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Attorney, OELD	
MGroff	

Docket No.: 50-133 JUN. 16 1976

Mr. Thomas Collins
P. O. Box 1347
Eureka, California 95501

Dear Mr. Collins:

Reference is made to your petition pursuant to 10 CFR §2.206, dated August 24, 1975, requesting suspension or revocation of the operating license for the Humboldt Bay Power Plant, Unit No. 3. Your petition is based on seismic concerns and is supported by your submittal of January 7, 1976, entitled "Seismic Hazards at the Humboldt Bay Nuclear Plant."

Currently we are involved in an extensive evaluation of the geologic and seismic conditions at Humboldt Bay, as we were at the time of receipt of your petition. We have reviewed your concerns in conjunction with our evaluation and have met with you on December 12, 1975 and March 16, 1976, during site visits, to review the evidence supporting your concerns.

As discussed in the attached "Status of Geologic/Seismic Review - Humboldt Bay Nuclear Power Plant", the conclusions, as stated in your January 7, 1976 report, address points considered in our evaluation of the Humboldt Bay region. As a result of our evaluation thus far we have identified specific geologic/seismic areas which require additional investigation before a determination, with respect to the geologic and seismic character of the Humboldt Bay region, can be made. By letter dated May 11, 1976, PG&E has committed to perform these additional investigations. PG&E has also committed to complete their current seismic design upgrading program prior to power operation following the next refueling outage. This program uses a 0.25g Operating Basis Earthquake (OBE) and an assumed Safe Shutdown Earthquake of 0.50g for design purposes. The requirement to perform the investigations and equipment upgrading has been incorporated in the Humboldt Bay license by the Order for Modification of License issued May 21, 1976. The Order also confirms PG&E's

commitments that Humboldt Bay°s 1976 refueling outage will commence by July 2, 1976 and return to power operation following this outage will require NRC approval with respect to the satisfactory completion of specified geologic/seismic investigations and specified seismic design upgrading.

We do not agree with your conclusion that sufficient grounds exist to suspend or revoke the Humboldt Bay license. The requirements of the Order insure timely completion of the necessary investivations in that all investigations, with the exception of the review of the Freshwater and Table Bluff faults, are required to be satisfactorily completed prior to power operation following the 1976 refueling outage. Investigation of the Freshwater and Table Bluff faults is not necessary prior to resumption of power operation because, even if determined capable, these faults do not constitute a threat of ground displacement at the site and are not expected to be controlling in establishing the Safe Shutdown Earthquake. Even so, the Order confirms PG&E°s commitment that the investigation of these faults will be completed in 1976.

We have evaluated the safety of continued power operation of the facility until July 2, 1976 and have found it to be acceptable. As discussed in the enclosed "Status of Geologic/Seismic Review - Humboldt Bay Nuclear Power Plant", we have determined that the probability of sustained ground motion exceeding a 0.25g acceleration is low during this period of time and the probability of surface displacement at the plant site is even lower.

The second element in considering the resistance of the plant to seismic loadings is the capability of the plant to withstand loadings and be safely shutdown. We have evaluated PG&E°s submittal of November 26, 1975, entitled "Humboldt Bay Power Plant Unit No. 3, Present Capability for 0.25g Earthquake" and have concluded that the capability exists for safe shutdown, in the event of an earthquake up to 0.25g, employing a single train of equipment which is seismically qualified to this amount of sustained ground motion. Furthermore, we have concluded that reliance on this single train of equipment for the interim period is acceptable due to the low probability of any significant seismic event during this short period. Seismic design upgrading of additional equipment is required prior to operation beyond July 2, 1976.

It should also be noted that equipment which has been analyzed using current methods is known to have substantial capabilities to withstand loads beyond those for which it has been qualified. That is, it is expected that the equipment will remain functional for earthquakes more severe than a 0.25g event. Therefore, the probability that an earthquake large enough to affect the performance of equipment required for safe shutdown of the facility is even lower than that of the OBE during the interim period.

