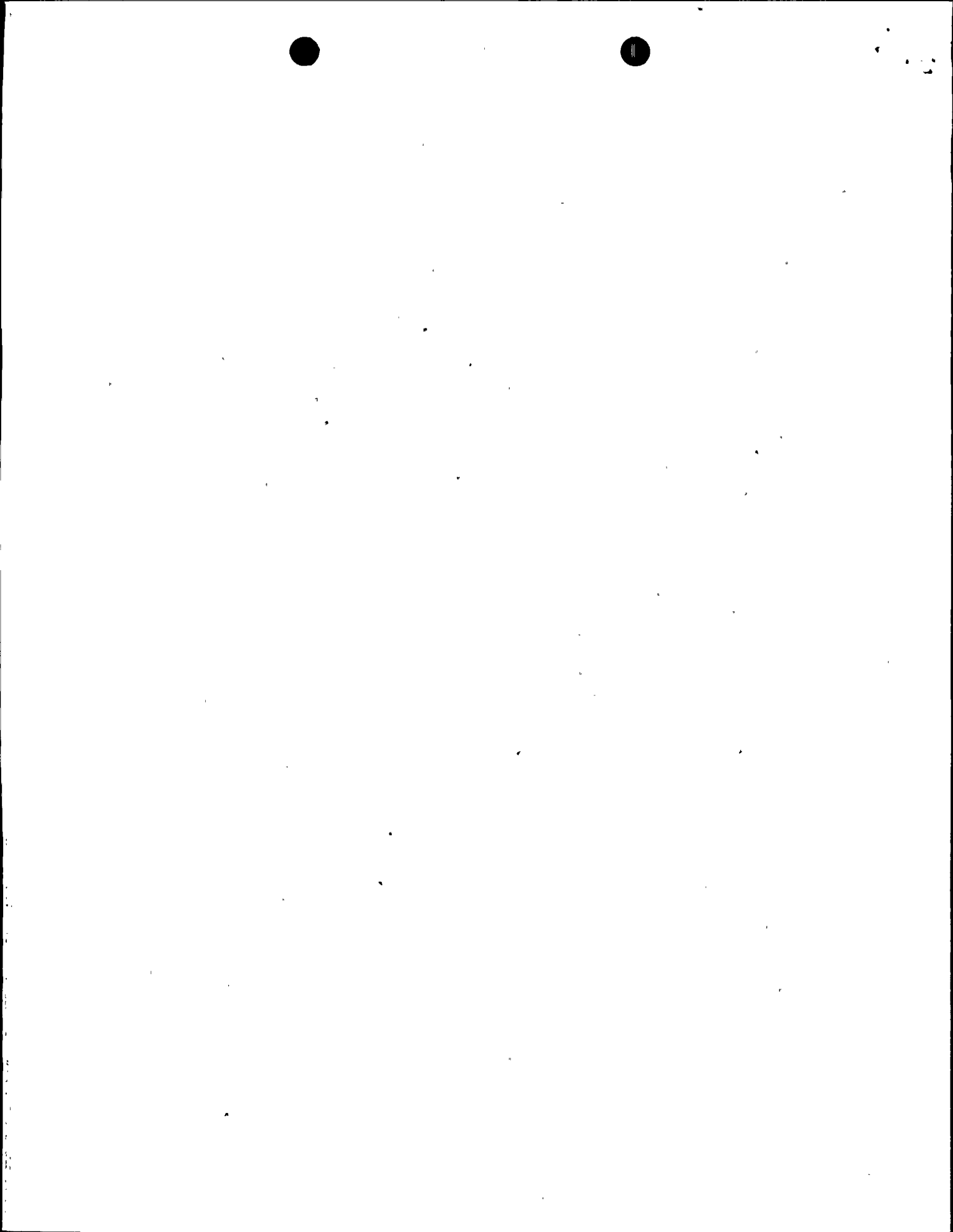


- 21 -

Dr. Okrent asked if PG&E had developed within their own procedures, the specific information, the instrumentation, and the evaluation of these readings such that the operator or some other responsible person could determine the nature of the events, given some postulated accident? In the question he included the range of situations discussed in Draft WASH-1400. Shiffer replied that their procedures did include specific offsite monitoring techniques, and procedures for interpretation of monitoring results, e.g., dose conversion tables. Considerable discussion ensued on this item, with Okrent emphasizing that early warning time of accident details was an important consideration in Draft WASH-1400. Shiffer indicated