Enrico Fermi Atomic Power Plant, Unit 2

Report No.: EF2-53332, Rev. 1

Supplementary Seismic Evaluation Report

by

The Detroit Edison Company

July 15, 1981

ABSTRACT

In response to a March 12, 1981 request from the NRC staff, Detroit Edison evaluated seismic design margins of the Fermi 2 plant for seismic spectra greater than the design basis earthquake. This report presents the results of that evaluation, including the development of site-specific ground spectra, floor response spectra, identification and evaluation of essential equipment, and evaluation and overview by an independent consultant. The results show that sufficient design margin exists to assure that systems necessary to achieve safe shutdown and cooldown will continue to function following the postulated site-specific safe shutdown earthquake.

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1.0 INTRODUCTION

1.1 Program Description

The supplementary seismic evaluation program was implemented by Detroit Edison in response to the NRC staff's request for information. The text of this request is presented in Appendix 1.1. This effort consisted of six parts:

1. development of site-specific ground response spectra for a magnitude 5.3 ± 0.5 earthquake at the Fermi-2 site
2. development of floor response spectra
3. assessment of the integrity of key structures under the effects of the new SSE
4. identification, analysis, and assessment of equipment in systems required for safe shutdown
5. identification, analysis, and assessment of piping and supports in systems required for safe shutdown
6. assessment of the seismic evaluation program

1.2 Summary of Results

In the Interim Safety Evaluation Report (SER) for Fermi 2, the NRC staff indicated that the seismic design basis for the Fermi-2 plant presented in the FSAR was considered acceptable. Detroit Edison believes the seismic design basis of the Fermi-2 plant remains adequate; in addition, the results of the supplementary seismic evaluation requested by the NRC staff and reported in the evaluation confirm the adequacy of the F-r .-2 seismic design even for an earthquake substantially higher than the design basic earthquake (DBE). The results of the evaluation confirm that safe shutdown of the Fermi-2 plant can be achieved under the site-specific seismic conditions stipulated by the NRC staff.

APPENDIX 1.1

Text of March 12, 1981 Telecopy

APPENDIX 1.1

The following telecopy was received by Detroit Edison from the NRC on March 12, 1981, and retyped by Detroit Edison:

> As described in the Fermi 2 Final Safety Analysis Report (Section 2.5.2.1), the Fermi 2 site is located within the Central Stable Region of North America. In the current staff Operating License review of the seismological input it has been determined that the design response spectrum for the Fermi-2 site is not consistent with that currently acceptable to the staff. Discussed below is the staff's current view as to the best approach to specifying the controlling earthquake (and associated response spectrum) from the Central Stable Region.
>
> The controlling earthquake we would currently require to be used in determining the Safe Shutdown Earthquake (SSE) for the Fermi 2 site is similar to that which occurred in Anna, Ohio in March 1937, and has a body wave magnitude of 5.0-5.3 (m_bL_g), and Modified Mercalli Intensity (MMI) of VII-VIII. We have observed that the recent July 27, 1980 Kentucky earthquake also had a magnitude of about (m_bL_g) 5.2-5.3 and occurred in the Central Stable Region.
>
> The following alternatives of characterizing the SSE would be acceptable to the staff and are contained within the staff's Standard Review Plan (SRP) Section 2.5.2. The Anna, Ohio earthquake of

March 1937 is the largest historic earthquake (in terms of intensity) in the Central Stable Region. This earthquake had a MMI-VII-VIII and should be assumed to occur near the site (Appendix A, Part 100, SRP Section 2.5.2). Using this intensity and the Standard Review Plan approach (NUREG-75/087) indicates that the Regulatory Guide 1.60 standardized response spectra be anchored at 0.19 g as determined by the trend of the means of the intensity acceleration values in Trifunac and Brady (Seismological Society of America Bulletin, V. 65, 1975). An alternative method of describing the SSE and response spectra resulting from an "Anna" type earthquake (and other similar magnitude events) assumed to occur near the site involves using the magnitude. Magnitude may be a more realistic estimate of earthquake size than intensity (see for example the Sequoyah OL review). Therefore, a description of the SSE can also be obtained by collecting representative real time histories for a magnitude of $m_b L_g = 5.3 \pm .5$ (this corresponds to a M_L of about 4.9 to 5.9 using Chung and Bernreuter, 1980), and epicentral distances less than 25 km at rock site (the plant foundation is on rock). Such a collection has been made by Lawrence Livermore Laboratory (LLL, Draft, Seismic Hazard Analysis: Site-Specific Response Spectra Results, August 23, 1979) but it would be beneficial if you update this data set as necessary. It is the staff's position that the representation appropriate for use in establishing the SSE is the 84th percentile of the response spectra as derived directly from the real time histories.

We are available to meet with you as soon as possible to discuss the above approach in order that the best available data and method of describing (input) vibratory ground motion can be utilized for the site.

Additional clarification on the conduct of the supplementary seismic evaluation was provided by the NRC staff in a March 27, 1981, meeting with Detroit Edison. The following ten points were stressed:

1. The new site-specific earthquake is not to be a new design basis earthquake (DBE), but Edison is required to evaluate and assess the plant capability to achieve safe shutdown following the new, higher earthquake.

2. Loss-of-coolant accident (LOCA) loads and pipe break loads are not considered coincident with the site-specific SSE. For piping and equipment, normal operational loads are considered with the site-specific SSE.

3. Operability and functionality are considered for key equipment and components.

4. Survivability may be assessed in terms of ultimate structural capacity using actual material strength (not Code required limits or material strengths). However, Code required limits should be used as an index in assessing margins.

5. 10-20% ductility may be used where appropriate and justified. Higher damping values may be used if justified by commensurate stresses. However, damping should not exceed that allowed by Regulatory Guide 1.61.

6. Structures, systems, and components required for shutdown and cooldown must be assessed.

7. The reassessment shall be based on a Regulatory Guide 1.60 spectrum anchored at 0.19 g or a site-specific spectrum based on an 84th-percentile spectrum of 5.3 $\pm$ 0.5 magnitude earthquakes. In lieu of the site-specific spectrum, the Lawrence Livermore spectrum, adjusted to include far-field strong motion effects and justified for use as a Fermi-2 site-specific spectrum, may be used.

8. Racks and panels may have additional margins due to use of conservative spectra and damping. Some may be assessed by inspection and judgment.

9. Buried pipe and duct must be reevaluated in light of a soil spectra application and ground motion effect.

10. Probabilistic approaches may be used in areas of extreme hardship.

2.0 DEVELOPMENT OF SITE-SPECIFIC GROUND RESPONSE SPECTRA

The seismic spectra used as the design basis of the Fermi-2 plant are presented in Section 3.7 of the Fermi-2 FSAR. These spectra were developed prior to the present guidelines used by the NRC, as contained in Regulatory Guide 1.60. In the March 12, 1981, telecopy from the NRC (see Appendix 1.1) it was stated that the design response spectrum (SSE) for the Fermi-2 site was not consistent with that currently acceptable to the staff and that the SSE response spectra for a controlling earthquake should be defined by using either:

1. the standardized response spectra of Regulatory Guide 1.60, anchored at an acceleration value determined from the intensity-acceleration relationship of Trifunac and Brady (0.19 g), or

2. site-specific response spectra developed from real-time histories of earthquakes whose magnitudes are 5.3 ± 0.5 and whose distance from the recording station, and foundation conditions are considered representative of the Fermi-2 site.

In the March 27, 1981, meeting Detroit Edison maintained that the Fermi-2 SSE is the design basis for the plant; however, they did commit to the development of site-specific spectra to be used for reassessing plant structures, systems, and components required for safe shutdown and cooldown of the plant. Detroit Edison retained Weston Geophysical to develop these spectra. The development and basis of a site-specific spectrum to permit the supplementary seismic evaluation to proceed are described below.

2.1 Site Specific Spectrum

2.1.1 Horizontal Spectrum

The site-specific horizontal spectrum was developed from examination of two site-specific spectra developed for a nearby earthquake of magnitude 5.3, recorded on hard rock sites, like that of Fermi-2. One of these spectra was developed by Lawrence Live more Laboratory and presented in their draft report entitled, "Seismic Hazard Analysis Site Specific Response Spectra Results," dated August 23, 1979. The other available spectrum was developed by Weston Geophysical for an eastern United States hard rock site, based on a nearby magnitude 5.3 earthquake. The 84th percentile of these spectra (the percentile specified by the staff) were similar to each other and to the Regulatory Guide 1.60-shaped spectrum in the higher frequency range (frequencies higher than approximately 4.5 Hz). As shown in Figure 2.1-1, a Fermi-2 site-specific response spectrum was conservatively assumed to have the shape of the Regulatory Guide 1.60 spectrum anchored at 0.15 g in that higher frequency range.

The low frequency portion of the site-specific response spectrum is controlled by the large, distant earthquakes. In the judgment of Weston Geophysical, the lower frequency range of the Fermi-2 SSE spectrum adequately reflects the influence of large earthquakes in the New Madrid area and in the western Quebec seismic zone, both more than 500 kilometers from the Fermi site. Thus, the low frequency portion of the Fermi-2 site-specific spectra shown in Figure 2.1-2 is the same as that of the Fermi-2 SSE shown in FSAR Figure 3.7-3.

2.1.2 Vertical Spectrum

Section 3.7.1 of the Fermi-2 FSAR describes the original vertical seismic design basis of the plant. vertical floor-response spectra were developed from four vertical time histories presented in Section 3.7.1.2 of the FSAR and in Reference 2-1. Sargent & Lundy reexamined these vertical time histories to determine a site-specific vertical spectrum in conjunction with the site-specific horizontal spectrum.

In accordance with the guidance from the NRC staff, the expected vertical spectrum is assumed to be a Regulatory Guide 1.60 spectrum with 7% damping anchored at 0.1 g, two-thirds of the anchor point of the horizontal spectrum, 0.15 g. This was compared with a 5% damped spectrum based on the average of the four vertical time histories used previously. The Regulatory Guide 1.60 spectrum and the average time history spectrum are shown in Figure 2.1-3. Comparison of these spectra shows that the former exceeds the latter by approximately a factor of 1.6 at the dominant structural periods of 0.081 seconds and 0.059 seconds.

The data used to obtain the average real-time spectrum included gaps in certain frequencies. The original records of the Taft and El Centro 1940 earthquakes showed missing data at a period of 0.06 seconds. These missing data would tend to drive down average spectra developed from these records. In addition, the consistent time history for the site-specific spectrum is likely to be 10% higher than the spectrum. For these reasons, Sargent & Lundy recommended that the SSE vertical spectrum, which is based on the four vertical time histories, be multiplied by a factor of 2.0 to bound the Regulatory Guide 1.60 spectrum at 7% damping. The SSE vertical spectrum multiplied by 2.0 was used as the site-specific vertical spectrum in the supplementary seismic evaluation.

2.1.3 Damping

The supplementary seismic evaluation of the structures was based on a structural damping of 7% as per Regulatory Guide 1.6.1

2.1.4 Recurrence Frequency of the Operating Basis Earthquake

The Fermi-2 Operating Basis Earthquake (OBE) is characterized as a horizontal ground surface (rock foundation) acceleration of 0.08 g. The frequency of occurrence of the OBE was estimated by interpreting the historical levels of seismic loading at the site resulting from earthquake activity known for the central region of the United States. This procedure is not considered to be a formal probabilistic seismic hazard assessment, since hypothetical activity is not considered. However, this historical analysis does yield useful results for the reccurrence frequency of low-amplitude ground motion.

2.1.4.1 Attenuation Models

The foundation material at the Fermi-2 site is rock (Paleozoic dolomite). The observation at near epicentral distances is that seismic intensities are lower by one or more intensity units (MM scale) at localities situated on rock or sound foundation materials than at adjacent localities underlain by alluvial materials. On the other hand, it is also observed that peak ground motion parameters can be larger on firm foundation materials than on softer materials for the same seismic intensity. To account for these observations, attenuation models are developed using the following assumptions first, seismic intensity attenuation on rock is characterized by a median value; second, the ground motion for that intensity is characterized as the median to median +1 standard deviation values.

Equation 1 is the form of the intensity attenuation model that predicts the median intensity at a distance (R in km) from an earthquake with size define by m_b-magnitude.

$$I(R) = 2.53 + 1.20\ m_b - 0.0027R - 1.84\ \text{Log}\ R \quad (1)$$

Ground motion paramters are determined from the site intensity by using the correlations found in References 2-2 and 2-3. Equations (2) and (3) are relations of sustained (3 cycle) acceleration and velocity determined from the data presented in Reference 2-2.

$$\text{Log}\ A_s = 0.326 + 0.214\ I_{MM} \quad (2)$$

$$\sigma\ \text{Log}\ A_s = 0.32$$

$$\text{Log}\ V_s = -1.210 + 0.289\ I_{MM} \quad (3)$$

$$\sigma\ \text{Log}\ V_s = 0.36$$

Equations (4) and (5) are correlations of peak acceleration and velocity to intensity observed on firm foundation materials (Reference 2-3).

$$\text{Log}\ A_p = -0.361 + 0.370\ I_{MM} \quad (4)$$

$$\sigma\ \text{Log}\ A_p = 0.33$$

$$\text{Log}\ V_p = -1.75 + 0.413\ I_{MM} \quad (5)$$

$$\sigma\ \text{Log}\ V_p = 0.33$$

Substitution of Equation (1) into Equations (2) through (5) results in the set of attenuation models used to calculate the historical seismic loading of the rock foundation at the Fermi-2 site.

2.1.4.2 Ground Motion Results

The ground motions at the Fermi-2 site were computed using earthquake activity located in the region bounded by 36° to 47° N latitude and 77° to 90° W longitude. This broad region was used so that all of the major activity in the central region would be included. Events documented with only epicentral intensities (I_o) were converted to m_b magnitudes using Equation (6).

$$m_b = 0.5\ I_o + 1.75 \qquad (6)$$

Table 2.1-1 lists earthquakes which resulted in estimated intensities of II or greater at the site, and also the corresponding median plus standard deviation sustained acceleration and velocity determined using Equations (1), (2), and (3). The data in Table 2.1-1 were sorted to determine the number of exceedances of various intensity levels during the period 1776-1976; these results are plotted in Figure 2.1-4. Similarly, the number of exceedances of sustained acceleration and sustained velocity, using the median plus standard deviation and the median correlations in Reference 2-2, are shown in Figures 2.1-5 and 2.1-6. Finally, in a parallel manner, results using conversions for peak motions on firm site conditions (Reference 2-3) are shown in Figures 2.1-7 and 2.1-8.

Also plotted in Figures 2.1-5 through 2.1-8 are the maximum historical horizontal ground motions in comparison to the OBE ground motion levels. The OBE acceleration is 0.08 g, while the velocity is taken to be in the range of 5 to 7 cm/sec at frequencies in the vicinity of 1 Hz. This ground velocity range is determined from the 11.5 cm/sec level of the OBE response spectrum at 5% of critical damping at the frequency of 1 Hz., by dividing by the median and 84th percentile response spectrum amplication factors of 1.65 and 2.3, respectively (Reference 2-4).

2.1.4.3 Conclusion

On the basis of the results of this historical analysis, it is concluded that the return frequency of the OBE at the Fermi-2 site is, as a minimum, on the order of 100 to 300 years.

There has been no change in the OBE level earthquake from that used in the original analysis and design.

2.2 References

2-1 Sargent & Lundy Report SL-2682, "Seismic Analysis of the Reactor Building--Auxiliary Building Complex, Enrico Fermi Atomic Power Plant, Unit 2, " prepared for Detroit Edison Company, September 1974 Revision.

2-2 Nuttli, O. W., 1979, "State-of-the-Art for Assessing Earthquake Hazards in the United States, Report 16 -- The Relation of Sustained Maximum Ground Acceleration and Velocity to Earthquake Intensity and Magnitude," U. S. Army Engineer Waterways Experiment Station Miscellaneous Paper S-73-1, Report 16.

2-3 McGuire, R. K., 1977, "The Use of Intensity Data in Seismic-Hazard Analysis," Proceedings of the 6th World Conference on Earthquake Engineering, New Delhi, Vol. 2, p. 353-358.

2-4 Newmark, N. M. and Hall, W. J., 1978, "Development of Criteria for Seismic Review of Selected Nuclear Power Plants," NUREG/CR-0098, prepared for U. S. Nuclear Regulatory Commission.

Table 2.1-1

EARTHQUAKE CATALOG FOR FERMI2 SITE
COORDINATES 41.9600N 83.2580W

YR MODA	HRMN	SEC	LAT.	LONG.	INT	MAGNITUDE MB	MN	ML	DISTANCE KM.	PEAK GROUND MOTION MMI	ACC(G)	VEL(CM/S)	SOURCE
1776	14		40.000N	82.000W	6	0.0	0.0	0.0	241.7	3.2	0.022	1.18	NU
18040820	2010		42.000N	87.800W	- 6	0.0	0.0	0.0	374.7	2.5	0.015	0.74	DO
18111216	0500		36.600N	89.600W	12	0.0	0.0	0.0	806.7	4.3	0.038	2.48	EH
18120123	15		36.600N	89.600W	12	0.0	0.0	0.0	806.7	4.3	0.038	2.48	NO
18120207	0945		36.600N	89.600W	12	0.0	0.0	0.0	806.7	4.3	0.038	2.48	NO
18270807	0730		38.300N	85.800W	6	0.0	0.0	0.0	460.0	2.1	0.013	0.57	EH
18270807	0660		38.300N	85.800W	6	0.0	0.0	0.0	460.0	2.1	0.013	0.57	EH
18330204			42.300N	85.600W	6	0.0	0.0	0.0	196.4	3.5	0.025	1.43	NU
18360709			41.500N	81.700W	4	0.0	0.0	0.0	139.7	2.7	0.017	0.86	NU 2
18380409	1445		38.500N	89.000W	- 8	0.0	0.0	0.0	619.8	2.6	0.016	0.81	NU1
18400910		.	43.200N	79.850W	5	0.0	0.0	0.0	310.6	2.2	0.013	0.61	EP
18501001			41.500N	81.700W	4	0.0	0.0	0.0	138.7	2.7	0.017	0.86	WG 2
18530313	10	.	43.100N	79.400W	5	0.0	0.0	0.0	339.9	2.1	0.012	0.55	EP 2
18570228	0140		41.900N	80.600W	- 5	0.0	0.0	0.0	220.3	2.7	0.017	0.87	WG 2
18571008	1000		38.700N	89.200W	7	0.0	0.0	0.0	619.3	2.0	0.012	0.54	NU1
18571023	2015	.	43.200N	79.600W	6	0.0	0.0	0.0	404.7	2.3	0.014	0.67	EP 2
18580419	1130		41.670N	81.250W	4	0.0	0.0	0.0	169.1	2.5	0.015	0.73	DO12
18730706	1430	.	43.000N	79.500W	6	0.0	0.0	0.0	328.5	2.7	0.017	0.86	EP 2
18750618	0743	. L.	40.200N	84.000W	7	0.0	0.0	0.0	205.0	4.0	0.033	2.05	EP
187606			40.400N	84.200W	- 4	0.0	0.0	0.0	190.2	2.3	0.014	0.66	DO12
18770317	1450		42.300N	83.300W	- 5	0.0	0.0	0.0	37.9	4.6	0.044	3.06	NU
18810420			41.590N	85.830W	4	0.0	0.0	0.0	217.0	2.1	0.013	0.59	DO
18820207	19		40.400N	84.200W	5	0.0	0.0	0.0	190.2	2.9	0.019	0.99	EH1
18830204	1000		42.300N	85.600W	6	0.0	0.0	0.0	196.4	3.5	0.025	1.43	EH
18840919	1914		40.700N	84.100W	6	0.0	0.0	0.0	156.5	3.8	0.029	1.73	EH
18860118	1030		41.100N	81.450W	4	0.0	0.0	0.0	173.0	2.4	0.015	0.70	WG 2
1892			40.390N	84.170W	4	0.0	0.0	0.0	190.2	2.3	0.014	0.66	DO12
18951031	1109		37.000N	89.400W	9	0.0	0.0	0.0	761.5	2.7	0.017	0.84	NU1
18960315	07		40.330N	84.170W	4	0.0	0.0	0.0	196.3	2.3	0.014	0.64	DO
18970531	1959		37.300N	80.700W	8	0.0	0.0	0.0	561.6	2.9	0.018	0.95	DO

Table 2.1-1 (cont.)

EARTHQUAKE CATALOG FOR FERMI2 SITE
COORDINATES 41.9600N 83.2590W

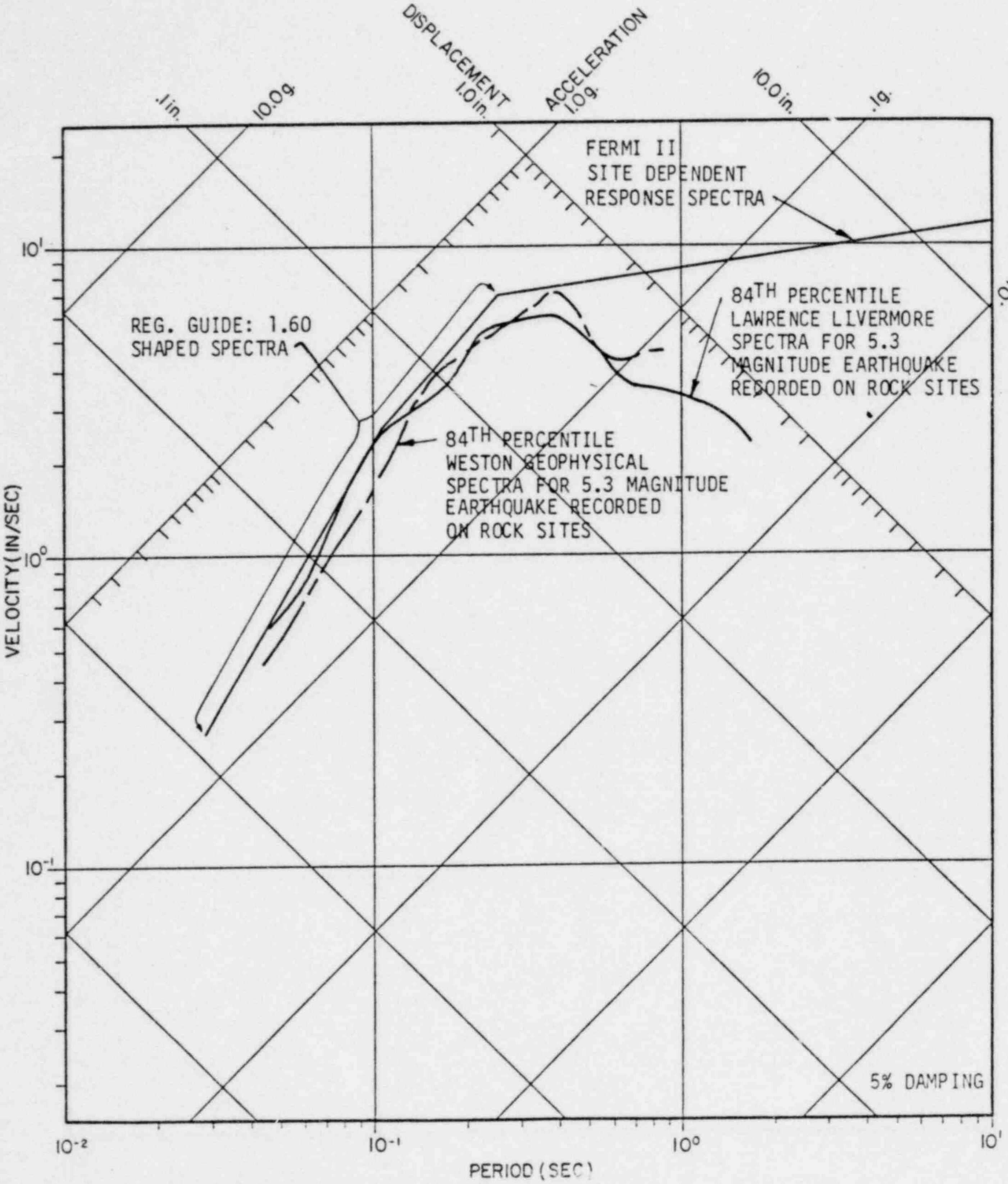
YR MODA	HRMN SEC	LAT.	LONG.	INT	MAGNITUDE MB	MN	ML	DISTANCE KM.	PEAK GROUND MOTION MMI	ACC(G)	VEL(CM/S)	SOURCE
18990430	0205	38.600N	87.000W	- 7	0.0	0.0	0.0	472.3	2.6	0.016	0.82	NU
19010517	0600	39.300N	82.500W	5	0.0	0.0	0.0	302.1	2.3	0.014	0.63	EH
19020514	0600	40.350N	81.450W	- 5	0.0	0.0	0.0	234.0	2.6	0.017	0.82	DO
19060424	0412	40.700N	83.600W	5	0.0	0.0	0.0	142.7	3.3	0.023	1.25	DO
19090526	1442	42.500N	89.000W	7	0.0	0.0	0.0	475.5	2.6	0.016	0.81	NU
19090719	0434	40.200N	90.000W	7	0.0	0.0	0.0	596.8	2.1	0.013	0.58	EH
19090927	0345	39.500N	87.400W	7	0.0	0.0	0.0	442.6	2.8	0.018	0.89	DO
19120102	1521	41.500N	88.500W	6	0.0	0.0	0.0	437.1	2.2	0.013	0.61	EH
19120327	1252	43.200N	79.700W	5	0.0	0.0	0.0	321.6	2.1	0.013	0.59	SM
19130222		42.950N	84.190W	4	0.0	0.0	0.0	124.4	2.8	0.018	0.91	DO
19250327	0406	39.500N	83.900W	5	0.0	0.0	0.0	278.3	2.4	0.015	0.69	NU
192504[illegible]	0305	38.300N	87.600W	- 7	0.0	0.0	0.0	548.4	2.3	0.014	0.66	NU1
19251028	1000	41.670N	83.580W	4	0.0	0.0	0.0	41.8	3.9	0.031	1.94	DO
19251105	1453	39.100N	82.100W	- 7	0.0	0.0	0.0	332.1	3.3	0.023	1.27	EH
19270217	0430	40.750N	82.500W	4	0.0	0.0	0.0	148.4	2.6	0.017	0.82	DO
19280909	2000	41.500N	82.000W	5	0.0	0.0	0.0	116.0	3.5	0.026	1.47	EH
19290308	0906 .	40.380N	84.180W	5	0.0	0.0	0.0	191.5	2.9	0.019	0.98	EP
19290812	112448.	42.870N	78.350W	8	0.0	5.2	5.8	414.5	2.8	0.018	0.93	EP12
19300526	2145 .	40.500N	84.000W	4	0.0	0.0	0.0	173.5	2.4	0.015	0.72	EP
19300627	0723 .	40.500N	84.000W	4	0.0	0.0	0.0	173.5	2.4	0.015	0.72	NU
19300711	0015	40.700N	83.700W	4	0.0	0.0	0.0	139.9	2.7	0.017	0.85	BB
19300920		40.390N	84.170W	6	0.0	0.0	0.0	190.2	3.5	0.026	1.47	BB1
19300930	2040	40.300N	84.300W	7	0.0	0.0	0.0	203.8	4.0	0.033	2.06	EH
193010		40.390N	84.170W	- 4	0.0	0.0	0.0	190.2	2.3	0.014	0.65	BB1
19310610	0330	41.320N	84.040W	5	0.0	0.0	0.0	96.2	3.7	0.028	1.68	BB1
19310920	2305	40.530N	84.260W	7	0.0	0.0	0.0	179.4	4.2	0.036	2.31	EH
19320122		41.080N	81.500W	4	0.0	0.0	0.0	175.7	2.4	0.015	0.71	BB12
19330923	0320	40.300N	84.200W	4	0.0	0.0	0.0	200.4	2.3	0.014	0.63	NU 2
19341029	2007	42.000N	80.200W	5	0.0	0.0	0.0	252.3	2.5	0.016	0.76	EH
19351101	060340.	46.780N	79.070W	7	0.0	6.2	6.2	629.8	3.1	0.021	1.13	EP 2

Table 2.1-1 (cont.)

EARTHQUAKE CATALOG FOR FERMI2 SITE
COORDINATES 41.9600N 83.2580W

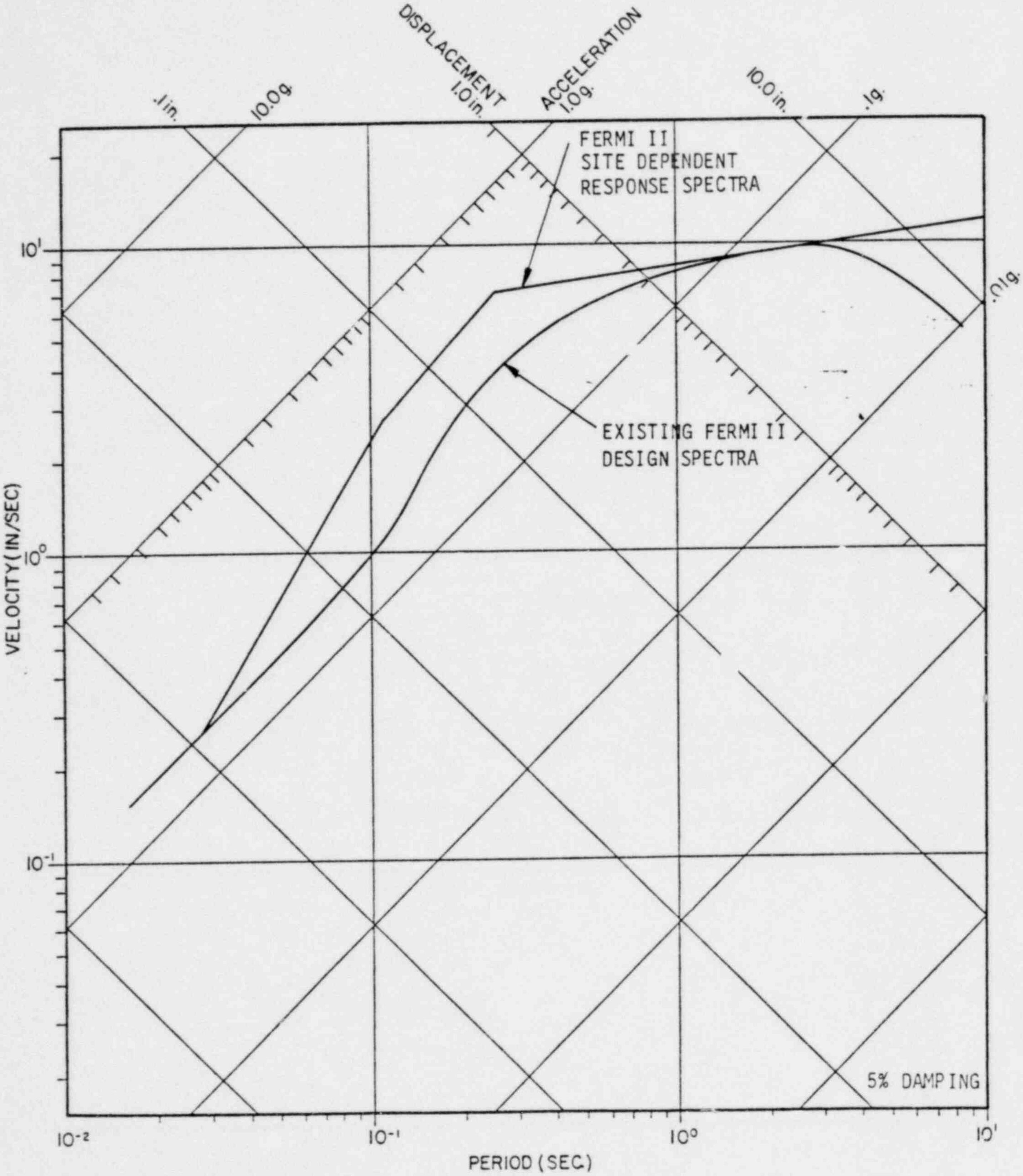
YR MODA	HRMN SEC	LAT.	LONG.		INT	MAGNITUDE MB	MN	ML	DISTANCE KM.	PEAK GROUND MOTION MMI	ACC(G)	VEL(CM/S)	SOURCE
19360131	1930	41.200N	83.200W		4	0.0	0.0	0.0	94.5	3.3	0.022	1.23	NU 2
19370302	144736.	40.500N	84.340W		7	0.0	0.0	0.0	185.5	4.2	0.035	2.24	NU1
19370303	0950	40.700N	84.000W		5	0.0	0.0	0.0	152.9	3.2	0.022	1.19	BB1
19370309	0545	40.470N	84.280W	-	9	0.0	0.0	0.0	186.1	4.7	0.047	3.33	DO1
19370502	1705	40.700N	84.000W		4	0.0	0.0	0.0	152.9	2.6	0.016	0.80	DO 2
19380212	0537	41.600N	87.000W		5	0.0	0.0	0.0	312.2	2.2	0.013	0.61	DO
19380313	1:10	42.400N	83.200W		4	3.8	0.0	2.4	49.1	3.8	0.030	1.83	NU12
19400816	0430	40.900N	82.300W		4	0.0	0.0	0.0	142.1	2.7	0.017	0.84	NU 2
19430309	042534.	41.610N	81.330W		5	0.0	0.0	0.0	164.2	3.1	0.021	1.12	EH12
19470810	0147	42.000N	85.000W		6	0.0	0.0	4.8	143.8	3.2	0.022	1.22	EH1
19511204	0702	41.650N	81.410W		4	0.0	0.0	0.0	156.7	2.6	0.016	0.78	WG 2
19520620	0935	39.700N	82.200W		6	0.0	0.0	5.0	266.1	2.6	0.016	0.79	EH1
19530612	0445	41.670N	83.550W		4	0.0	0.0	0.0	40.2	4.0	0.032	1.98	EP1
19550526	180923.	41.330N	81.400W	-	5	0.0	0.0	0.0	169.2	3.1	0.021	1.09	WG 2
19550429	011633.	41.330N	81.400W		4	0.0	0.0	4.3	169.2	2.6	0.016	0.79	WG12
19560127	1103	40.450N	84.220W		5	0.0	0.0	0.0	195.9	3.0	0.019	1.01	DO
19570629	112509.	42.920N	81.320W		0	0.0	3.8	4.2	191.2	2.4	0.015	0.69	EP12
19610222	0545	41.200N	83.400W		5	0.0	0.0	4.3	85.2	3.4	0.024	1.32	EH1
19660101	132338.	42.890N	79.200W		6	4.7	0.0	0.0	424.9	2.2	0.013	0.61	US12
19670202	0530	42.730N	84.540W		4	0.0	0.0	0.0	135.5	2.7	0.017	0.88	US1
19670405	054032.3	39.555N	82.489W		5	4.5	0.0	0.0	274.7	2.7	0.017	0.85	NO
19681109	170141.1	38.000N	88.500W		7	0.0	5.5	0.0	626.0	2.3	0.014	0.65	US1
19760202	211402.0	41.960N	82.670W		0	0.0	3.4	0.0	48.5	3.4	0.024	1.34	PD

THIS CATALOG LISTS 83 EARTHQUAKES



COMPARISON OF FERMI II SITE DEPENDENT RESPONSE SPECTRA WITH LAWRENCE LIVERMORE AND WESTON GEOPHYSICAL EASTERN U.S. ROCK SPECTRA FOR MAGNITUDE 5.3 EARTHQUAKES

FIGURE 2.1-1



COMPARISON OF FERMI II SITE DEPENDENT RESPONSE SPECTRA AND EXISTING FERMI II DESIGN SPECTRA

FIGURE 2.1-2

SARGENT & LUNDY
ENGINEERS

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A943YC

CALC NO. CALC NO 8 11 0-3
PROJECT FERMI REV 0
PROJECT NO. 6139-38
DAMPING 0.050
PAGE

SLS(NI)-18
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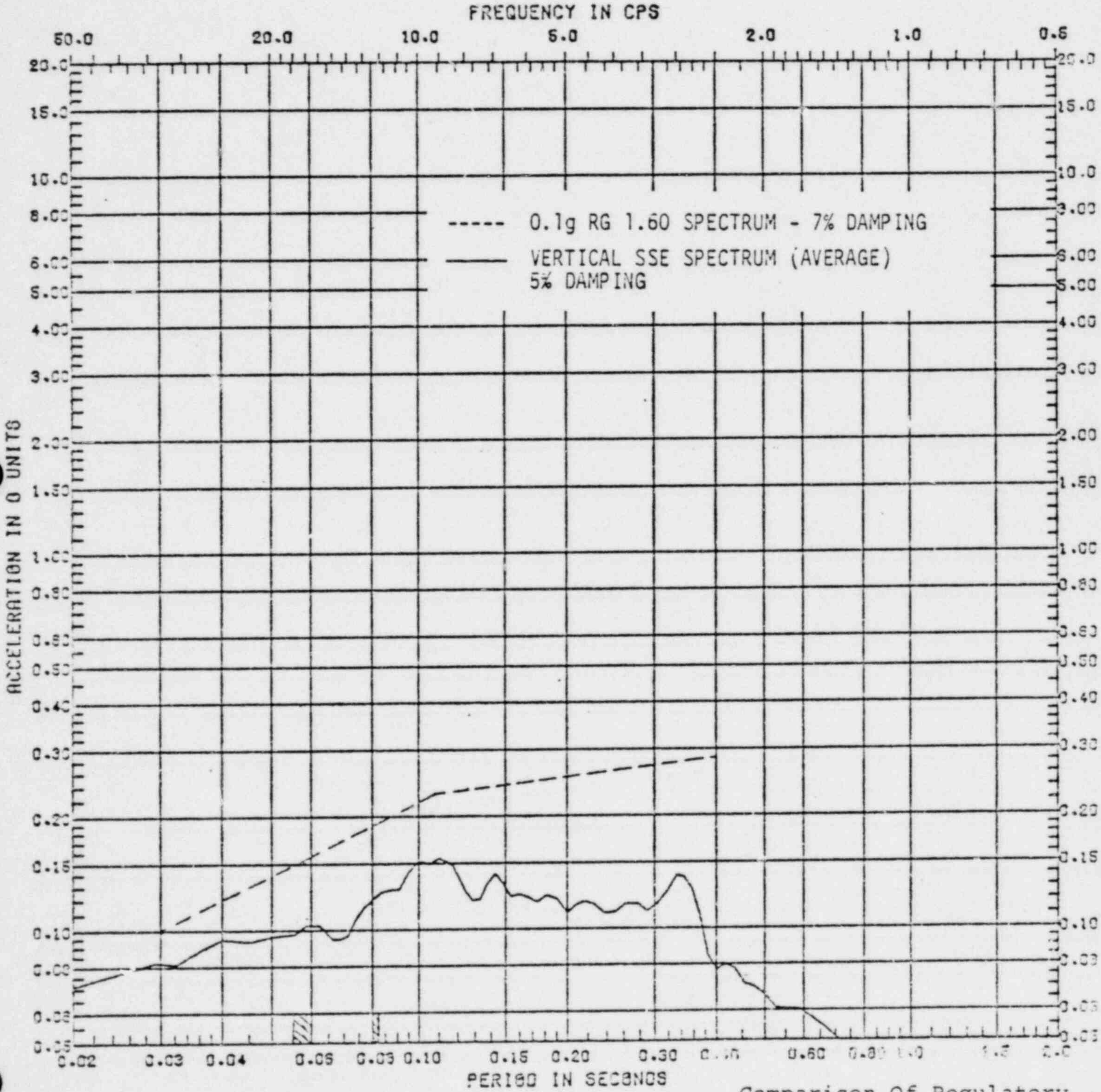