In so far as the Order for Modification of License requires additional geologic/seismic investigations to address specific concerns at the Humboldt Bay site, your request is granted. However, those portions of your petition which request actions which are not included in the Order for Modification of License should be considered to be denied. As the geologic/seismic investigations required to be performed involve areas in which you have indicated concern, you will be kept informed of the results of these investigations and significant NRC decisions and actions with respect to our review of these investigations.

Sincerely,

Original signed by
Ben C. Rusche

Ben C. Rusche, Director
Office of Nuclear Reactor Regulation

Enclosures:
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2. Letter from PG&E dated 5/11/76 to NRC
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4. Letter from PG&E dated 11/26/75 to NRC

*SEE PREVIOUS YELLOW FOR CONCURRENCE

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6/ /76	6/ /76	6/ /76

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SURNAME ►	CNelson:rm	*	KRGoller	WRussell	EGCase	BCRusche
DATE ►	6/16/76	6/ /76	6/16/76	6/ /76	6/16/76	6/16/76

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ENCLOSURE 1

STATUS OF GEOLOGY/SEISMOLOGY REVIEW
HUMBOLDT BAY NUCLEAR POWER PLANT
DOCKET NO. 50-133

Introduction

The Humboldt Bay facility was granted a provisional operating license on August 28, 1962. At the time of the full-term operating license application in January 1968, the Atomic Energy Commission Staff requested Pacific Gas and Electric Company (PG&E) to provide an updated seismic study of the Humboldt Bay site. Since that time, the geology and seismicity of the site have been under continuing reevaluation by the licensee and NRC and its consultants.

In the course of our review we, together with our U. S. Geological Survey advisors and with geologists from the California Bureau of Mines and Geology, have visited the site and met with the PG&E and its consultants. We have received written comments on the licensee's reports from the state geologists. In addition, we have met with Mr. Thomas Collins and other local geologists and have received written comments from Mr. Collins.

Discussion

Our review of PG&E's submittals prior to March 1973 concluded that PG&E had not adequately substantiated that the Little Salmon, the Bay Entrance, and the Table Bluff faults are tectonically inactive. We accepted PG&E's conclusion that two major faults, the Freshwater and Russ faults, are tectonically active, and we concluded that a major earthquake on either the Freshwater fault or the San Andreas fault could result in intensities as high as nine at the Humboldt Bay Plant site. As a result of that review, we concluded that an acceleration of 0.25g is representative of the ground motion likely to occur at the plant site during the operating life of the facility (the Operating Basis Earthquake - OBE) and that an acceleration of 0.5g is probably adequate for representing the maximum ground motion likely to affect the site (the Safe Shutdown Earthquake - SSE). This conclusion was, however, based on a premise that the faults near the plant site would be shown to be tectonically inactive. In 1973, additional geologic and seismic investigations were requested from PG&E to demonstrate the inactivity of faults near the plant site.

Evaluation

In response to NRC's request for additional geologic and seismic investigations, PG&E submitted two reports. The first report dated July, 1975 is entitled, "Geology of the Humboldt Bay Region." The conclusions set forth in this report are:

1. Regarding the activity of faults near the Humboldt Bay Power Plant site:

   a. The Little Salmon-Yager fault is not active or seismically capable. The latest movement along this fault antedated the deposition of the early Pleistocene Upper Carlotta Formation.

   b. The Bay Entrance fault and other small faults within a few miles of the plant site, including the Table Bluff, North Spit, and Ryan Creek faults, are probably inactive and not seismically capable.

   c. The Freshwater fault is not active. The latest movement along this fault antedated deposition of strata of the Pliocene or late Miocene undifferentiated Wildcat Formation.

2. Faults in the vicinity of the Mad River, especially the Falor and Korbel faults, show evidence of being seismically capable. One of these faults is probably the source of the magnitude 6.5 earthquake of December 21, 1954. Faults in the Mad River zone represent the closest source of relatively large earthquakes that could affect the plant site.

3. Faults in the Cape Mendocino-False Cape region are seismically capable. This region, and the southerly part of a seismically active zone in the offshore region, referred to as the continental slope zone, represent the most likely source areas of large earthquakes that could affect the plant site.

