U. S. ATOMIC ENERGY COMMISSION
REGION V
DIVISION OF COMPLIANCE

By: G. S. Spencer, Reactor Inspector
Region V, Division of Compliance

October 29, 1963

Title: PACIFIC GAS & ELECTRIC COMPANY (BODEGA BAY)
DOCKET NO. 50-205

SUMMARY

The proposed site of the Pacific Gas and Electric Company's Bodega Bay Reactor, Bodega, California, was visited on October 7, 1963. Three representatives of the U. S. Coast and Geodetic Survey, San Francisco, California accompanied the AEC inspectors on the visit. Since the U. S. Geological Survey geologists who have been making a detailed study of the site were not present during the visit, a later visit was made to their offices in Menlo Park, California on October 22, 1963 to discuss the current status of their studies.

Excavation to the -73 ft. elevation was completed by October 16. A final determination regarding the nature, probable origin, and significance of the fault observed in the reactor excavation, will not be made by the U.S.G.S. geologists until they have completed mapping the contours of the bedrock surface.

The U.S.G.S. final report on the geological investigation of the site will not be submitted to Washington D.C. until late November or early December.

The granitic rock found at the bottom depths of the reactor excavation is not competent, according to the U. S. geologists. The Dames & Moore compression tests of the rock taken from borings at -35 to -65 ft. elevations showed "ultimate compressive strengths" ranging from 1000 - 4000 psi. In contrast to this, references in other geology literature list typical granitic foundation rock as ranging from 10,000 - 40,000 psi.

The U.S.G.S. appears to have available at its Menlo Park facility, considerable resources in trained manpower and equipment for the study and evaluation of the data and samples obtained during their examination of the Bodega site. Techniques being utilized in the study include: X-ray diffraction studies, microscopic studies of granitic bedrock samples including the use of oil immersion techniques, differential staining techniques for studies of bedrock samples and statistical analyses of the

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Summary (continued)

distribution and orientation of the observed faults for determination of the nature of the stresses.

DETAILS

I. Scope of Visit

On October 7, 1963 G. S. Spencer and R. H. Engelken, Region V, Division of Compliance, accompanied Messrs. W. K. Cloud, C. F. Knudson, and V. A. Moore of the U. S. Coast and Geodetic Survey, San Francisco, California, on a visit to the proposed site of the Pacific Gas and Electric Company's Bodega Bay Reactor, Bodega Bay, California. The visit included:

1. A briefing by Don Tocher, PG&E's seismology consultant, summarizing the geological studies and findings made to date at the site.

2. A tour of the entire site to acquaint the U. S. Coast & Geodetic Survey representatives with the overall project layout.

3. Observation of the fault tracing exposed in the walls and along the floor of the proposed reactor building excavation, including examination of an apparently related fault indication in the sediments outside of the excavation at the +5 to +25 foot elevation.

Principal contacts during the visit were:

W. K. Cloud - Geophysicist, U. S. Coast & Geodetic Survey
C. F. Knudson - Geologist, " " " " "
V. A. Moore - Geologist, " " " " "
D. Tocher - Seismologist, Consultant to PG&E
E. Marliove - Geological Engineer, Consultant to PG&E
F. Lee - Geologist, U. S. Geological Survey, Denver, Colorado
F. Mautz - Project Engineer, PG&E

Since Messrs. Schlocker and Bonilla, the U.S.G.S. geologists who have been making a detailed study of the excavated areas of the site, were not present on the day of the visit, a later visit was made to their offices in Menlo Park, California, on October 22, 1963 for the purpose of discussing their findings.

II. Results of Visit

A. Status of Site Preparation

The floor of the reactor building excavation had progressed down

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Results of Visit (continued)

to the -61 foot elevation, with the I-beam ring girder and gunite shoring installation completed down to the -59 foot elevation. According to Mr. Mautz, the schedule called for the excavation to be completed (-73 ft. elev.) by the 18th of October. All on-site construction activities which had taken place up to the date of the visit appeared to be in accord with: (1) the letter from N. R. Sutherland to Robert Lowenstein, dated June 27, 1963, setting forth PG&E's plans for preparation of the proposed reactor excavation and requesting confirmation of PG&E's views concerning the application of the Commission's regulation 10 CFR 50.10, to such work, (2) the letter of reply from the General Counsel dated July 23, 1963; and (3) the conditions set forth in Section 50.10(b) of 10 CFR Part 50.

B. Status of Fault Tracing

As reported previously in our TWX dated September 16, 1963, a fault indication was discovered in the (proposed) reactor building excavation on September 12, 1963 by Schlocker and Tocher. In our subsequent TWX's dated September 28 and October 2, 1963, it was reported that the fault had been traced from the -11 ft. elevation in the southwest quadrant of the hole, down into and across the bedrock floor in a southwest to northeast direction, then vertically in the opposite wall at a point slightly south of due east where it was lost within 3 feet from the top of the bedrock at elevation -21 feet.

