CONSERVATIVE DESIGN IN-STRUCTURE RESPONSE SPECTRA FOR RESOLUTION OF UNRESOLVED SAFETY ISSUE A-46 FOR THE THREE MILE ISLAND NUCLEAR GENERATING STATION, UNIT 1

July 1993

Report No. 50097-R-001

Prepared for:

GENERAL PUBLIC UTILITIES NUCLEAR CORPORATION

EQE INTERNATIONAL

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One Upper Pond Road
Parsippany, New Jersey 07054

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Revision No.	Description of Revision	Date
0	Original Issue	July 8, 1993
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1. INTRODUCTION

Conservative design in-structure response spectra for resolution of Unresolved Safety Issue (USI) A-46 as defined in Section 4 of the SQUG Generic Implementation Procedure (GIP), Rev. 2 [1] are generated for the Three Mile Island Nuclear Generating Station, Unit 1 (TMI-1) Reactor/Internal Building (RB), Intermediate Building (IB), Auxiliary/Fuel/Control Building (AFCB), and Turbine Building (TB) at 3% and 5% damping. The ground motion definition is specified by the plant's safe shutdown earthquake (SSE) [2], and the buildings are analyzed consistent with procedures specified in the USNRC Standard Review Plan (SRP) [3] and other current regulatory guidelines (RG), for example, RG 1.61 [4] and 1.122 [5], as appropriate.

Soil-structure interaction (SSI) analyses are performed for the RB, IB, AFCB, and the Turbine Pedestal (TP). The TB is analyzed as a fixed-base structure.

Section 2 of this report describes the approach and the data used to perform the seismic analysis for the generation of the conservative design in-structure spectra. Section 3 contains a set of representative in-structure spectra for each building and a comparison between these spectra and the SQUG bounding spectrum. Section 4 contains a list of references associated with the work presented in this report.

2. ANALYSIS APPROACH

The RB, IB, and AFCB at Unit 1 of the TMI Nuclear Generating Station are embedded in about 27 feet of soil and founded on rock with a best-estimate low-strain shear wave velocity, Vs, of 4,082 feet/second (ft/sec). The bedrock surface at the site is essentially flat and at an elevation of about 277 feet. Lithologic types vary from red to brown, interbedded, fine- to medium-grain sandstone, shaley siltstone, and shaley claystone, which range from medium-hard to hard [6]. The 27-foot soil layer overlying the bedrock has an almost uniform best-estimate low-strain Vs of 960 ft/sec. A soil best estimate Vs profile is calculated [7] using the compressional wave velocity (Vp) profile shown in Figure 2.7-3 of Ref. 6. This results in a Vs profile ranging from 925 ft/sec at grade (Elev. 304 feet) to 996 ft/sec at the bottom of the layer (Elev. 277 feet). For the dynamic analysis of the RB, IB, AFCB, and TP, soil-structure interaction (SSI) analyses are performed using the industry standard SSI analysis codes CLASSI [8] and SASSI [9].

Figure 2-1 shows the basic elements of the substructure SSI approach used for the analyses of the TMI-1 structures listed above. The fixed-base analysis for the TB is described in Sec. 2.4. The following sections describe in detail each of the analysis elements as they are applied to the TMI-1 structures.

2.1 SEISMIC INPUT

Three statistically independent artificial time histories, two horizontal and one vertical, are generated such that their response spectra at 5% damping envelop the corresponding spectra for the TMI-1 safe shutdown earthquake (SSE) [2] (target spectra). The horizontal SSE peak ground acceleration (PGA) specified for TMI-1 is 0.12g [2]. The vertical SSE spectrum is specified as 2/3 of the horizontal SSE spectrum [2]. The horizontal operating basis earthquake (OBE) spectra are shown in Fig. 2-2, and are defined as 1/2 of the SSE [2]. The generated artificial time histories meet all the requirements of the Standard Review Plan (SRP) [3].

Figures 2-3 to 2-5 show the comparison between the response spectra of the artificial time histories and the SSE design basis (DBS) target response spectra. The requirement in the SRP that spectral accelerations at no more than 5 frequency points be below the target and that no spectral acceleration be 10% lower than the target is met by the artificial time histories developed for TMI-1. The comparison is performed between 0.2 and 34 Hz as recommended by the SRP. The main characteristics of the time histories and their cross-correlation coefficients are given in Table 2-1. The low cross-correlation coefficients between the three time histories demonstrate their statistical independence.

For SSI analysis, the SRP requires that the deconvolved motion at the foundation level be greater than 60% of the motion at the surface. If soil property variations are considered, the requirement is that the envelope of the deconvolved motion for three soil cases, best estimate, lower bound, and upper bound, must be larger than 60% of the motion at the surface. Figure 2-6 shows the deconvolved spectra at the bedrock (Elev. 277 feet), which is considered as the foundation level for all embedded buildings. This figure demonstrates that the time histories meet the 60% requirement. Figure 2-7 shows the power spectral density (PSD) function of the artificial time histories. Since no target PSD functions exist for TMI-1, the PSD functions are used in a qualitative way to study the frequency content of the artificial time histories. The PSD functions in Fig. 2-7 demonstrate that the artificial time histories have a smooth variation of energy at the frequency range of interest for the SSI analyses (about 2 to 33 Hz).

2.2 SOIL PROFILE

The best-estimate low-strain soil properties for the TMI-1 site are taken from information in the TMI-1 FSAR [6] as described above. This soil profile is shown in Table 2-2. To account for soil variation, three soil profiles are considered, best estimate, lower bound, and upper bound. For the lower-bound case, the low-strain soil shear modulus is equal to 1/2 of the low-strain best-estimate shear modulus, and for the upper-bound case, the low-strain soil shear modulus is equal to 2 times the low-strain best-estimate shear modulus, in compliance with the SRP recommendation. One-dimensional wave propagation analyses were performed for these three low-strain soil profiles to develop three soil profiles compatible with the level of shear strain generated by the design basis SSE event. These strain-compatible soil profiles are denoted "high strain soil profiles" and are described in

Tables 2-3, 2-4, and 2-5 and shown in Fig. 2-8. The high-strain soil profiles are used in the SSI analyses.

2.3 STRUCTURAL MODELS

Three-dimensional structural models are developed for the RB, AFCB, IB, TP, and TB. The structural models for the RB, AFCB, IB, and TP consist of equivalent beams located at the center of rigidity of groups of vertical structural elements that behave as a unit. The corresponding masses are modeled as lumped translational masses and mass moments of inertia located at the center of mass of each structure's elevation. For the TB model, the different structural elements are explicitly modeled to capture the more complex behavior of this building. Six degrees of freedom are considered at each nodal point. This modeling technique accounts for torsion and rocking of the structures. Figures 2-9 to 2-14 schematically show the structural models. These figures are not drawn to scale.

The RB consists of two separate structural systems: the external concrete shell and the internal structural system including the dynamic model of the NSSS. These two structural systems are connected only through a common foundation. Figure 2-9 (2-9a and 2-9b) shows the fixed-base model of the RB. Figure 2-9a shows the external concrete shell model, and Fig. 2-9b shows the internal model without the NSSS model. Table 2-6 gives fixed-base modal properties for the first 14 modes of the external shell model and the first 20 modes of the internal/NSSS model. The total number of modes of the external shell in the SSI analysis is 14, capturing 99% of the horizontal mass and 89% of the vertical mass. The total number of modes of the internal/NSSS in the SSI analysis is 68, capturing 99% of the horizontal mass and 93% of the vertical mass.

The IB was modeled as a one-stick system with equivalent beams and lumped masses. Three secondary columns of the TB are founded on one external wall of the IB. A sensitivity study is performed for the two buildings to determine the degree of interaction through these connections [10]. The IB supports steel framing between the TB and IB at three locations. All three supports are at Elevation 305 feet. To examine the effect of this steel framing, the IB is modeled with and without the steel framing. The three columns of the steel framing are connected to the IB stick at Elev. 305. The columns are modeled as two-span members between Elevs. 305 and 355 feet with a support at Elev. 322 feet and fixed at Elev. 355 feet. The column fixity overpredicts the columns' stiffness effect. A comparison of the IB's modal analyses with and without the framing demonstrates that the frequencies do not change and thus the steel frame's stiffness is insignificant. Since the frequencies are identical, the IB is modeled without the steel frame. It is concluded then that each building does not affect the other. The two buildings behave independently and thus two independent models are constructed. Figure 2-10 shows the fixed-base model of the IB. Table 2-7 gives fixed-base modal properties of this model for the first 15 modes. The total number of modes used in the SSI analysis is 15, capturing virtually 100% of the horizontal mass and 93% of the vertical mass.

The AFCB is a larger, more complex structure. To accurately model the complete structure, a three-stick system is generated. The sticks represent the Auxiliary Building, the Fuel Handling Building, and the Control Building, respectively. These three structural systems are connected at several elevations to represent the actual combined behavior of the complete system.

One particular detail studied in the Control Building is apparently for mitigating the effects of aircraft impact on the floors of the Control Room. The floor slabs are connected to the external walls through elastomeric pads that allow relative displacements between the floor slabs and the external walls only in the direction perpendicular to the walls. These slabs are rigidly connected to interior walls and in the longitudinal direction to the external walls. A sensitivity study shows that for dynamic modeling purposes, the floor behaves as a diaphragm rigidly connected to all surrounding walls [11]. The floor slab configuration consists of 5-inch concrete slabs surrounded by structural walls on all four sides (Elevs. 322, 338.5, 355, and 380 feet of the Control Room). On two adjacent sides of the slab, the steel members supporting these slabs are supported off Teflon and neoprene pads, allowing sliding in the direction orthogonal to the walls (see Fig. 2-11). In order to study the effect of this configuration on the overall structural response, three different finite element models of a typical floor and wall configuration are constructed. Each model includes a finite element representation of all floor slabs at a typical elevation, and of all structural walls above and below that elevation. The walls are restrained at a given height above the floor. The height of the walls is calibrated to yield natural frequencies of in-plane modes of about 10 Hz. The steel beams supporting the slabs are not explicitly included in the model.

The first model represents the two 5-inch slabs detached from the peripheral walls on two adjacent sides, with the slab flexible in its own plane. This represents a lower-bound estimate model because the in-plane stiffness of the steel beams and columns is neglected. The second model is similar to the first, except that the slabs are now modeled as rigid in their own plane. This model is considered to be representative of the actual configuration for in-plane floor loads. The third model represents the two slabs connected to all peripheral walls and rigid in their own plane.

A summary of the main in-plane structural frequencies is presented in Table 2-8. From the comparison in Table 2-8, it is clear that considering rigid diaphragm action, the separation of the slab and walls has only a minor effect on the overall response. This assumption is judged to be adequate for lumped mass representation, and therefore, the separations between the slab and walls are neglected. Thus, no special modeling is needed at those elevations due to the slab-external wall connections.

Figure 2-12 shows the fixed-base model of the AFCB. Table 2-9 gives fixed-base modal properties of this model for the first 25 modes. The total number of modes used in the SSI analysis is 25 (maximum frequency of 61.02 Hz) capturing 79% of the horizontal mass and 76% of the vertical mass. The rest of the structural mass does not contribute to the vibration of the structure due to its high frequency and only contributes to the rigid body motion of the structure (rocking and swaying). This rigid body motion is accurately calculated during the SSI analysis of the soil-foundation-structure system by using total mass of the structure-foundation system in evaluating the swaying and rocking of the foundation.

The TB is a steel structure with few vertical bracing systems. Furthermore, many of the bracing elements, due to their length, behave as tension-only members. Also, main floors cannot be considered to behave as horizontally rigid diaphragms in all areas of the structure. This makes the building behave very flexibly. Thus, a simple stick model is not able to represent the dynamic behavior of this structure. To obtain better representation of the dynamic behavior of the TB, the main structural elements, exterior columns, bracing systems, and rigid floor areas, are modeled individually and then those individual systems are connected to form the complete structural model. Figure 2-13 shows the fixed-base model of the TB. Table 2-10 gives fixed-base modal properties of this model for the first 18 modes. The total number of modes used in the analysis is 18, capturing virtually 100% of the horizontal and vertical mass.

The TP is a massive structure that is weakly connected to the steel TB. This weak connection does not affect the dynamic behavior or either structure; thus, a separate model is developed for the TP. Figure 2-14 shows the fixed-base model of the turbine pedestal. Table 2-11 gives the fixed-base modal properties of this model. The three modes in the table capture virtually 100% of the horizontal and vertical mass.

2.4 SEISMIC ANALYSIS

For the RB (external concrete shell and internal/NSSS models connected to a common foundation), IB, AFCB, and TP, impedance and scattering functions are developed for the three high-strain soil profiles described in Sec. 2.2. The impedance functions are controlled by the stiffness of the rock half-space below Elev. 277 feet. Once the impedance and scattering functions are obtained they are used in conjunction with the structural models described in Sec. 2.3 to perform three-dimensional dynamic SSI analyses with the three independent components of the input motion applied simultaneously. These SSI analyses are performed for the three soil profiles, best estimate, lower bound, and upper bound. In-structure time histories are obtained at all dynamic degrees of freedom for each analysis. From those time histories, in-structure spectra are generated at 3% and 5% damping.

To generate the conservative design in-structure spectra, the spectra corresponding to the best-estimate soil case are broadened by 15%, and the in-structure spectra corresponding to the lower- and upper-bound soil cases by 10%. The broadened in-structure spectra are then enveloped to obtain the final conservative design in-structure spectra.

The TB is a light structure, mainly founded on the surface on spread and individual foundations; hence the SSI effects are negligible, because little or no modification of the surface motion and minimal radiation damping would occur. Thus, a fixed-base analysis is performed for the TB using as seismic input the artificial time histories defined in Sec. 2.1. In-structure response spectra are calculated at all defined elevations and, due to the horizontal floor flexibility, at different locations at each of these elevations. For this building, since fixed-base analysis was performed, the calculated in-structure spectra are broadened by 15% for the final conservative design in-structure spectra.

The damping ratios recommended by Regulatory Guide (RG) 1.61 [4] were used to define the structural damping. For the Internal/NSSS structure, equivalent composite modal damping ratios were calculated using the weighted stiffness approach [3]. Table 2-12 gives the damping ratios used for each structure and material, and Table 2-6 shows the equivalent composite modal damping ratios for the Internal/NSSS structure.

The in-structure response spectra were calculated at the centers of mass defined for each "stick." For the TB, the effects of torsion and rocking can be considered important, thus the conservative design in-structure response spectra were calculated as the envelope of the spectra at the center of mass and the extreme corners of each floor. 1

For the ACFB and TB, masses are distributed at different locations at each floor; thus, the variation of motion at different floor locations due to the effects of torsion, rocking, or as in the case of the TB, relative motions due to non-rigid diaphragm are included in the in-structure response spectra at those centers of mass. Thus these in-structure response spectra are representative of the complete floor area defined by a particular mass point.

Conservative design in-structure response spectra at selected locations in the buildings are shown in the next section.

Table 2-1
ARTIFICIAL TIME HISTORIES CHARACTERISTICS

	CHARACTERISTICS			CORRELATION COEFFICIENTS		
	Duration Sec.	Dt Sec.	Strong Motion Sec.	TH1	TH2	TH3
TH 1 (Horizontal)	20.0	0.01	18.35	--	0.02	-0.01
TH 2 (Horizontal)	20.0	0.01	14.95	--	--	-0.04
TH 3 (Vertical)	20.0	0.01	16.75	--	--	--

Table 2-2
LOW-STRAIN BEST-ESTIMATE SOIL PROPERTIES

Layer	Thickness (ft)	Shear Modulus (ksf)	Vs (ft/sec)	Unit Weight (kcf)	Poisson's Ratio
1	4	3322	925	0.125	0.40
2	5	3430	940	0.125	0.40
3	5	3526	953	0.125	0.40
4	5	3653	970	0.125	0.40
5	5	3759	984	0.125	0.40
6	3	3851	996	0.125	0.40
7	half-space	67272	4082	0.130	0.40

Table 2-3
HIGH-STRAIN BEST-ESTIMATE SOIL PROPERTIES

Layer	Thickness (ft)	Shear Modulus (ksf)	Damping Ratio	Vs (ft/sec)	Unit Weight (kcf)	Poisson's Ratio
1	4	3237	0.020	913	0.125	0.40
2	5	3115	0.032	896	0.125	0.40
3	5	3044	0.039	886	0.125	0.40
4	5	3042	0.042	885	0.125	0.40
5	5	3044	0.044	886	0.125	0.40
6	3	3048	0.046	886	0.125	0.40
7	half-space	67272	0.020	4082	0.130	0.40

Table 2-4
HIGH-STRAIN LOWER-BOUND SOIL PROPERTIES

Layer	Thickness (ft)	Shear Modulus (ksf)	Damping Ratio	Vs (ft/sec)	Unit Weight (kcf)	Poisson's Ratio
1	4	1560	0.030	634	0.125	0.40
2	5	1448	0.047	611	0.125	0.40
3	5	1372	0.056	594	0.125	0.40
4	5	1332	0.062	586	0.125	0.40
5	5	1287	0.067	576	0.125	0.40
6	3	1243	0.072	566	0.125	0.40
7	half-space	33636	0.020	2886	0.130	0.40

Table 2-5 HIGH-STRAIN UPPER-BOUND SOIL PROPERTIES						
Layer	Thickness (ft)	Shear Modulus (ksf)	Damping Ratio	Vs (ft/sec)	Unit Weight (kcf)	Poisson's Ratio
1	4	6591	0.013	1303	0.125	0.40
2	5	6560	0.022	1300	0.125	0.40
3	5	6483	0.027	1292	0.125	0.40
4	5	6562	0.030	1300	0.125	0.40
5	5	6629	0.031	1307	0.125	0.40
6	3	6694	0.033	1313	0.125	0.40
7	half-space	134543	0.020	5773	0.130	0.40

Table 2-6
REACTOR BUILDING

REACTOR SHELL

FIXED-BASE MODAL PROPERTIES

Frequency Mode	(Hz)	Modal Participating Mass %			Modal Damping %
		E-W (X)	N-S (Y)	Vert. (Z)	
1	3.45	0.000	0.000	17.428	5.0
2	4.55	54.969	19.808	0.000	5.0
3	4.55	19.808	54.969	0.000	5.0
4	9.48	0.000	0.000	0.000	5.0
5	14.05	14.104	5.082	0.000	5.0
6	14.05	5.082	14.104	0.000	5.0
7	15.69	0.000	0.000	71.626	5.0
8	24.96	1.576	0.568	0.000	5.0
9	24.96	0.568	1.576	0.000	5.0
10	28.91	0.000	0.000	0.000	5.0
11	32.41	1.972	0.710	0.000	5.0
12	32.41	0.710	1.972	0.000	5.0
13	46.02	0.435	0.159	0.000	5.0
14	46.02	0.159	0.435	0.000	5.0

Table 2-6
REACTOR BUILDING (Cont.)

INTERNAL/NSSS STRUCTURE

FIXED-BASE MODAL PROPERTIES

Frequency Mode	(Hz)	Modal Participating Mass %			Modal Damping %
		E-W (X)	N-S (Y)	Vert. (Z)	
1	3.03	0.000	0.979	0.000	3.0
2	3.03	0.000	0.001	0.000	3.0
3	3.63	0.000	0.536	0.003	3.0
4	3.63	0.010	0.001	0.000	3.0
5	3.80	0.485	0.000	0.000	3.0
6	3.83	0.000	0.013	0.003	3.0
7	4.21	0.160	0.000	0.000	3.0
8	4.34	0.000	0.000	0.006	3.0
9	6.15	0.000	2.252	0.241	3.0
10	6.17	0.013	0.000	0.000	3.0
11	7.94	0.000	5.456	0.947	3.1
12	8.07	0.001	0.000	0.000	3.0
13	8.49	1.815	0.000	0.000	3.0
14	8.56	0.000	0.341	1.059	3.0
15	9.05	0.000	10.696	0.138	3.0
16	9.26	23.310	0.007	0.000	3.2
17	9.51	0.000	56.148	0.056	6.5
18	10.46	0.229	0.002	0.000	3.1
19	10.58	0.010	2.037	0.203	3.2
20	10.81	50.631	0.004	0.005	6.6

Table 2-7 INTERMEDIATE BUILDING					
FIXED-BASE MODAL PROPERTIES					
Frequency Mode	(Hz)	Modal Participating Mass %			Modal Damping %
		E-W (X)	N-S (Y)	Vert. (Z)	
1	6.96	44.576	3.755	0.321	7.0
2	7.75	4.859	64.796	5.732	7.0
3	11.71	30.740	1.101	0.004	7.0
4	17.59	0.274	17.426	51.366	7.0
5	19.81	12.023	0.046	0.431	7.0
6	27.51	1.717	1.507	0.753	7.0
7	27.66	0.727	1.257	6.485	7.0
8	29.91	1.316	4.030	14.258	7.0
9	36.15	0.537	0.211	2.070	7.0
10	36.65	0.861	1.406	0.074	7.0
11	41.20	0.479	3.293	3.799	7.0
12	47.05	0.557	0.403	2.068	7.0
13	49.16	0.787	0.399	1.968	7.0
14	52.48	0.166	0.315	3.109	7.0
15	54.51	0.272	0.003	0.041	7.0

Table 2-8
SENSITIVITY STUDY FOR CONTROL ROOM

Frequencies (Hz)		
Model 1	Model 2	Model 3
7.855	9.282	9.309
8.022	9.334	9.348
8.255	9.735	9.776
8.536	10.097	10.099

Table 2-9
AUXILIARY/FUEL/CONTROL BUILDING

FIXED-BASE MODAL PROPERTIES

Frequency Mode	(Hz)	Modal Participating Mass %			Modal Damping %
		E-W (X)	N-S (Y)	Vert. (Z)	
1	8.70	39.410	1.138	4.667	7.0
2	12.80	18.579	0.387	20.387	7.0
3	13.04	0.636	54.741	0.884	7.0
4	15.69	1.893	0.660	2.047	7.0
5	18.96	13.500	0.136	2.918	7.0
6	23.85	0.224	9.357	0.527	7.0
7	24.94	0.777	0.137	14.337	7.0
8	25.31	0.000	2.984	0.494	7.0
9	26.80	0.012	0.002	0.388	7.0
10	30.21	0.186	4.316	4.498	7.0
11	31.10	0.044	0.478	21.097	7.0
12	34.43	2.600	0.420	0.841	7.0
13	36.48	0.185	0.008	0.176	7.0
14	39.60	0.470	0.211	0.007	7.0
15	40.87	0.130	0.443	0.001	7.0
16	44.03	0.018	0.492	0.000	7.0
17	46.18	0.366	0.104	0.157	7.0
18	47.06	0.167	0.004	0.249	7.0
19	48.79	0.108	0.291	1.109	7.0
20	53.80	0.010	0.002	0.163	7.0
21	54.71	0.054	1.940	0.065	7.0
22	55.96	0.033	0.449	0.680	7.0
23	56.93	0.000	0.131	0.521	7.0
24	58.38	0.044	0.002	0.015	7.0
25	61.02	0.001	0.003	0.215	7.0

Table 2-10
TURBINE BUILDING

FIXED-BASE MODAL PROPERTIES

Frequency Mode	(Hz)	Modal Participating Mass %			Modal Damping %
		N-S (X)	E-W (Y)	Vert. (Z)	
1	1.14	0.012	80.809	0.000	7.0
2	1.39	74.204	0.026	0.000	7.0
3	2.37	0.246	7.421	0.000	7.0
4	2.69	11.769	0.092	0.000	7.0
5	3.68	0.004	0.082	0.000	7.0
6	4.64	0.095	11.457	0.000	7.0
7	5.22	4.252	0.076	0.000	7.0
8	5.54	0.413	0.009	0.004	7.0
9	5.87	7.937	0.026	0.000	7.0
10	9.01	1.033	0.002	0.000	7.0
11	9.90	0.033	0.000	0.002	7.0
12	12.36	0.000	0.000	78.870	7.0
13	22.64	0.000	0.000	0.076	7.0
14	25.72	0.000	0.000	12.047	7.0
15	43.15	0.000	0.000	0.045	7.0
16	45.76	0.000	0.000	1.989	7.0
17	50.26	0.000	0.000	6.967	7.0
18	90.24	0.000	0.000	0.000	7.0

Table 2-11 TURBINE PEDESTAL					
FIXED-BASE MODAL PROPERTIES					
Frequency Mode	(Hz)	Modal Participating Mass %			Modal Damping %
		N-S (X)	E-W (Y)	Vert. (Z)	
1	10.677	100.00	0.00	0.00	7.0
2	12.366	0.00	100.00	0.00	7.0
3	217.277	0.00	0.00	100.00	7.0

Table 2-12
STRUCTURAL DAMPING VALUES

Reactor Building	
Internal Structure	7%
NSSS	3%
Reactor Shell	5%
AFCB Building	7%
Intermediate Building	7%
Turbine Building	7%
Turbine Pedestal	7%

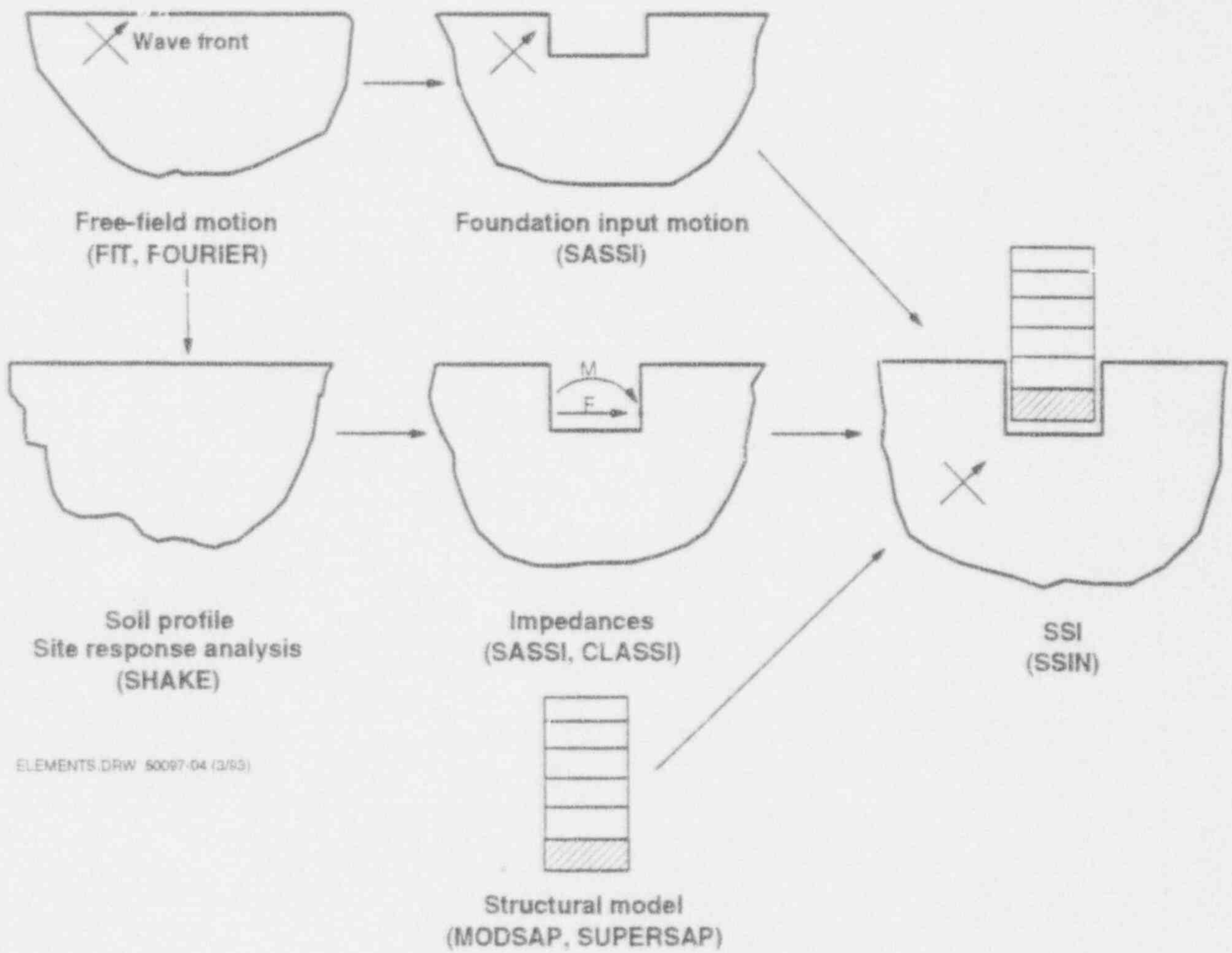


Figure 2-1: Elements of the substructure SSI analysis.

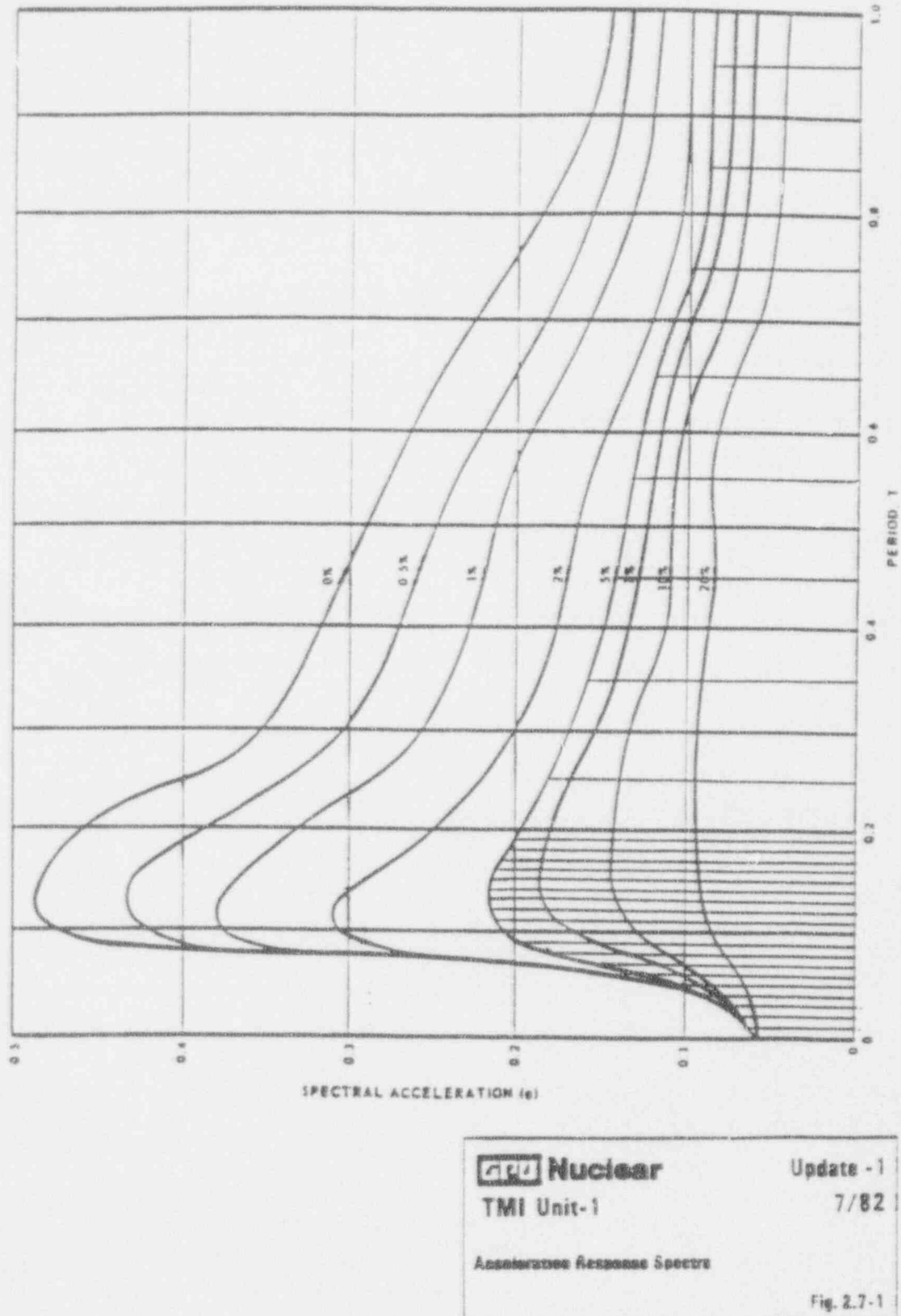
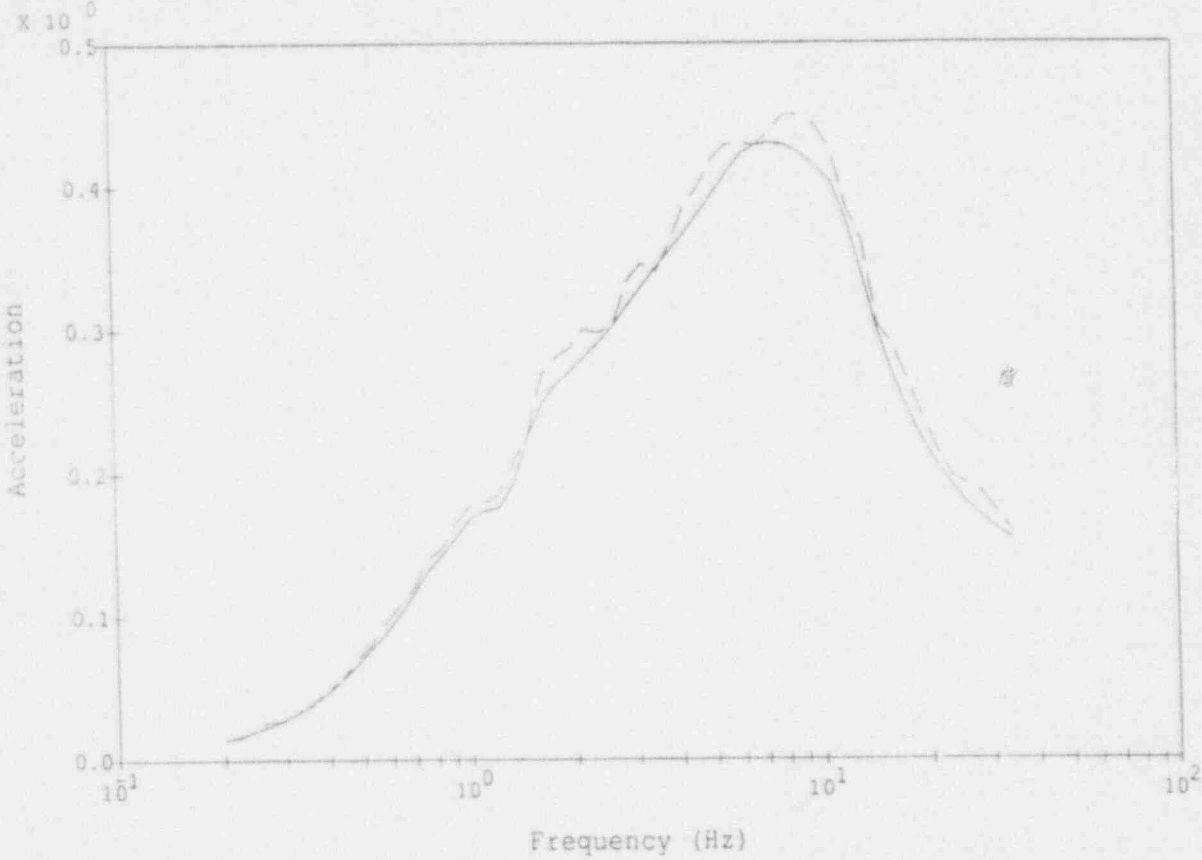


Figure 2-2: OBE design basis spectra for TMI-1.



Legend:
Target SSE DBS
Horizontal 1

Notes:
Accelerations in g's
Spectral Damping 5%
Target ZPA = 0.12g
SRP Frequencies
Scaled and BL Corrected

RSPLT SUN V1.2 plothlc 12:30:28 01/10/93

Figure 2-3: TMI-1. Comparison of time histories, Horizontal Component 1.

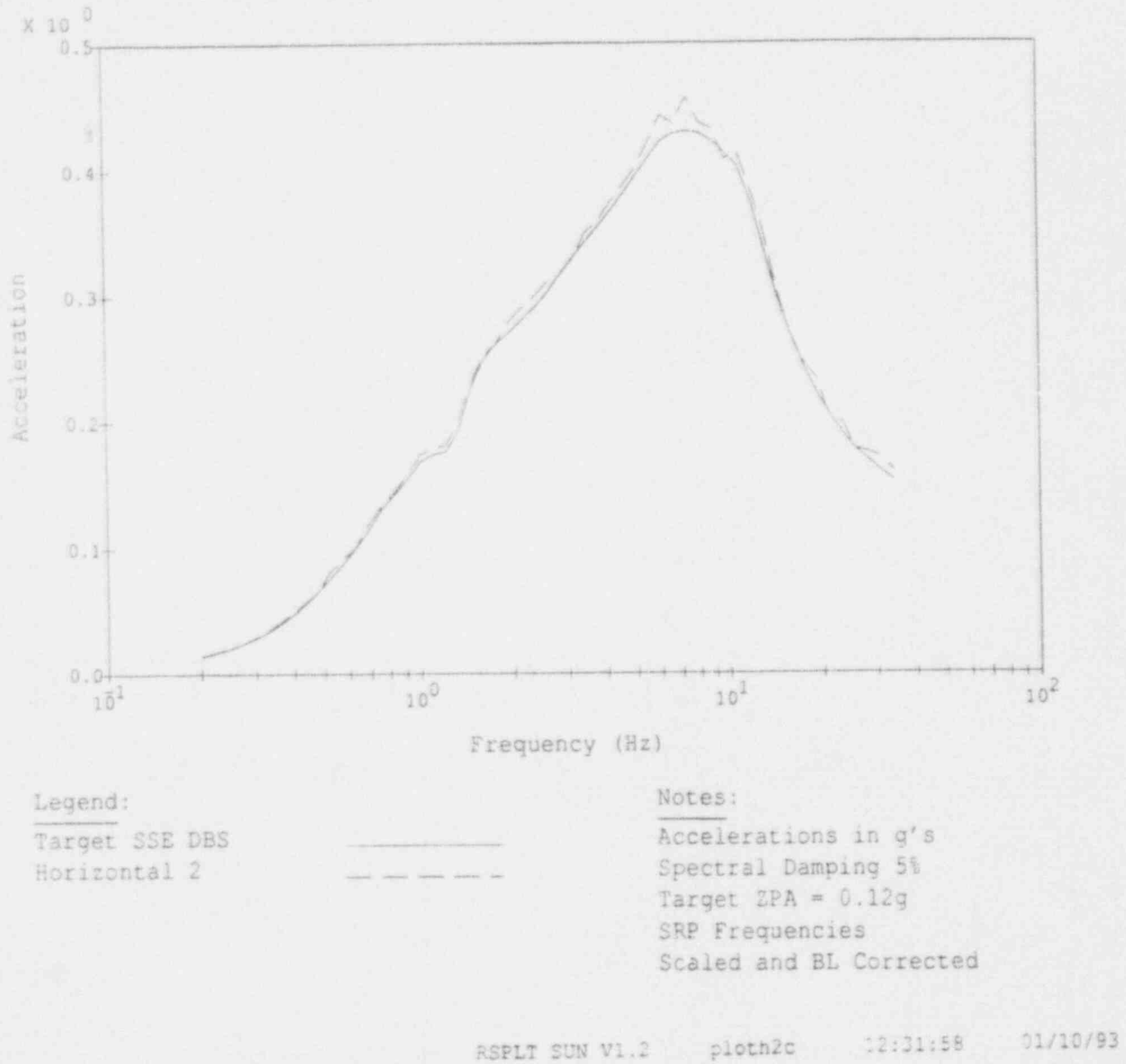
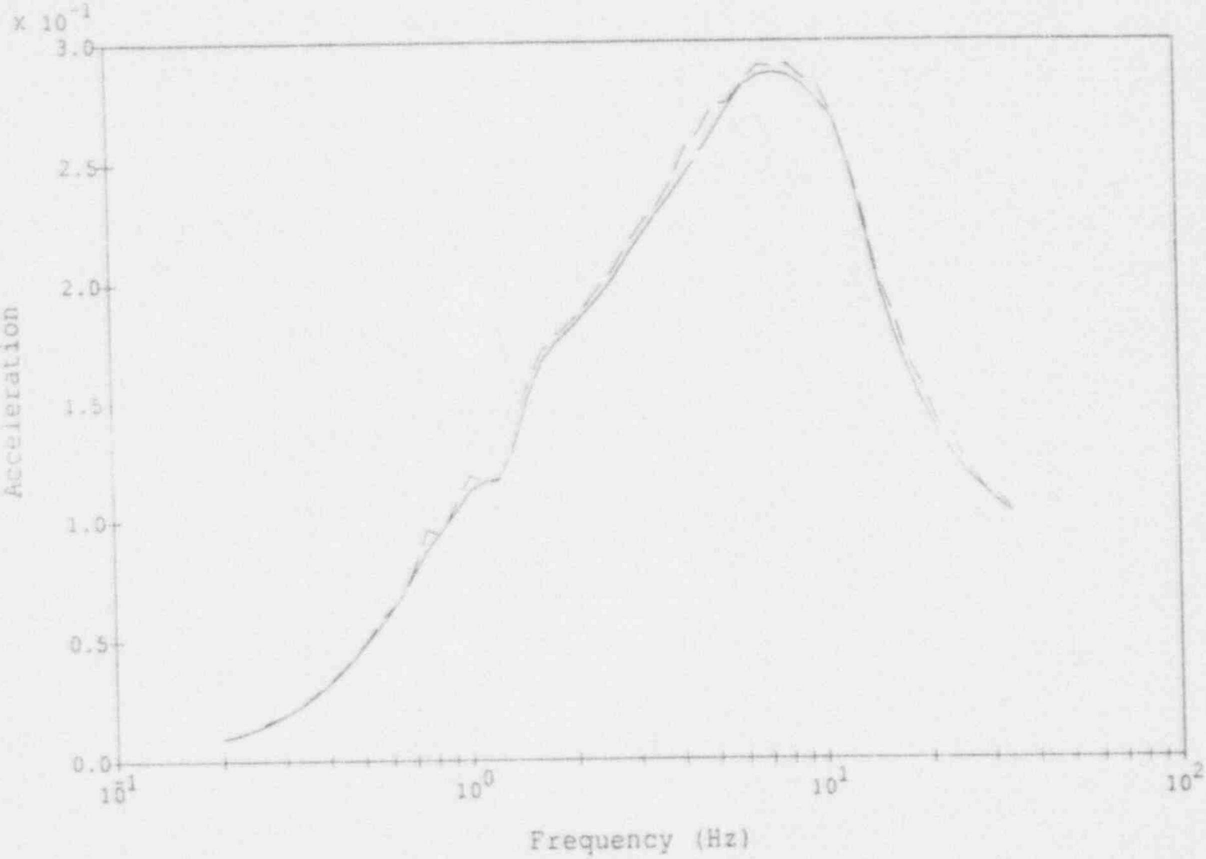


Figure 2-4: TMI-1. Comparison of time histories, Horizontal Component 2.

