EDAC-117-258.01

REVIEW OF SEISMIC ADEQUACY OF PIPING AND EQUIPMENT

GENERAL ELECTRIC TEST REACTOR

prepared for

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Vallecitos, California

30 June 1980

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INTRODUCTION

This document presents the results of a review of the seismic adequacy of the safety-related piping and equipment in the Reactor Building of the General Electric Test Reactor (GETR). This review was undertaken to confirm that the safety-related piping and equipment are adequate to resist the seismic motions postulated for the GETR site by the USNRC in their letter of 23 May 1980 (Ref. 1). These criteria are as follows:

- Due to a seismic event on the Calaveras Fault
  Ground Acceleration = 0.75g

- Due to a seismic event on the postulated Verona Fault
  Ground Acceleration = 0.6g
  Surface Rupture Offset = 1.0m

The discussion presented in this report demonstrates that the piping and equipment as originally analyzed and modified meets the above criteria.

BACKGROUND

Linear elastic dynamic analyses of the GETR Reactor Building were performed for a ground acceleration of 0.80g as described in Reference 2. In these analyses, a three-dimensional lumped mass analytical model for the soil-structure system was employed. Time history, modal superposition dynamic analyses were performed to obtain time histories of acceleration at the various floor levels. The time history analyses were performed for the two horizontal (X and Y) and the vertical (Z) directions. The time histories thus obtained were then used to calculate floor response spectra at the floor levels of the concrete structure. Envelope spectra were then generated from these floor response spectra, taking into account the range of the parameters such as soil modulus that could influence the analysis results (Ref. 2). The amplitudes and the widths of the peaks of the floor response spectra were thus conservatively determined. In addition, vertical floor response spectra caused by horizontal excitation (rocking) were also developed. As a convenience to the analysts and designers, the two horizontal spectra (X and Y) were then enveloped to produce a single horizontal spectrum, denoted herein for discussion purposes as the spectrum in the H-direction. Floor response spectra obtained as described above are shown in Figures 2-11, 2-12 and 2-13 of Reference 2.

The seismic analyses of each item of piping or equipment for inertial effects were performed using three-dimensional models, where the horizontal global axes were defined as x and y and the vertical global axes were defined as z. The analyses for each item were then performed separately for the horizontal spectrum (H) applied first in the x-direction, and secondly in the y-direction; the Z spectra was then applied in the z-direction. The response results for each of these spectral analyses were then combined by the SRSS method, which is the conservative conventional practice. The relative displacements of the concrete core structure which supports the safety related piping and equipment were determined to be extremely small and thus would not produce significant stresses in the piping and equipment.

It should also be mentioned that certain small items of piping and eqipment were analyzed using simplified equivalent static methods wherein a static load equal to a multiple (1.5) of the peak of the floor response spectrum was used. This also is in accordance with standard engineering practice.

COMPARISON OF SPECTRA

Figure 1 shows, as an example, the response spectrum for horizontal motions at the operating floor (elevation 611 ft. 7 in.) for 1 percent and 3 percent damping. This spectrum is reproduced from Figure 2-12 of Reference 2. The solid lines on this figure represents the original spectra as presented in Reference 2 and used in the Phase 2 analyses. The original spectra based on a ground acceleration of 0.80g exceed spectra for the revised NRC criteria of 0.75g.

The dotted line on Figure 1 shows the response spectra anticipated for the postulated seismic event on the Verona Fault (0.60g). This spectrum (shown for comparison purposes for 3% damping) was obtained by scaling the spectrum for the 0.8g case by the ratio (0.6/0.8).

CONCLUSIONS

It is evident from the spectra shown on Figure 1 that the piping and equipment as analyzed and modified during the previously reported investigations are adequate to resist the criteria postulated by the USNRC (Ref. 1) and summarized in the beginning of this report. The peaks of the original floor response spectra were broadened significantly and thus cover the anticipated frequency range of interest. Although the possibility is very remote, some additional flexibility of the soil-structure system due to soil deformations might be experienced during the combined vibratory motion and surface rupture offset load case induced by the postulated Verona event. This added flexibility could, in principle, produce floor response spectra with a peak broadened slightly to the left, (i.e. into the low frequency range) of the design spectra shown in Figure 1. Since the supported piping and equipment have fundamental frequencies in the high frequency range (see examples in Table 1), any such change in spectra shape would not produce additional stresses in the piping and equipment.

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Based on the results from the above, it was concluded that the piping and equipment supported in the GETR Reactor Building are adequate to resist the seismic motions postulated for the GETR site by the USNRC in Reference 1.

