ATTACHMENT 1 TO IPN-92-043

PROCEDURES AND CRITERIA FOR GENERATION OF IN-STRUCTURE RESPONSE SPECTRA

NEW YORK POWER AUTHORITY
INDIAN POINT 3 NUCLEAR POWER PLANT
DOCKET NO. 50-286
DPR-64

9210050260 920922
PDR ADOCK 05000286
P PDR

INDIAN POINT UNIT NO. 3
SUMMARY OF SEISMIC RESPONSE SPECTRA CHARACTERISTICS

Prepared for
New York Power Authority

Author: William S. LaPay

Reviewer: Narendra Prasad

Reviewer: Lee Tunon-Sanjur

Westinghouse Electric Corporation
Nuclear and Advanced Technology Division
Engineering Technology Department
Structural Engineering & Piping Technology
P.O. Box 355
Pittsburgh, Pa. 15230

Indian Point Unit No. 3
Summary of Seismic Response Spectra Characteristics

Table of Contents

List of Figures

List of Tables

1.0 Introduction

2.0 Seismic Design Basis

3.0 Plant Seismic Analysis

4.0 Floor Response Spectra Characteristics

4.1 Containment Structure

4.2 Inner Containment Structure

4.3 Primary Auxiliary Building

4.4 Control and Diesel Generator Building

4.5 Fan House Building

4.6 Intake Structure

4.7 Spent Fuel Pit

4.8 Shield Wall

Indian Point Unit No. 3
Summary of Seismic Response Spectra Characteristics

List of Figures

Figure	Title
1	Indian Point Unit No. 3 Plot Plan
2	Indian Point Unit No. 3 Plot Profile
3	Horizontal DBE Seismic Ground Response
4	Horizontal OBE Seismic Ground Response Spectra
5	Comparison of Desired Spectra and Actual Spectra Corresponding to Simulated Earthquake Record for 2% Damping
6	Comparison of Desired Spectra and Actual Spectra Corresponding to Simulated Earthquake Record for 5% Damping
7	Containment Building General Elevation Drawing
8	Dynamic Model of Containment Structure
9	Broadened DBE Response Spectra Associated with Containment Building, Mass Point 3, Elevation 213'5"
10	Unbroadened DBE Response Spectra Associated with Containment Building, Mass Point 3, Elevation 213'5
11	Dynamic Models of Inner Containment Structure
12	Broadened DBE Response Spectra Associated with Inner Containment Structure, North-South Direction, Mass Point 5, Elevation 94'0"
13	Unbroadened DBE Response Spectra Associated with Inner Containment Structure, North-South Direction, Mass Point 5, Elevation 94'0"
14	Broadened DBE Response Spectra Associated with Inner Containment Structure, East-West Direction, Mass Point 5, Elevation 94'0"
15	Unbroadened DBE Response Spectra Associated with Inner Containment Structure, East-West Direction, Mass Point 5, Elevation 94'0"

Indian Point Unit No. 3
Summary of Seismic Response Spectra Characteristics

List of Figures

Figure	Title
16	Cross Sectional View of Primary Auxiliary Building
17	Dynamic Model of Primary Auxiliary Building
18	Broadened DBE Response Spectra Associated with Primary Auxiliary Building, North-South Direction, Mass Point 4, Elevation 90'0"
19	Unbroadened DBE Response Spectra Associated with Primary Auxiliary Building, North-South Direction, Mass Point 4, Elevation 90'0"
20	Broadened DBE Response Spectra Associated with Primary Auxiliary Building, East-West Direction, Mass Point 4, Elevation 90'0"
21	Unbroadened DBE Response Spectra Associated with Primary Auxiliary Building, East-West Direction, Mass Point 4, Elevation 90'0"
22	Cross Sectional View of Control & Diesel Building
23	Dynamic Models of Control & Diesel Building
24	Broadened DBE Response Spectra Associated with Control & Diesel Generator Building, North-South Direction, Mass Point 4, Elevation 70'0"
25	Unbroadened DBE Response Spectra Associated with Control & Diesel Generator Building, North-South Direction, Mass Point 4, Elevation 70'0"
26	Broadened DBE Response Spectra Associated with Control & Diesel Generator Building, East-West Direction, Mass Point 4, Elevation 70'0"
27	Unbroadened DBE Response Spectra Associated with Control & Diesel Generator Building, East-West Direction, Mass Point 4, Elevation 70'0"
28	Dynamic Model of Fan House in East-West and North-South Directions
29	Broadened DBE Response Spectra Associated with Fan House, North-South Direction, Mass Point 8, Elevation 89'0"
30	Unbroadened DBE Response Spectra Associated with Fan House, North-South Direction, Mass Point 8, Elevation 89'0"

Indian Point Unit No. 3
Summary of Seismic Response Spectra Characteristics

List of Figures

Figure	Title
31	Broadened DBE Response Spectra Associated with Fan House, East-West Direction, Mass Point 8, Elevation 89'0"
32	Unbroadened DBE Response Spectra Associated with Fan House, East-West Direction, Mass Point 8, Elevation 89'0"
33	Intake Structure General Arrangement Sections
34	Intake Structure General Arrangement Plan
35	Dynamic Model of Intake Structure
36	Broadened DBE Response Spectra Associated with Intake Structure, North-South Direction, Mass Point 3, Elevation 15'0"
37	Unbroadened DBE Response Spectra Associated with Intake Structure, North-South Direction, Mass Point 3, Elevation 15'0"
38	Broadened DBE Response Spectra Associated with Intake Structure, East-West Direction, Mass Point 3, Elevation 15'0"
39	Unbroadened DBE Response Spectra Associated with Intake Structure, East-West Direction, Mass Point 3, Elevation 15'0"
40	Location of Spent Fuel Pit in relation to Containment
41	Spent Fuel Pit Building
42	Dynamic Models of Spent Fuel Pit
43	Broadened DBE Response Spectra Associated with Spent Fuel Pit, North-South Direction, Mass Point 5, Elevation 95'0"
44	Unbroadened DBE Response Spectra Associated with Spent Fuel Pit, North-South Direction, Mass Point 5, Elevation 95'0"
45	Broadened DBE Response Spectra Associated with Spent Fuel Pit, East-West Direction, Mass Point 5, Elevation 95'0

Indian Point Unit No. 3
Summary of Seismic Response Spectra Characteristics

List of Figures

Figure	Title
46	Unbroadened DBE Response Spectra Associated with Spent Fuel Pit, East-West Direction, Mass Point 5, Elevation 95'0"
47	Location of Shield Wall
48	Dynamic Model of Shield Wall
49	Broadened DBE Response Spectra Associated with Shield Wall, North-South Direction, Mass Point 2, Elevation 78'0"
50	Unbroadened DBE Response Spectra Associated with Shield Wall, North-South Direction, Mass Point 2, Elevation 78'0"
51	Broadened DBE Response Spectra Associated with Shield Wall, East-West Direction, Mass Point 2, Elevation 78'0"
52	Unbroadened DBE Response Spectra Associated with Shield Wall, East-West Direction, Mass Point 2, Elevation 78'0"

Indian Point Unit No. 3
Summary of Seismic Response Spectra Characteristics

List of Tables

Table	Title
1	Damping Factors for Class 1 Components and Structures
2	Indian Point Unit No. 3 Dynamic Characteristics, Containment Structure
3	Indian Point Unit No. 3 Dynamic Characteristics, Inner Containment, North-South
4	Indian Point Unit No. 3 Dynamic Characteristics, Inner Containment, East-West
5	Indian Point Unit No. 3 Dynamic Characteristics, Primary Auxiliary Building, North-South
6	Indian Point Unit No. 3 Dynamic Characteristics, Primary Auxiliary Building, East-West
7	Indian Point Unit No. 3 Dynamic Characteristics, Control & Diesel Generator Building, North-South
8	Indian Point Unit No. 3 Dynamic Characteristics, Control & Diesel Generator Building, East-West
9	Indian Point Unit No. 3 Dynamic Characteristics, Fan House, North-South
10	Indian Point Unit No. 3 Dynamic Characteristics, Fan House, East-West
11	Indian Point Unit No. 3 Dynamic Characteristics, Intake Structure, North-South
12	Indian Point Unit No. 3 Dynamic Characteristics, Intake Structure, East-West
13	Indian Point Unit No. 3 Dynamic Characteristics, Spent Fuel Pit, North-South
14	Indian Point Unit No. 3 Dynamic Characteristics, Spent Fuel Pit, East-West
15	Indian Point Unit No. 3 Dynamic Characteristics, Shield Wall, North-South
16	Indian Point Unit No. 3 Dynamic Characteristics, Shield Wall, East-West

Indian Point Unit No. 3
Summary of Seismic Response Spectra Characteristics

1.0 Introduction

This document was prepared to provide the information as to what procedures and criteria were used to generate the plant specific design in-structure response spectra. This information is required by the NRC in response to Supplement No. 1 to Generic Letter (GL) 87-02 that transmits Supplemental Safety Evaluation Report (SSER) No. 2 on SQUG Generic Implementation Procedure (GIP), Revision 2, as corrected on February 14, 1992 (GIP-2). Information was retrieved from the existing plant project file. Provided herein is the following information pertaining to the in-structure response spectra:

- Plant seismic design basis
- Description of plant seismic analysis methodology
- Building dynamic characteristics that include natural frequencies of dominate building modes, lateral mode shape components, and participation factors
- Sample in-structure Design Basis Earthquake response spectra
- Peak floor acceleration values
- Amplification factors associated with floor response spectra

Please note that the in-structure plant design response spectra developed for Indian Plant Unit No. 3 as reported herein, shall be utilized for resolution of USI A-46 program.