that they have looked at high temperature radiation monitors inside containment, and also the possibility of a detector outside containment looking at either the exterior concrete surface or at the liner at the containment equipment hatch. However, he questioned the validity of the interpretation of data which might be obtained from such instruments. T. Hirons indicated that the staff is still reviewing this question, both in a generic sense and specifically, for the Diablo Canyon Units; a draft Regulatory Guide on post-accident instrumentation is currently being formulated. Okrent asked both the applicant and staff to be prepared to discuss this item at the next meeting.

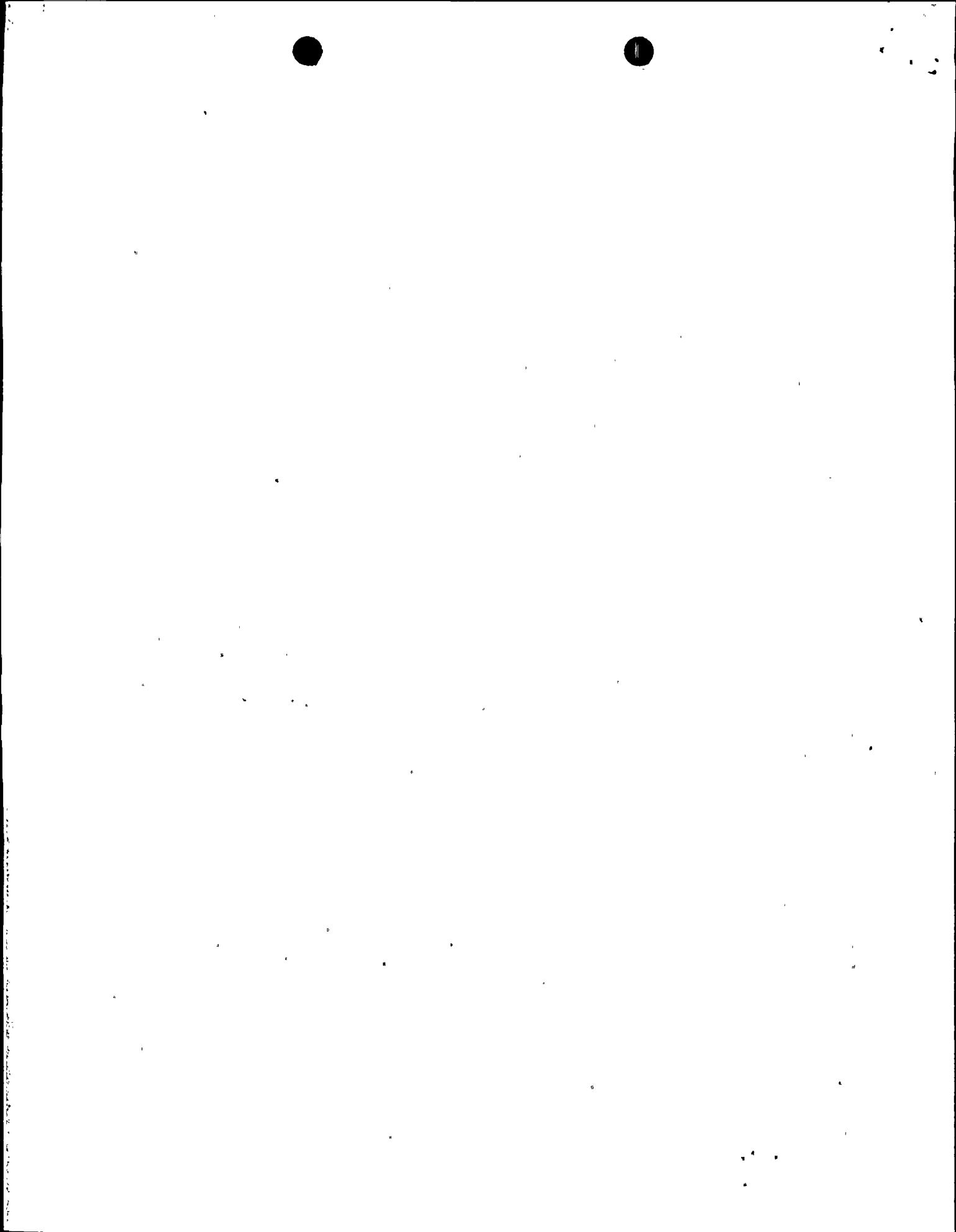
#### Miscellaneous Questions (continued)

