EDAC-117-253.01, Revision 1
Supplement 2

EVALUATIONS FOR 0.6g GROUND ACCELERATION CASE

SUPPLEMENT NO. 2 TO

ADDITIONAL INVESTIGATIONS TO DETERMINE THE EFFECTS OF COMBINED VIBRATORY MOTIONS AND SURFACE RUPTURE OFFSET DUE TO AN EARTHQUAKE ON THE POSTULATED VERONA FAULT

prepared for

GENERAL ELECTRIC COMPANY
Vallecitos, California

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## INTRODUCTION

This report presents a discussion of the adequacy of the GETR Reactor Building to withstand a maximum horizontal ground acceleration of 0.6g induced by a seismic event on the postulated Verona fault. This discussion is intended to supplement those presented in References 1 and 2, and has been prepared in response to a request received from the USNRC (Reference 3). Previous analyses have been conducted for a variety of senarios postulated for seismic events due to seismic activity in the vicinity of the GETR site. The purpose of this report is to summarize past relevant investigations to demonstrate that the GETR Reactor Building is adequate to withstand the postulated combined load case of a maximum horizontal ground acceleration of 0.6g and a one meter surface rupture offset beneath the Reactor Building as specified by the USNRC in Reference 4.

The two main parameters of interest regarding the combined loading for the Reactor Building are the vibratory ground motion and the "unsupported length," which is the physical configuration that analytically represents the surface rupture offset, and which is defined in Figure 1 of Reference 1.



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RELEVANT PREVIOUS INVESTIGATIONS

Recent investigations have been performed as follows:

- Addition investigations to demonstrate that the Reactor Building is adequate to withstand combined vibratory motions (with a maximum horizontal ground acceleration of 0.4g) and a surface rupture offset due to an earthquake on the postulated Verona fault are described in Reference 1. This report demonstrates that the Reactor Building is clearly adequate (with a substantial margin of safety) to withstand a horizontal ground acceleration of 0.4g combined with a surface rupture offset of 1.0 meter.

- An expanded description of soil pressure capacity analyses originally described in Reference 1 is presented in Reference 2. This report shows that consideration of the soil pressures beneath the Reactor Building for the combined load case of vibratory motion and surface rupture offset demonstrates that there are physical limits to the load combinations.

- A discussion of the conservatisms in the seismic evaluations of the GETR Reactor Building are presented in Reference 5. This report substantiates the qualitative conclusion that the actual total safety margin in the procedures to evaluate the seismic adequacy of the GETR Reactor Building is substantially greater than the margin determined by the conservative seismic evaluations.

CONCLUSIONS

The investigations described in Reference 1 demonstrate that the capacity of the Reactor Building to withstand combined load cases of vibratory motion and surface rupture offset (represented analytically by an "unsupported length") can be represented by a conservative capacity contour as plotted in Figure 1 (which is reproduced from Figure 11 of Reference 1). The dashed line in this figure represented a best estimate of a capacity contour for the Reactor Building, where capacity is conservatively derived and defined as initiation of concrete cracking. As stated in Reference 1, this capacity curve was based on the recent analyses for the following load case:

Ground Acceleration = 0.30g
Unsupported Length = 17 ft

as well as the Phase 2 analyses (Ref. 6) for the following cases:

Ground Acceleration = 0.80g
Unsupported Length = 0 ft

Ground Acceleration = 0.0g
Unsupported Length = 20 ft

The Phase 2 investigations (Ref. 6) were performed for one component of ground acceleration (0.80g). Reference 7 demonstrates that the Reactor Building is also adequate to withstand three orthogonal components of ground acceleration, where the maximum horizontal component is 0.75g.

It is evident that short unsupported lengths (Figure 2) result in a very small loss of support under walls in the actual structure, and thus will have little influence on concrete stresses. Thus, the Reactor Building concrete core structure can withstand postulated load combinations of short unsupported lengths and high ground motions, and the conservative capacity contour is thus flatter (i.e. horizontal) rather than sloping as shown in Figure 1 in the region of 0.8g and short unsupported lengths.

Figure 3 is the revised capacity contour for the GETR Reactor Building and represents a modification of the curve of Figure 1 to represent the conclusions of the investigations for the 0.75g horizontal acceleration load case (Ref. 7), and the fact that the capacity of the structure is not significantly affected by short unsupported lengths, as discussed above.