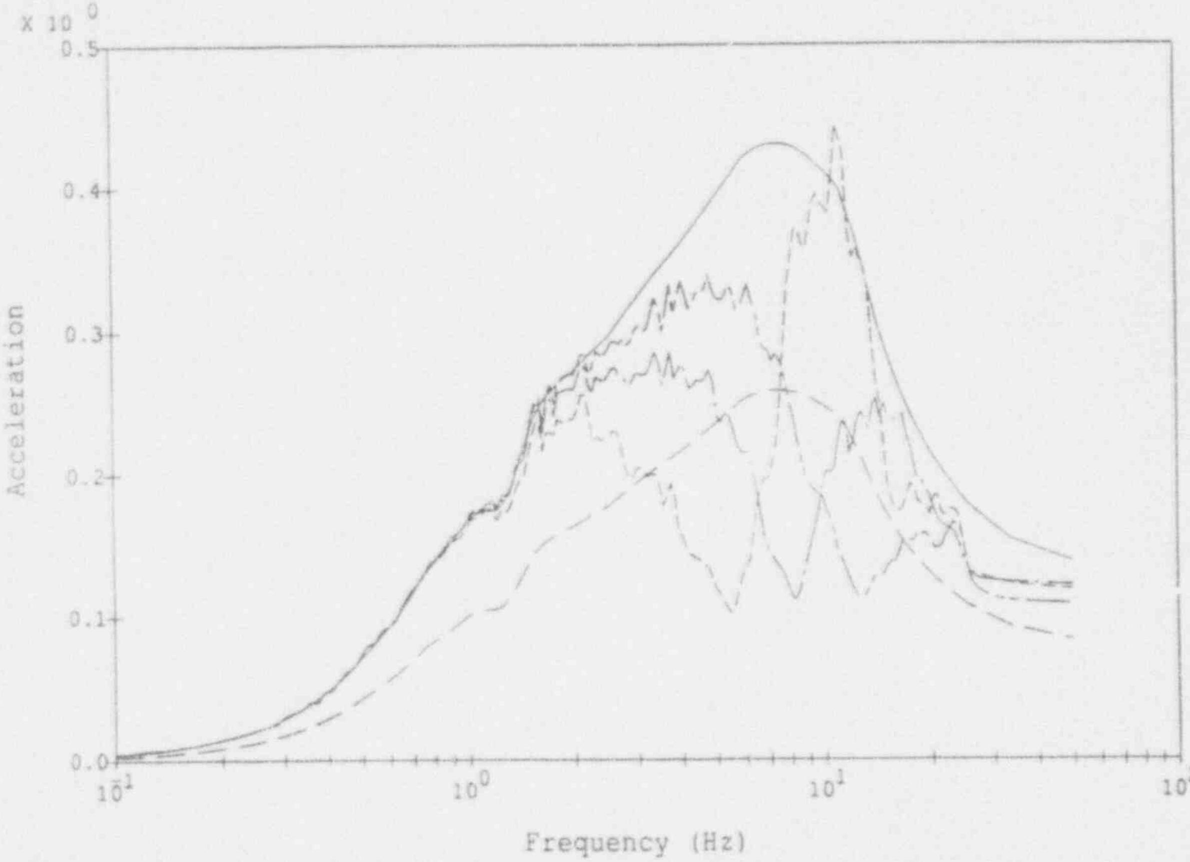


Legend:
Target SSE DBS
Vertical

Notes:
Accelerations in g's
Spectral Damping 5%
Target ZPA = 0.08g
SRP Frequencies
Scaled and BL Corrected

RSPLT SUN V1.2 plotvc 12:42:57 01/10/93

Figure 2-5: TMI-1. Comparison of time histories. Vertical Component.



Legend:

Target SSE DBS	————————
60% Target SSE DBS	— — — — —
Lower Bound Soil	- - - - - - - - -
Best	——— · ——— · ·
Upper Bound Soil	——— - - ——— - - -

Notes:

Accelerations in g's
Spectral Damping 5%
Target ZPA = 0.12g
Scaled and BL Corrected

RSPLT SUN V1.2 rscmp 08:30:31 01/12/93

Figure 2-6: Comparison of response spectra. SRP 60% requirement.

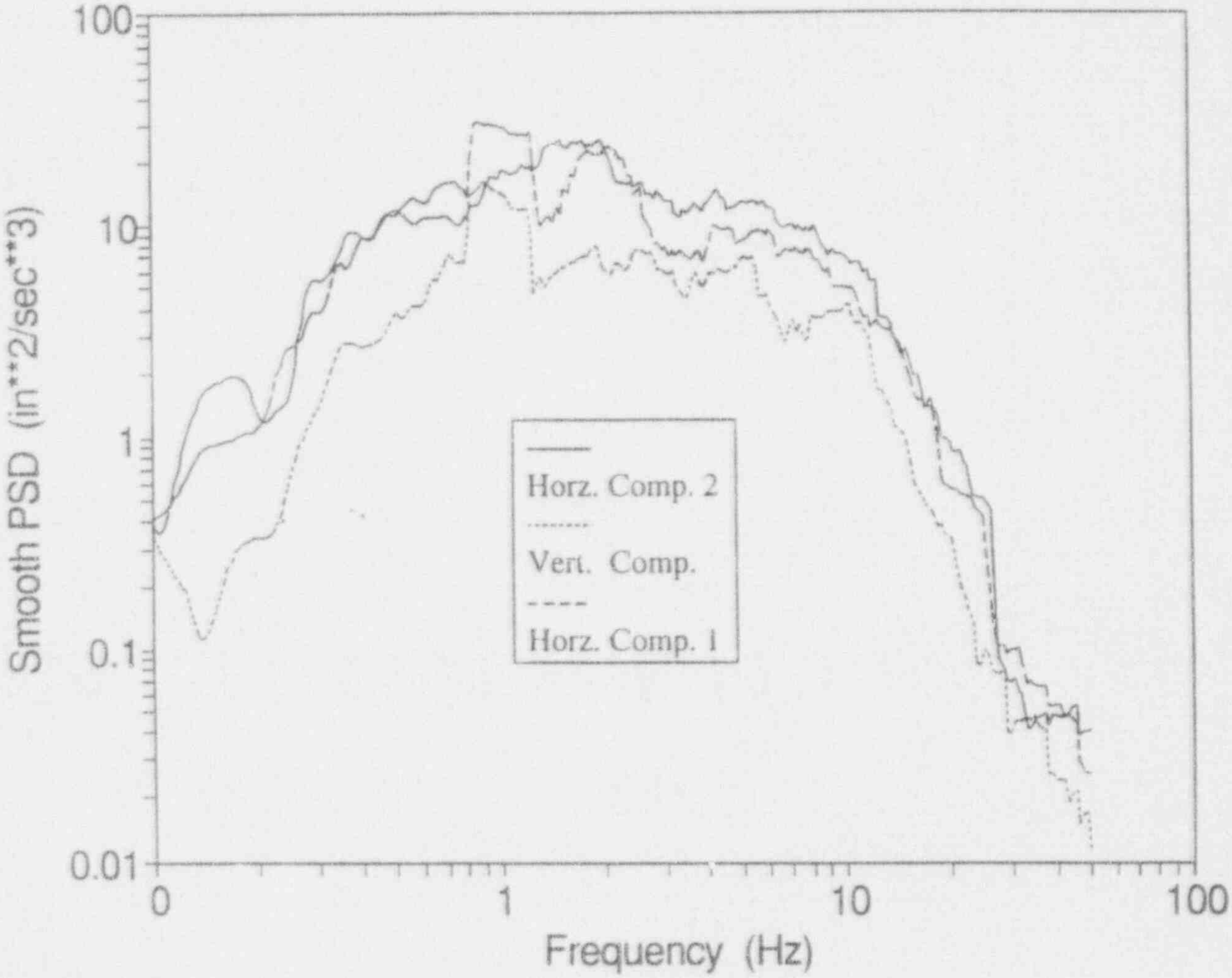


Figure 2-7: Power spectral density functions.

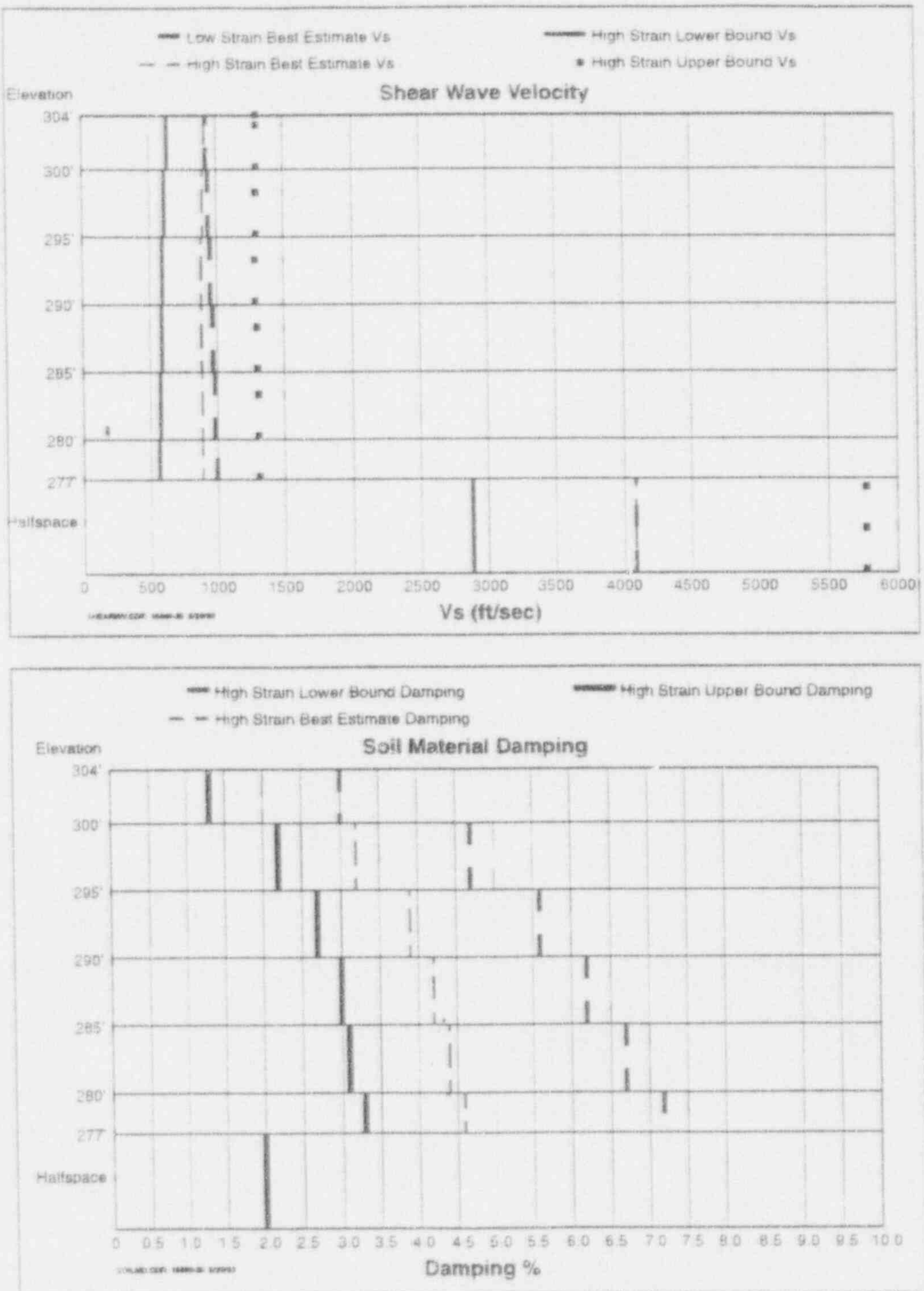


Figure 2-8: Soil profiles for SSI analysis.

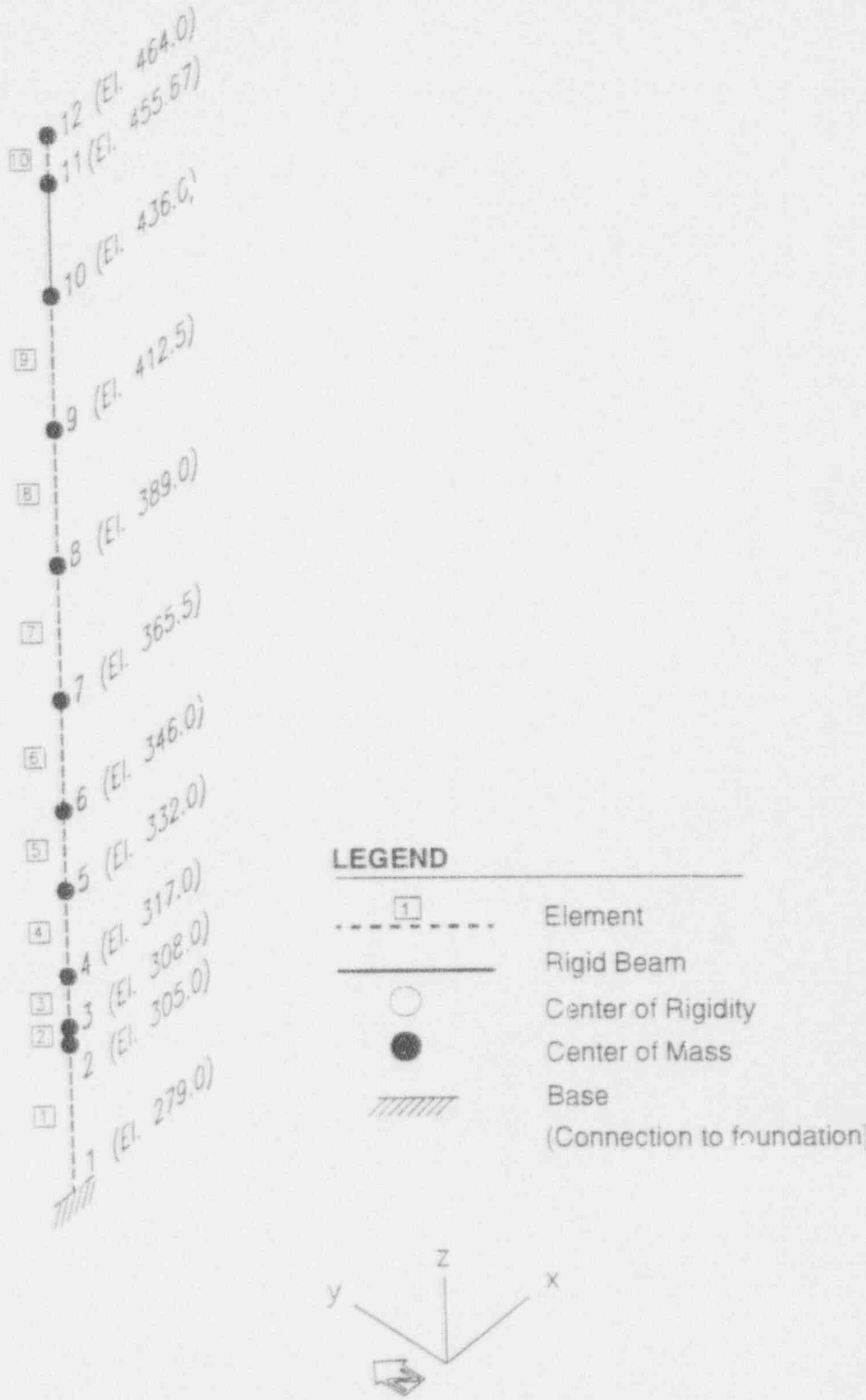


Figure 2-9a: GPUN-Three Mile Island Unit 1 - Reactor Building Shell

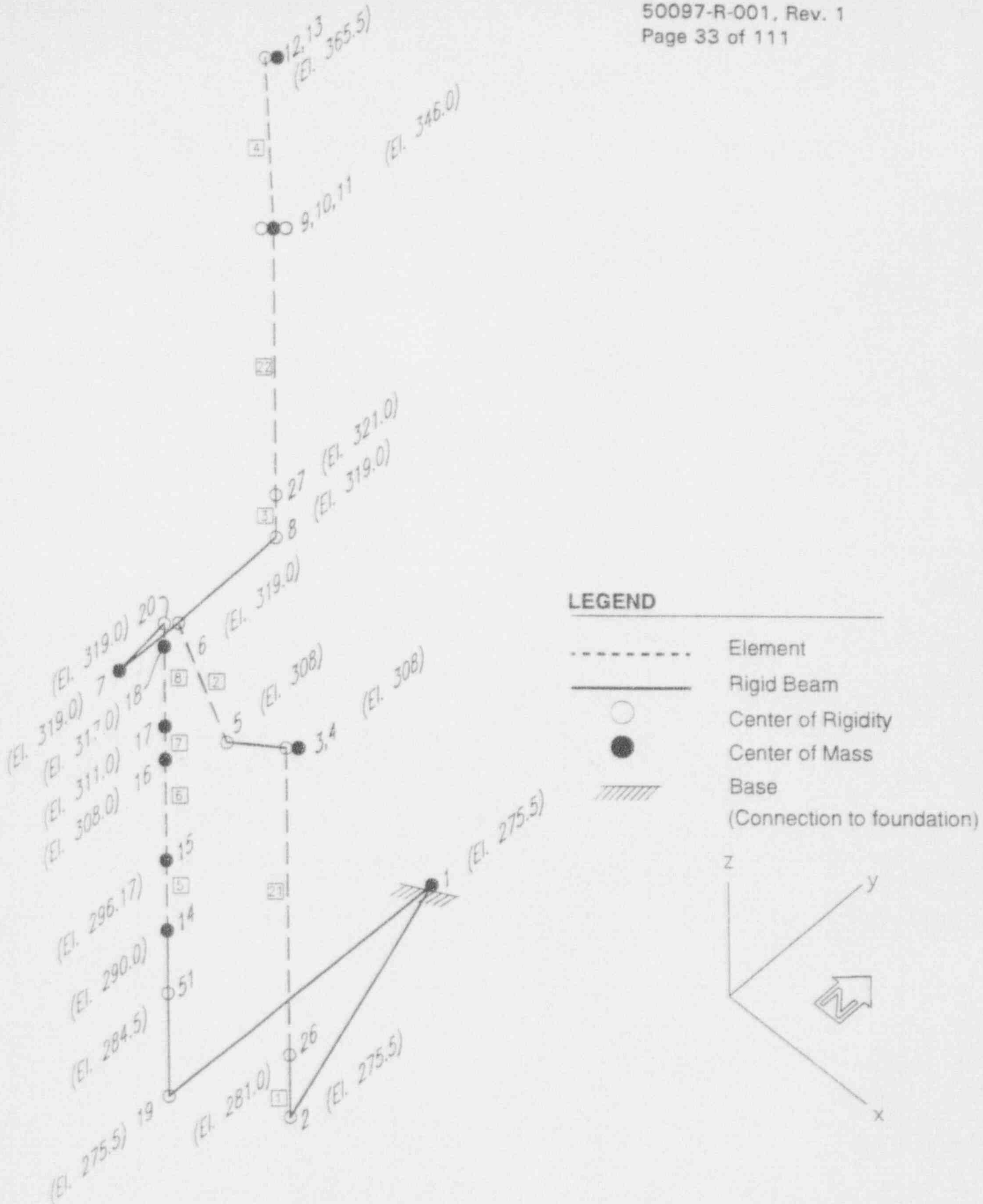


Figure 2-9b (Cont.):GPUN-Three Mile Island Unit 1 - Reactor Internal/NSSS Structure

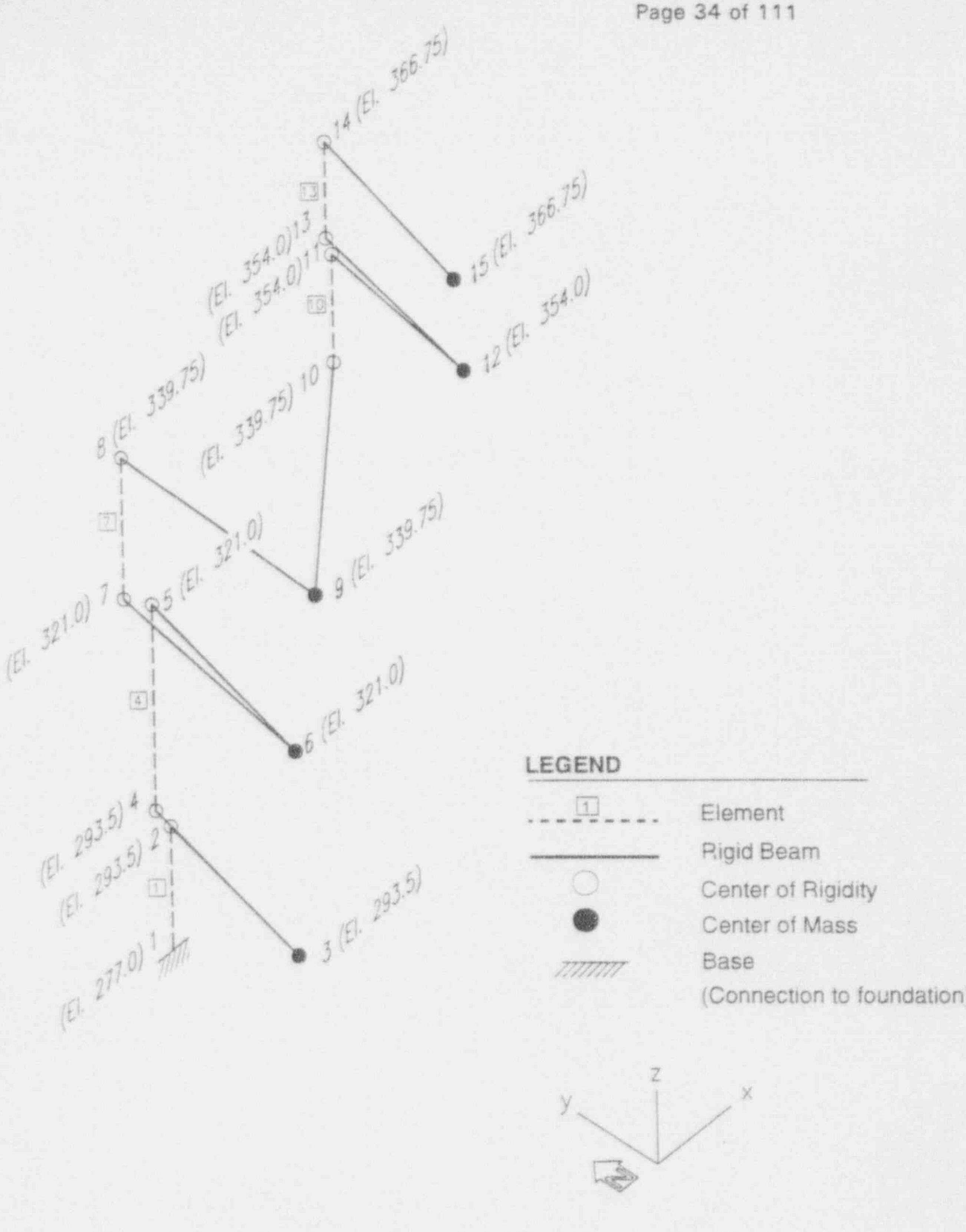


Figure 2-10: GPUN-Three Mile Island Unit 1 - Intermediate Building

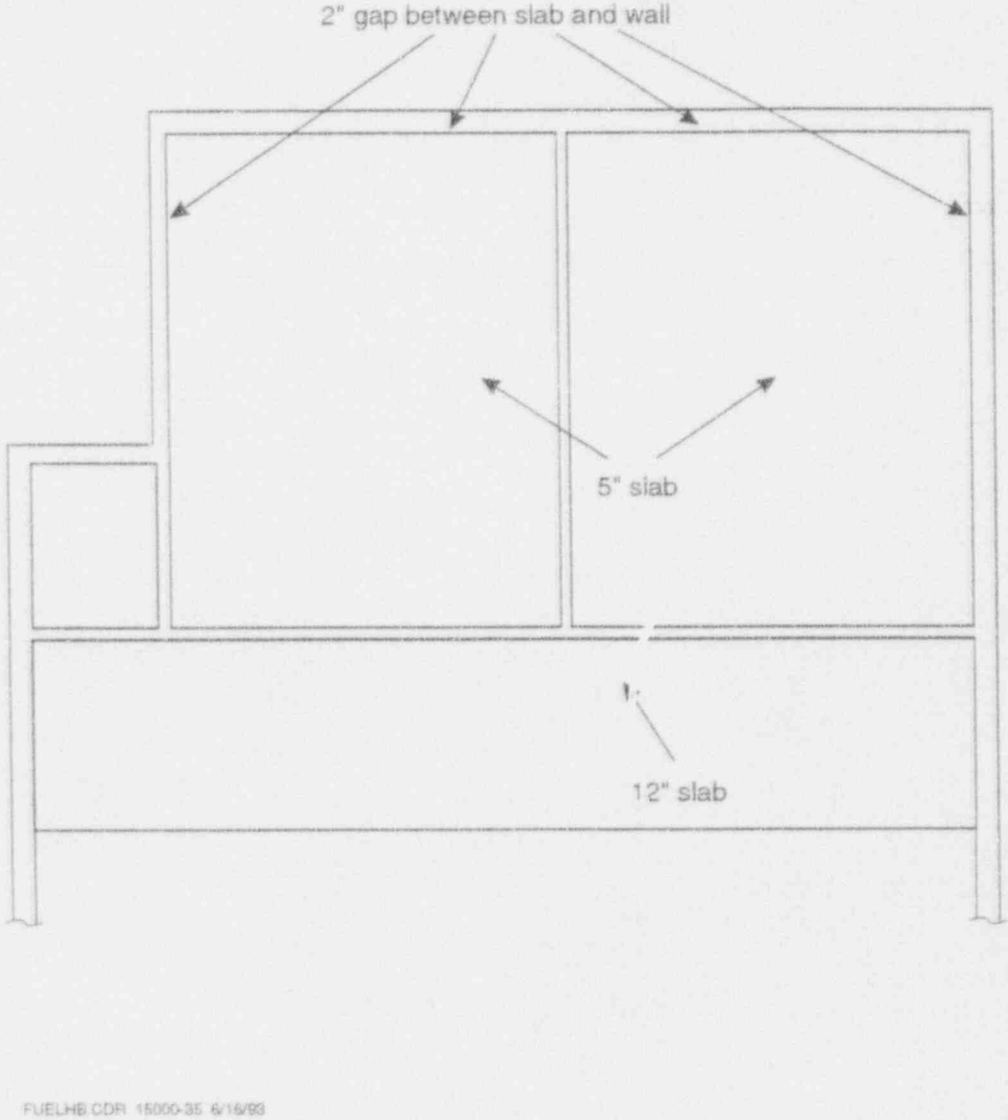


Figure 2-11: Control Room Study

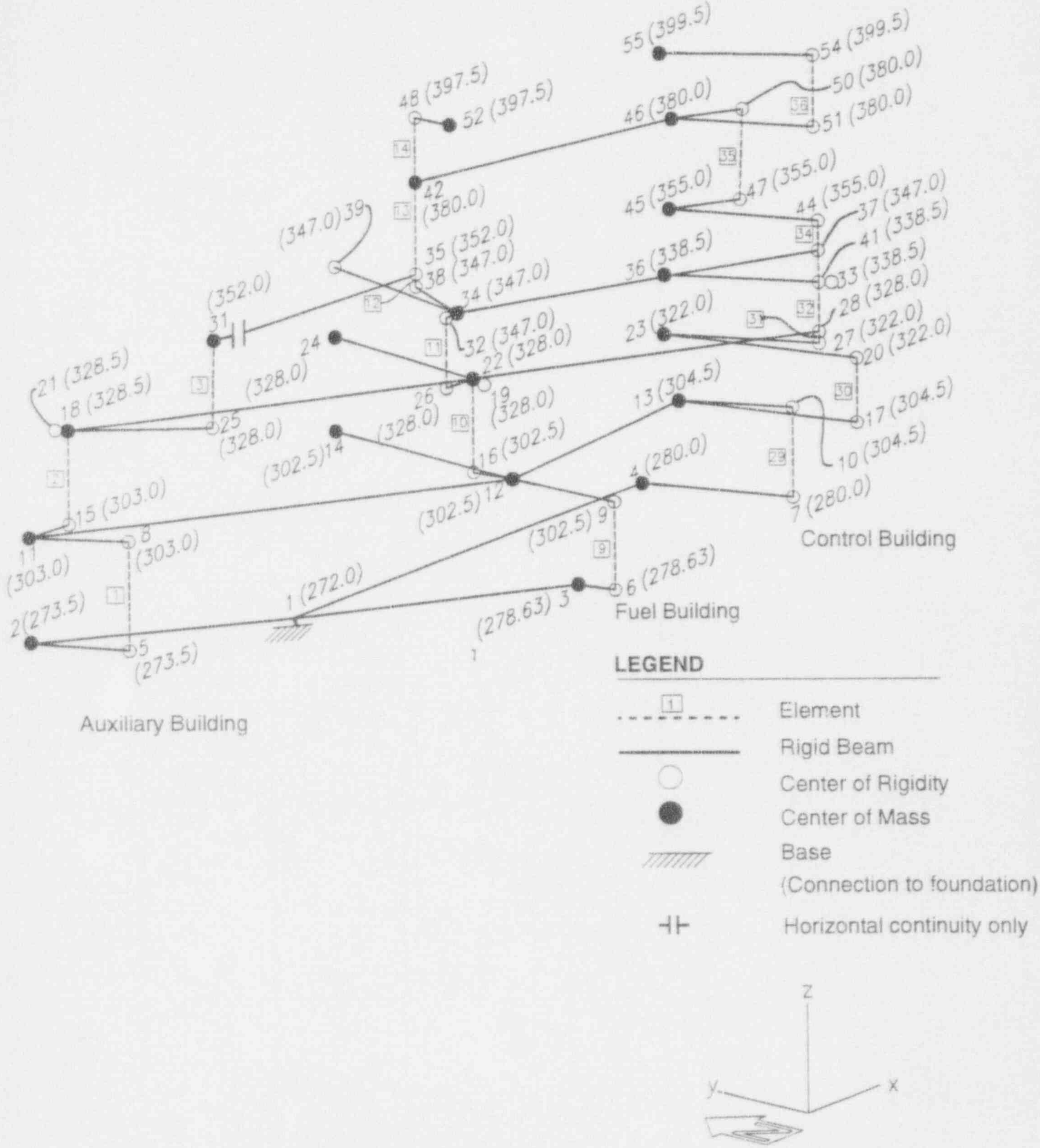


Figure 2-12: GPUN-Three Mile Island Unit 1 - Auxiliary/Fuel/Control Building

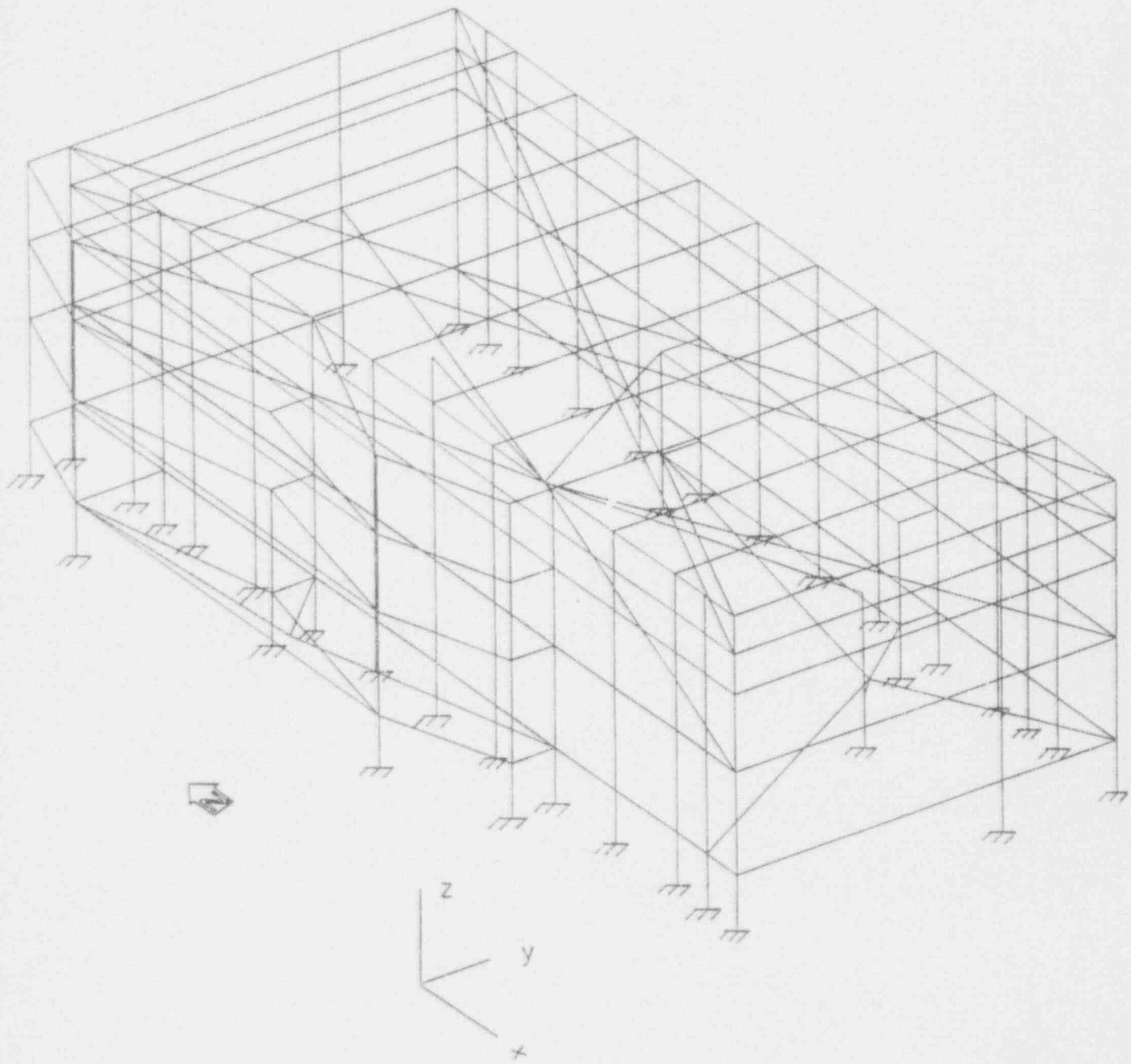


Figure 2-13: GPUN-Three Mile Island Unit 1 - Turbine Building

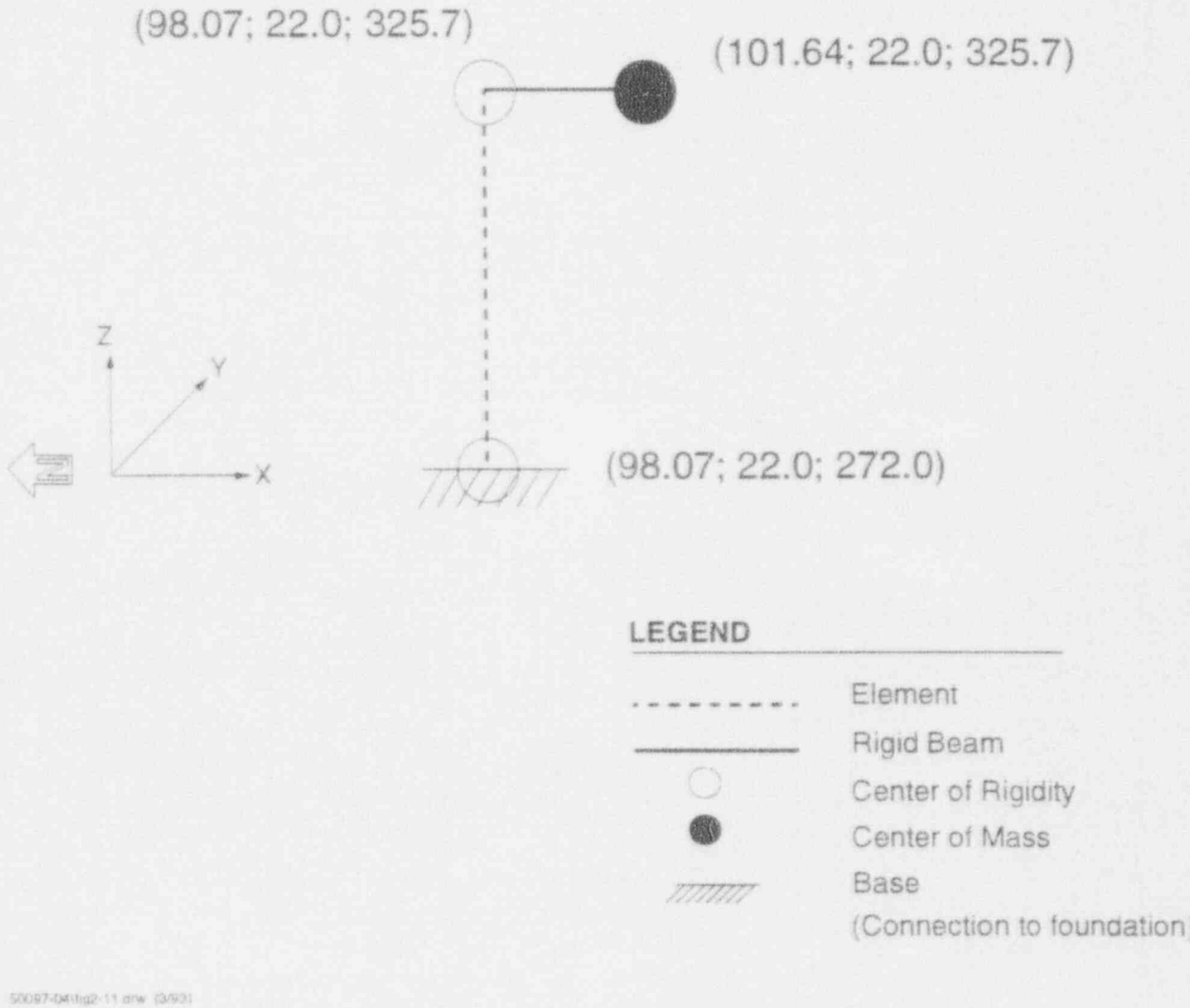


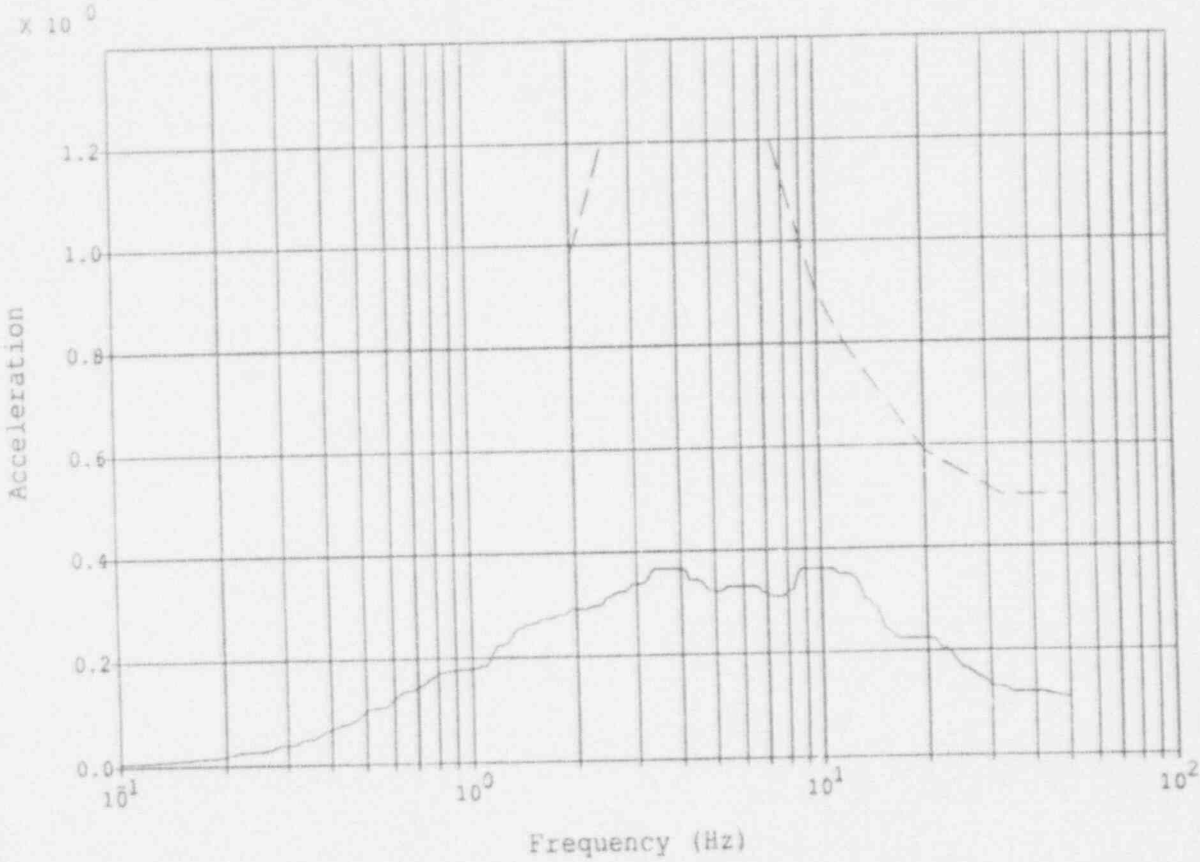
Figure 2-14: GPUN-Three Mile Island Unit 1 - Turbine Building: Concrete Pedestal

3. REPRESENTATIVE RESULTS

In this section, representative conservative design in-structure spectra for selected locations at each building and in the three orthogonal directions are shown. The spectra are shown at 5% damping, and the in-structure spectra in the horizontal directions are compared to the SQUG bounding spectrum multiplied by 1.5. Figures 3-1 to 3-12 show the in-structure spectra in the Reactor Shell and Figs. 3-13 to 3-24 in the Internal Structure. Figures 3-25 to 3-33 show the spectra in the Intermediate Building. Figures 3-34 to 3-39 in the Auxiliary Building, Figs. 3-40 to 3-48 in the Fuel Handling Building, and Figs. 3-49 to 3-57 in the Control Building. Figures 3-58 to 3-68 show the spectra in the Turbine Building, and Figs. 3-69 to 3-71 in the Turbine Pedestal.