- (4) Mr. Ebersole commented on the setting of valves in the RHR system, i.e., the setting of valves to cope with the problem of pipe break with regard to the paths which the water could follow. The question on this pertained to the fairly simple instruction on an FSAR drawing regarding adjustment and locking of a specific valve; Ebersole felt that perhaps this instruction should be expanded because of the number of possible fault situations. Mr. Lindblad replied that indeed more detailed instructions are available for the operators.
- (5) Ebersole asked about the intermediate common C train in the component cooling water system. If a major leak occurs in this C train, how do you prevent the operator from simply drying up the system by pumping the alternate water inventories in the A and B trains into the same fault? Mr. Gormly discussed the monitors which would alarm such a fault, and indicated that the C header would be isolated before any substantial loss in backup water supply had occurred.



- 22 -

- (6) Dr. Okrent asked whether the water hammer problems experienced at Indian Point 2 could be expected to occur at Diablo Canyon? Mr. Lindblad indicated that both Westinghouse and PG&E are currently reviewing the installed Diablo Canyon system to see how it compares with the Indian Point situation. Okrent further asked whether Diablo Canyon would be subject to the associated effect of containment liner heating that accompanied the feedwater line rupture at Indian Point? Lindblad stated that he did not think so, and that Diablo Canyon has a different feedwater design in that welds are removed from the immediate area of the liner plate.
- (7) Okrent postulated a LOCA situation downstream of the steam generator where a two-phase mixture coming out of the vessel might lead to dynamic forces, particularly in the steam generator. He asked whether Westinghouse had done any further examination of this question? Dr. Peacock indicated that Westinghouse had completed an analysis of the primary to secondary system interface in the steam generator; the analysis considered the dynamic loads resulting from seismic forces, blowdown, and various load combinations. One conclusion of the analysis was that slug flow would not be predicted by the blowdown process. Peacock stated that this work was documented in a WCAP report which was submitted to the staff over a year ago. Okrent asked the staff to check on the review status of this report and comment at the next meeting.
- (8) Okrent asked if the staff had reviewed the kinds of insulation used at Diablo Canyon, and examined the potential effects of insulation in the sump in the event of a LOCA? Hirons indicated that the staff had requested and received this information from PG&E, and that we were still reviewing it for acceptability. Okrent asked for additional discussion on this at the next meeting.
- (9) Okrent asked if it was planned to run the Diablo Canyon containment in the purge mode while the reactor is at power? Lindblad replied that the purge valves would normally be closed. He further added that the purge valves have the capability of closing during a LOCA.
- (10) Okrent asked whether the question of unacceptable forces on the check valve seats in the secondary system had been examined? Mr. Lindblad responded that this question had been analyzed by their consultant (Nuclear Services Corporation), and that the valve integrity was found to be satisfactory; he also stated that



the staff had reviewed the analysis and found it to be acceptable. Mr. Ebersole pursued the discussion with regard to one of the check valves experiencing steam flow reversal; he asked whether the discs will survive the tremendous impact upon closure. Mr. Allison of the staff stated that the discs would be deformed but not broken. In relation to this problem, Ebersole suggested that a pipe break in the vicinity of these valves could indeed effect the valve in the opposite line and possibly result in the blowdown of two steam generators. Lindblad stated that their analysis had shown that the second valve could withstand the failure of the first line. Peacock emphasized that protective functions have been incorporated in the design to assure that only one steam generator blows down.