The limits on combined loading cases based on both probabilistic (Ref. 8) and soil pressure capacity (Ref. 2) considerations, and the conservative capacity contour information were plotted in Figure 12 of Reference 1 (reproduced in this report as Figure 4). This figure clearly demonstrated that there is a substantial margin of safety for vibratory, gravity, and offset load combinations.

After the investigations described in Reference 1 were performed for a maximum horizontal ground acceleration of 0.4g, the soil pressure investigations were extended as described in Reference 2 to include the case of a maximum horizontal ground acceleration of 0.6g. The limiting load combinations based on local soil yielding are shown in Figure 5, which is reproduced from Figure 4 of Reference 2. This curve is the same as shown in Reference 1 except it has been extended to a maximum horizontal ground acceleration of 0.6g.

Figure 6 represents an updated version of Figure 4, wherein the curves of limiting load combinations based on soil pressure yielding (Figure 5) and probabilistic considerations (from Figure 4) are superimposed on the capacity curve of Figure 3. Figure 6 clearly demonstrates that the calculated conservative capacity of the GETR Reactor Building is significantly greater than loading criteria based upon probabilistic and soil pressure considerations for the case of a horizontal ground acceleration of 0.6g at the site induced by a seismic event on the Verona fault.

Reference 5 describes in qualitative terms the many additional conservatisms which exist in the procedures used to evaluate the GETR Reactor Building for seismic effects. Each of these conservatisms over-estimates response and under-estimate capacities. In addition, the conservatisms are cumulative; the total safety margin is the product of many individual margins. Referring to Reference 5, it is evident that the actual capacity of the GETR Reactor Building is substantially above the conservatively selected load combination values and capacities used for the evaluations described in this report. Consideration of these conservatisms would, in effect, raise the capacity curve substantially above the conservative capacity based on initiation of cracking shown in Figure 6.

Thus, based on the investigations described above, it is concluded that the concrete core structure of the Reactor Building is adequate to withstand without damage the combined load case of vibratory ground motion and surface rupture offset due to postulated seismic events on the hypothetical Verona fault as defined by the USNRC in Reference 4.