In these figures, the terms LB, UB, and BE refer to the lower-bound, upper-bound, and best estimate soil cases, respectively.

The results presented here are based on the calculations performed in Ref. 12.



Legend:

Enveloped In-Struct.
Response Spectrum ————————

1.5 times SOUG
Bounding Spectrum — — — — —

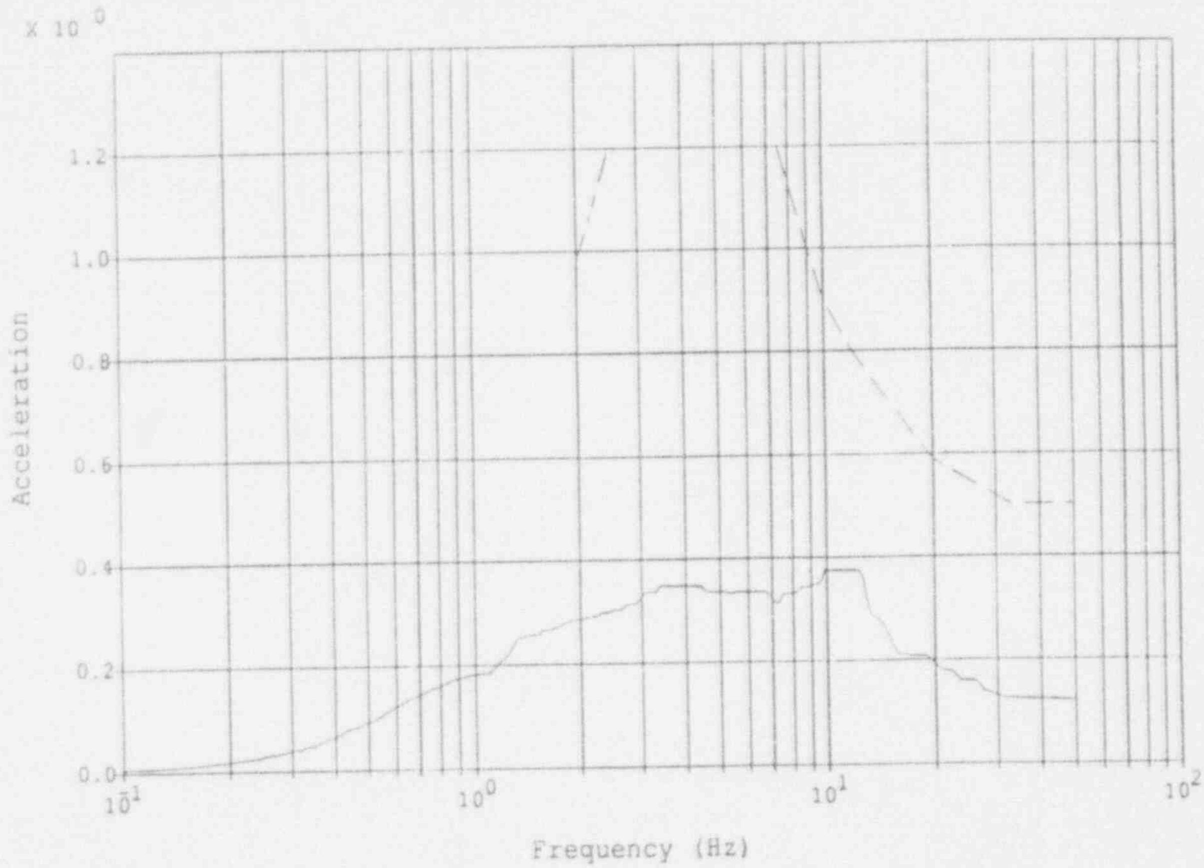
Notes:

LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Foundation, Elev. 270', Translation in EW Direction

RSPLT SUN V1.2 efndx.plt 09:19:35 03/16/93

Figure 3-1



Legend:

Enveloped In-Struct. Response Spectrum ————————

1.5 times SQUG Bounding Spectrum — — — — — —

Notes:

LB & UB Broadened 10%

BE Broadened 15%

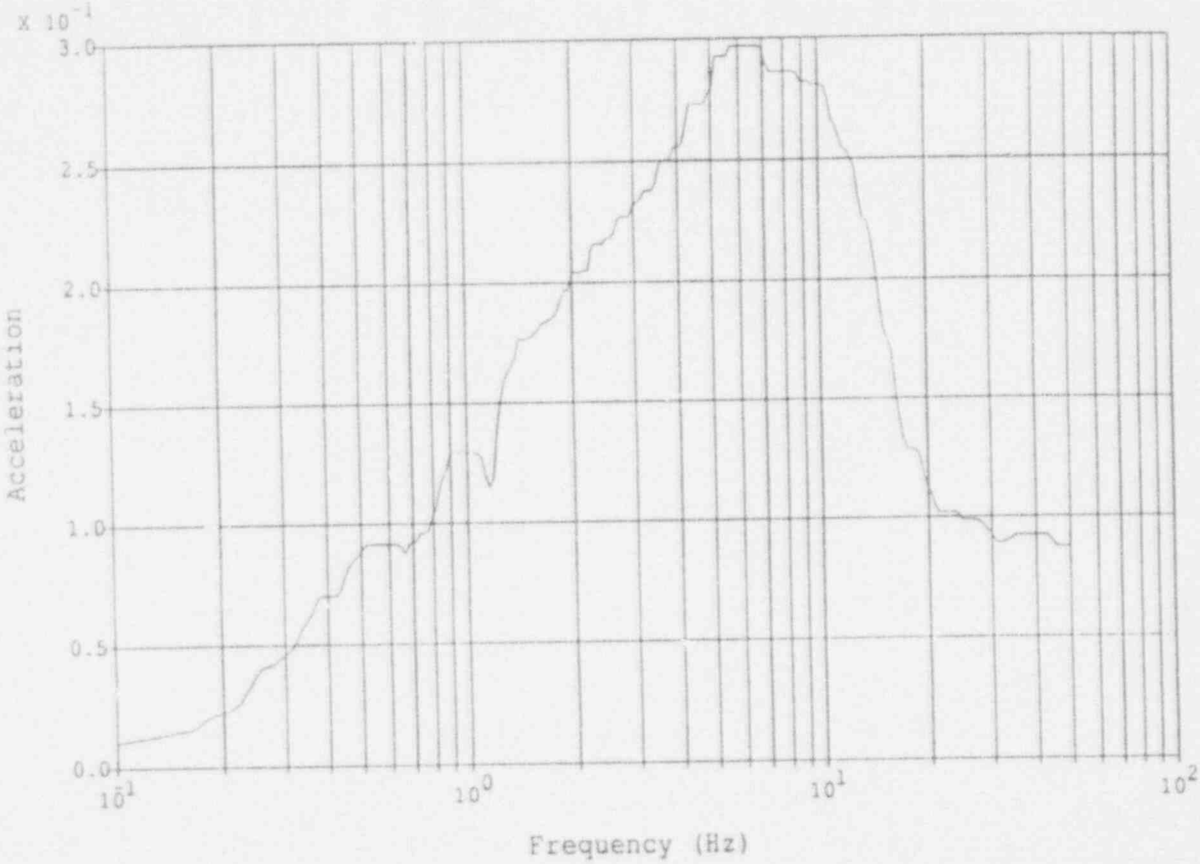
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Foundation, Elev. 270', Translation in NS Direction

RSPLT SUN V1.2 efndv.plt 09:19:35 03/16/93

Figure 3-2



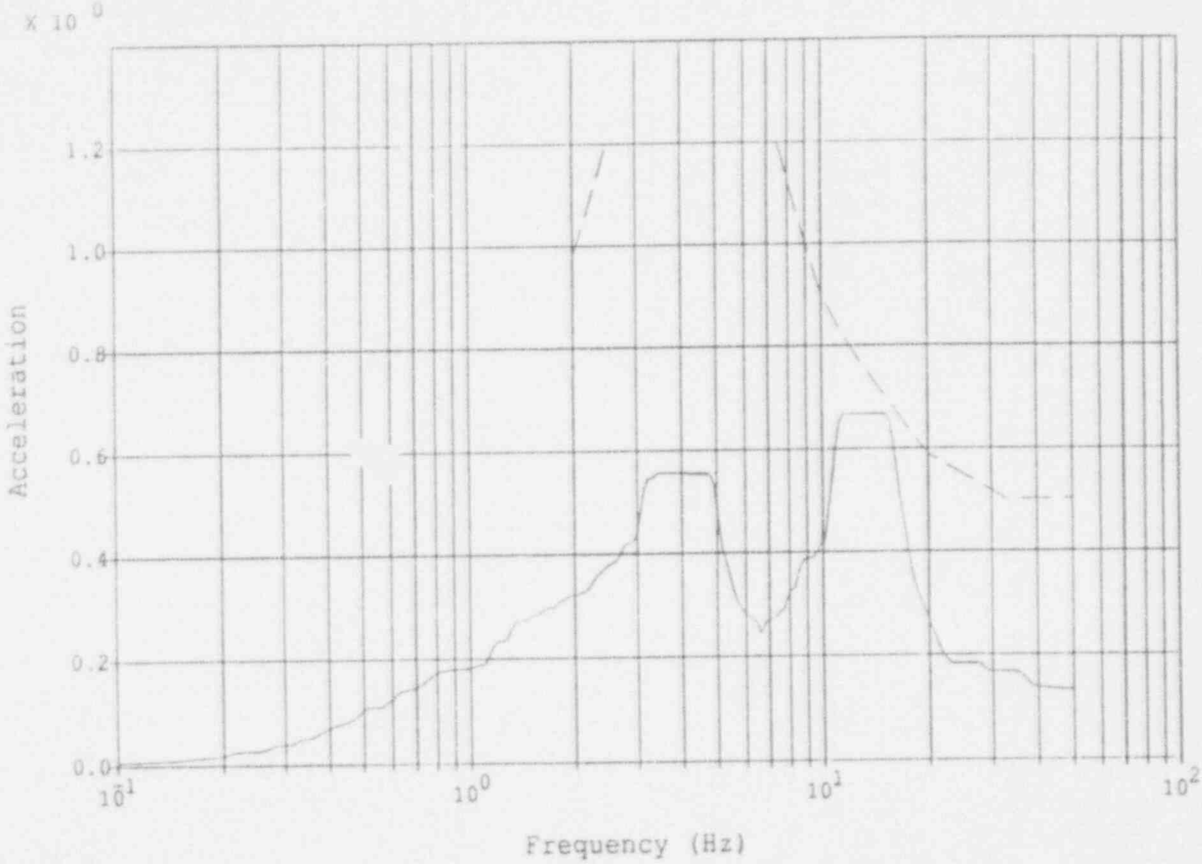
Notes:

Enveloped In-Strcuture Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Foundation, Elev. 270', Translation in Vertical Direction

RSPLT SUN V1.2 efndz.plt 09:19:35 03/16/93

Figure 3-3



Legend:

Enveloped In-Struct. Response Spectrum ————

1.5 times SQUG Bounding Spectrum — — — —

Notes:

LB & UB Broadened 10%

BE Broadened 15%

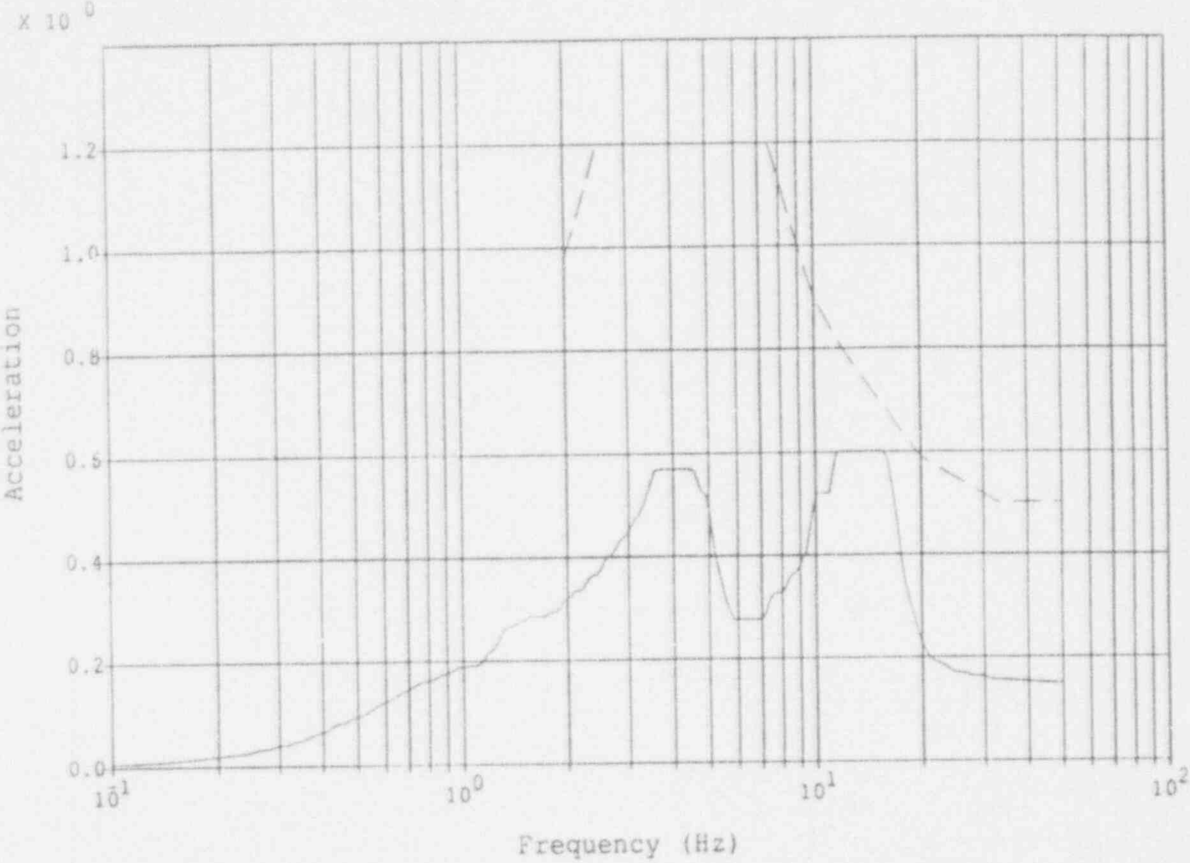
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Exterior Shell, Elev. 317'-0", Translation in EW Direction

RSPLT SUN V1.2 es105x.plt 09:19:47 03/16/93

Figure 3-4



Legend:

Enveloped In-Struct. Response Spectrum ————

1.5 times SQUG Bounding Spectrum — — — —

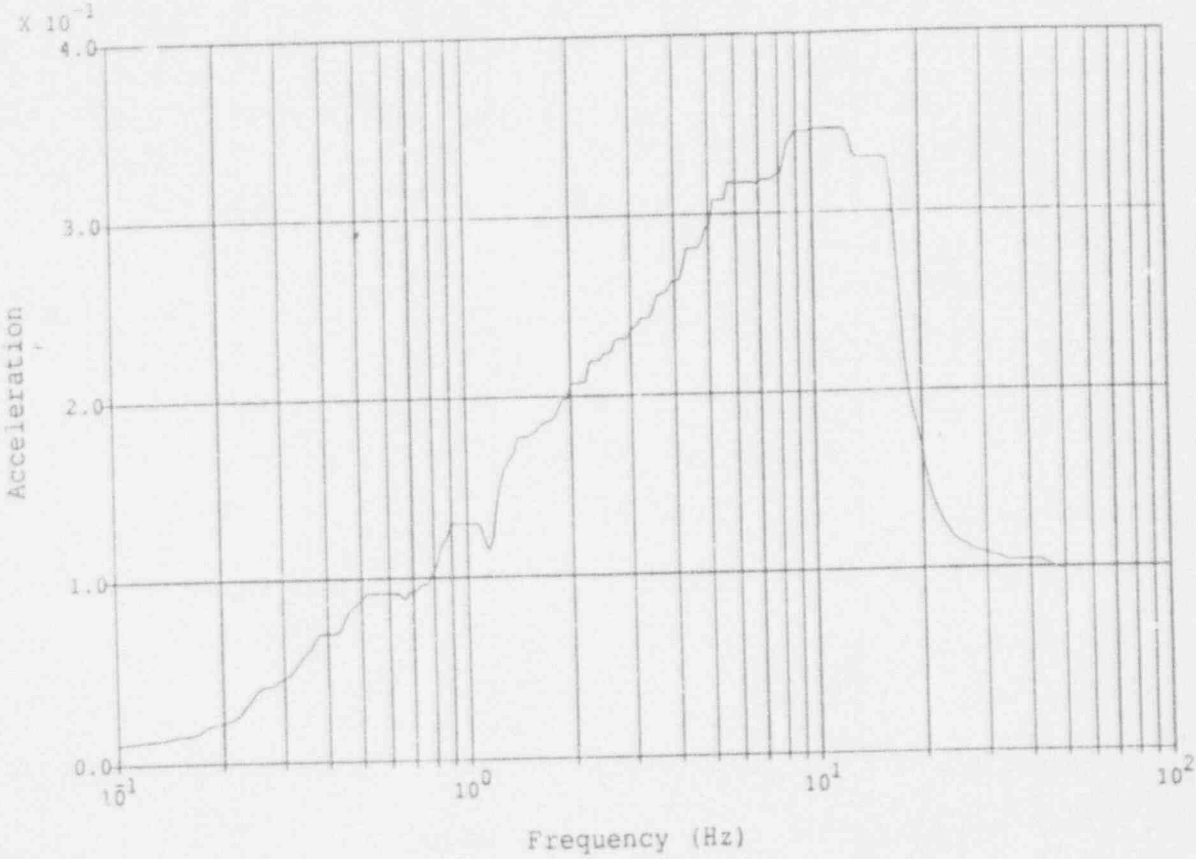
Notes:

LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Exterior Shell, Elev. 317'-0", Translation in NS Direction

RSPLT SUN V1.2 es105y.plt 13:19:47 03/16/93

Figure 3-5



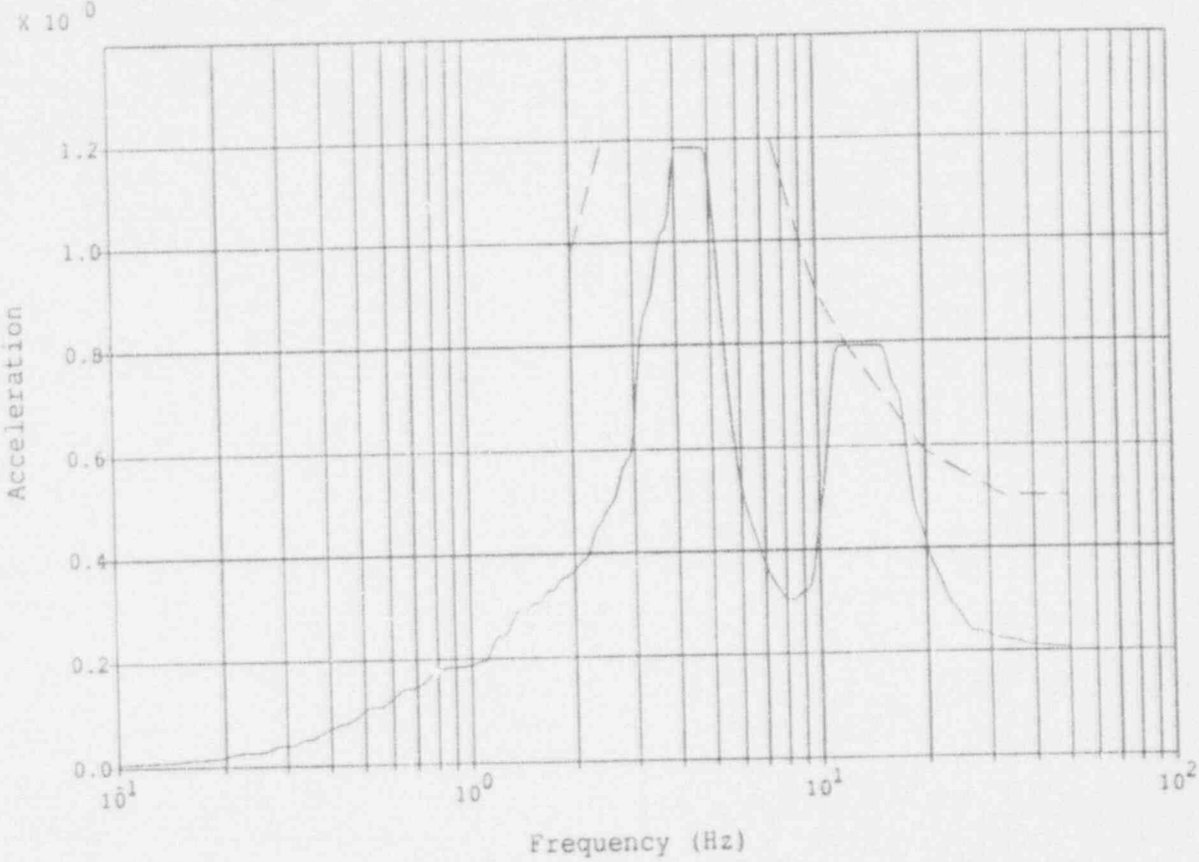
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Exterior Shell, Elev. 317'-0", Translation in Vertical Direction

RSPLT SUN V1.2 es105z.plt 03:19:47 03/16/93

Figure 3-6



Legend:

Enveloped In-Struct. Response Spectrum

1.5 times SQUG Bounding Spectrum

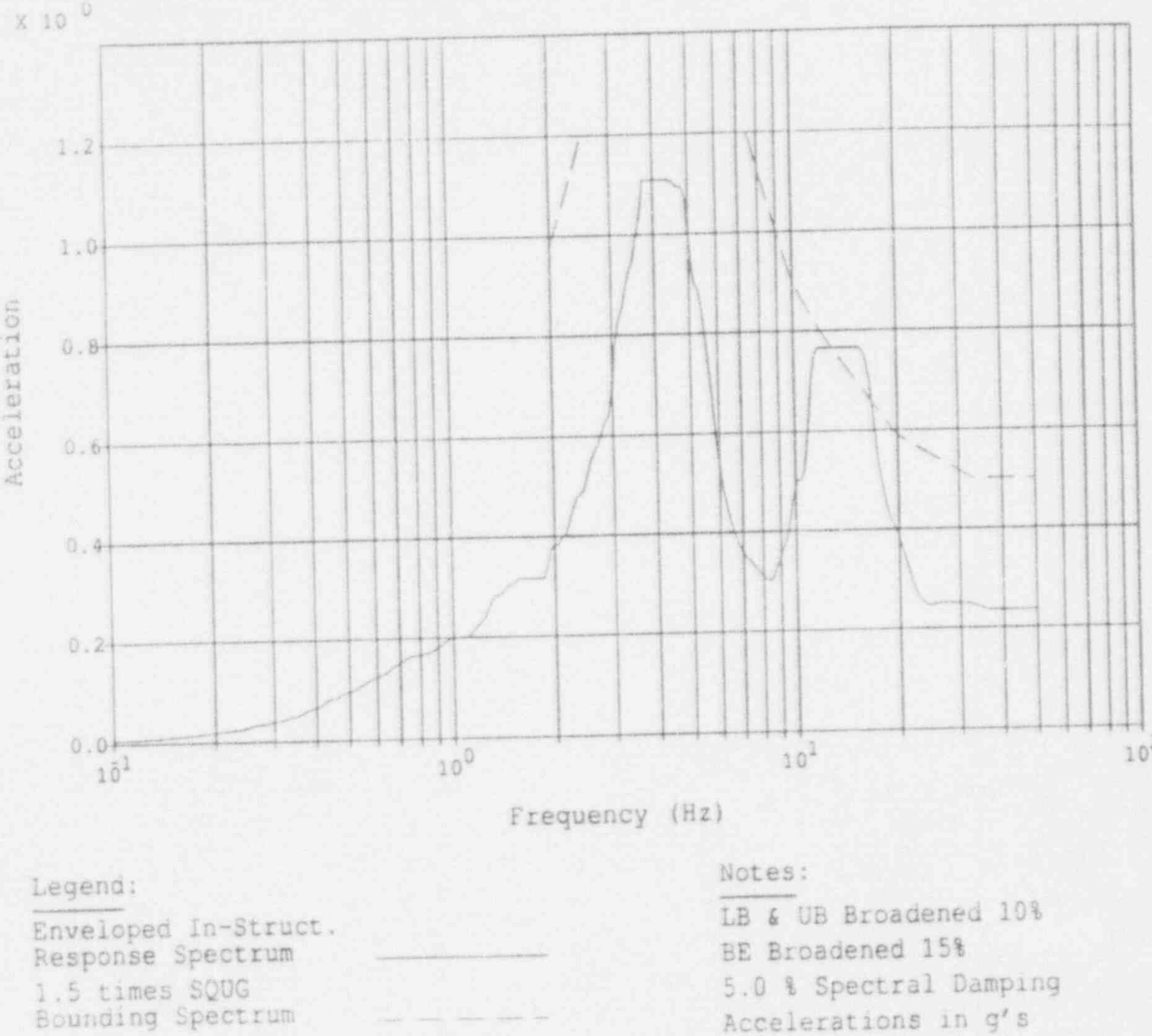
Notes:

LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Exterior Shell, Elev. 365'-6", Translation in EW Direction

RSPLT SUN V1.2 es108x.plt 19:19:55 15/16/93

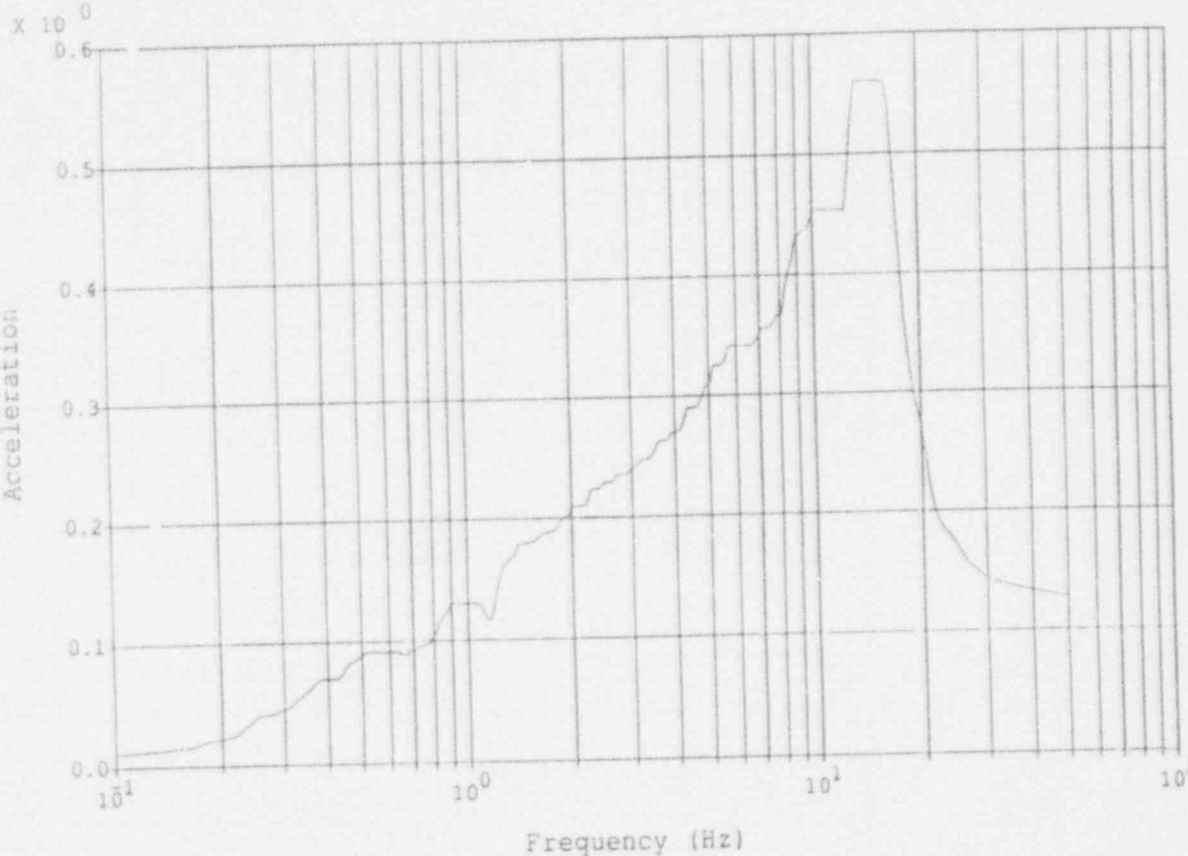
Figure 3-7



GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Exterior Shell, Elev. 365'-6", Translation in NS Direction

RSPLT SUN V1.2 es108y.plt 13:19:55 03/16/93

Figure 3-8



Notes:

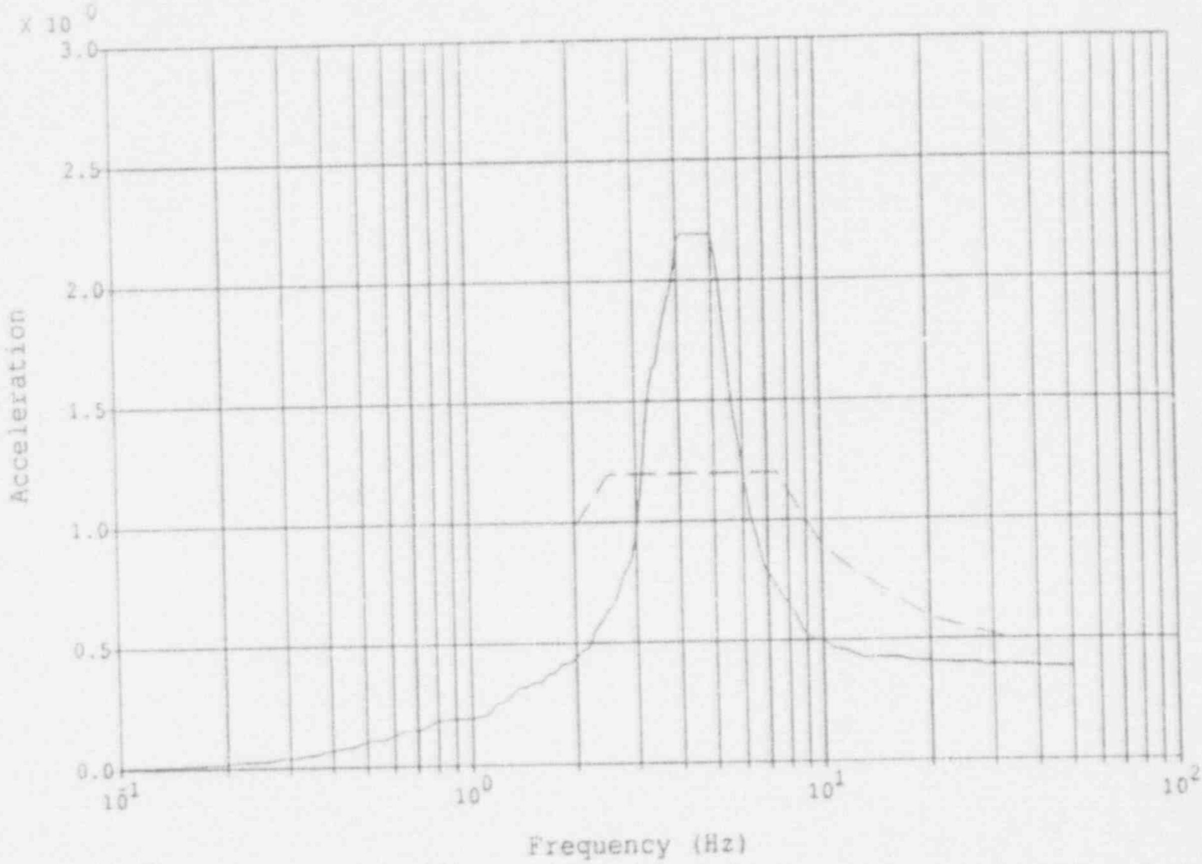
Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Exterior Shell, Elev. 365'-6", Translation in Vertical Direction

RSPLT SUN V1.2 es108z.plt 19:19:55 03/16/93

Figure 3-9

EQE



Legend:

Enveloped In-Struct. Response Spectrum ————————

1.5 times SQUG Bounding Spectrum — — — — —

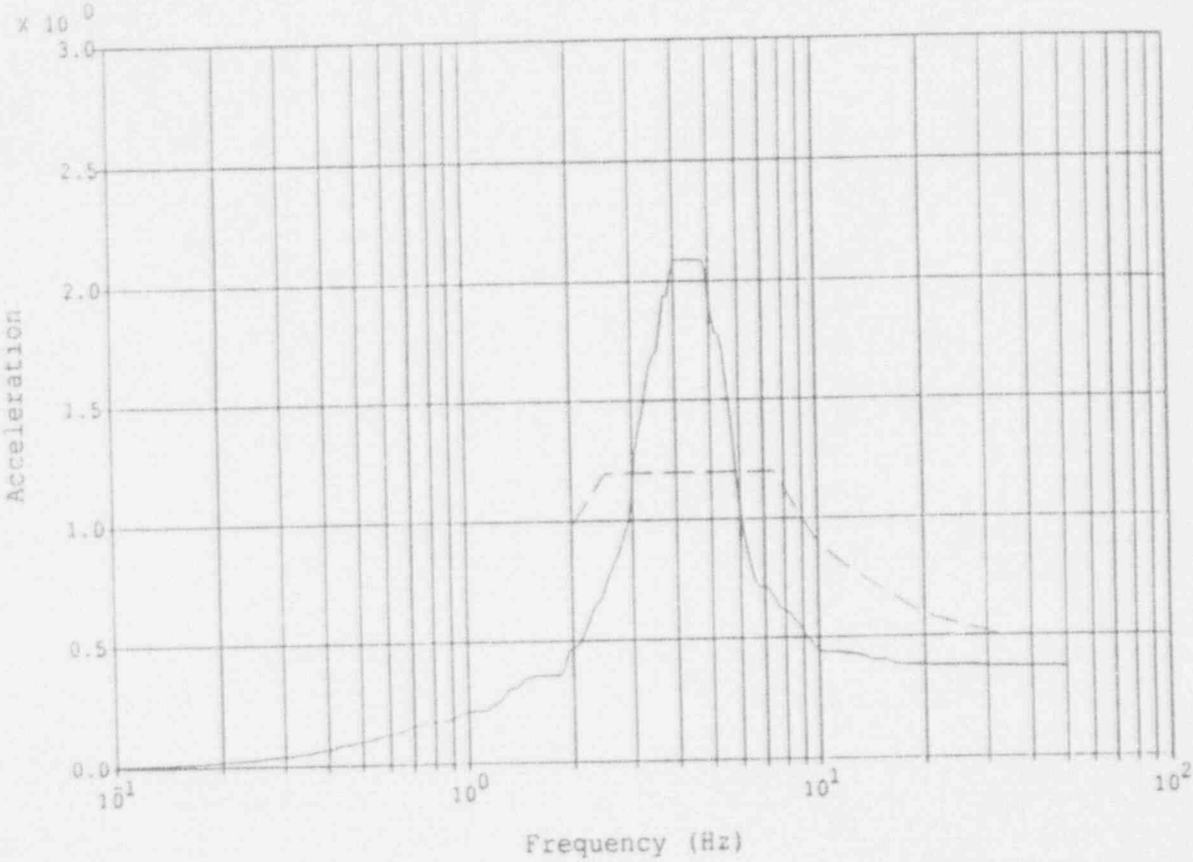
Notes:

LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Exterior Shell, Crane, Elev. 436'-0", Translation in EW Direction

RSPLT SUN V1.2 esl11x.plt 09:20:04 03/16/93

Figure 3-10



Legend:

Enveloped In-Struct. Response Spectrum ————

1.5 times SQUG Bounding Spectrum — — —

Notes:

LB & UB Broadened 10%

BE Broadened 15%

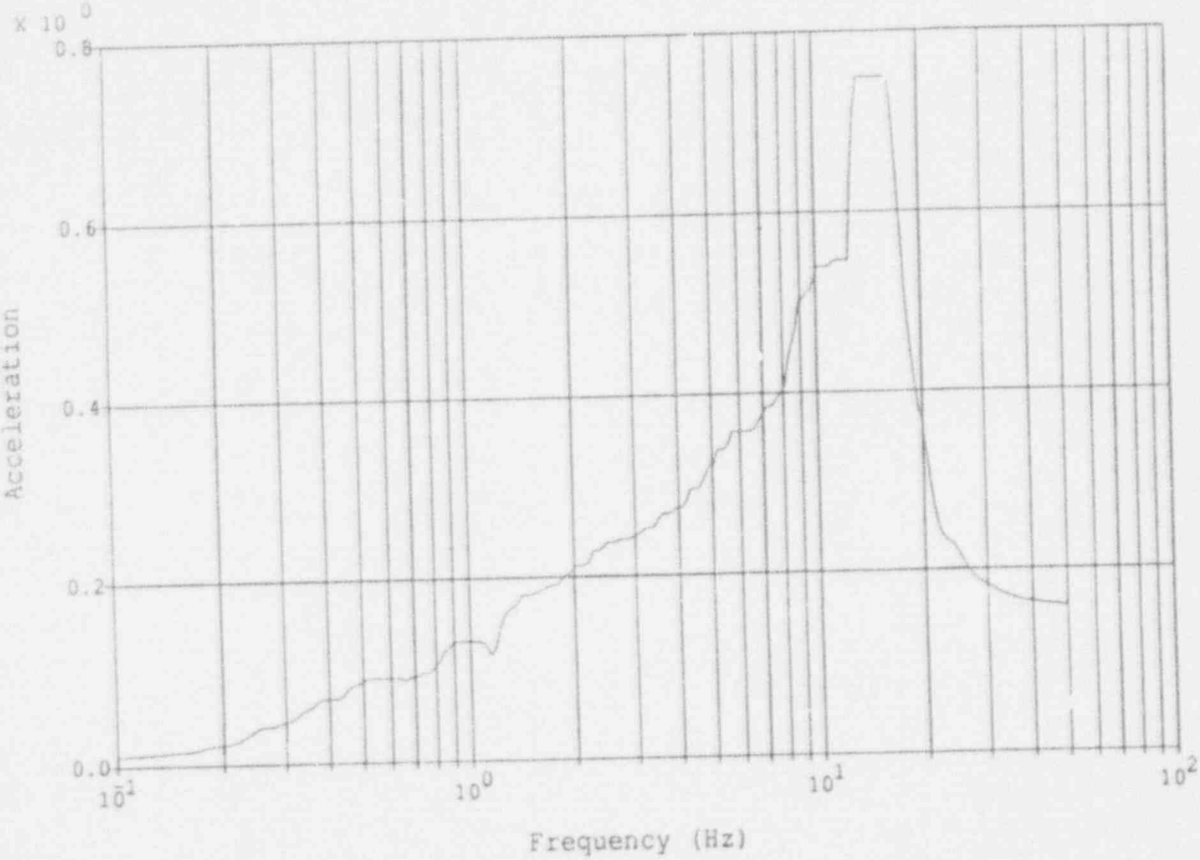
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Exterior Shell, Crane, Elev. 436'-0", Translation in NS Direction