Shown in Figures 1 and 2 are a plot plan and a plot profile associated with Indian Point Unit No. 3. They are from the plant FSAR Figure No. 1.2-3 and 1.2-4 respectively.

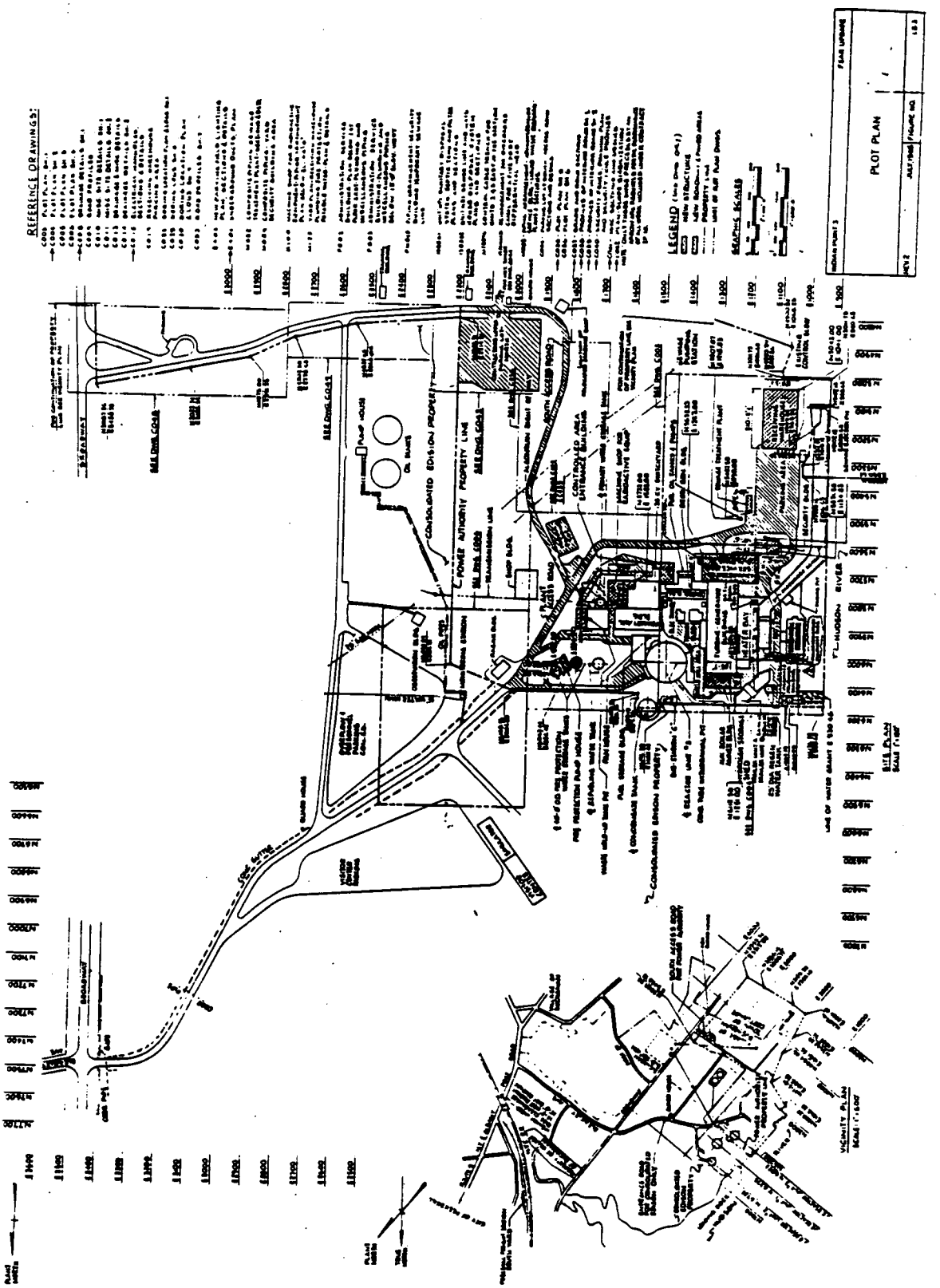
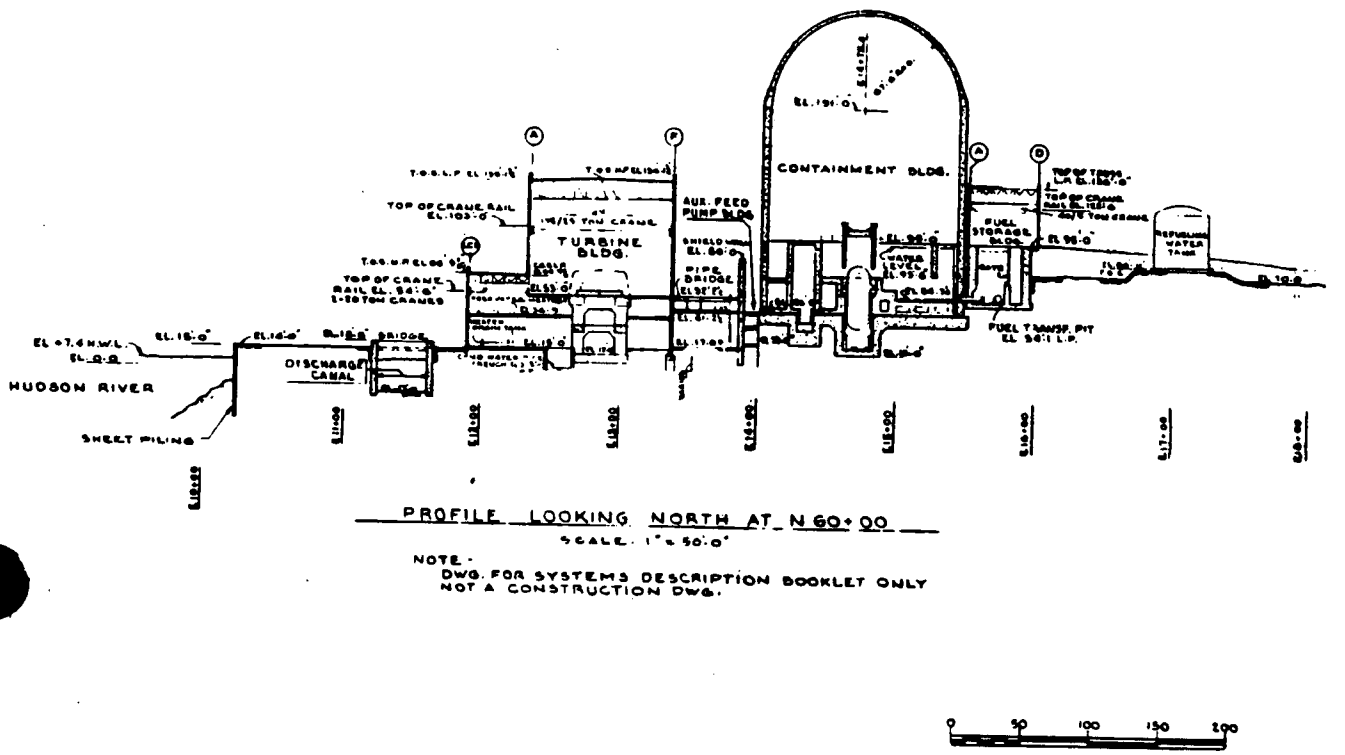


Figure 1 - Indian Point Unit No. 3 Plot Plan



INDIAN POINT 3		FSAR UPDATE
PROFILE LOOKING NORTH THRU TURBINE, CONTAINMENT AND FUEL STORAGE BUILDINGS		
REV. 0	JULY, 1982	FIGURE NO. 1.2-4

Figure 2 - Indian Point Unit No. 3 Plot Profile

2.0 Seismic Design Basis

The site seismic horizontal ground response spectra used in the design of Indian Point 3 are shown in Figures 3 and 4 for the OBE and DBE respectively. The vertical ground response spectra components are defined as two-thirds of the horizontal ground response spectra. The response spectra were developed from the average acceleration velocity displacement curves presented in TID-7024, "Nuclear Reactors and Earthquake," for large-magnitude earthquakes at moderate distances from the epicenter. As such, the curves are made up of the combined normalized response spectrum determined from components of four strong-motion ground accelerations: El Centro, California, December 30 1934; El Centro, California, May 18, 1940; Olympia, Washington, April 13, 1949; and Taft, California, July 21, 1952.