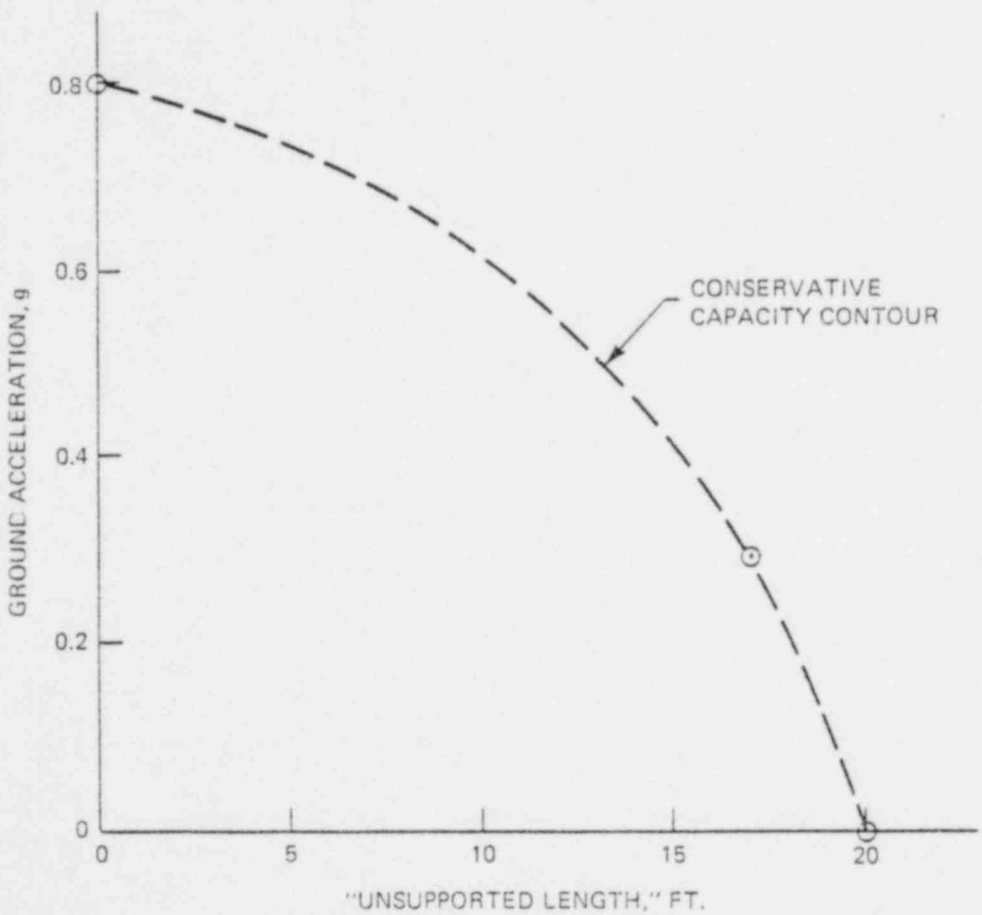


FIGURE 1. CAPACITY CONTOUR FOR COMBINED LOADING
(Reproduced from Figure 11 of Reference 1)



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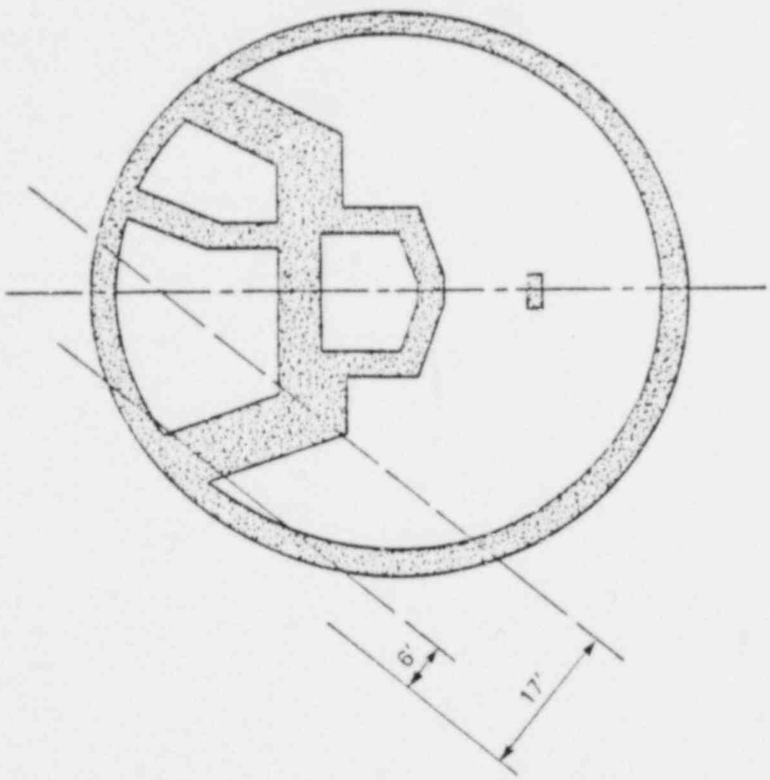


FIGURE 2. PLAN VIEW – SHORT "UNSUPPORTED LENGTH" (~6')