FIGURE 2.1-3

Comparison Of Regulatory Guide 1.60 and Average Time History Spectra

RESPONSE SPECTRUM SPECTRA NO

NODE AVERAG ELEVATION

1 DIRECTION ANGLE LOCATION ELCEN40.34.TAFT.OLYMPIA

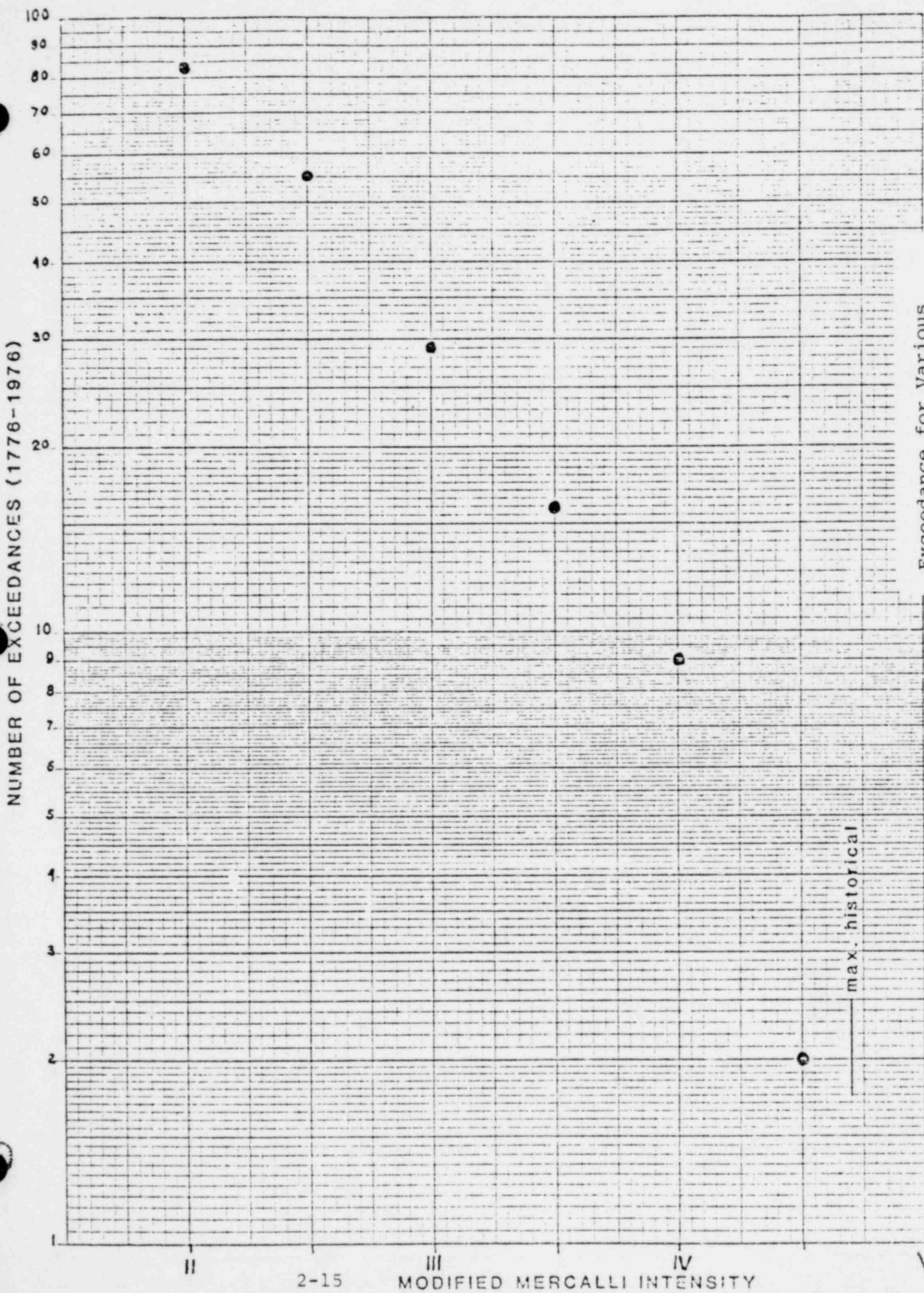


Figure 2.1-4 Exceedance for Various Intensity Level Earthquakes (1776-1976)

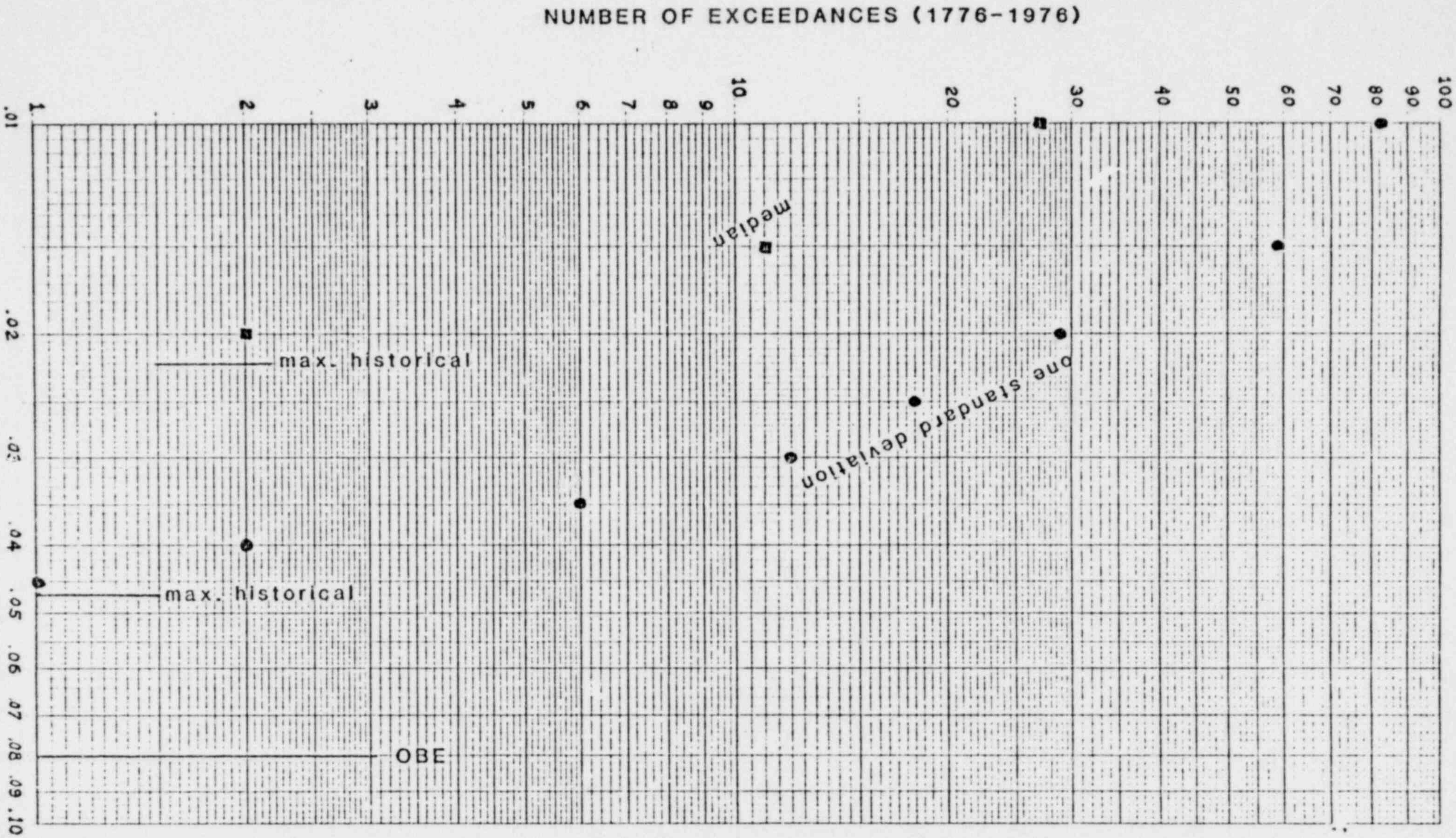


Figure 2.1-5 (from reference 2.2)
Exceedance for Sustained Acceleration

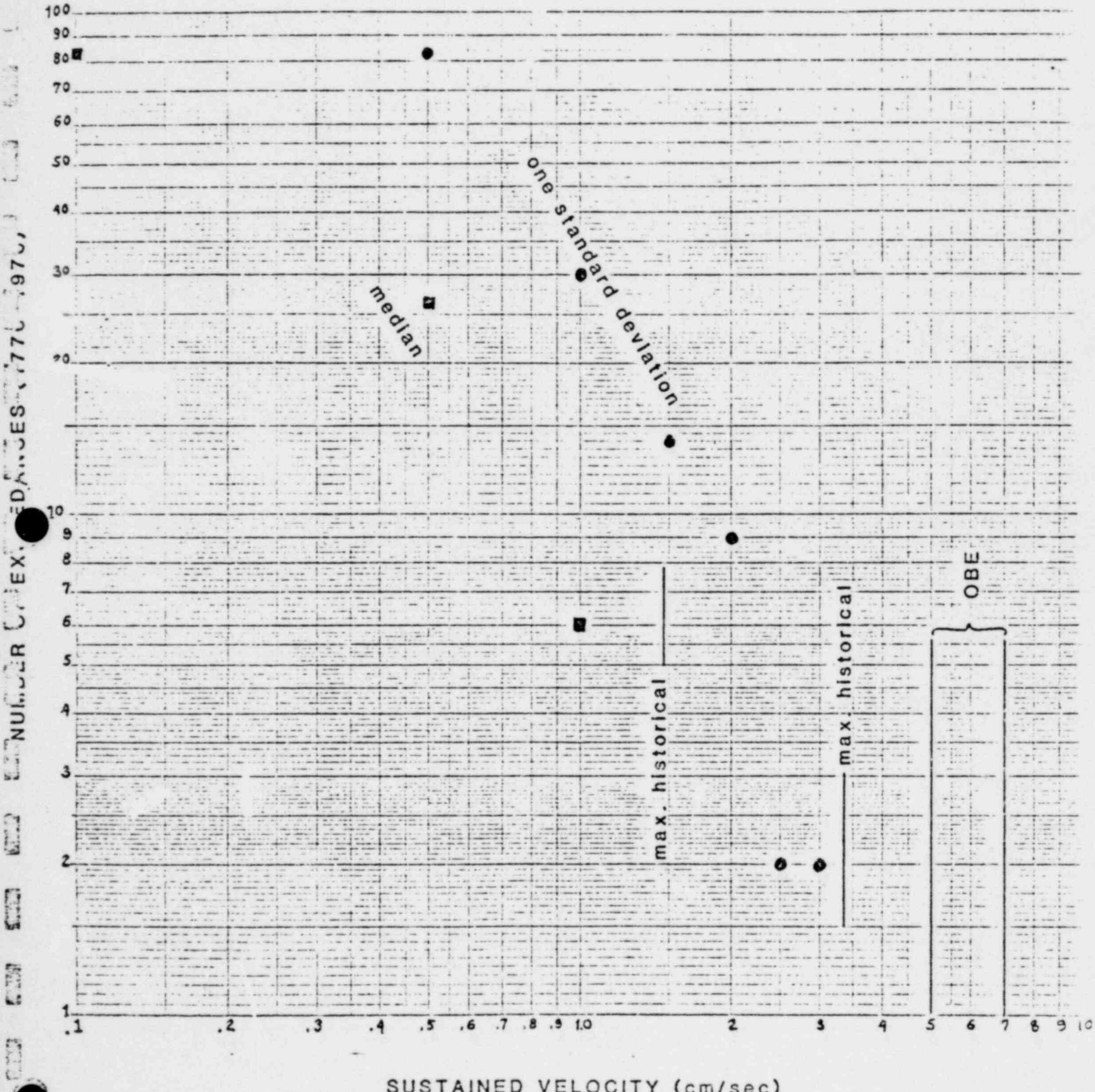


Figure 2.1-6
(from reference 2.2)
Exceedance for Sustained Velocity

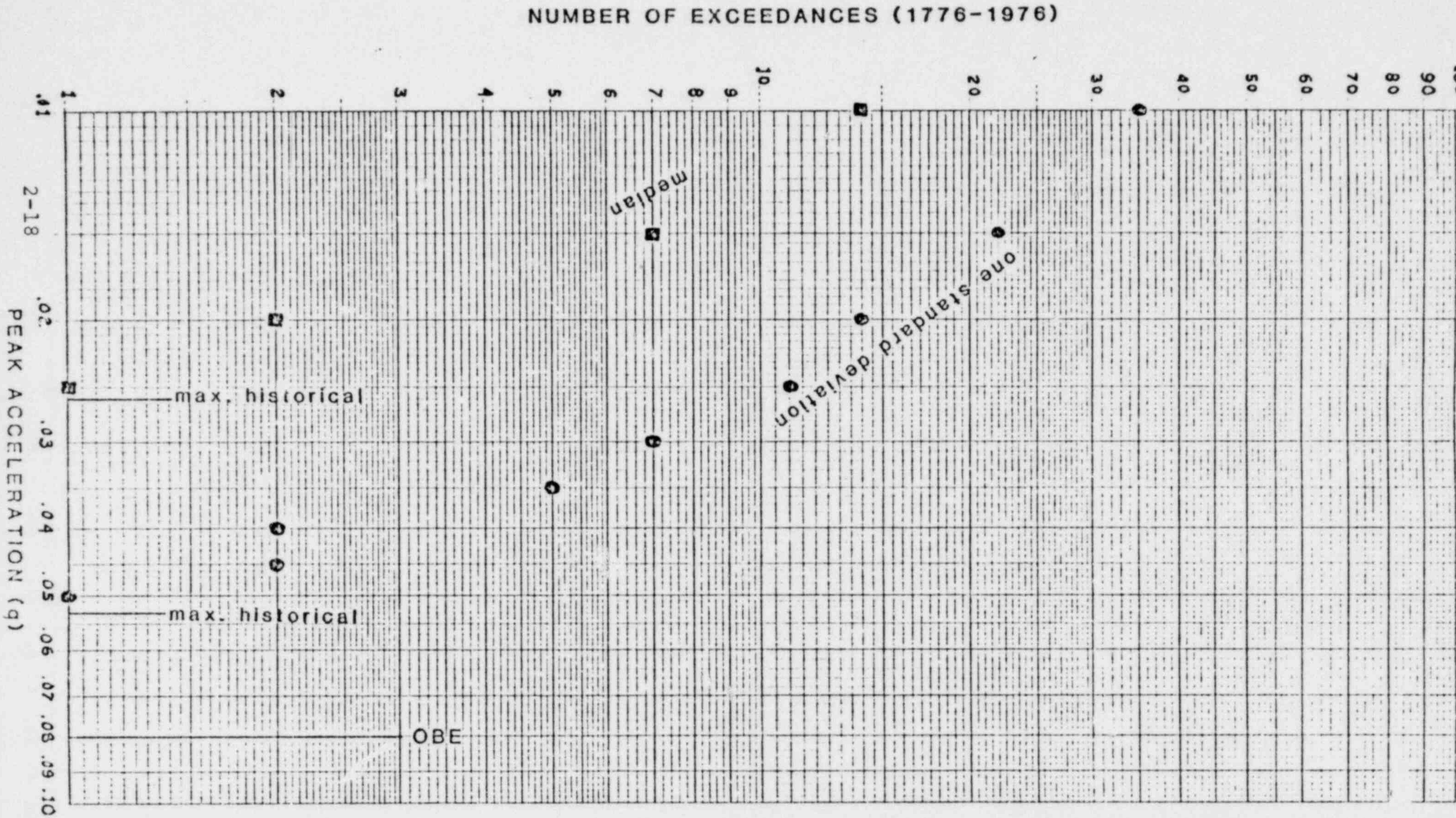


Figure 2.1-7 Exceedance for Peak Accelerat.( )

(from reference 2-3)

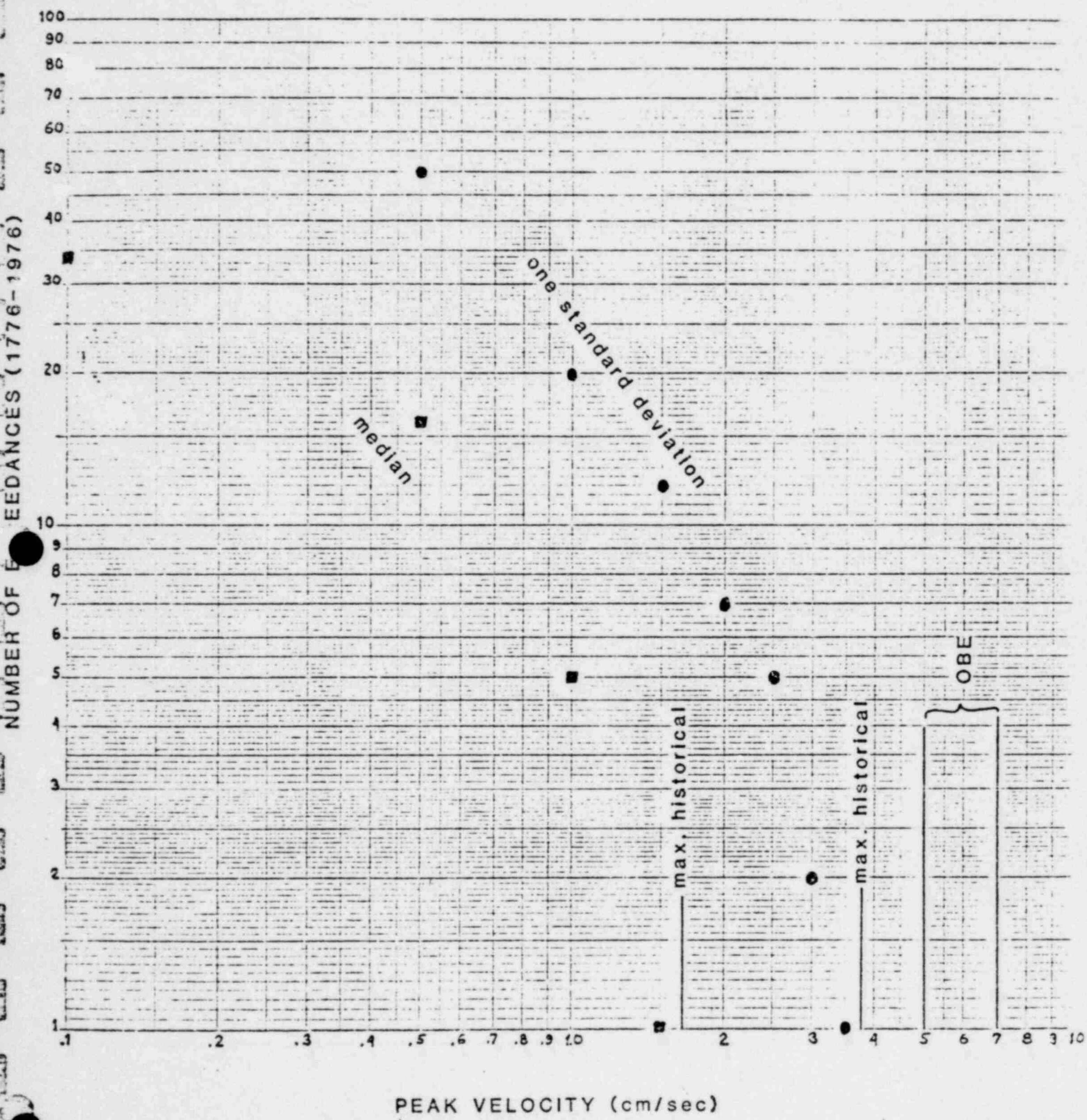


Figure 2.1-8
(from reference 2-3) Exceedance for Peak Velocity

3.0 STRUCTURAL ANALYSIS

This section summarizes the methods used to develop building response spectra from the site-specific ground motion spectra discussed in Section 2.0 of this report.

3.1 Synthetic Acceleration Time Histories

Two synthetic acceleration time histories matching the 7% damped site spectrum of Section 2.0 were generated for use as horizontal forcing functions. These time histories were developed by repeatedly modifying the N-S and E-W components of the 1940 El Centro data until the spectra they provided enveloped the ground response spectra discussed in Section 2.0. These envelopes meet the acceptance criteria of NRC Standard Review Plan 3.7.1. The synthetic time-history spectra and the site spectra are plotted in Figures 3.1-1 and 3.1-2.

The vertical forcing functions used in the original design-basis seismic analysis are described in the Fermi-2 FSAR Subsection 3.7.1.2. In the present reanalysis, the vertical seismic base spectrum was obtained by factoring the average of the four spectra discussed in FSAR Subsection 3.7.1.2 so it resulted in a spectrum equal to, or above, two-thirds the Fermi site-specific horizontal spectra discussed in Section 2.0. A factor of two was used to bound the site spectra with the design-basis vertical spectra, as discussed in Section 2.0.

3.2 Structural Analytical Models

3.2.1 Horizontal Seismic Models

Fermi-2 FSAR Subsection 3.7.2.1.2.2 describes the building models used in this seismic analysis. The damping values used in the building models are consistent with the damping values given in Regulatory Guide 1.61.

The reactor pressure vessel (RPV) was coupled with the reactor auxiliary building in this analysis. The RPV model is presented on GE drawing 761E774, Revision 4, dated September 5, 1979.

3.2.2 Vertical Seismic Models

The vertical seismic models used in this analysis are presented in Fermi-2 FSAR Subsection 3.7.2.2.1.2.

3.3 Method of Analysis and Response Spectra Generation

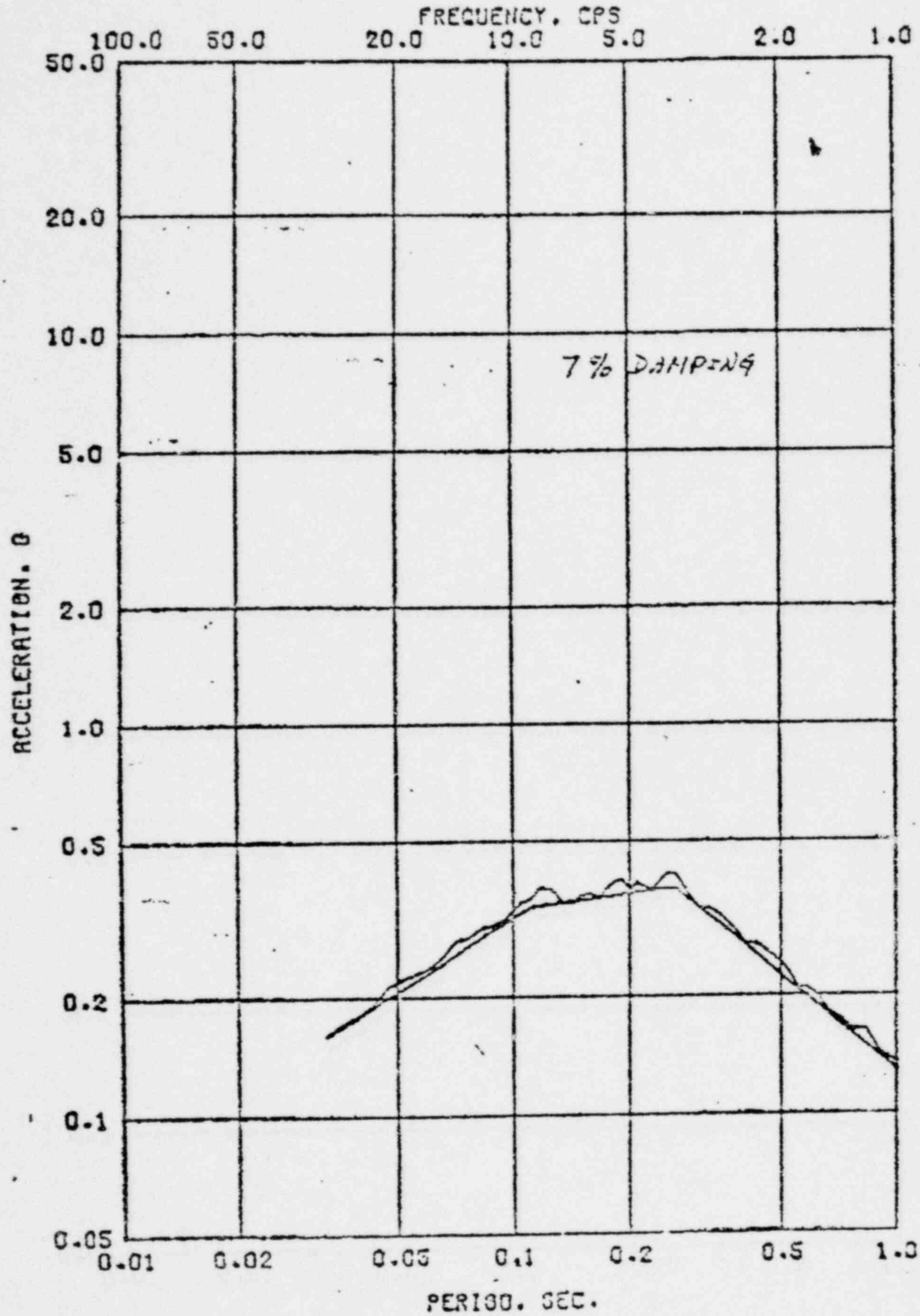
The horizontal seismic responses were obtained by a time-history method of analysis using the Sargent & Lundy computer program DYNAS. In the analysis, the two spectrum-consistent synthetic time histories (north-south direction and east-west direction) described in Section 3.1, were applied simultaneously. The acceleration response time histories for the slabs and the other structural nodes, and the maximum moments and forces in all the structural members were obtained from this analysis.

Response time-history motions obtained from the building model seismic analyses were used as input motions to the Sargent & Lundy computer program RSG which generated horizontal response spectra for 1%, 2%, 5%, 7%, and 10% damping. Peaks of the spectra were widened by 10% on each side.

As discussed previously, reanalysis of vertical seismic response spectra was unnecessary. The response spectra obtained from the original design-basis vertical analysis discussed in Fermi-2 FSAR Section 3.7.2.2.1.2 were multiplied by a factor of two to obtain the response spectra for the present reanalysis.

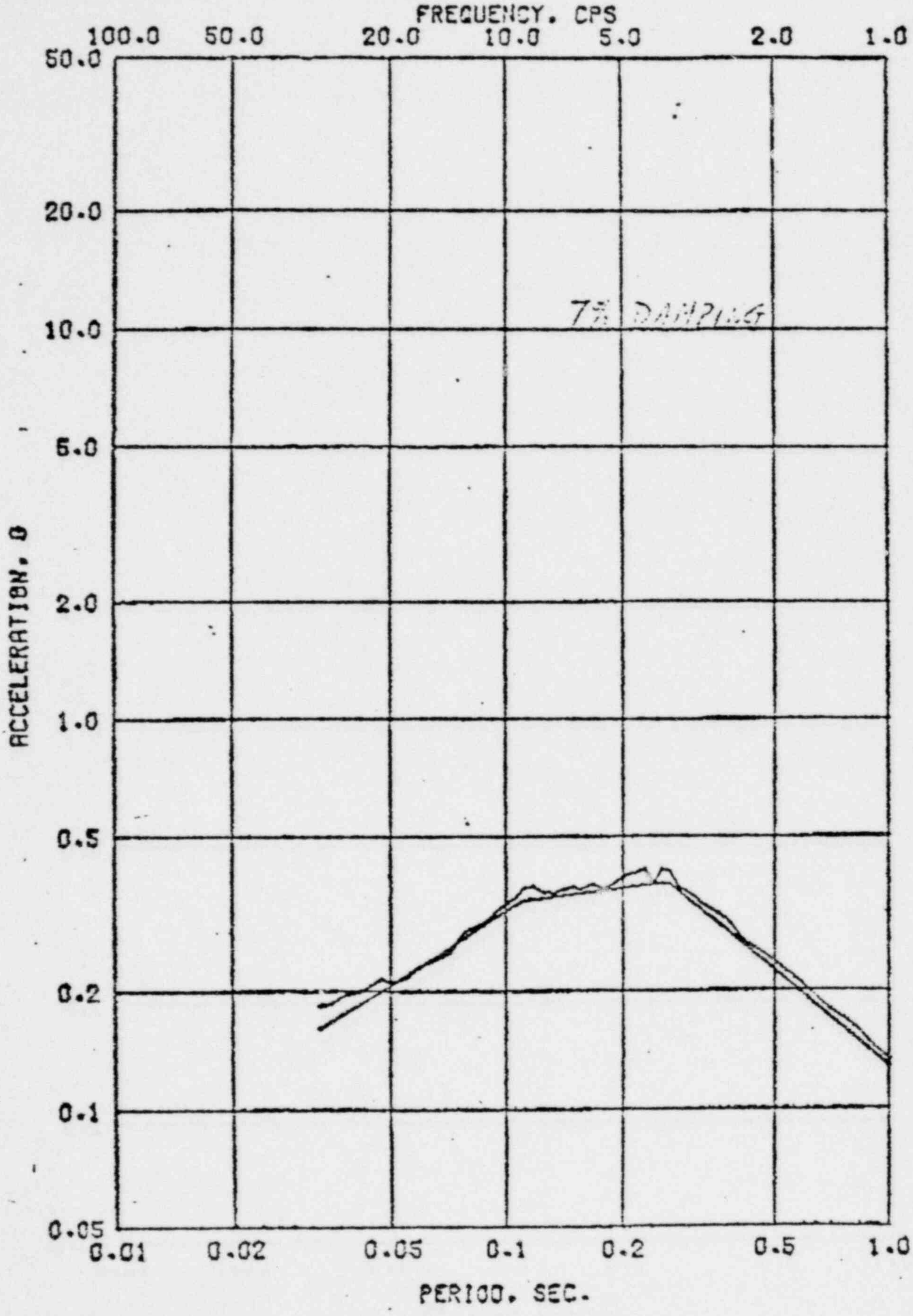
Overlays of all the response spectra from the site-specific SSE and the FSAR SSE have been generated. These 50 figures show the reactor auxiliary building and RHR complex floor response spectra resulting from the site-specific SSE overlaid with those of the original floor response spectra from the FSAR SSE.

The original spectra were drawn for damping values of 1%, 2%, 5%, and 10%. The overlaid curve from the site-specific SSE is based on 7% structural damping and 5% equipment damping.



HORIZONTAL RESPONSE SPECTRUM AND SYNTHETIC TIME HISTORY
FOR N-S COMPONENT OF EL CENTRO 1940

FIGURE 3.1-1



HORIZONTAL RESPONSE SPECTRUM AND SYNTHETIC TIME HISTORY
FOR E-W COMPONENT OF EL CENTRO 1940

FIGURE 3.1-2

4.0 STRUCTURAL REASSESSMENT

4.1 Program Description

The structural reassessment was performed using essentially the same models as were used in the FSAR, with site-specific SSE structural response spectra and associated structural loads as described in Section 3.0. Detailed analyses were performed on selected structures associated with the drywell, the reactor auxiliary building, and the RHR complex. The drywell structures are discussed in Section 4.2.1; the reactor auxiliary building and the RHR complex structural components are discussed in Section 4.2.2.

The evaluation of primary containment structural integrity is presented in Section 4.3. The suppression chamber calculations performed earlier were reexamined against the new site-specific spectra. A detailed reanalysis was determined to be unnecessary because the accelerations used to design the seismic ties envelope the peak response values from the new spectra. Section 4.3.2 provides more details on torus and torus supports. Similarly, the buried ducts and piping design calculations were reexamined against the new site-specific spectra, and the ground particle velocities used in the design were determined to be conservative when compared to the postulated new conditions. Section 4.4 provides more details on this reevaluation.

4.2 Reassessment of Structures

4.2.1 Drywell Structures

This section describes the assessment of the structural adequacy of the following parts of the Fermi-2 plant for the loads of the site-specific SSE with 7% structural damping:

- o reactor pedestal
- o stabilizer truss
- o sacrifical shield
- o drywell shield wall
- o spent fuel pool
- o dryer-separator pool

The drywell structural components were assessed for the following load combinations:

1. $DL + T_o$
2. $DL + T_o + SSE$
3. $DL + SSE$

where DL = dead load plus applicable live load (if any), from previous calculations

T_o = thermal load at operating temperature

SSE = loads due to the safe shutdown earthquake, including horizontal and vertical excitations

The horizontal SSE response spectra are those reported in the Sargent & Lundy (S&L) report SDD-DECO-003, dated April 18, 1981. The vertical loads were calculated using the FSAR SSE vertical response spectra (originally given in S&L report SL-2682, dated September 27, 1974) multiplied by a factor of 2.0, as discussed in Section 2.0 of this report.

The design sections of the reactor pedestal and the drywell shield wall were checked for their capacities based on the interaction diagrams plotted by the computer program COLID according to the ACI-1977 code. The adequacy of these sections is assessed by plotting on the interaction diagram the load point represented by the most critical load combination. The structural steel components, the stabilizer truss, and the sacrificial shield were assessed by comparing the principal stresses from the most critical load combination with the allowable stresses.

The structural components assessed were found to have strength adequate to accommodate the specified load combinations, including the site-specific SSE.

The seismic reevaluation summary for each of the following components required for hot shutdown, is provided in Table 4.2-1.

Component	Table Item No.
Reactor Pedestal	1
Stabilizer Truss	2
Sacrificial Shield	3
Drywell Shield Wall	4

4.2.1.1 Spent Fuel Pool

Though not required for hot shutdown, the spent fuel pool was reassessed to confirm that it would maintain its integrity under the loads of the site-specific SSE. The summary is presented as item 5 in Table 4.2-1. The analysis showed that the combined loads under the site-specific SSE are greater than the original design loads by approximately 3%, well within the margin of the original design.

4.2.1.2 Dryer-Separator Pool

Like the spent fuel pool, the dryer-separator pool is not required for hot shutdown but was reassessed to confirm that its integrity would be maintained under the loads of the site-specific SSE. The summary is presented as Item 6 in Table 4.2-1. The same method was used as that to evaluate other drywell structures. From the interaction diagrams, it is concluded that the dryer-separator pool would accommodate the loads resulting from the site-specific SSE.

4.2.1.3 Tabulation of Original Load Combinations

In response to the NRC staff's request, a tabulation of LOCA stresses was performed for structural components in which the stresses from the site-specific SSE represents more than 10% of the allowable stress. These are the reactor pedestal, the stabilizer truss, and the sacrificial shield.

4.2.2 Reactor Auxiliary Building and RHR Complex Structural Components

The assessments of structural components discussed in this section are summarized in Table 4.2-2. Detailed calculations have been performed.

4.2.2.1 Reactor Building Mat Foundation

The reactor building mat foundation was originally designed in 1970 for the most critical design condition including the hydrostatic load due to maximum water level. In 1980 the mat was reviewed for all the FSAR load combinations with ACI-318 (1977) allowable stresses to determine the acceptable additional loads transmitted by the torus supports due to SRV and LOCA.

For the reevaluation of the mat for the increased loads due to site-specific SSE, the same mat model was used to compute the additional moments in the critical areas of the mat. The mat was found adequate to sustain the site specific SSE load in combination with permanent loads on the structure, including hydrostatic pressure due to subsoil water at elevation 576'-0," with sufficient margin to sustain an additional uplift load of 1370 K per mitre.

4.2.2.2 Auxiliary Building Mat Foundation

The two mat areas at elevations 540'-0" and 551'-0" were reviewed separately for site specific SSE loads in combination with other permanent loads and hydrostatic loads with subsoil water at 576'-0".

The bending moments and shears developed in the mat for these design conditions were found to be within the mat capacities.

4.2.2.3 Reactor Auxiliary Building Shear Walls

Two levels of shear walls at elevations 540'-0" (at the mat foundations) and 583'-6" (just above the grade level) were identified as the most critical walls for structural reevaluation.

Shear forces in the various walls were obtained as spring forces from S&L Calculation No. SDD-DECO-003. The moments at the desired elevations were calculated individually for each wall. Dead loads on the walls were assembled from the existing calculations.

Shears were reviewed in each wall separately and the effect of moments due to seismic excitation in two directions was reviewed considering the shear wall grouping at an elevation acting as an overall box-type cross-section. Effect of vertical seismic forces was combined on a SRSS basis.

At elevations 540'-0" and 583'-6" the shear walls remain in compression, at all points, under the combined dead loads and seismic loads. The shear stresses in the concrete are quite low and the shear capacity of the concrete and reinforcement provided are well above these seismic shear stresses.

4.2.2.4 Reactor Auxiliary Building Cable Tray Hangers

The reactor auxiliary building contains approximately 3500 Category I cable tray hangers. A random 10% sample of hangers at various elevations was used to evaluate the effect of higher response spectra based on the site-specific SSE.

An envelope of N-S and E-W response spectra at each elevation in combination with enveloped vertical response spectra for all elevations was used to determine the adequancy of cable tray hangers with design basis load of 40 psf (50 psf in relay room).

The review qualified about 70% of the hangers as adequate. The remaining 30% will be assessed based on as built cable loading.

4.2.2.5 Reactor Auxiliary Building Superstructure Steel

The seismic shear stresses in each braced row of columns above elevation 684'-6" and horizontal roof loads were obtained as corresponding spring forces and slab loads from S&L Calculation

No. SDD-DECO-003 in order to review the structural adequacy of vertical and horizontal bracings. For other major structural members seismic forces were obtained from crane level response spectra; for horizontal forces, a scale factor based on the ratio of the maximum of the values at the roof level and crane level was used. The forces and stresses obtained for these members were compared with the corresponding values in the existing design which was governed by the design-basis tornado loads.

The effect on the structural members due to the new seismic loads was found to be considerably less than the effect of tornado loads. All members were found structurally adequate.

4.2.2.6 RHR Complex Base Mat

The RHR complex base mat with thick perimeter walls and fairly equal internal column spacing was assumed to act as a flat slab.

The most critical load condition was identified as one with an empty cold water basin and high subsoil water level in combination with new seismic loads. This load condition is extremely conservative for slab design since during any safe shutdown event the cold water base will have some amount of water.

The capacity of the mat was found to be more than adequate to safely sustain the above loads.

4.2.2.7 RHR Complex Shear Walls

All shear walls of the RHR complex were evaluated for revised seismic forces. Design procedure was generally similar to that used for the reactor auxiliary building walls, except that for moment capacity a smaller flange length of the cross-walls was used due to the low height of the structure. Wall stresses were checked in combination with shear stresses and moments due to lateral soil pressures.

All the shear walls in the RHR complex were found to be structurally adequate.

4.2.2.8 RHR Complex Cable Tray Hangers

The RHR complex contains approximately 480 Category I cable tray hangers. Fifty hangers were randomly selected from the various elevations for seismic reevaluation. The review procedure is the same as that used for the reactor auxiliary building (Section 4.2.2.4).

This review qualified approximately 95% of the hangers as adequate. The remaining 5% will be assessed based on as built cable loading.

4.2.2.9 Cable Trays

The cable trays behave as essentially rigid bodies. They were designed for a load of 100 pounds per square foot, but are actually limited to a load of 40 pounds per square foot.

In the judgment of Detroit Edison, the design of the cable trays is adequate to ensure their integrity when subjected to the loads of the site-specific SSE.

4.3 Reassessment of Containment

4.3.1 Primary Containment

The structural integrity of the primary containment under the loads of the site-specific SSE was evaluated by examination of the most highly stressed point. From Chicago Bridge & Iron (CB&I) stress report number T23-00-A-900-RA-005 (File no. B2-204), the location of highest stress is the drywell shell at the embedment interface.

Shear and moment values for the containment vessel resulting from the FSAR SSE and the site-specific SSE are shown in Figure 4.3-1. The original horizontal seismic stresses at the critical point were multiplied by the ratio of the shear forces and the moments to obtain the horizontal seismic stresses resulting from the site-specific SSE. The original vertical seismic stresses were multiplied by the factor of 2.0 ratio between the FSAR SSE vertical spectrum and the site-specific SSE vertical spectrum. These original and revised stress values are shown in Table 4.3-1, excerpted from the CB&I design report with annotation by Detroit Edison. The table shows that the combined stresses of the highest stressed point are well below the maximum code allowable of S_y = 33,800 psi. The seismic reevaluation summary table for the primary containment is shown in Table 4.3-2.

4.3.2 Torus and Torus Supports

The structural adequacy of the torus and the torus supports was assessed by comparison of the original CB&I seismic design loads with the loads resulting from the site-specific

SSE loads. In the CB&I design calculations, the governing design loading was conservatively assumed to be 0.46 g for the SSE, with the torus evaluated on the basis of yield strength allowables. The site-specific SSE gives a peak response of 0.42 g to be evaluated under similar conditions. Because this value is lower than the design value, the design of the torus and torus supports is considered to be adequate to accommodate the loads of the site-specific SSE.

Evaluation of torus design under normal operating loads plus the SSE will be conducted as part of the Mark I containment plant-unique analysis. It is expected that this evaluation will show that the conservative design of the torus is adequate to accommodate these loads.

4.4 Reassessment of Buried Pipes and Duct Runs

The following paragraphs summarize the effects of the recently defined site-specific spectra on the seismic design of buried pipes and duct runs. The site parameters affecting the seismic design of buried pipes and duct runs include the apparent shear wave velocity, the maximum ground particle velocity, and the modulus of subgrade reaction for the backfill. In the Fermi-2 design, an apparent shear wave velocity of 2500 ft/sec, maximum ground particle velocity of 7.2 in/sec, and a modulus of subgrade reaction of 50 to 100 lb/in^3 (depending on pipe diameter) were used.

The apparent shear wave velocity and the modulus of subgrade reaction for the backfill are physical properties of the medium and are independent of SSE level. Thus, these parameters are not affected by the use of the site-specific spectra.