4. The Humboldt Bay Power Plant site is underlain by unfaulted Upper Carlotta Formation strata of early Pleistocene or Plio-Pleistocene age. The nearest fault to the site, the Bay Entrance fault, is about 2000 feet distant from the plant at its closest point of approach.

The second report dated December 1975 is entitled, "Ground Motion Analysis for the Humboldt Bay Nuclear Power Plant." This report states: "The objective of this study was to redetermine the Safe Shutdown Earthquake for the Humboldt Bay site, taking into account all seismological and geological information obtained subsequent to the original reports (Byerly, 1958, 1969). The new information available includes strong

motion data obtained at the plant from nearby earthquakes, results of extensive field geological investigations, and subsurface information on active seismic structures from a high-resolution microearthquake network." The report gives three peak accelerations at the plant site for the Safe Shutdown Earthquake based on three different sources as follows: an earthquake on the San Andreas fault, 55km distant, would generate 0.27g acceleration; the Mad River fault zone, 30km distant, would generate 0.36g acceleration; and the deep seismic zone, 25km deep, would produce 0.37g acceleration.

Based on these results, the report recommends that two different spectra be considered in the seismic analysis of the plant, one characteristic of a large, distant earthquake on the San Andreas-Mendocino fault system, and the other representing a short duration, higher acceleration event on the Mad River zone which, in the context of this report, includes the Falor and Korbel faults. Seismic events occurring in the deep seismic zone produce accelerations similar to those events occurring in the Mad River zone and are therefore not considered separately.

On August 24, 1975, we received a telegram from Mr. Thomas Collins citing what he considered to be anomalously high acceleration (0.35g) experienced at the Humboldt site as a result of the moderate sized (magnitude 5.5) earthquake which occurred on June 7, 1975 near Ferndale, California. He expressed concern that site conditions are very poor for seismic safety, and a major earthquake might produce accelerations two or three times greater than 0.35g at the site. Based on the above, he requested that we institute a proceeding to suspend or revoke the operating license. On January 7, 1976, Mr. Collins submitted a report entitled, "Seismic Hazards at the Humboldt Bay Nuclear Plant Site," in further support of his request that a proceeding to suspend or revoke the operating license of the Humboldt Bay Nuclear Plant be instituted. Mr. Collins' conclusions are:

1. The Humboldt Bay Nuclear Plant is located directly above an active fault zone. This seismically capable fault zone is a major tectonic structure extending northward from the Cape Mendocino area at depths between 15 to 40km. The plant site is situated in the potential epicentral area of earthquakes having magnitudes from 5 to 7.2 (and possibly greater).

2. The nuclear plant is also situated in the epicentral zone of an active fault which has very shallow hypocenters (10km or less). Epicenters from this active fault have been located less than two miles from the Humboldt plant. The epicenters can be associated with the Bay Entrance fault which has about 700 feet of vertical separation.

3. The 0.25g acceleration used for the original seismic design and the 0.40g acceleration currently used for the Safe Shutdown Earthquake at the Humboldt plant are inadequate and far from conservative. A realistic basis for the Safe Shutdown Earthquake would be a maximum acceleration in excess of 0.50g.

4. The plant site is subject to a substantial risk of surface faulting. The coastal zone in which the plant is situated is dissected by numerous and widespread late Quaternary faults. Several capable faults are less than one mile from the plant, and can produce surface ruptures at the plant.

5. The seismic hazards relating to the site and the design of the Humboldt plant create potentially hazardous conditions which are sufficient grounds to suspend or revoke the license to operate the plant. In addition, the high seismicity of the Humboldt Bay region, as well as the presence of several earthquakes between August 1974 and August 1975 which had epicentral distances within two miles of the Humboldt plant, provide sufficient ground for the Director of Regulation to find that the public safety requires the proposed action be temporarily effective pending further order.