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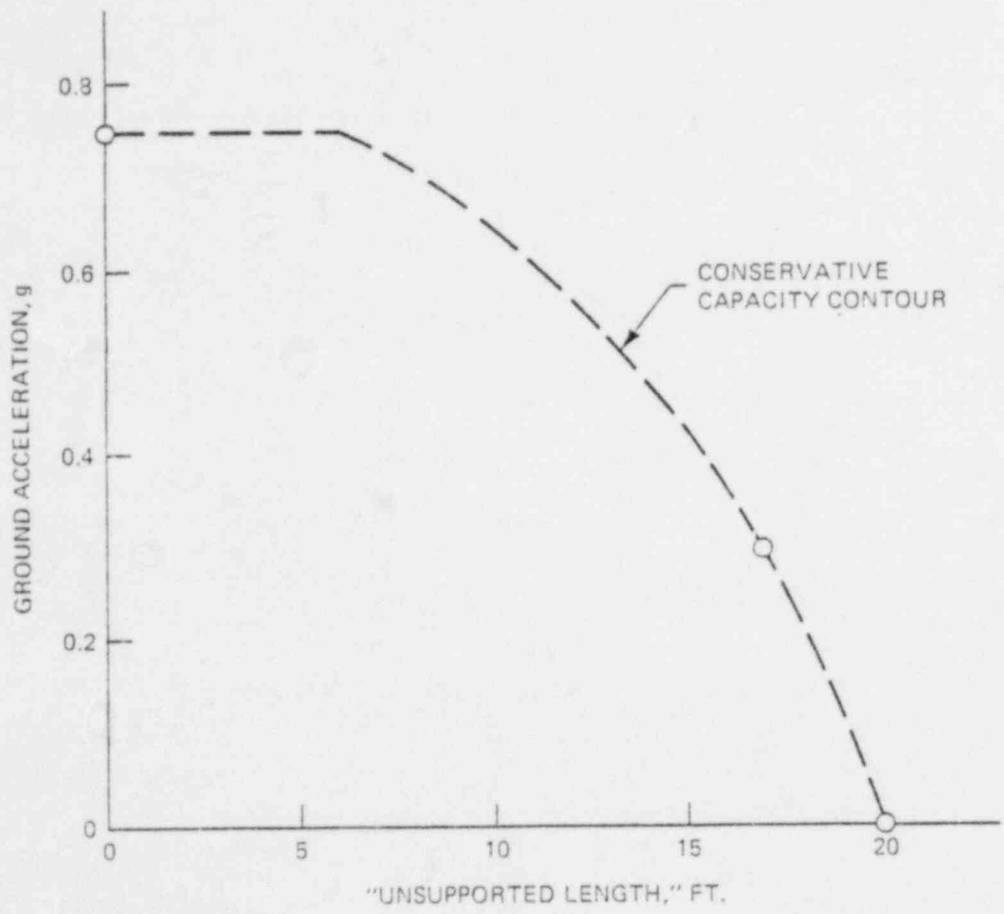


FIGURE 3. REVISED CAPACITY CONTOUR FOR COMBINED LOADING



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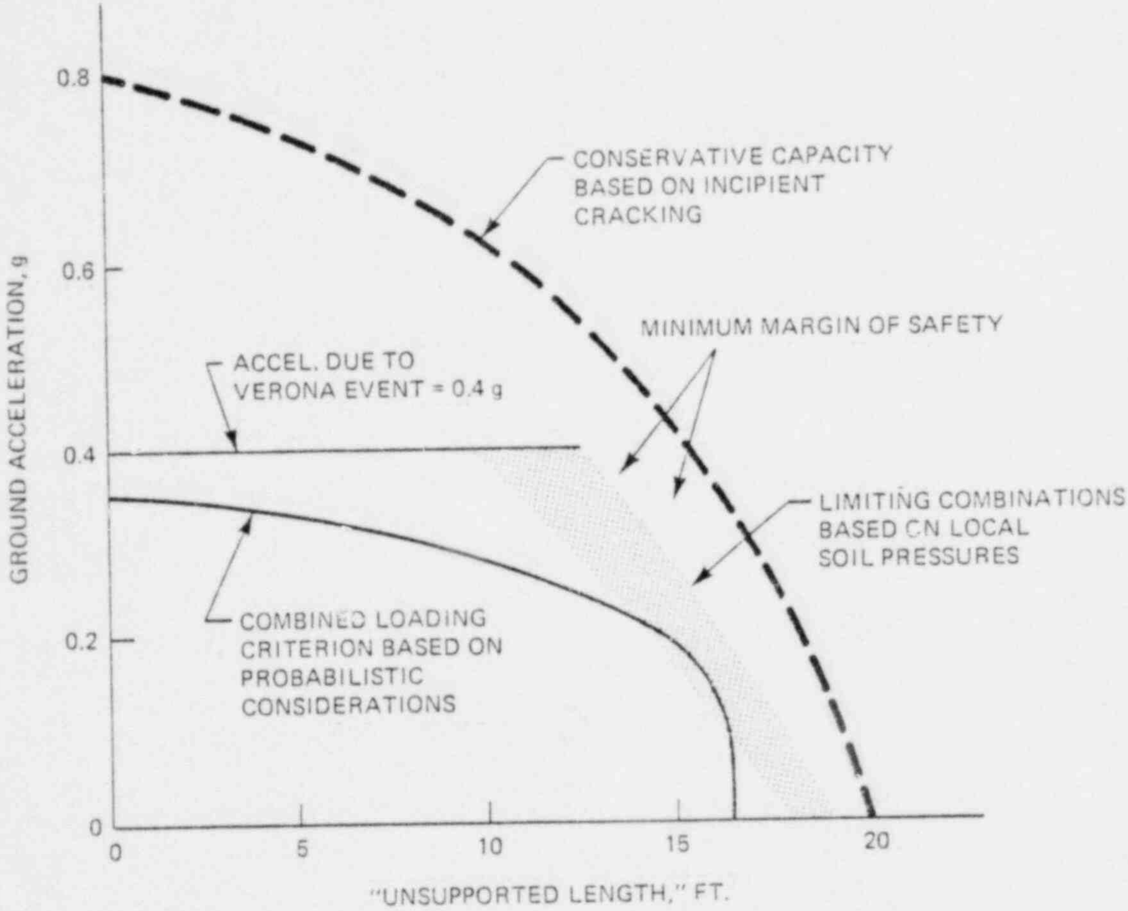


