E. G. Case, Assistant Director
for Facilities Licensing

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'Original Signed by:
Robert H. Bryan

Robert H. Bryan, Chief
Research & Power Reactor Safety Branch
Division of Licensing & Regulation
COMMENTS ON BODEGA APPLICATION, DOCKET NO. 50-205

In the various discussions of the earthquake design criteria for Bodega with our consultants, it has been clear from the very beginning that our consultants had no major reservations with respect to the requirements for the design of structures (in which instances stress levels, deflections, or permanent set would be the limiting factors). This was the case even though Mr. Neumann and Dr. Newmark had both indicated that an earthquake of the order of intensity of the San Francisco 1906 Quake, if it occurred in the vicinity of Bodega, would result in ground motions having maximum acceleration in the neighborhood of 2/3g in rock (compared to PG&E's estimate of 1/3g).

At the moment, it appears that even though PG&E's proposed criteria in Amendment 4 are vague they will be resolved to the satisfaction of our consultants insofar as structural integrity is concerned. From Dr. Newmark's draft report and his oral remarks, it is clear that this is so because he believes that structures designed by these criteria will, by virtue of the conservatism of the design method, have substantial reserve strength with a 2/3g earthquake.

It is obvious to me that similar expert attention has not been given to those problems of design in which stress, deflection, etc. are not the limiting factors of concern. It is obvious also that PG&E's vague proposal (in Amendment 4) to design certain "critical equipment and systems" so as to "be capable of bringing the unit to a safe shut down" in event of a 2/3g earthquake doesn't provide, in itself, any expressed or implied conservatism comparable to the conservatism that one is assured to have in structures. In other words, there is no margin for misjudgment or error in estimating the ground motion of earthquakes, in designing to provide the desirable functions in the event of that earthquake, or to account for deficiencies in fabrication and installation of components whose operation may be adversely affected by the inertial effects of earthquake motion.

As I understand PG&E's proposal, they will assure that the plant will be capable of being brought to a safe shut down in earthquakes resulting in accelerations up to, but not in excess of 2/3g. Assuming that "bringing the unit to a safe shut down" is intended to include satisfactory emergency action which might be required in the event of any credible accident, one must then examine critically the conservatism or reliability of our collective past estimates of expected earthquake intensity at this site. At least three persons who are considered to be experts on this question have expressed judgments on this point in the past:

1. Mr. Neumann estimates from examination of seismological records that basement rock motion at Bodega from a 1906 type earthquake in the vicinity of the site would involve ground accelerations in the range of .6 to 1.0g.

2. Dr. Newmark, from his own experience, has stated that the intensity of the expected maximum motion, in terms of accelerations and velocities, may be taken as about twice that of the north-south component of motion recorded in the El Centro earthquake.

3. Dr. Hausner in the meeting at ANL July 2, 1963 commented on the basis of his recommendation that in addition to elastic design being based upon an "average El Centro spectrum" with maximum acceleration in the neighborhood of 1/5 to 1/4g, a further analysis should be made to insure that ground motion five times as intense as this design spectrum would be required to produce incipient failure of structures. (This criterion was proposed in Amendment 3.) Dr. Hausner stated that it was the intent of this requirement that the specified structures be analyzed with accelerations, velocities, etc. five times the design values (i.e. accelerations of 1 to 1½g). He stated and reiterated that his objective in proposing this criterion was to make it extremely unlikely that structural members would fall on and impair the performance of equipment and systems which are essential to nuclear safety. He stated further that he considered the factor of 5 to be reasonable from an engineering viewpoint to take into account (a) uncertainties in estimating the intensities of motion of earthquakes; (b) lack of precision or misjudgment in making the structural design; (c) imperfections in materials and (d) errors in construction.

It seems to me that if Dr. Hausner is so concerned about checking structures at 1 to 1½g to assure that they don't fail on and prevent some safety action, we should be interested in seeing that safety-essential components are designed and constructed so as to be operable in the event of ground motions at least that intense. It does not seem to make any sense at all to think of protecting an essential piece of equipment (as Dr. Hausner recommended) far beyond the point at which it has already failed.

Dr. Hausner indicated that he did not attempt to advise PG&E except with respect to structural design matters. Our consultants, likewise, appear to have given too little consideration to problems that are not related to structural design. I believe it imperative that we obtain expert advice on the particular subject of the ultimate design criteria for components in which structural behavior (stress levels, deflection, etc.) may not be the limiting factor. I believe also that we must have a much greater understanding of the methods by which conservative component design can be achieved. We should have advice, for instance, on the application of existing military or industrial specifications on shock resistant components and on the need for special shock testing methods for components to which such specifications do not apply.

The following are a few examples of equipment and components which will be used in the Bodega Power Plant whose performance may be affected by the inertial effects of earthquakes:

1. Check valves which are depended upon as isolation valves.

2. Pressure regulating valves and other pressure or shock sensitive devices in control and instrumentation systems.

3. Control rod drives.

4. The suppression pool. Sloshing of water in the suppression pool would diminish the head of water above some of the pipes from the dry well. This would tend to short circuit the flow of steam from the dry well.

cc: R. L. Lowenstein
F. N. Watson
R. H. Bryan

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