FRANK NEUMANN
4546 FORTY-FIFTH AVENUE N.E.
SEATTLE, WASH., 98105

50-205
(Suppl. Only)

February 7, 1964. L&R File Copy

Mr. Robert Lowenstein, Director,
Division of Licensing and Regulation,
U. S. Atomic Energy Commission,
Washington 25, D. C.

Dear Mr. Lowenstein:

Thank you for your letter of January 24, 1964 forwarding me a copy of Amendment No. 5 filed by the Pacific Gas and Electric Company. (Your file 50-205). After more delay than I expected, due to local activities, I am enclosing several pages of comments on those items which concern seismology.

Mr. Robert Bryan has informed me of the conference to be held in Washington next week and I am looking forward to seeing you then.

Sincerely yours,

Frank Neumann

Frank Neumann.

Enclosure: Comments on Pacific Gas and Electric Company's Amendment No. 5.

50-205

COMMENTS ON PACIFIC GAS AND ELECTRIC COMPANY'S AMMENDMENT NO. 5

(Containing statements by Tocher and Marliave, Hugo Benioff and Wm.Quaide)

By F. Neumann

Geologic and Seismic Investigation of the Site for a Nuclear Power Plant on Bodega Head, Calif. (By Don Tocher and E. C. Marliave.)

Page 5. It is stated that exposed rock on Point Reyes Peninsula is similar in character to that on Bodega Head. It is also a fact that the auxiliary fault movement on the peninsula in 1906 was very close to the epicenter of that shock. With these two facts in mind one may assume that if a shock of 1906 intensity originated near Bodega Head auxiliary faults adjacent to the principal fault might also be expected to slip including that found by Schlocker and Bonilla in the P.G.&E. pit (TEI-844). In other words there is strong support for the idea that auxiliary faults may slip where the fault movements and vibrational intensity are the greates, namely, in epicentral areas.

Pp. 12-13. Tocher states categorically the "it is possible to create a suitable and safe design". The writer does not believe that earthquake engineering has developed to the point where such a matter-of-fact statement can be made. Practicing engineers would not doubt be the first to admit that there are many shortcomings in the art and that in the final analysi the effectiveness of earthquake resistant design is largely a matter of good judgment on the part of the design engineer. Until buildings designed to resist strong earthquake forces are actually subjected to forces as severe as those of 1906 there will be no proof that the earthquake engineer has really mastered his art or even that it is economically feasible to design standard type structures that will successfully withstand a very violent earthquake.

P. 14. It is stated that the MM intensity scale is misleading for large shocks; ground phenomena -- faulting, fissuring, etc. -- indicate one intensity while building damage in the same area indicates an entirely different intensity. This is a partially legitimate criticism. The writer has never felt that non-vibrational phenomena occurring in the ground are an adequate measure of vibrational intensity, and that is what is really meant by intensity -- the degree of violence of the shaking. Slipping along a fault, or fissuring due to slumping are not practical measures of vibrational intensity and the scale must be interpreted in that light even though in its present state of development no distinction is speciafically made. The fact that intensity as measured by building damage my vary greatly over long stretches of active faulting is quite well known (many photographs are available to illustrate the point) but this fact still needs to be recognized in the scale. Mr. Wood in developing this scale made a notable contribution to engineering seismology and would (if he were alive) be the last to claim perfection in its present form.

Even in its present form the writer has found the scale eminently useful for both engineering and purely seismological studies. The consistency of results obtained are proof of this. The writer's recent chart, for example.

showing the relationship between intensity and magnitude is proof that intensity is quite as valuable and accurate as a measure of this form of earthquake energy as earthquake magnitude numbers which many seismologists (especially Californians) are quite ready to accept for no other apparent reason than that it is based on a more sophisticated type of data, namely, teleseismic records. Magnitude, of course, is a measure of the total energy released at the focus of a shock but the magnitude formula is still in a state of development the same as the MM intensity scale.

The writer has grown weary of the claims made by critics of the MM intensity scale that the data (largely post-card questionnaires)are of questionable value because of their subjective nature and because they involve no real measurements. To counter this claim the writer argues that any person of average intelligence who has a reasonable knowledge of what is going on about him can supply information that will enable the seismologist to determine whether a particular disturbance suggests 2, 4 or 8 times the ground motion suggested by some weaker disturbance. This is the situation when the seismologist evaluates descriptive reports involving four successive grades of intensity. If one disturbance involves double the ground motion, or half the ground motion of some arbitrary disturbance the writer believes that the average layman is capable of sensing this difference through what his community feels and sees. The writer feels that his researches over many years have proved this point. No critic has yet published any material that would invalidate the writer's findings other than expressing broad opinions on seismic phenomena that they have obviously made no serious effort to understand.

Tocher cites the response spectrum technique as the best quide line for intensity. Having suggested the first feasible method (the torsion pendulum) for determining oscillator response spectra the writer is quite familiar with their value to earthquake engineers. For a multitude of reasons that are evident in the writer's various memoranda to the A.C.E. the response spectrum will never serve as a substitute for MM intensity if for no other reason than an oscillator response spectrum may cost hundreds or even thousands of dollars while intensity data are obtained at virtually no cost whatever.

In summary the writer does not attach too much weight to Tocher's opinions in the field of engineering seismology because he has been a spectator rather than a worker in this field.