The maximum ground particle velocity is a function of the earthquake characteristics. The 7.2 in/sec velocity used for the design at Fermi 2 was based on a 0.15 g SSE and the Reference 4-1 for strong motion (a >0.1 g) earthquakes recorded on firm ground.

For the Fermi-2 site-specific SSE, a ground particle velocity of 6.0 in/sec would be appropriate, based on engineering judgment and Reference 4-2. As larger ground particle velocities lead to higher stresses, the 7.2 in/sec value used in the design is conservative, and further reevaluation is considered unnecessary.

4.5 References

4-1 Hall, W. J., Mohraz, B., and Newmark, N. M., Statistical Studies of Vertical and Horizontal Earthquake Spectra, Report NUREG-0003, January 1976, for the U.S. Nuclear Regulatory Commission, Washington, D. C.

4-2 Hall, W. J., and Newmark, N. M., "Seismic Design Criteria for Pipelines and Facilities," Journal of the Technical Councils of ASCE, Proceedings of the American Society of Civil Engineers, Vol. 104, No. TCI, November 1978.

TABLE 4.2-1

DRYWELL STRUCTURES

SEISMIC REEVALUATION SUMMARY TABLE

Item	System, Structure, Component Description	Method of Original Qualification				Reevaluation Results				Conclusion and Remarks
		Test	Analysis	Calc. #	Spectra #	Site Specific Spectra	% Margin	Analysis Calc. #	% Margin of Safety	
1	Reactor Pedestal		X	NO-01	FSAR Fig. 3.7-3, 3.7-9	Fig. 2-2, 2-3	--	SDD-DECO-004	(1)	Adequate
2	Stabilizer Truss		X	NO-02	"		--	"	1000	Adequate
3	Sacrificial Shield		X	NO-03	"		--	"	240	Adequate
4	Drywell Shield Wall		X	5.04.12	"		--	"	(1)	Adequate
5	Spent Fuel Pool		X	7.01.00	"		--	"	--	3% over stressed See Subsection: 4.2.1.1
6	Dryer Separator Pool		X	7.01.00	"		--	"	(1)	Adequate

(1) The actual forces are plotted on the capacity interaction diagram.

TABLE 4.2-2

SEISMIC REEVALUATION OF REACTOR/AUXILIARY BUILDING

AND RHR COMPLEX STRUCTURAL COMPONENTS

SUMMARY TABLE

Item	System, Structure, Component Description	Method of Original Qualification				Reevaluation Results				Conclusion and Remarks
		Test	Analysis	Calc. #	Spectra #	Site Specific Spectra	% Margin	Analysis Calc. #	% Margin of Safety	
1	Reactor Building Mat		X	SF-0002	FSAR Fig. 3.7-3 & 3.7-9	Fig. 2-2, 2-3	--	SF 0003	See Remarks	Section 4.2.2.1 describes adequacy
2	Auxiliary Building Mat		X	3-02	"	"	--	AF-01	30%	Adequate
3	Reactor/Aux. Building Shear Walls		X	3.01	"	"	--	SC-0001	20%	Adequate
4	Reactor/Aux. Building Cable Tray Hangers		X	2.02.01-2.02.08 & EE 0005, EE 0006	Pg. 1-15, Part A of Calc. # EE 0005	Pgs. 3.1-3.7 of EE0013	--	EE 0013	See Remarks	Section 4.2.2.4 describes adequacy
5	Reactor/Aux. Building Superstructural Steel		X	4.02.08	FSAR Fig. 3.7-3 & 3.7-9	Fig. 2-2, 2-3	--	SS 0001	15%	Adequate

TABLE 4.2-2 (Cont'd)

SEISMIC REEVALUATION OF REACTOR/AUXILIARY BUILDING

AND RHR COMPLEX STRUCTURAL COMPONENTS

SUMMARY TABLE

Item	System, Structure, Component Description	Method of Original Qualification				Reevaluation Results				Conclusion and Remarks
		Test	Analysis	Calc. #	Spectra #	Site Specific Spectra	% Margin	Analysis Calc. #	% Margin of Safety	
6	RHR Complex Mat		X	1.2.1	FSAR Fig. 3.7-3, 3.7-9	Fig. 2-2, 2-3	--	1.31.1	20%	Adequate
7	RHR Complex Shear Walls		X	1.15.10	"	"	--	1.30.1	15%	Adequate
8	RHR Comlex Cable Tray Hangers		X	EE-0101 EE 0008, EE 0009	SL-3147, SHT. A4-A7, A10-A13 & B12-B15	Pgs. 1.6-1.9 of EE0014	--	EE 0014	See Remarks	Section 4.2.2.8 describes adequacy

CHICAGO BRIDGE & IRON COMPANY

Location Memphis

Summation of Drywell Stresses ; CB & I Case # 6 ACCIDENT LBE & 56 PSIG

Point	?		M		CASE TO NEW EARTHQUAKE		ASME CODE ALL. Sy For SA-516 Gr 70	
Thickness								
Loadings \ Stresses	Merid lb/in	Circum lb/in	Merid lb/in	Circum lb/in	Merid lb/in	Circum lb/in	Merid lb/in	Circum lb/in
General Pressure	11424	11424	11424	11424	11,424	11,424		
Dead & Live Load ⚠1	-2823	2981	-3530	3702	-3,530	3,702		
Vertical Seismic ⚠1	380	-400	472	-494	944	-988		
Horizontal Seismic	1840	-1840	⚠1 2605	-2605	4,819	-4,819		
Summation (+ Ea.) lb/in ⚠1	10821	12165	10971	12027	13,657	9,319	33,800	33,800
Summation (- Ea.) lb/in	6381	16645	4817	18225	2,131	20,933		
Summation (+ Ea.) psi ⚠1	7214	8110	7314	8018	9,104	6,212	33,800	33,800
Summation (- Ea) psi	4254	11097	3211	12150	1,420	13,955		

ADDED BY F.E. GREGOR
DETROIT EDISON. 5-18-81

Note: Stresses due to horizontal and verticle earthquake are (+) or (-). (+) earthquake stresses yield a (+) meridional stress resultant.

TABLE 4.3-1

CALCULATED STRESSES IN PRIMARY CONTAINMENT

Subject: Drywell Stress Summary

Change No. 69-5562

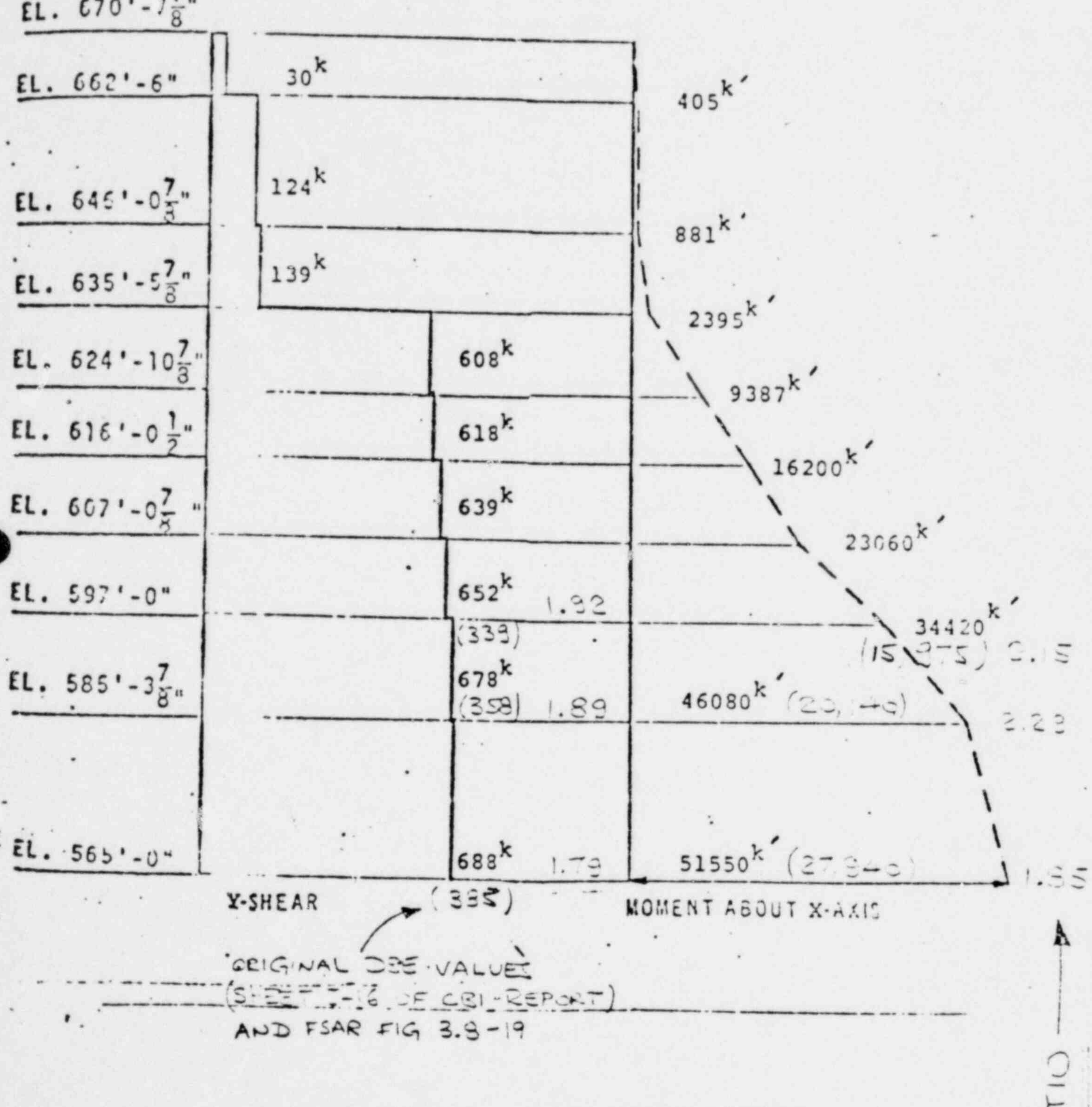
TABLE 4.3-2

PRIMARY CONTAINMENT

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Primary Containment		X	T23-00-A-900-RA005	Shear Moment Diagram	No		Attached		Equipment is qualified



CONTAINMENT VESSEL - SHEAR MOMENT DIAGRAM
SAFE SHUTDOWN EARTHQUAKE - 7% DAMPED SITE SPECTRA

FIGURE 4.3-1

5.0 EQUIPMENT SELECTION AND EVALUATION

The approach used to demonstrate the seismic design adequacy of the Fermi-2 systems involves the following elements:

- o A scenario is identified which describes the way in which Fermi-2 would respond to the postulated seismic event
- o Based upon the results of the scenario, systems are identified which are required to shut down and cool down the reactor
- o The components associated with requisite systems are identified
- o Components are evaluated with regard to seismic response

The information contained in this section addresses the above process as it relates to selection of equipment. Section 6.0 of this report addresses equipment interconnections, including nozzles, valves, piping, and associated snubbers and supports which are qualified by detailed analysis. Section 6.0 also describes small diameter piping elements, such as tubing and conduit, which can be addressed by generic analysis.

5.1 Event Scenario

The postulated seismic event induces a loss of offsite power (LOP) that is similar to that presented for the loss of all grid connections, presented in Subsection 15B.2.6 of the Fermi-2 FSAR. Table 5.1-1 presents the scenario for a seismically induced LOP. The scenario is characterized by early automatic control of reactor level and pressure by the RCIC and SRV, respectively. Following stabilization of reactor vessel level and pressure, operator action is taken to cool down and depressurize the reactor. As indicated in Subsection 15B.2.6.5 of the FSAR, the consequences of a LOP are not significant:

> "While the consequences of this event do not result in fuel failure, it does result in the discharge of normal coolant activity to the suppression pool via SRV operation. Since this activity is contained in the primary containment, there will be no exposure to operating personnel. Since this event does not result in an uncontrolled release to the environment, the plant operator can choose to leave the activity bottled up in the primary containment or discharge it to the environment under controlled meteorological and release conditions."

5.2 Identification of Systems and Components

Based upon the scenario in Table 5.1-1, a list of principal systems required to safely shut down and cool down the reactor was developed. In addition, a list of auxiliary systems required for principal systems operation was developed. The list of principal and auxiliary systems is contained in Table 5.2-1. Finally, a generic equipment list was developed to reflect the types of components which comprise the principal and auxiliary systems; the list is contained in Table 5.2-2.

5.3 Equipment Evaluation

The equipment which comprises the principal and auxiliary systems presented in Table 5.2-1 is characterized by mechanical, electrical (power), and instrumentation and control elements. These elements are evaluated in the following sections. Piping is evaluated in Section 6.0.

5.3.1 Mechanical Components of Principal Systems

The capability of the following RPV and internal components to accommodate the proposed higher seismic loads has been reassessed:

- o Top guide
- o Core plate
- o Stabilizer
- o Shroud support
- o CRD housing
- o CRD housing restraint beam
- o Fuel assembly

The assessment was based on the following:

1. Horizontal loads were taken from Sargent & Lundy calculation SDD-DECO-003.

2. Vertical loads were estimated by multiplying the SSE vertical loads in GE report 22A5676, Revision 1, by a factor of 2.

3. In the Sargent & Lundy study only half the CRD housings are accounted for. The CRD housing and CRD restraint beam loads are approximated by doubling the loads in SDD-DECO-003.

For this study, the core plate and top guide new seismic loads were compared to La Salle 1 loads (LOCA and seismic) as shown in Table 5.3-1. The Fermi-2 core plate loads are bounded by La Salle. The Fermi-2 top guide vertical load is bounded by La Salle's vertical load but is 18 kips over La Salle's horizontal load. However, due to the large margin the top guide is judged to be within design limits.

For the RPV support, the margin for moment is so large (221,000 in-kip versus 1,152,000 in-kip allowable) that the support is judged to be within design limits, and there is no need for further analysis.

Due to the large loads on the shroud support, a stress evaluation was performed as shown in Table 5.3-1. The results of this evaluation show that the stresses are within ASME Code allowable limits.

In summary, the RPV and internal components evaluated are judged to be able to accommodate the higher seismic loads. Analysis of the control rod drive system hydraulic control unit indicates considerable margin remains upon application of the revised response spectrum. Details of the evaluation are provided in Table 5.3-2.

The PHR pump and RCIC pump acceleration values for horizontal and vertical directions were determined as follows:

1. Original static coefficients:

   o Horizontal: 1.5 g
   o Vertical: 0.14 g x 2 = 0.28 g

2. Response spectra curves

   o Horizontal natural frequency: unknown
   o Vertical natural frequency: greater than 33 Hz

   Therefore, from spectra and dynamic methods currently accepted by the NRC, use 1.5 times the peak of the curve for horizontal direction, and the zero period acceleration (ZPA) value for the vertical direction. This results in:

   o Horizontal: 0.825 g
   o Vertical: 0.11 g x 2 = 0.22 g

3. The equipment was originally qualified for:

   o Horizontal: 1.5 g
   o Vertical: 0.14 g

4. This assessment is based on vertical seismic loads that are approximately twice the original seismic loads. It was judged acceptable to use a horizontal load less than that originally used to offset the increased vertical load, because the stresses are calculated using the combined vertical and horizontal loads.

5. Since the response spectra curves are unique to Fermi 2, and the 1.5 x peak acceleration was used to account for unknown frequency and multimode response, the response spectra curves were used in the horizontal

direction and the original seismic loads used in the vertical direction as follows:

- o Horizontal: 0.825 g
- o Vertical: 0.28 g

Revision of the RCIC pump and RHR pump calculations resulted in stresses at the pump critical locations considered in the original calculations to be less than the allowable values. Therefore, the pump is considered acceptable for the above seismic loads.

The RHR motor was qualified for 1.5 g horizontal and 0.14 g vertical as stated on the motor outline drawing. Based on values supplied with the motor it was determined that the additional vertical seismic load will provide shaft thrust loads that exceed the maximum allowable value at the motor thrust bearings. Increased load on the thrust bearing would result in a decreased service life which is still adequate to assure the 12 to 18 hours operation required from this equipment.

The RCIC turbine and turbine stop valve have been analyzed and found to be acceptable for the acceleration values listed in item 5 above. However, the turbine oil piping cannot be shown acceptable with regard to the higher vertical seismic load at this time (see Section 5.4).

Analysis of the RHR pump anchor bolts, RHR heat exchanger (and anchors), and the RCIC equipment and anchor bolts are respectively summarized in Tables 5.3-3, 5.3-3A, 5.3-3B, 5.3-4, and 5.3-5.

A seismic reevaluation of the fuel assemblies, was performed with respect to the proposed cold shutdown earthquake.

The results are as follows:

	From S&L Report SSD-DECO-003	Allowable
Shear	250 Kip	687 Kip
Moment	12,024 in-Kip	32,200 in-Kip

Vertical acceleration was calculated as 0.24 g, versus the design-basis acceleration of 3.12 g. This was derived from the calculated vertical OBE acceleration of 0.064 g in GE Report 22A5676 as follows:

SSE = 1.875 X 0.064 = 0.12 g

New vertical = 2 X 0.12 = 0.24 g

From the above, it can be concluded that the Fermi-2 fuel has ample margin to withstand the proposed cold shutdown earthquake.

5.3.2 Mechanical Components of Auxiliary Systems

For the remaining auxiliary systems associated with the Fermi-2 balance of plant, a general procedure was developed to provide a quick and highly conservative method for reevaluating equipment subjected to the new site-specific spectra. This procedure consisted of performing the following steps:

1. Identify equipment natural frequency(s).

2. Identify the acceleration values (for the north-south, east-west, and vertical directions) used in the original equipment seismic qualification.

3. Identify the new acceleration values, using equipment damping consistent with Regulatory Guide 1.61, for the new site-specific spectra at the same frequencies used in the existing seismic qualification.

4. Divide each of the acceleration values in Step 3 by the corresponding accelerations in Step 2 to determine the acceleration increase at each frequency of interest and for each direction (i.e., north-south, east-west, vertical).

5. Select the greatest acceleration increase found in Step 4 and multiply each of the old stresses/deflections by this ratio to determine a conservative estimate of the new equipment stresses/deflections.

6. If the new stresses are less than the new allowable stresses and the new deflections are within the deflection criteria, the piece of equipment is considered requalified. For the new site-specific evaluation, the allowable normal stresses were taken to be the yield strength (in some cases the buckling criteria governed) and the allowable shear stresses were taken to be 0.577 times the yield strength.

Note that the above procedure was intended to be used as an initial approach; no attempt was made to separate the seismic stresses from the stresses due to weight or normal operation. Since an elastic analysis was employed throughout, no credit was taken for any plastic action which might occur in a structural member subjected to bending stresses. The AISC specification permits plastic design with steels of yield strengths up to 65 ksi. For a rectangular steel section, it can be shown that the moment necessary to cause plastic action throughout the section, (plastic moment) is 50% greater than the moment necessary to produce yielding in only the outer fibers, (elastic moment). Also, the new calculated stresses are compared to the minimum code allowable material yield strengths, though the actual material yield strength may be considerably higher. Thus, the new stresses and deflections calculated using this procedure are highly conservative. Therefore, if the new stresses are equal to or less than the material yield strength, the equipment is considered requalified and no further analysis is considered necessary. If the values do not meet this criterion, a more detailed evaluation is performed.

For mechanical equipment originally qualified by test, the original test response spectra showed that it enveloped the new site-specific seismic response spectra. In case of dwell testing, the shaker table's input acceleration is equal to or higher than the new spectra ZPA.

5.3.2.1 Equipment, Systems, and Components

The following mechanical equipment has been reanalyzed. Summaries of their reevaluation can be found in Tables 5.3-6 through 5.3-20.

	Table
Residual Heat Removal Service Water (RHRSW)	
RHR cooling tower	5.3-6
RHRSW service water pump and motor	5.3-6
Diesel Generators (DG)	
DG skid assembly	5.3-7
Heat exchanger stack assembly	5.3-7
DG skid piping	5.3-8

5.3.2.2 Essential HVAC

The essential HVAC includes components on the air and water sides of the system. Ductwork stress reports evaluated were chosen through random sampling. A buckling criterion was used to determine the allowable moments that would insure duct integrity. This criterion can be considered conservative because credit is not taken for the stiffeners used in duct construction, and also because the criterion assumed simply supported edges.

The ductwork stress reports were evaluated against the site-specific SSE. For the duct analyzed by a static seismic method, the largest ratio of site-specific SSE ZPA over the analyzed ZPA was used as a multiplier on the OBE reactions. These reactions were then compared to the allowable stress limit. Likewise for the duct analyzed by a dynamic method, the worst ratio of site-specific SSE acceleration to the analyzed acceleration for the different modes was determined and used as a multiplier on the OBE reactions. Based upon guidance given in Regulatory Guide 1.61, response curves for 2% of critical damping were used. Two example analyses, one static and one dynamic, are provided as part of Table 5.3-21 to illustrate the method.

Because the design basis SSE loading was evaluated using a multiplier of 2.0 on OBE loading (instead of using the actual SSE response spectra), it was expected that the site specific results would be on the same order as the design basis. The results, summarized in Table 5.3-21, showed this assumption was correct.

The original calculations for the HVAC duct supports were performed using the worst combination of OBE plus weight loads with a safety factor of 5.0. Several typical supports were examined in the site-specific SSE evaluation to verify the safety factor and the following additional input was considered:

1. The safety factor is on weight plus OBE loads, not just OBE loads. As a majority of ducts are in the rigid range (i.e., accelerations a fraction of one g), this results in an increase in the above safety factor if the safety factor is considered as a spectra multiplier on OBE (to compare with the site-specific SSE).

2. The duct supports are typically designed using standard hangers with allowable loads so when considering actual loads, additional conservatism exists.

3. Results of piping analyses (see Section 6.0) have shown that 1.875 times OBE loads generally envelope site-specific SSE loads. Therefore, it was concluded that the HVAC duct supports are adequately designed to perform their intended function during and after a postulated site-specific SSE.

Other essential HVAC components reanalyzed are summarized in the follows tables:

EQUIPMENT	TABLE
Dampers	5.3-23
HVAC Return Air Fans	5.3-24
Centrifugal Chilling Units	5.3-25
Emergency Makeup Motors	5.3-26
Emergency Makeup and Recirculation Air Filters Units	5.3-27
Multi-Zone Climate Changer	5.3-28
Chilled Water Pump and Motor	5.3-29
Switch Gear Room Coolers, EECW Pump Room Coolers, and Control Air Compressor Cooler	5.3-31
RHR Room Cooler	5.3-32
Equipment Room Fan-Coil Unit	5.3-33
RCIC Pump Room Cooler	5.3-34
HVAC Cable Tray Cooling Fan	5.3-35
HVAC Equipment Anchors	5.3-35A

5.3.2.3 Drywell Cooling

The components of the drywell cooling system, the drywell cooling fans and drywell coolers (and anchors) are addressed in Table 5.3-35B.

5.3.2.4 RHR Complex HVAC System

The seismic requalification analysis summaries for the subject system, which includes the deisel-generator room ventilation, is contained in Table 5.3-36. As-built finite element models for the RHR complex duct systems, including hangers, were constructed. Modal analysis was performed using the original and new site-specific spectra. Results showed no significant increase in loads, stresses, accelerations, or deflections. The results are still within the original design allowable values.

5.3.2.5 Torus

See Section 4.3.2 of this report.

5.3.2.6 Motor-Operated Valve (MOV) Actuators

The original seismic qualification for MOV actuators was performed on April 26, 1972, by Ogden Technology Laboratories, Inc. on an electro-hydraulic vibration machine. The test unit with motor was scanned in each of the three major axes over a frequency range of 1 to 35 Hz with a maximum acceleration of 1.0 g to search for resonance. Since no resonance was found, the test sample was then vibrated for a period of ten seconds at each even integer of frequency from 4 to 34 Hz in each axis at an excitation of 3 g. The unit was operated during each dwell through one cycle from open limit to torque switch seated position and back to the original position. The test unit was then vibrated for a minimum of ten seconds at 35 Hz in each axis at an excitation level of 5 g with the unit being operated as indicated above.

As indicated in Section 6.6, the maximum predicted value accelerations, as developed from the piping reevaluation analysis, do not exceed 2.0 g. Since these new predicted accelerations are less than the levels to which the MOV actuators were originally qualified, it is concluded that the original seismic qualification remains valid for the loadings associated with the revised postulated earthquake.

5.3.3 Instrumentation and Control for Principal Systems

Table 5.3-37 presents a summary of the seismic requalification of I&C components associated with the principal systems.

The major I&C components for the principal systems consist of local and control room panels. The following procedure was used to evaluate the control panels:

1. Determine test data available that is applicable to the panel being reviewed.

2. Determine the ZPA for the floor region where the panel is located from spectra provided. For the horizontal direction, use the square root of the sum of the squares (SRSS) of the N-S and E-W data for the applicable ZPA. (Vertical acceleration is twice the spectral value.)

3. From test data, determine the maximum measured acceleration transmissibility in each direction, regardless of frequency or location on the panel, multiply this transmissibility by the ZPA from (2) above to get the maximum acceleration in each direction.

4. Combine the three directional accelerations by SRSS to give a maximum acceleration.

5. Review the list of essential devices on the panel and determine the lowest fragility limit for all the devices in any direction. (The fragility limit is that acceleration which, if exceeded, will result in malfunction of the device.)

6. Determine margin by dividing the maximum acceleration from (4) above by the fragility limit from (5), subtracting that resulting ratio from one (1), and then multiplying that value by 100 to obtain percent.

The above procedure has a number of conservatisms. First, the horizontal ZPA combination is applied to both horizontal directions (if N-S and E-S values are equal, the result is about 40% greater than the actual case). Second, the maximum test acceleration is used, regardless of its location. This means that in most cases, the essential equipment is subject to acceleration values substantially smaller than the values used in the evaluation. Third, the acceleration value used in the combination of the highest values in all direction, regardless of whether they occur at the same location or not. Fourth, the composite acceleration value is compared to the lowest fragility limit, regardless of direction. The actual fragility of any essential component will undoubtedly be greater in the actual direction of that acceleration resultant.

This procedure was followed in all panels, with the following exceptions:

H11-P613

Here, the essential items were located lower in the panel and compensation for the height was included in the analysis, but all three directions were still combined for the determination of margins.

H11-P617, P618

Height compensation was included in the analysis, as in H11-P613 above. Margin was determined based on the combination of the three directions of motions compared with the lowest fragility limit, regardless of direction.

H11-P621

Height compensation was included here, but the combination of the three directions of motion resulted in a "g" level greater than the minimum fragility level. A second calculation was made with the larger of the two horizontal ZPAs applied to the horizontal direction with the largest transmissibility value (the smaller was applied to the direction of less transmissibility). The three directions were combined (SRSS), and then this value was averaged with the original acceleration value. Margin was determined from this average "g" value. This analysis is still conservative because the use of the largest ZPA with the greatest transmissibility is conservative, the use of the combination of the three directions is conservative; the use of the combination of the three directions is conservative; and the use of the average value, averaging with the original value (a conservative number), is conservative.

H11-P622, P623

These panels were qualified by tests of essentially identical panels built for other plants (Zimmer and Laguna Verde) which have much higher ZPA values (0.55 g and 0.87 g, respectively).

H11-P628

This panel was qualified by similarity to H11-P617.

The following comments are provided with regard to the operation of principal systems:

Control Rod Drive

No I&C equipment is required since the shutdown scenario involves a LOP which will cause the HCUs to effect a scram. The HCUs are hydraulic/mechanical assemblies.

Nuclear Boiler System

Safety/relief valves are used to depressurize the reactor. Remote-manual control of these Division I dc-operated valves is from the control room via a relay cabinet.

Reactor Core Isolation Cooling

RCIC starts automatically and provides makeup water to the reactor as required during depressurization. The operator uses vessel level instrumentation to determine the RCIC flow setpoint. Essential RCIC protective instrumentation and control is required to protect the RCIC turbine.

Residual Heat Removal

1. The shutdown cooling mode of RHR is initiated by the operator before the RCIC turbine trips due to low steam pressure. Instruments provide the shutdown cooling low pressure permissive of 110 psi dome pressure.

2. Torus cooling is not required.

3. Head spray may be used if necessary.

4. Only one RHR loop is required with one pump and one heat exchanger.

5. The recirculation pump discharge valve is closed by swing bus power. This is necessary to isolate the recirculation pump.

5.3.4 Instrumentation and Control for Auxiliary Systems

5.3.4.1 Emergency Equipment Cooling Water (EECW)

Table 5.3-38 shows the seismic requalification summary for I&C components associated with the EECW system.

The EECW pump will be started manually in the control room, upon LOP, after receipt of the EDG load sequencer start signal. The EECW pump start permissive signals are generated by non-seismically qualified pump suction pressure switches and makeup tank level switches arranged in "one out of two taken twice" logic to normally deenergized control relays with contacts in the EECW pump start circuit. Since the switches are non-seismic a failure of the switches in the right combination would prevent pump start. DECo will reorder the switches as seismic Level I devices.

5.3.4.2 Control Air System

Table 5.3-39 presents the seismic requalification summary for I&C components of the control air system.

The Division I control air compressor will be started manually in the control room upon receipt of the EDG start signal. DECo has had no success in retrieving seismic qualification documentation for the control air compressors control panels. Thus, we are assuming that the control panel is not seismically qualified. DECo will pursue having the panels qualified.

5.3.4.3 Essential HVAC

Table 5.3-40 presents the seismic requalification summary for I&C components of essential HVAC systems. The Control [illegible] HVAC system has been analyzed in the chlorine mode with auto start. The majority of the air operated dampers will be manually opened or closed as required.

5.3.4.4 Drywell Cooling System

Table 5.3-41 presents the seismic requalification summary of I&C components of the drywell cooling system.

No instrumentation is required for operation of the drywell cooling system under the postulated scenario. The two-speed cooling fans will automatically start in high speed upon receipt of the DG start signal. The drywell cooling system controls reevaluated seismically, consist of drywell local panel H21-P328A, relay room cabinets (H11-P898A and H11-P889) and COP insert H11-P808B512.

5.3.4.5 RHR Complex

Table 5.3-42 presents the seismic requalification summary of I&C components which are located in the RHR complex. The following systems are identified:

- RHR Service Water
- Emergency Equipment Service Water
- Diesel Generator
- Diesel Generator Fuel and Lube Oil
- Diesel Generator Ventilation
- Diesel Generator Service Water
- Diesel Generator Control Console
- Diesel Generator Load Sequence

5.3.5 Electrical Components

Electrical components which supply power to principal and auxiliary systems were requalified generically by equipment type and manufacturer. Table 5.3-43 provides the locations of the equipment described above and the systems which the equipment serves. From each equipment category, a single component is selected for requalification according to the most seismically limiting location. Table 5.3-44 provides the accelerations for various locations within the Fermi-2 facility.

The seismic requalification of the equipment listed in Table 5.3-43 is summarized in the following tables:

Equipment	Table
480 Vac and 260 Vdc Motor Control Centers (ITE)	5.3-45
480 V Switchgear (ITE)	5.3-46
4160 V Switchgear (ITE)	5.3-47
Battery Main dc Fuse Cabinet	5.3-48
Batteries and Battery Racks (with mountings) C&D	5.3-49
Battery Chargers (with mountings)	5.3-50
dc Fused Distribution Cabinets (Square D)	5.3-51
120 Vac Modular Power Supply Units	5.3-52
Drywell Penetrations (Conax Corporation)	5.3-53
Terminal Boxes and Terminal Boxes Attached to Drywell Penetrations	5.3-54

5.4 Equipment Requiring Further Assessment and Documentation

In the process of reanalyizing the ability of components to resist the revised seismic loads, it was found that certain components could not be requalified at this time. The remedial action to be taken for these components will include one or more of the following measures:

- o documentation will be identified
- o additional calculations will be performed
- o equipment will be repurchased
- o existing equipment will be tested

The goal of these measures is to requalify components in the most expeditious and economical manner. The following components have been identified which require remedial action:

- RCIC Turbine Lube Oil Piping

  The lube oil piping, mounted as an integral part of the RCIC turbine assembly skid, requires a detailed dynamic piping analysis. The original assembly was qualified based on static coefficients.

- Emergency Equipment Cooling Water Pump Suction Pressure and Makeup Tank Level Switches.

  Qualification records for these switches could not be located. Requalification or replacement is required.

- Diesel Generator Fuel Oil Transfer Pumps

  Seismic qualification records could not be retrieved in time. The vendor has been contacted to supply the records.

In addition to the components described above, Table 5.4-1 provides a summary of the components presented in Tables 5.3-2 through 5.3-54, which require remedial action.

TABLE 5.1-1

Scenario for Seismically Induced Loss of Offsite Power

1. Seismic Event Causes Loss of Offsite Power (LOP)

2. LOP Initiates Isolation and Scram Via CRD

3. Diesel Generator Starts and Accepts Loads

4. RCIC Starts Automatically

5. SRVs May Open on High Pressure

6. RPV Level and Pressure Stabilizes, Based Upon the Operation of the RCIC and SRVs

7. Operator Action is Taken to Cooldown and Depressurize the RPV to 95 PSIG, Using SRV and RCIC in Torus Suction Mode.

8. RHR/SD Cooling Mode Initiates - RCIC Trips

9. RHR/SDC Cools RPV to $<$ 200F

-Transient Ends-

TABLE 5.2-1

PRINCIPAL AND AUXILIARY SYSTEMS REQUIRED FOR SAFE SHUTDOWN AND COOLDOWN

Principal Systems

1) RCIC
2) Nuclear Boiler
3) RHR - Division II
4) CRD

Auxiliary (Support) Systems

1) RHR SW - Division I
2) Diesel Gens - Division I
3) Diesel Fuel Oil & Lube Oil - Division I
4) EECW Division I
5) EESW Division I
6) EDGSW Division I
7) Control Air - Division I
8) Control Center HVAC - Air Side*
9) Control Center HVAC - Water Side*
10) Drywell Cooling - 4 Two-speed Fans Only
11) Diesel Generator Ventilation - Division I
12) Torus and Attached Piping

*Essential HVAC

TABLE 5.2-2

GENERIC ESSENTIAL EQUIPMENT

Drywell Coolers

Room Coolers

Electric Tray

Electric Conduit Hangers

I & C Tubing

MCC s

Switchgear

Relay Room and Control Room Racks

Batteries and Chargers

Diesel Generators

Underground Electric Ducts

Underground QAI Pipe (RHR Complex)

MOV Operators

Pumps and Motors

Control Center Ceiling and Lights

Valves

TABLE 5.3-1

LOADS FOR CERTAIN RPV AND INTERNAL COMPONENTS

	Horizontal	Vertical	Allowable
Top Guide (Shear)	350	31.7	687 kip (1)
Core Plate (Shear)	347	361	687 kip (1)
Stabilizer (Load)	513	0	2,765 kip (2)
RPV Support (Moment)	221,000	N/A	1,152,000 in-kip (1)
RPV Support (Shear)	679	1,191	2,600 kip (1)
CRD Housing (Moment)	507	N/A	18,870 in-kip (2)
CRD Housing (Shear)	14	Negligible	4,400 kip (1)
CRD Restraint Beam (Load)	14	N/A	266 kip (2)
Shroud Support (Moment)	276,000	N/A	347,900 in-kip (2)
Shroud Support (Shear)	1,176	1,031	1,434 kip (2)
Fuel Assembly (Moment)	12,024	See Section 5.3.1	32,200 in-kip
Fuel Assembly (Shear)	250	See Section 5.3.1	687 kip

(1) From Fermi 2 mathematical model 761E774, Revision 4

(2) From equipment design spec. or analysis

TABLE 5.3-1 (Continued)

LOADS FOR CERTAIN RPV AND INTERNAL COMPONENTS

	Plant	Load Combination	Vertical Force (kips)	Horizontal Force (kips)
Core Plate	LaSalle 1	E1	423	471
	Fermi 2	New Seismic	361	347
Top Guide	LaSalle 1	B2	40.8	332
	Fermi 2	New Seismic	31.7	350

Load Combinations

E1 = NL + (U - Delta P) + SRV + SSE

B2 = NL + (A - Delta P) + Chg. + SRV - 1 + SSE

TABLE 5.3-2

HYDRAULIC CONTROL UNIT

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Hydraulic Control Unit, MPL C11D001	X		DRF 147-C11D001-N*5-5	B5 B6 B29 B30 C6 C16 All dated 4/18/72	C16 dated 4/18/72 Vertical B29 & B30 dated 4/17/81 Horizontal	1300% Horizontal, 500% Vertical	DRF 147-C11D001-N*5-5A	1300% Horizontal 500% Vertical	The new peak response spectra curves were 1.05 g's horizontal capability of the HCU is 14 g's = 1300% margin by test, horizontal Vertical was 2.8 g's peak vs 14 g's capability by test = 500% margin, therefore the HCUs are acceptable.

TABLE 5.3-3

RHR PUMP ANCHORS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
RHR Pump Anchor Bolts		X	Edison Design Calculation	.15 g horz. .10 g vert.	S & L report SDD-DECo -003 Figures 3 C-11	1415% based on yield		N/A	The Anchor bolt stresses were recalculated by applying the new site-specific seismic loads, the equipment nozzle loads from the attached piping, and the equipment dead weight loads. The shear and tension stresses were combined and shown to be less than the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE 5.3-3A

RHR HEAT EXCHANGER AND ANCHORS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
RHR Heat Exchanger and anchor bolts		X	See G.E. Letter TDFC-4002 dated 6/22/81	1.5 g horiz. 0.14 g vert.	0.4 G horiz. 0.36 G vert.	5% on yield		N/A	The stresses resulting from the site specific SSE were obtained by multiplying the OBE allowable stresses (based on .75 G horiz, .07 G vertical) by the vertical acceleration ratio and comparing with SSE allowables (yield). The stresses due to nozzle loads and deadweight were also increased even though they didn't change. The calculated stresses are less than the new allowable values; therefore, the equipment is qualified to the site specific SSE.

TABLE 5.3-3B

RCIC PUMP ANCHOR BOLTS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
RCIC Pump anchor bolts		X	Edison Design calculation DC-369 item 2	.15 G horiz. .10 G vert.	S & L report SDD-DECo -003 figures 3 C-11	609% based on yield		N/A	The anchor bolt stresses were recalculated by applying the new site-specific seismic loads, the equipment nozzle loads from the attached piping, and the equipment dead weight loads. The shear and tension stresses were combined and shown to be less than the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE 5.3-4

RCIC TURBINE ANCHOR BOLTS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
RCIC Turbine anchor bolts		X	Edison file No. DC-369 item 2	1.5 g Horz .14 g vert.	S & L report SDD-DECo -003 Fig's 3 C-11	25.6%		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE 5.3-5

RCIC PUMP SUCTION STRAINER

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
RCIC Pump suction strainers (Leslie) PIS # E5101D011		X	Edison File No. P1-2416	5 g horz. 3 g vert.	S & L Report SDD-DECo -003 Fig's. 3 C-11	N/A		N/A	The new site-specific earthquake accelerations are less severe than the acceleration loadings that were used in the original seismic qualification; therefore, this equipment is requalified.

TABLE [illegible]3-6

RHR SERVICE WATER

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
RHR Cooling Tower Equip. No. E1156B001A, B, 2A, B Location RHR Elevation 617		X	Marley Co. dated 2-8-74 S & L EMD-011785				S&L EMD-029950	33% based on tornado loads	Beams were found to be flexible and the resultant acceleration is above ZPA. The piping was found to be close to rigid. Fill stresses are very low. Eliminator stresses are very low. Fill retainers & eliminator retainers are analyzed based on tornado loads (higher loads). Stresses on the following mechanical equipment and parts are: Motor Support Branch Arm Pipe Support Anchor Bolts Embedment Tornado loads are governing loads. Stresses are within allowables.
RHR Service Water Pump and Motor Equip. No. E1151C001A, C & D Location RHR Elevation 590'		X	McDonald Eng. Analysis dated 2-4-74 Goulds Pump Inc. dated 9-23-75 (motor)				S&L EMD-029950	>100% *	Stresses are below yielding limits. Water pump and motor qualifies to new response spectra.

* For Flange based on yield.

TABLE 5.3-7

DIESEL GENERATOR COMPONENTS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Diesel Generator Skid Assembly Equip. No. R30015001-4 Location RHR Elevation 590' Elevation 590'		X	Colt Ind. Report dated 4-4-75 S&L EMD-001659				S&L EMD-029950	53% *	Stresses are well within allowables. Skid assembly qualifies to new response spectra.
Heat Exchanger Stack Assembly Equip. No. R30015001-4 Location RHR Elevation 590'		X	Colt Ind. Report dated 4-4-75 S&L EMD-001659				S&L EMD-029950	>100% **	The equipment qualifies to new response spectra. Stresses very low.