### Conclusions

Another Diablo Canyon Subcommittee Meeting will be scheduled once the evaluation of Geology and Seismology has been completed. The staff plans to complete this evaluation sometime in May of this year.

*Thomas J. Hirons*

Thomas J. Hirons  
Light Water Reactors  
Project Branch 1-3  
Division of Reactor Licensing

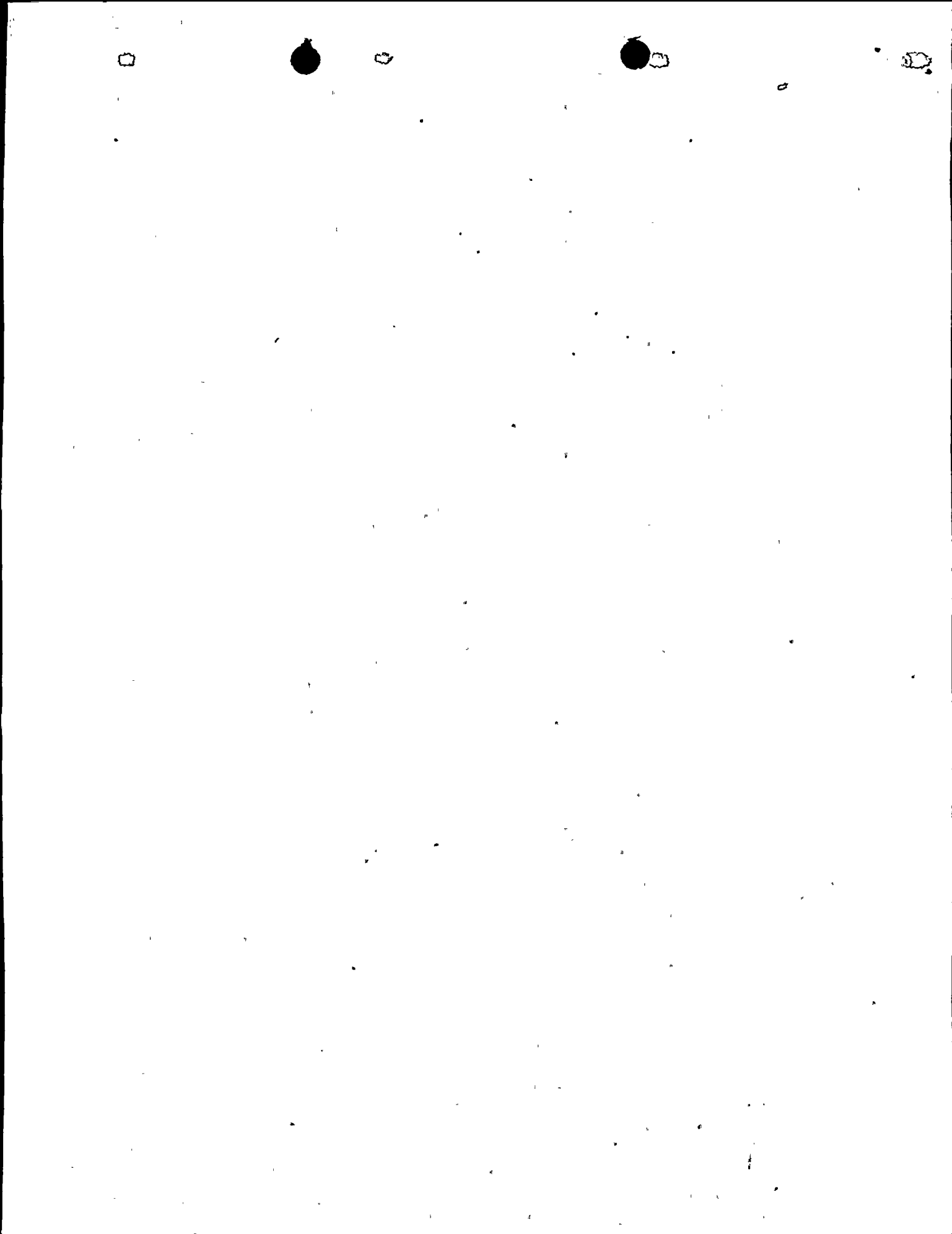
### Enclosures:

1. Proposed Agenda
2. Attendance List

### cc w/encl:

Mr. John C. Morrissey  
Philip A. Crane, Jr., Esq.  
Andrew J. Skaff, Esq.  
Mr. Frederick Eissler  
Ms. Elizabeth E. Apfelberg  
Ms. Sandra A. Silver  
Mr. John Forster  
Mr. Lonnie Valentine  
Mr. William P. Cornwell  
Mr. W. J. Lindblad  
Mr. J. W. Dorrycott

OFFICE	RL:LWR 1-3				
SURNAME	THIRONS, pga				
DATE	3/18/75				





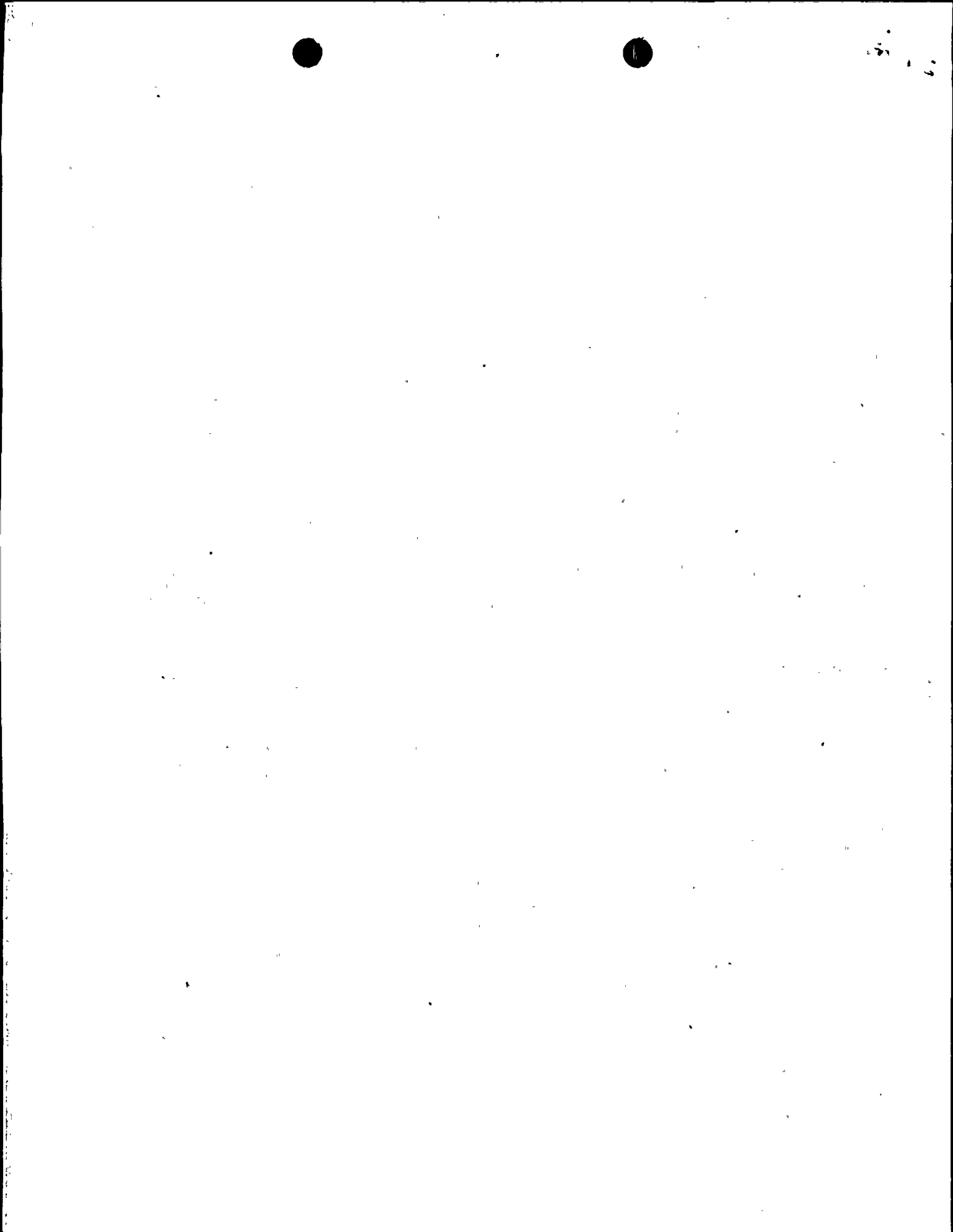
PROPOSED AGENDA

DIABLO CANYON UNITS 1 & 2 SUBCOMMITTEE MEETING  
FEBRUARY 18-19, 1975 - SAN LUIS OBISPO, CALIFORNIA

PRINCIPAL SPOKESMEN: W. J. Lindblad - PG&E, Project Manager  
Tom Hiron - Project Manager, Reg. Staff

TUESDAY, FEBRUARY 18, 1975

- (30 min.) I. Executive Session - CLOSED -(8:30 a.m. - 9:00 a.m.)
- (5 min.) II. Introductory Statement (PG&E)  
 A. Brief Description of Site Location/Layout  
 B. Construction Status - Units 1 & 2  
 C. Fuel Load/Operation Schedule
- (15 min.) III. Project Review Summary and Status Report (DL)  
 A. Update on ~~Sept.~~<sup>Oct.</sup>, 1974 SER Unresolved/Outstanding Items  
 B. Resolution/Status of ACRS CP Letter Items
- (2 hrs.) IV. Site Characteristics  
 A. Geology/Seismology  
 1. Detailed Status of DL Review (DL/USGS)  