Indian Point Unit No. 3 was designed for both the Design Basis Earthquake (DBE) and the Operating Basis Earthquake (OBE). The peak ground acceleration levels associated with each of these earthquakes is given below:

Design Basis Earthquake

0.15g horizontal ground acceleration component
0.10g vertical ground acceleration component

Operating Basis Earthquake

0.10g horizontal ground acceleration component
0.05g vertical ground acceleration component

These seismic acceleration values were established based on the seismology associated with the plant site. The nearest event larger than the Modified Mercalli intensity VII occurred near Cape Ann, Massachusetts in 1755. This event was classified as intensity VIII on the Modified Mercalli Scale. However, the location of this event was more than 200 miles from the site. There are faults that pass through the foundations of Unit 3 structures. These faults are not capable per Appendix A of 10CFR Part 100 definitions. More detailed information concerning seismology can be found in the plant FSAR, Chapter 2, Site and Environment, Section 2.8, Seismology.

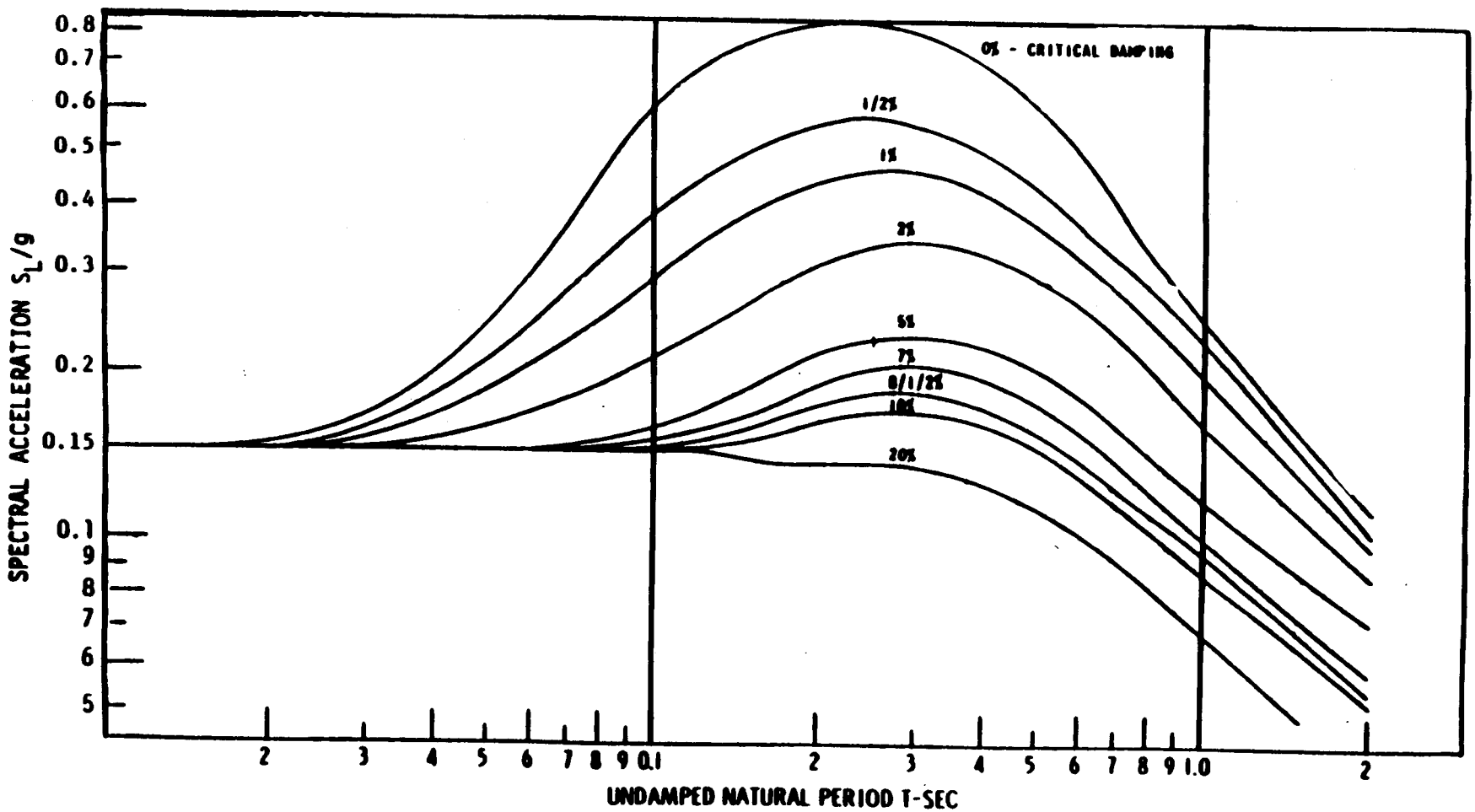


Figure 3 - Horizontal DBE Seismic Ground Response Spectra

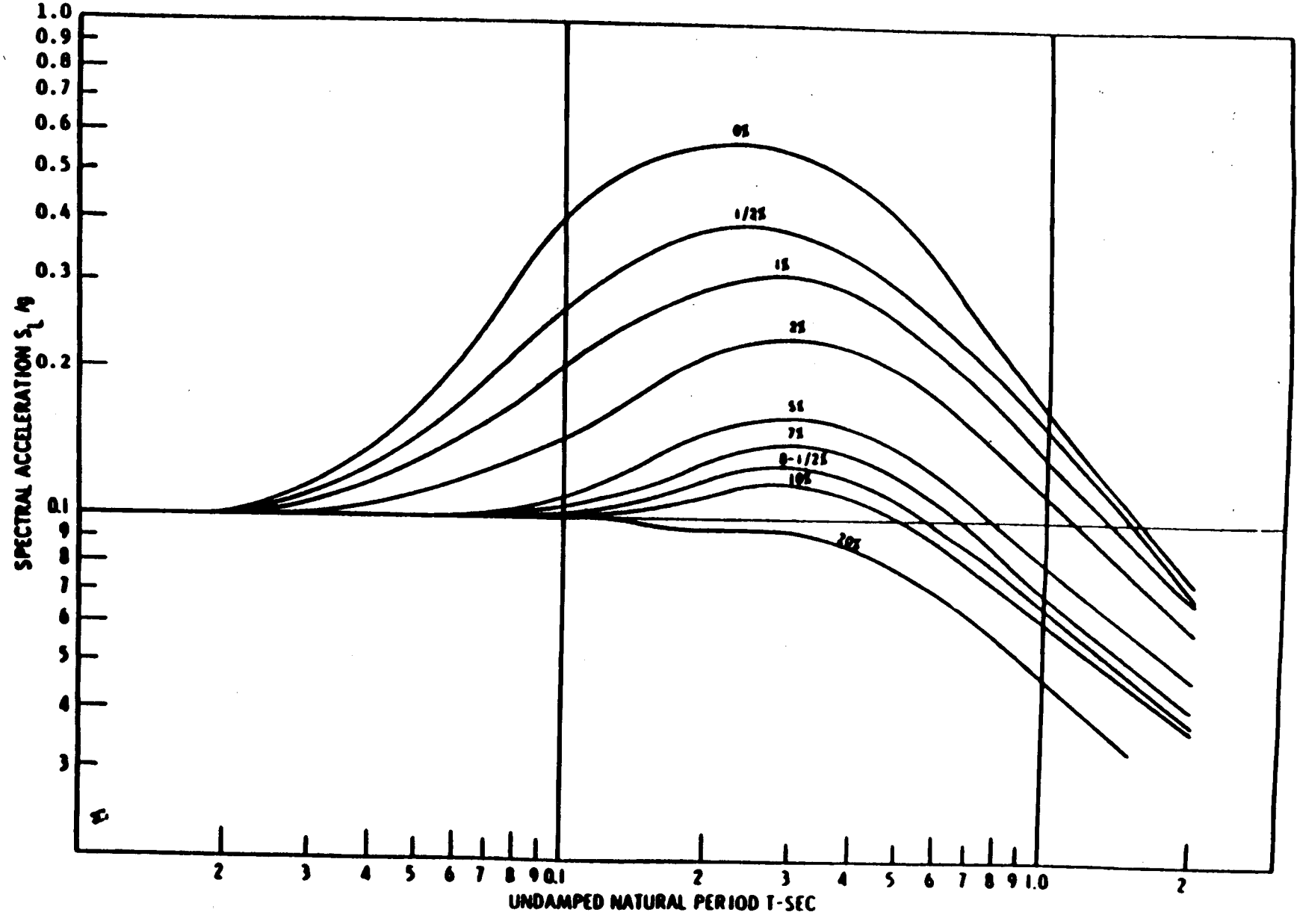


Figure 4 - Horizontal OBE Seismic Ground Response Spectra

3.0 Plant Seismic Analysis

Time history analyses were used to generate the floor response spectra for Indian Point Unit No. 3. A time history compatible with the Housner type site ground design response spectra (Figures 3 and 4) was used. Shown in Figures 5 and 6 are comparisons of the site design ground response spectra and the spectra associated with the time history for 2 and 5 percent damping normalized to 0.1g. The time histories were normalized to the OBE and DBE horizontal ground acceleration component levels for the respective analyses.