* Turbocharger mounting bolts based on allowables

** For attachment plate based on allowables

TABLE 5.3-8

DIESEL GENERATOR COMPONENTS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Diesel Generator Skid Piping Equip. No. R30015001-4 Location RHR Elevation 590'		X	Colt Ind. Report dated 4-4-75 S&L EMD-001659				S&L EMD-029950	17% *	The equipment qualifies to new response spectra. Stresses are within allowables.
Jacket Water Expansion Tanks Equip. No. R3000A005-8 Location RHR Elevation 604' -2"		X	Colt Ind. Report dated 4-4-75 S&L EMD-001659				S&L EMD-029950	53%**	The equipment qualifies to new response spectra. Stresses very low.
Air Receiver Tank Equip. No. R3000A009-16 Location RHR Elevation 590'		X	Colt Ind. Report dated 4-4-75 S&L EMD-001659				S&L EMD-029950	100%***	The equipment qualifies to new response spectra. Stresses very small.

* In piping based on allowables

** For mounting flange based on allowables

*** In bolts based on allowables

TABLE 5.3-9

DIESEL GENERATOR FUEL OIL

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Fuel Oil Day Tanks Equip. No. R3000A017-20 Location RHR Elevation 590'		X	Colt Ind. Report dated 4-17-74 S&L EMD-001659				S&L EMD-029950	18%*	Stress levels due to revised response spectra are within allowable values. This component is requalified.

* For tank holddown bolts based on allowables.

TABLE 5.3-10

DIESEL GENERATOR LUBE OIL

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Lube Oil Strainer Equip. No. R30015001-4 Location RHR Elevation 590'		X	Colt Ind. Report dated 4-4-75 S&L EMD-001659				S&L EMD-029950	1.0%*	Stress levels due to revised response spectra are within allowable values. This component is requalified.

* For shell based on allowables.

TABLE 5.[illegible]-11

DIESEL GENERATOR LUBE OIL

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Lube Oil Filter Equip. No. R30015001-4 Location RHR Elevation 590'		X	Colt Ind. Report dated 4-4-75 S&L EMD-001659				S&L EMD-029950	>100% *	Stress levels due to revised response spectra are within allowable values. This component is requalified.

* For shell based on allowables.

TABLE 5.3-12

DIESEL GENERATOR FUEL OIL

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Fuel Oil Storage Tanks Equip. No. R300A001-4 Location RSR Elevation 590'		X	Graver Tank & Mfg. Co, dated 6-5-74 S&L EMD-008913				S&L EMD-029950	-97% *	Additional bolts are required at the foundation support. All other calculated stresses are below allowables. See Section 5.4
* For foundation bolts based on yield.									

TABLE 5.3-13

EMERGENCY EQUIPMENT COOLING WATER

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
EECW Pump and Motor (includes Anchors) PIS # P4400C001A		X	Edison File No. S24-116	1.41 horz. .5 vert.	S&L Report SDD-DECo -003 Figures B-31 B-32 C-16	9% Based on original allow-ables except for pump outboard bearings See remarks		N/A	For the equipment's critical components the original qualification used the vector sum of the vertical and horizontal accelerations as the equipment's seismic loading. The vector sum of the NS, EW, & vertical accelerations obtained from the new site-specific response spectra was divided by the acceleration value used in the original qualification to determine the "acceleration increase". The new stresses were conservatively estimated by multiplying the original stresses by this "acceleration increase". These new stresses are below the new allowable values; however, the pump outboard bearing radial load (8726#) is 40% greater than its original allowable load rating of 6215# at 100 hours of operation. When a bearing is subjected to a constant load greater than its rated load, the bearing life is reduced. For a constant bearing load of 8726#, it is estimated that the bearing life would be reduced from 100 hrs to 30 hours;

TABLE 5.3-13 (continued)

EMERGENCY EQUIPMENT COOLING WATER

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
EECW Pump and Motor (includes anchors) PIS #P4400C001A									however, the seismic loading is clearly not constant but occurs for a maximum duration of 30 seconds, therefore, The equipment is requalified to the new site-specific earthquake.

TABLE [illegible].3-14

EMERGENCY EQUIPMENT COOLING WATER

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
EECW Make-up tank (including anchor bolts) PIS #P4400A001		X	Edison File No. S20-24	S&L Report SL-2682 Figures B-31 B-32 B-16	S&L Report SDD-DECo -003 Figures B-31 B-32 C-16	13% Based on yield		N/A	The original seismic stresses were separated out of the original qualification, increased for the new site-specific earthquake, and then added to the original normal operating and deadweight loads. The new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE [illegible]-15

EMERGENCY EQUIPMENT COOLING WATER

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
EECW Heat exchanger (including anchor bolts) PIS #P4400B001		X	Edison File No. S21-7	S&L Report SL-2682 Figures B-31 B-32 C-16	S&L report SDD-DECo -003 Figures B-31 B-32 C-16	20.3% Based on yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE 5.3-16

DIESEL GENERATOR SERVICE WATER

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Motor for Diesel Generator Service water pumps and emergency equipment Equip. No. R300C005-8 Location RHR Elevation 590'		X	Allis Chalmers dated 5-13-76 S&L EMD-003791				S&L EMD-0029950	20%*	Stresses are within the allowable limits. Motor qualifies to new response spectra.
Diesel Generator Service Water Pump		X							See Section 5.4

* For anchorage bolts based on allowables.

TABLE 5.3-17

EMERGENCY EQUIPMENT SERVICE WATER

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Emergency Equipment Service Water Pumps Equip. No. P4500C002A, B Location RHR Elevation 590'		X	McDonald Eng. Rep. #ME-229 dated 6-21-75 S&L EMD-001554				S&L EMD-029950	43%*	Stresses and deflections are below allowables. Pump qualifies to new response spectrum.
Motor for Diesel Generator Service water pumps and emergency equipment Equip. No. R300C005-8 Location RHR Elevation 590'		X	Allis Chalmers dated 5-13-76 S&L EMD-003791				S&L EMD-029950	20%**	Stresses are within the allowable limits. Motor qualifies to new response spectra.

* In shaft deflection based on allowable.

** For anchorage bolts based on allowables.

TABLE 5.3-18

CONTROL AIR

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Control air compressor and motor (including anchor bolts) PIS # P5002D001		X	Edison File No. B11-1[illegible] B11-506	S&L report SL-2682 Figures B-29 B-30 C-16	S&L report SDD-DECo -003 Figures 3 C-11	189% Based on yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the eqqipment is requalified to the new site-specific earthquake.

TABLE 5.3-19

CONTROL AIR AFTER COOLER

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Control air after-cooler (including anchors) PIS #P5002B004		X	Edison File No. B11-405	2.4 g horz. 1.9 g vert.	S&L report SDD-DECo -003 Figures B-29 B-30 C-11	N/A		N/A	The new site-specific earthquake accelerations are less severe than the acceleration loadings that were used in the original seismic qualification; therefore, this equipment is requalified.

TABLE 5.3-20

CONTROL AIR

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Control Air Receiver PIS#P5002A001		X	Edison File No.	S&L Report SL-2682 Figures B-5 B-6 B-29 B-30 C-6 C-16	S&L Report SDD-DECo-003 Figures B-29 B-30 C-11	N/A		N/A	The new site-specific earthquake accelerations are less severe than the acceleration loadings that were used in the original seismic qualification; therefore, this equipment is requalified.

TABLE 5.3-21

HVAC DUCTS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
HVAC Ducts		X							A survey of maximum duct moments due to seismic and dead weight loads indicates that values are within allowable limits. This component is requalified to the site-specific SSE.

5/8/81

ENRICO FERMI POWER PLANT - UNIT 2

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REVIEW OF HVAC DUCT REPORT RICO - 2848 - 5

REPORT PART	DESIGN ACCELERATION VALUES (OBE)		
	X	Y	Z
2848 - 5	.200 g	.200 g	.200 g

NEW ACCELERATION VALUES (ZPA) — ANALYZED SSE VALUES

B37 (N-S)	.44 g	.50 g
B38 (E-W)	.47 g	.50 g
C17 (U-D)	.22 × 2 = .44 g	.50 g

SURVEY OF MAXIMUM DUCT MOMENTS DUE TO DEADWEIGHT AND (OBE) SEISMIC LOADS

REPORT PART 2848 - 5
NODES 100 - 365
DUCT SIZE 10" x 10" 18 GAGE

ANALYSIS TYPE: STATIC (RIGID)

LOADING	Mx (ft-lb)	My (ft-lb)	NODE
DEADWEIGHT	62	0	320 (x)
SEISMIC (2.5 × OBE)	50	522.5	335 (y)
MAX MOMENT	112	522.5	
ALLOWABLE	1540	1540	

CONCLUSION

IT IS OBVIOUS THAT THE DUCT IS QUALIFIED TO THE NEW SER SSE.

5/8/81

ENRICO FERMI POWER PLANT - UNIT 2

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REVIEW OF NRC DUC- REPORT RICO-3848-3

MODE	PERIOD	ANALYZED OBE ACCELERATION (g)	NEW ACCELERATION (g)	% CHANGE	
1	.0568	.27	.57	111.1	(N-S)
2	.0399	.2	.49	122.7	
3	.0259	.17	.45	136.8	
4	.0214	.19	.44	131.6	
5	.0143	.19	.44	131.6	
1	.0568	.32	.70	118.8	(E-W)
2	.0399	.26	.49	88.5	
3	.0259	.20	.48	140.0	
4	.0214	.185	.47	154.1	
5	.0143	.185	.47	154.1	
1	.0568	1.1	3.3	200	([illegible])
2	.0399	.5	1.40	180	
3	.0259	.22	.44	100	
4	.0214	.18	.44	144.4	
5	.0143	.18	.44	144.4	

ANALYSIS TYPE: DYNAMIC

ENRICO FERMI POWER PLANT - UNIT 2

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13 4/6
4 1/5

SURVEY OF MAXIMUM DUCT MOMENTS DUE TO DEADWEIGHT AND (OBE) SEISMIC LOADS (RICO - 2848-3)

NODES 300 TO 565
DUCT SIZE 18" O.D. 18 gage

LOADING	Mx (ft-lb)	My (ft-lb)	NODE
DEADWEIGHT	379	0	415 (X)
SEISMIC (2.0 x OBE)	315	1914	[illegible] (Y)
MAX MOMENT	694	1914	—
ALLOWABLE	24408	24408	—

CONCLUSION: IT IS OBVIOUS THAT THE DUCT IS QUALIFIED TO THE NEW SER SSE.

TABLE 5.3-22

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TABLE 5.3-23

ESSENTIAL HVAC DAMPERS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
			Edison File No.	S&L Report SL-2682 Figures	S&L Report SDD-DECo-003 Figures				
PD 300 Fire Damper		X	B9-2175	B-37 C-19	B-37 C-19	7% based on yield		N/A	The original seismic stresses were separated out of the original qualification, increased for the site-specific SSE, and added to the normal operating loads (in cases where stresses were low, the combined normal operating and seismic stresses were increased by the worst acceleration ratio). Calculated stresses are below the new allowable values; therefore the equipment is requalified to the site-specific SSE.
Backdraft Damper (Pacific Air Products Company)		X	B9-2175	B-37 C-19	B-37 C-19	180% based on original allowable		N/A	
Air Damper (Pacific Air Products Company)		X	B9-2175	B-37 C-19	B-37 C-19	10% based on original allowable		N/A	
Flexible Hose		X	B9-2175	B-37 C-19	B-37 C-19	large		N/A	

TABLE 5.[illegible]3 (Continued)

ESSENTIAL HVAC DAMPERS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Fire Dampers and Air Control Damper (Air Balance Inc.)	X		B9-2131 or B9-2175 TAB IV	Test input acceleration of 5 g minimum	B-37 C-19	28%		N/A	The original test response spectra envelops the new site-specific reponse spectra; therefore, this equipment is requalified.
Damper Motor Mountings for T4100F157A & B thru F163A & B		X	Edison File No. B9-2174	S&L Report SL-2682 Figures B-37 C-19	S&L Report SDD-DECo-003 Figures B-37 C-19	46% based on yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.
Damper Motor Mountings for T4100F070 thru F073		X	Edison File No. B9-2150	S&L Report SL-2682 Figures B-37 B-38 C-9	S&L Report SDD-DECo-003 Figures B-37 B-38 C-19	4.1% based on yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE 5.[illegible]3 (Continued)

ESSENTIAL HVAC DAMPERS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Fire Dampers T4100F099 & F102 T4100F111 & F112 T4100F086		X	Edison File No. B9-2184	S&L Report SL-2682 Figures B-37 C-9	S&L Report SDD-DECo-003 Figures B-37 B-38 C-19	54% based on yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.
Butterfly Dampers (Valves) Type 4340 Damper Sizes 8", 10", 14", 18", & 48"		X	Edison File No. B9-1119	5 g (N-S) 5 g (E-W) 3 g (Vert)	S&L Report SDD-DECo-003 Figures B-37 B-38 C-19	13.2% based on yield	.	N/A	(as above)
Manual Air Dampers Sizes 32 x 30 96 x 24 48 x 48 36 x 36		X	Edison File No. B9-2[illegible]6	S&L Report SL 2682 Figures B-37 B-38 C-19	S&L Report SDD-DECo-003 Figures B-37 B-38 C-19	36% based on yield		N/A	The original seismic stresses were separated out of the original qualification, increased for the new site-specific earthquake, and then added to the original normal operating and deadweight loads. The new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE 5.[illegible]-23 (Continued)

ESSENTIAL HVAC DAMPERS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Type CD31 Dampers 75" x 52" thru 16" x 16"		X	Edison File No. B9-761	S&L Report SL-2682 Figures B-37 B-38 C-19	S&L Report SDD-DECo-003 Figures B-37 B-38 C-19	45% based on allowable buckling load		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.
112" x 33" Control Room Dampers		X	Edison File No. B9-761	4.3 g (N-S) 3.5 g (E-W) 3.5 g (Vert)	S&L Report SDD-DECo-003 Figures B-37 B-38 C-19	162% based on yield		N/A	(as above)
Fire Dampers PIS#T4100F		X	Edison File No. B9-2090	5.6 g (NS) 5.6 g (EW) 5.0 g (Vert)	S&L Report SDD-DECo-003 Figures B-37 B-38 C-15	N/A		N/A	The new site-specific earthquake accelerations are less severe than the acceleration loadings that were used in the original seismic qualification; therefore, this equipment is requalified.

TABLE 5.3-24

HVAC RETURN AIR FANS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Return Air Fan (Including Anchor Bolts) PIS#T4100C031		X	Edison File No. B9-365	S&L Report SL-2682 Figures B-37 B-38 C-19	S&L Report SDD-DECo-003 Figures B-37 B-38 C-19	weakest component has a 0% margin based on yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE 5.3-25

HVAC CENTRIFUGAL CHILLING UNITS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Centrifugal Chilling Units (Includes Anchors) PIS#T4100B008 & 9		X	Edison File No. B9-653	S&L Report SL-2682 Figures B-37 B-38 C-19	S&L Report SDD-DECo-003 Figures B-37 B-38 C-19	29.1% based on original allowable		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.
Rupture Disc for Centrifugal Chilling Units	X		Edison File No. B9-684	10 g input	S&L Report SDD-DECo-003 Figures B-37 B-38 C-19	2100%		N/A	The original qualification indicates that the disc was subjected to a 10 g input. This acceleration is well above the new site-specific response spectra; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE 5.3-26

HVAC EMERGENCY MAKE-UP MOTORS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Emergency Make-up Motors for Fans with PIS #'s T41000047 & 16		X	Edison File No. B9-1196	S & L Report SL-2682 Fig's B-37 B-38 C-19	S & L Report SDD-DECo-003 Fig's B-37 B-38 C-19	N/A		N/A	The new site-specific earthquake accelerations are less severe than the acceleration loadings that were used in the original seismic qualification; therefore, this equipment is requalified.

TABL[illegible] 3-27

HVAC EMERGENCY MAKE-UP AND RECIRCULATION AIR FILTERS UNITS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Emergency Make-up Fans PIS # T41000047 & 16		X	Edison File No. B9-1387	S & L Report SL-2682 Fig's B-37 B-38 C-19	S & L Report SDD-DECo-003 Fig's B-37 B-38 C-19	214% Based on Yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.
Emergency Make-up Filters PIS # T4100-011		X	Edison File No. B9-762	Fig's B-13 B-14 C-9 of S & L Report SL-2682	Fig's B-37 B-38 C-19 of S & L Report SDD-DECO-003	78.4% Based on Yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE 5.3-28

HVAC MULTI-ZONE CLIMATE CHANGER

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Multi-Zone Climate Changer PIS # T4100B007		X	Edison File No. B9-544 B9-674	S & L Report SL-2682 Fig's B-37 B-38 C-19	S & L Report SDD-DECO-003 Fig's B-37 B-38 C-19	Weakest Component has 0% Margin Based on Yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.
Plenum for HVAC Multi-Zone Unit		X	Edison File No. B9-2203	S & L Report SL-2682 Fig's B-37 B-38 C-15	S & L Report SDD-DECO-003 Fig's B-37 B-38 C-15	Weakest Component has a 0% Margin Based on Yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.
Plenum Casing Access Door for HVAC Multi-Zone Unit		X	Edison File No. B9-2202	S & L Report SL-2682 Fig's B-37 B-38 C-9	S & L Report SDD-DECO-003 Fig's B-37 B-38 C-19	N/A		N/A	The new site-specific earthquake accelerations are less severe than the acceleration loadings that were used in the original seismic qualification; therefore, this equipment is requalified.

TABLE 5.3-29

HVAC CHILLED WATER PUMP AND MOTOR

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Chilled Water Pump and Motor PIS # T4100C040 & 41		X	Edison File No. B9-651 B9-1875	Pumps 3 g N-S 3 g E-W 2 g Vert MTR's 3.6 g N-S 4.25 g E-W 3.6 g Vert	S & L Report SDD-DECo-003 Fig's B-37 B-38 C-19	N/A		N/A	The new site-specific earthquake accelerations are less severe than the acceleration loadings that were used in the original seismic qualification; therefore, this equipment is requalified.

TABLE 5.3-30

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TAB[illegible].3-31

HVAC COOLERS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Switchgear room Coolers EECW Pump Room Coolers Control Air Compressor Cooler (T41-00B001 & 3 T41-00B034 T41-C0B029 Respectively)		X	Edison File No. B9-643	B33, B34, C19 SL-2682 (Vertical Times 2.0)	B33, B34, C-19 S & L Report SDD-DECo-003	20% Based on Yield		N/A	The original seismic stresses were separated out of the original qualification, increased for the site-specific SSE, and added to the normal operating loads. Calculated stresses are below allowables; therefore, the equipment is requalified to the site specific SSE.

TABLE 5.3-32

RHR ROOM COOLERS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
RHR Room Cooler (Including Anchor Bolts) PIS#T4100B018		X	Edison File No. B9-554	S&L Report SL-2682 Figures B-29 B-30 C-14	S&L Report SDD-DECo-003 Figures B-29 B-30 C-14	N/A		N/A	The new site-specific earthquake accelerations are less severe than the acceleration loadings that were used in the original seismic qualification; therefore, this equipment is requalified.

TABLE 5.3-33

HVAC Equipment Room Fan-Coil Unit

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Equipment Room Fan-Coil Unit PIS#T4100B028		X	Edison File No. B9-554	S&L Report SL-2682 Figures B-37 B-38 C-19	S&L Report SDD-DECc-003 Figures B-37 B-38 C-19	511% based on yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE 5.3-34

HVAC RCIC PUMP ROOM COOLER

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
RCIC Pump Room Cooler PIS#T410CB021		X	Edison File No. B9-554	S&L Report SL-2682 Exhibit 2 and Fig. C-11	S&L Report SDD-DECo-003 Figures B-29 B-30 C-11	23.4% based on yield		N/A	The new stresses were conservatively estimated by multiplying the original stresses by the largest acceleration increase comparing all three directions. These new stresses are below the new allowable values; therefore, the equipment is requalified to the new site-specific earthquake.

TABLE 5.3-35

HVAC CABLE TRAY COOLING FAN

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Cable Tray Cooling Fan PIS#T4100C053									See Section 5.4

TABLE 5.3-35A

HVAC EQUIPMENT ANCHORS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Anchor Bolts for the following equipment:			Edison File No.	S&L Report SL-2682 Figures	S&L Report SDD-DECo-003 Figures				
EECW Pump Room Cooler		X	DC-575	B-31 B-32 C-16	B-31 B-32 C-16	257% based on yield		N/A	The anchor bolt stresses were recalculated by applying the new site-specific seismic loads. The resulting shear & tension stresses are below the new allowable stresses; therefore, the anchors will safely sustain the effect of the new site-specific earthquake.
Control Air Compressor Cooler		X	DC-577	B-29 B-30 C-18	B-29 B-30 C-18	376% based on yield		N/A	Same as above
Equipment Room Fan-coil Unit		X	DC-582	B-37 B-38 C-19	B-37 B-38 C-19	594% based on original allowable		N/A	Same as above
Chilled Water Pump and Motor		X	DC-585	B-13 B-14 C-9	B-37 B-38 C-19	119% based on original allowable		N/A	Same as above

HVAC EQUIPMENT ANCHORS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Emergency Make-up Filter Unit		X	DC-593 B9-762	B-13 B-14 C-9	B-37 B-38 C-19	95.3% based on yield		N/A	Same as above
Multi-zone Climate Changer		X	DC-589	B-37 B-38 C-19	B-37 B-38 C-19	22% based on yield		N/A	Same as above
Switchgear Room Coolers		X	DC-572	B-33 B-34 C-19	B-33 B-34 C-19	N/A		N/A	The new site-specific earthquake accelerations are less severe than the acceleration loadings that were used in the original seismic anchor bolt calculation; therefore, the anchors are requalified.
RCIC Pump Room Cooler		X	DC-579	B-29 B-30 C-18	B-29 B-30 C-18	N/A		N/A	Same as above

TAB[illegible].3-35B

DRYWELL COOLING SYSTEM

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Drywell Cooling Fans PIS#T4700C001 & 2		X	Edison File No. B9-1106 B9-1107	S&L Report SL-2682 Figures B-43 B-44 B-62	S&L Report SDD-DECo-003 Figures B-59 B-57 B-62	N/A		N/A	The new site-specific earthquake accelerations are less severe than the acceleration loadings that were used in the original seismic qualification; therefore, this equipment is requalified.
Drywell Coolers & Anchors T4700B001 & 2		X	B9-637	B43, B44, B62	B59, B57, B62	-3%			The cooler mounting feet show considerable margin with regard to yield stress. The cooling coil frame and anchor bolts are also adequate and are considered requalified.

TABLE 5.3-36

RHR COMPLEX HVAC

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
RHR Complex Pump Room Ventilation, Switchgear exhaust Ventilation A, B, Diesel Generator Ventilation Div. I & II Location RHR Elevation 590' - 617'		x	S&L EMD-029830				S&L EMD-029950 & EMD-029830	20% for angle attached to base plate	Reevaluation was based on a dynamic analysis of linear elastic structural model utilizing the method of response spectrum analysis. A continuous, uninterupted operation and structural integrity of the subject systems during and following an earthquake was demonstrated in the above mentioned analysis. Stresses are within AISC allowables.
Control Dampers, type CD31-PB and OB Isolation Dampers, type CD R2-92 Location RHR		X	Ruskin Mfg. Co. CDRI-92 1/29/79 S&L EMD-017492 3/20/79 EMD-017187 2/14/79 2/27/79				S&L EMD-029950	1.27%*	Stresses are within the allowable limits. Control dampers qualify to new response spectra.

* For top blade based on allowables

TABLE 5.3-36 (cont.)

RHR COMPLEX HVAC

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
RHR Complex Fans Equip. No. X-41-03-C01, 02, 03, 04, 05, 06, 07, 08 Location RHR Elevation 617'		X	Buffalo Forge Co. 77K-25508-23;9/78 S&L EMD-016338				S&L EMD-029950	15.8% *	Stresses are below yielding on foundation bolts and within allowables on the other sections. This equipment is requalified.
RHR Complex Fans Equip. No. X-41-03-C021, 22, 23, 24 Location RHR Elevation 617'		X	Buffalo Forge Co. 77K-25528-31; 9/78 S&L EMD-016338				S&L EMD-029950	-13.7%**	Based on a more sophisticated analysis the fans should qualify. Reanalysis is underway. See Section 5.4
RHR Complex Fans Equip. No. X-41-03-017, 018, 019, 020 Location RHR Elevation 590'		X	Buffalo Forge Co. 77K-25-524-27; 9/78 S&L EMD-016338				S&L EMD-029950	>100%***	Based on a very conservative evaluation, the stresses in the same components are higher than allowables. However, when analyzed in detail, the fans may qualify with little or no modification. Reanalysis is underway. See Section 5.4

* For foundation bolts based on yield

** For inlet stand based on yield

*** For shaft over yield

TABLE 5[illegible]36 (cont.)

RHR COMPLEX HVAC

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
RHR Complex Fans Equip. No. X-41-03, C009, 010, 011, 012, 013, 014, 015, 016 Location RHR Elevation 617'		X	Buffalo Forge Co. 77K-25516-23 S&L EMD-016338				S&L EMD-029950	16.7% *	Stresses are below yielding limits

* For inlet stand based on yield

TABLE 5.3-37

INSTRUMENTATION AND CONTROL--PRINCIPAL SYSTEMS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
CONTROL ROOM PANELS									
H11-P601	X	X						20%	Panel meets seismic requirements by comparison with H11-P602 test
H11-P602	X		SPE Memo 107-78-110					48%	Panel meets seismic requirements based on original test
H11-P603	X	X	SPE MEMO 994-78-138					26%	Panel meets seismic requirements by comparison with H11-P602 test
H11-P612*	X		262A7242					21%	Panel meets seismic requirements based on original test
H11-P613*			SPE Memo 994-73-131					7.5%	Panel meets seismic requirements by comparison with H11-P612 test
H11-P617/P618*								28%	Panel meets seismic requirements by comparison with H11-P612 test
H11-P621*								15%	Panel meets seismic requirements by comparison with H11-P612 test
H11-P622/623*			SPE MEMO 994-78-132					37%	Panel meets seismic requirements based on tests of similar panels for Zimmer and Laguna Verde
H11-P628*								28%	Panel meets seismic requirements by comparison with H11-P612 test

*Relay Room

TABLE 5.3-37 (Continued)

INSTRUMENTATION AND CONTROL--PRINCIPAL SYSTEMS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
H11-P809			SPE MEMO 994-78-118					12%	Panel meets seismic requirements based on original test
H11-P807								--	Panel meets seismic requirements by comparison with H11-P809 test
H11-P808								--	Panel meets seismic requirements by comparison with H11-P809 test
H11-P817								49	Panel meets seismic requirements by comparison with original H11-P809 test
Local Racks & Panels									
H21-P004 P005 P006 P017 P021 P022	X X X X X X						DRF A00794-22	48%	This equipment is requalified to the new site specific earthquake
H21-P037							DRF A00794-22	74%	This equipment is requalified to the new site-specific earthquake
H21-P080 P081 P082 P083 P084 P085 P086 P087	X X X X X X X X		OPE-33-1078				DRF A00794-22	68%	(as above)

TABLE 5.[illegible] (Continued)

INSTRUMENTATION AND CONTROL--PRINCIPAL SYSTEMS

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
H21-P296 A & B		X	H21-00 P296A & B						This equipment is requalified to the new site specific earthquake
H21-P296 E & F		X	R-30-01-S-900-RA-009						(as above)

TABLE 5.3-38

INSTRUMENTATION AND CONTROL--EECW

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
H11-P857 (relay cab)		X	262A7245				DRF A00794-22	41%	This equipment is requalified to the new site specific earthquake
H11-P868 (termination cab)									See Section 5.4-1
H11-P891 (termination cab)									See Section 5.4-1
H11-P601 (insert L514)									See Table 5.3-37
H11-P808 (insert A500)									See Table 5.3-37

TABLE 5.3-39

INSTRUMENTATION AND CONTROL--CONTROL AIR

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
P50 - North Control Air Compresser Control Panel									See Section 5.4
P50-P001 including PSE-P50-N021A and E/V-P50-F008A									See Section 5.4
PSE-P50-N020A									See Section 5.4
North Dehydration Unit - P50 02D003, 5, 7	X		B11-436						See Section 5.4
H11-P914 (relay rm cab.) H11-P915		X	Nuclear Struc-tures					4%	The 4% margin is based upon the minimum yield strength. This compon-ent is requalified.
H11-P898A (relay rm cab.)									See Section 5.4
H11-P601 (B514)									See Table 5.3-37
H11-P868 (termination cab.)									See Section 5.4

TABLE 5.3-40

INSTRUMENTATION AND CONTROL--ESSENTIAL HVAC

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
H21-P296A DIV I HVAC control panel with all internal controls: solenoids, relays 5th floor aux. building			York 77113-2						Seismic Test Report "Edison File No. B9-1838" submitted to W. Street $g_{reass} < g_{qualif} \therefore$ ok
H21-P296E HVAC control panel with internal controls: solenoids, relays 5th floor aux. building			York 77113-2						This equipment is requalified to the new site specific earthquake
H21-P285A chiller compressor control panel			[illegible]41-00 B-008-RA-004 Trane B9-1018						(as above)
H21-P572 York Seismic Rack			York 7[illegible]13-2						Seismic Test Report "York Final Report 77113-2" submitted to W. Street $g_{reass} < g_{qualif} \therefore$ ok
TSP-T41-N061A, -N062A, N063A, N065A, N066A, N067A (local)									See Section 5.4
TSE-T41-N374A, N374C, N374E, N374G, N375A, N375C, N375E, N375G, N327A, N222A									See Section 5.4
TE-T41-N119A, N334A									
PDS-T41-N059A, N323A, N324A									See Section 5.4

TABLE 5.3-40 (Continued)

INSTRUMENTATION AND CONTROL--ESSENTIAL HVAC

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
PDS-T41-N060A, N325A									See Section 5.4
PSE-T41-N326A									See Section 5.4
Seismic Design Calculations for HVAC duct mtd. instruments: pressure sw & temp. sensing elements		X	T41-00-G-900-LB-010 B9-1811					43%	Fluor Report RICO-8901-2 (DECo file No. 1811). Margin based upon yield stress. This component is requalified.
T41 components Damper Motor Mountings for T-4100 F157A & B thru F163 A & B			Fluor Pioneer Rico 8901-4 B9-2174					89%	(Same as Above)
Powers Motor with positioning relay 332-2799 NAMCO Limit Switch EA-700	X		T41-00-0-000-QX-016						This equipment is requalified to the new site specific earthquake
H11-P888 (termination cab.)									See Section 5.4
H11-889 (termination cab.)									See Section 5.4
H11-P808B511									See Table 5.3-37

TABLE 5.3-41

INSTRUMENTATION AND CONTROL--DRYWELL COOLING

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
H21-P128A Local Panel			EA[illegible] 1001-12-7 B9-1933						This equipment is requalified to the new site specific earthquake
H11-P808 insert A502									See Table 5.3-37
H11-P889 (termination cabinet)									See Section 5.4
H11-P898A (relay room cab.)									See Section 5.4

TABLE 5.3-42

INSTRUMENTATION AND CONTROL--RHR COMPLEX

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
COP INSERTS									
H11-P601A501 RHR SW									See Table 5.3-37
H11-P601B514 EESW									See Table 5.3-37
H11-P807B510 RHR SW									See Table 5.3-37
H11-P809A501 Diesel Fuel &									See Table 5.3-37
H11-P809A502 Lube									See Table 5.3-37
H11-P602B510 EDGSW									See Table 5.3-37
TERMINATION CABINETS H11-P823 RHR SW H11-P868 RHR SW EESW H11-P869 Diesel Fuel & Lube									See Section 5.4
H21-P350 (Local HVAC Control Panel) - Diesel Generator Ventilation									See Section 5.4
H21-P351 (Local HVAC Control Panel) - Diesel Generator Ventilation									See Section 5.4
Skid Terminal and Relay Box Equip. No. R30015001-4 Location RHR Elevation 590'	X	ITE Imperial dated 12-19-72 S&L EMD-0093971 EMD-011980					S&L EMD-029950	>100%*	Qualifies to the new response spectra. TRS envelopes the new RRS.

* For vertical and horizontal direction.

TABLE 5.[illegible]2 (Continued)

INSTRUMENTATION AND CONTROL--RHR COMPLEX

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				[illegible]luation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Engine Panel Instrumentation Location RHR Elevation 590'	X		Wyle Labs dated 5/1/78 S&L EMD-013860 EMD-001659				S&L EMD-029950	>100%*	Instruments qualify to new response spectra. TRS envelopes the new RRS.
Diesel Gener tor Control Console Equip. No. R300S002, 004, 005, & 007 Location RHR Elevation 617'	X		Colt Ind. R30-Do-S-9(0-BA-022 (205981) 7/2/75				S&L EMD-029950	N/A	See Section 5.4
H21-P517 Auto Temp Control Panel - DG Ventilation									See Section 5.4
DG Load Sequencer	X								See Section 5.4
Engine Overspeed Governor Equp. No. R30015001-4 Location RHR Elevation 590'		X	Colt Ind. Report dated 1/24/73 S&L EMD-001659				S&L EMD-029950	>100% to trip	Qualifies to the new response spectra.

* For vertical & horizontal direction

TABLE 5[illegible]12 (Continued)

INSTRUMENTATION AND CONTROL RHR COMPLEX

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
TEW-X41-N056A (EDG #11) TEW-X41-N056B (EDG #12) Switchgear room HVAC									See Section 5.4
TEW-X41-N057A TEW-X41-N057C EDG Room HVAC									See Section 5.4
TEW-X41-N058A Pump Room HVAC									See Section 5.4
Operators (ITT) For Ruskin Dampers									See Section 5.4

TABLE 5.3-43

ELECTRICAL COMPONENTS LIST

(Attached)

EQUIPMENT TITLE - 480 V AC AND 260 V DC MOTOR CONTROL CENTERS (ITE)

EQUIPMENT IDENTIFICATION AND POSITION	LOCATION BUILDING-ELEVATION-COLUMN LINES	SYSTEMS OR EQUIPMENT FED FROM THE REFERENCED EQUIPMENT	REMARKS
72B-2A	AUXILIARY BLDG 2ND FLR COL. "F-10"	T41 - Essential HVAC	
72C-3A	REACTOR BLDG. 2ND FLR. COL. "B-15"	E11 RHR T41 Essential HVAC P44 EECWS	
72C-2A	AUXILIARY BLDG. 5TH FLR. COL. "H-15"	P44 EECWS T41 Essential HVAC	
72B-3A	AUXILIARY BLDG. 1ST FLR. COL. "G-13"	T47 Drywell Cooling E11 RHR T41 Essential HVAC P500 Control Air	
72C-F	REACTOR BLDG. 2ND FLR. COL. "A-11"	E11 RHR B31 Nuclear Boiler	
2PA-1	AUXILIARY BLDG. 3RD FLR. COL. "H-11"	E51 RCIC	
2PB-1	AUXILIARY BLDG 3RD FLR. COL "H-11"	E11 RHR	
72EB-2D	RHR COMPLEX SWGR. RM. EL. 617'-0" COL. "E-6"	E11 RHR Service Water X41 Essential HVAC R300 Diesel Generator Service Water	
72EA-2C	RHR COMPLEX SWGR. RM EL. 617'-0" COL. "E-7"	E11 RHR Service Water X41 Essential HVAC R300 Diesel Generator Service Water	
72F-4A	REACTOR BLDG. 2ND FLR. COL. "D-9"	E11 RHR	
72E-5A	REACTOR BLDG. 1ST FLR. COL. "D-9"	E11 RHR P500 Control Air	

EQUIPMENT TITLE - 480 V SWITCHGEAR (ITE)

EQUIPMENT IDENTIFICATION AND POSITION	LOCATION BUILDING-ELEVATION-COLUMN LINES	SYSTEMS OR EQUIPMENT FED FROM THE REFERENCED EQUIPMENT	REMARKS
72 C	AUX. BLDG SWGR RM EL. 613'-6" (2ND FLR) Col G-10	T41 Essential HVAC MCC 72C-2A MCC 72C-3A MCC 72C-F	
72 F	AUX. BLDG. SWGR RM EL. 643'-6" (3RD FLR) Col G-10	E-11 RHR MCC 72F-4A MCC 72C-F	
72 B	AUX BLDG. SWGR RM EL. 613'-6" (2ND FLR) Col. H-10	MCC 72B-3A MCC 72B-2A	
72 E	AUX BLDG. SWGR RM EL. 643'-6" (3RD FLR) Col H-10	MCC 72E-5A	
72 EA	RHR COMPLEX EL. 617'-0" Col. F-6	E-11 RHR MCC 72EA-2C	
72 EB	RHR COMPLEX EL. 617'-0" Col. F-5	P-45 EESW MCC 72EB-2D	

EQUIPMENT TITLE - 4160 SWITCHGEAR (ITE IMPERIAL)

EQUIPMENT IDENTIFICATION AND POSITION	LOCATION BUILDING-ELEVATION-COLUMN LINES	SYSTEMS OR EQUIPMENT FED FROM THE REFERENCED EQUIPMENT	REMARKS
64 B	AUX. BLDG SWGR RM EL. 613'-6" (2ND FLR) COL. H-10	E-11 RHR SWGR 72B	
65 E	AUX. BLDG. SWGR RM EL 643'-6" (3RD FLR) COL. H-10	E-11 RHR SWGR 72E	
64 C	AUX. BLDG. SWGR RM EL. 613'-6" (2ND FLR) COL. G-10	SWGR 72C	
65 F	AUX. BLDG. SWGR RM. EL. 643'-6" (3RD FLR) COL G-10	SWGR 72F	
11 EA	RHR COMPLEX EL. 617'-0" COL. F-7	E-11 RHR SWGR 72 EA	
12 EB	RHR COMPLEX EL. 617'-0" COL. F-6	P-45 EESW SWGR 72 EB	

EQUIPMENT TITLE - BATTERY MAIN DC FUSE CABINETS

EQUIPMENT IDENTIFICATION AND POSITION	LOCATION BUILDING-ELEVATION-COLUMN LINES	SYSTEMS OR EQUIPMENT FED FROM THE REFERENCED EQUIPMENT	REMARKS
MAIN FUSE CAB. DIV I	AUX. BLDG 643'-6" (3RD FLR) G-11	BATTERY	
NEG. MAIN FUSE CAB. DIV I	AUX. BLDG. 643'-6" (3RD FLR) G-11	BATTERY	
NEUT. MAIN FUSE CAB. DIV I	AUX. BLDG. 643'-6" (3RD FLR) G-11	BATTERY	
MAIN FUSE CAB. DIV II	AUX. BLDG. 643'-6" (3RD FLR) F-11	BATTERY	
NEG. MAIN FUSE CAB. DIV II	AUX. BLDG. 643'-6" (3RD FLR) F-11	BATTERY	
NEUT. MAIN FUSE CAB. DIV II	AUX. BLDG. 643'-6" (3RD FLR) F-11	BATTERY	

EQUIPMENT TITLE - BATTERIES & BATTERY RACKS & THEIR MOUNTINGS (C&D)

EQUIPMENT IDENTIFICATION AND POSITION	LOCATION BUILDING-ELEVATION-COLUMN LINES	SYSTEMS OR EQUIPMENT FED FROM THE REFERENCED EQUIPMENT	REMARKS
24/48V 21A & 21B	AUX BLDG. 643'-6" (3RD FLR) Col. F,G - 11, 12		
260/130 V 2PA & 2PB RACKS - 2A1, 2A2, 2B1 AND 2B2	AUX. BLDG. 643'-6" (3RD FLR) Col. F,G - 11, 12		

EQUIPMENT TITLE - BATTERY CHARGERS AND THEIR MOUNTINGS

EQUIPMENT IDENTIFICATION AND POSITION	LOCATION BUILDING-ELEVATION-COLUMN LINES	SYSTEMS OR EQUIPMENT FED FROM THE REFERENCED EQUIPMENT	REMARKS
24 V D.C. A-1, A-2, B-1, B-2 & A-B	AUX BLDG. 643'-6" (3RD FLR) Col. F, G - 11 (3RD FLR)		
130 V D.C. 2A-1, 2A-2, 2A1-2, 2B-1, 2B-2, 2B1-2	AUX. BLDG. 643'-6" Col. F, G - 11		

EQUIPMENT TITLE - DC FUSED DISTRIBUTION CABINETS (SQUARE D)

EQUIPMENT IDENTIFICATION AND POSITION	LOCATION BUILDING-ELEVATION-COLUMN LINES	SYSTEMS OR EQUIPMENT FED FROM THE REFERENCED EQUIPMENT	REMARKS
2PA-2 MAIN D.C. DIST. CAB. DIV I	AUX BLDG. 643'-6" (3RD FLR) Col. G-11		
2PB-2 MAIN D.C. DIST. CAB. DIV II	AUX BLDG. 643'-6" (3RD FLR) Col. F-11		
2PA2-5,6 RELAY RM DIST. CAB. DIV I	AUX BLDG. 613'-6" (2RD FLR) Col. F-17		
2PB2-5,6 RELAY RM. DIST. CAB. DIV II	AUX BLDG. 613'-6" (2ND FLR) Col. F-13		
2PA2-14 SWGR RM DIST. CAB. DIV. I	AUX. BLDG. 613'-6" (2ND FLR) Col. H-10		
2PB2-15 SWGR RM DIST. CAB. DIV II	AUX BLDG. 643'-6" (3RD FLR) Col. G-10		
2PA2-13 SWGR & DIESEL DIST. CAB. DIV I	RHR COMPLEX 617'-0" Col. G-6		
2PB2-14 SWGR & DIESEL DIST. CAB. DIV II	RHR COMPLEX 617'-0" Col. G-9		

EQUIPMENT TITLE - 120 V AC MODULAR POWER SUPPLY UNITS (MPUs)

EQUIPMENT IDENTIFICATION AND POSITION	LOCATION BUILDING-ELEVATION-COLUMN LINES	SYSTEMS OR EQUIPMENT FED FROM THE REFERENCED EQUIPMENT	REMARKS
MPU #1	AUX. BLDG. EL. 613'-6" (2ND FLR) Col. F-10,11		
MPU #2	AUX. BLDG. EL. 643'-6" (3RD FLR) Col. F-10,11		

EQUIPMENT TITLE - DRYWELL PENETRATIONS (CONAX CORP.)