 2. Applicant Presentations (PG&E)  
 a) Basic Geologic/Seismic Data  
 b) Vibratory Ground Motion  
 c) Surface Faulting  
 d) Offshore Seismic Interpretation Program  
 e) Determination of SSE and Seismic Design "g" Value for Site
- (30 min.) B. Tsunami Analysis (Model/Analysis/Review Status) (PG&E/DL)  
 (15 min.) C. Tornado Design/Criteria  
 1. Applicant Presentation (PG&E)  
 2. Conformance to Current Criteria (DL)  
 3. Systems for Safe Shutdown Weakly Protected (PG&E/DL)
- (15 min.) D. Other Site Characteristics  
 1. Meteorology, Hydrology, Demography, etc. (PG&E)
- (1 hr.) V. Seismic Design (PG&E/DL)  
 A. Design Criteria for Containment/Major Components  
 B. Significant Changes in Design Since CP Stage  
 C. Design Criteria/Qualification Requirements for Safety-Related Instr.  
 D. Stress Levels at 0.4g/0.5g/Higher "g" values  
 1. Safety-Related Systems Most Vulnerable to Seismic Events  
 E. Possible Effect of Non-Seismic Class I System Failure on Safety
- (15 min.) VI. Experimental Confirmation of Seismic Design Aspects (PG&E)
- (30 min.) VII. Seismic Scram (PG&E/DL)  
 A. Existing Designs/Available Methods  
 B. Experience & Reliability Considerations