RSPLT SUN V1.2 esilly.plt 13:20:04 03/16/93

Figure 3-11

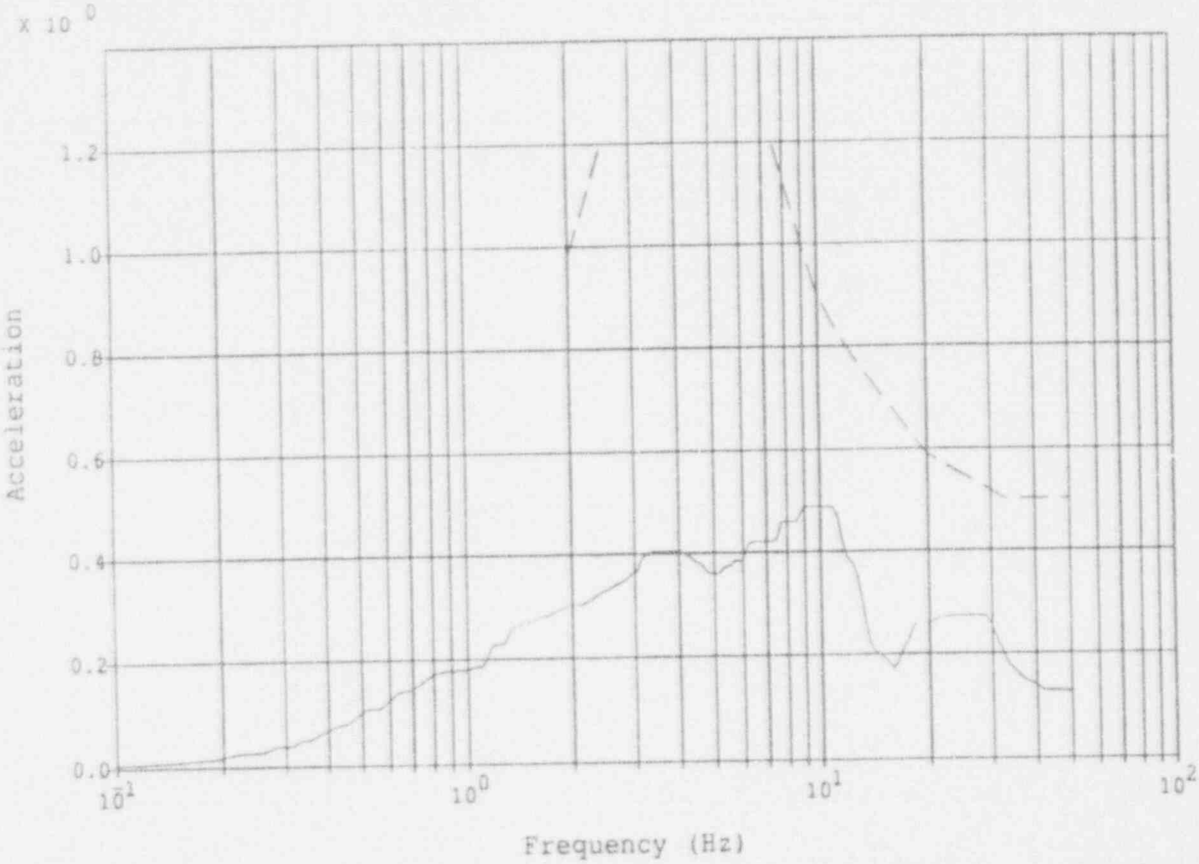


Notes:
Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Exterior Shell, Crane, Elev. 436'-0", Translation in Vertical Direction

RSPLT SUN V1.2 eslllz.plt 09:20:04 03/16/93

Figure 3-12



Legend:

Enveloped In-Struct. Response Spectrum ————————

1.5 times SQUG Bounding Spectrum — — — — —

Notes:

LB & UB Broadened 10%

BE Broadened 15%

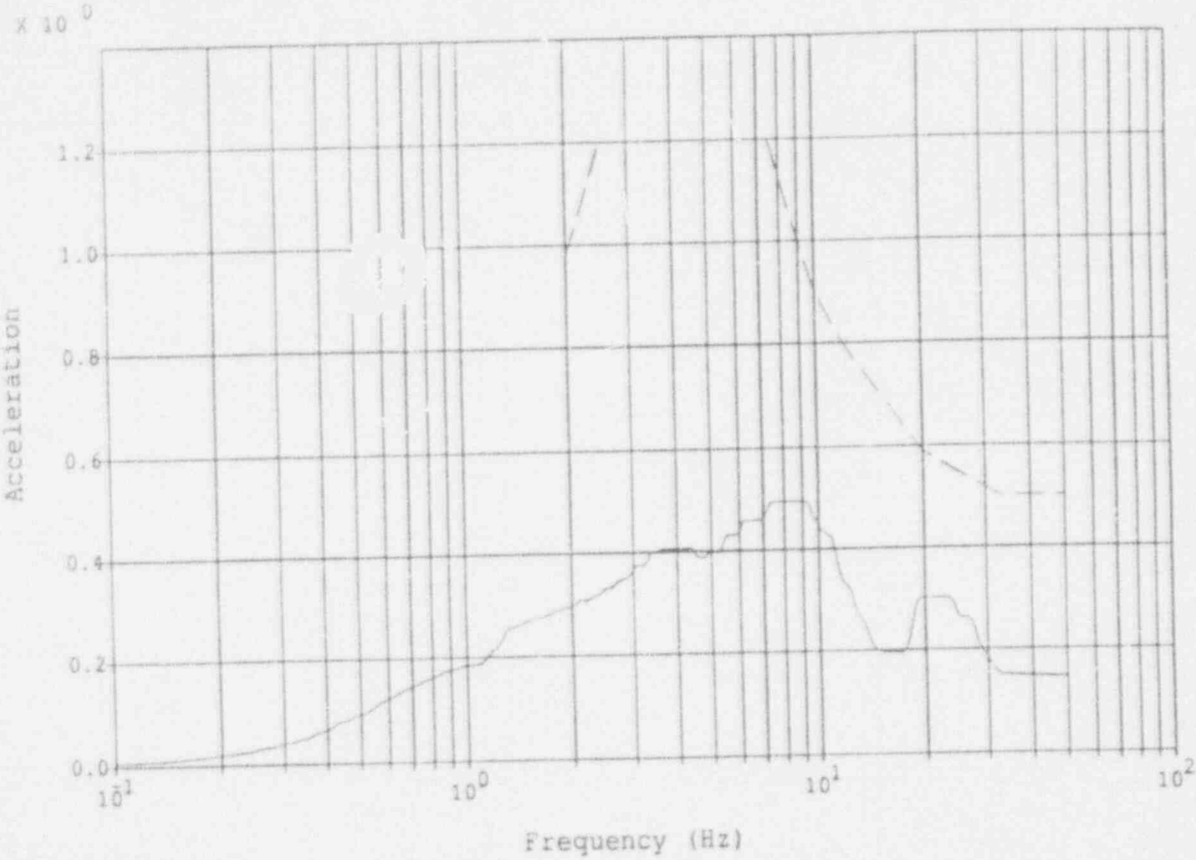
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Internal Structure, Elev. 308'-0", Translation in EW Direction

RSPLT SUN V1.2 es204x.plt 09:20:16 03/16/93

Figure 3-13



Legend:

Enveloped In-Struct. Response Spectrum ————

1.5 times SQUG Bounding Spectrum — — — —

Notes:

LB & UB Broadened 10%

BE Broadened 15%

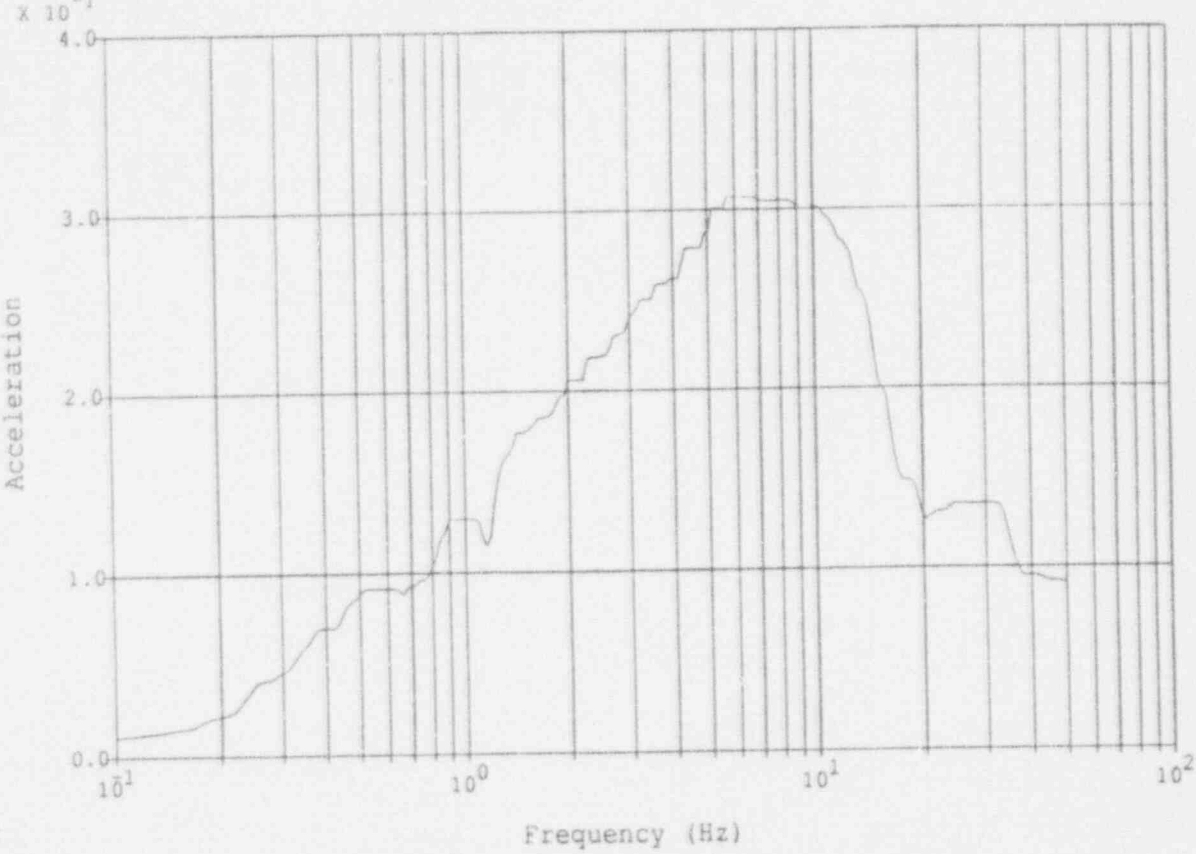
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Internal Structure, Elev. 308'-0", Translation in NS Direction

RSPLT SUN V1.2 es204v.plt 09:20:16 03/16/93

Figure 3-14



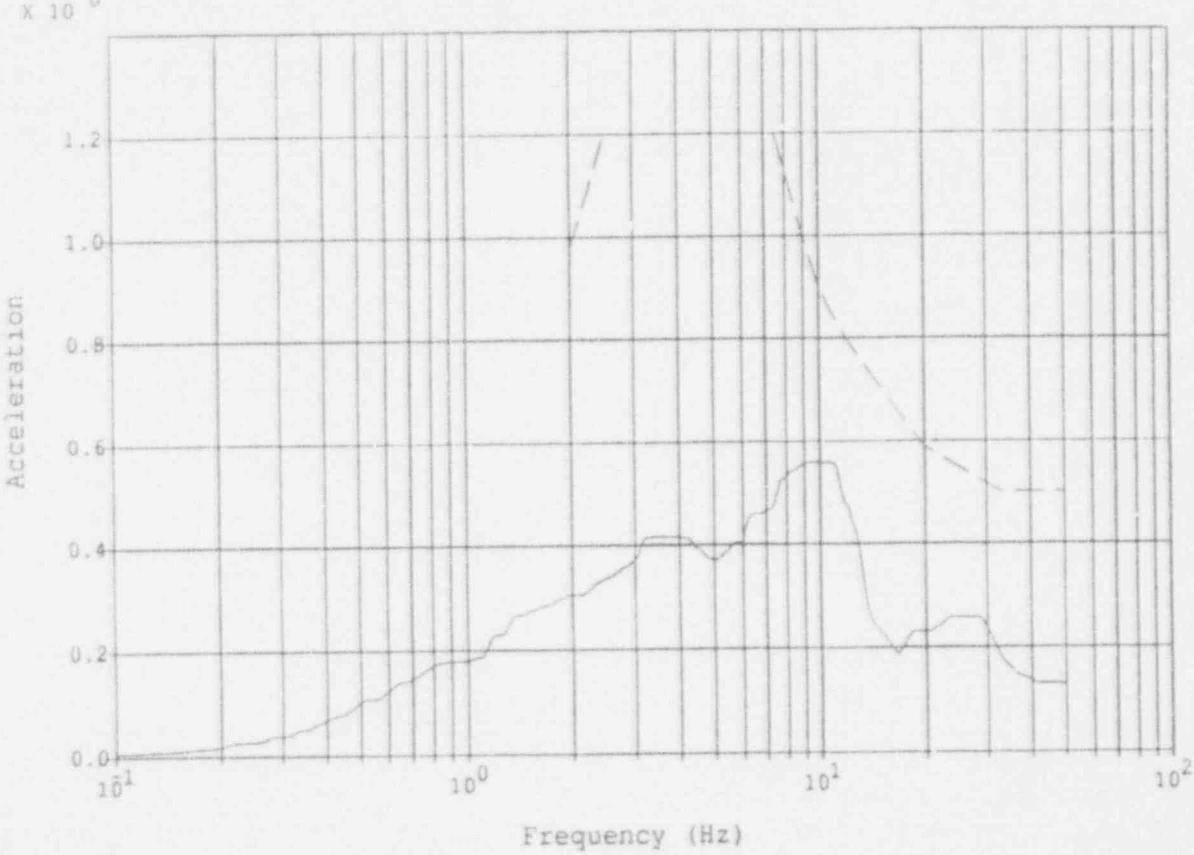
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Internal Structure, Elev. 308'-0", Translation in Vertical Direction

RSPLT SUN V1.2 es204z.plt 09:20:16 03/16/93

Figure 3-15



Legend:

Enveloped In-Struct. Response Spectrum ————

1.5 times SQUG Bounding Spectrum — — — — —

Notes:

LB & UB Broadened 10%

BE Broadened 15%

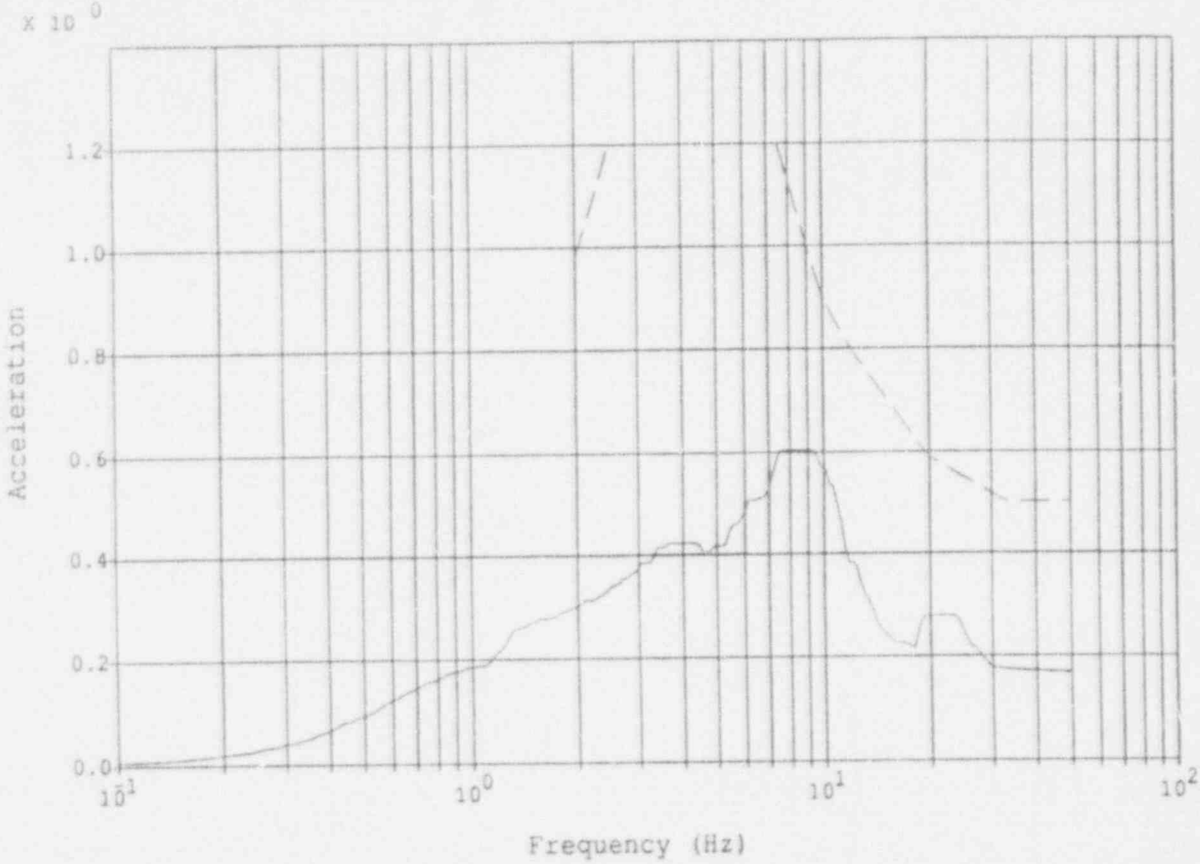
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Internal Structure, Elev. 319'-0", Translation in EW Direction

ESPLT SUN V1.2 es207x.plt 13:20:21 03/16/93

Figure 3-16



Legend:

Enveloped In-Struct. Response Spectrum ————————

1.5 times SQUG Bounding Spectrum — — — — —

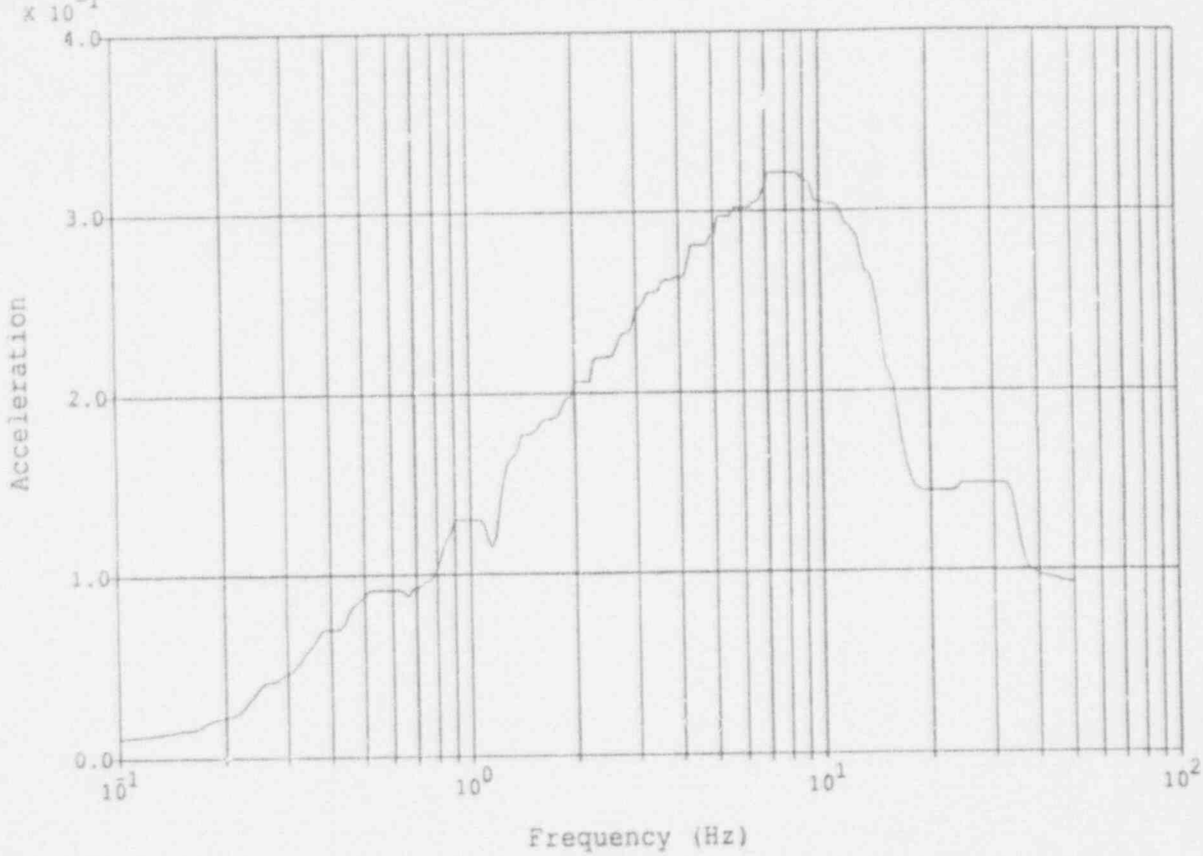
Notes:

LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building USI-A46 Analysis
Internal Structure, Elev. 319'-0", Translation in NS Direction

RSPLT SUN V1.2 es207y.plt 09:20:21 03/16/93

Figure 3-17



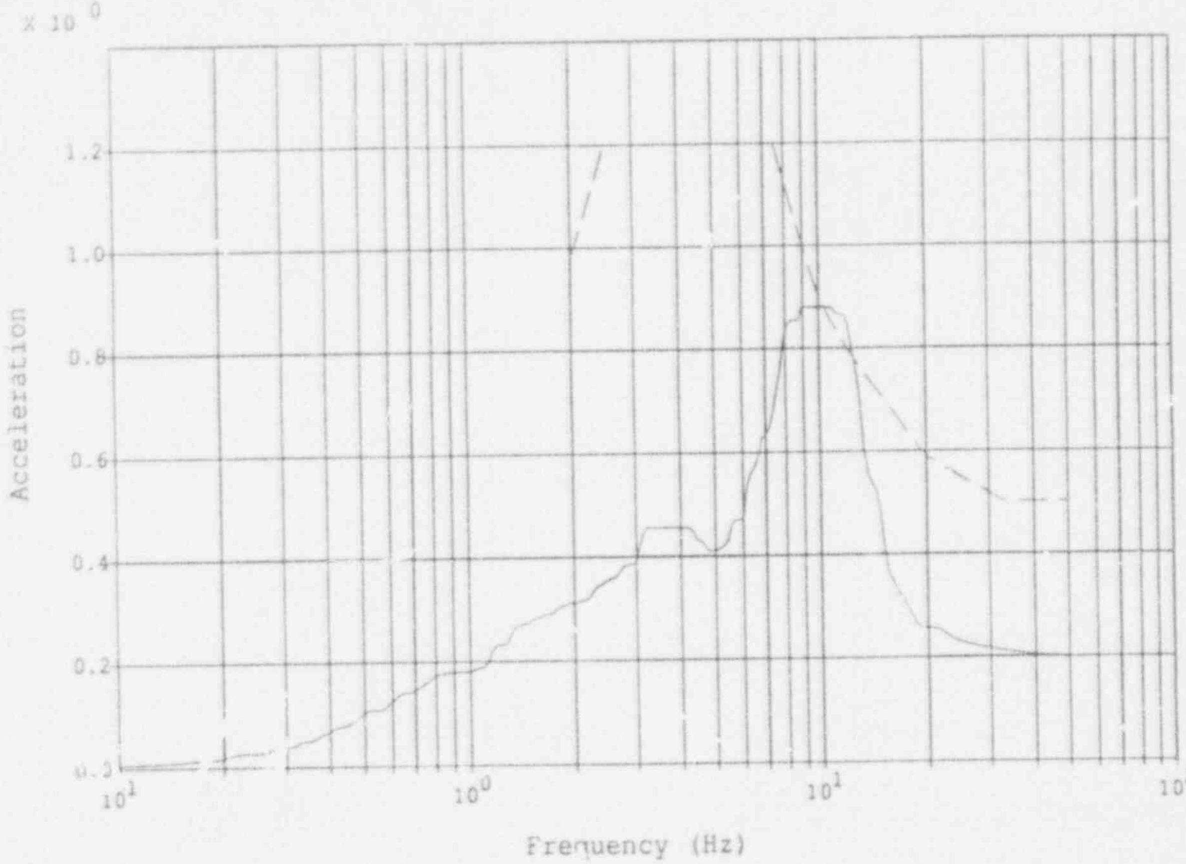
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Internal Structure, Elev. 319'-0", Translation in Vertical Direction

RSPLT SUN V1.2 es207z.plt 09:20:21 03/16/93

Figure 3-18



Legend:

Enveloped In-Struct. Response Spectrum ————————

1.5 times SQUG Bounding Spectrum — — — — —

Notes:

LB & UB Broadened 10%

BE Broadened 15%

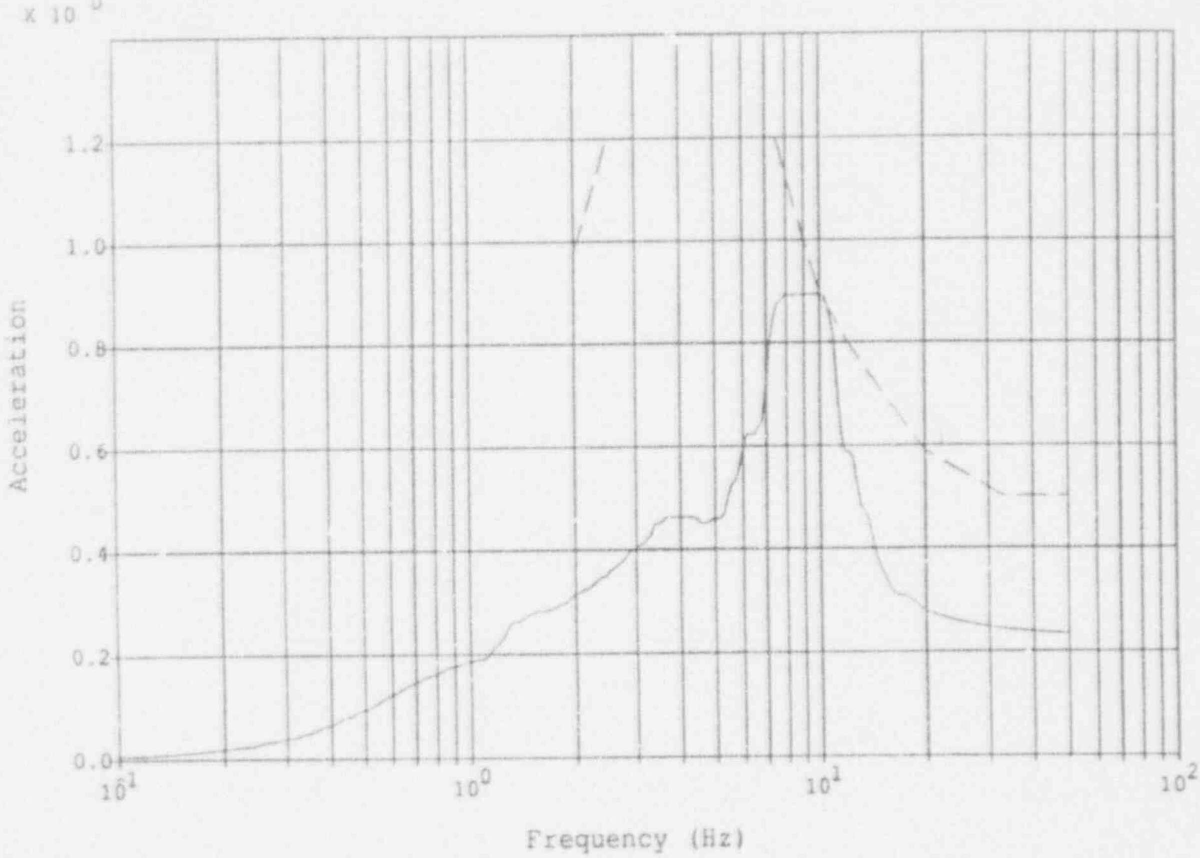
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Internal Structure, Elev. 346'-0", Translation in EW Direction

RSPLT SUN V1.2 es210x.plt 09:20:25 03/16/93

Figure 3-19



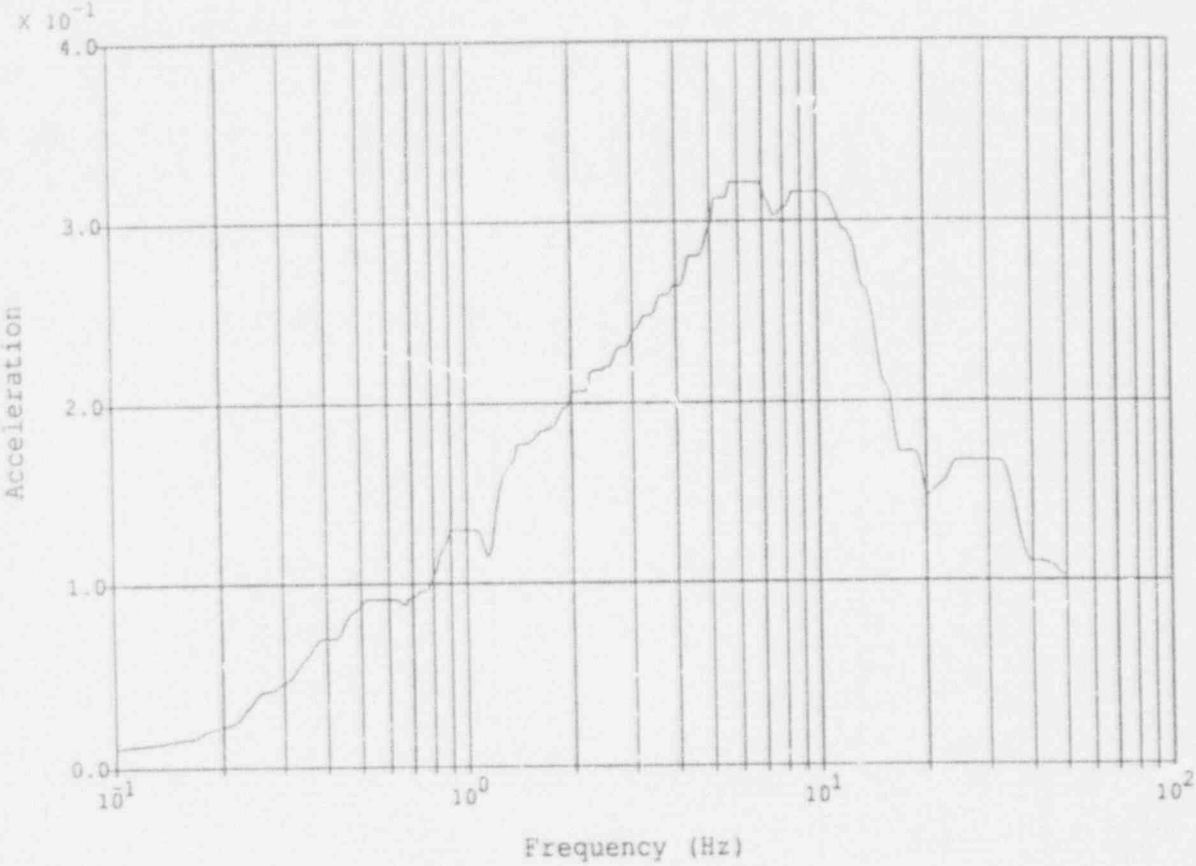
Legend:
Enveloped In-Struct. Response Spectrum ————
1.5 times SQUG Bounding Spectrum — — — —

Notes:
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Internal Structure, Elev. 346'-0", Translation in NS Direction

RSPLT SUN V1.2 es210y.plt 09:20:25 03/16/93

Figure 3-20



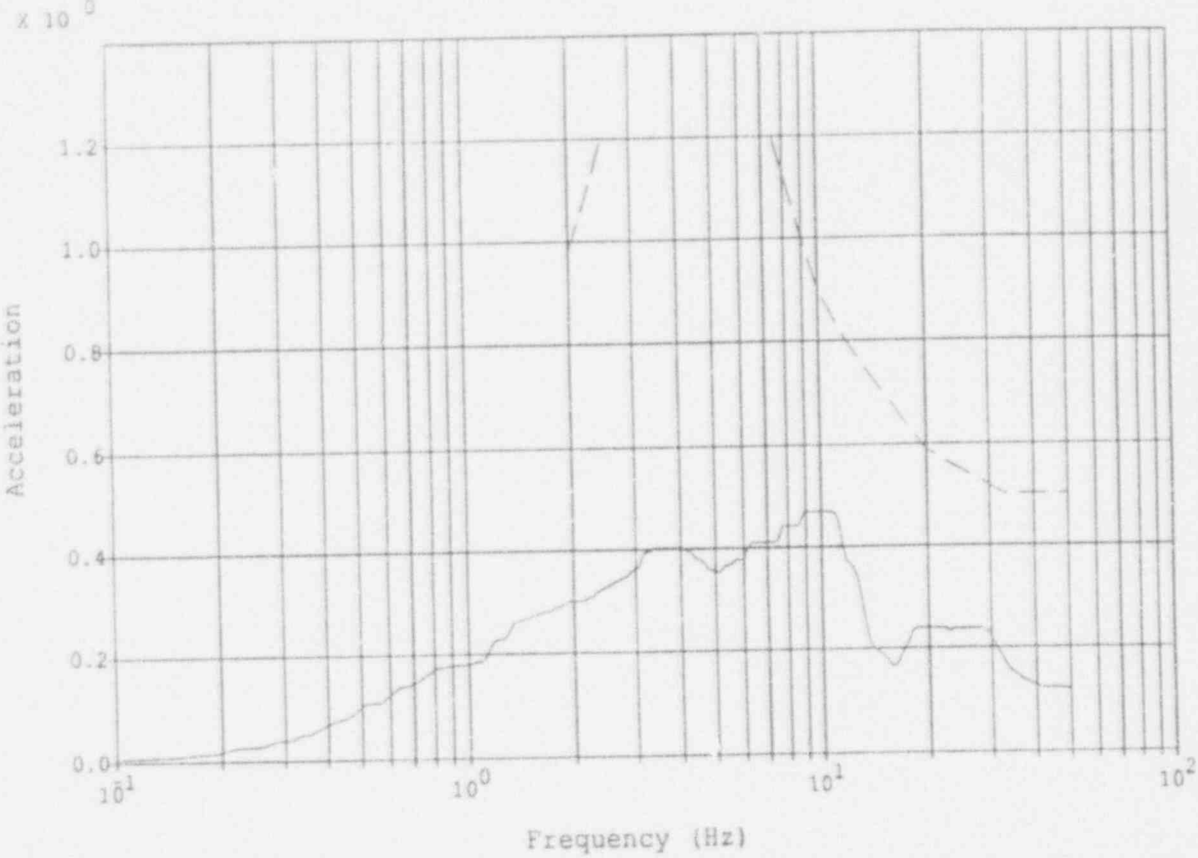
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Internal Structure, Elev. 346'-0", Translation in Vertical Direction

[illegible] 3/16/93

Figure 3-21



Legend:

Enveloped In-Struct. Response Spectrum ————

1.5 times SQUG Bounding Spectrum — — — —

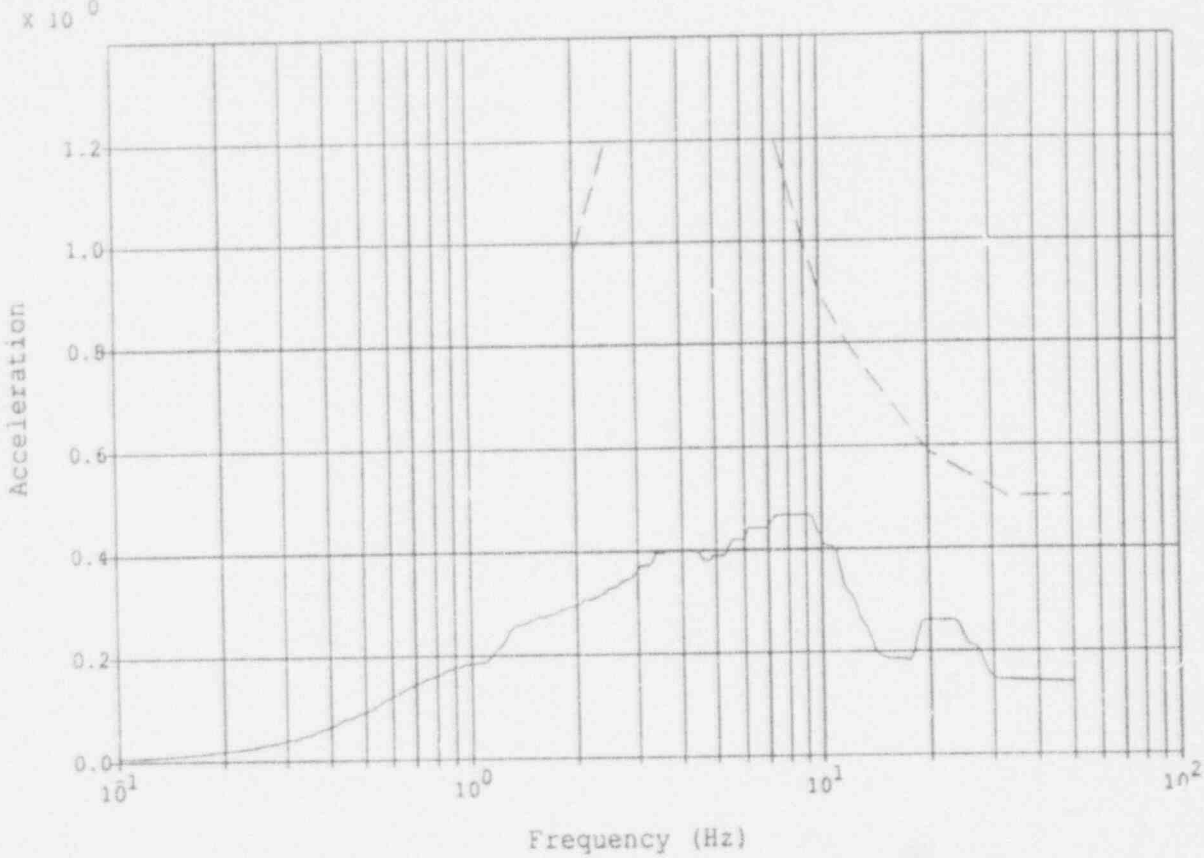
Notes:

LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Reactor Vessel Primary Wall, Elev. 308'-0", Translation in EW Dir.

RSPLT SUN V1.2 es216x.plt 09:20:37 03/16/93

Figure 3-22



Legend:

Enveloped In-Struct. Response Spectrum ————

1.5 times SQUG Bounding Spectrum — — — —

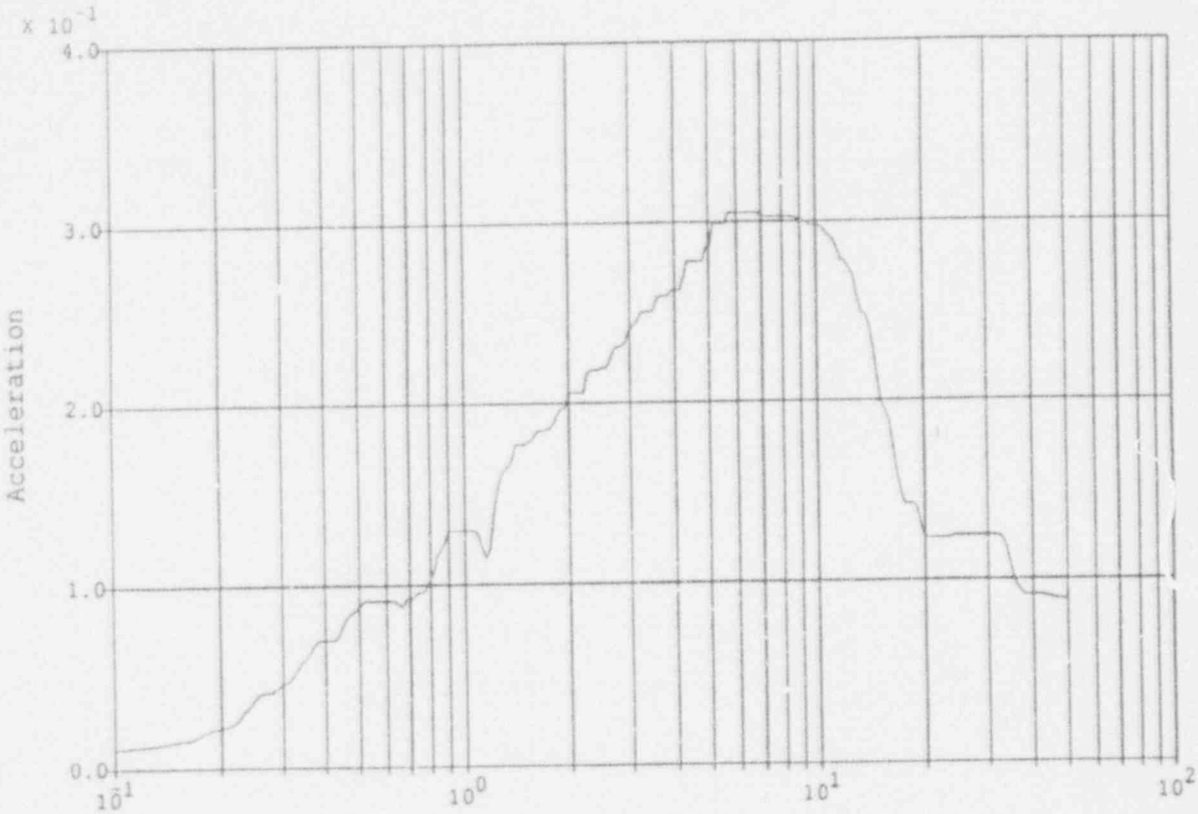
Notes:

LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Reactor Vessel Primary Wall, Elev. 308'-0", Translation in NS Dir.