EQUIPMENT IDENTIFICATION AND POSITION	LOCATION BUILDING-ELEVATION-COLUMN LINES	SYSTEMS OR EQUIPMENT FED FROM THE REFERENCED EQUIPMENT	REMARKS
GENERAL	REACTOR BUILDING COL C11, C12, C13, E11, E13 ELEV. 603'-3"	—	—

EQUIPMENT TITLE - TERMINAL BOXES AND TERMINAL BOXES ATTACHED

EQUIPMENT IDENTIFICATION AND POSITION	LOCATION BUILDING-ELEVATION-COLUMN LINES	SYSTEMS OR EQUIPMENT FED FROM THE REFERENCED EQUIPMENT	REMARKS
GENERAL	REACTOR & AUX BLDG. —		

TABLE 5.3-44

7% g DAMPING - HORIZONTAL

GRAPH No	LOCATION	PEAK ACCELERATION OBE 2%	PEAK ACCELERATION SSE 4%	RE-ASS GRAPH No	Reassesed Earthquake RAE 5% DAMPING		Zero Period Acceleration @ 33_{Hz} EXIST	Zero Period Acceleration @ 33_{Hz} RAE
B5	REACTOR AUX BLDG SLAB 1 EL 583-6 N-S	.65g	—	B5RA (B29)	0.91	.8g	.08g	14.23g
B6	REA-AUX BLDG SLAB 1 EL 583-6 E-W	.4g	—	B6RA (B30)	0.77	.7g	.06g	19.22g
B7	REA-AUX BLG SLAB 2 EL.613-6 N-S	1.8g	—	B7RA (B31)	1.65	1.5g	.115	30.27g
B8	REA-AUX BLDG SLAB 2 EL 613-6 E-W	1.2g	—	B8RA (B32)	1.50	1.2g	.16g	34.32g
B9	REA-AUX BLDG SLAB 3 EL 641-6 N-S	2.5g	—	B9.RA (B33)	2.20	2.0g	.16g	40.35g
B10	REA-AUX BLDG SLAB 3 EL 641-6 E-W	1.8g.	—	B10RA (B.34)	2.10	1.7g	.16g	45.42g
B11	REA-AUX BLDG SLAB 4 EL 659-0 N-S	2.5g	—	B11 RA (B35)	2.40	2.2g	.17g	43.4[illegible]g
B12	REA-AUX BLDG SLAB 4 EL 659-0 E-W	1.8g	—	B12 RA (B36)	2.40	1.9g	.175g	48.45g
B13	REA-AUX BLDG SLAB 5 EL 684-6 N-S	2.6g		B13 RA (B37)	2.60	2.4g.	.2g	46.4[illegible]
B14	REA-AUX BLDG SLAB 5 EL. 684-6 E-W	2.9g		B14.RA (B-38)	2.60	2.2g	.19g	[illegible]

TABLE 5.3-44 (Continued)

7% g DAMPING - HORIZONTAL

GRAPH No	LOCATION	PEAK ACCELERATION OBE 2%	SSE 4%	RE-ASS GRAPH No	Reassesed Earthquake RAE 5% DAMPING	Zero Period Acceleration @ 33_{Hz} EXIST	RAE
B-15	CRANE COL 17 N-S	3.7g	–	B 15 RA (B-39)	6.8g	.29g	1.4g
B16.	CRANE COL 17. E-W.	3.6.	–	B16 RA (B 40)	9.20 7.09g	.23g	1.9 1.46g
B17	DRYWELL 18'-0" BELOW RPV INVERT N-S.	NOT SPECIFIED	–	B 17 RA. (B 41)	0.75 .74 g	.08g	.17 .17g
B 18	DRYWELL 18-0 BELOW RPV INVERT E-W	NOT SPECIFIED	–	B18. RA (B 42)	0.75 .7 g	.08g	.19 2.2g
B 19	DRYWELL 6-0 BELOW RPV. INVERT N-S.	NOT SPECIFIED	–	B19 RA (B43)	1.30 1.25 g	.08g	.24 .23g
B 20	DRYWELL 6-0 BELOW RPV INVERT E-W	NOT SPECIFIED	–	B20 RA (B44)	1.40 1.3 g	.08g	.35 .32g
B 21	R. PEDESTAL 18-0 BELOW RPV INVERT N-S.	NOT SPECIFIED	–	B 21. RA (B45)	0.70 .7 g	.08g	.17 .17g
B 22	R. PEDESTAL 18-0 BELOW R PV INVERT E-W.	NOT SPECIFIED	–	B 22 RA (B46)	0.70 .7g	.08g	.19 .22g
B 23	TOP OF REA-PEDESTAL N-S.	NOT SPECIFIED	–	B 23 RA (B 47)	0.86 .83 g	.08g	.16 .2g
B 24	TOP OF REA-PEDESTAL E-W.	NOT SPECIFIED	–	B 24 RA (B, 48)	0.86 .81 g	.08g	.21 .24g
B25	R.P.V. 14-1 ABOVE RPV INVERT N-S.	NOT SPECIFIED		B 25. RA. (B 49)	1.20 1.15 g	.30g	.21 .28g

DAMPING 1/2 % AND 1% HAV. SHOWN.

TABLE 5.3-44 (Continued)

7% g DAMPING - HORIZONTAL

DAMPING 1/2% AND 1% USED ONLY.

GRAPH No	LOCATION	PEAK ACCELERATION OBE 2%	SSE 4%	RE-ASS GRAPH No	Reassesed Earthquake RAE 5% DAMPING		Zero Period Acceleration @ 33 Hz EXIST	RAE
B 26.	R.P.V. 14'-1" ABOVE RPV INVERT E-W	NOT SPECIFIED	—	B 26 RA (B 50)	1.30	1.1g	.36g	.28 .28g
B 27	R.P.V. 52-11 ABOVE RPV INVERT N-S	NOT SPECIFIED	—	B 27 RA (B 51)	2.20	2.0 g	.29 g	.45, .42g
B.28	R P V. 52-11" ABOVE RPV. INVERT E-W.	NOT SPECIFIED	—	B 28 RA (B 52)	2.40	.9g	.29g	.20 .23g
B.53	SACRIF SHIELD EL 606'-0" E-W	2.05g	—	B.53 RA (B.57)	1.05	.9g	.15g	.22 .26g
B.54	SACRIF-SHIELD EL 627'-11" E-W	1.7g	—	B. 54 RA (B.58)	1.60	1.3g	.24g	.24 .3g
B.55	SACRIF. SHIELD EL 606'-0" N-S	.6g	—	B 55 RA (B.59)	1.00	.95g	.135g	.17 .23g
B 56	SACRIF SHIELD EL 627-11" N-S	1.0g	—	B.56.RA (B 60)	1.50	1.35g	.175	.26 .32g
No CORRESP	SHROUD EL 33-9 N-S.			B 61	4.10	4.3g	-	.55, .64g
No CORRESP	SHROUD EL 33-9 E-W.			B 62	2.80	4.2g	—	.60, .66g
No CORRESP	SHROUD EL. 30-9 N-S.			B 63	3.60	3.8g	-	.57, .55g
No CORRESP	SHROUD EL 30-9 E-W.			B 64	2.50	3.6g		.53 - .53

TABLE 5.3-44 (Continued)

7% g DAMPING - HORIZONTAL

GRAPH No	LOCATION	PEAK ACCELERATION OBE 2%	PEAK ACCELERATION SSE 4%	RE-ASS. GRAPH No	Reassesed Earthquake RAE 5% DAMPING	Zero Period Acceleration @ 33 Hz EXIST	Zero Period Acceleration @ 33 Hz RAE
No CORRESP	R.P.V. EL. 10'-11" ABOV RPV INVRT N-S	-	-	B 65	1.10 1.1 g	-	.20 .26 g
No CORRESP	R.P.V. EL. 10-11" ABOV RPV INVRT E-W	-	-	B 66	1.20 1.0 g	-	.25 .28 g
No CORRESP	R.P.V. EL. 15-11 ABOVE RPV INVRT N-S	-	-	B 67	1.20 1.35 g	-	.23 .25 g
No CORRESP	R.P.V. EL. 15-11 ABOVE RPV INVRT E-W	-	-	B 68	1.30 1.2 g	-	.29 .26 g
No CORRESP	R.P.V. EL 36-10 ABOVE RPV INVRT N-S	-	-	B 69	1.80 1.25 g	-	.34 .36 g
No CORRESP	R.P.V. EL 36-10 ABOVE RPV INVRT E-W	-	-	B 70	1.90 1.1 g	-	.45 .34 g
No CORRESP	R.P.V. EL. 42-1 ABOVE RPV INVRT N-S	-	-	B 71	1.90 1.5 g	-	.38 .36 g
No CORRESP	R.P.V. EL. 42-1 ABOVE RPV INVRT E-W	-	-	B 72	2.0 1.7 g	-	.50 .37 g
No CORRESP	R.P.V. EL 59-1 ABOVE RPV INVRT N-S	-	-	B 73	2.40 2.15 g	-	.48 .48 g
No CORRESP	R.P.V. EL 59-1 ABOVE RPV INVRT E-W	-	-	B 74	2.50 2.1 g	-	.65 .5 g

TABLE 5.3-45

480 V AC & 260 V DC MOTOR CONTROL CENTERS (ITE)

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Supplement Seismic with Standability Test Report MCC-Devices Oct. 8, 1973 R-STS-2D Supplement	X		R1600S-900-RA-003 (E4-468)						See Section 5.4
Seismic Withstandability Test Report Oct. 18, 1977 R-STS-16 Wyle Lab Report #43472-1	X		R1600S-900-RA-003 (E5-468)						See Section 5.4
Seismic Simulation Test Report to Qualify the Structure Welds, July 31, 1979 R-STS-20 Rev. 1 Wyle Lab. Report #43801-2	X		R1600S-900-RA-010 (E5-594) R1600S-900-RA-012 (E5-607)						See Section 5.4
Seismic Mounting for MCC		X	R1600S-900-RA-007	N/A					This component is requalified to the new site specific earthquake since: g_{reass} g_{qualif}
Seismic Mounting of Relays in the MCC		X	New	N/A					

TABLE 5.3-46

480 V SWITCHGEAR (ITE)

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Seismic Certification Report for Class 1E Swgr Electrical Equipment ITE Report R-09322	X		R1400S-900-PA-010 (E5-439)						Ok: TRS envelopes the RRS.
Test Report Seismic Shock - 600 V Metal Enclosed Switch-board and Components A.D. Report No. R-8792	X		R1400S-900-QL-001						Ok: TRS envelopes the RRS,
Seismic Certification Test Report for 750 KVA Voltage Regulators Wyle Lab Report 43169-1	X		R1400S-038-RA-001						See Section 5.4
Seismic Simulation Test Report Voltage Regulators Wyle Lab Report No. 42949-1	X		R1400S-900-QL-031 (E5-429)						Ok: TRS envelopes the RRS.
Seismic Certification Voltage Regulators ITE	X		R1400S-900-LB-096						Seismic certification only. No attachments.
Electrical Equipment Class 1 Seismic Shock Certification - 1500 KVA Transformer Wyle Report No. R-09402	X		R1400S-900-QL-027 (E5-427)						Ok: TRS envelopes the RRS.
Addendum to Test Report R-09402			R1400S-900-RA-007 R1400S-000-LB-030						

TABLE 5.3-46 (Continued)

480 V SWITCHGEAR (ITE)

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Seismic Certification and Analysis Type VU-9 Dry Type Transform. (ITE)	X		R1400S-900-RA-009						Ok: $g_{reass} < g_{qualif.}$
Switchgear Seismic Mounting by Giffels		X	R1400S-900-RA-013	N/A					This equipment is requalified to the new site specific earthquake
Switchgear Seismic Mounting by Giffels		X	R1400S-900-RA-014	N/A					This equipment is requalified to the new site specific earthquake

TABLE 5.[illegible]7

4160 V SWITCHGEAR **(ITE IMPERIAL)**

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Seismic Certification for Class IE Electrical Equipment (Buses 64B, 64C, 65E, 65F, 64T, 65T, 11 EA, 12 EB, ITE #33-47196)	X		R14000-000-SC-009-E4-333						See Section 5.4
Test Report Seismic Shock 5kV Metal Clad Switchboard and Components. Wyle Lab R-09321	X		R14000-000-RA-003						See Section 5.4
Seismic Withstandability Auxiliary Relay GE 12KFA51A42F Report R-09161-BE	X		R1400S-000-RA-011						See Section 5.4
Seismic Withstandability Over-Under Voltage Relay GE 12IAV53LIA Report R-0916BF	X								**This equipment is requalified to the new site specific earthquake**
Seismic Withstandability Overcurrent Relay GE IAC53B104A (Per ITE TD-7629 Procedure) Report R-09161-AT	X								See Section 5.4
Seismic Withstandability Overcurrent Relay GE 12PJC11AVIA (Per ITE TD-7629 Procedure) Report R-09161-BK)	X		R14000-000-RA-006						See Section 5.4

TABLE 5.[illegible]7 (Continued)

4160 V SWITCHGEAR (ITE IMPERIAL)

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Seismic Withstandability Lockout Relay Electro Switch Type LOR Cat. 78030 (Per ITE TD-7629 Procedure) Report No. R-0916!-BC	X		R14000-000-RA-007						This equipment is requalified to the new site specific earthquake
Seismic Withstandability Overcurrent Relay GE 121AC66C1A (Per ITE TD-7629 Procedure) Report No. R-09161-AV	X		R14000-000-RA-008						See Section 5.4
Seismic Withstandability J10 & J13 Relay ITE-STD-1-35/36/37	X		R14000-000-BA-002 (E4-402)						See Section 5.4
Switchgear Mounting Seismic Report by Giffels		X	R1400S-900-RA-013						This equipment is requalified to the new site specific earthquake
Switchgear Seismic Mounting by Giffels		X	R1400S 900-RA=013						This equipment is requalified to the new site specific earthquake

TABLE 5.3-48

BATTERY MAIN DC FUSE CABINETS VDP NO. EF2-39, 120B

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Main DC Fuse Cabinet Seismic Report		X	R3200S-900-BA-011	N/A				20.9%	O.K. A mathematical analysis has been made based on material and fabrication as per Dwg. 5E721-2297-2 which indicates that this component is requalified to the revised response spectra.

TABLE 5.3-49

BATTERIES & BATTERY RACKS & THEIR MOUNTING (C&D)

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
24 V DC Battery--Report of seismic test on 2 (3DCU-9) batteries for C&D. ETL Report #4887 and report for seismic test on two (3-DCU-3) batteries and one ARR 130 AC 3 charger for C&D. ETL Report #5263	X		R3200S-900-RA-008 (E11-84)						$g_{reass} < g_{qualif}$ ok. Most critical slab is slab #5 bldg. aux. 0.665 g 1.5 g.
130 V DC Battery--Seismic simulation test program on two KC-13 battery cells & one ARR 130 HK100 battery charger Wyle Report #42954-1	X		R3200S-900-RA-004 (E11-80)						Ok. Test response spectra envelopes the required response spectra (aux. bldg. 643'-6)
Battery racks for 24 V DC batteries--seismic analysis of C&D battery support racks for the C&D No. 3 DCU-7 battery		X	R3200S-900-RA-007 (E11-85)	N/A					$g_{reass} < g_{qualif}$ ok. (3rd Floor aux. bldg.)
Battery racks for 130 V DC batteries--seismic analysis report of KCU-17 single tier battery rack CCL Report #A-119-77		X	R3200S-900-RA-003 (E11-81)	N/A					$g_{reass} < g_{qualif}$ ok.
Seismic Report of 24/48 V battery rack mounting GAI-001-EF2-159-156 (78-GAI-0364)		X	R32-00S-900-BA-011 R32-00S-900-LC-182	N/A N/A			468 6#	17.31%	This equipment is requalified to the new site specific earthquake

TABLE 5.3-49 (Continued)

BATTERIES & BATTERY RACKS & THEIR MOUNTING (C&D)

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Seismic design of 130/260 V & 24/48 V battery rack supports, fuse box & its supports (78-GA1-0143)		X	R32-00S-900-BA-C11	N/A			28.49 RSI	20.9%	This equipment is requalified to the new site specific earthquake
Seismic design of 130/260 V battery rack supports 24/48 V battery rack supports		X	Part of the DDP. No report number	N/A					This equipment is requalified to the new site specific earthquake
Seismic report for the design of the battery racks		X	No report number	N/A					This equipment is requalified to the new site specific earthquake

TABLE 5.3-50

BATTERY CHARGERS AND THEIR MOUNTING (C&D BATTERIES)

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
130 V dc battery charger report of seismic test on two (3-DCU-3) batteries and one APR13AC3 charger and C&D batteries ETL Lab Report #5263	X		R32-00S-900-RA-005 (E11-84)						$q_{reass} < q_{qualif}$ = ok
130 V dc battery charger seismic simulation test program on two KC-13 battery cell and one APR13HK100 battery charger Wyle Lab Report #42954-1	X		R3200S-900RA-006 (E11-80)						This equipment is requalified to the new site specific earthquake
Seismic Class 1 attachment for 130 V battery charger 24 V battery charger and voltmeter -GAI-0016)	X		R3200S-900RA-013 R3200S 900LC-075 (E11-105)	N/A				48%	This equipment is requalified to the new site specific earthquake

TABLE 5.3-51

DC FUSED DISTRIBUTION CABINETS (SQUARE D) VDP NO. EF2-30,121C

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Seismic Qualification for a 250 V DC QMB Panel Board Square D 8998-10-09-L16R	X		R3200S-900-RA-015 (EG-87)						See Section 5.4
Seismic Class I DC Distribution Panel Installation at the Reactor Building		X	T51000000-RA-001 (E11-128)	N/A			52%		This equipment is requalified to the new site specific earthquake
Seismic Class I DC Distribution Panel Installation at the RHR Complex		X	R3200S-063	N/A			43%		This equipment is requalified to the new site specific earthquake

TABLE 5.3-52

120 V AC MODULAR POWER SUPPLY UNITS (MPUs)

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Seismic analysis Report of I&C power supply panel structure #74021-1		X	R3101S-001-00-001	N/A				34.02%	This equipment is requalified to the new site specific earthquake
Seismic vibration tests of I&C power supply panel components--ASCO transfer switch solatron voltage regulator & GE fusible disconnect Report 74021-1	X		R3101AS-900-RA-002 (E5-443)		0.636 g				$g_{reass} < g_{qualif}$ ok
Analysis of seismic Class 1E mountings for modular power units #1 & 2 GAI-001-EF2-193-118 (78-GAI-221)		X	R1600S-900-RA-009 (E11-130)	N/A					This equipment is requalified to the new site specific earthquake
Seismic Qualification of the SBM test switch mounting for MPUs 1 & 2. GAI-001-EF2-228-269 (79-GAI-352)		A	R3101S-001- (E11-140)	N/A					$g_{reass} < g_{qualif}$ ok

TABLE 5.3-53

DRYWELL PENETRATIONS (CONAX CORP.) VDP NO. EF2-39,115C

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Seismic analysis of electrical penetration assemblies & addenda. (Conax Corp.) IPS-88		X	T23-01-X900-BA-009 (E5-335)	N/A					This equipment is requalified to the new site specific earthquake
Stress analysis nuclear penetration, canister assembly and addenda. (Conax Corp.) IPS-87		X	T2301X-900-BA-008 (E5-284)	N/A					$g_{reass} < g_{qualif}$ ok

TABLE 5.3-54

TERMINAL BOXES AND TERMINAL BOXES ATTACHED TO DRYWELL PENETRATIONS (HOFFMAN)

SEISMIC RE-EVALUATION

SUMMARY TABLE

System, Structure, Component Description	Method of Original Qualification				Re-Evaluation Results				Conclusion and Remarks
	Test	Analysis	Report #	Spectra #	Spectra Comparison Fig. #	% Margin	Analysis Report #	% Margin of Safety	
Terminal boxes seismic qualification report Hoffman Type A-1210 CHNF A-1008 CHNF and A-606 CHNF		X	GASI (E11-109)	N/A				73.1%	This equipment is requalified to the new site specific earthquake
Terminal box attachment to drywell penetrations, Reactor Bldg.		X	GASI T23 01X 102A RA-001 (E11-136)	N/A				43.4%	This equipment is requalified to the new site specific earthquake

TABLE 5.4-1

Components Requiring Seismic Requalification

	Component	Reference Table
1.	Diesel Generator Fuel Oil Storage Tank	5.3-12
2.	Diesel Generator Service Water Pump	5.3-16
3.	Cable Tray Cooling Fans	5.3-35
4.	RHR Complex HVAC Fans	5.3-36
5.	H11-P868 (Termination Cabinet)	5.3-38
6.	H11-P891 (Termination Cabinet)	5.3-38
7.	North Control Air Compressor Control Panel	5.3-39
8.	Control Air I&C	5.3-39
9.	North Dehydration Unit (Control Air)	5.3-39

TABLE 5.4-1 (Continued)

Component	Reference Table
10. H11-P898A (Relay Room Cabinet)	5.3-39
11. Essential HVAC I&C	5.3-40
12. H11-P888 (Termination Cabinet)	5.3-40
13. H11-P889 (Termination Cabinet)	5.3-40
14. H11-P823 (Termination Cabinet)	5.3-42
15. H11-P869 (Termination Cabinet)	5.3-42
16. H21-P350 (Termination Cabinet)	5.3-42
17. H21-P351 (Termination Cabinet)	5.3-42
18. EDG Control Console	5.3-42
19. H21-P517	5.3-42
20. EDG Load Sequencer	5.3-42
21. 480 VAC and 260 VDC Motor Control Center (ITE)	5.3-45
22. 48 V Switchgear (ITE)	5.3-46
23. 4160 V Switchgear (ITE Imperial)	5.3-47
24. DC Fused Distribution Cabinets (Square D)	5.3-51

6.0 PIPING EVALUATION

The effects of the postulated site-specific SSE spectra on plant piping systems were evaluated by performing detailed analyses of large-bore piping and instrumentation and control piping, and by generic analysis of small-bore piping and Class 1E conduit.

Sections 6.1, 6.3, 6.5, and 6.6 present the results for large-bore piping. Sections 6.2 and 6.4 describe the requalification of instrumentation and control piping. Sections 6.7 and 6.8 present the generic evaluations of Class 1E conduit supports and small-bore piping, respectively.

The results of the evaluations show that these systems have the capability of withstanding the defined site-specific earthquake and the ability to subsequently support a cold shutdown of the plant.

6.1 Large-Bore Piping Stresses

The original seismic analysis of large-bore piping is described in Section 3.7 of the Fermi-2 FSAR. The supplementary analysis discussed here was limited to piping in systems required for safe shutdown (identified in Section 5.2 of this report), as listed in Table 6.1-1.

In the FSAR analyses, the SSE response was obtained by multiplying the OBE response by 1.875, instead of using the SSE response spectra. (The value of 1.875 is the ratio of the SSE ground acceleration, 0.15g, to the OBE ground acceleration, 0.08g.) These analyses were based on structural damping of 5% and equipment damping of 0.5%. The supplemental evaluation was based on structural damping of 7% and equipment damping of 2%, as required by Regulatory Guide 1.61. In general, the multiplied

OBE response spectra bounds the corresponding site-specific spectra through a considerable portion of the low frequency range. Since most significant loads generally result from the lower frequency modes, it was expected that the design-basis piping stresses calculated using the multiplied OBE response spectra would bound the site-specific piping stresses. The numerical results proved this assumption to be correct in almost all cases.

In the April 28, 1981, meeting the NRC staff expressed its desire to see a revised vertical spectrum in the supplementary evaluation. As discussed in Section 2 of this report, the revised vertical spectrum is assumed to be two times the FSAR SSE spectrum. Inclusion of the revised vertical spectrum in the calculation of loads on the piping systems listed in A.1 of Table 6.1-1 did not significantly increase the loads. For this reason and the reasons discussed previously, reanalysis of the systems listed in items A.3 and B of Table 6.1-1 was considered unwarranted.

The NSSS supplier originally used the response spectra that most closely corresponded to the center of gravity of the piping system to evaluate the main steam system, reactor recirculation system, and attached piping. These piping analyses will be revised to include all the response spectra applicable to the support and anchor locations. As these analyses will use a multiplied OBE response to evaluate SSE loadings, the conclusions reached in this section will apply to these piping systems as well.

Results are presented herein for one piping analysis subsystem, FW-01, which consists of the feedwater piping from the flued head anchor structure to the reactor vessel. Piping modal periods are tabulated in Table 6.1-2. The design-basis response spectra used in the piping analysis are compared with the corresponding site-specific spectra in Figures 6.1-1 through 6.1-6.

Piping stresses are tabulated in Tables 6.1-3 and 6.1-4. Overall, the results from all the piping analyses performed showed the predicted piping stresses to be lower for the site-specific earthquake than for the design-basis in almost all cases. Therefore, the plant large-bore piping is considered to be adequate in this aspect of design.

6.2 Instrumentation and Control Piping Stresses

Loads on the instrumentation and control (I & C) piping inside containment required for safe shutdown were originally calculated using the FSAR SSE response spectra at 1% equipment damping. All of these piping systems were analyzed for the supplementary evaluation using both the revised horizontal and the revised vertical response spectra.

Instrumentation and control piping stress results are presented in Table 6.2-1 for one piping system. Overall results show all I & C piping stresses to be within Code allowables for faulted (level D) conditions, with the vast majority within emergency (level C) limits. Thus, the present design of the I & C piping in the plant is considered adequate.

6.3 Large-Bore Pipe Supports

The design of supports for piping systems at Fermi-2 includes considerable safety margin. Factors contributing to this margin include the following:

a. the design of structural components is based upon AISC code limits without including the 1/3 increase allowed for seismic loads (margin to failure would be larger);
b. the piping analysis is conservative, including the assumptions such as rigid supports in the analysis of thermal loads, broadening of response spectra peaks, enveloped

response spectra and the simultaneous occurrence of low probability worst-case loads;

c. loads for the majority of the supports in the reactor building are based on either 1.25 times the piping analysis predicted load or the actual rating of the component, (i.e. snubber, strut, etc.) whichever is smaller;

d. anchor bolts are sized using the factors of safety given in IE Bulletin 79-02.

Representative pipe support loads as predicted by one piping analysis (FW-01) are presented in Tables 6.3-1 and 6.3-2. The definition of combined load used in these tables is the maximum of the following 4 loads:

1. seismic inertia + seismic anchor displacement + deadweight

2. seismic inertia + seismic anchor displacement + deadweight + thermal

3. (-) seismic inertia - seismic anchor displacement + deadweight

4. (-) seismic inertia - seismic anchor displacement + deadweight + thermal

The old combined load includes seismic inertia loads based on the FSAR SSE (OBE scaled by 1.875). The new combined load includes seismic inertia loads based on the site-specific SSE.

Overall, the pipe support loads resulting from the site-specific SSE were found in nearly all cases to be lower than the loads resulting from the FSAR OBE scaled by 1.875. In addition, the rigid support loads were lower than those of the original analyses because normal operating temperatures, rather than design-basis temperatures, could be assumed under the guidelines provided by the NRC staff for the supplementary seismic evaluation. For these reasons, detailed evaluation of each support was considered unwarranted. The present design of the large-bore pipe supports in the plant is considered adequate.

6.4 Instrumentation and Control Pipe Supports

As indicated previously, the I & C piping was originally evaluated using the SSE response spectra with 1% equipment damping, not the scaled OBE spectra used to evaluate large-bore piping. Thus, it was expected that the supplementary seismic evaluation would predict a number of support loads higher than originally calculated.

A representative sample of the drywell I & C supports were evaluated. This sample consisted of 43 of the 191 areas originally analyzed and it provided load change data for 1294 structural supports.

To evaluate the significance of the load changes, they were grouped into the four categories shown in Table 6.4-1. The results of this grouping are shown in Figure 6.4-1. Inspection of this histogram shows that the new loads are less than the original loads calculated for half of the supports. The new loads are less than code-specified minimum yield strength for 75% of the supports. The large number of supports shown in Category D results from small changes in very small loads originally calculated. A sample of this type of data is presented in Table 6.4-2. From this analysis, the present design of the I & C piping support is considered to provide sufficient margin to assure that the plant can be shut down safely following the postulated site-specific earthquake.

6.5 Equipment Nozzle Loads

Forces and moments at equipment connections predicted by the large-bore piping analyses previously described were compared with the design-basis reactions and the allowable reactions. In all cases, the loadings resulting from the site-specific earthquake were lower than the original design values. Results for the feedwater piping RPV nozzle connections are provided in Table 6.5-1 as an example of this evaluation.

As presented in Table 6.5-1, the resulting forces (F_R) and moments (M_R) are defined as follows:

$$F_R = \sqrt{F_x^2 + F_y^2 + F_z^2} \text{, units of pounds-force}$$

$$M_R = \sqrt{M_x^2 + M_y^2 + M_z^2} \text{, units of foot-pounds-force}$$

The quantities F_x, F_y, F_z, M_x, M_y, and M_z are those arising from the worst combination of weight, thermal, seismic anchor, and seismic inertia loadings.

6.6 Valve Accelerations

The accelerations at the center of gravity of operated valves were calculated in the large-bore piping analyses previously described and compared with the vendor allowable values. In all cases, the calculated values were much less than the allowable values. Results for several valves are presented in Table 6.6-1 as an example of this evaluation.

The EECW pump differential control valves and the EECW heat exchanger outlet temperature control valves (mark nos. V8-2481, V8-2482, V15-2036 and V15-2040) were not included in this evaluation because of the following problems:

1. These valves are furnished with accessories (controllers, positioners) that may not be qualified to fail the valves in their designed failure mode.

2. These valves have fundamental frequencies (of the operator with respect to the valve body) considerably less than 33 Hz. As the valves are modeled with rigid elements between the pipe centerline and the valve center of gravity in the existing piping analysis, accelerations thus obtained are invalid.

In pursuing a solution to this problem, DECo commits to use the multiplied OBE response to obtain the SSE response in the affected piping analyses. The trends apparent in the analyses previously described indicate that the valve accelerations thus obtained will be similar to those obtained from a site-specific analysis. Therefore, we see no need to consider this problem as an open item with regard to the site-specific earthquake.

6.7 Evaluation of Class IE Conduit Supports by Generic Analysis

The original seismic design for the Class IE electrical conduit supports is described generically in the Giffels Associates, Inc. report entitled "Seismic Analysis and Design of Class IE Electrical Conduit Supports - Enrico Fermi Power Plant - Unit II," and specifical in a series of individual design calculations which are typically represented in form and content by a document entitled "Seismic Calculation for DCR E-2307," which was transmitted to DECo via Giffels Letter 81-GA1-101 dated 4/24/81.

The original seismic design was done by conceptually dividing the reactor auxiliary building into two seismic zones at an elevation of 640-0 ft (which is below the third floor) and then designing the conduit supports for each zone using static analysis techniques based upon the simultaneous application of three orthogonal peak-of-the-spectra acceleration coefficients. In each case, the maximum acceleration was used as the basis for the analysis. In order to account for the contribution of higher-ordered modes, all acceleration coefficients were multiplied by 1.5 as is recommended by SRP 3.7. After a review of all relevant spectra, it was determined that due to the lower damping, designs would be governed by the OBE loads. Consequently, all calculations were done using the approp iate OBE spectra, calculated at 2% damping as is required by Regulatory Guide 1.61. Allowable stresses used were as specified by the AISC code, 1970 edition, without the allowed increase for seismic loads.

Method

The basic steps followed in the reevaluation are outlined below:

(1) The originally calculated seismic acceleration coefficients for each seismic zone were listed.

(2) The seismic acceleration coefficient based upon new SSE spectra were calculated using the same techniques that were applied in original analysis.

(3) The new seismic coefficients for the new SSE were scaled down based upon the ratio of SSE to OBE allowable stresses (F_y vs $F_{allowable}$).

(4) The scaled seismic coefficients developed in step 3 were checked on a floor-by-floor basis against the original coefficients used in step 1, and the appropriate conclusions were drawn.

Assumptions

(1) Allowable stress for SSE = 1.0 F_y

(2) Allowable stress for OBE = 0.69 F_y

(3) New acceleration coefficients will be based upon 5% equipment damping rather than the 4% specified in Regulatory Guide 1.6 for welded structures. This is defensible since the 4% figure is for welded steel structures, and does not take into consideration the additional damping that the conduit supports will experience due to the cables "slapping" inside the conduits during a seismic event.

(4) If the new adjusted seismic acceleration coefficient for a slab (floor) is less than or equal to the original seismic acceleration coefficient for the seismic zone containing that slab, than all conduit supports attached to that slab are considered qualified to the new tabulated earthquake loadings.

(5) A multiplier of 2.0 on the existing SSE acceleration coefficients was used to obtain values for the new "larger than SSE" in the vertical direction.

Conclusion

The results of this analysis are shown in Tables 6.7-1, 6.7-2, and 6.7-3. The ratio of the new earthquake horizontal design acceleration amplitudes, scaled to reflect the higher allowable stresses permitted during the SSE versus the original amplitudes, varies from 0.32 to 0.96.

capacity of the existing conduit support design varies from 4% to 68%. It is therefore concluded that the existing IE conduit support system is qualified to the new postulated SSE.

6.8 Generic Analysis of Small Piping

This section presents the generic evaluation of the effects of the site-specific spectra on the design of small-bore piping given in the Sargent & Lundy report SL-3159, Revision 1, "Small Piping Design Standard," July 29, 1977.

Procedures

The present design-basis data are shown in Tables C-1 and C-3 of SL-3159. Pipe sizes, schedules, and recommended span lengths were reviewed. Using the procedures of Section A-4.2 of SL-3159, the first modal period was calculated for the specified span lengths. This period was used to select appropriate acceleration values from Figures 6.8-1, 6.8-2, and 6.8-3 for the Reactor Building ing and from Figures 6.8-4, 6.8-5, and 6.8-6 for the RHR complex. Predicted support loads were calculated from this acceleration value.

Results

A complete set of calculation for support loads, pipe stress, and displacements is given in the Sargent & Lundy calculation package EMD 030163. For piping in the Reactor Building, Tables 6.8-1, 6.8-2, and 6.8-3 present a comparison of the design-basis loads with those predicted under the revised response spectrum. The predicted loads do not exceed 70% of those given in SL-3159. For piping in the RHR complex, Tables 6.8-4, 6.8-5, and 6.8-6 present a comparison of the design-basis loads with those predicted under the revised response spectra. The predicted loads do not exceed 90% of those given in SL-3159. Thus, all values were confirmed to be within the design-basis values of SL-3159, the small piping design standard for the Fermi-2 plant. Hence, the design of small piping is considered acceptable.

Table 6.1-1

Large Bore Piping Analyses

A. Systems Reanalyzed for Supplementary Evaluation

1. New horizontal and new vertical (2xDBE vertical) and, for comparison, without new vertical

Reactor Building	RHR Complex
RHR-03 & -19	SX-13 (RHR Service Water Return)
FW-01 & -04	EDG-12 (Diesel Gen. Starting Air System)
EECW-9 & -17	

2. New horizontal and new vertical

EECW Makeup Tank Piping

3. New horizontal only

RHR-07
EECW-08, -10, -11, -12, -13
EECW-14, -15, -16, -21, -22
RCIC-03, -04
EDG-11 (Diesel Generator Air Intake)
SX-06 (EDG Service Water Supply)
SX-08 (EESW Supply)
SX- 09 (RHR Service Water Supply)
SX-10, -11 (EDG Service Water Return)

B. Systems not Reanalyzed for Supplementary Evaluation

RCIC-01 (Outside drywell, steam supply to RCIC turbine)
RHR-02 (Outside drywell, RHR SDC return piping)
CRD (Small piping inside & outside drywell originally analyzed in detail)
SRV Discharge Lines (3 lines off mainsteamline B)
RRS (Including attached RHRS and RHRR Piping)
Main Steam Line B (Including Attached RCIC Steam Piping Inside Drywell)

TABLE 6.1-2

Stress Analysis Subsystem FW-01
Feedwater Piping Inside The Containment
Model Periods

Mode	Period (sec)
1	.11122
2	.10526
3	.08960
4	.08254
5	.07026
6	.06401
7	.06251
8	.05826
9	.04812
10	.04232
11	.03913
12	.03481
13	.03287
14	.03229
15	.02931
16	.02792
17	.02628
18	.02602
19	.02505
20	.02480
21	.02364
22	.02291
23	.02233
24	.02070
25	.01938
26	.01803
27	.01710
28	.[illegible]1689
29	.01678
30	.01646

TABLE 6.1-3

PIPING STRESSES (VALUES WITHOUT 2 x EXISTING VERTICAL)

STRESS REPORT	NODE	DESIGN BASIS SSE STRESS	ASSESSMENT SSE STRESS	% CHANGE	DESIGN BASIS COMBINED STRESS**	ASSESSMENT** COMBINED STRESS	% CHANGE	ALLOWABLE* COMBINED STRESS
FW-01	15A	3028	1962	-35.2	14036	12970	-7.6	43762
	35B	3154	1976	-37.8	13930	12752	-8.5	↓
	75A	3874	2285	-41.0	14515	12926	-10.9	↓
	95B	2224	1327	-40.3	13068	12171	-6.9	↓
	120B	3510	2146	-38.9	15315	13951	-8.9	↓
	140A	2998	1776	-40.8	14916	13694	-8.2	↓
	160B	3964	2455	-38.1	14549	13040	-10.4	↓
	180B	3971	2166	-45.5	15030	13225	-12.0	↓
	215B	6229	3791	-39.1	17389	14951	-14.0	↓

* Value indicated is Level C Equation 9 Allowable, 2.25 Sm

** Combined Stress Means Equation 9, NB-3652, Level C values

TABLE 6.1-4

PIPING STRESSES (VALUES INCLUDING 2 x EXISTING VERTICAL)

STRESS REPORT	NODE	DESIGN BASIS SSE STRESS	ASSESSMENT SSE STRESS	% CHANGE	DESIGN BASIS COMBINED STRESS**	ASSESSMENT** COMBINED STRESS	% CHANCE	ALLOWABLE*
FW-01	15A	3028	2004	-33.8	14036	13012	-7.3	43762
	35B	3154	2026	-35.8	13930	12802	-8.1	↓
	75A	3874	3157	-18.5	14515	13798	-4.9	↓
	95B	2224	1656	-25.5	13068	12500	-4.3	↓
	120B	3510	2885	-17.8	15315	14690	-4.1	↓
	140A	2998	1934	-35.5	14916	13852	-7.1	↓
	160B	3964	2575	-35.0	14549	13160	-9.5	↓
	180B	3971	2185	-45.0	15030	13244	-11.9	↓
	215B	6229	3920	-37.1	17389	15080	-13.3	↓

* Value indicated is Level C Equation 9 Allowable, 2.25 Sm
** Combined Stress Means Equation 9, NB-3652, Level C values

CALCULATION SHEET

J.O./W.O./CALCULATION NO.: 13067.25 | REVISION: | PAGE:

PREPARER/DATE: Frank X Fichtle 5/8/81 | REVIEWER/CHECKER/DATE: E N Palato 5-8-81 | INDEPENDENT REVIEWER/DATE:

SUBJECT/TITLE: STRESS EVALUATION | QA CATEGORY/CODE CLASS:

TABLE 6.2-1

Instrumentation and Control Piping Stress Results for Representative Piping System

AX NO (DWG. NO)	NODE PT.	NORMAL OPER. STRESS (PST) P & DW	OLD SSE STRESS (PSI)	NEW SSE STRESS (PSI)	% CHANGE	OLD COMBINED STRESS (PSI)	NEW COMBINED STRESS	% CHANGE
X-XSSB-014-01	20	3334.	9019.	13492.	49%.	12353.	16816.	36%
	25	3330.	9112.	13652.	50%.	12442.	16982.	36%
	30	3035.	11652.	16076.	40%.	14687.	19111.	30%.
	35	2960.	11764.	16081.	37%.	14724.	19041.	29%.
	260	5732.	10570.	7918.	-25%	16302.	13650.	-16%
	315	4746.	11686.	11901.	1.8%.	16432.	16647.	1.3%.
	340	5532.	9684.	10756.	11%	15216.	16288.	7%
	1015	3492.	11472.	18011.	57%.	14964.	21503	44%
	1020	3618.	11897.	18668.	57%	15515.	22286.	44%.
	1025	3524.	11173.	17513.	57%.	14697.	21037.	43%.