## SUBCOMMITTEE CAUCUS - CLOSED SESSION

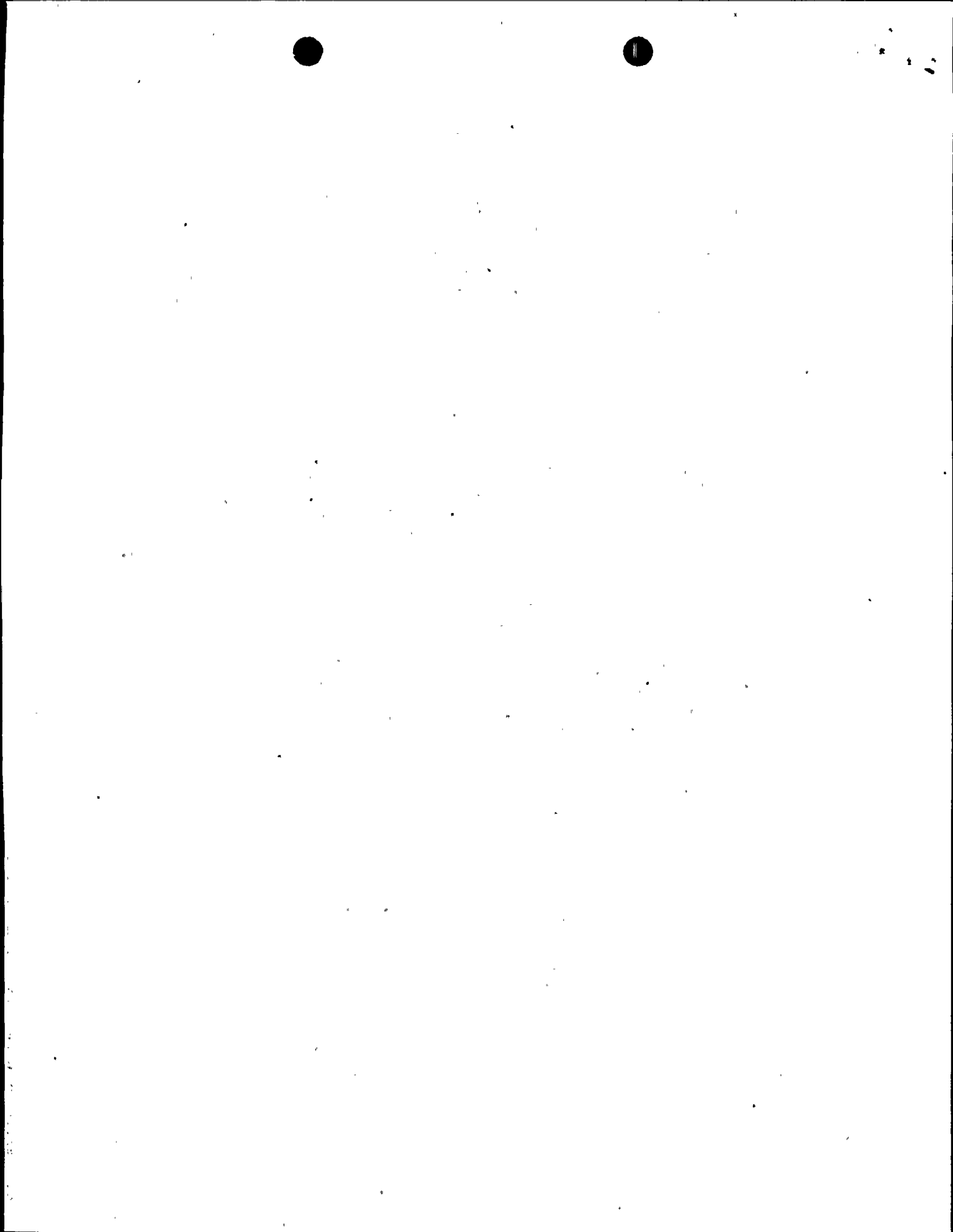
- (15 min.) VIII. Systems Interactions (PG&E/DL)  
(reference letter, dated 11/8/74, WRS to Muntzing)

Adjourn meeting at 7:00 p.m.