We have completed our review of the reports on the geologic aspects of the Humboldt site submitted by PG&E in July and December 1975. In our review, we have also considered the concerns expressed by state geologists, Mr. Collins, and other local geologists. Our conclusions are as follows:

1. On the basis of available data, the Bay Entrance fault cannot be considered tectonically inactive as the July 1975 report (p. 13) suggests. This conclusion is based on the following observations.

   a. Figure 9 and Profile B-B in the December 1975 report show that the epicenters of three microearthquakes are located near the surface trace of the Bay Entrance fault. These events were recorded during the first year of high-resolution seismic monitoring in the site vicinity.

   b. The location of the Bay Entrance fault is defined offshore from the interpretation of seismic reflection records. One record shows a break in slope at the base of the Holocene sediments which is on the trend of the Bay Entrance fault and which could be interpreted as indicating late Quaternary movement.

c. The relationship, if any, of the Bay Entrance fault to the other faults in the region, which may be tectonically active, has not been clearly defined.

2. The inactivity of the Little Salmon fault has not been adequately demonstrated. We find that ambiguities exist in the data regarding the date of most recent movement on the fault and the location of the buried trace of the fault. The Upper Carlotta Formation is used to date the most recent movement on the fault. The age of the Upper Carlotta Formation is based primarily on foraminiferal assemblages identified in core samples. As these samples are few in number and have yielded only a relatively few diagnostic individuals, we do not consider the Plio-Pleistocene age for the Upper Carlotta to be adequately substantiated for use as evidence to establish the antiquity of the Little Salmon fault. Additionally, we do not believe that the existence and configuration of the erosion surface at the base of the Upper Carlotta has been clearly enough demonstrated to use in defining the limit (buried trace) of the Little Salmon fault. If it can be shown, however, that the Little Salmon fault is truncated by an unconformity and that the overlying Upper Carlotta formation is of Plio-Pleistocene age, then the fault will have been demonstrated to be noncapable within the meaning of Appendix A to 10 CFR Part 100.

3. While it is recognized that landsliding and slumping are widespread in the site vicinity, sufficient evidence has not been presented to demonstrate that the displacements observed in the ravine in Humboldt Hill and the quarry at Fields Landing are due to such mechanisms and are not due to tectonic activity.

4. Adequate evidence has not been provided to show that the Freshwater fault is inactive. Prior to the July 1975 report, the Freshwater fault had been characterized as an active fault on the basis of an associated earthquake (an event which occurred on December 21, 1954) and the displacement of young sediments (Quaternary sediments of the Hookton formation are juxtaposed against Franciscan rocks of Jurassic age). The July 1975 report points out that the 1954 event has been relocated (Bolt and Miller, 1975) and is now believed to have occurred on a fault strand of the Falor-Korbel system. The apparent displacement of the Hookton formation is attributed to movement on a fault (the Bayside Cutoff fault) which is distinct from the Freshwater fault. At present, we consider that inherent

inadequacies in the original instrumental data do not permit a location of the 1954 event which is sufficiently precise to preclude its association with the Freshwater fault. We also do not consider that sufficient evidence has been developed to disassociate the Bayside Cutoff fault from the Freshwater fault. The data presented to date have not resolved the structural relationship of the Freshwater fault with the Mad River system.

5. The presence of small stratigraphic displacements observed on the north side of Table Bluff casts some doubt on the antiquity of movement on the Table Bluff fault. The implications of these features cannot be assessed without additional information regarding the location and upward extent of the Table Bluff fault.

6. The December 1975 report ("Ground Motion Analysis for the Humboldt Bay Nuclear Power Plant") did not contain sufficient information for us to complete our review of the Safe Shutdown Earthquake (SSE) design acceleration. We cannot yet conduct an in depth review of the SSE in view of the additional geologic and seismologic studies which will be required.

Outstanding Geologic and Seismic Concerns

Several geological and seismological concerns remain to be resolved in order to complete our reevaluation of the Humboldt Bay site geology and seismicity. The concerns, stated in detail below, incorporate those of the state geologists, Mr. Collins and other local geologists and those of our advisor, the U. S. Geological Survey. They are: (1) resolution of the location and determination of capability of the Bay Entrance and Little Salmon faults according to Section III(g) of Appendix A to 10 CFR Part 100; (2) the tectonic activity of the Freshwater and Table Bluff faults; (3) the origin of the offsets in the ravine in Humboldt Hill and the quarry at Fields Landing; and (4) the distribution of earthquakes in the region and their relationship to faulting.