FIGURE 4. LOADING VS. CAPACITY
(Reproduced from Figure 12 of Reference 1)

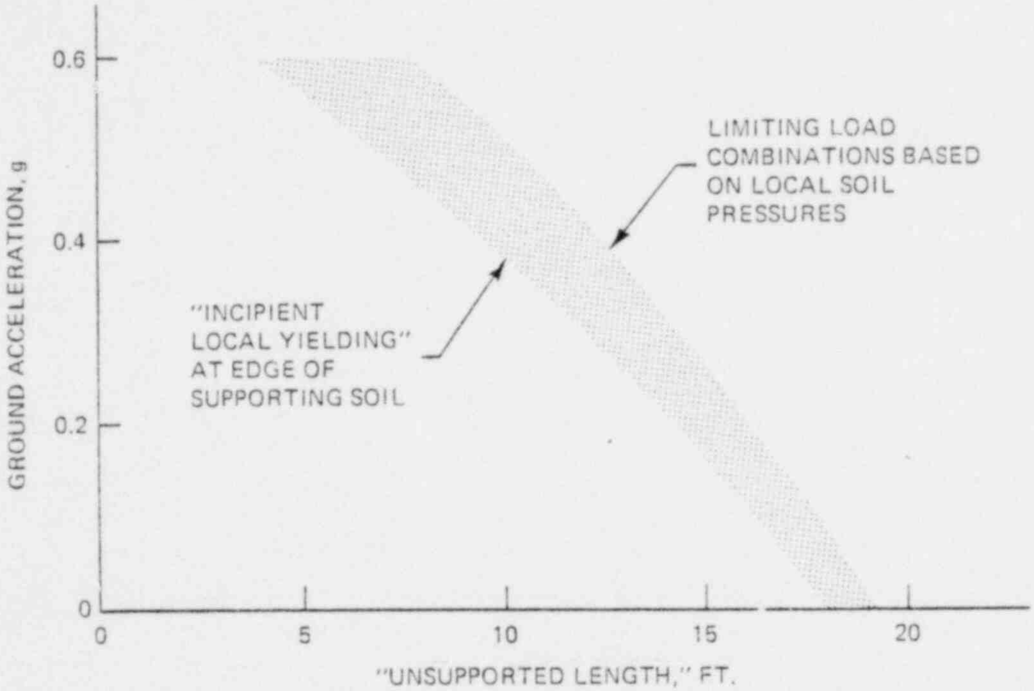


FIGURE 5. RESULTS OF SOIL PRESSURE ANALYSES
(Reproduced from Figure 4 of Reference 2)