During the visit covered by this report, it was noted that PG&E was attempting to determine the age of the fault in the reactor excavation by searching for an extension of the fault in the younger upper level sediments located outside of the reactor excavation. Later discussions with Schlocker and Bonilla on October 22, 1963 established that a fault indication had been picked up just outside of the excavation and traced for a distance of 165 feet in a southwesterly direction where it was lost at the +55 foot elevation. However, the relationship between this long fault trace observed in the upper level sediments and the fault trace found in the reactor excavation has not been established as yet, according to Schlocker, due to their echeloned orientation relative to one another (i.e., the trace end of one is parallel to and staggered relative to the trace beginning of the other). Schlocker explained that "echelon folding" of sediments overlying rock formations sometimes occurs as a result of horizontal displacement of the rock, and could be the explanation for this particular fault pattern.

III. Results of Visit to U.S.G.S., Menlo Park

Since Messrs. Schlocker and Bonilla, the U.S.G.S. geologists who have been making a detailed study of the excavated areas of the site, were not present at the site on the day of the visit (October 7), a later

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Results of Visit to U.S.G.S., Menlo Park (continued)

visit was made to their offices in Menlo Park, California on October 22, 1963 to discuss the current status of their studies. The following pertinent information was obtained:

1. Excavation to the -73 ft. elevation was completed by October 16. Schlocker stated that a final determination regarding the nature, probable origin, and significance of the fault observed in the reactor excavation will not be made until contour mapping of the bedrock surface is completed.

2. The U.S.G.S. final report on the geological investigation of the site will not be submitted to Washington, D. C. until late November or early December, according to Schlocker. He also mentioned that the report from PG&E's seismology consultant, Mr. Don Tocher, was not yet available.

3. Mr. Bonilla stated that he and Schlocker were surprised to find that the quartz diorite granite rock found at the bottom depths of the excavation was not competent. The excavating contractor apparently was surprised at this too, according to Bonilla, and had not anticipated a need for shoring the bottom (bedrock) levels with I-beam ring girders. However, the rock proved to be so deteriorated and sand-like, that shoring was required. Schlocker stated that this indicated the rock has been subjected to tremendous stresses in the past.

   The Dames and Moore compression tests of the rock taken from borings at levels of -35 feet to -65 feet elevations, showed ultimate compressive strengths ranging from 1,000 - 4,000 psi, as shown below:

   a. Boring No. 14
   (rock encountered at -40 ft. elev.)

Ultimate Compression Strengths	Level of Sample
2108 psi	-40 ft. elev.
1861 psi	-62 ft. elev.
2448 psi	-65 ft. elev.

   b. Boring No. 16 (Center of reactor hole)
   (rock encountered at -28 ft. elev.)

Ultimate Compression Strengths	Level of Sample
1037 psi	-35 ft. elev.
3673 psi	-41 ft. elev.
3953 psi	-43 ft. elev.

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Results of Visit to U.S.G.S., Menlo Park (continued)

In contrast to this, the inspectors were shown data in other geology literature which indicated compressive strengths for typical granitic foundation rock as ranging from 10,000 - 40,000 psi. For example, the American Geological Institute, Data Sheet 24, listed the following values:

	Avg. Compression Strength
Granite - slightly altered -	9400 psi
Granite - " " -	10,460 psi
Granite - medium grain -	21,580 psi

Another reference indicated that the average compressive strength of three specimens of typical foundation quartz diorite taken from the Garden Valley dam site, Mountain Home, Idaho, was 12,670 psi. The samples were described as coarse grained, massive and very slightly fractured. Other references, such as Physical Properties of Mine Rock, dated March 1949 (R.I. 4459) show compressive strengths of up to 35,000 and 40,000 psi for granite.

4. In the course of touring the laboratory facilities of the U.S.G.S. at Menlo Park, it became readily apparent to the inspectors that Schlocker and Bonilla appear to have available to them considerable resources in trained manpower and equipment for the study and evaluation of the extensive data and mineral samples obtained during their examination of the Bodega site. It was noted that techniques being utilized in this study included the following:

   a. X-ray diffraction studies.

   b. Microscopic studies of thin sections ($\sim$ 30 microns) of granitic bedrock samples, including the use of oil immersion techniques.

   c. Differential staining techniques for mineral analysis of sawed pieces of bedrock samples.

   d. Statistical analyses of the distribution and orientation of all faults observed and mapped in the reactor excavation, for determination of the nature of the stresses.

   The inspectors viewed several slides under the microscope which contained specimens of granitic rock taken from the Bodega site excavation and other regions for comparison purposes. As pointed out by Schlocker, the fracturing of the Bodega rock was so extensive that it could even be discerned in the individual crystals of the quartz material in the rock.

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