TABLE 6.3-1

PIPE HANGER LOAD ASSESSMENT

STRESS REPORT ON FW-01

(WITHOUT 2 x EXISTING VERTICAL)

NODE	"OLD" COMBINED LOAD	"NEW" COMBINED LOAD	% CHANGE	(BLANK)
18	3929	3631	-8.00	
20	10254	9017	-12.00	
41	6724	4975	-26.00	
45B	2450	1980	-19.00	
65	5310	3957	-25.00	
70	6260	4729	-24.00	
100	2624	2328	-11.00	
100	4260	3064	-28.00	
155A	3254	2035	-37.00	
155A	2657	2214	-17.00	
155B	10225	6704	-34.00	
165A	5909	4089	-31.00	
185	8888	5395	-39.00	
195	1775	1520	-14.00	
210	6344	3651	-42.00	

TABLE 6.3-2

PIPE HANGER LOAD ASSESSMENT

STRESS REPORT ON FW-01

(INCLUDING 2 x EXISTING VERTICAL)

NODE	"OLD" COMBINED LOAD	"NEW" COMBINED LOAD	% CHANGE	(BLANK)
18	3929	4462	14.00	
20	10254	9381	-9.00	
41	6724	5236	-22.00	
45B	2450	2322	-5.00	
65	5310	4315	-19.00	
70	6260	5120	-18.00	
100	2624	2527	-4.00	
100	4260	3366	-21.00	
155A	3254	2150	-34.00	
155A	2657	2363	-11.00	
155B	10225	6991	-32.00	
165A	5909	4826	-18.00	
185	8888	5968	-33.00	
195	1775	1619	-9.00	
210	6344	4396	-31.00	

TABLE 6.4-1

Grouping of I&C Piping Load Changes

Category	Description	Assigned Design Margin Index
A	New Load ≤ Original load	1.0
B	New Load ≤ Original load plus the 25% margin included in the support design	.89
C	New Load ≤ Original load multiplied by the yield stress divided by the governing code design stress	.75
D	New Load ≥ Original load multiplied by the yield stress divided by the governing code design stress	.5

CULATION SHEET

STONE & WEBSTER ENGINEERING CORPO...

J.O./W.O./CALCULATION NO.	REVISION
13067.25	

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
S.E. N Awoikoya 6/8/81	[illegible] 5/18/81	H. J. Torng 5/18/81

SUBJECT:

QA CATEGORY/CODE CLASS

TABLE 6.4-2

Sample Support Loading Evaluation

AX NO (DWG. NO)	NODE PT	TYPE OF SUPPORT	OLD COMBINED SSE & NORM		NEW COMBINED SSE & NORM		% CHANGE
AX-X54A-023-01	5	Anchor	Fx	203	Fx	260 C	28
			Fy	1610	Fy	2223 D	38
			Fz	83	Fz	114 D	37.4
	135	VC, LC	Fx	7	Fx	8 C	14.3
			Fy	62	Fy	76 C	22.6
			Fz	23	Fz	28 C	21.7
	156	VC, Rz	Fx	0	Fx	0	—
			Fy	11	Fy	15 D	36.4
			Fz	6	Fz	9 D	50
	166	Rx, Rz	Fx	10	Fx	14 D	40.0
			Fy	0	Fy	0	—
			Fz	2	Fz	3 D	50
	180	ANC	Fx	6	Fx	8 D	33.3
			Fy	10	Fy	12 C	20
			Fz	3	Fz	5 D	[illegible]
	500	ANC	Fx	1	Fx	1	—
			Fy	5	Fy	6 C	20
			Fz	1	Fz	1	—
	510	Rx, Rz	Fx	1	Fx	1	—
			Fy	0	Fy	0	—
			Fz	1	Fz	1	—
	525	VC, Rz	Fx	0	Fx	0	—
			Fy	4	Fy	5 C	25
			Fz	1	Fz	1	—
	915	Assumed Anc.	Fx	1	Fx	1	—
			Fy	2	Fy	3 D	50
			Fz	2	Fz	2	—
	555	ANC.	Fx	1	Fx	2 D	100
			Fy	10	Fy	12 C	20
			Fz	3	Fz	5 D	66.7
	930	VC.	Fx	0	Fx	0	—
			Fy	8	Fy	9 C	12.5
			Fz	0	Fz	0	—
	970	Ass. ANC	Fx	1	Fx	1	—
			Fy	3	Fy	3	—
			Fz	3	Fz	5 D	66.7
	600	Rx, Rz	Fx	1	Fx	1	—
			Fy	0	Fy	0	—
			Fz	4	Fz	6 D	50

TABLE 6.5-1

Equipment Loads

Stress Report	Node	Equipment ID	Old Resultant		New Resultant *		New Resultant **	
			F_R	M_R	F_R	M_R	F_R	M_R
FW-01	125	RPV Nozzle	6760	38470	5937	35691	4828	31693
	135	↓	4988	33742	4238	30376	4085	29756
	175	↓	22323	48988	20096	47484	20051	46747

* Including 2× FSAR SSE Vertical
** Without 2× FSAR SSE Vertical

Feedwater RPV Nozzles - Allowable Reactions

Loading	H (kips)	M (inch-kips)
Deadweight	10.29	277.8
Seismic SSE	41.16	740.8
Thermal Movt.	51.44	1235.0

$$H = \sqrt{F_y^2 + F_z^2} \qquad M = \tfrac{1}{2}\left(K + \sqrt{K^2 + M_x^2}\right) + |F_x|\, Z/A$$

where: Z = Section Modulus of Pipe
A = Cross sectional metal area of Pipe
F_x, M_x = along|about the nozzle axis (kip, in-kip)
F_y, F_z, M_x, M_z = along|about the orthogonal axes in the plane perpendicular to the nozzle axis (kip, in-kip)

TABLE 6.6-1

Valve Acceleration Assessment

STRESS REPORT	NODE	VALVE MARK	OLD ACCELERATION	NEW* ACCELERATION	NEW** ACCELERATION	ALLOWABLE
RHR-03&19	45B	V8-2141	.593	.694	.597	7.6
↓	50	↓	.555	.685	.593	
↓	53	↓	.480	.648	.551	
↓	100B	V8-2139	1.658	1.223	1.068	7.87
↓	105	↓	3.017	1.862	1.674	
↓	110	↓	2.162	1.489	1.269	
↓	195	V8-2137	.296	.634	.488	7.6
↓	200	↓	1.708	1.410	.912	
↓	205	↓	.746	.824	.586	
↓	445	V15-2018	.482	.652	.573	18.3
↓	450	↓	.818	.797	.700	
↓	465A	↓	.499	.724	.611	

* Includes 2 x Existing SSE Vertical
** Without 2 x Existing SSE Vertical

NOTES 1. All accelerations are in units of G's
2. All accelerations are SRSS values (IE $[A_x^2 + A_y^2 + A_z^2]^{1/2}$)

TABLE 6.7-1

RATIO OF ALLOWABLE TO ULTIMATE STRESSES

Code	Stress	Ultimate Stress	Allowable Stress	(Allowable Stress / Ultimate Stress)
AISC	Bending & Tension	F_y	$0.6\ F_y$	0.60
	Shear	$0.577\ F_y$	$0.4\ F_y$	0.69[a]
	Compression	F_y to F_{euler}	$0.6\ F_y$ to $\frac{12}{23}\ F_{euler}$	0.60 to 0.52
	Plate Bending	F_y	$0.75\ F_y$	0.75[b]
AISI	Bending & Tension	F_y	$0.6\ F_y$	0.60
	Shear	$0.577\ F_y$	$0.4\ F_y$	0.69[a]
	Compression	F_y to F_{euler}	$0.6\ F_y$ to $\frac{12}{23}\ F_y$	0.60 to 0.522
AWS	Tension & Shear	F_{xx} $0.577\ F_y$	min ($0.3\ F_{xx}$ & $0.4\ F_y$)	0.30 to 0.69[a]

[a] Governs

[b] Does not occur independently in structures, but is combined with other forms of loading to increase FOS

TABLE 6.7-2

HORIZONTAL ACCELERATIONS OF CLASS IE CONDUIT

FLOOR	ZONE	(A) ZONE ACCEL	NS NEW SPEC	NS SSE ACCEL	EW NEW SPEC	EW SSE ACCEL	NEW SSE $1.5\sqrt{An^2+Ac^2}$	(B) $\frac{1.5\sqrt{An^2+Ac^2}}{F_y/.69F_y}$	RATIO $\frac{B}{A}$	CONCLUSION
1st	I	3.5 g	B29	0.80	B30	0.71	1.61	1.11	.32	SAFE
2nd	I		B31	1.5	B32	1.22	2.90	2.00	.62	SAFE
EL. 640'-0"										
3rd	II	5.41 g	B33	2.0	B34	1.72	3.96	2.73	.78	SAFE
4th	II		B35	2.2	B36	1.9	4.36	3.01	.56	SAFE
5th	II		B37	2.4	B38	2.2	4.88	3.37	.62	SAFE

TABLE 6.7-3

VERTICAL ACCELERATIONS OF CLASS IE CONDUIT

FLOOR	ZONE	(A) ZONE ACCEL	NEW SSE SPECT	NEW SSE DAMPING	NEW SSE ACCEL	1.5 Av+1g	(B) $\frac{1.5\ Av+1g}{F_y/0.69F_y}$	RATIO B/A	MARGIN	CONCLUSION
1st	I		C-16	5%	2.20	4.30	2.97	.96	4%	SAFE
2nd	I	3.1g	C-16	5%	2.20	4.30	2.97	.96	4%	SAFE
EL. 640'-0"										
3rd	II		C-19	5%	2.80	5.20	3.59	.69	31%	SAFE
4th	II	5.2g	C-17	5%	1.90	3.85	2.66	.51	49%	SAFE
5th	II		C-19	5%	2.80	5.20	3.59	.69	31%	SAFE

TABLE 6.8-1
Reactor Building
Seismic Support Loads
(East-West)

Nom Dia (in.)	SCH.	Span (Ft)	Design Basis Load (lbs)	Assessment Load (lbs)	Margin Assessment / Design Basis
3/8	0.049" Wall	7	2.50	0.413	0.165
1/2	160	9	19	5	0.263
5/8	0.083" Wall	9	8.5	1.51	0.178
3/4	160	11	44	11.84	0.269
1	160	12	46	17.16	0.373
1 1/4	160	14	80	30.46	0.381
1 1/2	160	15	95.5	42.14	0.441
2	160	17	163.5	78.6	0.481
2 1/2	160	19	253.5	123.7	0.488
3	160	21	371	202.76	0.546
3/1/2	80xS	23	522	243.88	0.467
4	120	24	599	331.38	0.553

TABLE 6.8-2

Reactor Building
Seismic Support Loads
(North-South)

Nom Dia. (in.)	SCH.	Span (Ft.)	Design Basis Load (lbs)	Assessment Load (lbs)	Margin Assessment / Design Basis
3/8	0.049" Wall	7	2.50	0.409	0.164
1/2	160	10	33.5	7.3	0.224
5/8	0.083" Wall	9	6	1.5	0.25
3/4	160	11	28.5	10.78	0.378
1	160	13	66	24.2	0.367
1 1/4	160	15	103	41.18	0.4
1 1/2	160	16	116	57.04	0.492
2	160	18	182	98.34	0.540
2 1/2	160	20	266	154.9	0.582
3	160	22	356	242.48	0.681
3 1/2	80xS	24	531	272.4	0.513
4	120	26	882	441.16	0.50

TABLE 6.8-3

Reactor Building
Seismic Support Loads
(Vertical)

Nom Dia. (in.)	SCH.	Span (Ft)	Design Basis Load (lbs)	Assessment Load (lbs)	Margin Assessment / Design Basis
3/8	0.049" Wall	4	2	0.574	0.287
1/2	160	6	31	9	0.290
5/8	0.083" Wall	6	9	3.56	0.39
3/4	160	7	48	15.8	0.329
1	160	8	77	27.2	0.353
1 1/4	160	10	126.5	50.6	0.4
1 1/2	160	10	158.5	60.2	0.38
2	160	12	282.5	120	0.425
2 1/2	160	13	410	164	0.4
3	160	14	542.5	256.6	0.473
3 1/2	80xS	15	635.5	266.6	0.42
4	120	16	847	407.6	0.481

TABLE 6.8-4

RHR Complex
Seismic Support Loads
(East-West)

Nom Dia. (in.)	SCH.	Span (Ft)	Design Basis Load (lbs)	Assessment Load (lbs)	Margin Assessment / Design Basis
3/8	0.049" Wall	6	3	0.68	0.227
1/2	160	8	36	3.54	0.098
5/8	0.083" Wall	8	10.5	3.04	0.29
3/4	160	9	53	6.22	0.117
1	160	11	93.5	19.72	0.211
1 1/4	160	12	137.5	21.72	0.158
1 1/2	160	13	183.5	33.22	0.181
2	160	15	316	75.44	0.239
2 1/2	160	17	479	126.04	0.263
3	160	18	446.5	149.06	0.334
3 1/2	80xS	20	788	216	0.274
4	120	21	1164	309	0.265

TABLE 6.8-5

RHR Complex
Seismic Support Loads
(North-South)

Nom Dia. (in.)	SCH.	Span (Ft)	Design Basis Load (lbs)	Assessment Load (lbs)	Margin Assessment / Design Basis
3/8	0.049" Wall	5	1.5	0.31	0.207
1/2	160	7	16.5	3.06	0.185
5/8	0.083" Wall	7	5	1.43	0.286
3/4	160	8	28	5.2	0.186
1	160	10	44	11.58	0.263
1 1/4	160	11	69.5	16.9	0.243
1 1/2	160	12	93.5	23.94	0.256
2	160	13	151	39.78	0.263
2 1/2	160	15	231	64.5	0.279
3	160	17	367	123.06	0.335
3 1/2	80xS	18	383	121.34	0.317
4	120	19	589	179.6	0.305

TABLE 6.8-6

RHR Complex
Seismic Support Loads
(Vertical)

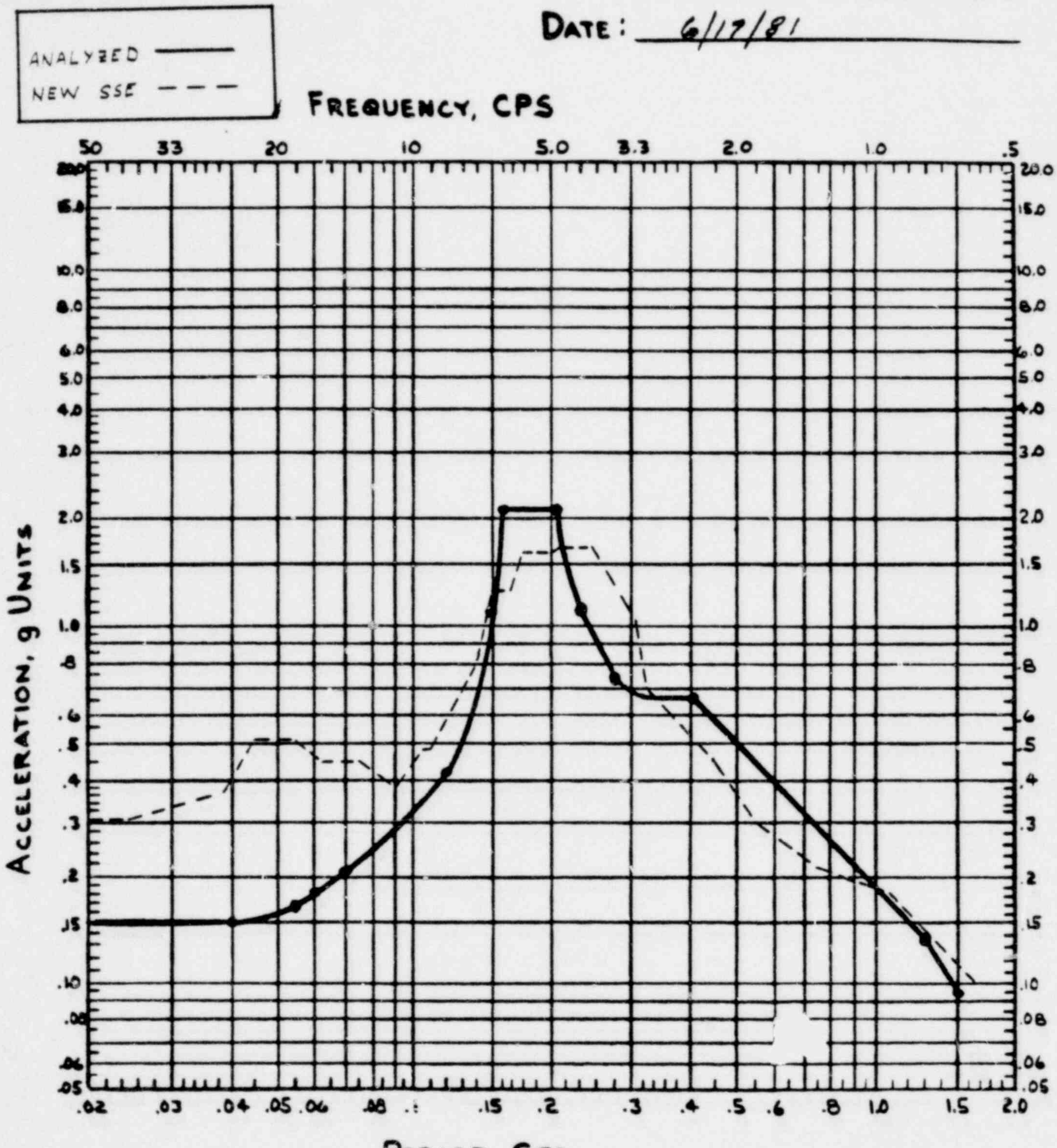
Nom Dia. (in.)	SCH.	Span (Ft)	Design Basis Load (lbs)	Assessment Load (lbs)	Margin Assessment / Design Basis
3/8	0.049" Wall	6	2	1.534	0.767
1/2	160	7	19	8.94	0.47
5/8	0.083" Wall	8	6.5	5.74	0.88
3/4	160	9	33	24.54	0.744
1	160	10	51.5	40.48	0.786
1 1/4	160	12	81.5	67.04	0.823
1 1/2	160	13	110	90.2	0.82
2	160	14	176	148.5	0.823
2 1/2	160	16	271.5	230	0.847
3	160	18	324	378	0.875
3 1/2	80xS	19	450	392	0.871
4	120	20	667	598	0.897

ENRICO FERMI - UNIT 2
SEISMIC REASSESSMENT

SHT.___ OF____

NAME: Williams

DATE: 6/17/81



% DAMPING	BUILD.	EQUIP.
DBE	5	1/2
SER	7	2

TITLE: PLOT OF 1.875 TIMES FIGURE 8RO, SL-2682 @ ½% DAMPING - DRYWELL - 6' BELOW INVERT - EAST-WEST COMPONENT VRS SAME SITE SPECIFIC SPECTRA (B42) @ 2% DAMPING

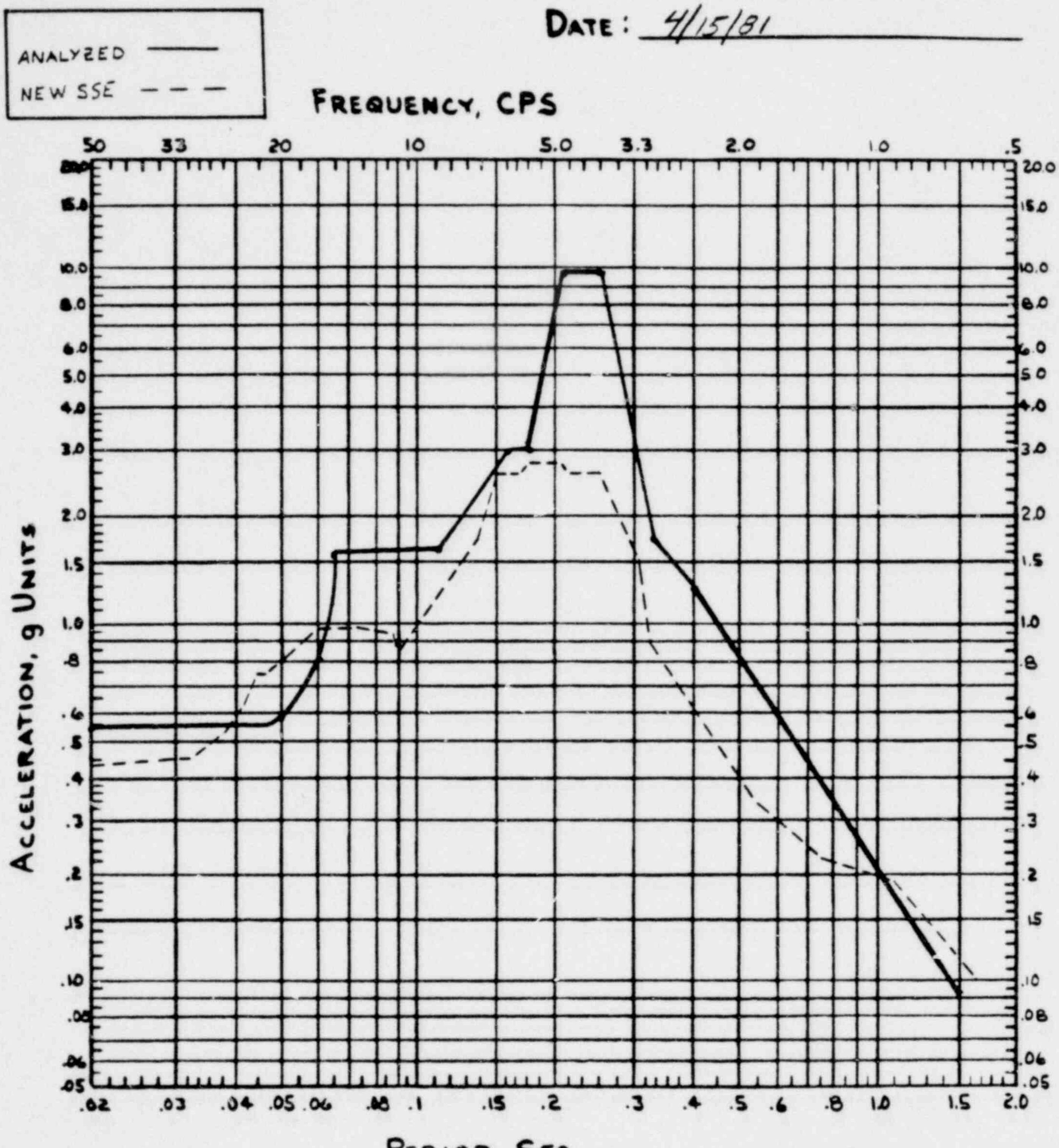
FIGURE No. 6.1-1

ENRICO FERMI - UNIT 2
SEISMIC REASSESSMENT

SHT.___ OF____

NAME: Williams

DATE: 4/15/81



% DAMPING

	BUILD.	EQUIP.
DBE	5	1/2
SER	7	2

TITLE: Plot of 1.875 times Figure B28, SL-2692 @ 1/2 % Damping - RPV - 54' above invert East West Component VRS same site specific spectra (B52) @ 2% Damping

FIGURE NO. 6.1-2

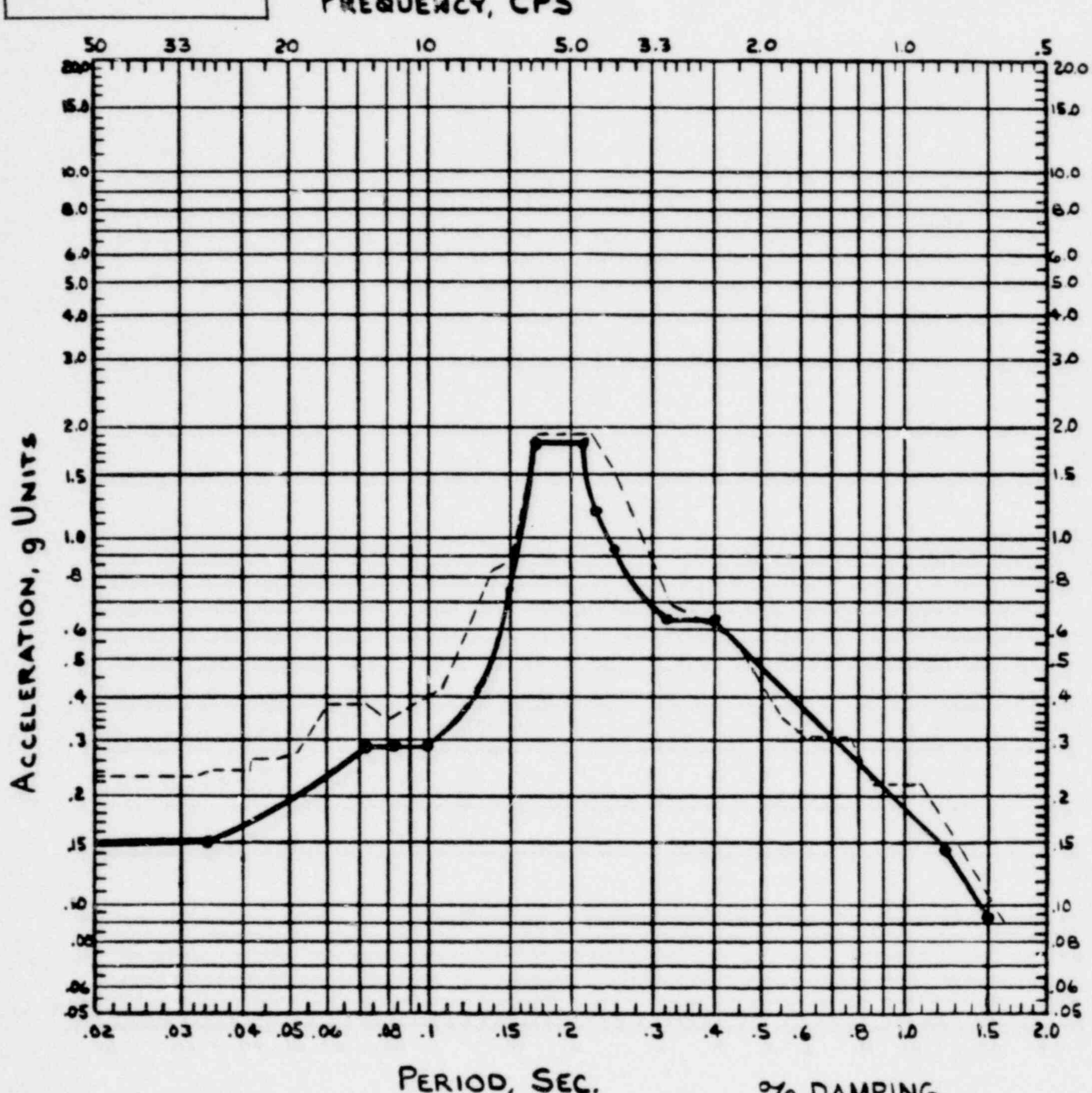
ENRICO FERMI - UNIT 2
SEISMIC REASSESSMENT

SHT.___OF____

NAME: *Williams*

DATE: *6/17/81*

ANALYZED ———
NEW SSE - - -



% DAMPING

	BUILD.	EQUIP.
DBE	5	1/2
SER	7	2

TITLE: *PLOT OF 1.875 TIMES FIGURE B19 CL-2682 @ 1/2 % DAMPING - DRYWELL - 6'-0" BELOW INVERT - NORTH SOUTH COMPONENT - VRS SAME SITE SPECIFIC SPECTRA (843) @ 2% DAMPING*

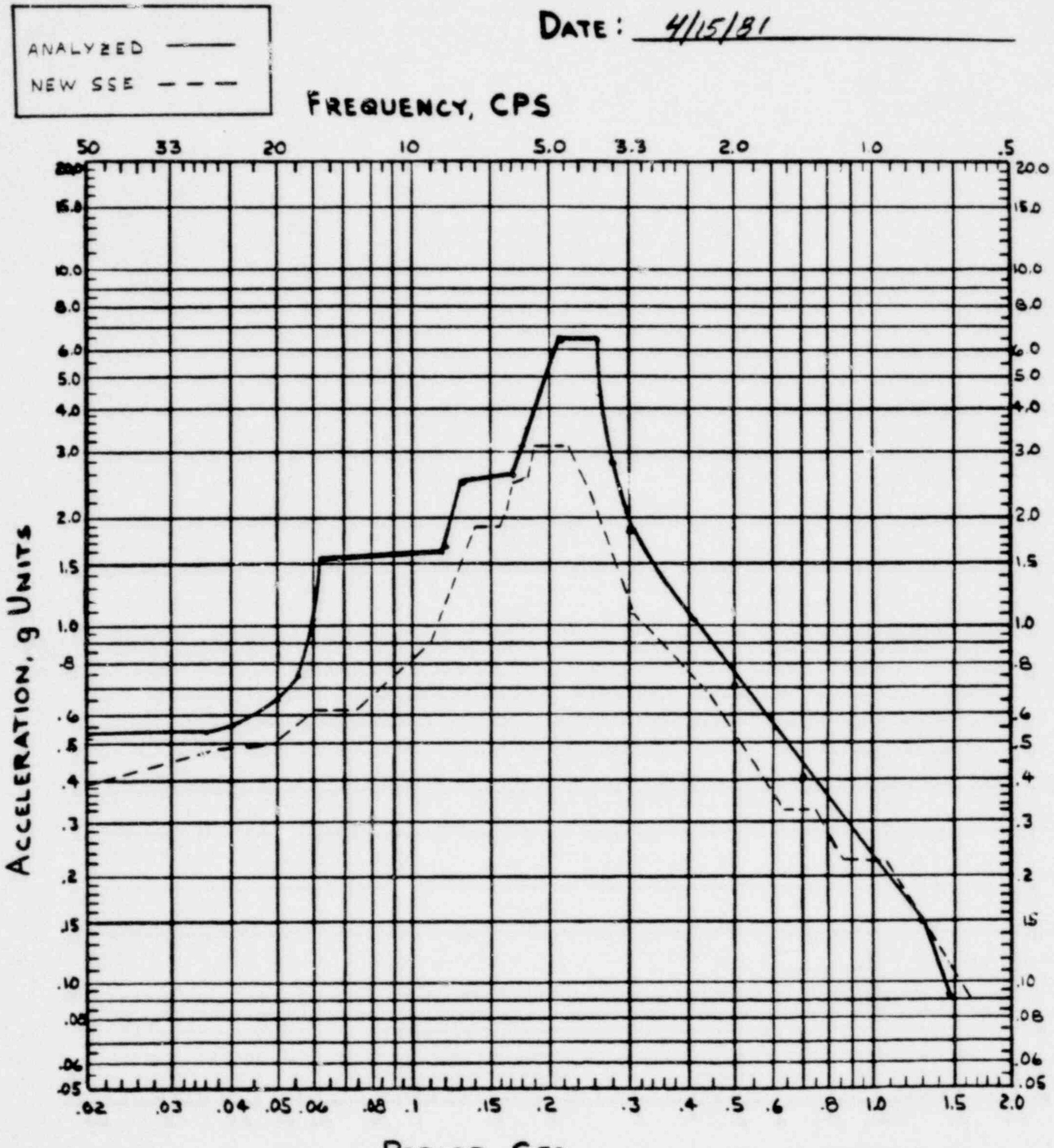
 FIGURE NO. *6.1-3*

ENRICO FERMI - UNIT 2
SEISMIC REASSESSMENT

SHT.___OF___

NAME: *Williams*

DATE: *4/15/81*



% DAMPING

	BUILD.	EQUIP.
DBE	5	1/2
SER	7	2

TITLE: *PLOT OF 1.875 TIMES FIGURE B27, SL-2692 @ 1/2% DAMPING - RPV - 54' ABOVE INVERT NORTH SOUTH COMPONENT VRS SAME SITE SPECIFIC SPECTRA (B51) @ 2% DAMPING*

FIGURE NO. *6.1-4*

ENRICO FERMI - UNIT 2
SEISMIC REASSESSMENT

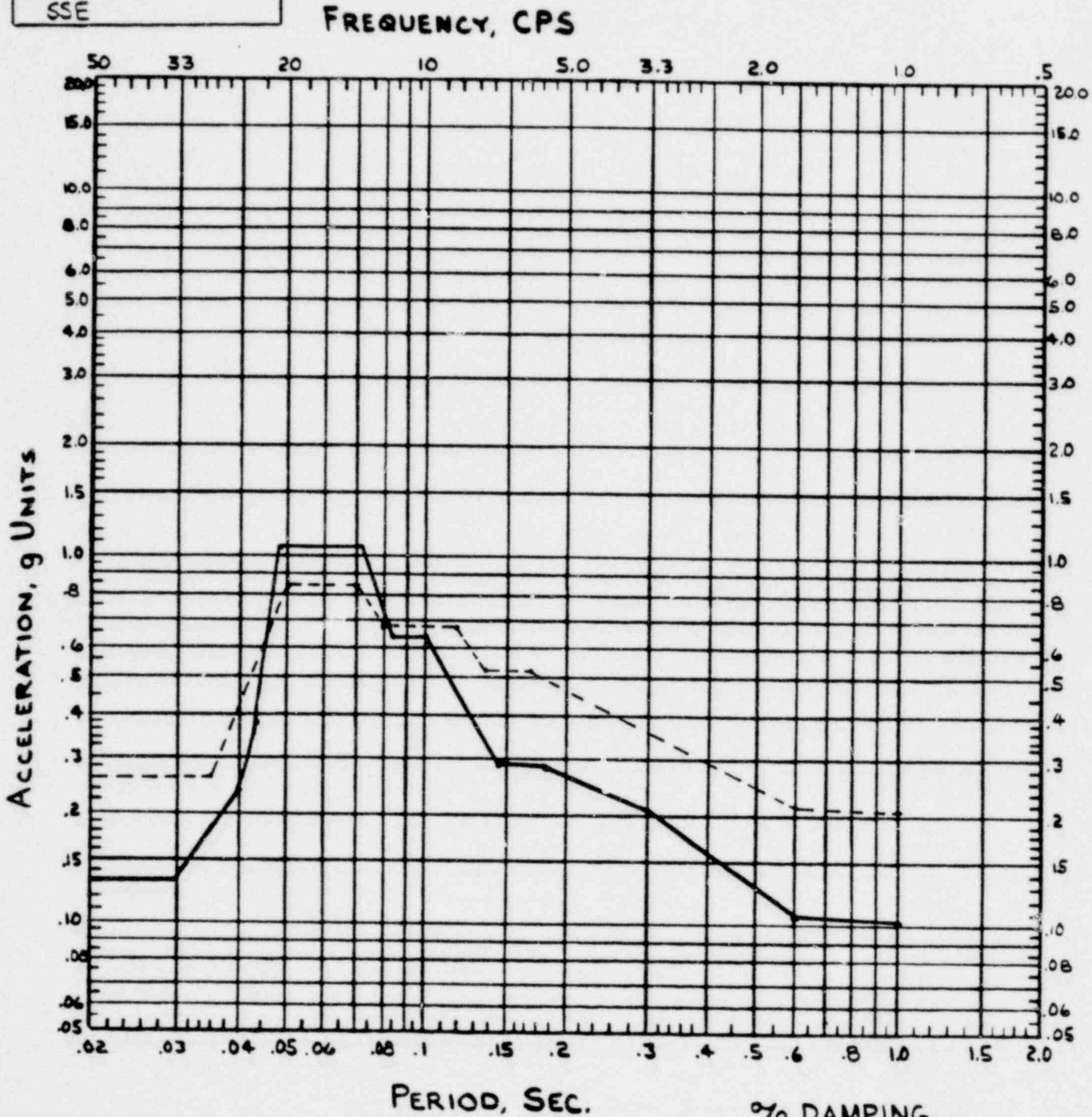
SHT.___OF____

NAME: Williams

DATE: 6/17/81

ANALYZED ———

SITE SPECIFIC SSE - - - - -



% DAMPING

	BUILD.	EQUIP.
DBE	5	1/2
SER	7	2

TITLE: PLOT OF 1.875 times FIGURE C2, SL-2682 @ 1/2 % DAMPING - CONT SHIELD EL 583'-6", 613'-6" - VERTICAL COMPONENT VRS SAME SITE SPECIFIC SPECTRA (2.0 times C12) 2% DAMPING