The DBE vertical floor response spectra are defined as equal to two-thirds of the horizontal DBE floor response spectra.

The floor response spectra were generally broadened by +/- 10% or larger as discussed in the plant FSAR, Section 16.1.3, under "Ground Response Spectra."

The damping values used in the design of seismic Class I components and structures are given in Table 1 as defined in the plant FSAR Table 16.1-1. It is noted that for the USI A-46 program, 5% damping will be used for the seismic analysis of SSER 1 safety equipment.

The plant site soil conditions are classified as rock, hard limestone formations. The building structures are founded on the rock. Therefore, soil structure interaction effects were not considered. The base of each building seismic model was fixed.

The seismic criteria used was based on the seismic classification of the equipment and structures. The seismic classification was based on the recommendation given in:

- TID-7024, "Nuclear Reactors and Earthquakes," August, 1963, and
- G.W. Housner, "Design of Nuclear Power Reactors Against Earthquakes," Proceedings of the Second World Conference on Earthquake Engineering, Vol I, Japan, 1960, pg. 133. 134, and 137.

Equipment and structures were classified as seismic Class I, II, or III. A discussion of these classifications is given in the plant FSAR in Section 16.1.1, "Definition of Seismic Design Classifications." The seismic design criteria used for Indian Point Unit No. 3 for each of these classifications is presented in the plant FSAR, Chapter 16.

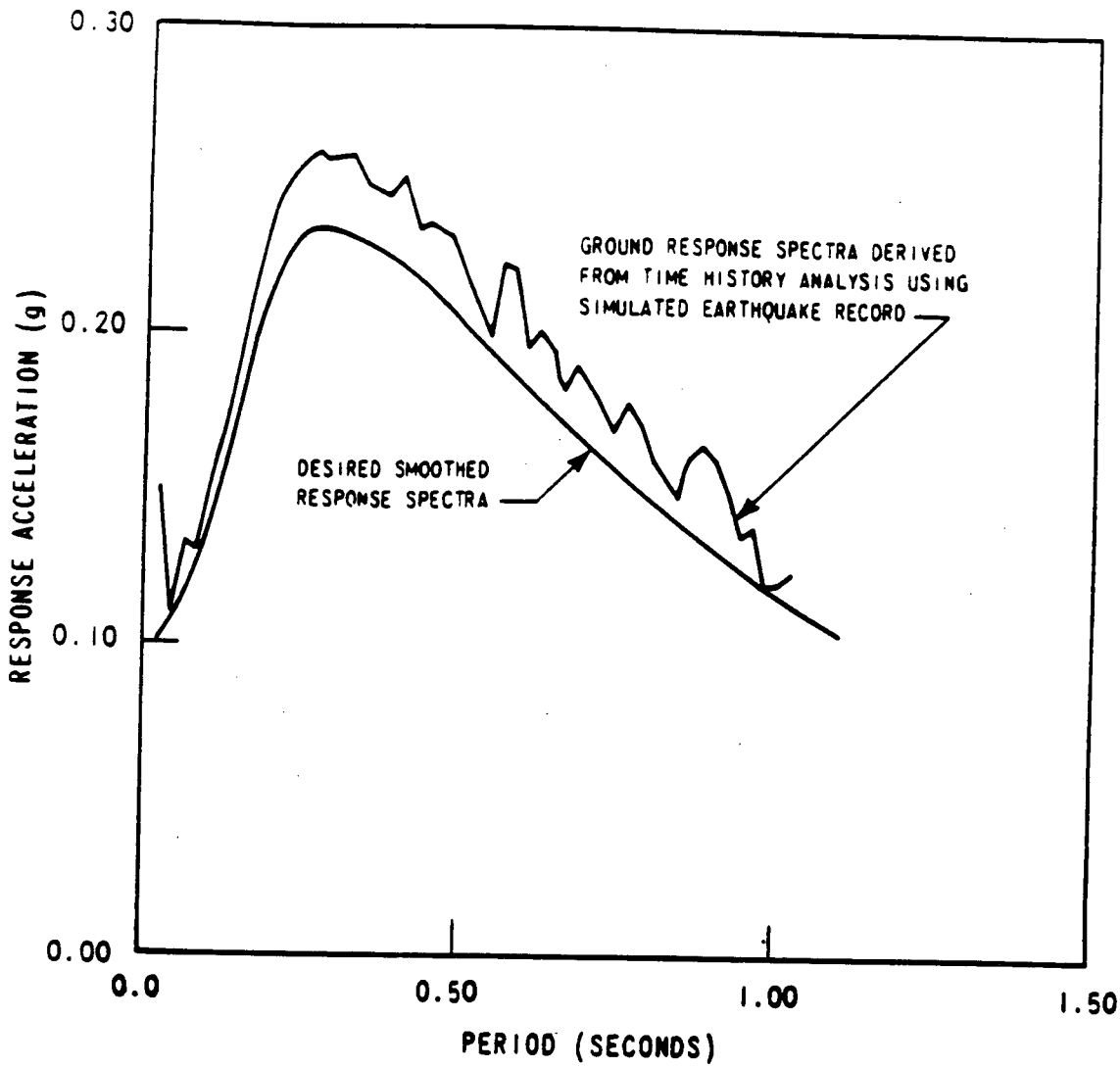


Figure 5 - Comparison of Desired Spectra and Actual Spectra Corresponding to Simulated Earthquake Record for 2% Damping