TABLE 1
FUNDAMENTAL FREQUENCIES OF SELECTED PIPING AND EQUIPMENT

Component	Frequency
Primary Cooling System Run 1	$f_1 = 7.4$ Hz
Primary Cooling System Run 2	$f_1 = 11.4$ Hz
Heat Exchanger 101	$f_1 = 19.1$ Hz
Control Rod Drive Assembly	$f_1 \geq 33$ Hz, $f_1' > 13$ Hz
Incore Shuttle Drive Assembly	$f_1 > 33$ Hz

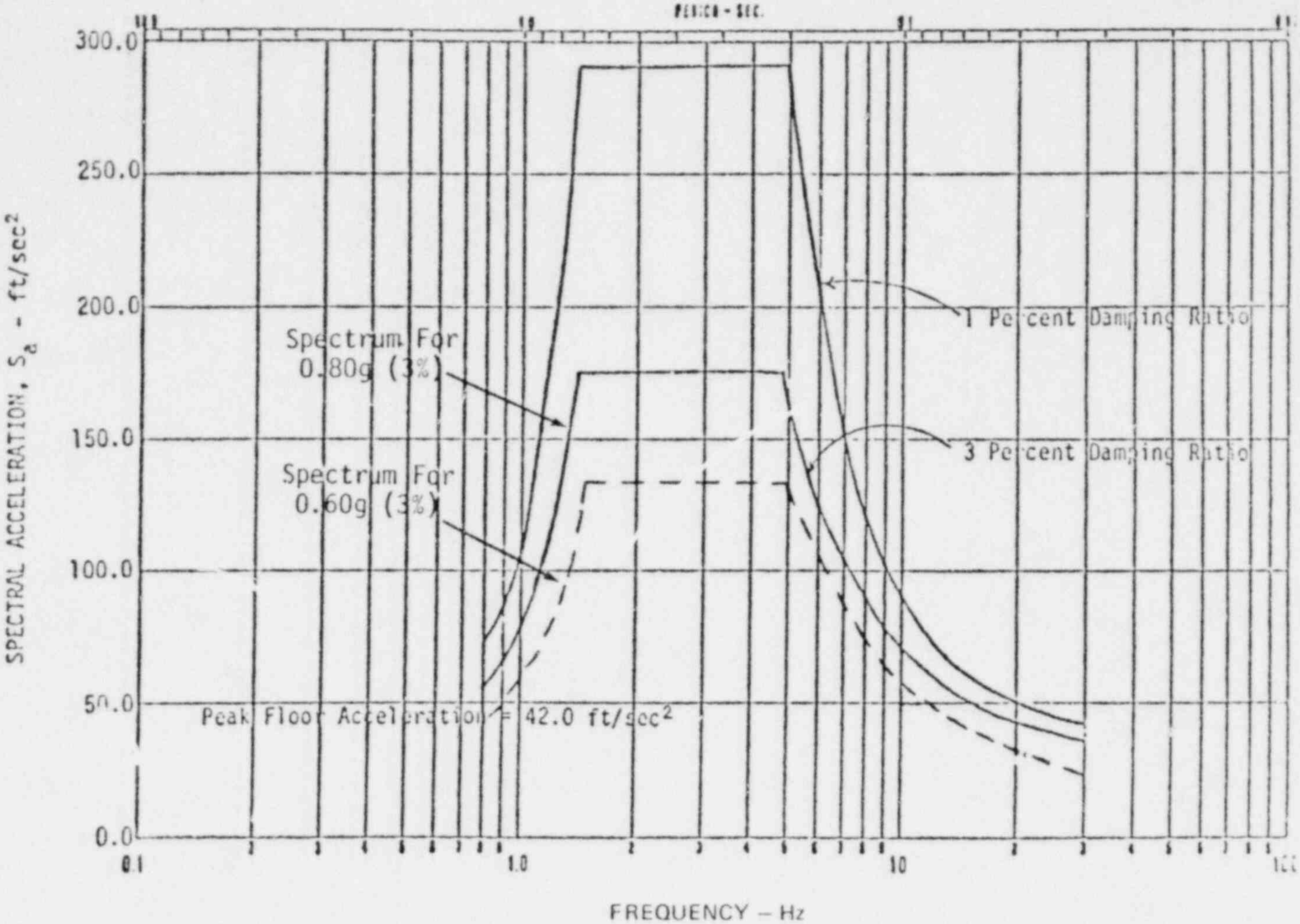

FIGURE 1. ENVELOPE FLOOR RESPONSE SPECTRA FOR HORIZONTAL MOTION AT ELEVATION 611.0 FT 7.0 IN.

REFERENCES

REFERENCES

1. United States Nuclear Regulatory Commission (G. Eisenhut) Letter to General Electric Company (R. W. Darmitzel), 23 May 1980.

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