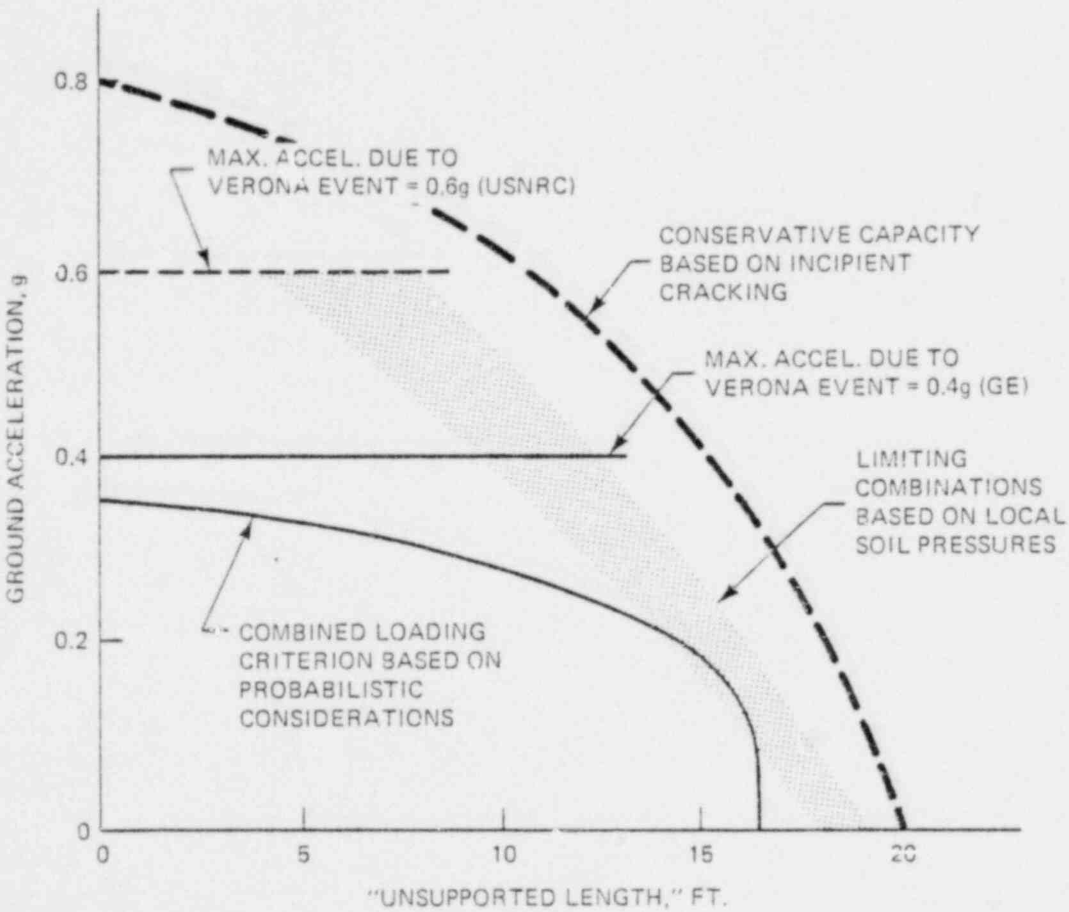


FIGURE 6. LOADING VS. CAPACITY
(Reproduced from Reference 7)



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REFERENCES

## REFERENCES


1. Engineering Decision Analysis Company, Inc., "Additional Investigations to Determine the Effects of Combined Vibratory Motions and Surface Rupture Offset Due to an Earthquake on the Postulated Verona Fault," EDAC-117-253.01, Revision 1, prepared for General Electric Company, 8 May 1980.

2. Engineering Decision Analysis Company, Inc., "Expanded Description of Soil Pressure Analyses, Supplement No. 1 to Additional Investigations to Determine the Effects of Combined Vibratory Motions and Surface Rupture Offset Due to an Earthquake on the Postulated Verona Fault," EDAC-117-253.01, Revision 1, Supplement 1, prepared for General Electric Company, 27 June 1980.

3. USNRC (R. A. Clark) Letter to General Electric Company (R. W. Darmitzel) 10 June 1980.

4. USNRC (D. G. Eisenhut) Letter to General Electric Company, (R. W. Darmitzel) 23 May 1980.

5. Engineering Decision Analysis Company, Inc., "Conservatisms in the Seismic Evaluations of the GETR Reactor Building, "EDAC-117-254.02, prepared for General Electric Company, 30 April 1980.

6. Engineering Decision Analysis Company, Inc., "Seismic Analysis of Reactor Building, General Electric Test Reactor - Phase 2," EDAC-117-217.03, prepared for General Electric Company, 1 June 1978.

7. Engineering Decision Analysis Company, Inc., "Additional Investigations to Determine Effects of Vibratory Motions Due to an Earthquake on the Calaveras Fault," EDAC-117-253.02, Revision 1, prepared for General Electric Company, 30 June 1980.

8. Jack R. Benjamin and Associates, Inc., "Probability Analysis for Combined Surface Rupture Offset and Vibratory Ground Motion, General Electric Test Reactor," JBA-111-014-01, 29 April 1980.




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