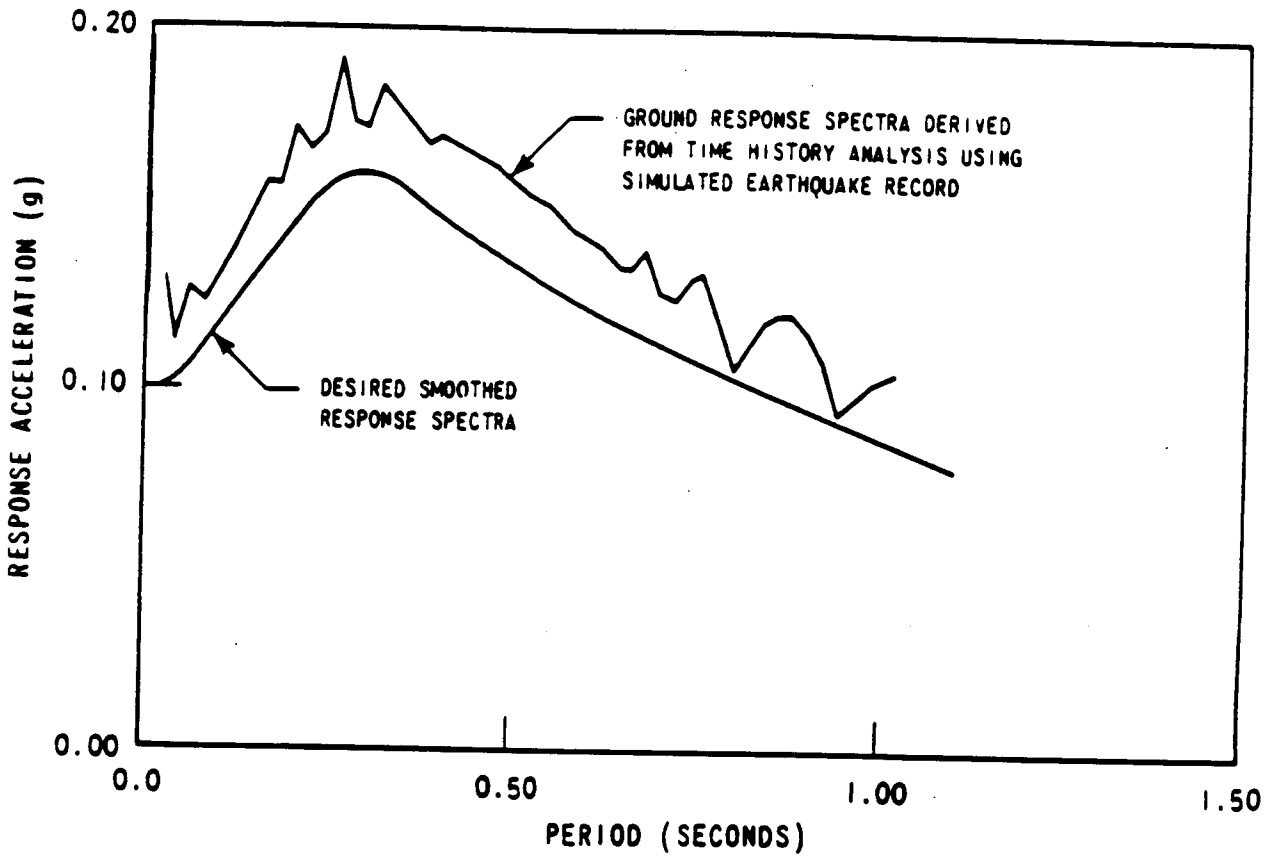


Figure 6 - Comparison of Desired Spectra and Actual Spectra Corresponding to Simulated Earthquake Record for 5% Damping

Table 1
Damping Factors for Class 1 Components and Structures

Component	Per Cent of Critical Damping
Containment Structure	
(a) Design Basis Earthquake (larger)	5.0
(b) Operating Basis Earthquake (smaller)	2.0
Concrete Support Structure of Reactor Vessel	2.0
Steel Assemblies:	
(a) Bolted or Riveted	2.5
(b) Welded	1.0
Concrete Structures above Ground:	
(a) Shear Wall	5.0
(b) Rigid Frame	5.0
Piping	0.5

Note: For the USI A-46 program, the NRC approved 5% damping value will be used for the seismic analyses of the structures and equipment.

4.0 Floor Response Spectra Characteristics

In the design basis analyses performed in the early seventies, floor response spectra were developed for the following Seismic Class I structures at the Indian Point Unit No. 3 site:

- Containment Structure
- Inner Containment Structure
- Primary Auxiliary Building
- Control and Diesel Generator Building
- Fan House Building
- Intake Structure
- Spent Fuel Pit
- Shield Wall

Each building/structure was modelled separately for the North-South and East-West response directions. Only one model was used when the building is symmetrical. The structural drawings were used in the development of the dynamic models. Multi-degree-of-freedom lumped mass elastic dynamic models were developed for each building/structure. Floor response spectra were developed from the time history motion associated with the floor as determined by dynamic analysis. The time history ground input was defined compatible with the defined ground response spectra for the site (see Section 2.0 above). The structures of interest are of reinforced concrete construction, therefore, the structural damping used for the building structures in the DBE seismic analyses was 5 percent. The rigid region associated with each of the floor response spectra was defined as beginning at 25 Hz.

Provided in the sections that follow are the following for each of the identified structures:

- Building Dynamic Characteristics: natural frequencies of dominant building modes contributing to the in-structure response spectra; lateral mode shape components; and participation factors

- In-structure DBE response spectra (broadened and unbroadened) at important floor locations in each building

- Peak floor acceleration values at the important floor locations where response spectra are provided

- Amplification factors associated with the floor response spectra provided, defined as the ratio of the peak floor spectral acceleration value (at 2% and 5% equipment damping) to ground DBE ZPA value (0.15g) as well as floor ZPA values.

The amplifications of the spectra peaks are reasonable. The amplifications are similar to those expected from random motion and sine beats between 5 to 10 cycles per beat (Reference 1) when the building motion is amplified. For building motion associated with structures responding near the "rigid" region, or points low in the building, the response is similar to the ground response spectrum. This is seen in the summary tables provided for each of the buildings/structures given in the sections that follow.

4.1 Containment Structure

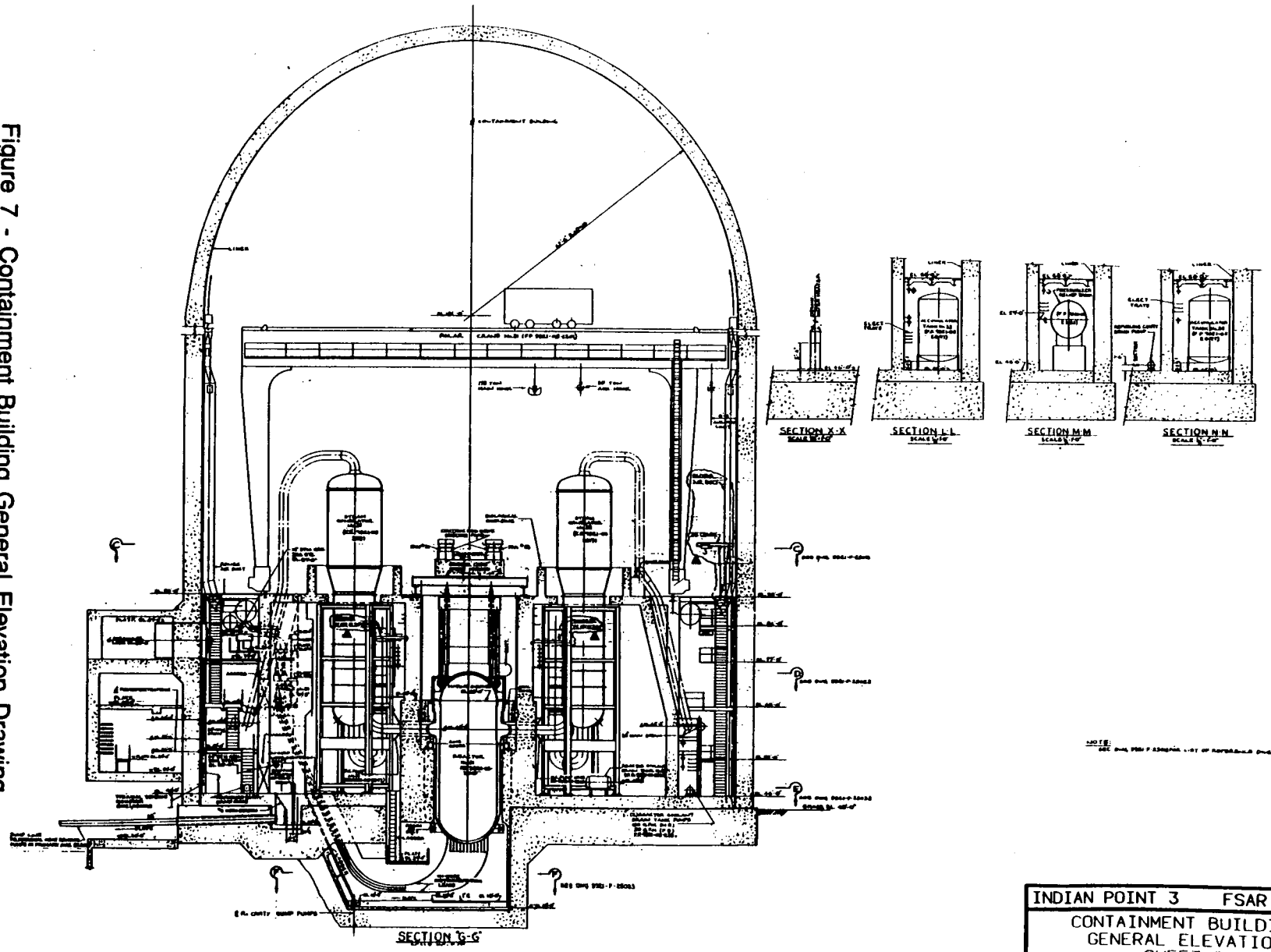
The Reactor Containment is a steel lined reinforced concrete right cylinder with a hemispherical dome and a flat base. The steel liner is a welded plate with a minimum thickness of one-quarter inch. It is attached by stud anchors to the inside face of the concrete. The containment structure cylindrical wall measures 148 feet from the basemat liner to the springline of the dome, and has an inside diameter of 135 feet. The concrete walls of the cylinder and the dome are 4'6" and 3'6" thick respectively. The inside radius of the dome is equal to the inside radius of the cylinder so that the discontinuity at the springline due to the change in thickness is on the outer surface. The flat concrete base mat is 9' thick with the bottom liner plate located on top of this mat. The bottom liner plate is covered with 3' structural slab of concrete which serves to carry internal equipment loads and forms the floor of the containment. The top of the base mat is at grade (El 43'). A General Elevation drawing of the Containment Building is shown in Figure 7. It was obtained from the plant FSAR, Figure No. 5.1.7.