-----  
WEDNESDAY - FEBRUARY 19, 1975

- (30 min.) I. Executive Session - Closed (8:00 a.m. -8:30 am)
- (30 min.) II. Reactor (PG&E)
- A. Brief Description of Major Features/Comparison with Existing Designs
  - B. ECCS/LOCA - Appendix K Evaluations.
    - 1. Unit 1/Unit 2 Results - Comparison with Existing Designs
    - 2. Limiting  $F_Q^T$  calculated for Unit 1/Unit 2
    - 3. Status/Schedule for Completion
  - C. Power Distribution Control Method - Ex-core/APDMS/COAC (PGE/DL/W)
  - D. Significant changes in Design from CP Stage
  - E. Status of 17x17 Verification/Review
- (15 min.) III. Electric Power Systems (One Line Diagram) (PG&E)
- A. Offsite Power
  - B. Onsite Power
  - C. Emergency Power
  - D. Reliability Considerations - Diesel Qualifications
- (15 min.) IV. Emergency Plan (PG&E)
- (15 min.) V. Industrial Security - Closed (PG&E)
- (?? ) VI. Resolution/Status of Generic Items (PG&E)
- A. List ??
  - B. List ??
  - C. List ??
- (20 min.) VII. Plant Items (PG&E/DL)
- A. Brief Description of Plant/Layout
  - C. Major Design Changes Since CP Stages
  - C. Lessons Learned from Operating Experience/Related Design Changes
- VIII. Lockout of Power-Operated ESF Valves (PG&E/DL)

Adjourn Meeting at 2:00 p.m.



ENCLOSURE NO. 2

ATTENDANCE LIST

DIABLO CANYON ACRS SUBCOMMITTEE MEETING

ACRS

Dr. D. Okrent  
Dr. S. Bush

ACRS CONSULTANTS

Dr. B. Page\* (Stanford University)  
Dr. G. Thompson\* (Stanford University)  
Dr. M. Trifunac\* (California Tech.)  
Dr. M. White (University of Massachusetts)  
Mr. K. Steinbrugge\* (University of California)  
Mr. J. Ebersole\*\*\* (on leave of absence from TVA)  
Mr. E. Koffman (Los Angeles Water & Power  
Department - Retired)  
Dr. S. Siegel (Atomics International - Retired)

ACRS STAFF

J. Conran

PACIFIC GAS AND ELECTRIC COMPANY (PG&E)

W. J. Lindblad  
J. B. Hoch  
R. V. Bettinger  
W. K. Brunot  
H. J. Gormly  
E. P. Wollak  
V. J. Ghio  
D. Nielsen  
R. A. Young  
R. R. Fray  
J. C. Carroll  
J. R. Herrera  
P. A. Crane\*  
D. Sullivan  
R. Ramsay  
J. Shiffer  
R. Patterson



6  
2

PG&E CONSULTANTS

Dr. R. Jahns\* (Stanford University)  
Dr. S. W. Smith\* (University of Washington)  
Mr. D. H. Hamilton\* (Earth Sciences Associates)  
D. J. A. Blume\* (John A. Blume & Associates,  
Engineers)  
R. Gallagher\* (John A. Blume & Associates,  
Engineers)  
D. Jhaveri\* (John A. Blume & Associates,  
Engineers)  
Dr. L. S. Hwang\* (Tetra Tech, Incorporated)

WESTINGHOUSE

Dr. D. W. Peacock  
Dr. T. C. Esselman  
Dr. Chi-Wen Lin  
Mr. J. W. Dorrycott  
Mr. A. J. Abels

NRC - STAFF

T. J. Hirons  
D. P. Allison  
O. D. Parr  
R. C. DeYoung\*  
J. C. Stepp\*  
R. B. McMullen\*  
R. B. Hofmann\*  
W. P. Gammill\*  
H. R. Denton\*  
L. G. Hulman\*  
M. L. Fliegel\*  
K. K. Kapur\*  
L. Shao\*  
J. R. Tourtellotte\*





USGS

J. Devine\*  
F. McKeown\*  
H. Wagner\*  
R. Yerkes\*

GENERAL PUBLIC

Attendance by the general public ranged between 10 and 30 people, depending on the particular subject being discussed.

\* Denotes attendance on first day only.

\*\* Denotes attendance on second day only.