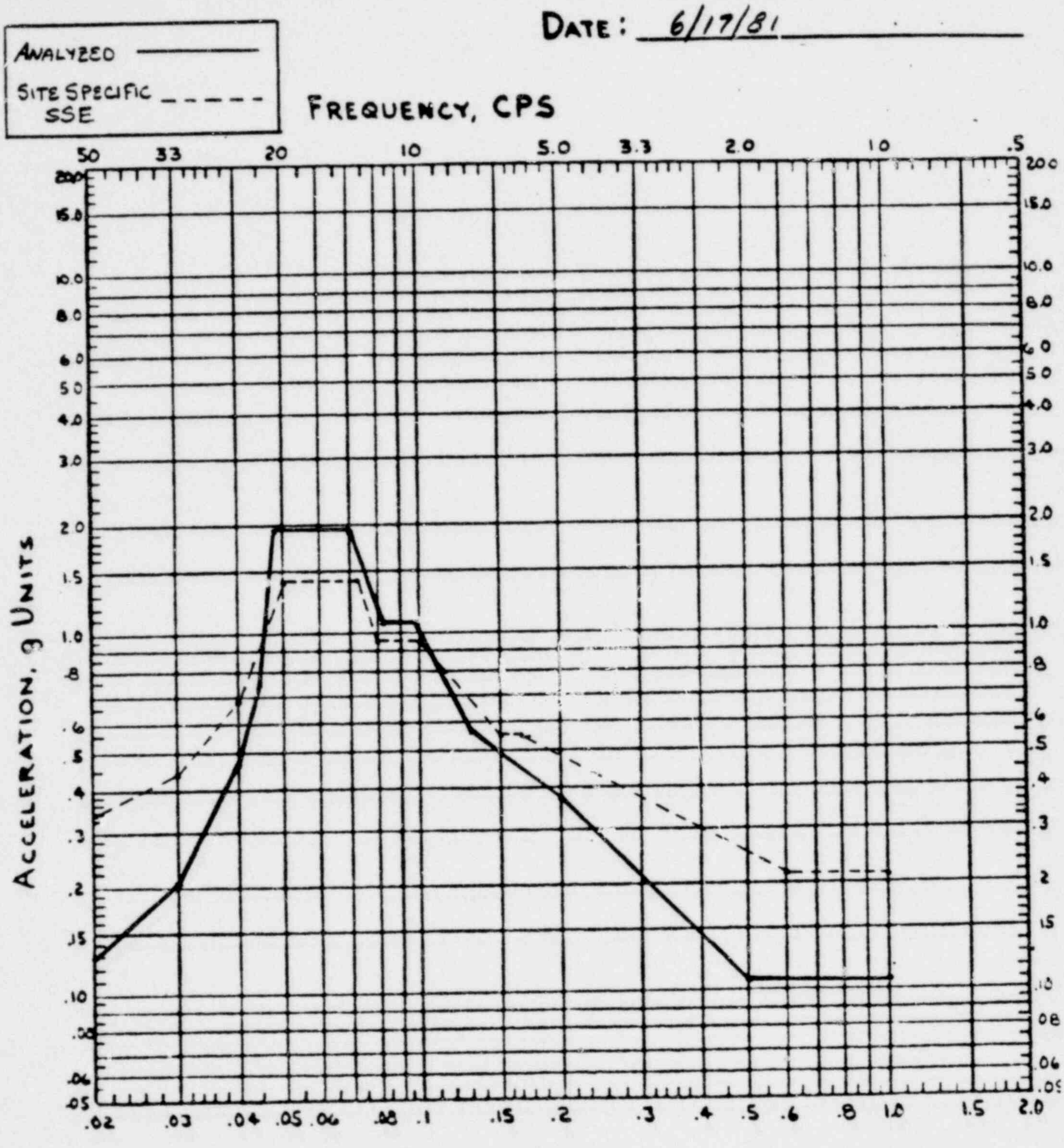
 FIGURE NO. 6.1-5

ENRICO FERMI - UNIT 2
SEISMIC REASSESSMENT

SHT.___OF____

NAME: William

DATE: 6/17/81

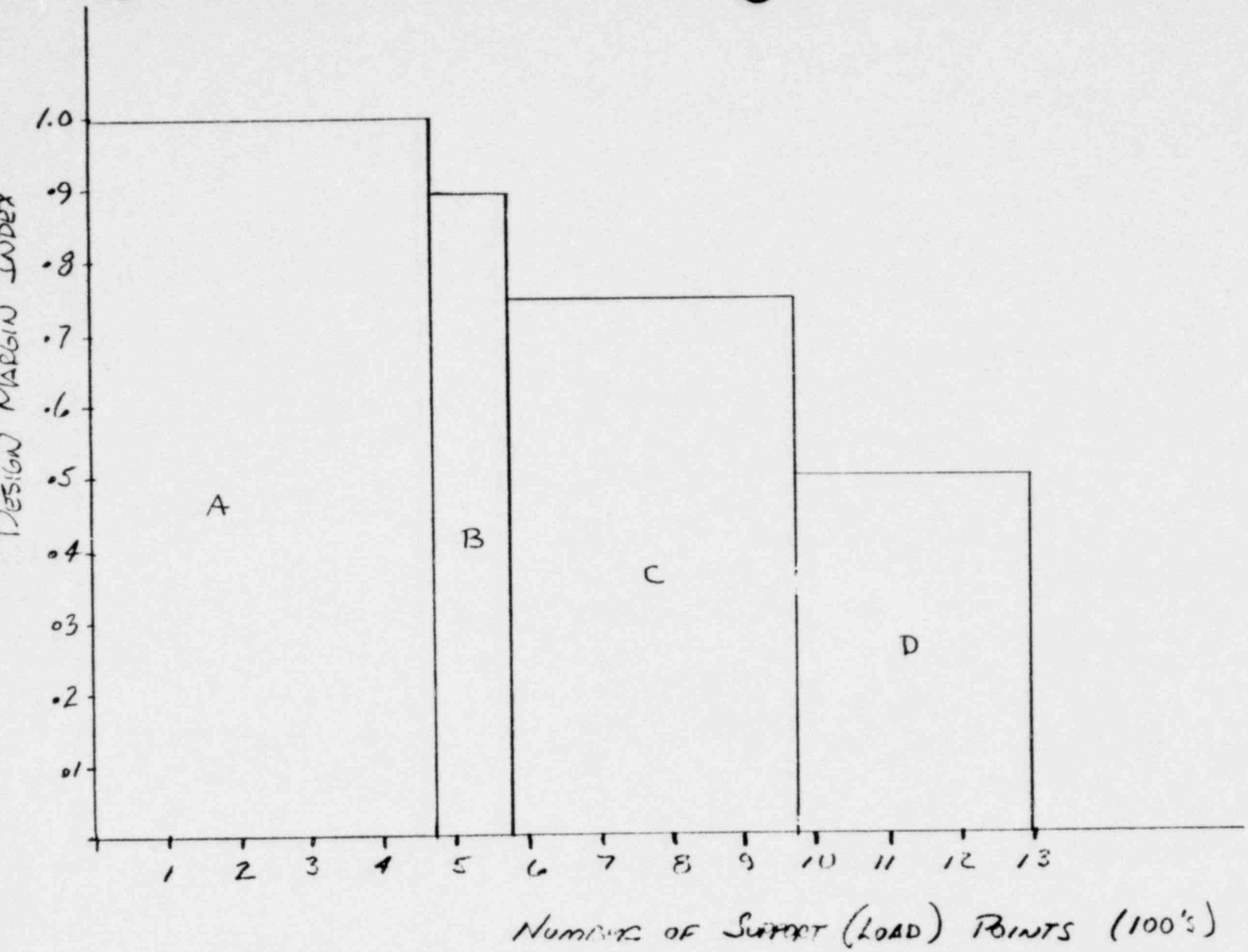


% DAMPING

	BUILD.	EQUIP.
OBE	5	1/2
SSE	7	2

TITLE: PLOT OF 1.875 TIMES FIGURE C3, SL-2682 @ 1/2% DAMPING - CONT SHIELD EL 643'-6", 659'-6", 684'-6" - VERTICAL COMPONENT VRS SAME SITE SPECIFIC SPECTRA (2.0 TIMES C13) @ 2% DAMPING

FIGURE NO. 6.1-6



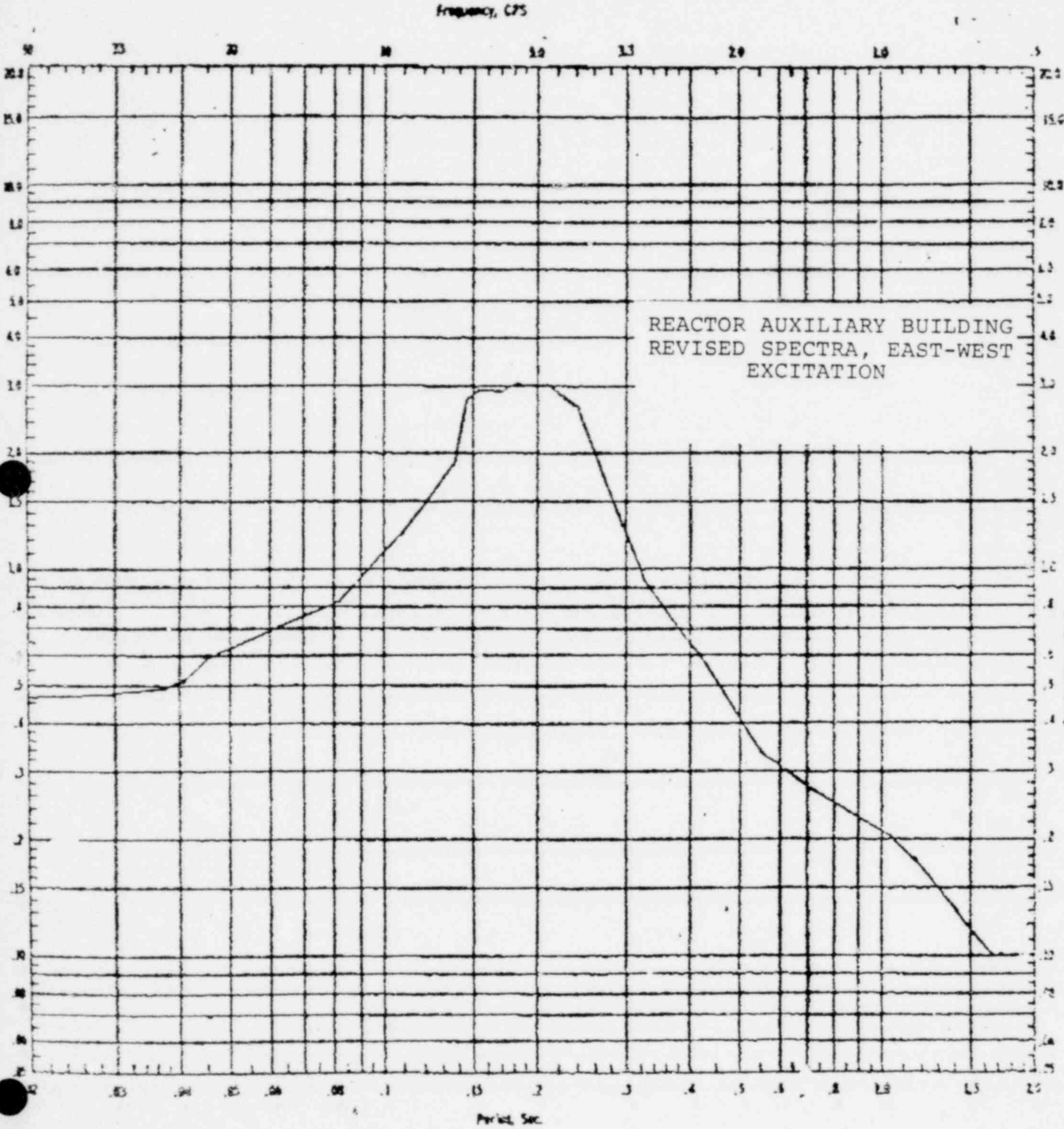
HISTOGRAM OF I&C PIPING SUPPORT LOADS

FIGURE 6.4-1

SARGENT & LUNDY ENGINEERS CHICAGO

SPECTRA FOR REACTOR - AUX BLDG.		Calc. No.
REVISED SPECTRA		Rev. / Date
X Safety-Related	Non-Safety-Related	Page of

Client DETROIT EDISON CO	Prepared by / Date
Project ENRICO FERMI - UNIT 2	Reviewed by / Date
Proj. No. 6139-38 Equip. No.	Approved by / Date



EXCITATION EAST-WEST

FIGURE 6.8-1 LOCATION: REACTOR-AUX. BLDG

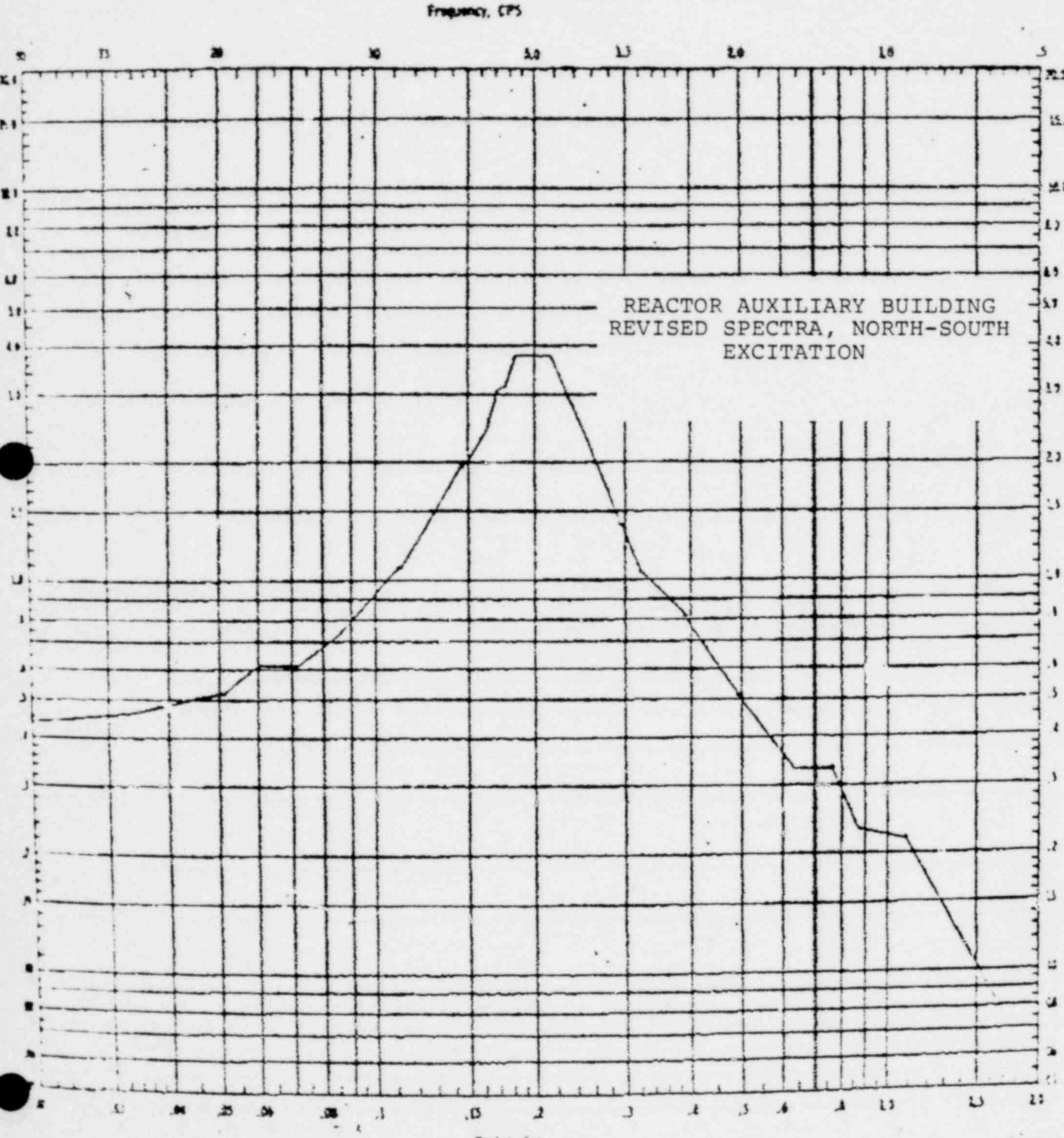
SPECTRA NO.

ELEVATION: ENVELOPED

SARGENT & LUNDY ENGINEERS CHICAGO

SPECTRA FOR REACTOR-AUX BLDG.	Calc. No.	
REVISED SPECTRA	Rev.	Date
Safety-Related / Non-Safety-Related	Page	of

Client DETROIT EDISON CO	Prepared by	Date
Project ENRICO FERMI - UNIT 2	Reviewed by	Date
Proj. No. 6139-38 Equip. No.	Approved by	Date



EXCITATION NORTH - SOUTH

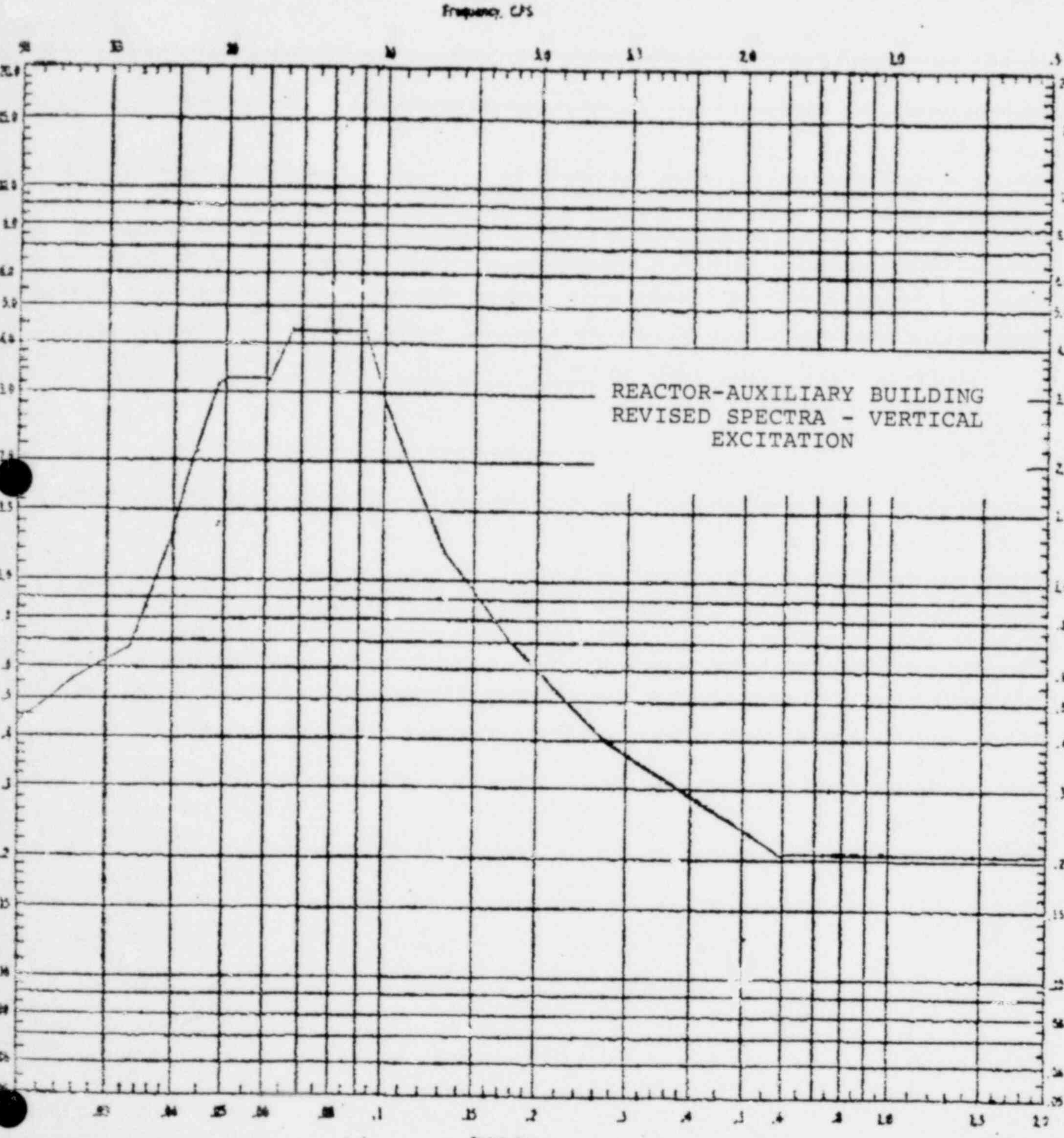
FIGURE 6.8-2

LOCATION: REACTOR - AUX. BLDG

ELEVATION: ENVELOPED

SARGENT & LUNDY ENGINEERS CHICAGO	SPECTRA FOR REACTOR-AUX BLDG. REVISED SPECTRA	Calc. No.
	Safety-Related / Non-Safety-Related	Rev. / Date
		Page of

Client DETROIT EDISON CO.	Prepared by / Date
Project ENRICO FERMI - UNIT 2	Reviewed by / Date
Proj. No. 6139-38 Equip. No.	Approved by / Date



EXCITATION VERTICAL

FIGURE 6.8-3

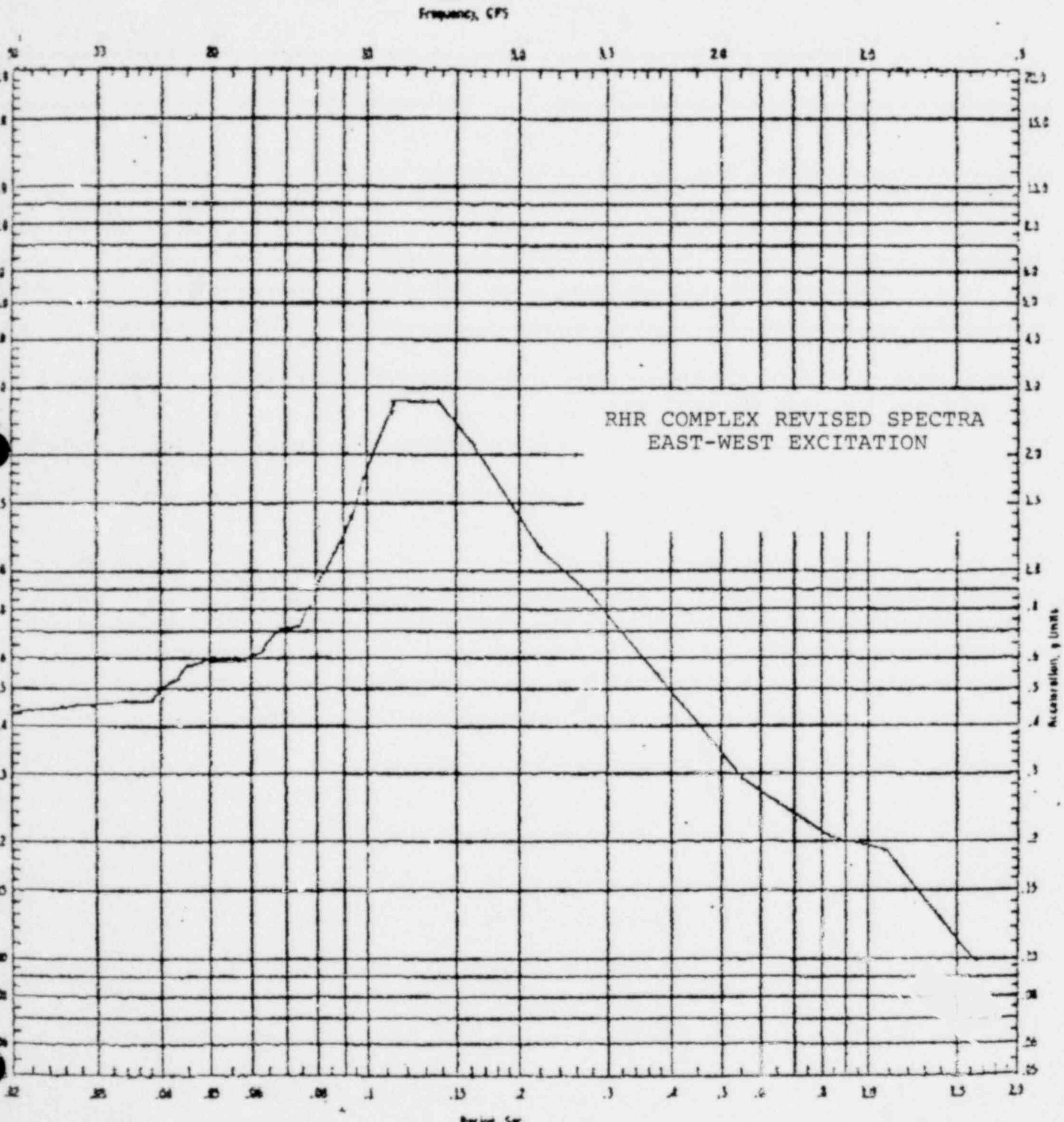
LOCATION: REACTOR-AUX. BLDG.

ELEVATION:

SARGENT & LUNDY
ENGINEERS
CHICAGO

SPECTRA FOR RHR COMPLEX		Calc. No.
REVISED SPECTRA		Rev. / Date
Safety-Related	Non-Safety-Related	Page of

Client DETROIT EDISON CO.	Prepared by / Date
Project ENRICO FERMI - UNIT 2	Reviewed by / Date
Proj. No. 6139-38 Equip. No.	Approved by / Date



EXCITATION EAST - WEST

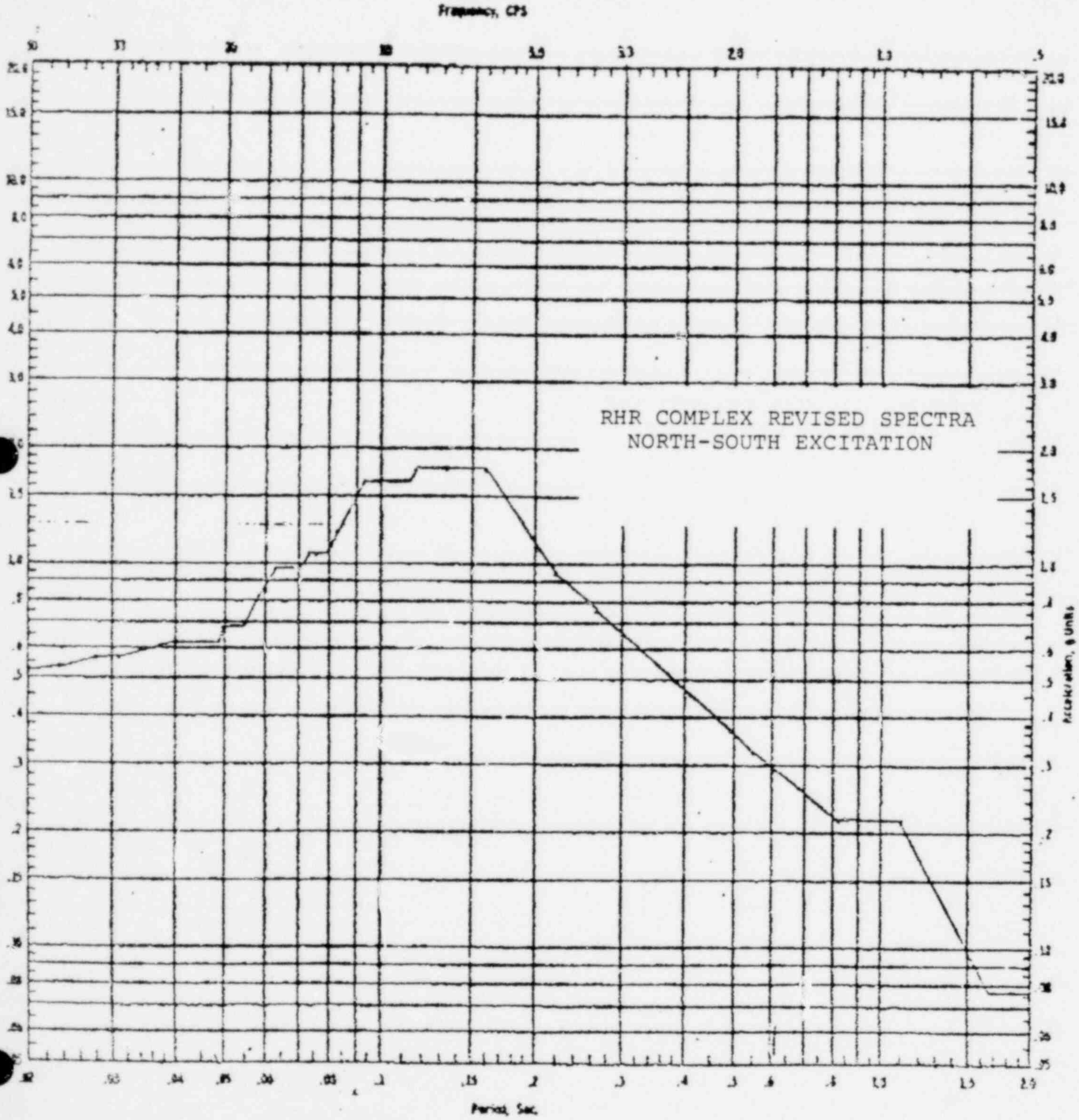
FIGURE 6.8-4

LOCATION: RHR COMPLEX

SARGENT & LUNDY ENGINEERS CHICAGO	SPECTRA FOR RHR COMPLEX REVISED SPECTRA	Calc. No.
	Safety-Related / Non-Safety-Related	Rev. / Date / Page of

Client	DETROIT EDISON CO.
Project	ENRICO FERMI - UNIT 2
Proj. No.	6139-38 Equip. No. -

Prepared by	Date
Reviewed by	Date
Approved by	Date



EXCITATION NORTH - SOUTH

FIGURE 6.8-5

LOCATION: RHR - COMPLEX

SARGENT & LUNDY ENGINEERS CHICAGO	SPECTRA FOR RHR COMPLEX	Calc. No.
	REVISED SPECTRA	Rev. / Date
	Safety-Related / Non-Safety-Related	Page of

Client DETROIT EDISON CO	Prepared by / Date
Project ENRICO FERMI - UNIT 2	Reviewed by / Date
Proj. No. 6139-37 Equip. No.	Approved by / Date

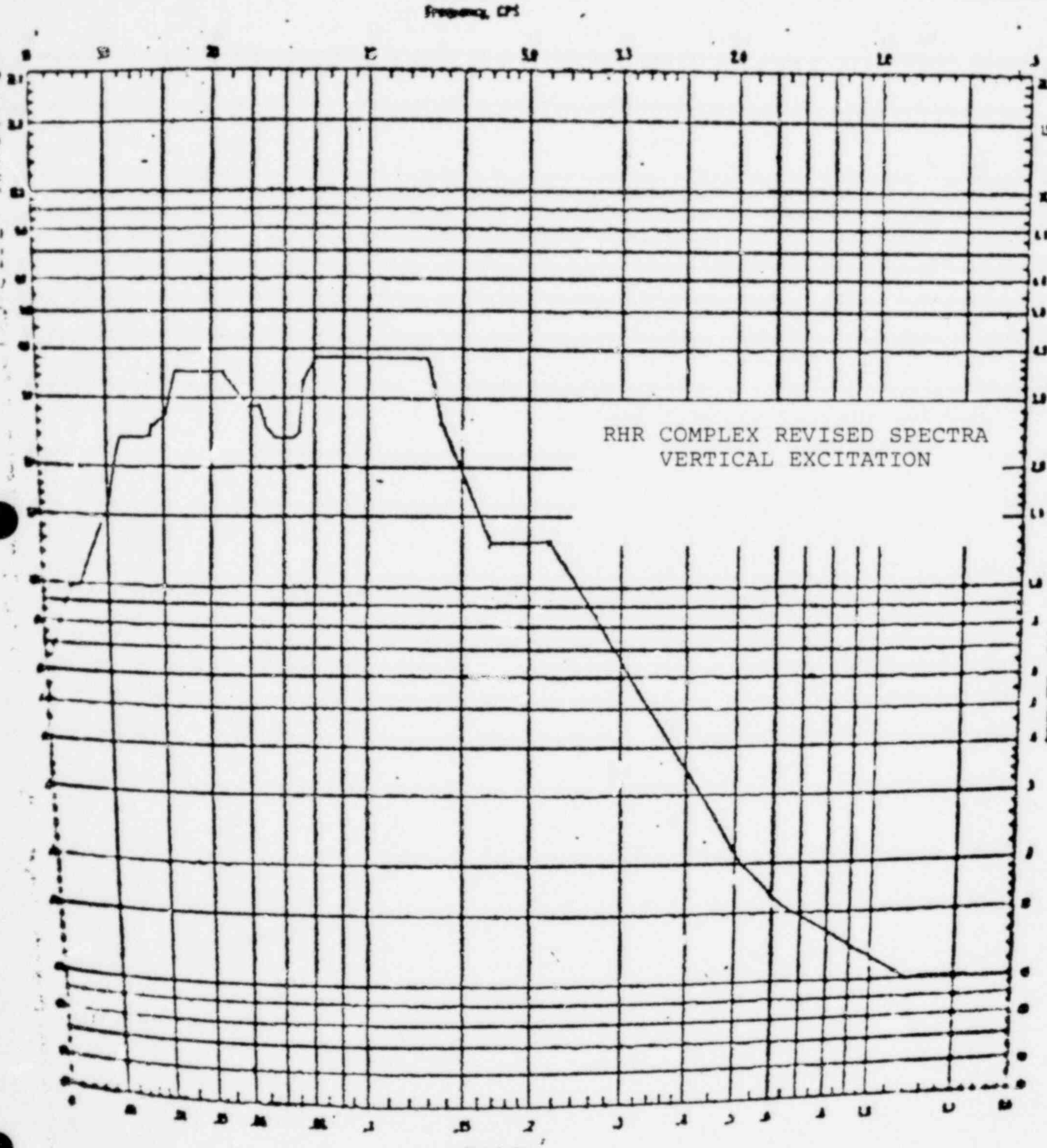


FIGURE 6.8-6

7.0 INDEPENDENT EVALUATION

In addition to the detailed evaluations discussed in preceding sections, DECo commissioned an independent overview of the response of the reactor building/auxiliary building structures and equipment to the newly defined horizontal and vertical site-specific response spectra (Reference 7-1.) This effort, conducted by Hopper & Associates, served as independent verification of portions of the detailed evaluations performed by others. The details of the independent evaluation are presented in the following sections.

7.1 Purpose

The independent evaluation was undertaken to assess the sensitivity of critical Fermi-2 plant structures and internal components to excitation by an earthquake larger than that currently specified in the Fermi-2 Final Safety Analysis Report for safe shutdown purposes.

Structural and equipment response problems associated with a postulated earthquake larger than that previously considered were evaluated and the acceptability of facility structures and components for shutdown capability after such an occurrence was generically considered.

This evaluation considered the inherent capability of structural and mechanical elements to withstand deformations exceeding their elastic limits without degrading their functional capability. This yields a quick, conservative assessment of the overall facility shutdown capability and provides independent verification of detailed results obtained by more accurate and less conservative deterministic analyses.

Analytical undertakings have primarily emphasized horizontal excitation phenomena, as they are anticipated to be most critical from the facility operability standpoint. Vertical excitation phenomena have also been included in the investigation and considered when deemed desirable for specific critical internal equipment capability evaluation.

7.2 Site Ground Motion

Earthquake excitations for nuclear reactor sites are commonly defined by the use of ground response spectra. These spectra yield a practical representation of loading to be anticipated on structures at a particular site as a function of structural response frequency. The literature on response spectra is abundant and detailed theoretical discussions are unnecessary herein.

Essentially all site spectra indicate a low frequency displacement bound indicative of the maximum ground motion to be anticipated at a given site, a high frequency acceleration bound indicative of the maximum ground accelera-tion to be anticipated at a given site, and a mid-frequency range of values exhibiting acceleration amplification phenomena dependent upon the specific site characteristics.

Rules exist for construction of ground response spectra for specific sites. Over the years, rules for construction of such spectra have varied, but have remained essentially consistent with respect to the overall results obtained. Included as Figure 7.2-1 is a plot of comparative ground spectra indicating various design guidelines established by seismic authorities over the years. These spectra are all normalized to the .15 g acceleration accepted as the established value for the Fermi-2 site. The Fermi-2 FSAR spectra are plotted for 5% structural damping as used in the baseline analysis. Other comparative spectra are plotted for 7% damping as used in the structural reassessment analysis.

The spectra currently in the Fermi-2 FSAR were proposed by Dames and Moore at the time the Fermi project design basis was established. Other spectra shown in Figure 7.2-1 were developed from more conservative assumptions proposed subsequently. The Fermi site-specific spectra were developed utilizing actual Fermi site-specific information to obtain a conservative bound on design accelerations as a function of response frequency.

The Fermi-2 site-specific spectra used with 7% structural damping were confirmed by the NRC as appropriate for use in the supplementary seismic evaluation of the Fermi-2 plant. These spectra exhibit higher response than the FSAR spectra used with 5% structural damping in an intermediate frequency range up to 33 cps. The maximum acceleration amplifiction associated with these spectra is approximately 60% greater than the existing FSAR spectra in the frequency range which encompasses the primary response frequencies of both the reactor auxiliary building and the RHR complex in the horizontal and vertical directions.

7.3 Energy-Absorbing Mechanisms

A structure or piece of equipment subjected to a dynamic environment does not respond in the idealized, linearly elastic way in which it normally must be analyzed. Inherent characteristics in all materials absorb energy in a dynamic response situation and render the equipment capable of withstanding a greater dynamic excitation than one would predict from a purely elastic analysis. Two of the simplest and most effective idealizations of energy-absorbing mechanisms are associated with damping and inelastic response or ductility.

7.3.1 Damping

An item responding to a dynamic excitation below its ultimate or yield capacity absorbs energy through system nonlinearities and viscoelastic effects every time it experiences a cycle of dynamic excitation. This energy-absorbing mechanism is normally idealized as a velocity-dependent damping whereby energy is absorbed in proportion to the velocity of motion of the dynamic system mass. Critical damping is the value of that energy-absorbing mechanism great enough to dampen all motion prior to completion of the first dynamic vibration cycle. Damping is significant in practical situations. It is normally expressed as a percentage of this critical value and usually ranges from less than 1% to 10%, depending upon the item considered and its effective response stress level.

On Fermi 2, damping of 5% was assumed for the DBE response of all facility structures. The analytical undertakings in this report assume that this initial assumption is somewhat overconservative. Reassessment evaluations have thus been completed assuming 7% structural damping.

7.3.2 Inelastic Response

Ductility is the most significant energy-absorbing mechanism in structural dynamics. It refers to the energy absorbed by a structure once it exceeds its elastic limit and initiates plastic deformation. Permanent deformation is associated with this phenomena. The amount of plastic deformation is defined by use of a ductility factor or ductility ratio which indicates the maximum system deforma-tion relative to the elastic limit system deformation. As an example, a structure which deforms 50% beyond its elastic limit during a dynamic excitation would be said to be experiencing a ductility factor of 1.5. Clearly, purely elastic response is indicated by ductility ratios of 1 or less.

Response spectra may be modified to indicate the influence of ductile response characteristics in a straightforward manner. The modified spectra are applicable only for accelerations on the three-way paper frequently used. Since deformations are essentially preserved in inelastic response but accelerations are significantly reduced, the unique correspondence between displacement and acceleration automatically shown on typical spectra paper is not applicable in the inelastic range.

In the very low frequency zone it is customary to assume that accelerations are reduced directly by the ratio of $1/\mu$ where μ represents the ductility factor. In an intermediate frequency zone it is customarily assumed that elastic and inelastic energy is preserved for a given cycle of response and accelerations are thus reduced by the factor $1/2\mu-1$. In the high frequency region it is customary to assume no decrease in effective design acceleration due to inelastic response phenomena. A transition zone exists between the intermediate range and the high frequency range to smoothly effect a transition from energy equivalence to acceleration equivalence.

Figures 7.3-1 and 7.3-2 illustrate these transition zones and the applicable accleration reduction relationships.

7.4 Facility Response Phenomena

The Fermi-2 reactor auxiliary building structure, the RHR structure, and internal equipment in both complexes have been evaluated to determine their ability to function under the loads of site-specific SSE ground motion spectrum assuming a constant 7% structural damping.

The generic structural response phenomena are illustrated on the spectral plots in Figure 7.4-1. This figure identifies the Fermi-2 FSAR spectrum to which all facility structures, including the reactor auxiliary building and the RHR complex, have been designed. Additionally, the site-specific spectra have been overlaid to indicate the correlation between the design requirements so imposed with those already fulfilled. The site-specific spectra are plotted for purely elastic response $\mu = 1$ and inelastic response ranging up to a ductility factor $\mu = 4$. From these plots, it can be seen that mobilization of a ductility ratio of 2 would be sufficient to ensure that the design basis is acceptable in all frequencies.

7.5 Internal Equipment

Internal equipment was also evaluated. For this evaluation, it was assumed that the building itself will not exhibit deformation in the plastic zone. This assumption is based on consideration of reserved strength capacity existing in structures of this type. If the structure were to exhibit inelastic behavior, internal equipment seismic loads would be significantly reduced. However, by assuming the structure remains entirely elastic in its response mode, the maximum potential internal equipment environments were conservatively enveloped on a spectrum plot. From this, the internal equipment ductility necessary to ensure complete conformance with the initial Fermi-2 design requirements was determined.

Figure 7.5-1 shows horizontal and vertical envelope response spectra for the reactor auxiliary building (excluding the crane rail location) obtained from Fermi-2 FSAR design requirements assuming 1% internal equipment damping. Overlaid on these curves are similar reactor auxiliary building envelope spectra for the site-specific SSE ground motion input assuming 2% equipment damping. The assumption of 2% internal equipment damping is more realistic for the current seismic evaluation.

Also overlaid on Figure 7.5-1 are curves representing the influence of ductility on the internal equipment spectra envelope generated from the site-specific SSE input. Comparing the FSAR DBE spectrum with the site-specific spectra in this figure shows results similar to those observed for the structures. A ductility of no more than 2 in the critical frequency regions is sufficient to ensure that the design and qualification of the most heavily loaded equipment remains satisfactory under the postulated site-specific SSE with 7% damping.

Acceptable ductility limits for common structural and mechanical materials are exceptionally high. Even very brittle structures exhibit ductility prior to failure; it is virtually impossible to envision even the most brittle element exhibiting failure below a ductility ratio of 1.3. Moderately brittle material such as unreinforced concrete exhibits ductility ratios on the order of 2 to 3 prior to failure and ductile items such as reinforced concrete structures, steel structures, piping, metal equipment, and brittle items mounted in a ductile fashion, experience ductility factors ranging from 10 to 20 prior to observable distress.

For example, the hardened missile facilities so vital to our national defense are designed of reinforced concrete and are filled with highly sophisticated mechanical and electrical equipment. These structures are customarily designed to a ductility ratio of 10 inside and out and have been subjected to numerous shock survivability tests to validate the acceptability of such design assumptions. Similar vibratory testing has been accomplished on multi-story office buildings in reinforced concrete and steel. Results of testing on the reinforced concrete buildings indicates that it is difficult to observe any structural distress whatsoever below a ductility ratio of 7.