One lump mass dynamic model was used for both the North-South and East-West directions since the structure is symmetrical. The model is shown in Figure 8.

Floor response spectra associated with the DBE are given in Figures 9 and 10 (broadened and unbroadened) for mass point 3. Mass point 3 is located at Elevation 213'5". The dominant mode of the Containment Structure is at approximately 4 Hz. Given in Table 2 are the frequencies and lateral mode shape components and participation factors associated with the significant modes.

Given below is a summary of important key parameters associated with the horizontal spectra using mass point 3 and the peak at 4.2 Hz.

Mass Point	Elevation	Ground ZPA	Floor ZPA	Damping	Peak Acc.	Ratio (6)/(4)	Ratio (6)/(3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
3	213'5"	0.15g	0.3g	2%	3.6g	12.0	24.0
3	213'5"	0.15g	0.3g	5%	1.9g	6.4	12.7



INDIAN POINT 3	FSAR UPDATE
CONTAINMENT BUILDING GENERAL ELEVATION SHEET 3	
REV. 2, JULY 1992	FIGURE NO. 5.1-7

Figure 7 - Containment Building General Elevation Drawing

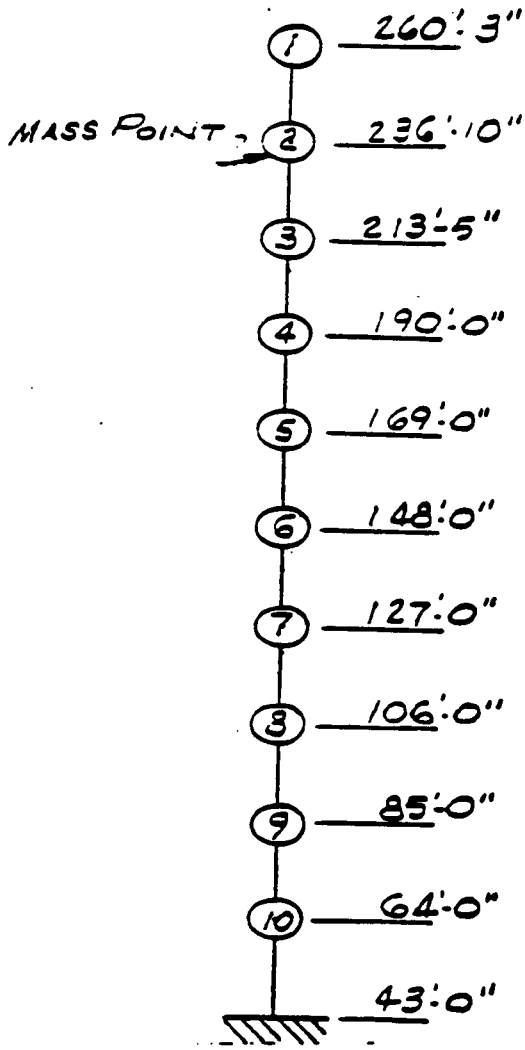


Figure 8 - Dynamic Model of Containment Structure

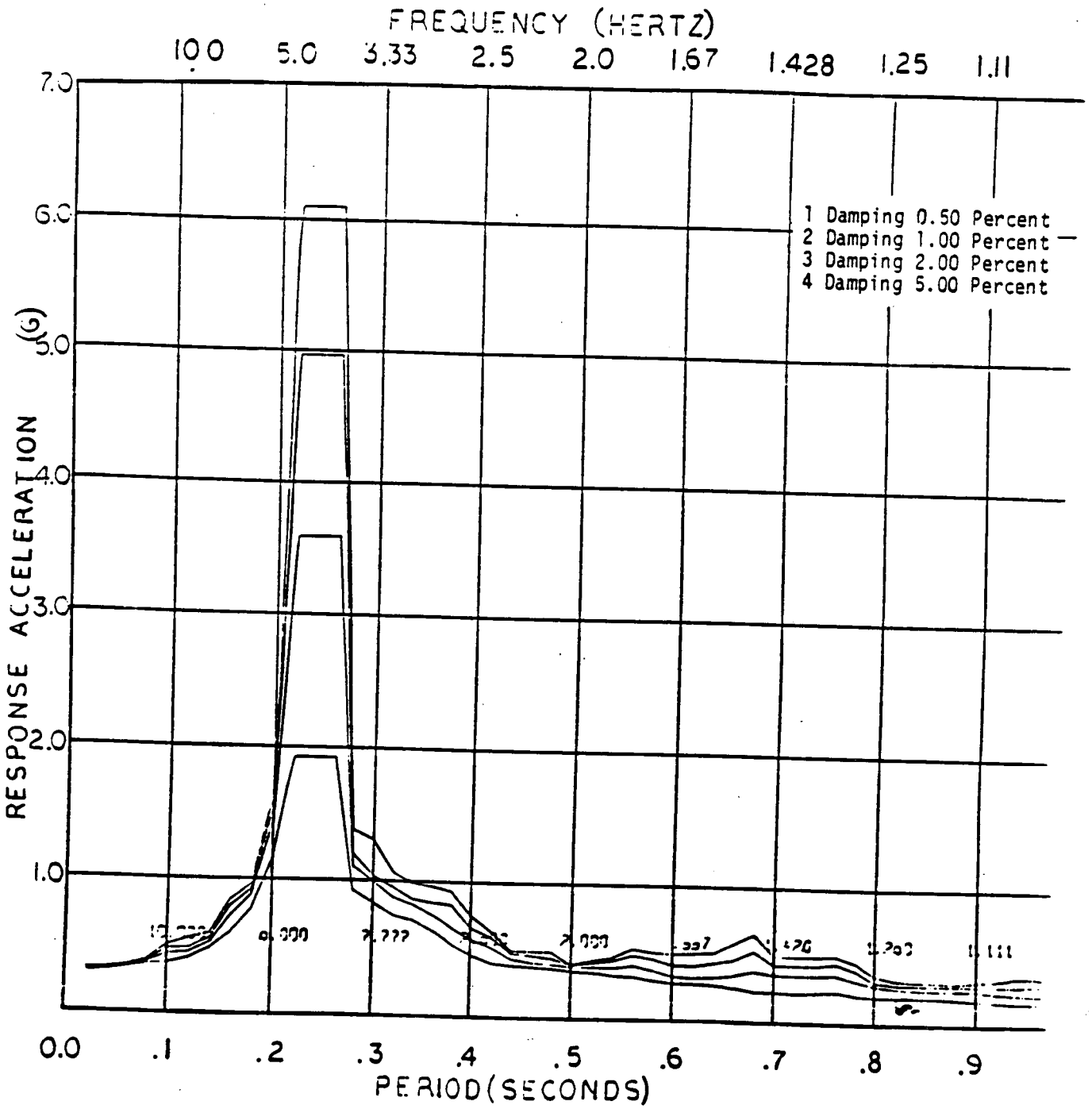


Figure 9 - Broadened DBE Response Spectra Associated with Containment Building, Mass Point 3, Elevation 213'5"