RSPLT SUN V1.2 es216y.plt 09:20:37 03/16/93

Figure 3-23



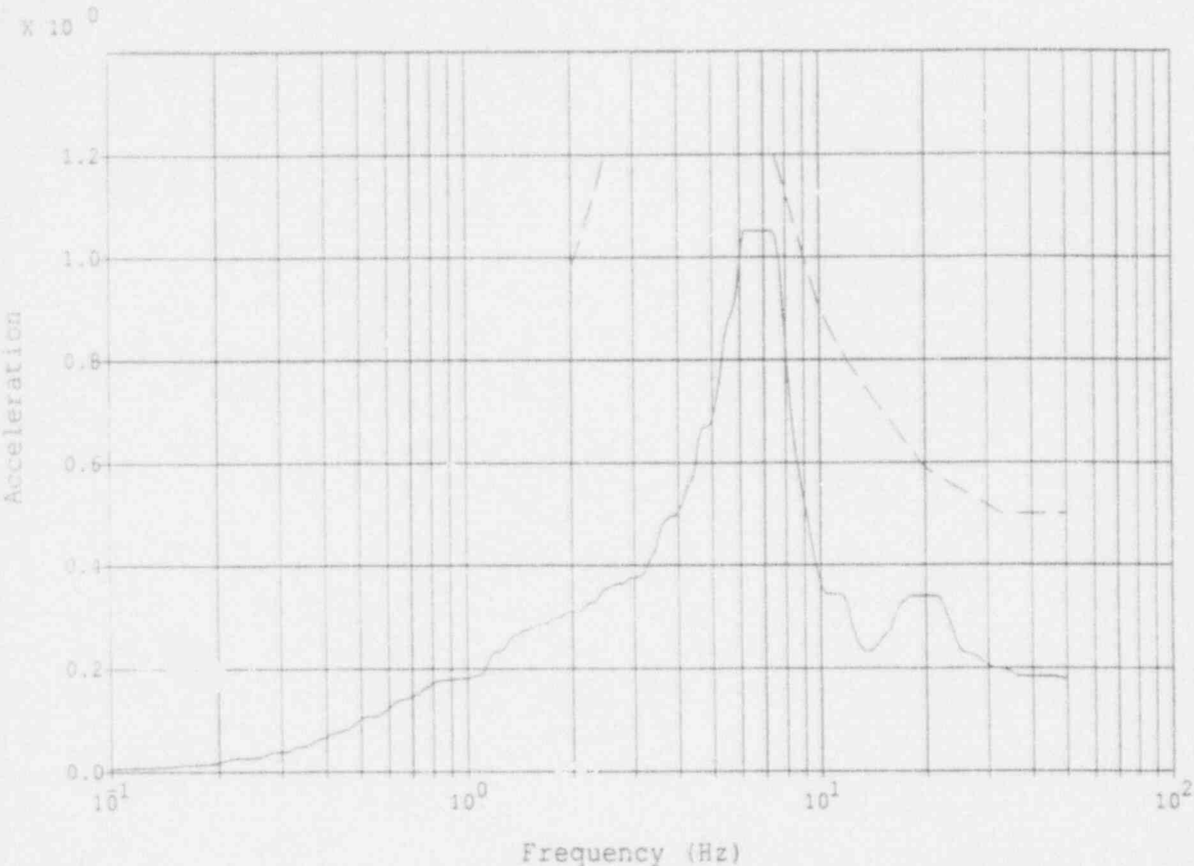
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Unit 1 Reactor Building, USI-A46 Analysis
Reactor Vessel Primary Wall, Elev. 308'-0", Transl. in Vertical Dir.

RSPLT SUN V1.2 es216z.plt 09:20:37 03/16/93

Figure 3-24



Legend:

Envelope of LB, BE UB Spectra ————————

1.5 x SQUG Bounding Spectrum — — — — —

Notes:

Enveloped In-Structure Response Spectrum

LB & UB Broadened 10%

BE Broadened 15%

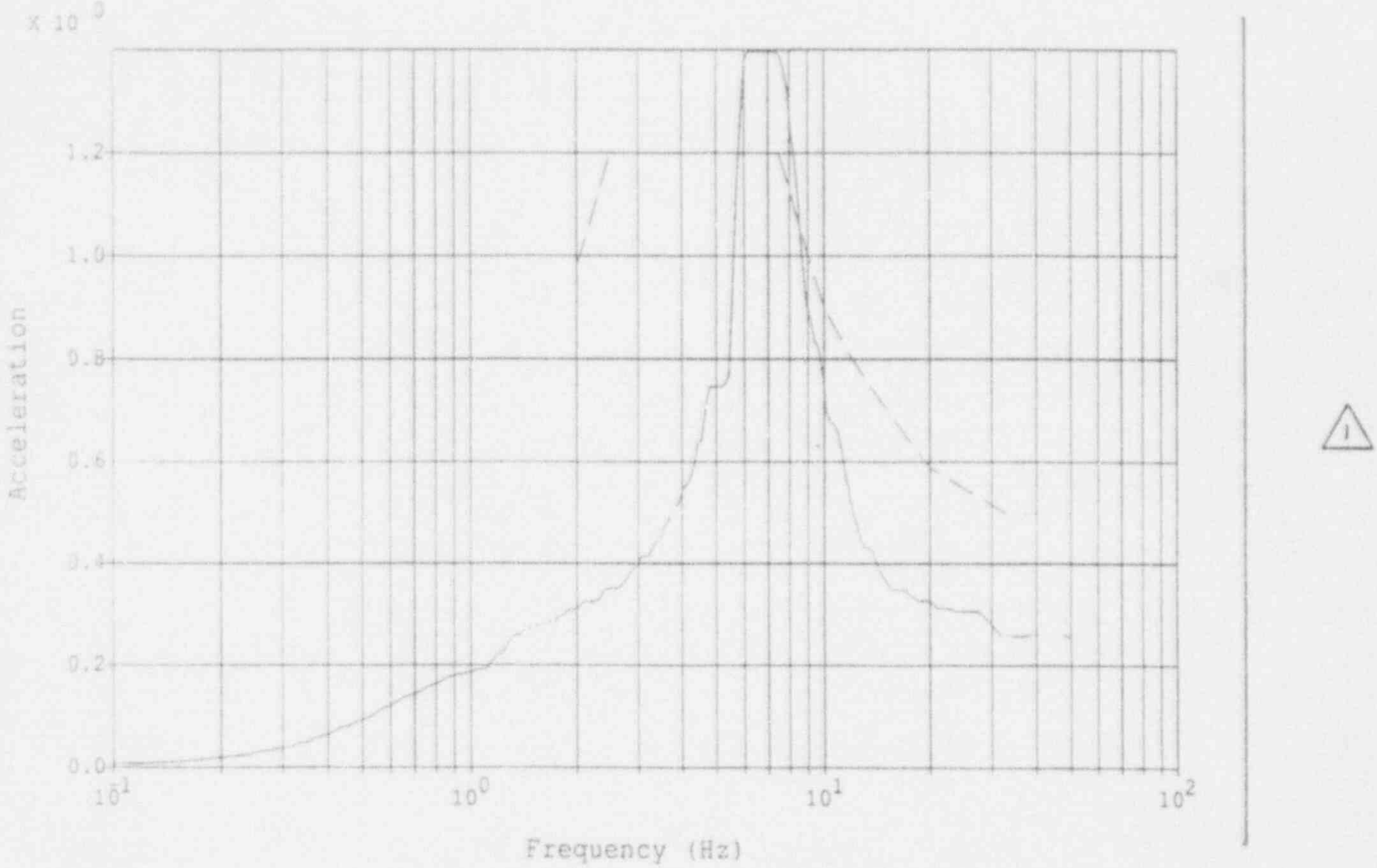
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Intermediate Building, USI-A46 Analysis
Floor, Elev. 321', Translation in EW Direction

RSPLT SUN V1.2 e321x.plt 08:27:59 07/29/93

Figure 3-25



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — —

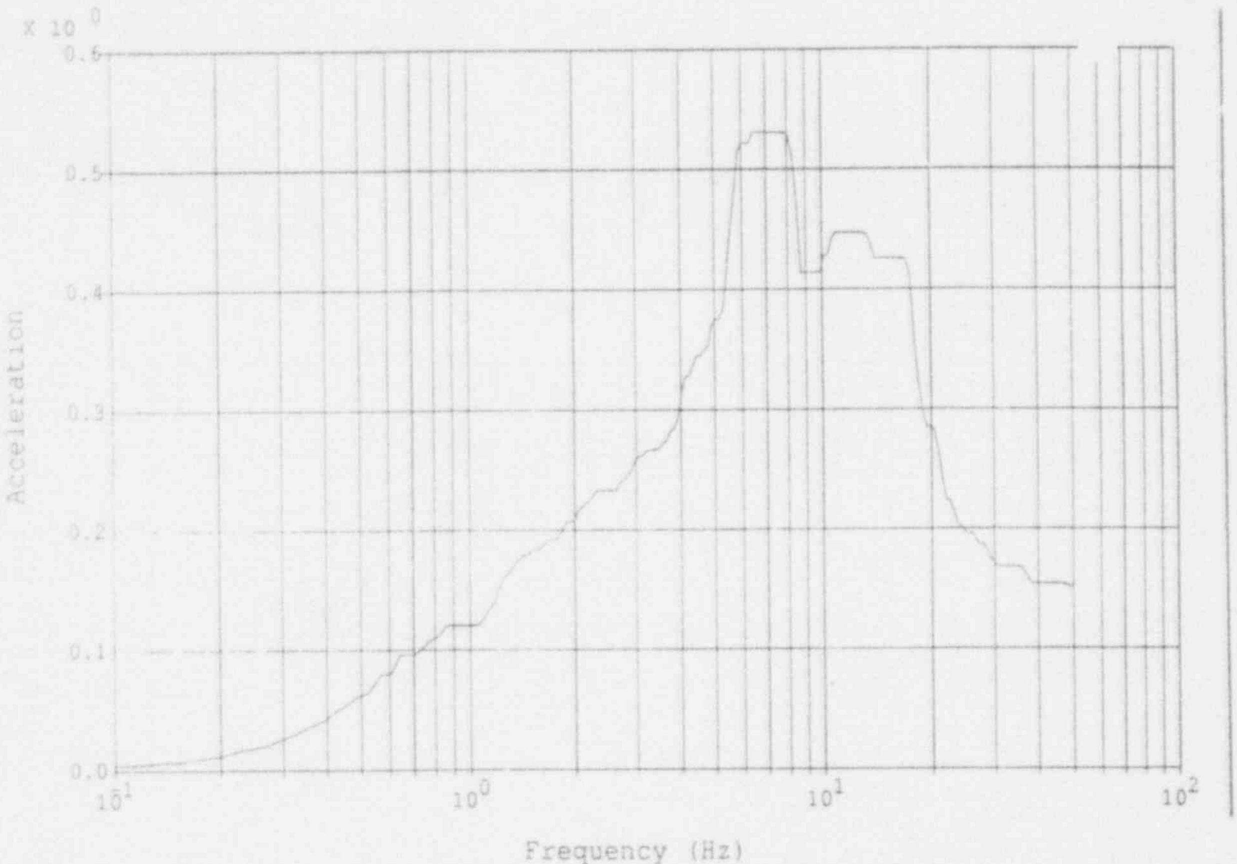
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Intermediate Building, USI-A46 Analysis
Floor, Elev. 321', Translation in NS Direction

RSPLT SUN V1.2 e321y.plt 08:27:59 07/29/93

Figure 3-26



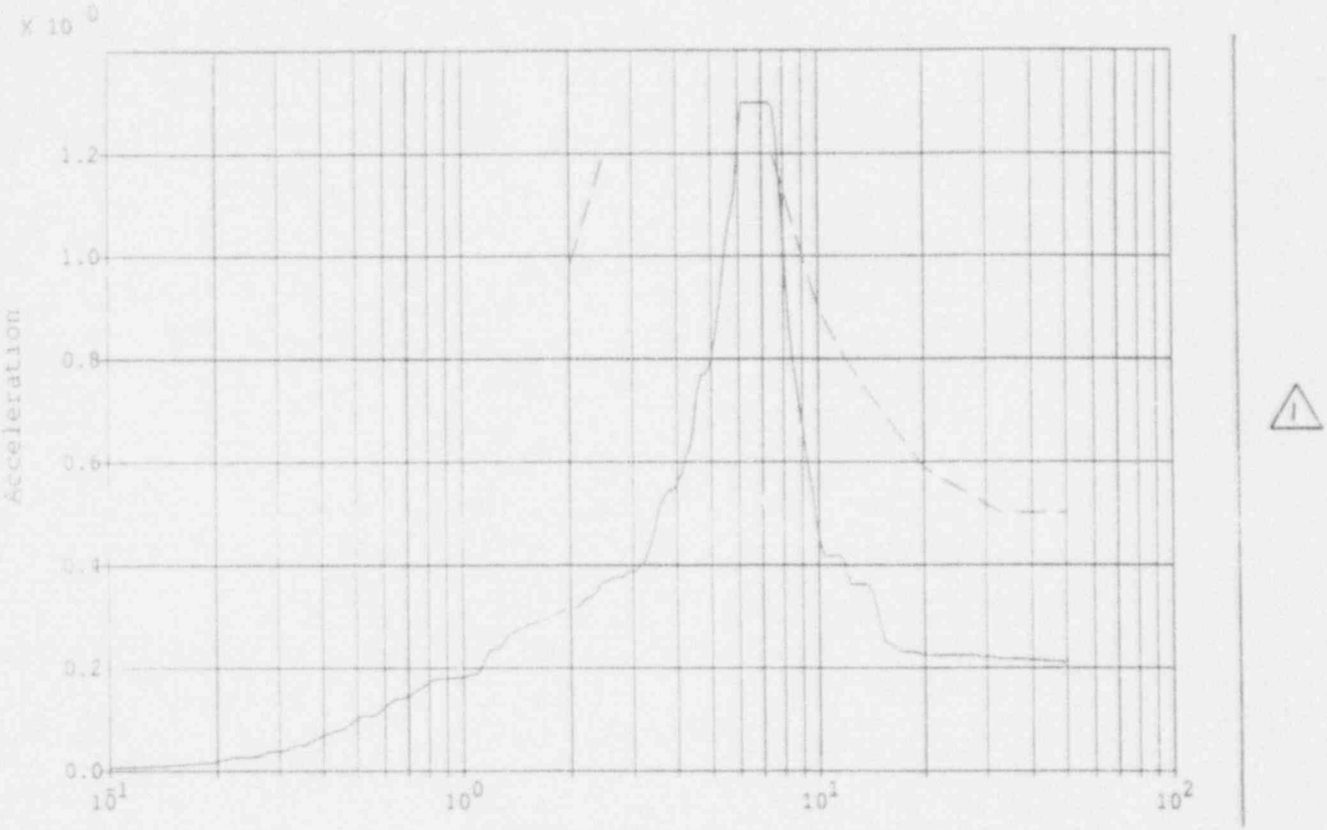
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Intermediate Building, USI-A46 Analysis
Floor, Elev. 321', Translation in Vertical Direction

RSPLT SUN V1.2 e321z.plt 08:28:20 07/29/93

Figure 3-27



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — — —

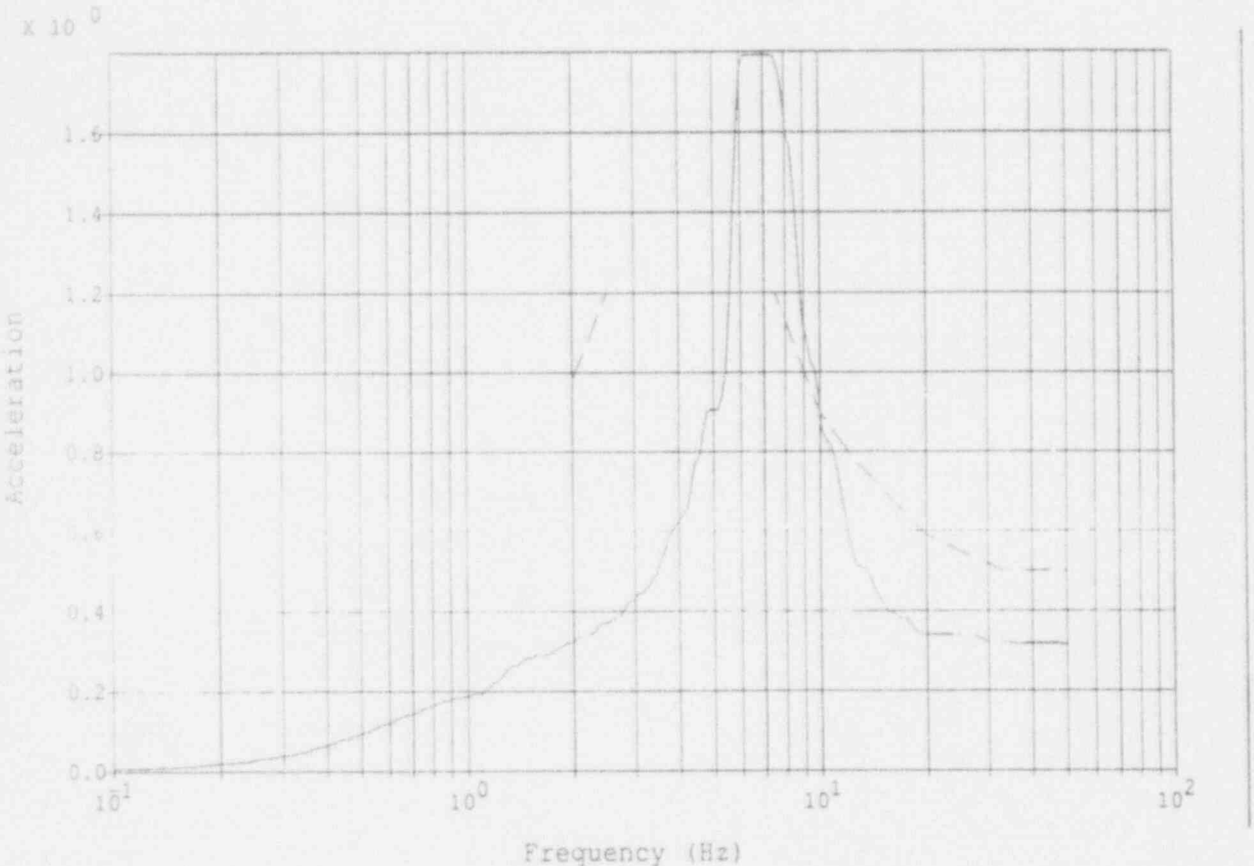
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Intermediate Building, USI-A46 Analysis
Floor, Elev. 339'-9", Translation in EW Direction

RSPLT SUN V1.2 e339x.plt 08:27:59 07/29/93

Figure 3-28



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — —

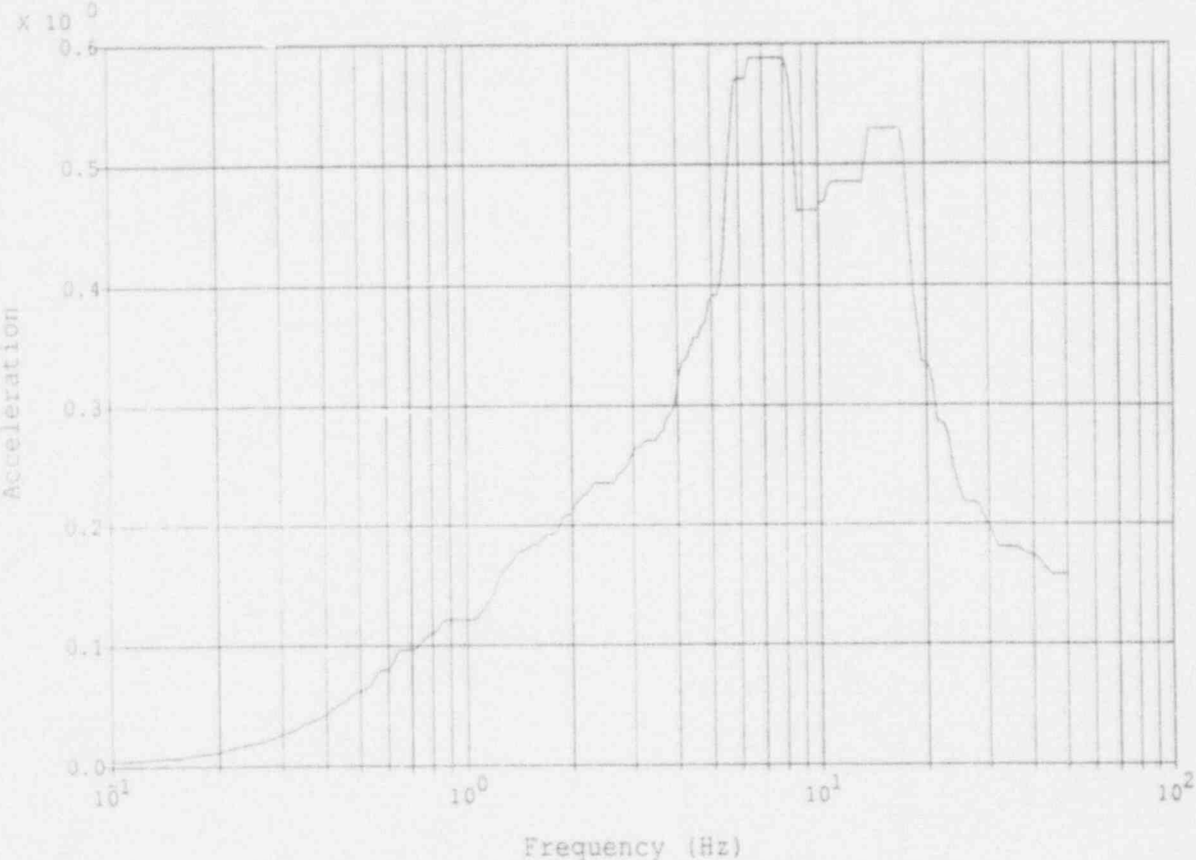
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Intermediate Building, USI-A46 Analysis
Floor, Elev. 339'-9", Translation in NS Direction

RSPLT SUN V1.2 e339y.plt 08:27:59 07/29/93

Figure 3-29



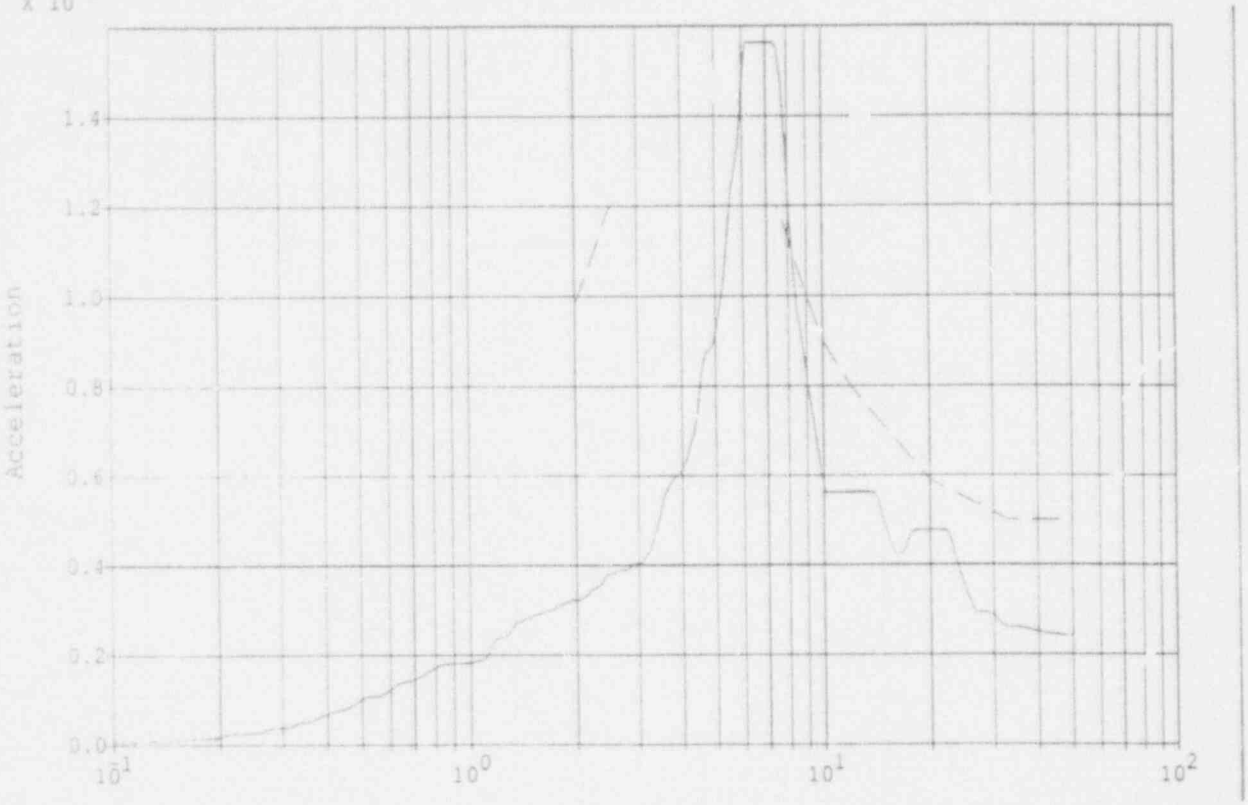
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Intermediate Building, USI-A46 Analysis
Floor, Elev. 339'-9", Translation in Vertical Direction

RSPLT SUN V1.2 e339z.plt 08:28:20 07/29/93

Figure 3-30



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — — —

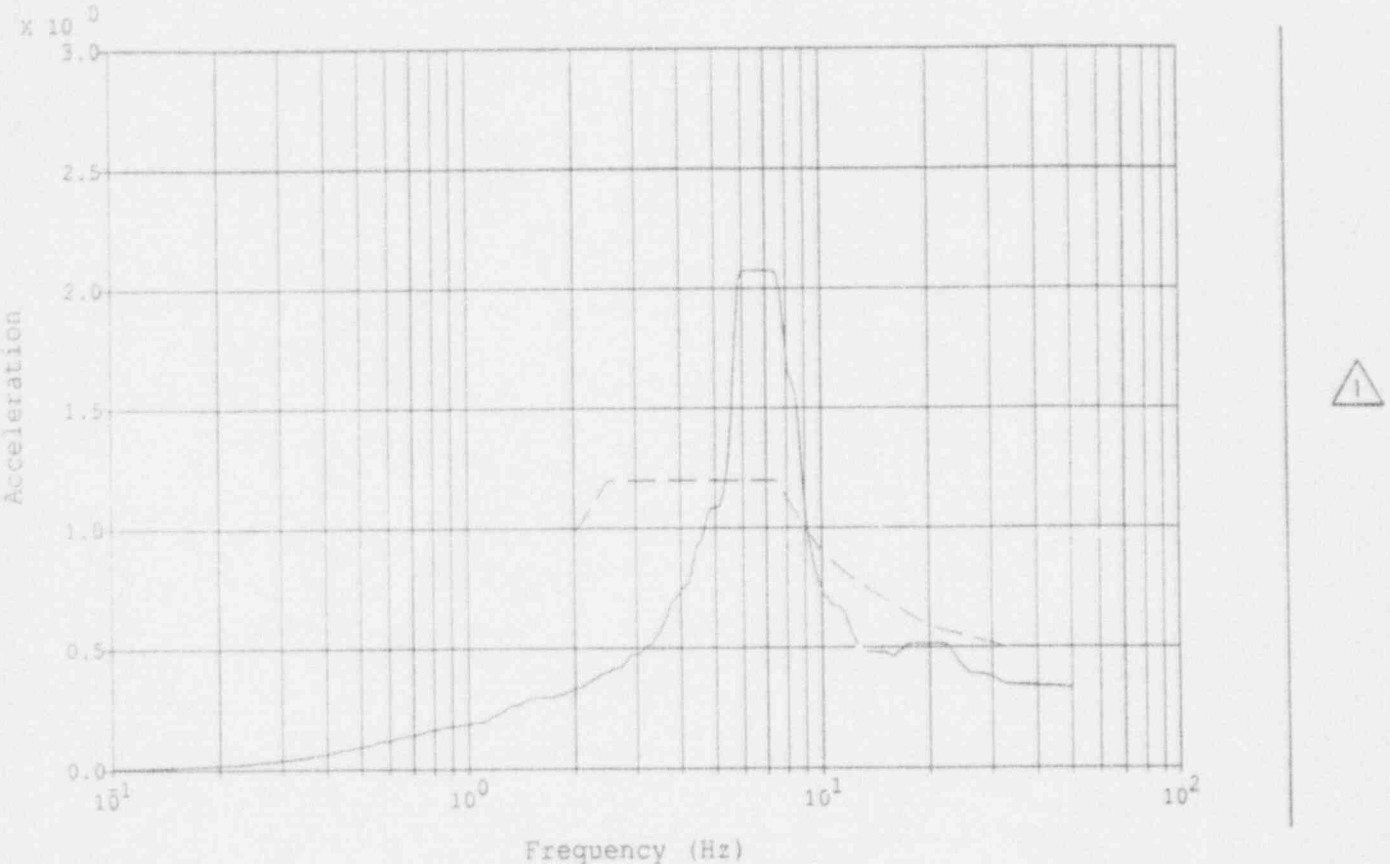
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Intermediate Building, USI-A46 Analysis
Floor, Elev. 366'-9", Translation in EW Direction

RSPLT SUN V1.2 e366x.plt 08:28:09 07/29/93

Figure 3-31



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — —

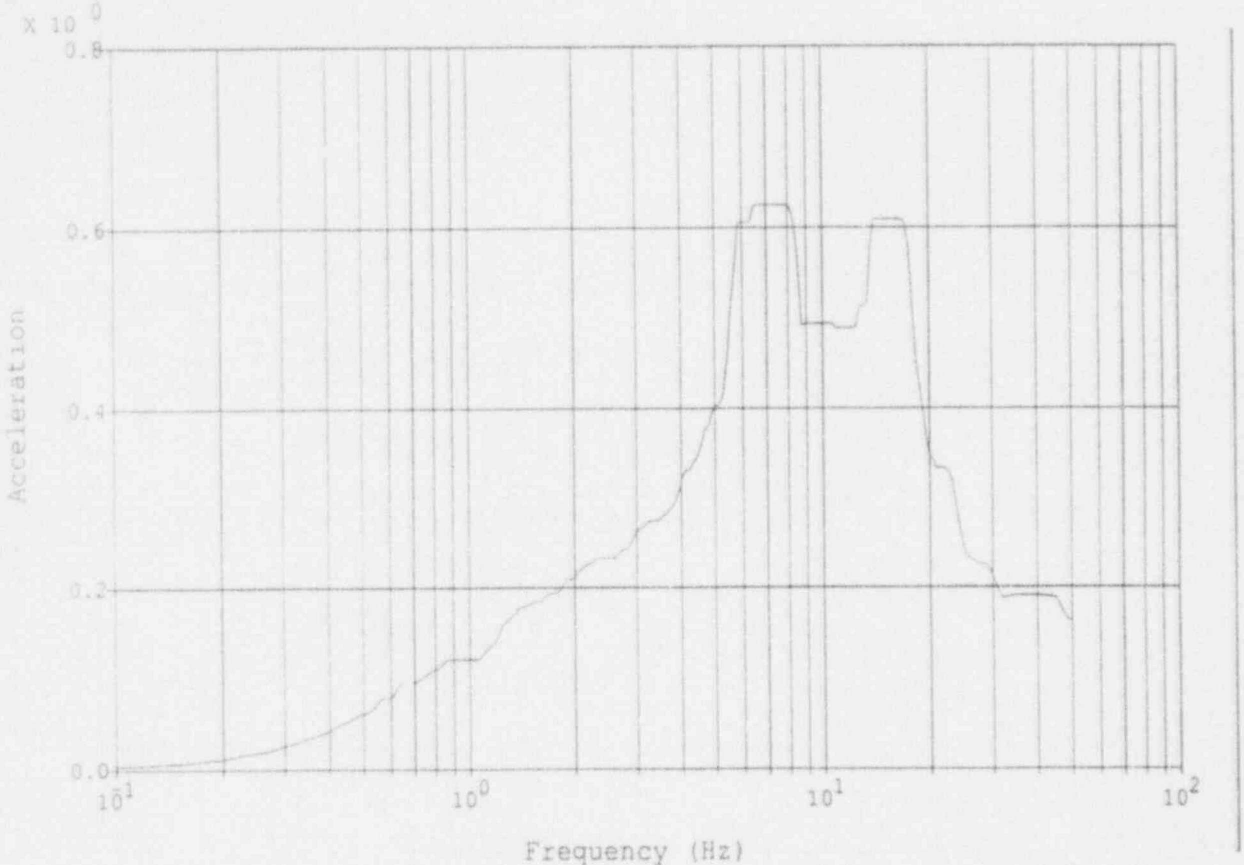
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Intermediate Building, USI-A46 Analysis
Floor, Elev. 366'-9", Translation in NS Direction

RSPLT SUN V1.2 e366y.plt 08:28:09 07/29/93

Figure 3-32

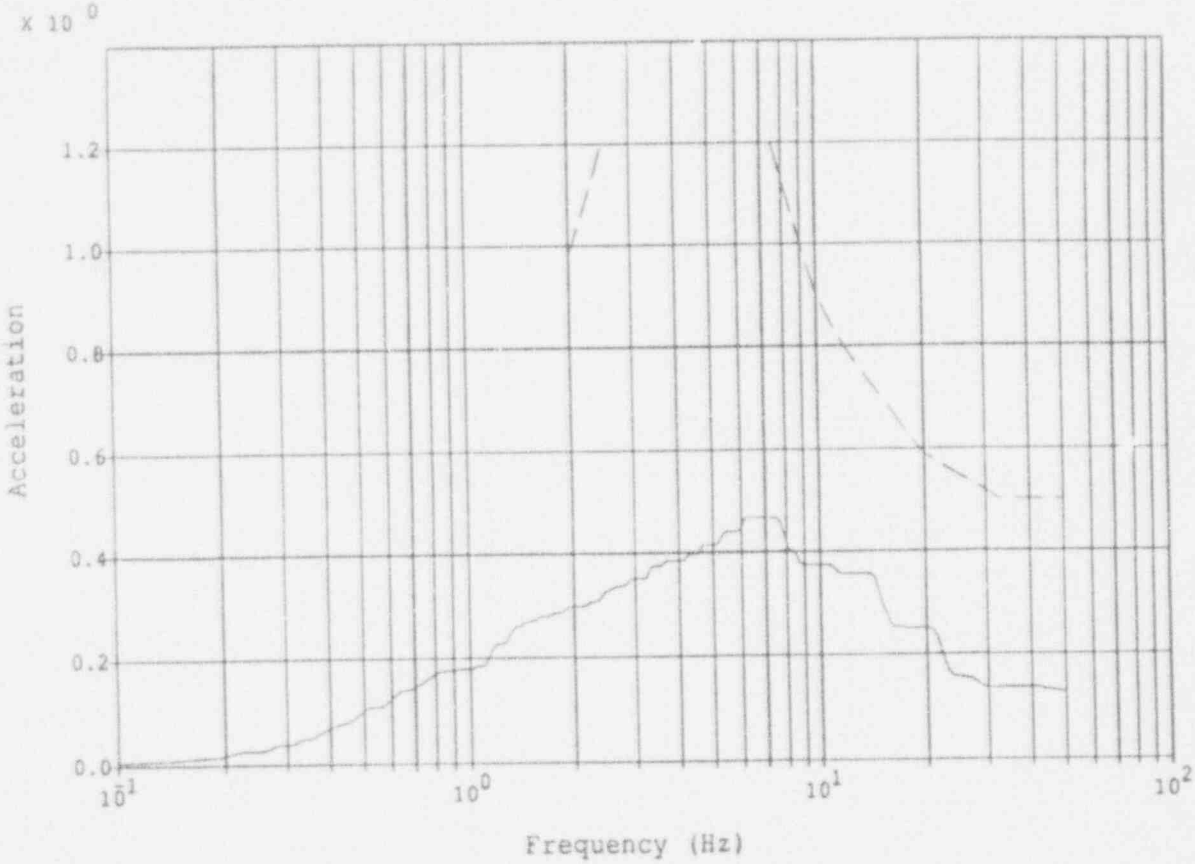


Notes:
Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Intermediate Building, USI-A46 Analysis
Floor, Elev. 366'-9", Translation in Vertical Direction

RSPLT SUN V1.2 e366z.plt 08:28:28 07/29/93

Figure 3-33



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — — —

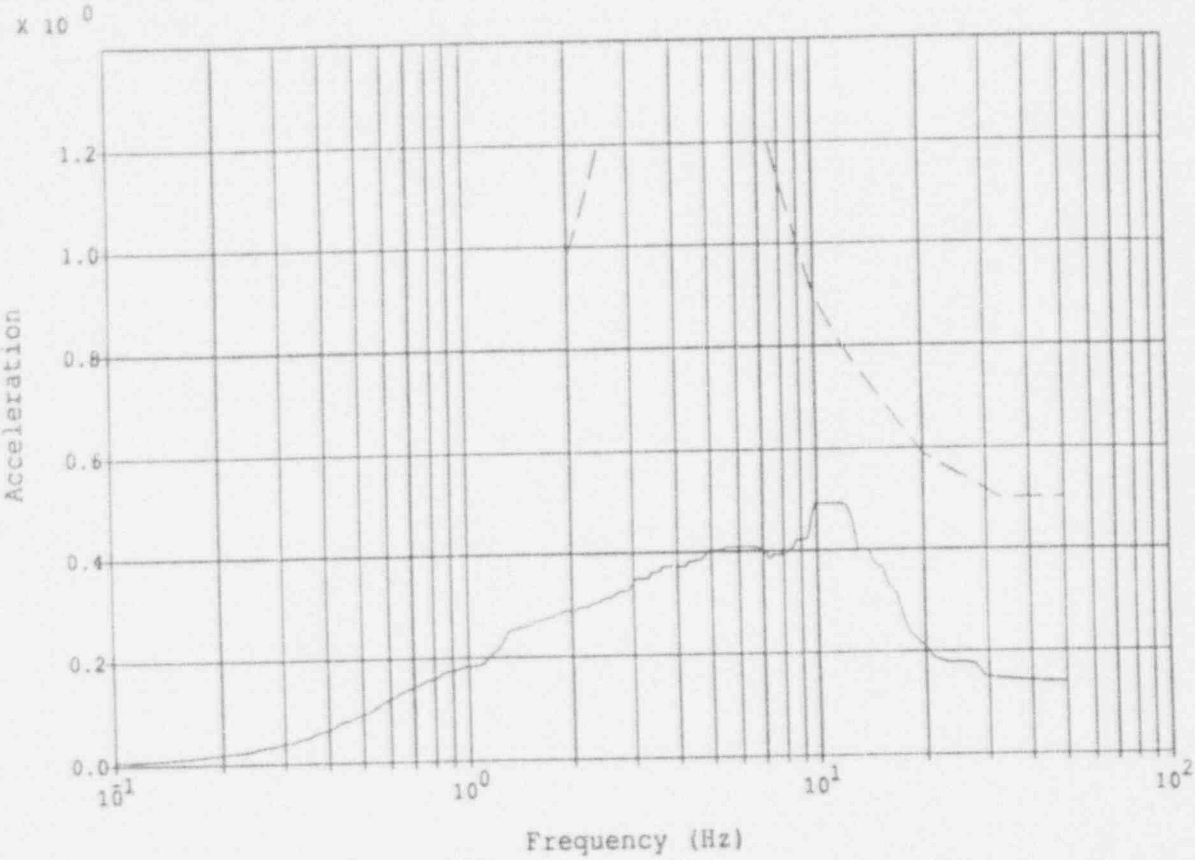
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Auxiliary Building, USI-A46 Analysis
Floor, Elev. 303', Translation in EW Direction

RSPLT SUN V1.2 sndllx.plt 14:23:40 03/17/93

Figure 3-34



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum - - - - -

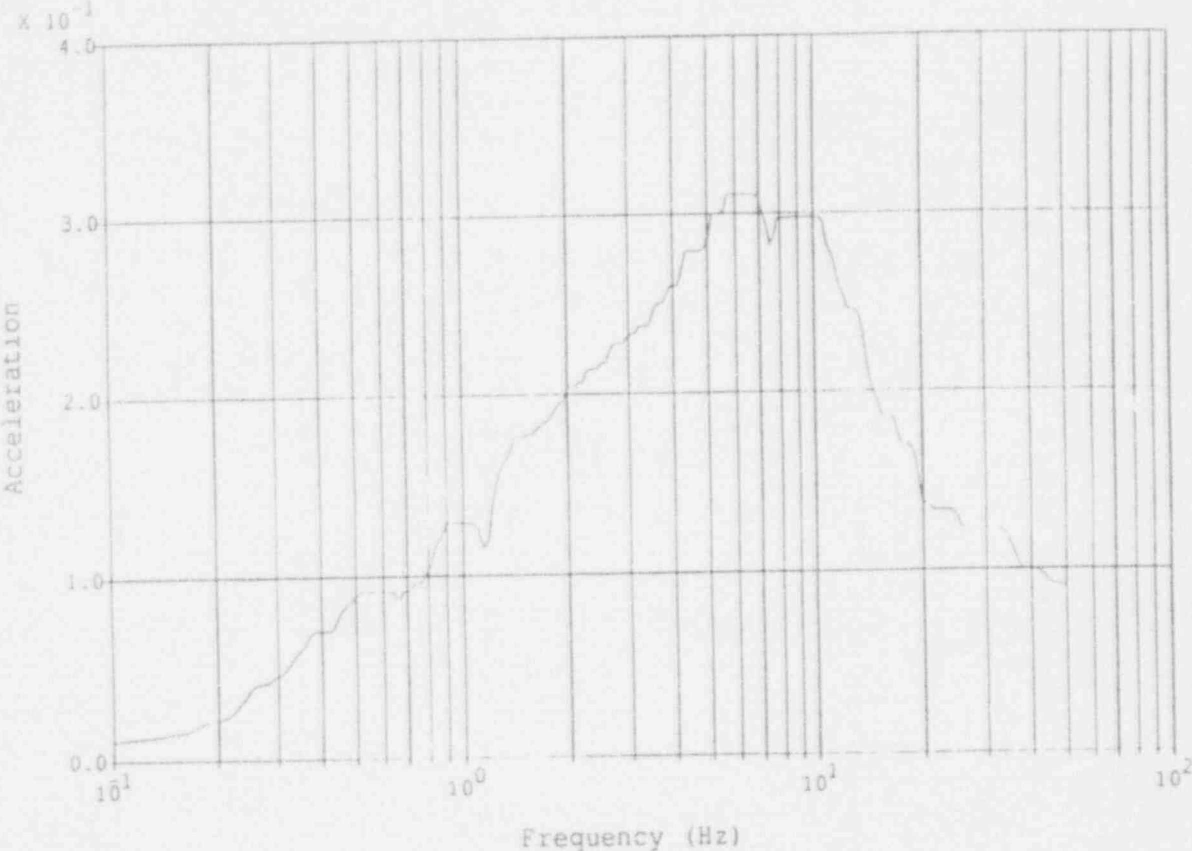
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Auxiliary Building, USI-A46 Analysis
Floor, Elev. 303', Translation in NS Direction