7.6 Generic Facility Evaluation

7.6.1 Reactor Auxiliary Building

The Fermi reactor auxiliary building design is considered adequate to withstand the newly postulated site-specific earthquake input with minimum inelastic deformation. It is concluded that the maximum ductility factor associated with potential inelastic deformation is $\mu = 1.5$ and permanent structural deformation associated with this inelastic response would be on the order of 0.100 inches.

It is our judgement that no plastic deformation will occur in the reactor auxiliary building complex during the postulated site-specific SSE because of margins in the design of structures of this type.

7.6.2 RHR Complex

Like the reactor auxiliary building, the RHR complex structure is considered acceptable as it exists. The maximum ductility factor associated with potential inelastic deformation is $\mu = 1.5$ and maximum permanent structural deformation associated with this inelastic response would be predicted to be on the order of 0.02 inch.

7.6.3 Internal Equipment

The internal equipment mounted in the Fermi-2 reactor auxiliary building should also be capable of withstanding the SSE loads from the site-specific spectra input without degradation of its functional capability. Similar conclusions may be inferred with respect to in-line items or devices mounted on internal equipment.

The envelope spectra of operation indicate that plastic yielding of items qualified to the existing Fermi-2 design basis could be possible only in limited frequency ranges. A ductility of no more than 2 would be sufficient to ensure that the initial design requirements are satisfactory in the critical frequency regions.

Figure 7.6-1 presents a plot of maximum permanent equipment deformation as a function of primary system frequency to achieve necessary response ductility. From this figure, it may be seen that all permanent deformations are no greater than than 0.11 inches. Margins in the design of internal mechanical equipment and devices should preclude the necessity for mobilization of this ductility and should ensure that all existing equipment items remain fully elastic.

7.7 Specific Internal Equipment Overview

The preceding equipment evaluation was based upon generic consideration of the reactor auxiliary building envelope spectra. The reactor auxiliary building complex was also examined on a location-by-location basis to ensure that the generic envelope equipment spectra evaluation is adequately conservative in all structural zones. The results of this building zone comparison are shown in Table 7.7-1.

This evaluation reveals certain building locations where equipment loading would be more severe than indicated by the envelope spectra evaluation. The containment structure appears to respond more severely and the reactor pressure vessel seems to respond less severely than indicted in the previous reactor building analysis. Additionally, there is a zone at the 20 cps region where higher spectral accelerations are observed due to an apparent secondary horizontal containment load excitation not previously observed. The zone-by-zone evaluation does, however, support the general observations made from the generic spectra.

All internal equipment identified as critical for this supplementary seismic evaluation has been analyzed for its building location and potential response characteristics with acceptable results.

7.8 Conclusions

The results of the independent investigation described above lead to the conclusion that the Fermi-2 RHR structure, reactor auxiliary building structure and internal equipment housed therein, are capable of withstanding the newly postulated site-specific SSE ground motion input without degradation of the functional characteristics of either the structures or associated critical internal equipment.

7.9 Reference

7-1 Letter, from D. M. Hopper, Hopper and Associates Engineers, to Dr. Yogindra Anand, Detroit Edison Company, "Plant Structure and Component Seismic Reassessment", May 7, 1981, revised May 25, 1981 with attached report.

TABLE 7.7 - 1 Page 1 of 2

HORIZONTAL REACTOR AUXILIARY BUILDING ZONE COMPARISON

BUILDING LOCATION	MAX. AMPLIFICATION	REMARKS
1st Floor El. 583'-6"	1.40 @ 9cps	Previous spectral valley eliminated at critical location. Slight lowering of building primary frequency in EW direction not considered significant. Equipment plastic deformation needs insignificant.
2nd Floor El. 613'-6"	1.40 @5 0cps	Excellent correlation with previous analysis. Maximum amplification in high frequency zone of EW directional response.
3rd Floor El. 641'-6"	1.4 @ 10cps	Same comment as above.
4th Floor El. 659'-0"	1.45 @ 10cps	Same comment as above.
5th Floor El. 684'-6"	1.45 @ 50cps	Higher accelerations in the NS direction above 7cps.
Drywall 18' below invert	1.65 @ 20cps	Same phenomena previously described with the critical problem at the high frequency end of the spectrum.
Drywall 6' below invert	2.80 @ 20cps	Higher accelerations in the le EW direction above 7cps. Critical amplification at 20cps.
Pedestal 18' below invert	1.60 @ 20cps	Same comment as above. Slight frequency shift apparent.
Pedestal Top	2.0 @ 25cps	All regions acceptable except the zone above the 7cps frequency bound.
RPV 14' above invert	.5	Large reduction in all Spectral Accelerations.
RPV 54' above invert	1.4 @ 20cps	All spectral accelerations are lower with the exception of a high frequency amplification in the EW direction only at the 20cps region.
Sacrificial Shield all elevations	1.35 @ 25cps	All spectral accelerations are lower with the exception of some high frequency amplification in the EW direction above 15cps.

TABLE 7.7-1 Page 2 of 2

VERTICAL REACTOR AUXILIARY BUILDING ZONE COMPARISON

BUILDING LOCATION	MAX. AMPLIFICATION	REMARKS
Reactor Containment Shield	2.0 @ 50cps	Complete envelope of initial analysis by reassessment work. High predominant frequency response initiates amplification in range normally above consideration.
Building Walls	2.0 @ 50cps	Reassessment results indicate amplification in only the high and low frequency regions.
Building Slabs	2.0 @ 1cps	Reassessment results indicate major amplification in the low frequency region with some additional amplification above 20cps.

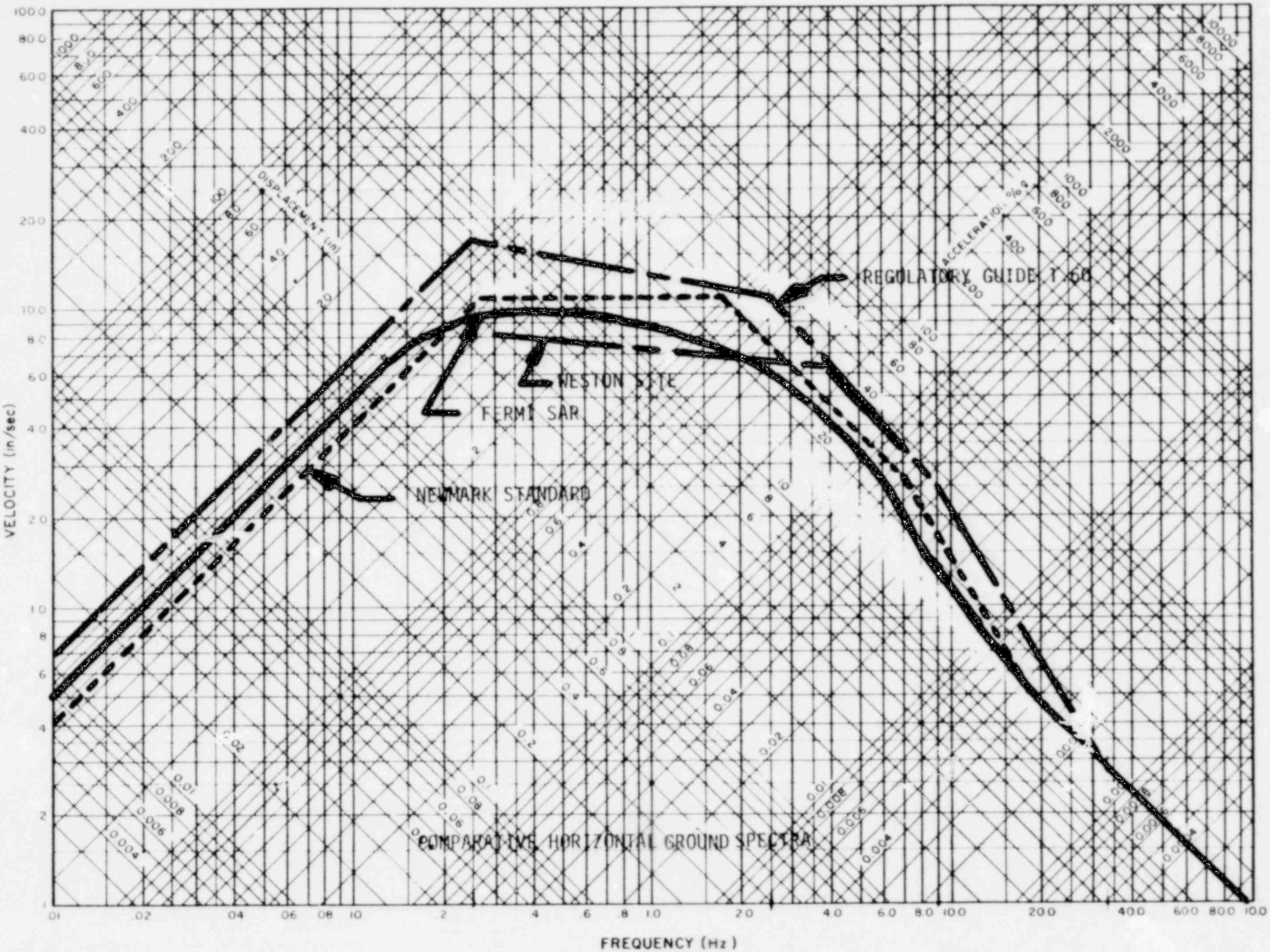


FIGURE 7.2-1 Page 1 of 2

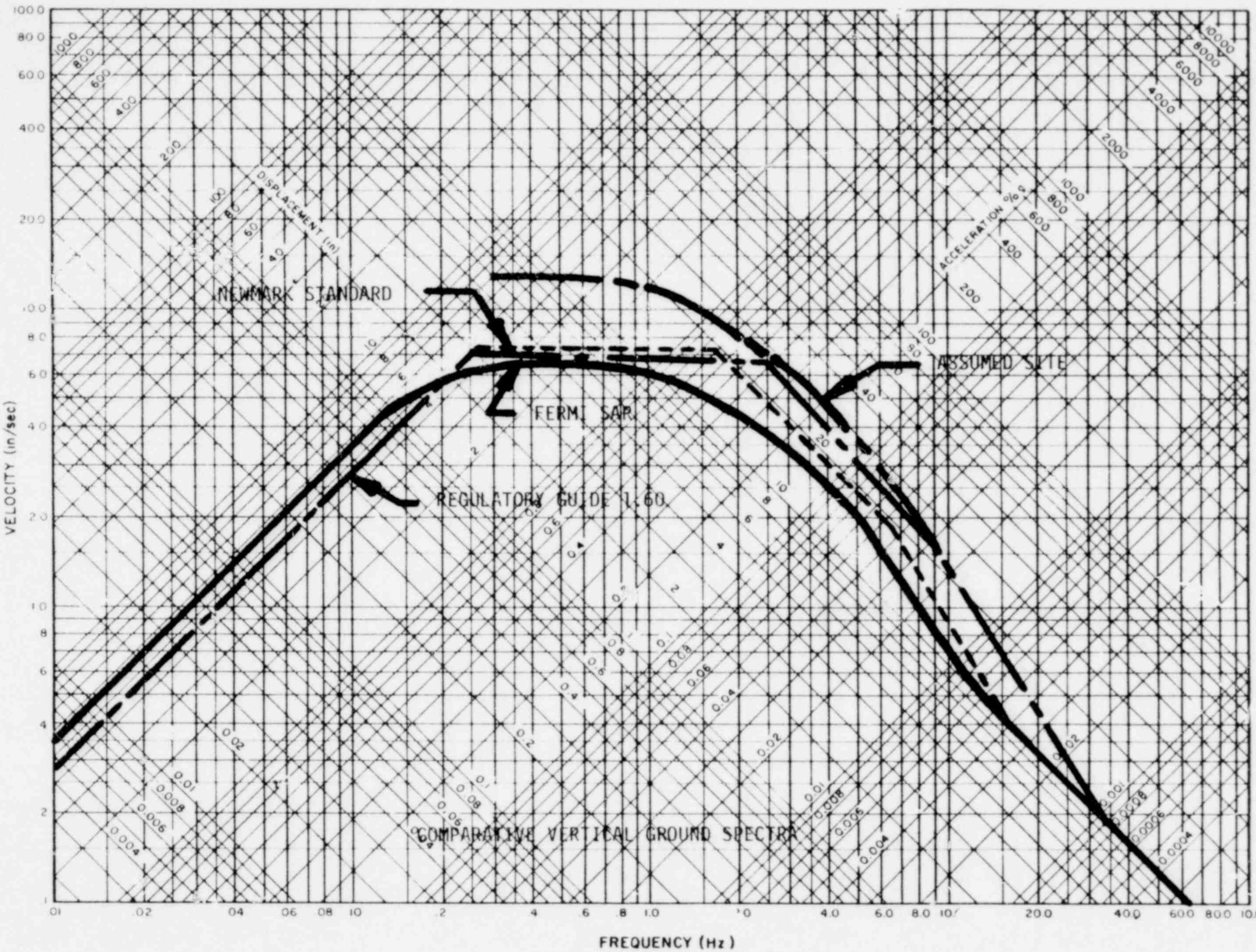


FIGURE 7.2-1 Page 2 of 2

FIGURE 7.3-1, Page 1 of 2

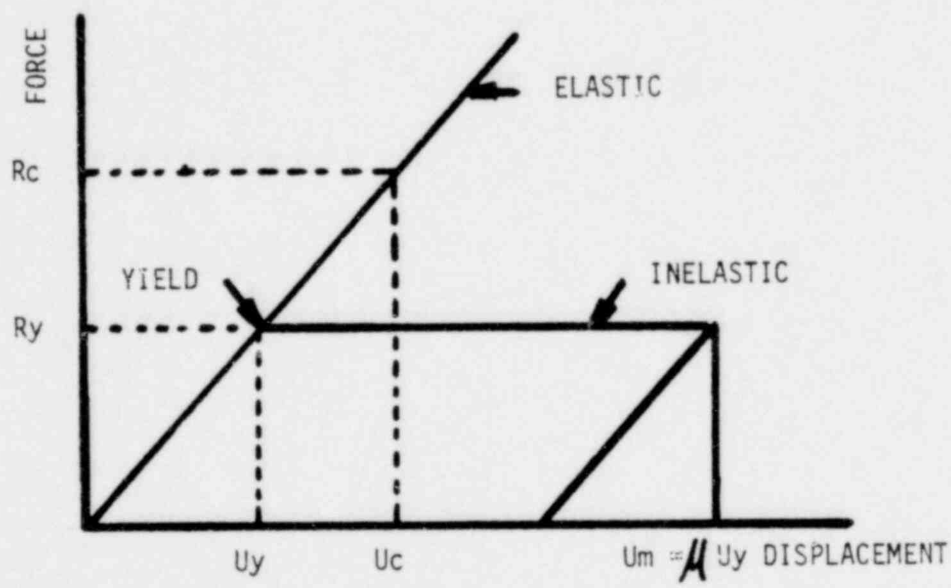
INFLUENCE OF DUCTILITY ON DESIGN RESPONSE SPECTRA

Acceleration response spectra may be modified to account for the influence of ductility by use of simple rules developed from detailed inelastic analysis of dynamic system subjected to earthquake, random, and shock pulse acceleration excitations.

The influence of ductility on spectral acceleration is described as a function of the frequency zones on a given response spectrum and is partioned into four different regions.

Region 1 - Is the low frequency range in which spectral deformations are equivalent in the elastic and inelastic systems. Therefore spectral accelerations must be $1/\mu$ times the elastic accelerations for the inelastic system. This range extends up to the frequency approximately 1/3 the distance between the frequency at which the spectrum drops sharply to the right and the frequency where displacement is no longer constant.

Region 2 - Is the intermediate frequency range where observations reveal that elastic and inelastic energies are preserved.



$$Ry(Um-\tfrac{1}{2}Uy) = Ry(\mu Uy-\tfrac{1}{2}Uy)$$
$$= RyUy(\mu - \tfrac{1}{2})$$

or

$$\frac{RyUy}{2}(2\mu - 1) = \frac{RcUc}{2}$$

However

$$\frac{Rc}{Ry} = \frac{Uc}{Uy} \text{ since linear}$$

Thus

$$\frac{Uc}{Uy} = \sqrt{2\mu - 1}$$

FIGURE 7.3-1, Page 2 of 2

So spectral accelerations must be reduced from the elastic to the inelastic situation by the factor:

$$\frac{Ry}{Rc} = \frac{1}{\sqrt{2\mu - 1}}$$

This range extends up to the point where acceleration drops from a plateau to transition with the zero period acceleration.

Region 3 - Is a "smoothed in" transition zone between region 2 and region 4.

Region 4 - Is the high frequency range in which spectral accelerations are equivalent in the elastic and inelastic systems.
This range begins at the location where the spectrum becomes constant at a zero period acceleration.

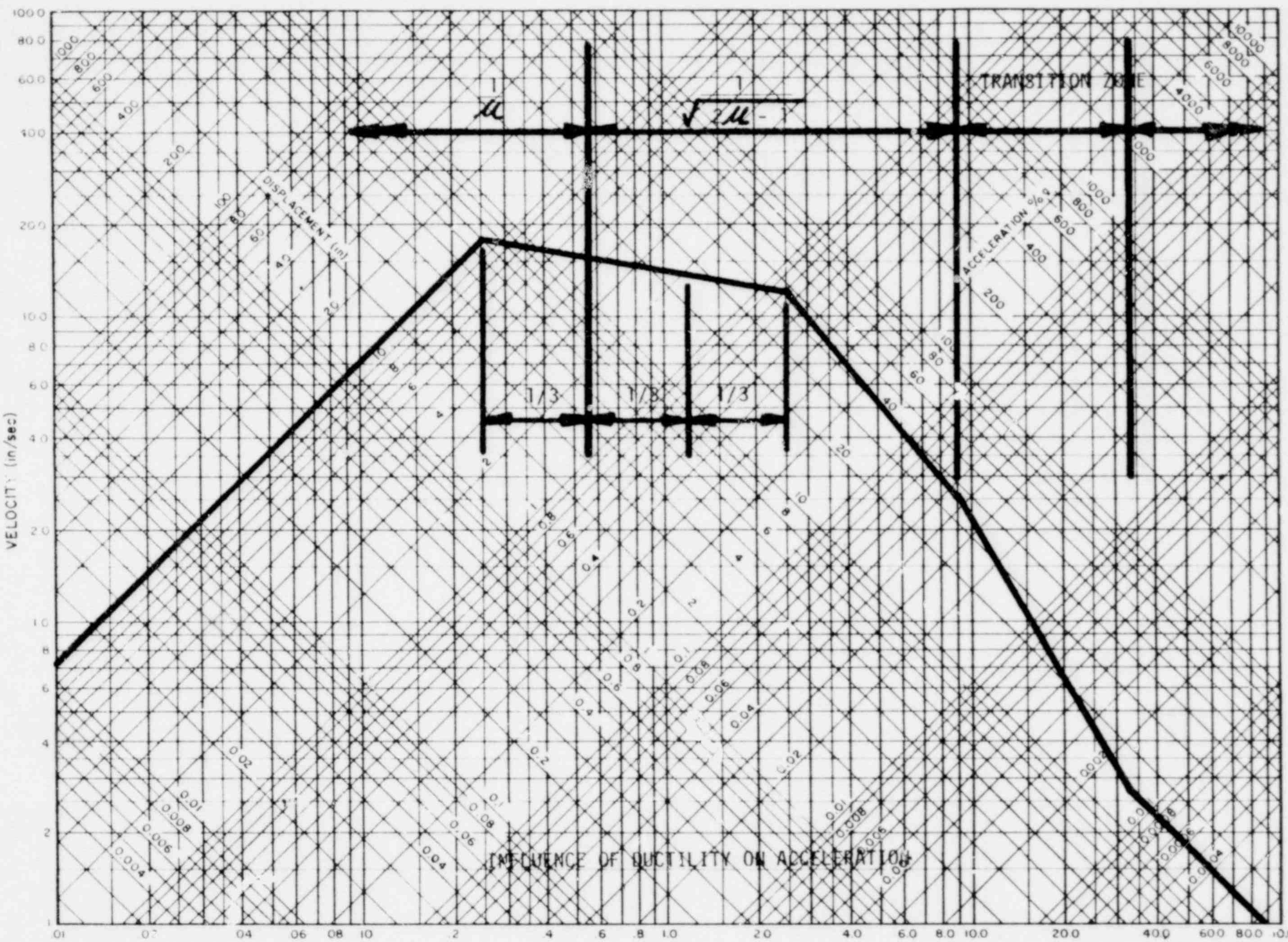

TRANSITION ZONE
1/μ
1/√(2μ-1)
1/3
1/8
1/3
DISPLACEMENT (in)
ACCELERATION % g
INFLUENCE OF DUCTILITY ON ACCELERATION
VELOCITY (in/sec)
FREQUENCY (Hz)

FIGURE 7.3-2

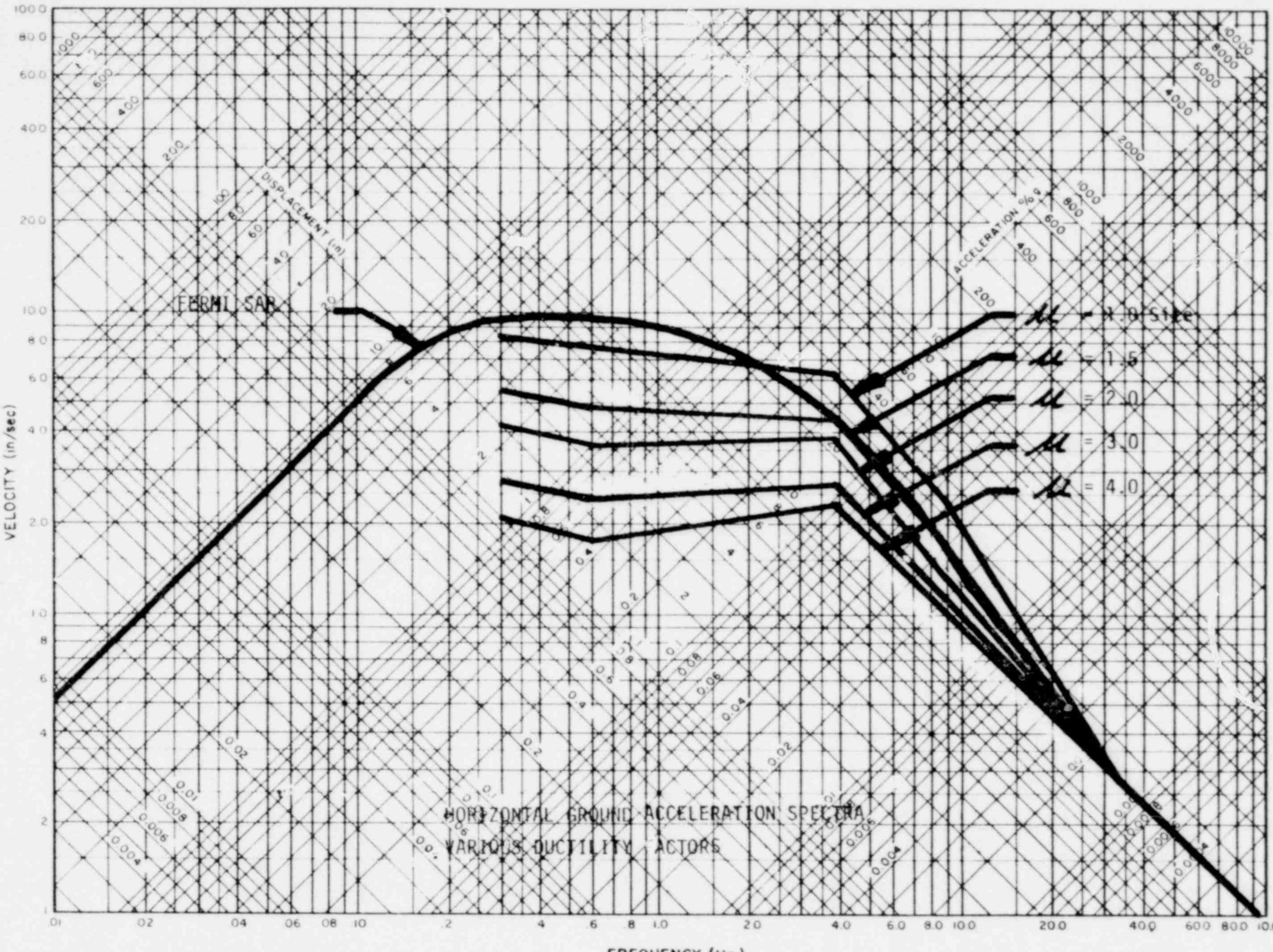


FIGURE 7.4-1 Page 1 of 2

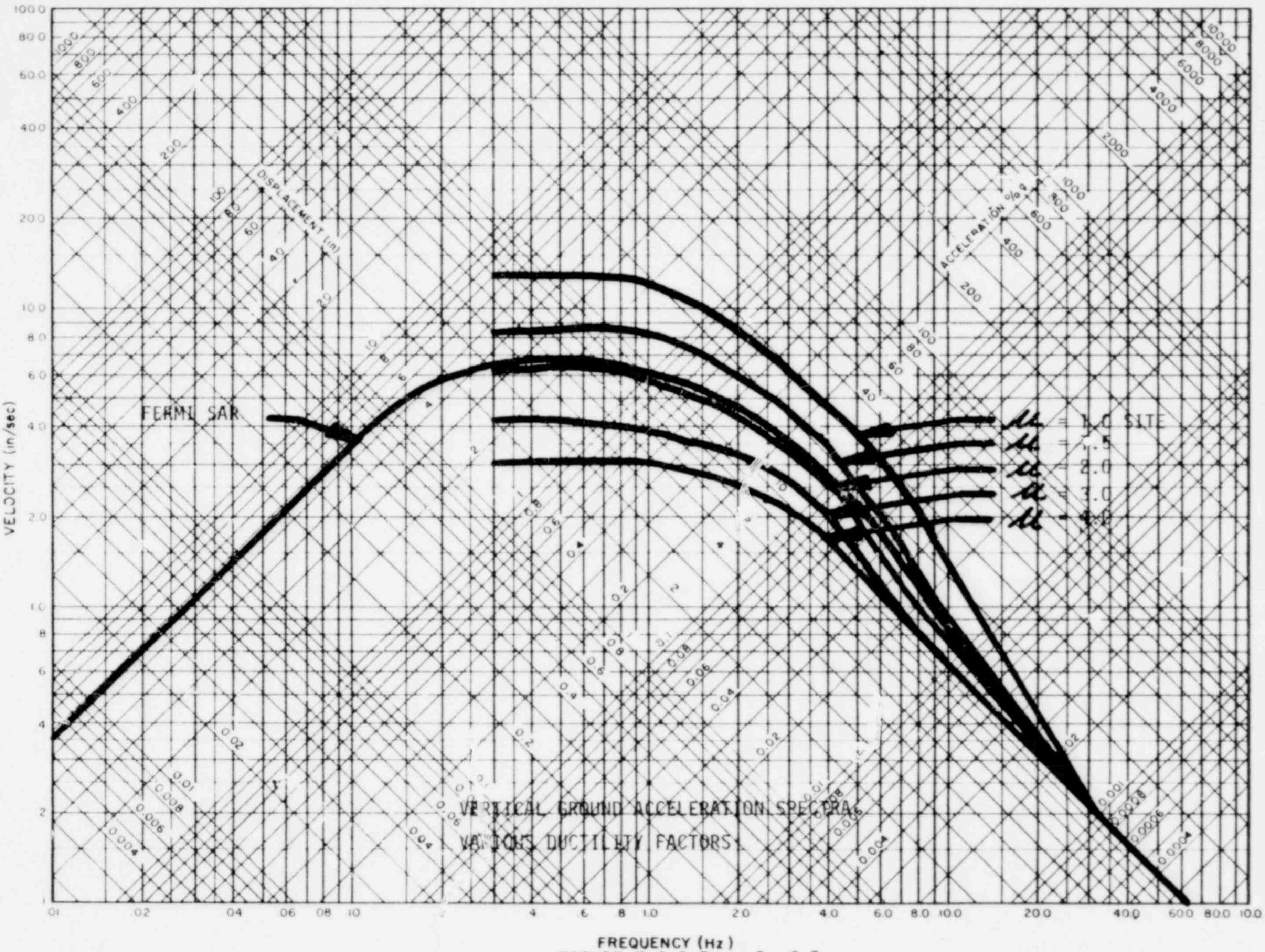


FIGURE 7.4-1 Page 2 of 2

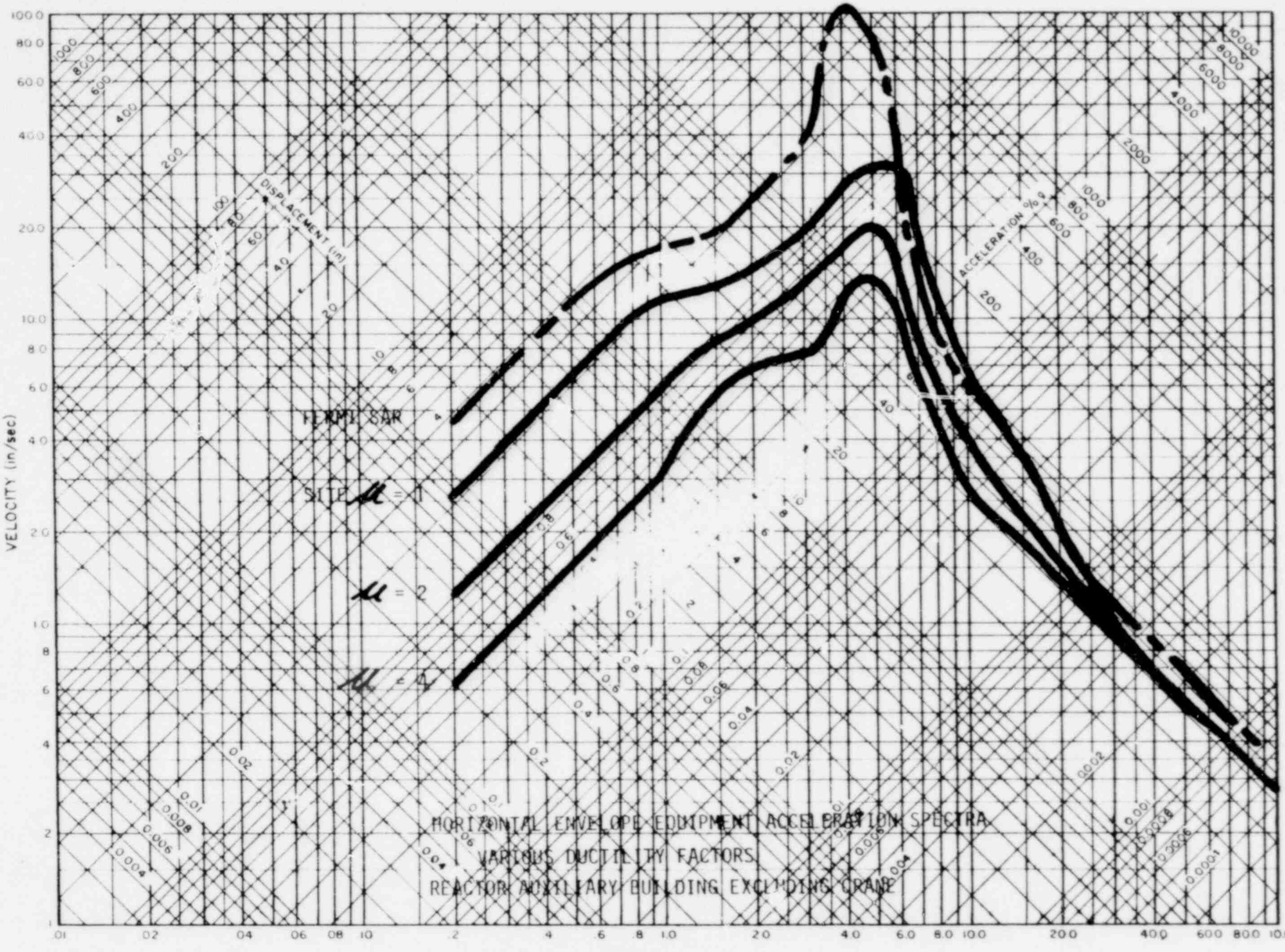


FIGURE 7.5-1 Page 1 of 2

HOPPER AND ASSOCIATES
ENGINEERS

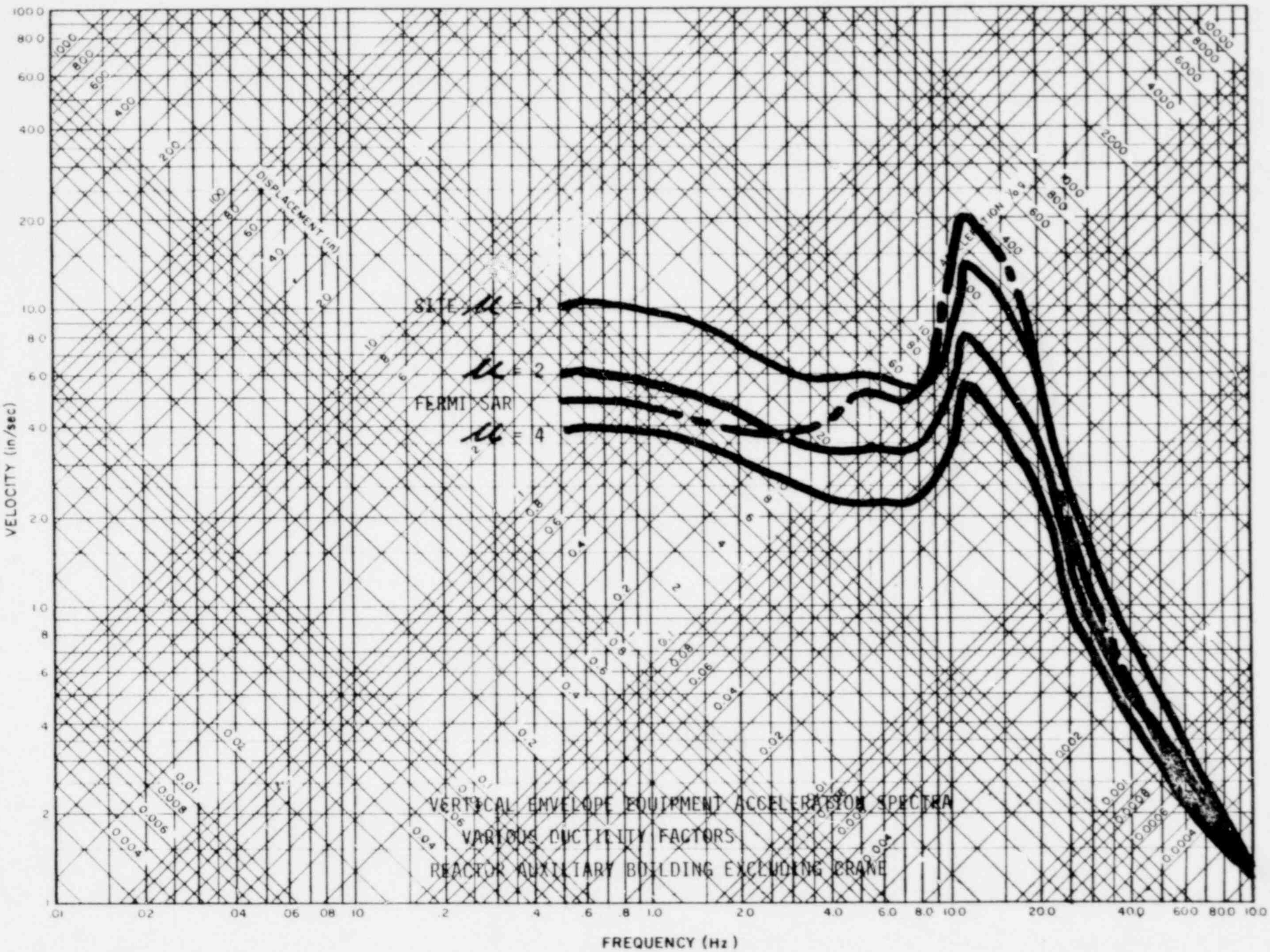


FIGURE 7.5-1 Page 2 of 2

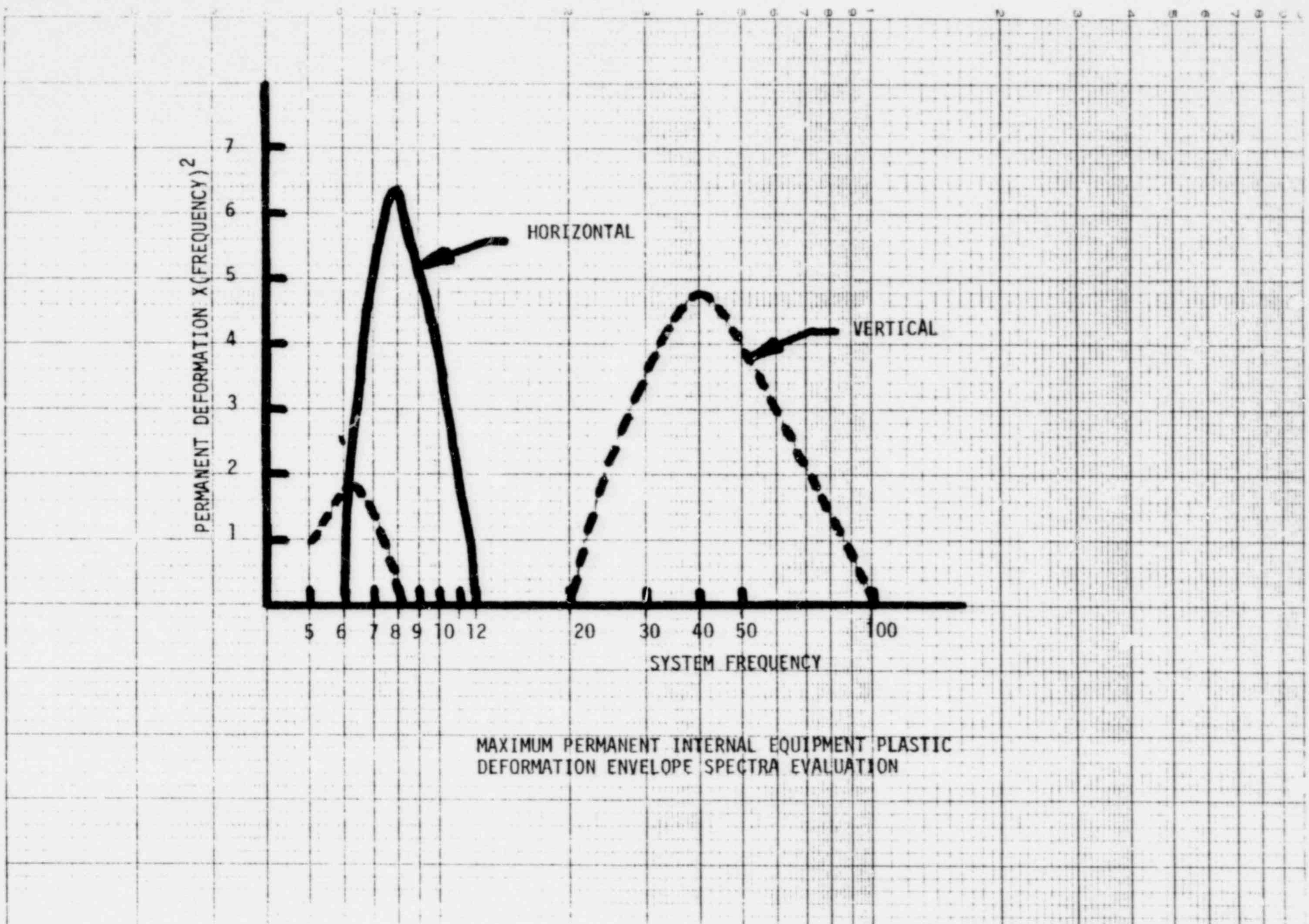

PERMANENT DEFORMATION X(FREQUENCY)^2
7
6
5
4
3
2
1
HORIZONTAL
VERTICAL
5 6 7 8 9 10 12
20 30 40 50 100
SYSTEM FREQUENCY
MAXIMUM PERMANENT INTERNAL EQUIPMENT PLASTIC
DEFORMATION ENVELOPE SPECTRA EVALUATION

FIGURE 7.6-1

8.0 CONCLUSIONS

Detroit Edison is convinced that the seismic design basis of Fermi 2 remains adequate and believes that the results of the supplementary seismic evaluation requested by the NRR Staff and reported here confirm this conclusion. The results of the supplementary seismic evaluation confirm that safe shutdown of Fermi 2 would be achieved under the site-specific seismic conditions suggested by the NRR Staff.

The outstanding items identified in Section 5.4 are not considered major deficiencies and will be resolved within the next 90 days.