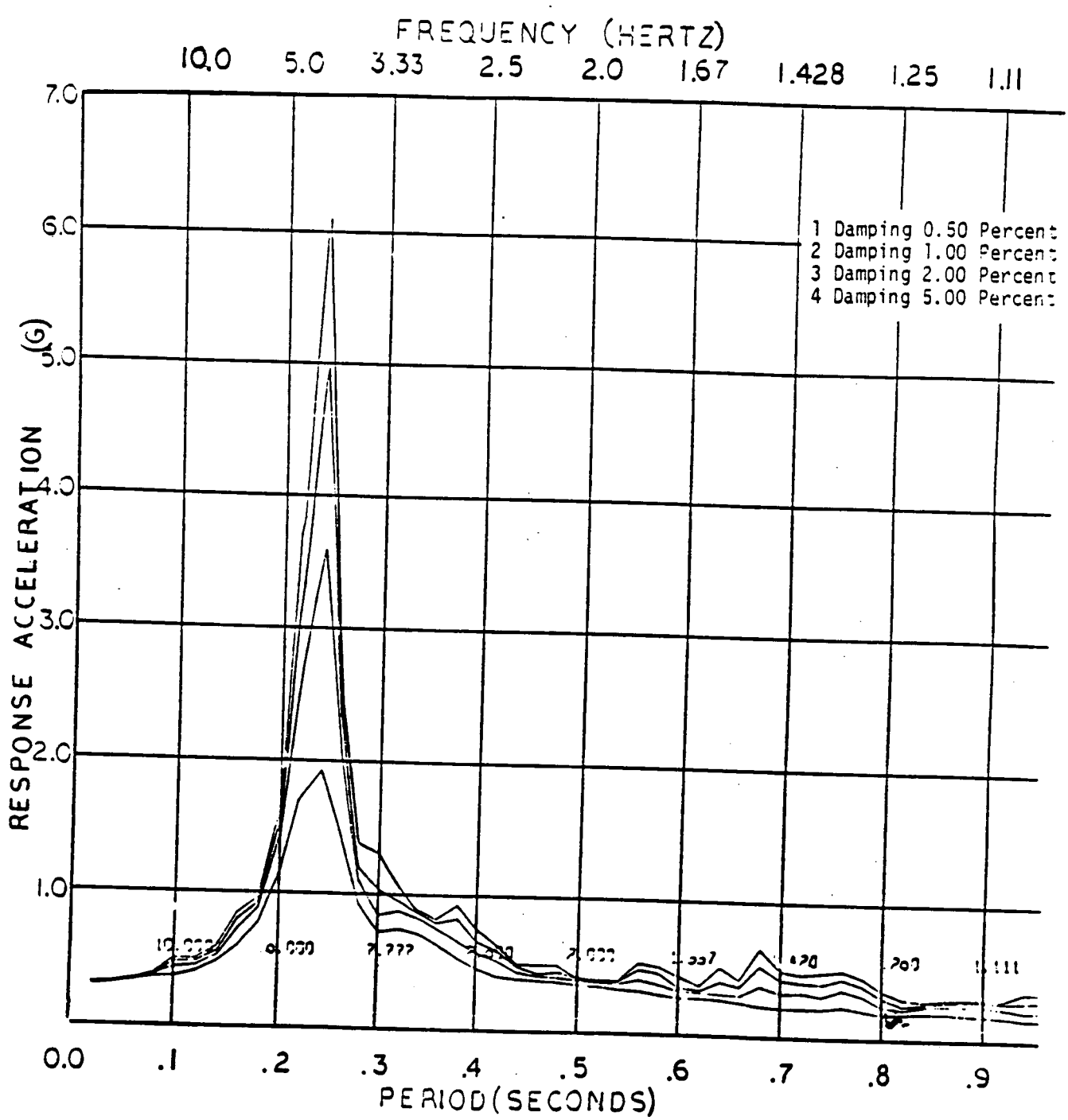


Figure 10 - Unbroadened DBE Response Spectra Associated with Containment Building, Mass Point 3, Elevation 213'5"

Table 2
Indian Point Unit No. 3
Dynamic Characteristics
Containment Structure

Modes		1	2
Frequency (Hz)		4.19	11.91
	Mass Points	Mode Shapes	
	1	1.000	-1.000
	2	0.907	-0.631
	3	0.801	-0.197
	4	0.683	0.238
	5	0.579	0.538
	6	0.471	0.745
	7	0.363	0.828
	8	0.257	0.778
	9	0.159	0.602
	10	0.072	0.329
Participation Factors		1.45	0.64

4.2 Inner Containment Structure

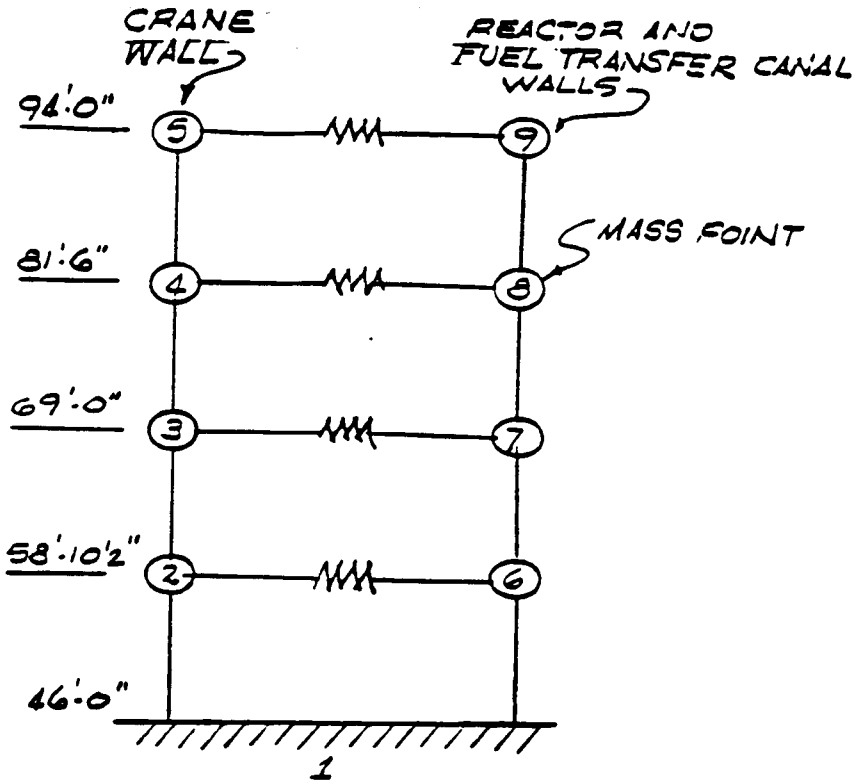
The Inner Containment structure includes the basemat, shielding, reactor cavity and canal for fuel transfer, and miscellaneous concrete and steel for floors and stairs. A three foot thick concrete ring wall, serving as a missile and partial radiation shield, surrounds the Reactor Coolant System components and supports the polar-type reactor containment crane. A 2' thick reinforced concrete floor covers the Reactor Coolant System, with removable gratings in the floor provided for crane access to the equipment underneath the floor. The operating deck is at Elevation 94 feet. The Inner Containment Structure is shown in Figure 7 given in Section 4.1.

Two separate lump mass dynamic models were used for both the North-South and East-West directions. These models are shown in Figure 11.

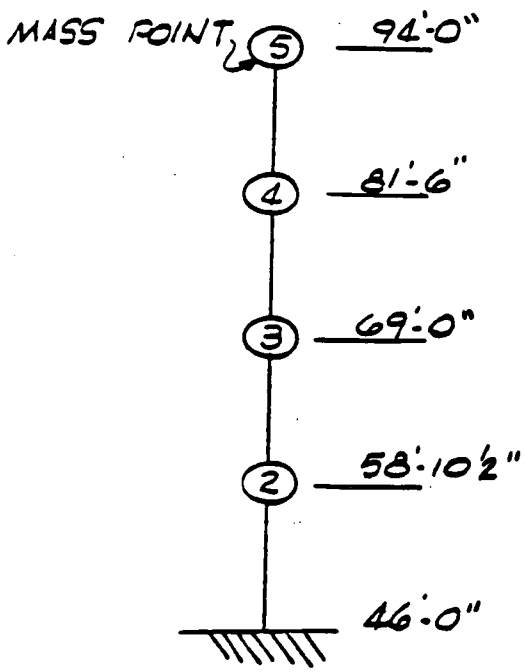
Floor response spectra associated with the DBE are given in Figures 12 to 15 (broadened and unbroadened) for mass point 5 which is on the operating deck. The dominant mode is at a frequency of approximately 17 Hz and is associated with the North-South direction. The other modes, considering both the North-South and East-West directions, are above 30 Hz. Given in Table 3 and 4 are the frequencies and lateral mode shape components and participation factors associated with the significant modes.

Given below is a summary of important key parameters associated with the mass point 5 horizontal spectra using the spectra peaks at 17.1 Hz (North-South direction). The East-West direction was not considered since the fundamental frequency is above 30 Hz.