RSPLT SUN V1.2 sndlly.plt 14:23:40 03/17/93

Figure 3-35



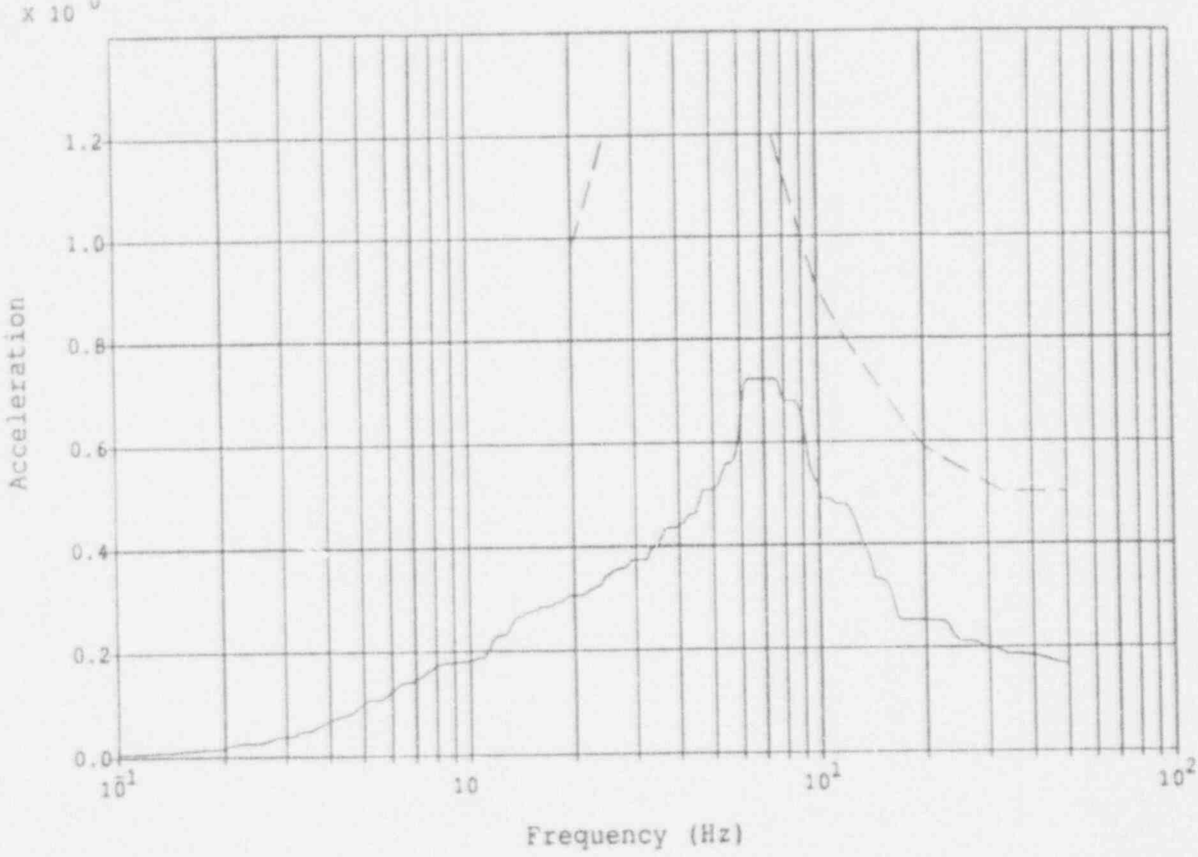
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Auxiliary Building, USI-A46 Analysis
Floor, Elev. 303', Translation in Vertical Direction

RSPLT SUN V1.2 endllz.plt [illegible]:22:19 [illegible]3/17/93

Figure 3-36



Legend:

Envelope of LB, BE UB Spectra ————————

1.5 x SQUG Bounding Spectrum — — — — —

Notes:

Enveloped In-Structure Response Spectru

LB & UB Broadened 10%

BE Broadened 15%

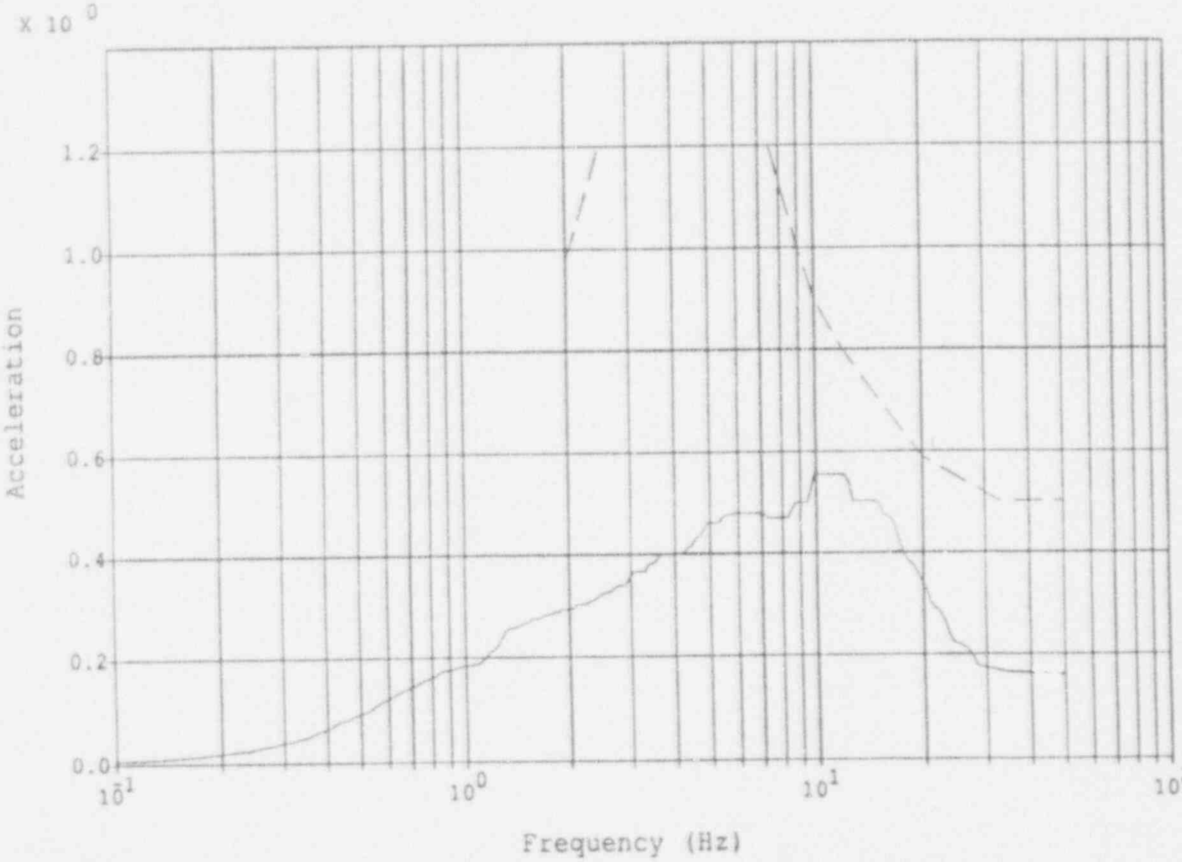
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Auxiliary Building, USI-A46 Analysis
Roof, Elev. 352', Translation in EW Direction

RSPLT SUN V1.2 snd31x.plt 14:24:08 03/17/93

Figure 3-37



Legend:

Envelope of LB, BE UB Spectra ————————

1.5 x SQUG Bounding Spectrum — — — — —

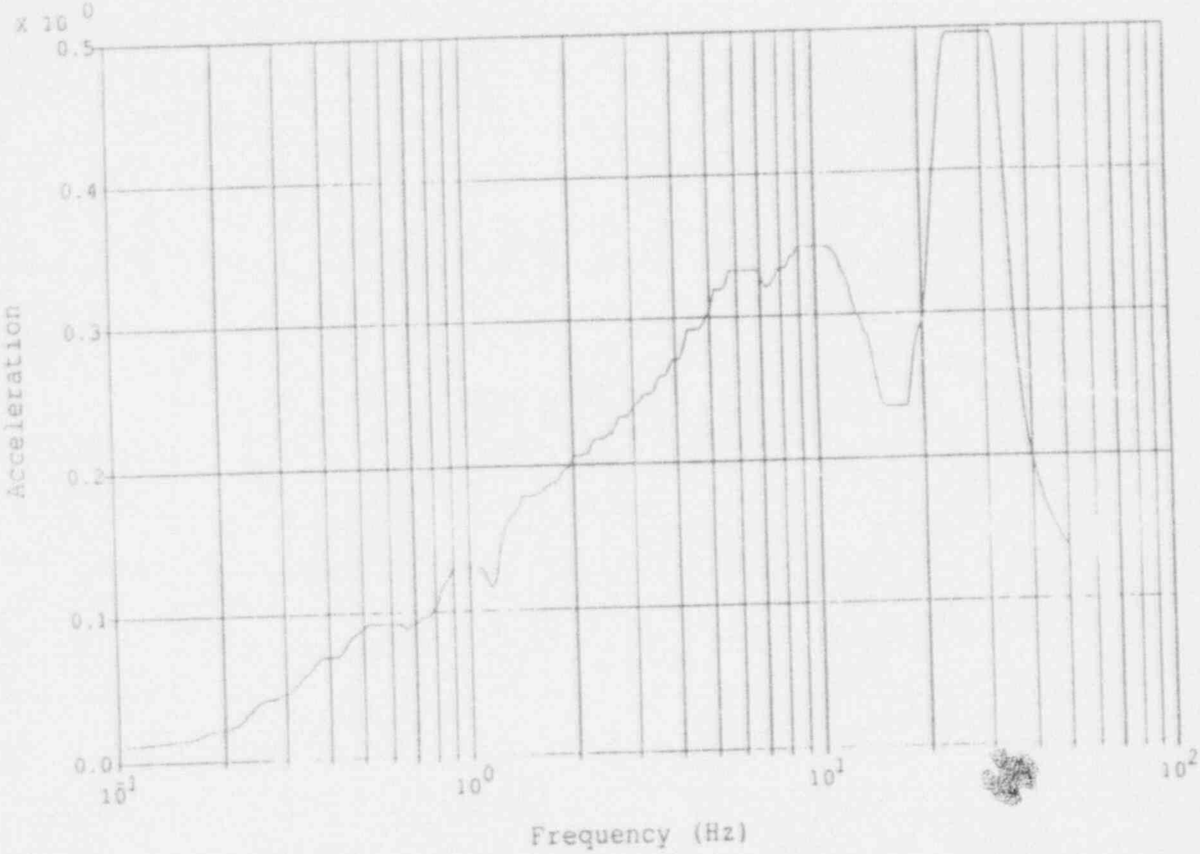
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Auxiliary Building, USI-A46 Analysis
Roof, Elev. 352', Translation in NS Direction

RSPLT SUN V1.2 snd3ly.plt 14:24:08 03/17/93

Figure 3-38

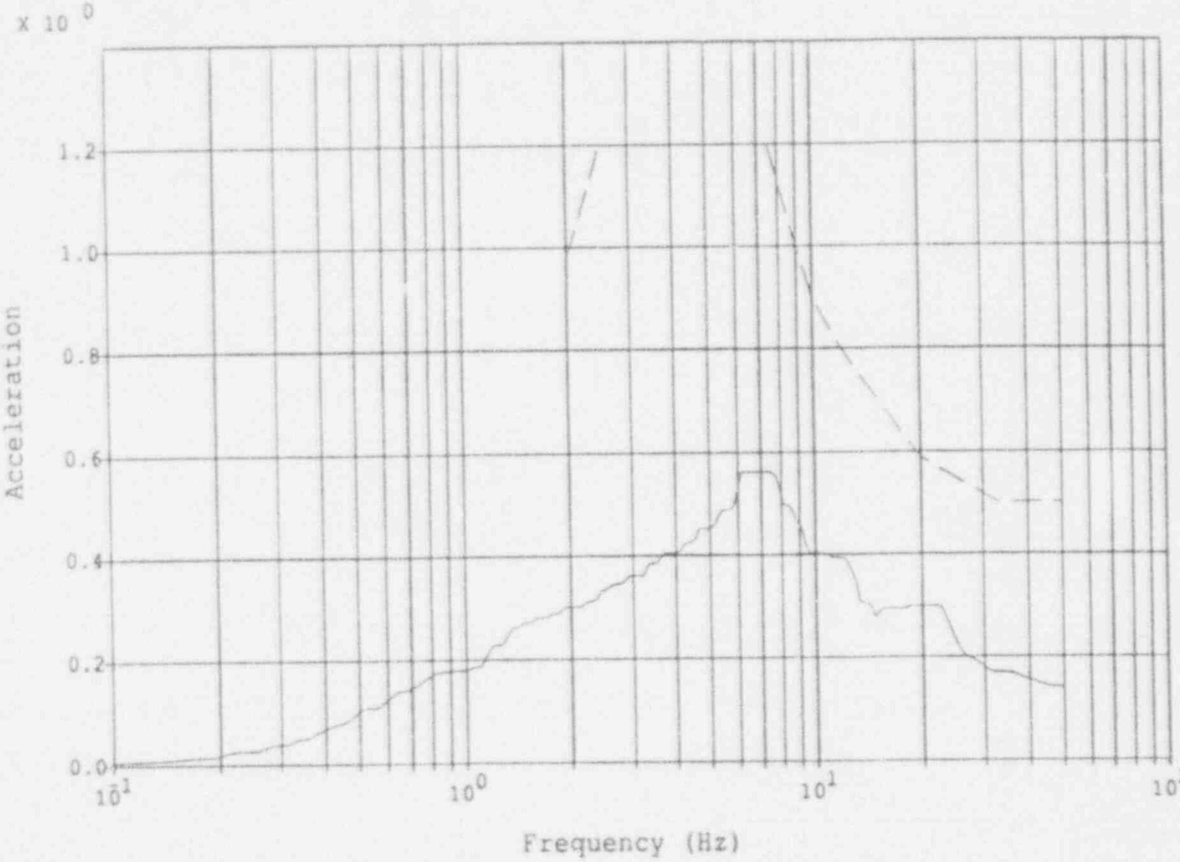


Notes:
Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Auxiliary Building, USI-A46 Analysis
Roof, Elev. 352', Translation in Vertical Direction

RSPLT SUN V1.2 ana31z.plt 14:22:48 03/17/93

Figure 3-39



Legend:

Envelope of LB, BE UB Spectra ————————

1.5 x SQUG Bounding Spectrum — — — — —

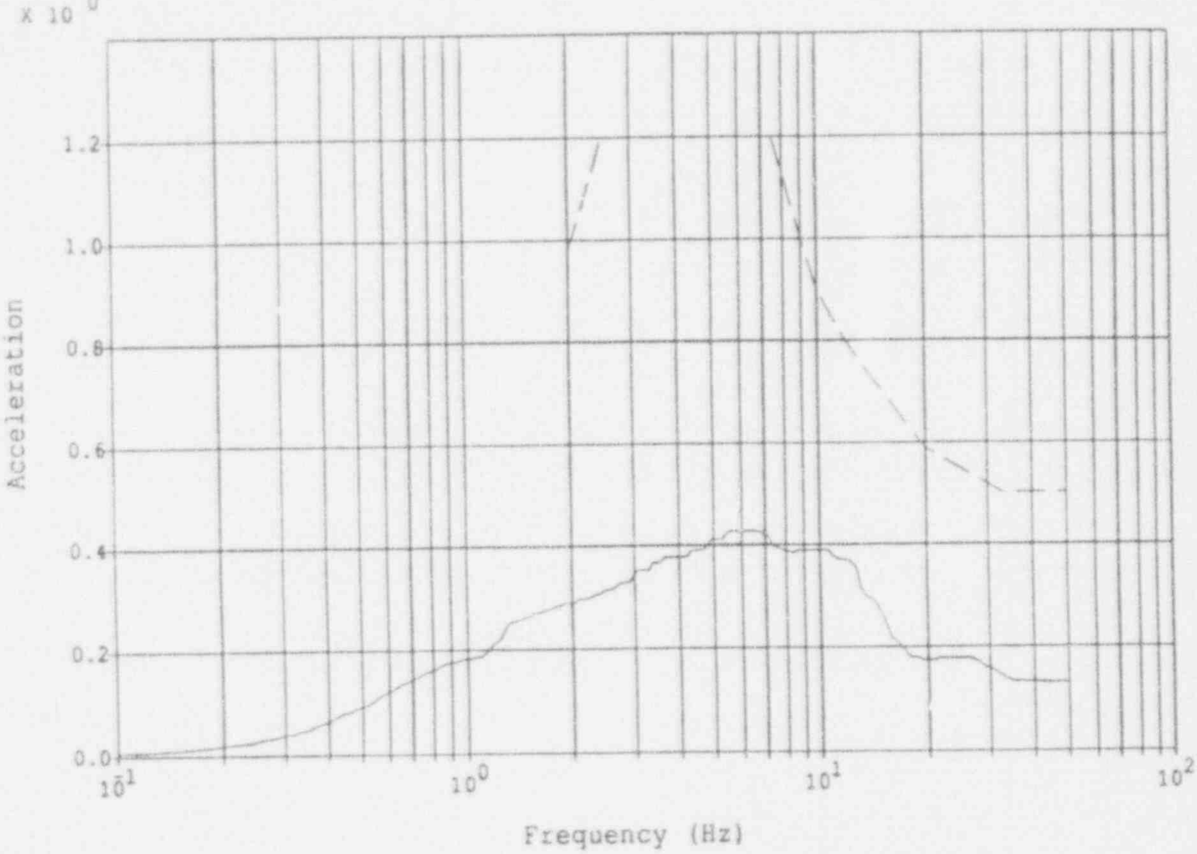
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Fuel Building, USI-A46 Analysis
Floor, Elev. 328', Translation in EW Direction

RSPLT SUN V1.2 snd22x.plt 14:23:58 03/17/93

Figure 3-40



Legend:

Envelope of LB, BE UB Spectra ————————

1.5 x SQUG Bounding Spectrum — — — — —

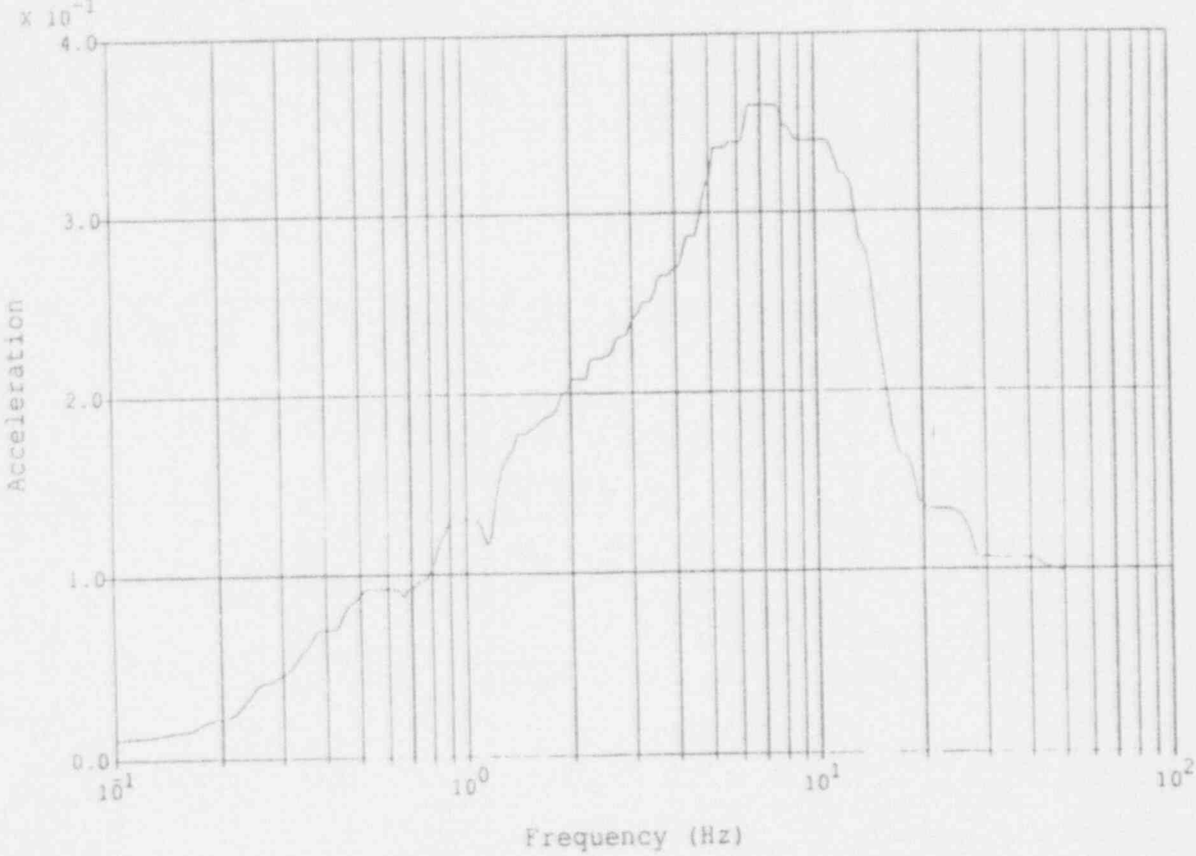
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Fuel Building, USI-A46 Analysis
Floor, Elev. 328', Translation in NS Direction

RSPLT SUN V1.2 snd22y.plt 14:23:58 03/17/93

Figure 3-41



Notes:

Enveloped In-Structure Response Spectrum

LB & UB Broadened 10%

BE Broadened 15%

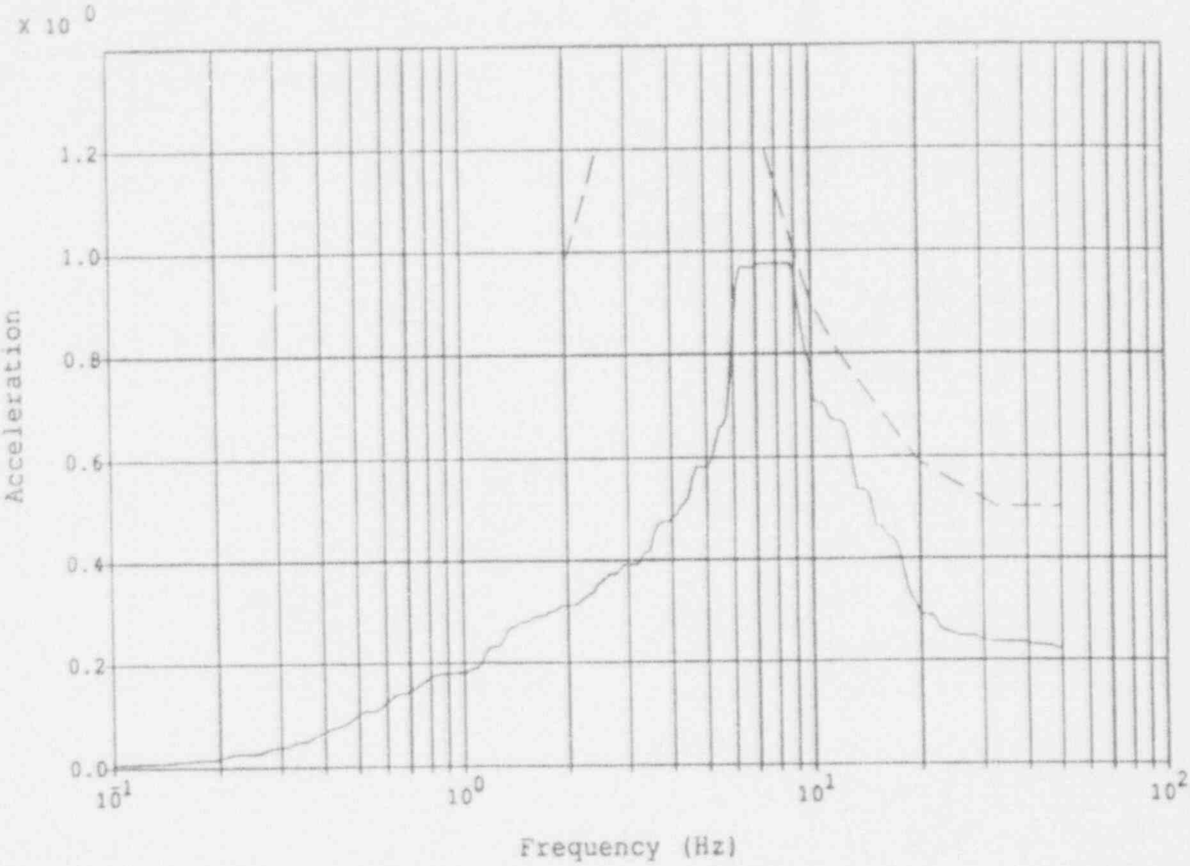
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Fuel Building, USI-A46 Analysis
Floor, Elev. 328', Translation in Vertical Direction

ASPLT SUN V1.2 enq22z.plt 14:22:40 03/17/93

Figure 3-42



Legend:

Envelope of LB, BE UB Spectra ————————

1.5 x SQUG Bounding Spectrum — — — — —

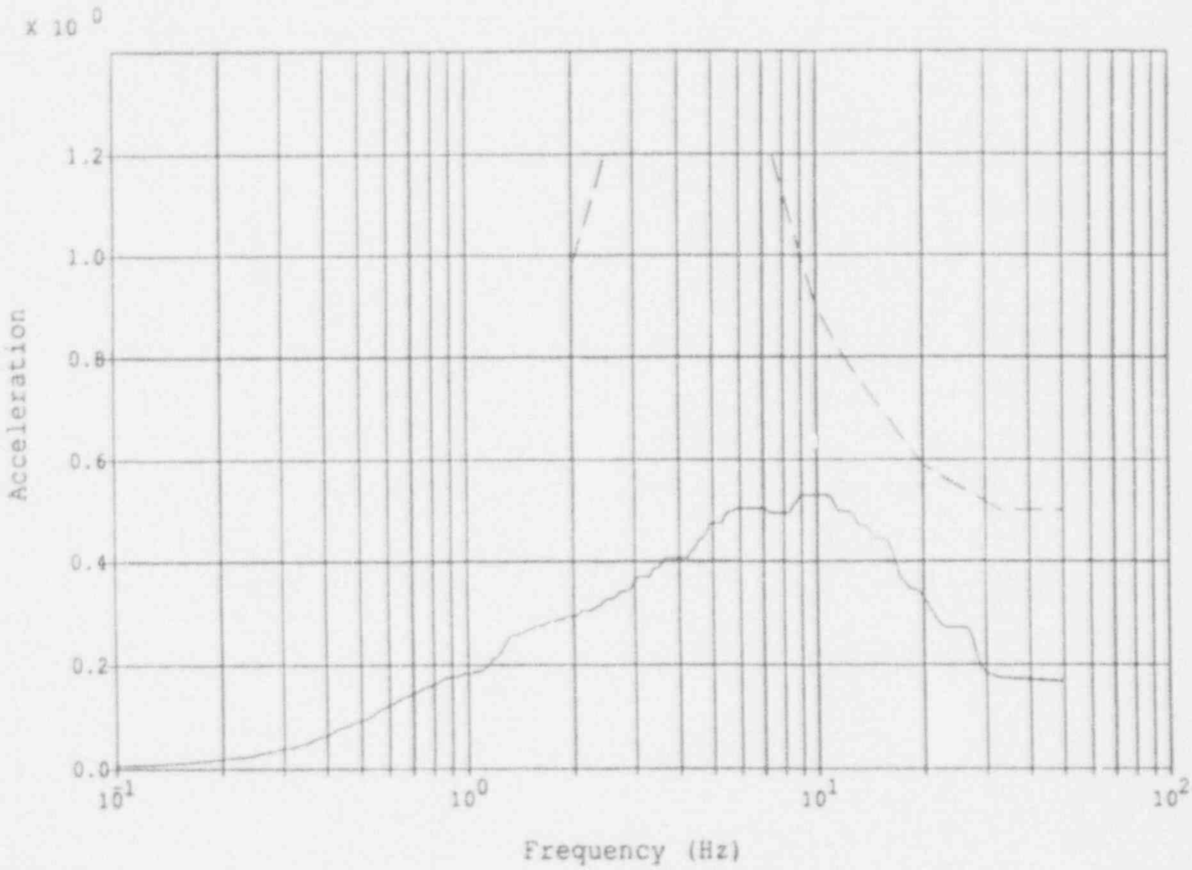
Notes:

Enveloped In-Structure Response Spectra
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Fuel Building, USI-A46 Analysis
Crane, Elev. 380', Translation in EW Direction

RSPLT SUN V1.2 snd42x.plt 14:24:31 03/17/93

Figure 3-43



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — — —

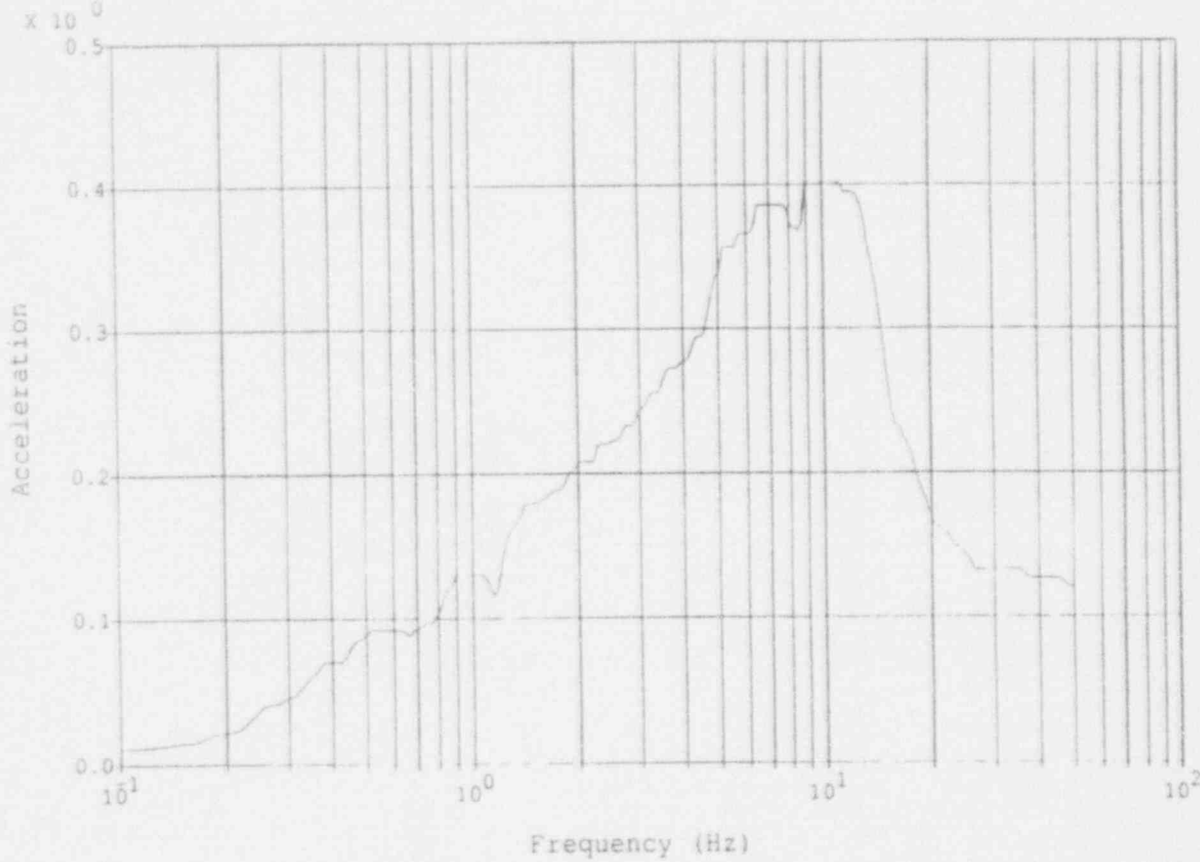
Notes:

Enveloped In-Structure Response Spectru
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Fuel Building, USI-A46 Analysis
Crane, Elev. 380', Translation in NS Direction

RSPLT SUN V1.2 snd42v.plt 14:24:31 03/17/93

Figure 3-44



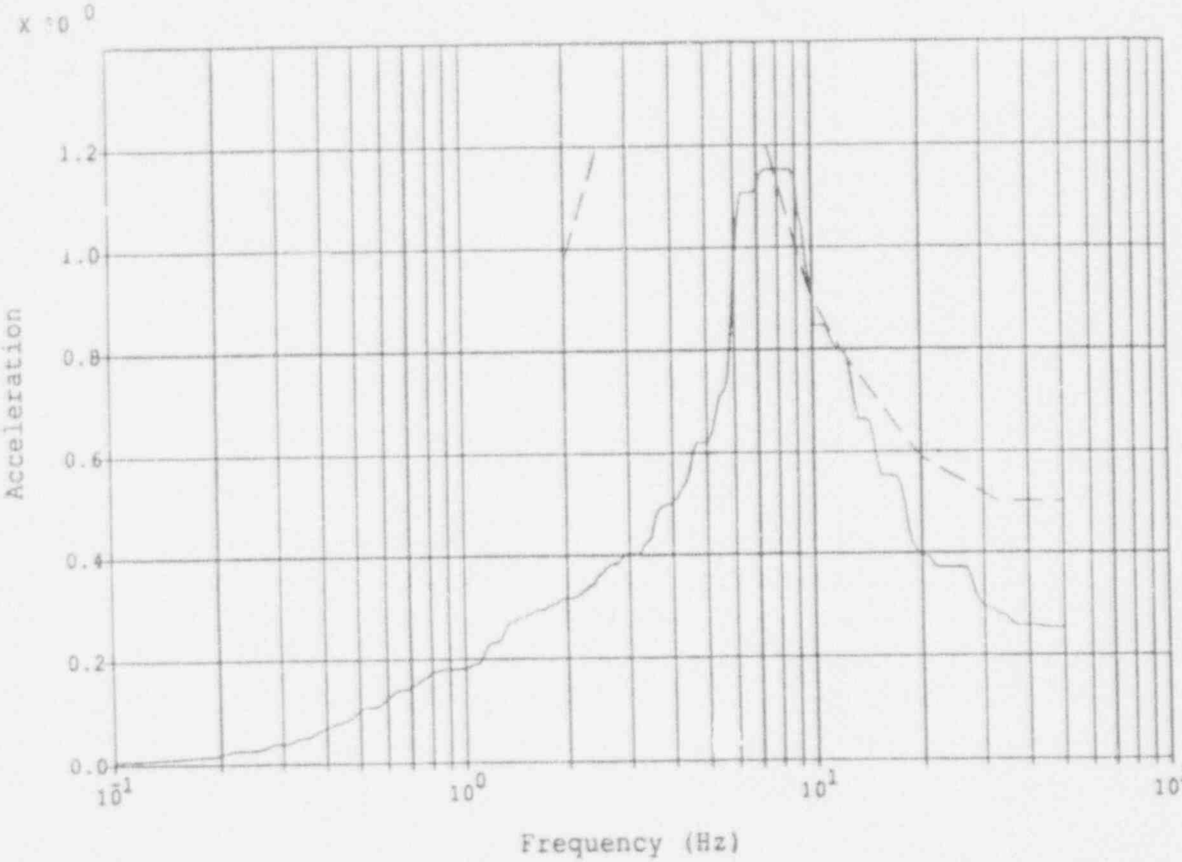
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Fuel Building, USI-A46 Analysis
Crane, Elev. 380', Translation in Vertical Direction

RSPLT SUN V1.2 end42z.plt 14:23:03 03/17/93

Figure 3-45



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — — —

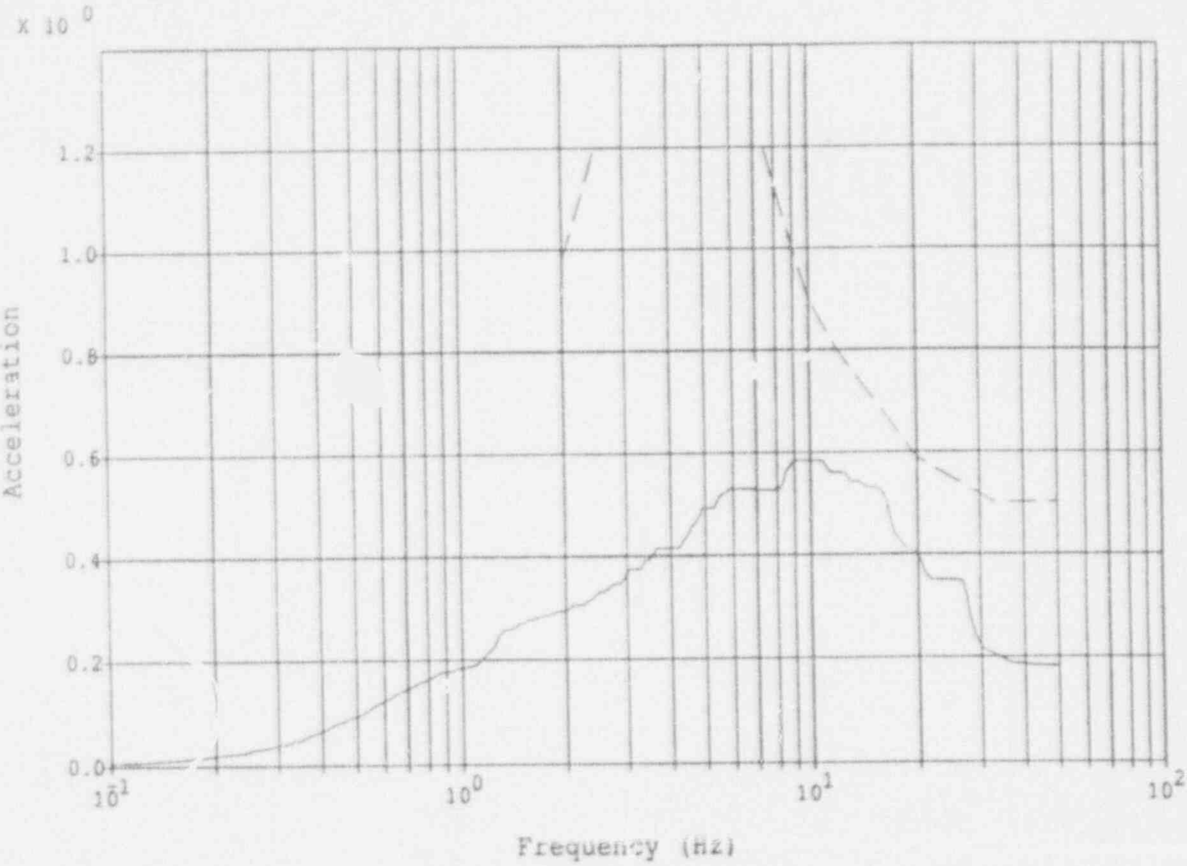
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Fuel Building, USI-A46 Analysis
Roof, Elev. 397'-6", Translation in EW Direction

RSPLT SUN V1.2 snd52x.plt 14:24:40 03/17/93

Figure 3-46



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — —

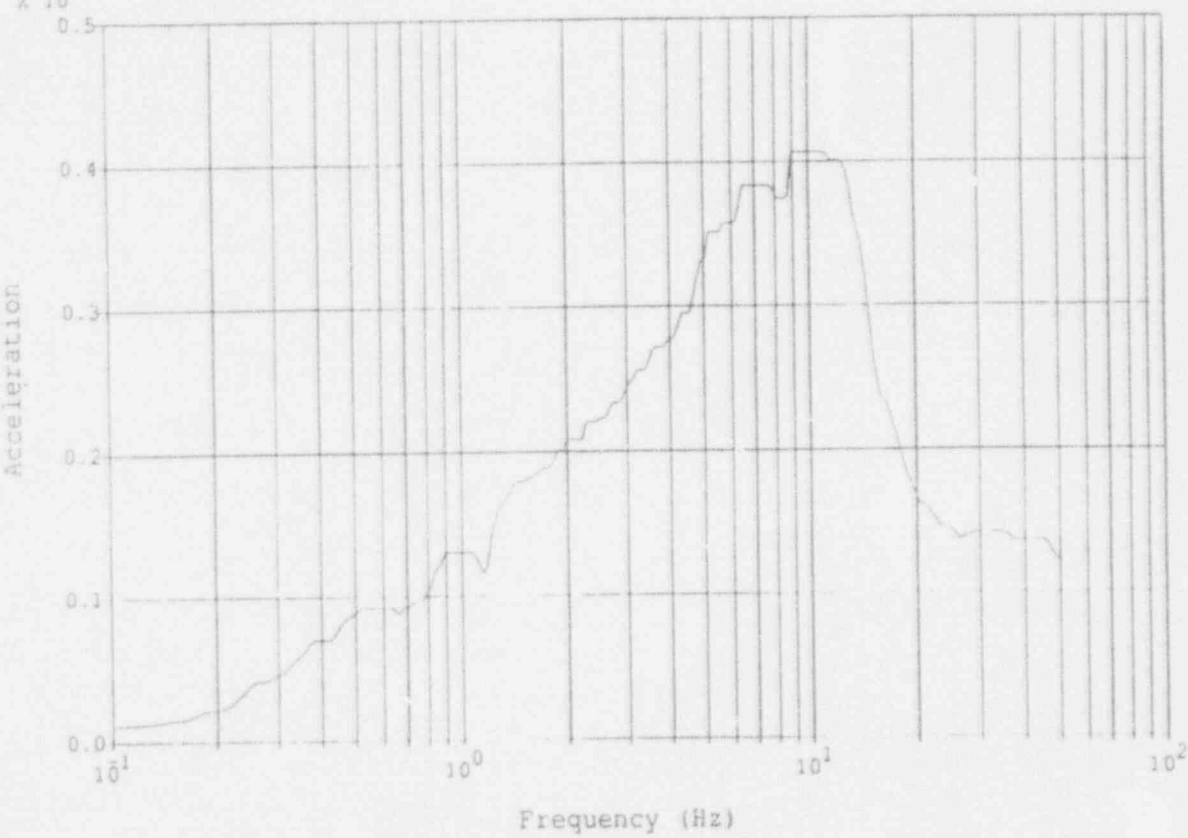
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Fuel Building, USI-A46 Analysis
Roof, Elev. 397'-6", Translation in NS Direction