The resolution of these concerns will, in our view, require the following additional work:

1. The Bay Entrance fault system must be accurately located at its closest approach to the plant site. The attitude, extent, amount of displacement, and age of most recent movements on this fault must be determined. If this fault cannot be shown to be noncapable within the meaning of Appendix A, Section IIIg(1), it must be demonstrated that movement on it cannot be expected to cause surface displacement within the plant area.

2. The location and age of the Little Salmon fault must be clearly defined. In order to show the attitude of the fault plane, it must be observed at a sufficient number of points to accurately determine its geometry. Its location, with respect to the plant site, must be determined and assurance that it is capped by a datable stratigraphic unit must be provided. The existence and configuration of the erosion surface at the base of the Upper Carlotta formation, which is interpreted to truncate the fault, must be thoroughly demonstrated. An upper limit for the age of last movement on the fault must be established by reliable dating techniques sufficient to demonstrate that the fault is noncapable.

3. Definitive evidence must be provided to show that the displacement in the ravine at Humboldt Hill and the quarry at Fields Landing are not of tectonic origin.

4. The Freshwater and Table Bluff faults must be investigated in sufficient detail to determine their seismic potential and relationship to the regional tectonic framework. If these faults cannot be shown to be noncapable within the meaning of Appendix A, Section IIIg, their structural relationship to the Little Salmon-Yager fault must be determined in order to demonstrate that movement on the Freshwater or Table Bluff faults could not be reasonably expected to be accompanied by movement on the Little Salmon-Yager fault (Appenidx A, Section IIIg(3)).

5. The seismic monitoring network must be reinstated. One station of the reinstated seismic network must be located as close as possible to the Humboldt Plant and still maintain a background noise level similar to that of other stations in the network. The preferred location would be within two miles of the plant, i. e., a site between the plant and Buhne Point. Deeper than normal burial should be considered as a possible means of reducing background noise. The purpose of this instrument is to resolve whether poorly recorded events are occurring close to be plant.

6. All earthquakes from past and future monitoring must be listed, regardless of size, whose P-S intervals indicate possible location on the Bay Entrance or other faults in the vicinity of the plant. If an event can be shown not to have occurred in the vicinity of the plant site (e.g., intersection of three P-S circles is distant from the site) so indicate and provide the alternative epicenters including an error estimate.

We consider Items 1, 2, and 3 above to be of immediate safety significance to the Humboldt Bay Unit 3 and must be satisfied prior to resumption of power operation following the 1976 refueling outage.

The results of the licensees' investigations for Item 4 will be submitted by the end of 1976, but not necessarily be completed or found acceptable prior to resumption of power operation. Implementation of the requirements listed under Items 5 and 6 should be required prior to resumption of operation.

PG&E has committed to address each of our geologic and seismic concerns and has presented the program with which they propose to pursue these concerns in a May 11, 1976, letter describing the objectives and details of the program. Commission approval with respect to the satisfactory completion of the geologic and seismic investigation program will be required prior to power operation following a planned refueling outage beginning July 2, 1976. We have reviewed PG&E's submittal dated May 11, 1976, and have concluded that the commitments made adequately address the action necessary for resolution of the geologic and seismic concerns and can be expected to be accomplished in a timely manner.

Discussion of Accelerations Recorded at the Plant Site During the June 7, 1975 Earthquake

An acceleration of 0.36g was recorded at the Humboldt Nuclear Power Plant on June 7, 1975 from a magnitude 5.5 earthquake about 20km distant. This acceleration is about twice that predicted for hard rock (Schnable and Seed, 1973) or for average site conditions (Cloud & Perez 1970; Housner 1965; Hofmann 1974). The 0.36g peak was recorded in a storage shed near Unit 3. Loose objects in the shed were not displaced from shelves or otherwise disturbed.

