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TRIP REPORT

21-22 MARCH 1985 MEETING

ACRS SUBCOMMITTEES

ON

EXTREME EXTERNAL PHENOMENA AND DIABLO CANYON

LOS ANGLES, CA

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1. INTRODUCTION

Two major topic areas were discussed at the ACRS subcommitte meeting:

(1) NRC Seismic Margins Program (SMP)

(2) Long Term Seismic Program (LTSP) of the Diablo Canyon Power Plant (DCPP)

Presentations were made by the NRC Staff, Consultants to the NRC, PG&E Staff, and Consultants to PG&E.

Listed below are some of my comments relevant to these two topic areas.

2.0 DISCUSSION

2.1 ELECTRICAL RELAYS

There is concern about the response and operation of electrical relays during a seismic event. A fragility test program is planned. This test program is very important to insure plant safety.

The US Navy has developed significant experience on the response of circuit breakers and the behavior of other electrical equipment to high impact shock loads. It is recommended that the NRC Staff make use of this experience in their evaluation of electrical components for nuclear power plants.

2.2 CAST/BRITTLE MATERIALS

Materials with low ductility respond poorly to dynamic loads. Specifically, Gray and White Cast Irons, Cast Aluminums, Fiber Glass Epoxy Composites and Ceramics historically have failed when subjected to vibration or shock loads. This statement does not mean that every component with a part fabricated from one of these materials will fail. However failure of one of these components is much more likely than those fabricated from ductile materials. For example, the only failure in a fossile fuel power plant (not seismically designed) that I know of occured in a cast iron pipe fitting or flange. It should be emphasized that the type of cast iron used for this fitting (gray ductile, etc.) is not known.

As a result, it is recommended that a survey be made of the materials used in safety related items of nuclear power plants and that special consideration be given to the fragility of these items fabricated from brittle materials using both test and analysis.

2.3 ANCHORS

Failures of equipment from earthquake excitation have often occured from bolt or anchor failures. Furthemore, equipment is often anchored into concrete. As a result, fragility of anchors of safety related equipment must be throughly evaluated.

2.4 BOLTS

It was mentioned in the presentation (by Dr. R. Kennedy) that bolt yielding is sometimes considered in joint analyses. Furthermore, it is understood that high strength bolts are sometimes used to anchor major components to the containment structure.

It is strongly recommended that anchor bolts be designed for maximum energy absorption by cutting the shank diameter to the root diameter of the bolt if this design feature is not already being employed. If this modification is not done and if the bolt is loaded beyond the yield point, plastic strains concentrate at the first few threads of the bolt. In general, the stronger the bolt the less the plastic strain before fracture. The fatigue impact strength of bolts can be increased by a factor of two to four (or more) by cutting the bolt shank to the root diameter.(Ref. Harris & Crede "SHOCH AND VIBRATION HANDBOOK",2nd Edition, McGraw Hill,p 43-8). Thus, this simple modification can increase the margin of safety for dynamic loads significantly and , therefore, should be considered in both the SMP and the LTSP of DCPP.

2.5 SOIL-STRUCTURE INTERACTION

The LTSP proposed by PG&E is to be commended of its throughness. A few sugestion are offered related to the soil-structure interaction problem.

(1)Program

The proposed program provides a unique opportunity to further understand soil structure interaction and the tau effect for a stiff soil (soft rock) site (Vs about 4000fps).

(2)Free Field Ground motion

Three triaxial accelerometers at different locations on the plant property can be used to record free field ground motion. However, because of the complex topography, it is expected that recordings at these three "free field" locations may be significantly different. This problem should be investigated by comparing both time-history motion and response spectra of th~ motion at these three locations. If these three motion~ ~e significantly different, consideration should b~ given to FEM analysis of different, consideration should be given to FEM analysis of the plant site in an attempt to understand recorded motions and to extend that work to study soil-structure interaction effects.

(3)Calculated Ground Motion

It is understood that an estimate of site free motion will be made starting with an assumed fault motion. It is suggested that an attempt be made to calculate free field motion of small recorded earthquakes measured at the site in order to assess the accuracy of the analytical procedure.

2.6 FIRE SAFETY CONSIDERATIONS

The interrelationship between fire started by an earthquake and plant safety should be evaluated. For example, a ceramic high voltage insolator could fail starting a fire. How would plant safety be compromised?

2.7 EMPHASIS

The original seismic design of the DCPP was based on a peak ground acceleration of 0.2G. Reevaluation of this motion in light of the Hosgri fault and additional earthquake data will probably lead to analyses of seismic margins based on ground motions from 0.5 G to 1.0 G peak ground accelerations. As a result Code allowable stress criteria may be exceeded at some locations. However, because of the energy absorbtion capability of ductile metals, failure of ductile components or structures is not expected. Failures of anchors, materials with low ductility and control systems is much more likely. Emphasis should be placed on these failure modes.