RSPLT SUN V1.2 snd52v.plt 14:24:40 03/17/93

Figure 3-47

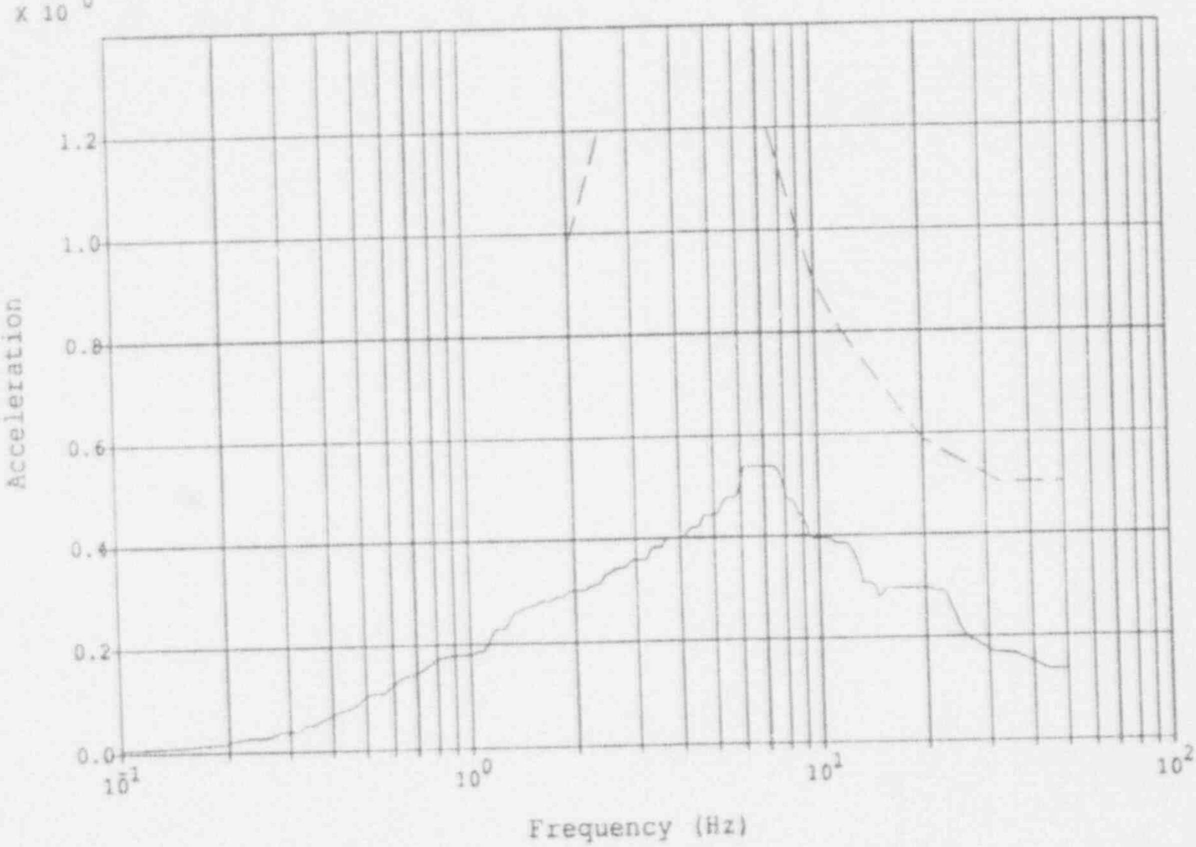


Notes:
Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Fuel Building, USI-A46 Analysis
Roof, Elev. 397'-6", Translation in Vertical Direction

RSPLT SUN V1.2 end52z.plt :23:16 03/17/93

Figure 3-48



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — —

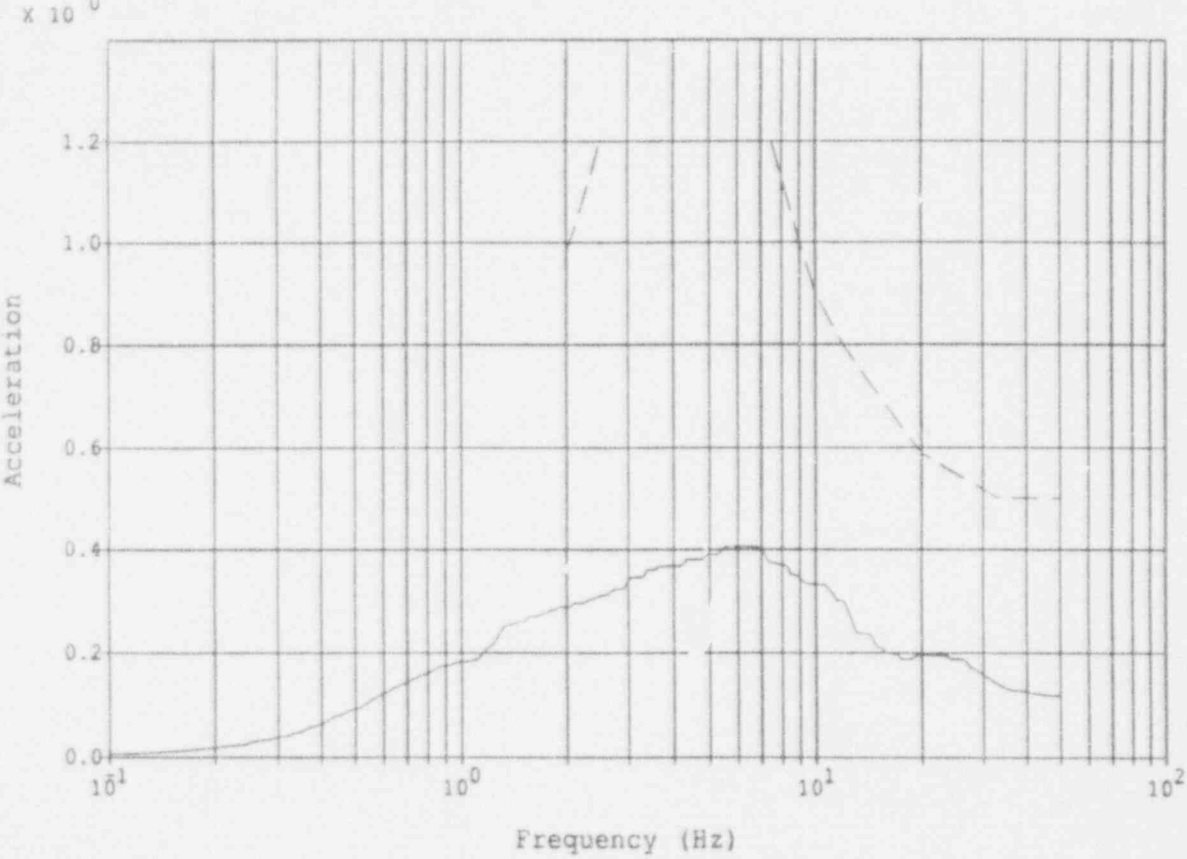
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Control Building, USI-A46 Analysis
Floor, Elev. 322', Translation in EW Direction

RSPLT SUN V1.2 snd23x.plt 14:24:08 03/17/93

Figure 3-49



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — —

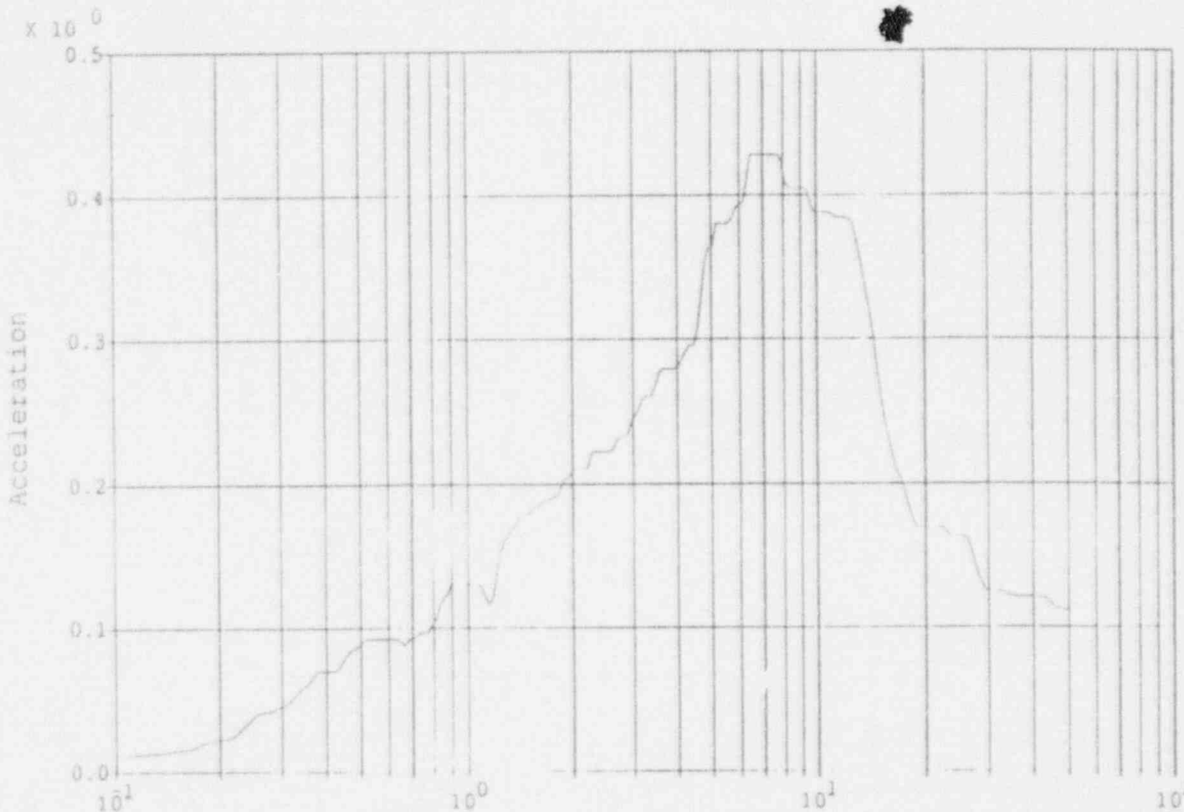
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Control Building, USI-A46 Analysis
Floor, Elev. 322', Translation in NS Direction

RSPLT SUN V1.2 snq23y.plt 14:24:08 03/17/93

Figure 3-50



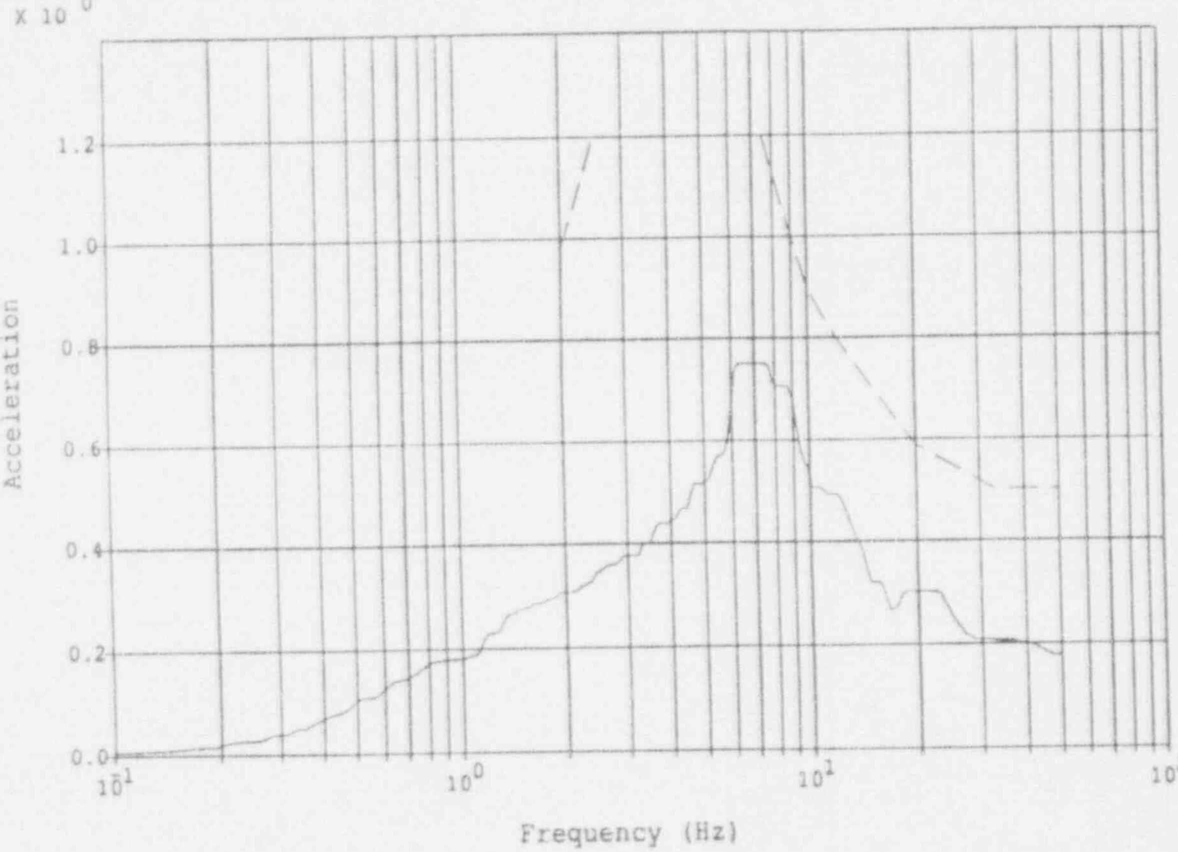
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Control Building, USI-A46 Analysis
Floor, Elev. 322', Translation in Vertical Direction

RSPLT SUN V1.2 end23z.plt 14:22:44 03/17/93

Figure 3-51



Legend:

Envelope of LB, BE UB Spectra ————

1.5 x SQUG Bounding Spectrum — — — —

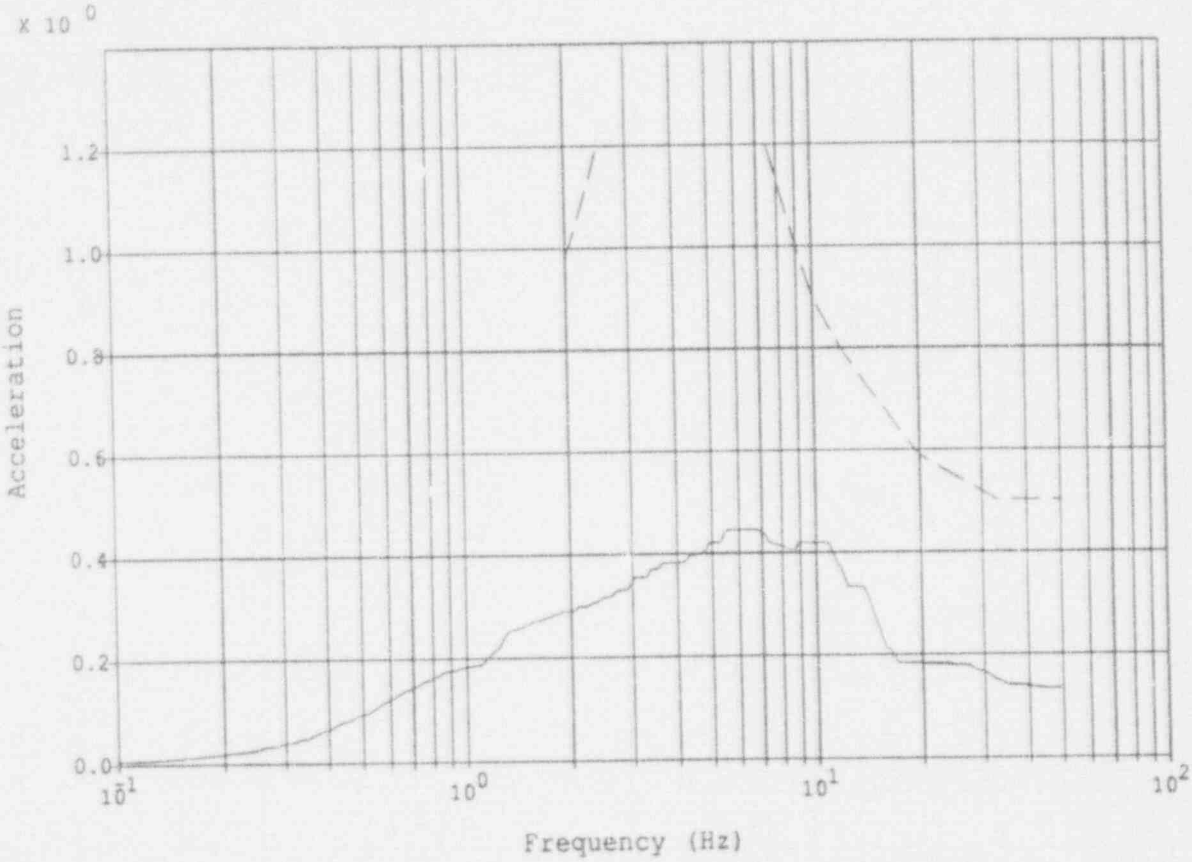
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Control Building, USI-A46 Analysis
Floor, Elev. 355', Translation in EW Direction

RSPLT SUN V1.2 snd45x.plt 14:24:31 03/17/92

Figure 3-52



Legend:

Envelope of LB, BE UB Spectra ————————

1.5 x SQUG Bounding Spectrum — — — — —

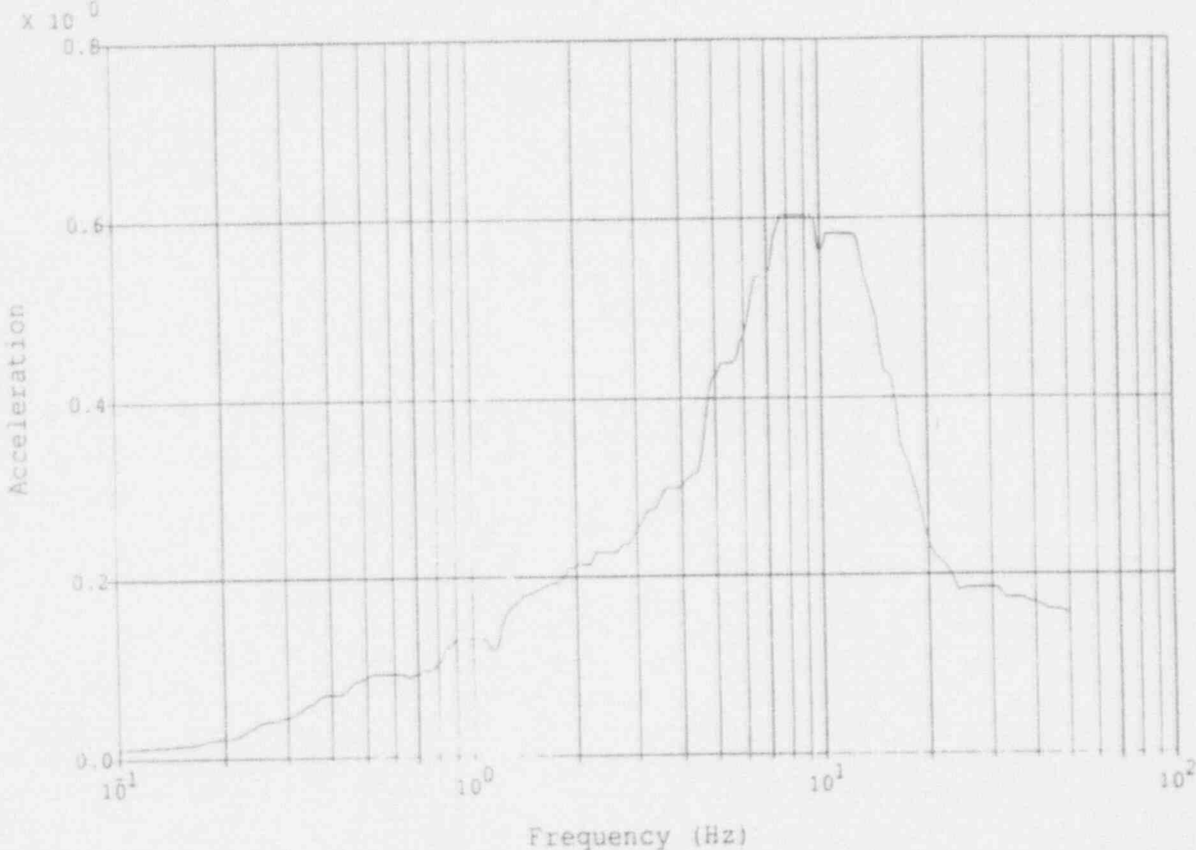
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Control Building, USI-A46 Analysis
Floor, Elev. 355', Translation in NS Direction

RSPLT SUN V1.2 snd45y.plt 14:24:31 03/17/93

Figure 3-53



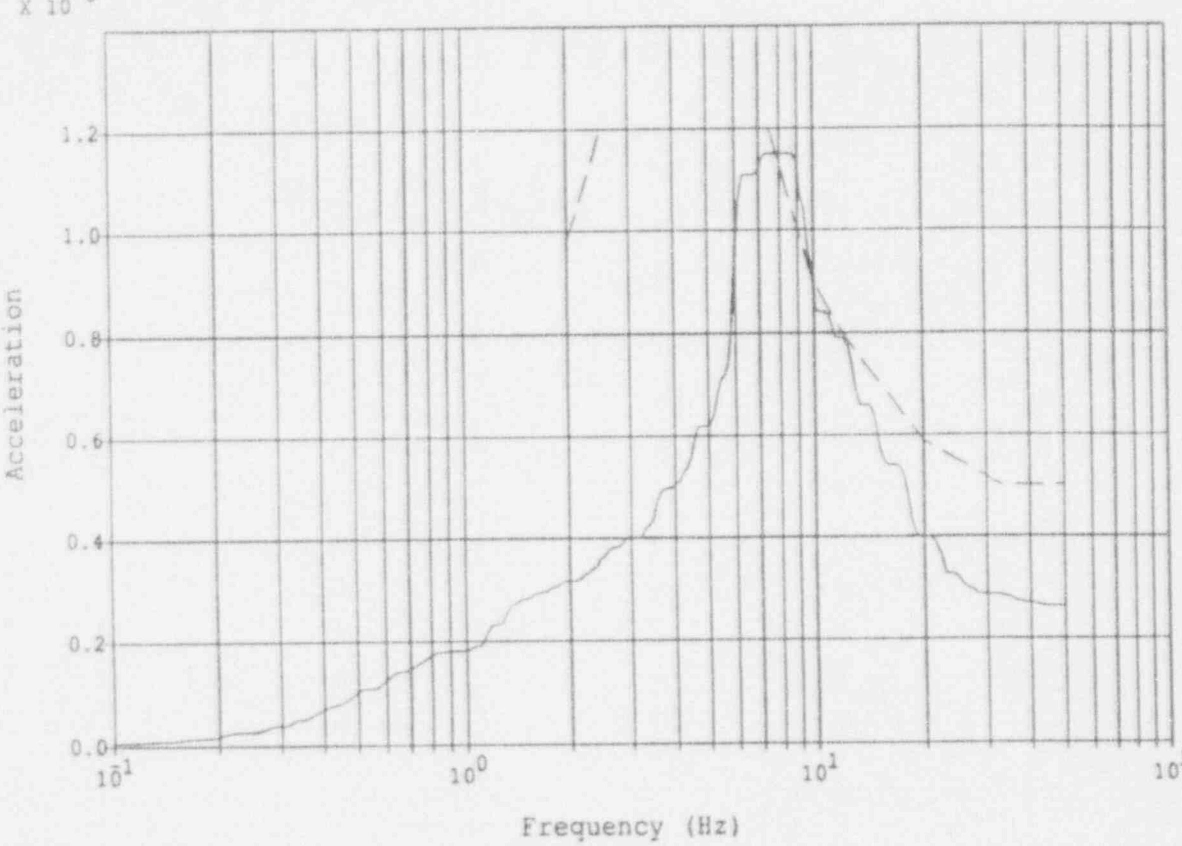
Notes:
Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Control Building, USI-A46 Analysis
Floor, Elev. 355', Translation in Vertical Direction

RSPLT SUN V1.2 end45z.plt 14:23:07 03/17/93

Figure 3-54

EQE



Legend:

Envelope of LB, BE UB Spectra ————————

1.5 x SQUG Bounding Spectrum — — — — —

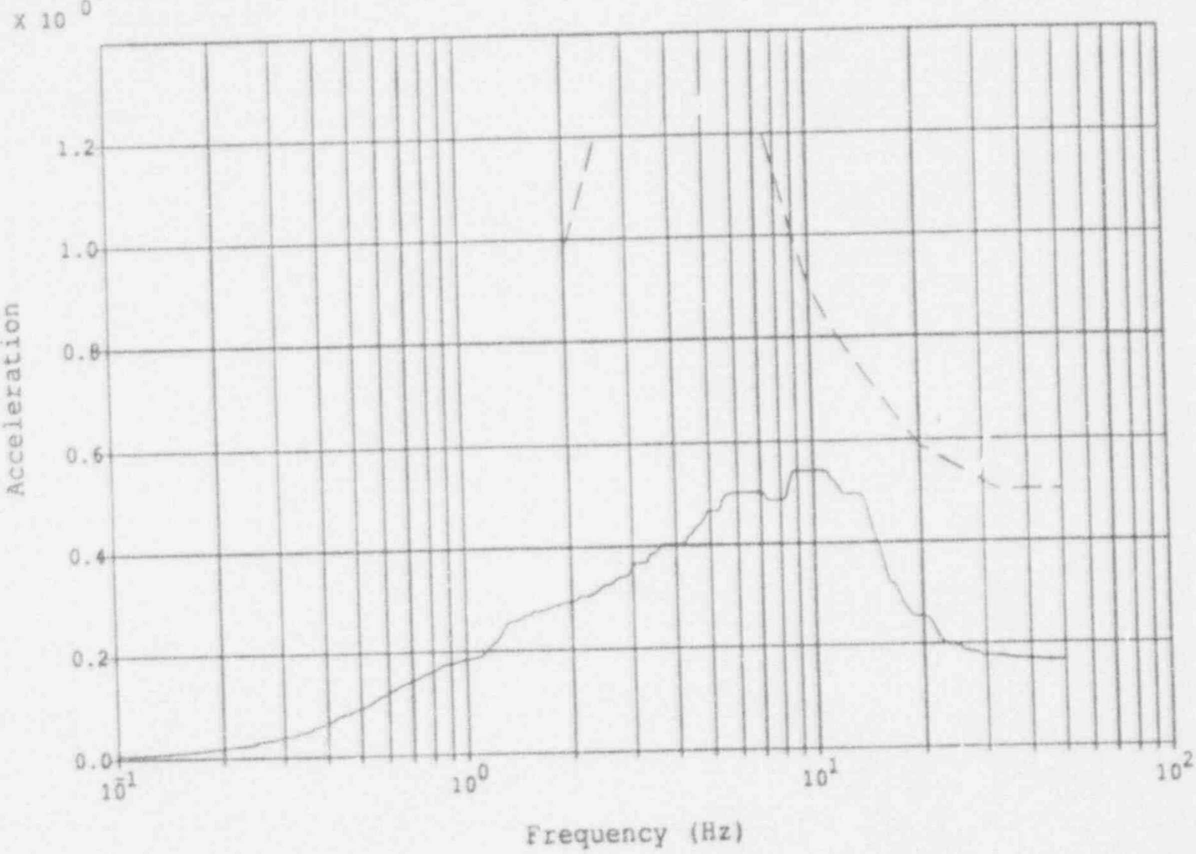
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Control Building, USI-A46 Analysis
Roof, Elev. 399'-6", Translation in EW Direction

RSPLT SUN V1.2 snd55x.plt 14:24:49 03/17/93

Figure 3-55



Legend:

Envelope of LB, BE UB Spectra ————————

1.5 x SQUG Bounding Spectrum — — — — —

Notes:

Enveloped In-Structure Response Spectra

LB & UB Broadened 10%

BE Broadened 15%

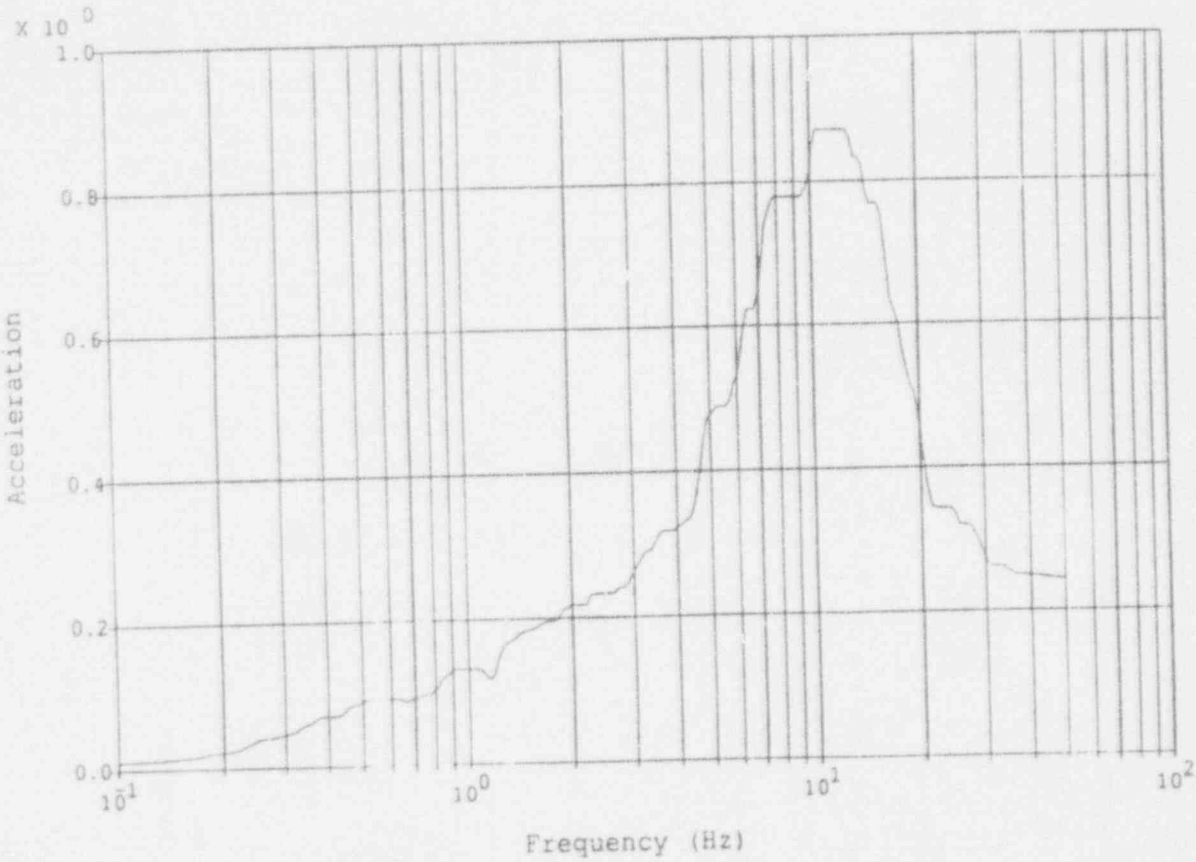
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Control Building, USI-A46 Analysis
Roof, Elev. 399'-6", Translation in NS Direction

RSPLT SUN V1.2 snd55y.plt 14:24:49 03/17/93

Figure 3-56



Notes:

Enveloped In-Structure Response Spectrum

LB & UB Broadened 10%

BE Broadened 15%

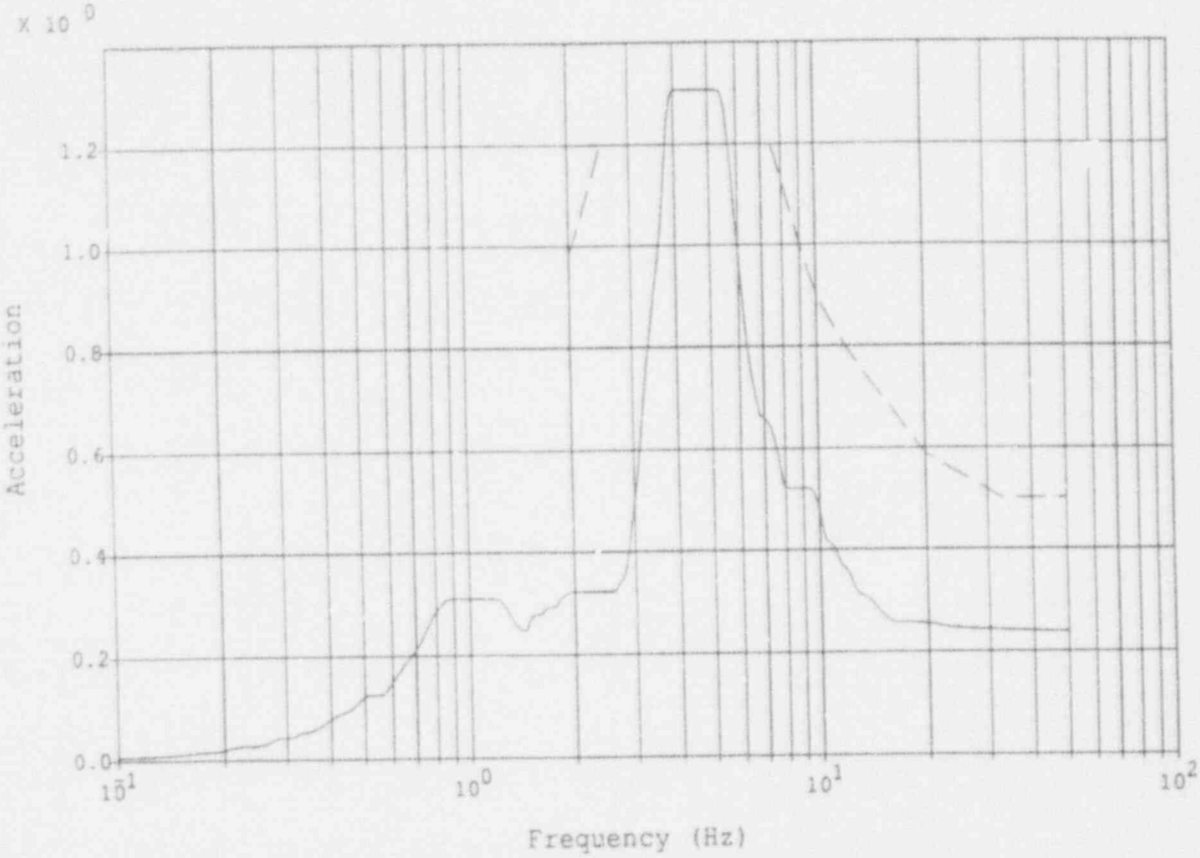
5.0 % Spectral Damping

Accelerations in g's

GPU: Three Mile Island Control Building, USI-A46 Analysis
Roof, Elev. 399'-6", Translation in Vertical Direction

RSPLT SUN V1.2 end55z.plt 14:23:21 03/17/93

Figure 3-57



Legend:

In-Struct. Response Spectrum ————————

1.5 times SQUG Bounding Spectrum — — — — —

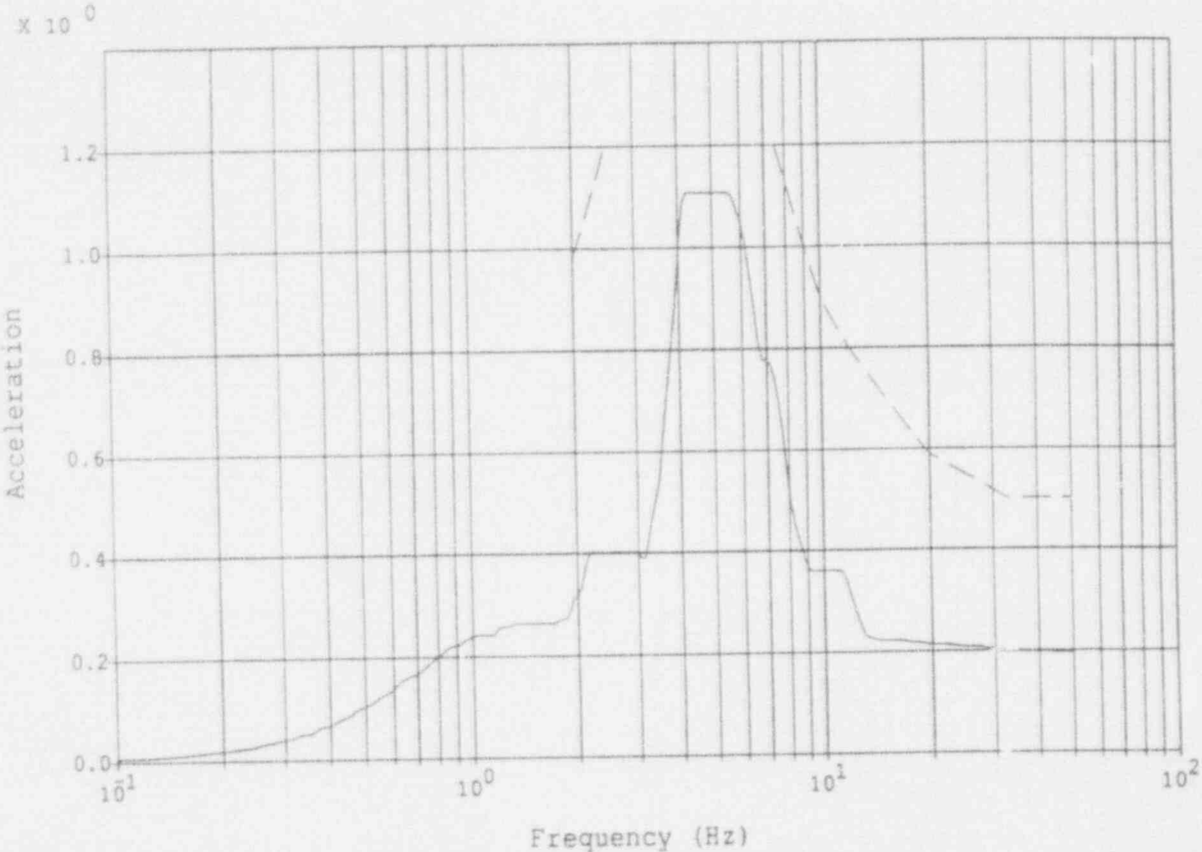
Notes:

In-Structure Response Spectrum
Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Turbine Building, USI-A46 Analysis
SE Slab, Elev. 322', Translation in NS Direction

RSPLT SUN V1.2 rnd65x.plt 08:39:57 03/24/93

Figure 3-58



Legend:

In-Struct. Response Spectrum ————————

1.5 times SQUG Bounding Spectrum — — — — —

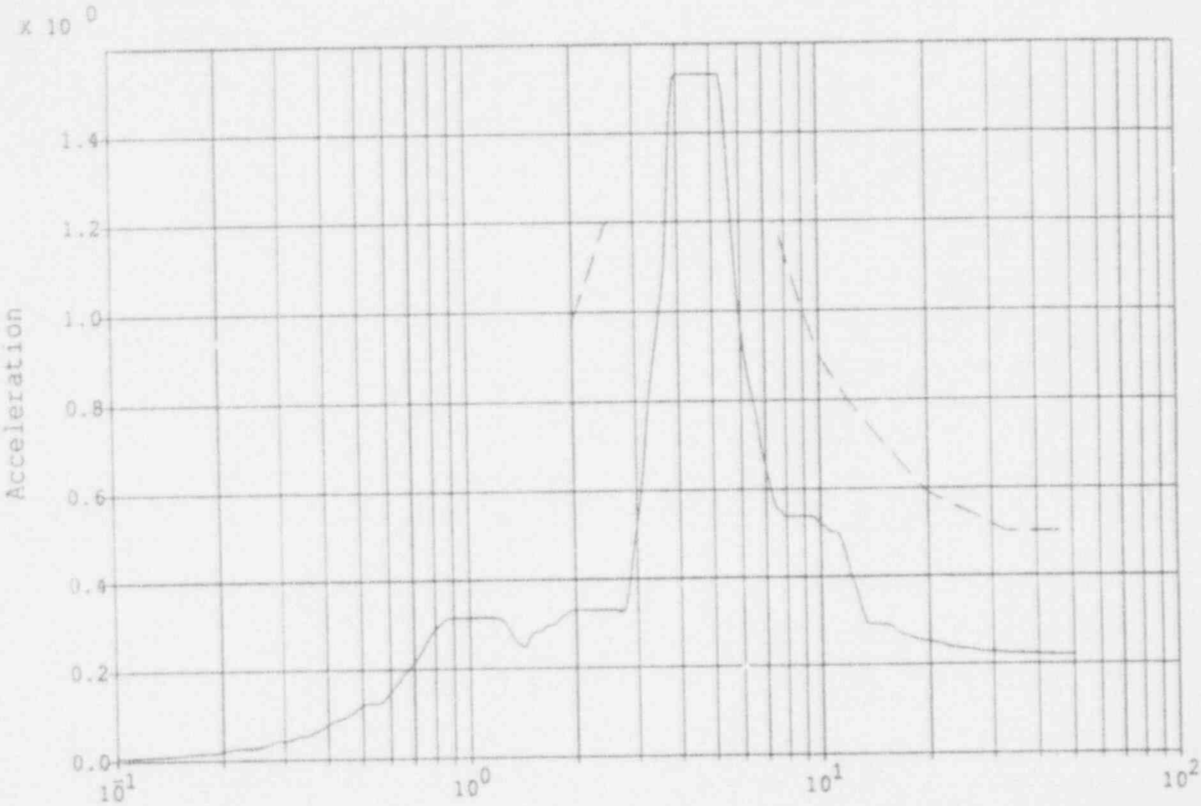
Notes:

In-Structure Response Spectrum
Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Turbine Building, USI-A46 Analysis
SE Slab, Elev. 322', Translation in EW Direction

RSPLT SUN V1.2 rnd65y.plt 08:39:57 03/24/93

Figure 3-59



Legend:

In-Struct. Response Spectrum ————————

1.5 times SQUG Bounding Spectrum — — — — —

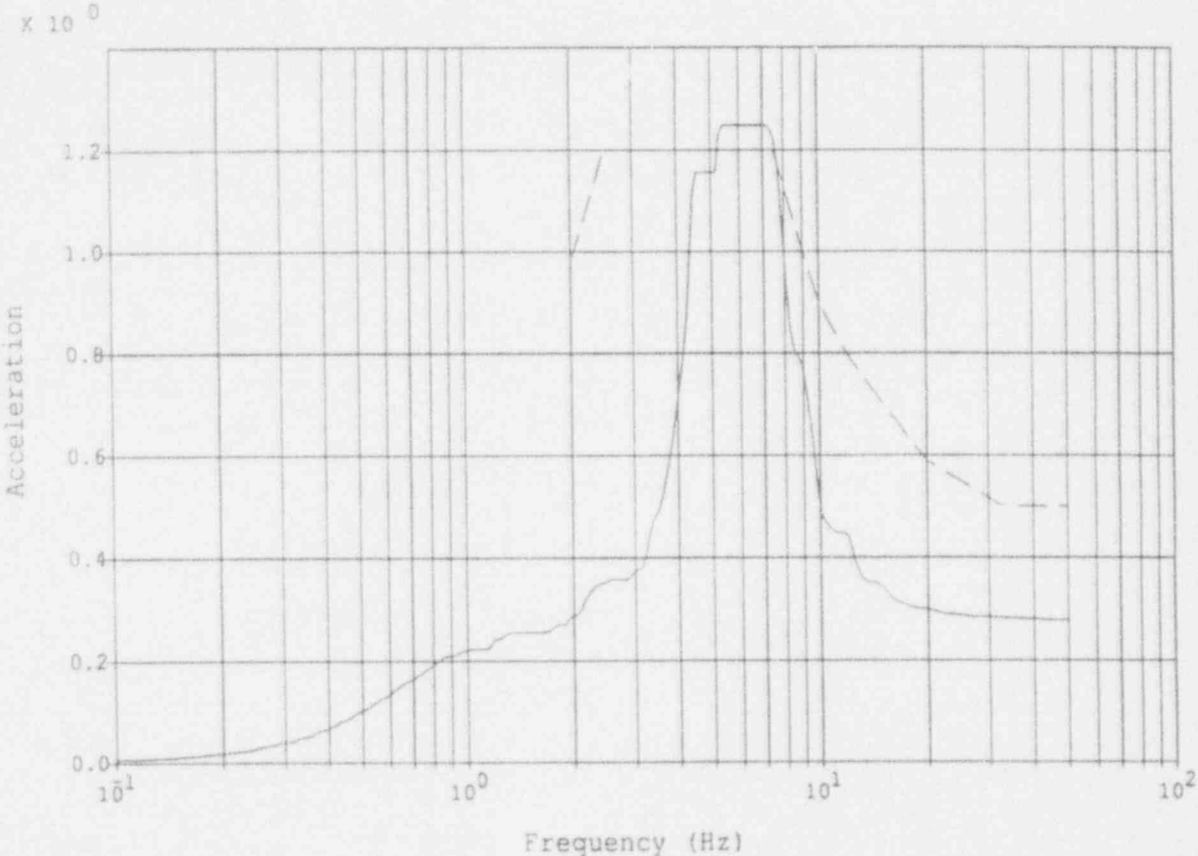
Notes:

In-Structure Response Spectrum
Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Turbine Building, USI-A46 Analysis
NW Slab, Elev. 322', Translation in NS Direction

RSPLT SUN V1.2 rnd89x.plt 08:39:57 03/24/93

Figure 3-60



Legend:

In-Struct. Response Spectrum ————

1.5 times SQUG Bounding Spectrum — — — —

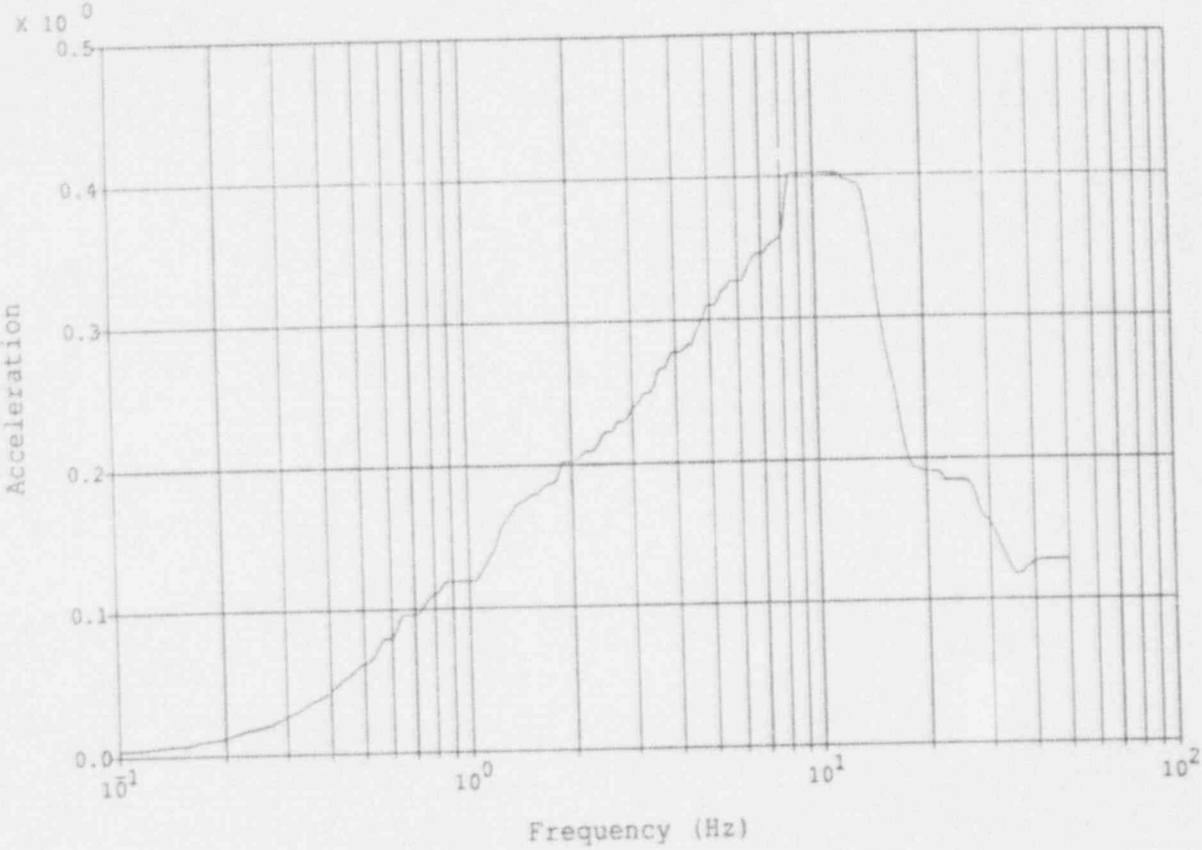
Notes:

In-Structure Response Spectrum
Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Turbine Building, USI-A46 Analysis
NW Slab, Elev. 322', Translation in EW Direction

RSPLT SUN V1.2 rnd89y.plt 08:39:57 03/24/93

Figure 3-61

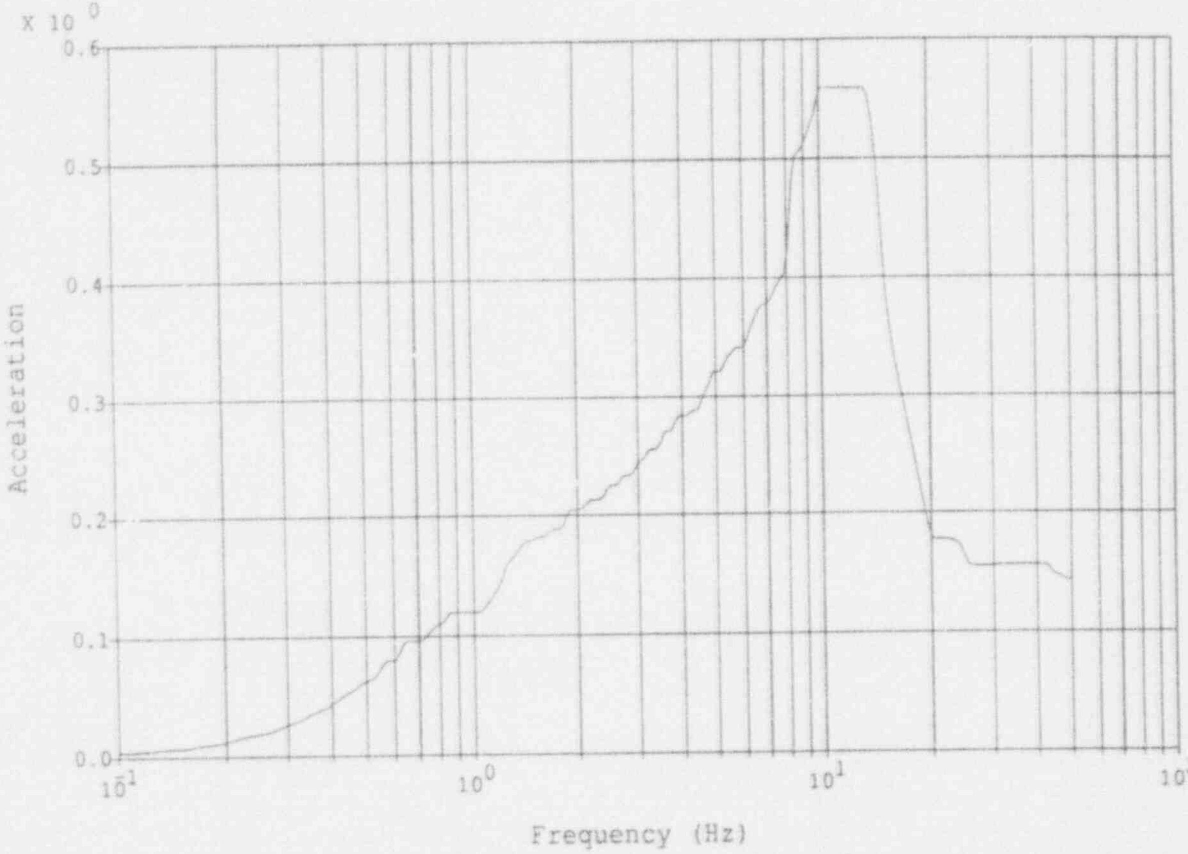


Notes:
In-Structure Response Spectrum
5.0 % Spectral Damping
Accelerations in g's
Broadening of +/- 15%

GPU: Three Mile Island Turbine Building, USI-A46 Analysis
SE Slab, Elev. 322', Translation in Vertical Direction

RSPLT SUN V1.2 rnd65z.plt 16:44:09 03/23/93

Figure 3-62

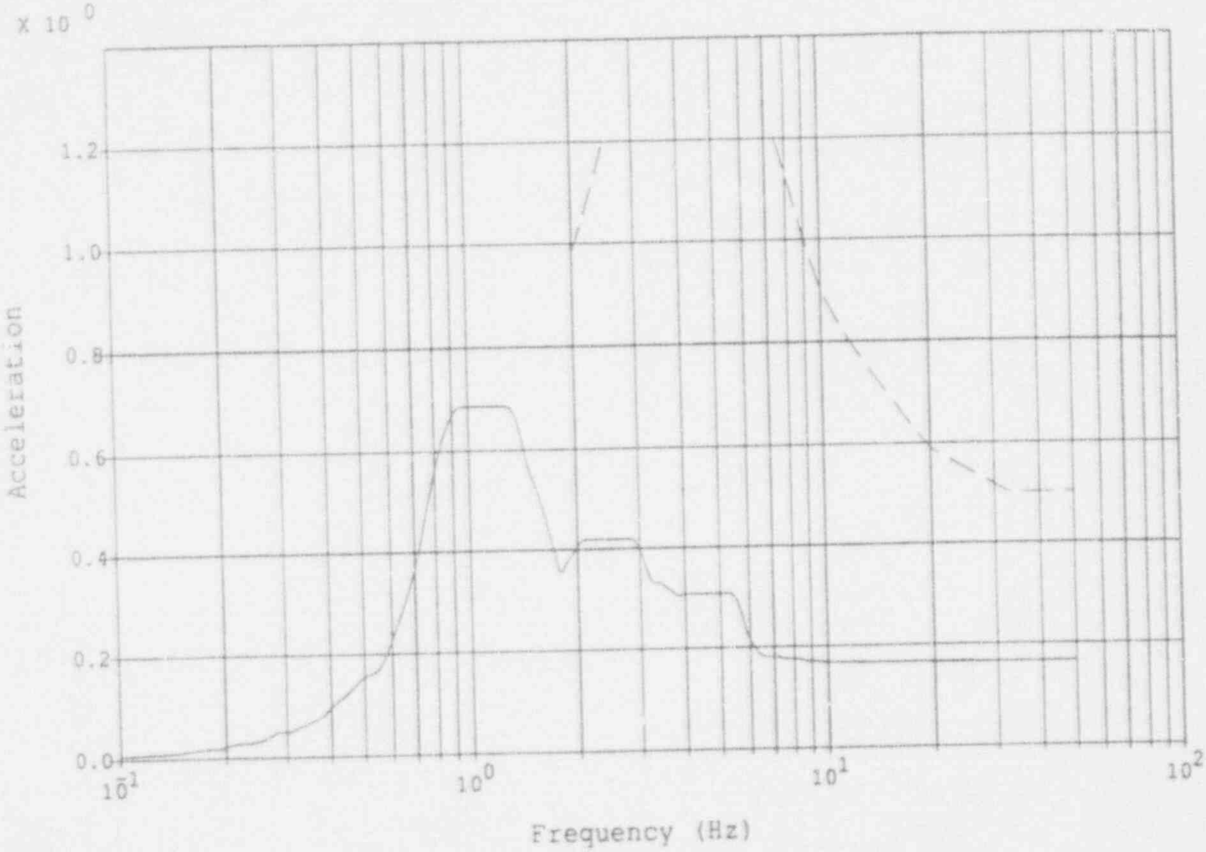


Notes:
In-Structure Response Spectrum
5.0 % Spectral Damping
Accelerations in g's
Broadening of +/- 15%

GPU: Three Mile Island Turbine Building, USI-A46 Analysis
NW Slab, Elev. 322', Translation in Vertical Direction

RSPLT SUN V1.2 rnd89z.plt 16:44:09 03/23/93

Figure 3-63



Legend:

In-Struct. Response Spectrum ————————

1.5 times SQUG Bounding Spectrum — — — — —

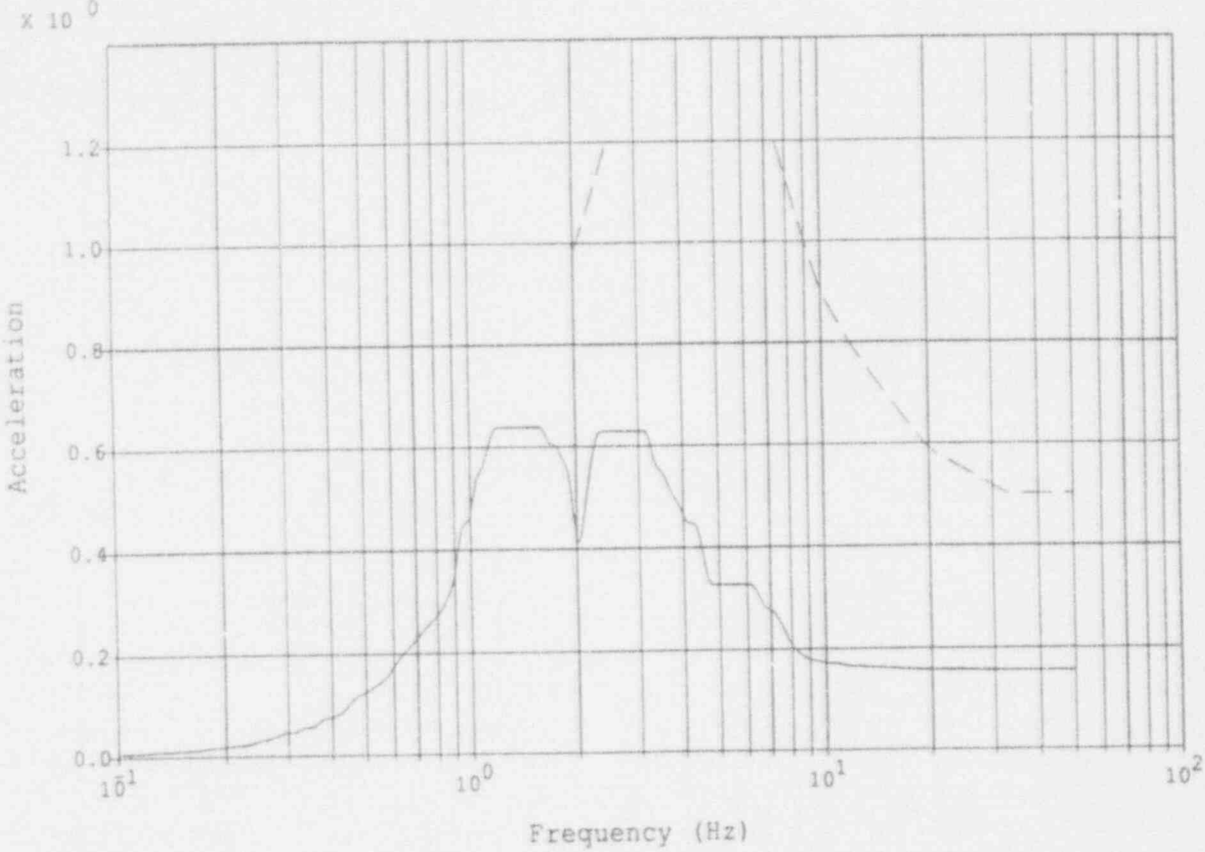
Notes:

In-Structure Response Spectrum
Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Turbine Building, USI-A46 Analysis
Floor, Elev. 355', Translation in NS Direction

RSPLT SUN V1.2 rnd116x.plt 08:39:57 03/24/93

Figure 3-64



Legend:

In-Struct. Response Spectrum ————————

1.5 times SQUG Bounding Spectrum — — — — —

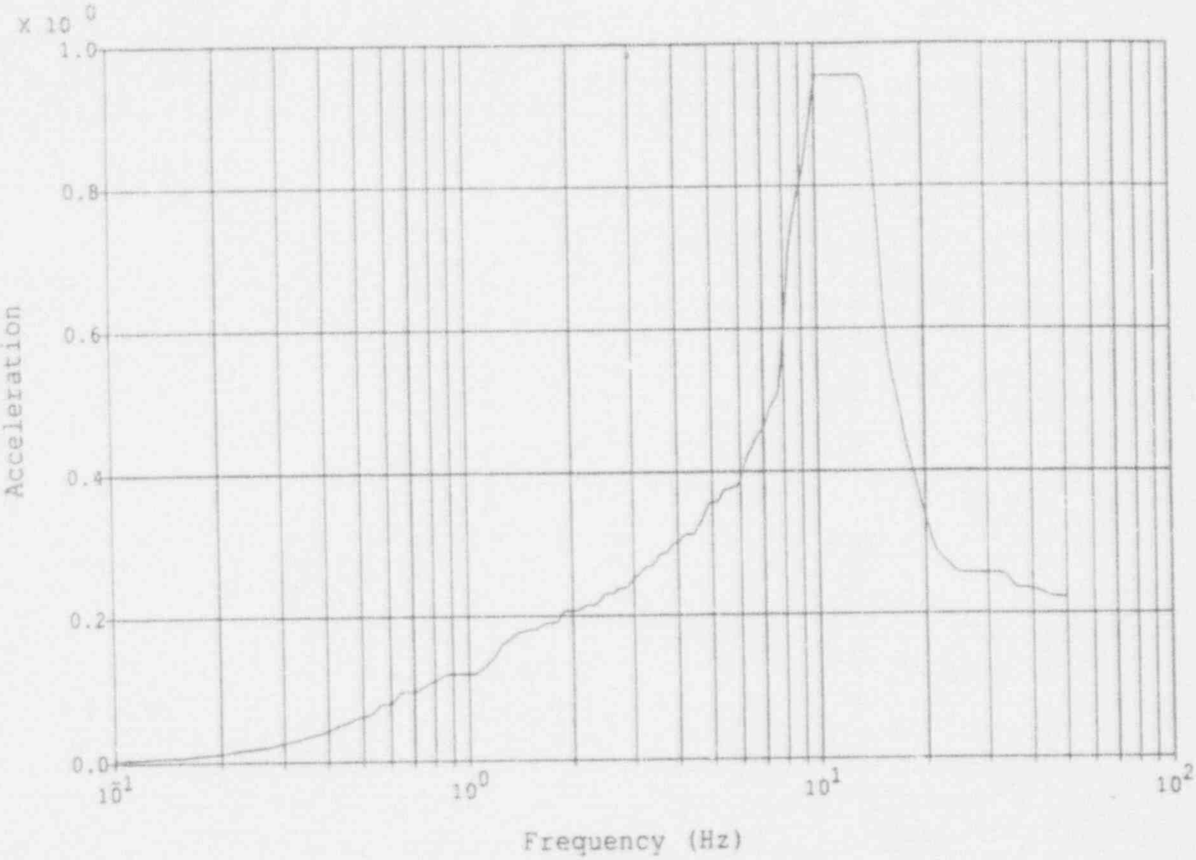
Notes:

In-Structure Response Spectrum
Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Turbine Building, USI-A46 Analysis
Floor, Elev. 355', Translation in EW Direction

RSPLT SUN V1.2 rnd116y.plt 08:39:57 03/24/93

Figure 3-65



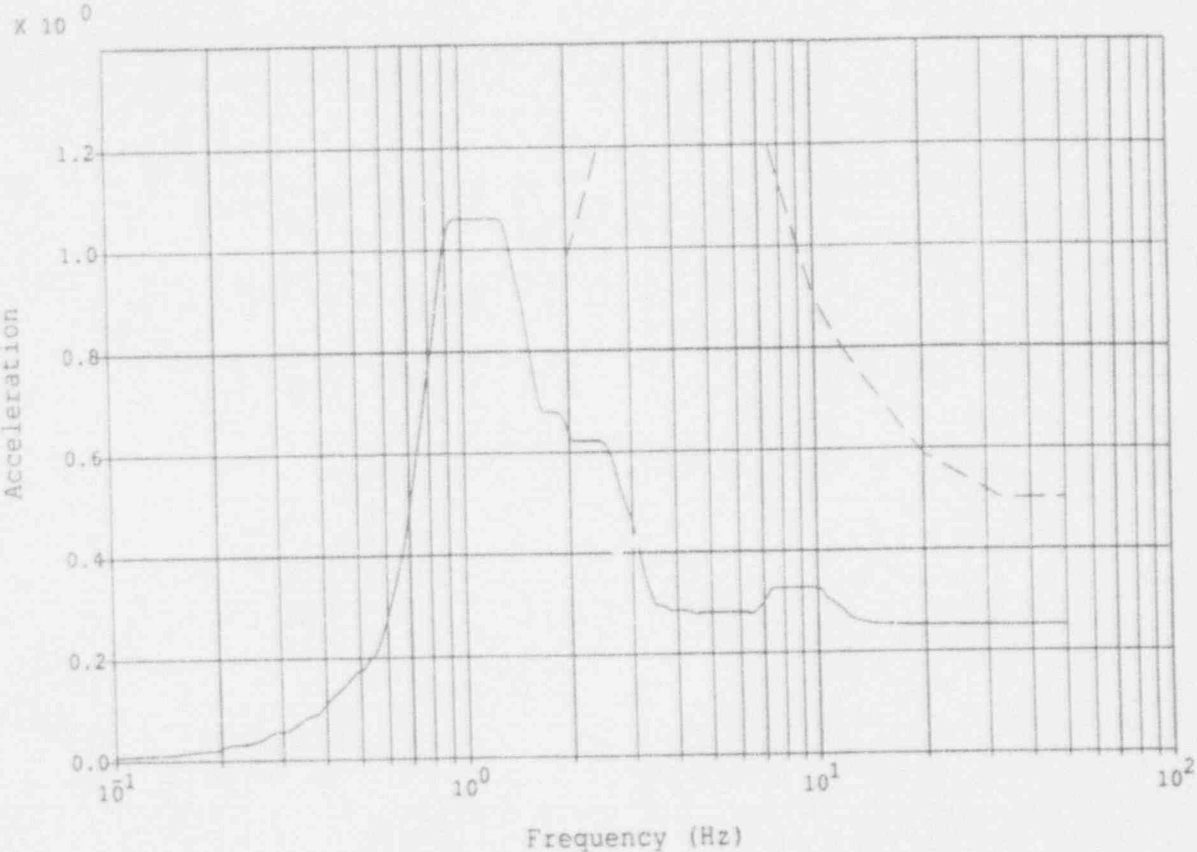
Notes:

In-Structure Response Spectrum
5.0 % Spectral Damping
Accelerations in g's
Broadening of +/- 15%

GPU: Three Mile Island Turbine Building, USI-A46 Analysis
Floor, Elev. 355', Translation in Vertical Direction

RSPLT SUN V1.2 rnd116z.plt 16:44:09 03/23/93

Figure 3-66



Legend:

In-Struct. Response Spectrum ————————

1.5 times SQUG Bounding Spectrum — — — — —

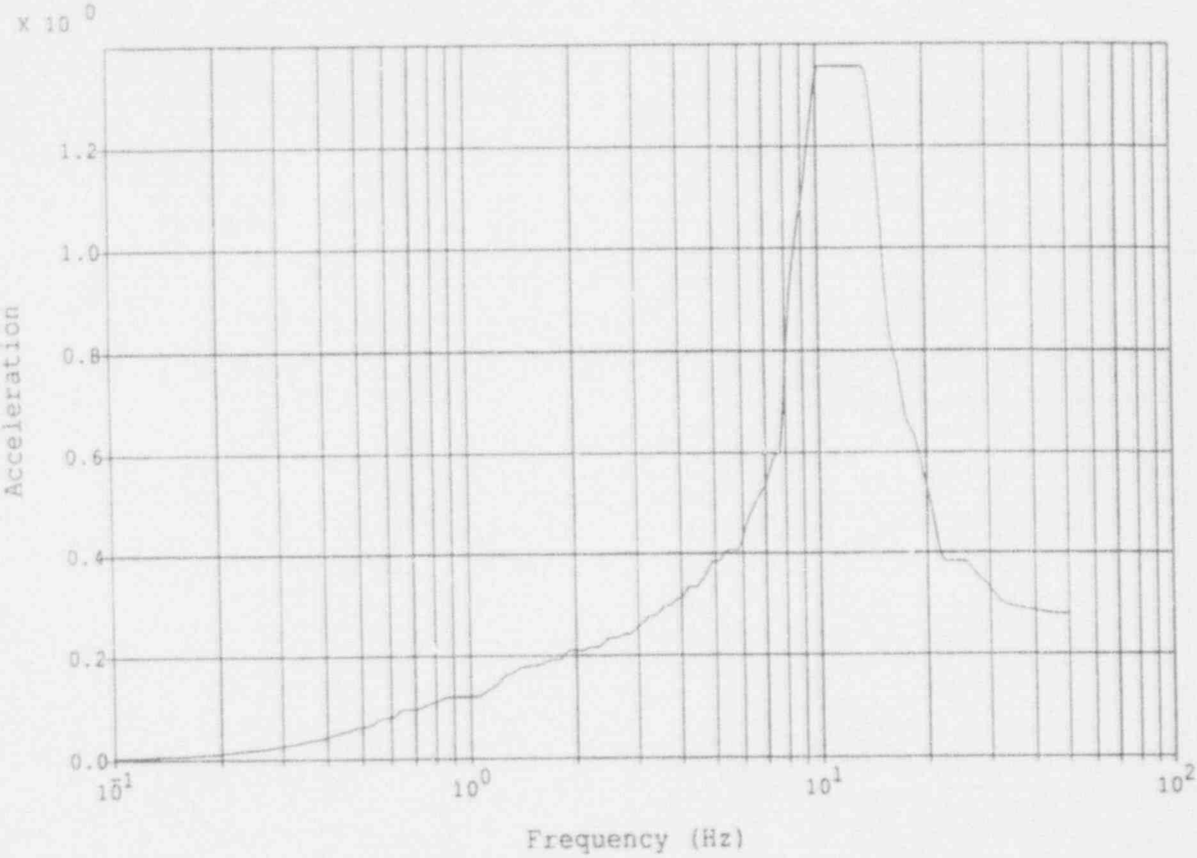
Notes:

In-Structure Response Spectrum
Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Turbine Building, USI-A46 Analysis
Crane, Elev. 393', Translation in NS Direction

RSPLT SUN V1.2 rnd179x.plt 08:39:57 03/24/93

Figure 3-67



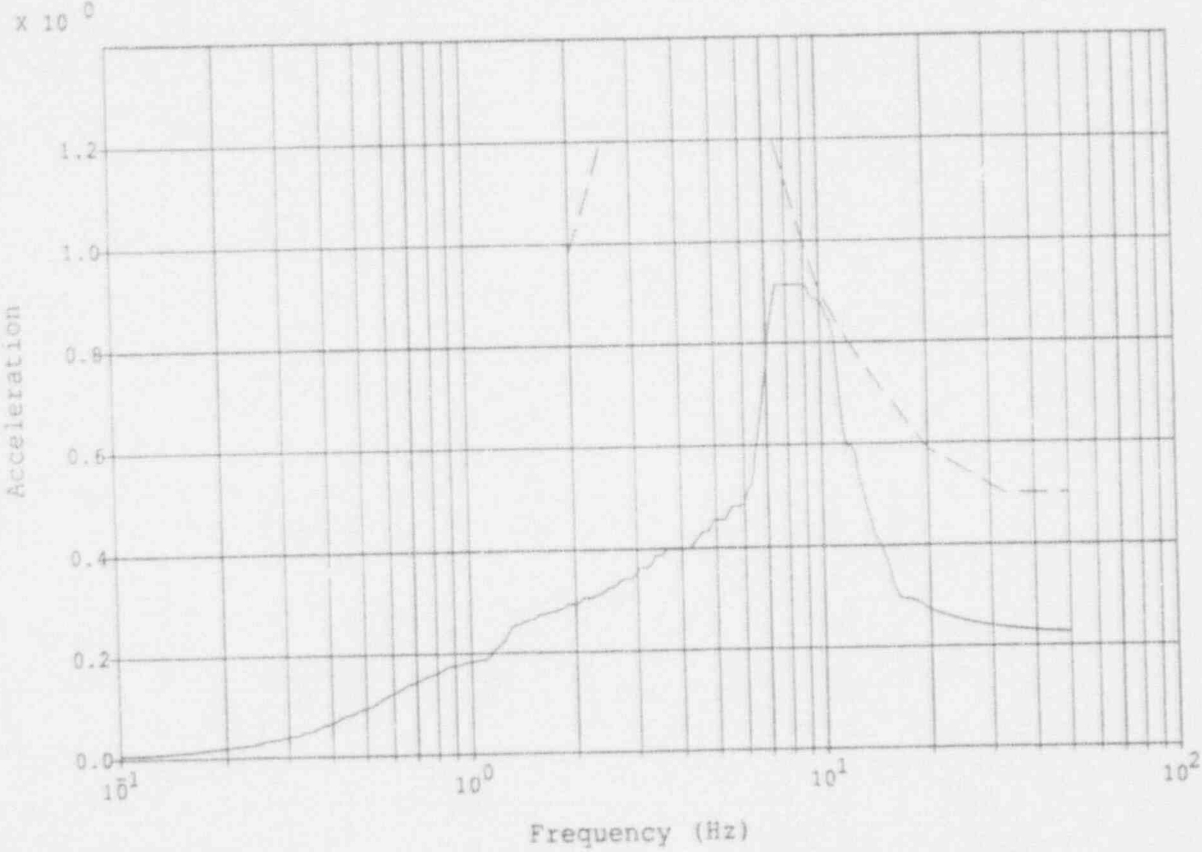
Notes:

In-Structure Response Spectrum
5.0 % Spectral Damping
Accelerations in g's
Broadening of +/- 15%

GPU: Three Mile Island Turbine Building, USI-A46 Analysis
Crane, Elev. 393', Translation in Vertical Direction

RSPLT SUN V1.2 rnd179z.plt 16:44:09 03/23/93

Figure 3-68



Legend:

Envelope of LB, BE UB Spectra ————————

1.5 x SQUG Bounding Spectrum — — — — —

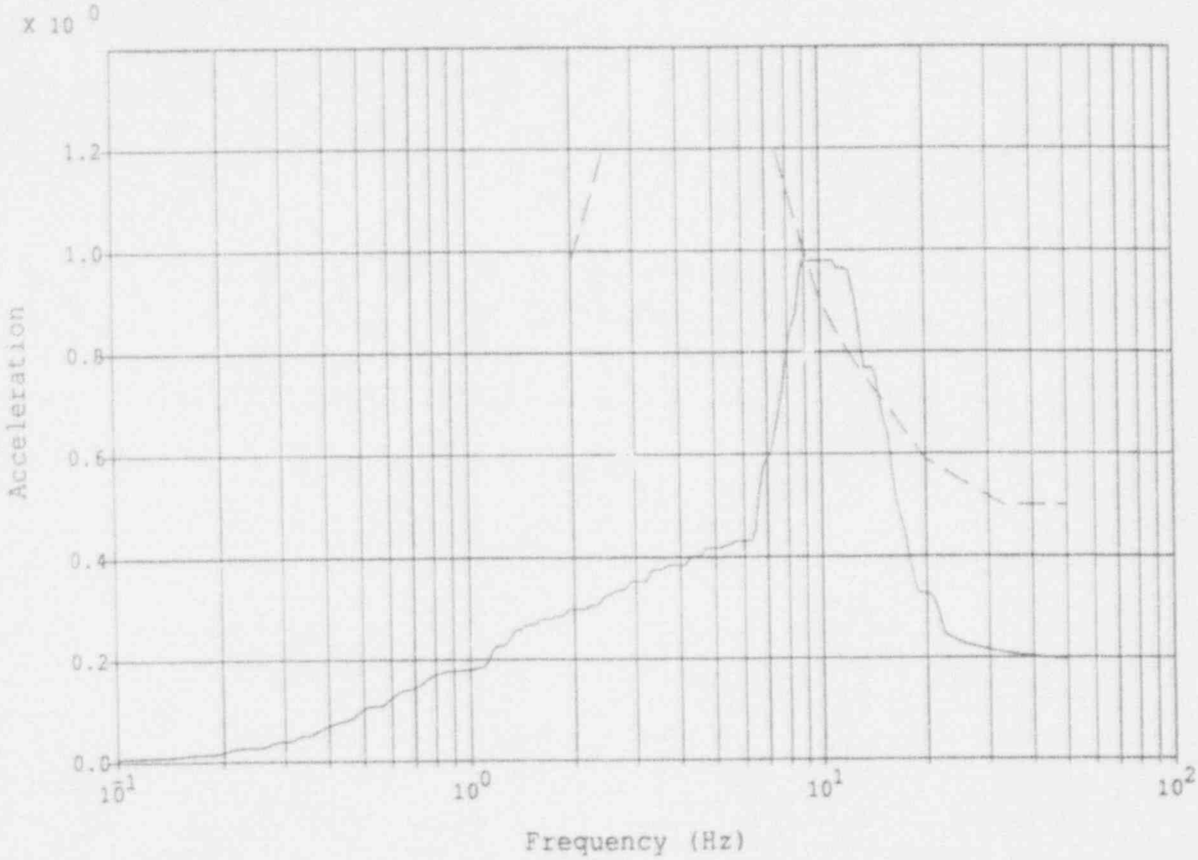
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Turbine Pedestal, USI-A46 Analysis
Floor, Elev. 355', Translation in EW Direction

RSPLT SUN V1.2 snd03y.plt 15:12:52 03/25/93

Figure 3-69



Legend:

Envelope of LB, BE UB Spectra ————————

1.5 x SQUG Bounding Spectrum — — — — —

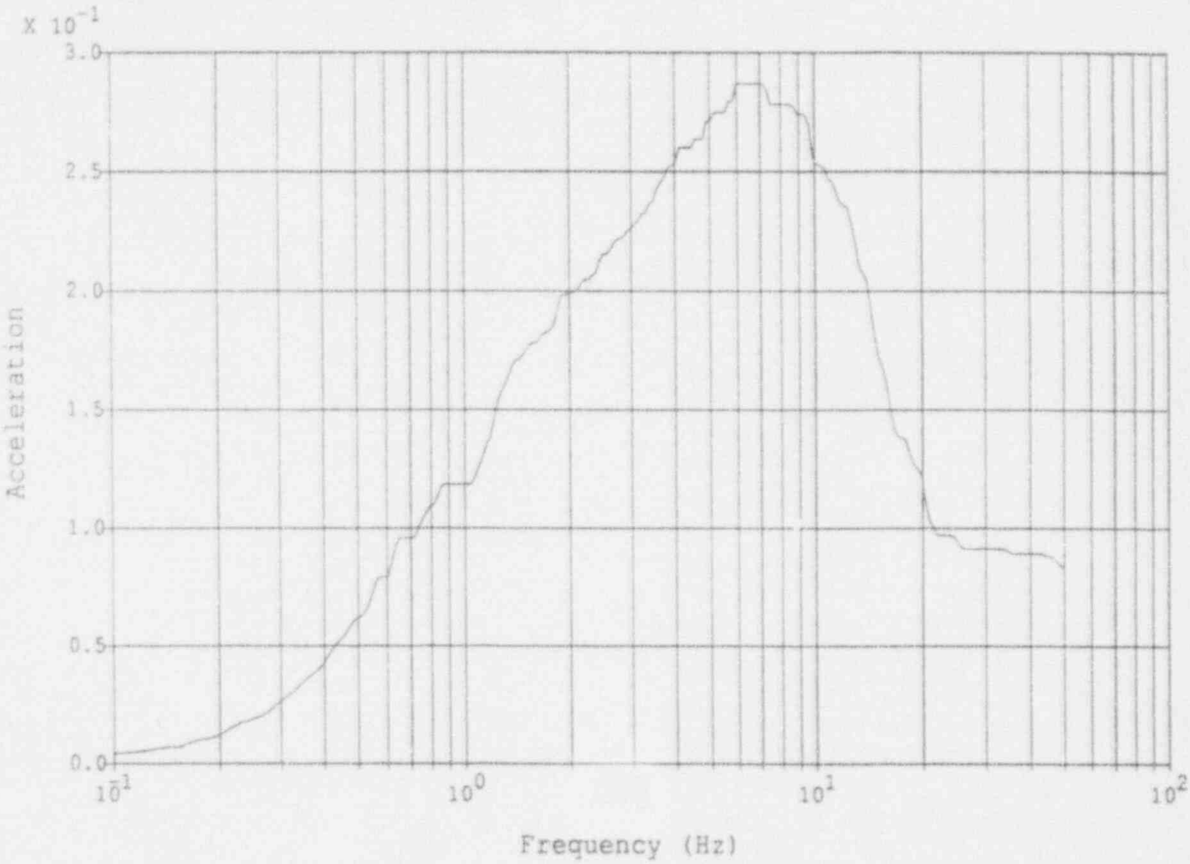
Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Turbine Pedestal, USI-A46 Analysis
Floor, Elev. 355', Translation in NS Direction

RSPLT SUN V1.2 snd03x.plt 15:12:52 03/25/93

Figure 3-70



Notes:

Enveloped In-Structure Response Spectrum
LB & UB Broadened 10%
BE Broadened 15%
5.0 % Spectral Damping
Accelerations in g's

GPU: Three Mile Island Turbine Pedestal, USI-A46 Analysis
Floor, Elev. 355', Translation in Vertical Direction

RSPLT SUN V1.2 end03z.plt 15:07:38 03/25/93

Figure 3-71

4. REFERENCES

1. Seismic Qualification Utility Group. February 1992. *Generic Implementation Procedure for Seismic Verification of Nuclear Plant Equipment*. Rev. 2.

2. GPU Nuclear TMI - Unit 1 FSAR. July 1982. Update 1.

3. U. S. Nuclear Regulatory Commission. August 1989. "Standard Review Plan." NUREG-0800. Section 3.7. Revision 2.

4. U.S. Atomic Energy Commission. October 1973. *Damping Value for Seismic Design of Nuclear Power Plants.* Regulatory Guide 1.61.

5. U.S. Nuclear Regulatory Commission. February 1978. *Development of Floor Design Response Spectra for Seismic Design of Floor-supported Equipment or Components.* Regulatory Guide 1.122. Revision 1.

6. GPU Nuclear TMI - Unit 1 FSAR. July 1990. Section 2.7. Update 9.

7. EQE International. Calculation 50097-C-009. "Development of High Strain Soil Properties." Rev. 0.

8. CLASSI: EQE QA Documents AA-QA-005 and AA-QA-004A-01.

9. SASSI: EQE QA Documents AA-QA-041.

10. EQE International. Calculation 50097-C-002. "Intermediate Building Model." Rev. 0.

11. EQE International. Calculation 50097-C-005. "Control Building Model." Rev. 0.

12. EQE International. Calculation 50097-C-001 to 50097-C-006, 50097-C-008 to 50097-C-010, 50097-C-012 to 50097-C-018, 50097-C-029 and 50097-C-030.

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