Earthquakes of short durations even at high peak accelerations contain relatively little energy. Such shaking does not subject structures or components which have modest damping ratios, such as those typical of nuclear power plants, to dynamic forces in proportion to observed high peak accelerations. The duration of shaking at the Humboldt site from the June 7, 1975 earthquake was between two and three seconds. The 0.36g peak acceleration was caused by a single displacement pulse of about .5 second period. Such short durations of shaking are typical of earthquakes in the magnitude 5 range (Gutenberg and Richter, 1956).

Generally, undamped or slightly damped response spectra reach high values even when shaking is of very short duration. Response spectra for higher damping values, which are typical for nuclear power plant components, require longer durations of shaking to reach high values. Thus, observed accelerations at the plant site during the June 7, 1975 event should not be used to anchor response spectra with amplification factors typical of those used to design structures; such large structures do not respond to low energy, short duration peaks in the accelerogram.

Acceleration on the surface of relatively soft sedimentary columns, such as that at the Humboldt Nuclear Power Plant site, can be anomalously high with respect to acceleration on hard rock or average foundation conditions when shaken by relatively small earthquakes. Foundation material at the site is primarily composed of slightly cemented dense sand interbedded with clay. These materials are harder and have greater resistance to loss of shear strength than the more recently deposited sands in the general vicinity, but are still relatively "soft" foundation materials. Soft sedimentary layers have been shown to amplify horizontally polarized shear waves. This has been shown, for example, in studies with portable sensitive seismographs such as reported in California Department of Water Resources Bulletin 116-4, 1968. Soft material may also act to reduce accelerations when ground motions reach levels where intergranular movement occurs and energy is absorbed by the internal friction of the soil (Seed and Idriss 1969; and Seed, Idriss and Kiefer 1969). The excitation of the foundation material at the Humboldt site by the magnitude 5.5 earthquake of June 7, 1975 was apparently low enough that foundation material behavior was primarily elastic. Because the foundation material is relatively soft, amplification of motion would be expected and was observed in the near surface layers. Under such circumstances, a lower acceleration should occur at depth. This occurred during the 1975 earthquake as demonstrated by the acceleration of 0.12g which was observed at -66 feet, less than one-half of that observed at the surface. Earthquakes like that of June 7, 1975, are typical of those occurring in the Humboldt Bay area and are accommodated by "anchoring" seismic design spectra at the recommended OBE level (0.25g). Larger earthquakes would be expected to produce inelastic behavior in the deep sedimentary sequence below the plant and reduce rather than amplify acceleration levels predicted by standard curves. Thus, a larger earthquake would not be expected to cause a correspondingly higher peak acceleration at the plant site.

Justification for Continuing Plant Operation to July 2, 1976

While we find that Mr. Collins' concerns are generally consistent with those of the staff, it is clear that, based on present information, reasonable alternate interpretations can be put forth concerning those aspects of the geology and seismicity of the site which could affect

plant safety. In any event, we believe that the required investigations, outlined above, will resolve the questions which have led to these concerns in a final and timely manner.

In considering the basis upon which to assess the overall safety of the plant operation during the interim period to July 2, 1976, a judgment was made with respect to the probability that the plant may be subjected to earthquakes exceeding the OBE during the time interval. General studies of earthquake recurrence in the Humboldt Bay region indicate that the probability of earthquake induced ground motion exceeding that for a 0.25g acceleration for seismic design, the OBE is acceptably low (on the order of 10^{-4}) in the short time period before July 2, 1976.

Because of the proximity to the site of the Bay Entrance and Little Salmon faults, we have considered the possibility of surface movement on these faults. Seismic activity in the site region is predominantly at depths greater than about 18km. We, therefore, consider the probability of surface movement on any fault in the region to be considerably lower than that of the OBE itself and the risk of movement on those segments of the Bay Entrance and Little Salmon faults near the plant site is still lower, even if these faults were found to be capable. Therefore, with respect to the potential for fault movement at the plant site, we consider the probability of movement during the short interval of time between now and shutdown on July 2 to be acceptable.

Dated: JUN. 16 1976

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