P. 34. Tocher's assurances that future faulting along the San Andreas will be confined to the present 1-mile width (near Bodega Head) is pure speculation. We know so little about stress patterns in the deeper rocks that no one can predict with certainty whether the next big slip will lie within or without the present zone of fracturing. What investigators <u>think</u> about such matters and what they <u>know</u> about them are two entirely different things.

MOVEMENTS AND SEISMIC DESTRUCTIVENESS ASSOCIATED WITH THE SAN ANDREAS FAULT. (By Hugo Benioff)

Pages 1-3. In describing the mechanism of earthquake faulting Benioff places no emphasis on his fault lock theory presumably because it conflicts with Housner's "planar energy source" concept. Nevertheless, in item 4 of his conclusions he states (with reference to the one mile width of the zone of faulting): "This wandering of the break has occurred --- as a result of departures from linearity of segments of the fault --". This brings him back not only to the fault lock concept but he uses this concept to explain the 1 mile width of the zone of fracturing.

P. 3. In stressing the presence of only small oscillatory motions in the immediate vicinity of a fault Benioff leans heavily on theory with little if any supporting evidence from observational facts. An extremely few close-up blast-like records might support his view but it otherwise has little support from either instrumental records or field observations. Low intensities along faults can always be found at great distances from an epicenter but in immediate epicentral areas the intensity reaches a maximum. He states in effect that at 2 to 12 miles from the break the intensity is constant. The writer has found (as shown in graphs furnished the A.E.C.) that intensity in basement rock is generally a maximum out to a three mile limit where it decreases exponentially with increasing distance. The Benioff concept as outlined in Amendment No. 5 calls for supporting evidence. This, however, along with the time it takes for a fault to rupture do not seem vitally pertinent to the problem in hand because no one knows just where the next big shock will originate in this area.

When Benioff on p. 4 quotes Housner as obtaining .3 g on rock and .5g on firm alluvium in the 1940 Imperial Valley earthquake he differs but little from the writer's values if reference is made to the epicenter of the shock rather than the seismograph station site in El Centro.

Benioff apparently does not take into consideration the complications that can be introduced by multiple lock breaks. That such phenomena are quite common is strongly supported by both instrumental and noninstrumental evidence; it is quite simple to locate an initial break from teleseismic data, while a second and generally greater break (or secondary epicenter) is indicated by the concentration of higher intensities at some other point. The Long Beach earthquake of 1933 was a notable example.

P. 4. Benioff attributes the fault traversing the reactor pit to a slip along the San Andreas zone of fracture. As might be inferred from the previous discussion of the Point Reyes peninsula slip in 1906 it is very probable that when the pit fracture did occur the epicenter was quite close to Bodega Head.

P. 5. Benioff states that inactive auxiliary faults will not suddenly exhibit significant movements during a slip on the principal fault. How is he sure that this did not happen on the Point Reyes Peninsula in 1906? Does anyone know definitely whether this auxiliary fault was previously active or inactive?

P. 5. By way of explaining structural response to complex earthquake motion Benioff goes to considerable length to explain that resonance is a primary factor in damage. This is basically what response spectra show if resonance is indicated by the ground and oscillator periods. He stresses duration as one of the controlling factors in damage and to this extent agrees with the writer that duration is also a factor which governs intensity.

P. 8, item 6. Regardless of the reasoning behind it single maximum acceleration factors are still a significant part of current building codes and will probably continue to serve as equivalent static accelerations for a long time to come. The writer has discussed this in certain A.E.C. memoranda and believes that such acceleration factors serve a useful purpose when properly interpreted, that is, when eveluated in the light of theoretical spectral accelerations.

P. 5. The writer does not believe, as previously stated, that the use of MM intensity scales in engineering design constitutes unsound practice. The reasons for this are evident in various memoranda furnished the A.E.C. and especially in a summary statement forwarded in November, 1963. Benioff may be justified in stating that the equation he quotes, for acceleration, represents pure nonsense. It yields only an average value whereas the true relationship between intensity and acceleration is quite complicated. The writer believes that in breaking down earthquakes into four broad types (as shown in various A.E.C. memoranda) he has corrected the major deficiency inherent in the equation quoted.

P. 9, item d. Whether or not a structure can be built in the P.G. and E. Co. pit that will suffer no significant damage is primarily an engineering problem. Like Tocher and the writer Benioff is primarily a seismologist.

Papers by Tocher and Quaide. The last two papers in Amendment No. 5 by these authors are primarily of geological interest and do not concern seismology except where one of them attaches special significance to the fact that no epicenters have ever been found on Bodega Head. The only way to be certain that no earthquakes, including those too small to be felt, are occurring or have occurred there is to operate a sensitive seismograph right on the Head. Up to 1930 no really systematic program to keep a record of shocks strong enough to be felt had been established. Instrumental control over the area has been quite inadequate except over the last two or three decades, and even if adequate control had been maintained over the past 100 years a history of quiescense would not be a guarantee of future immunity in an area as active as this. Judging by the number of strong-motion earthquake records obtained since 1932 the northern California area is less active than southern California yet the greatest known California earthquake centered in the northern part.

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Seattle, Washing. 98105

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TO: Lowenstein

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