Mass Point	Elevation	Ground ZPA	Floor ZPA	Damping	Peak Acc.	Ratio (6)/(4)	Ratio (6)/(3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
5 (N-S)	94'0"	0.15g	0.22g	2%	1.1g	5.0	7.3
5 (N-S)	94'0"	0.15g	0.22g	5%	0.7g	3.2	4.7



North-South Direction



East-West Direction

Figure 11 - Dynamic Models of Inner Containment Structure

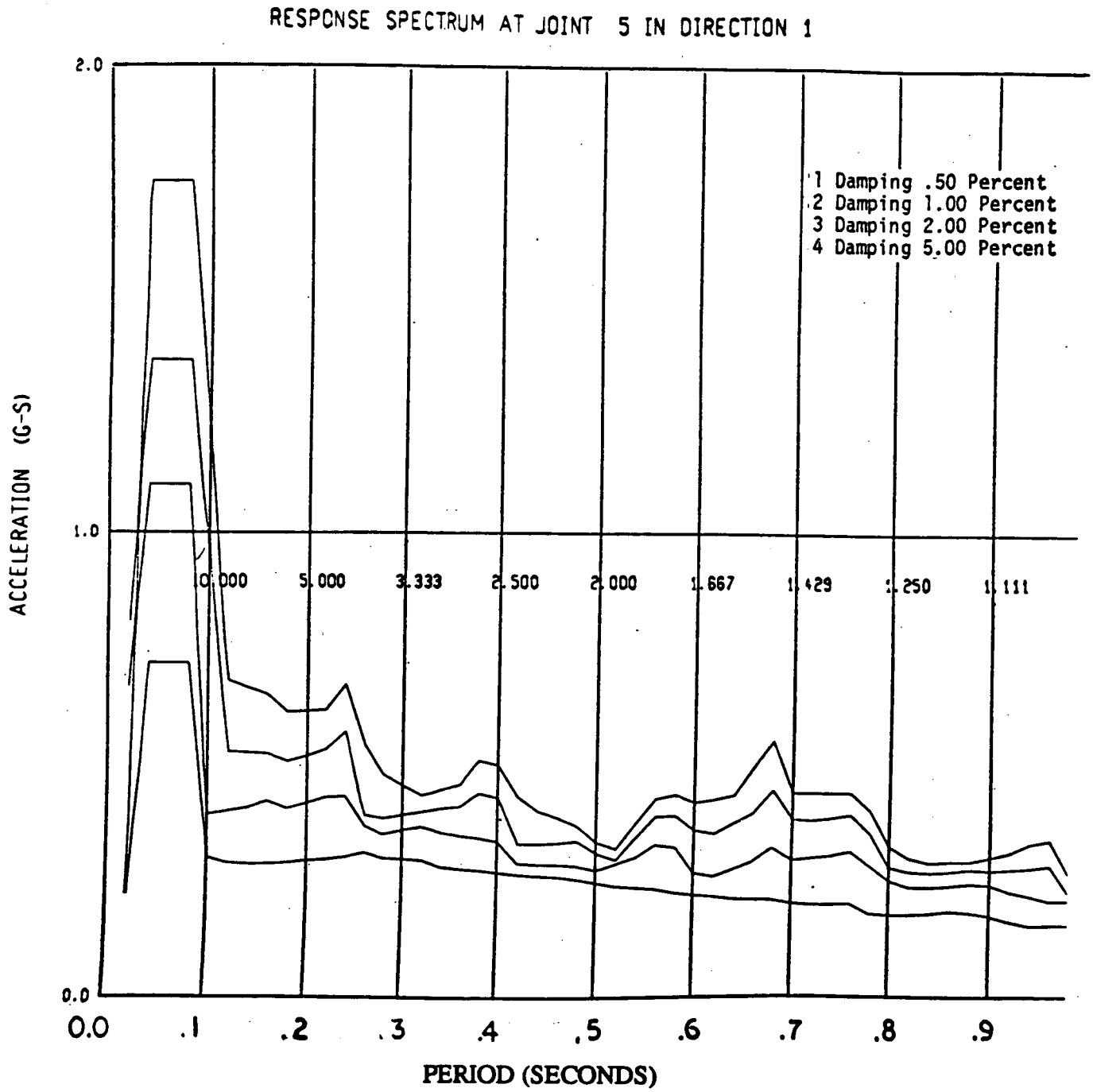


Figure 12 - Broadened DBE Response Spectra Associated with Inner Containment Structure, North-South Direction, Mass Point 5, Elevation 94'0"

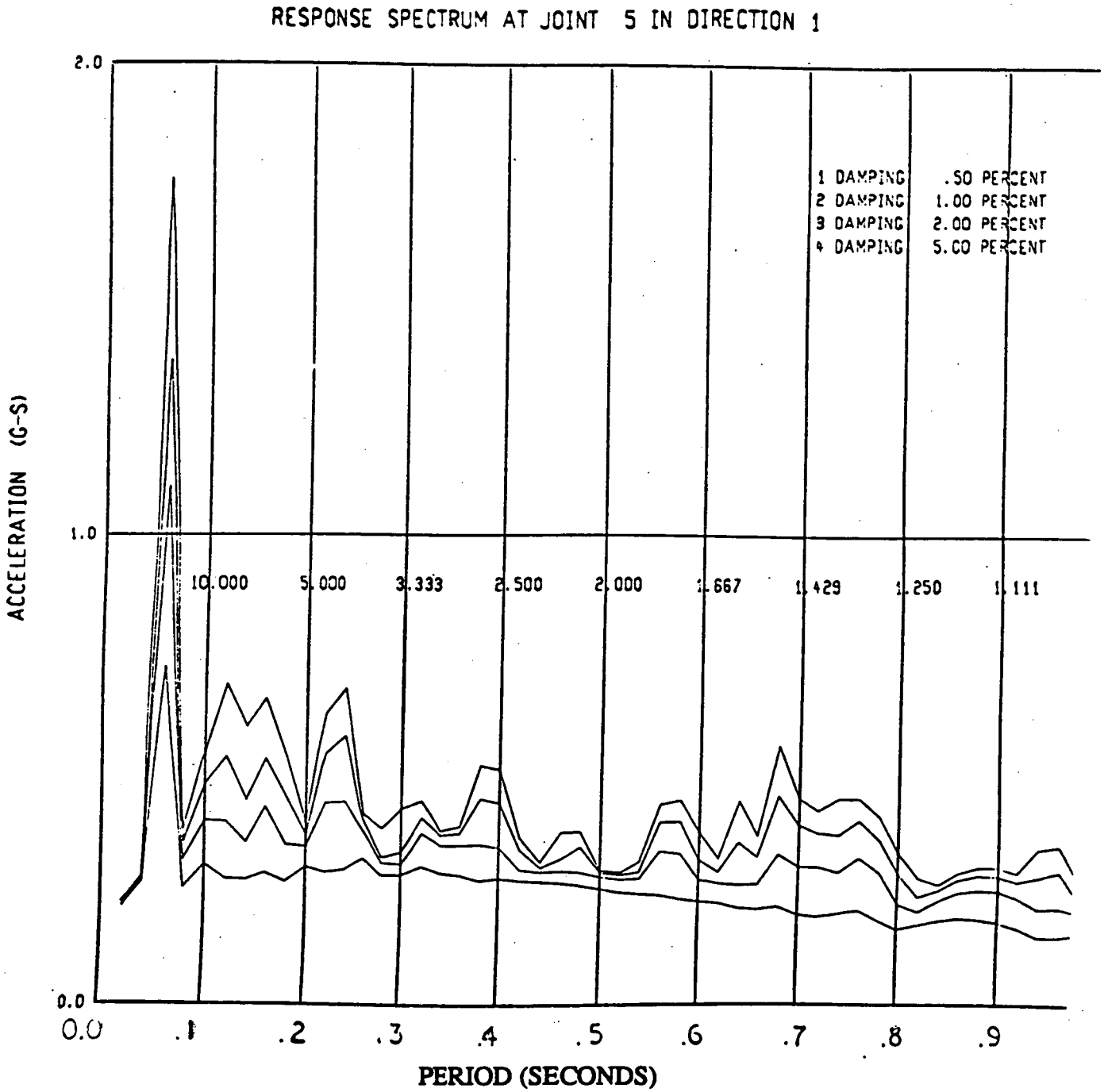


Figure 13 - Unbroadened DBE Response Spectra Associated with Inner Containment Structure, North-South Direction, Mass Point 5, Elevation 94'0"

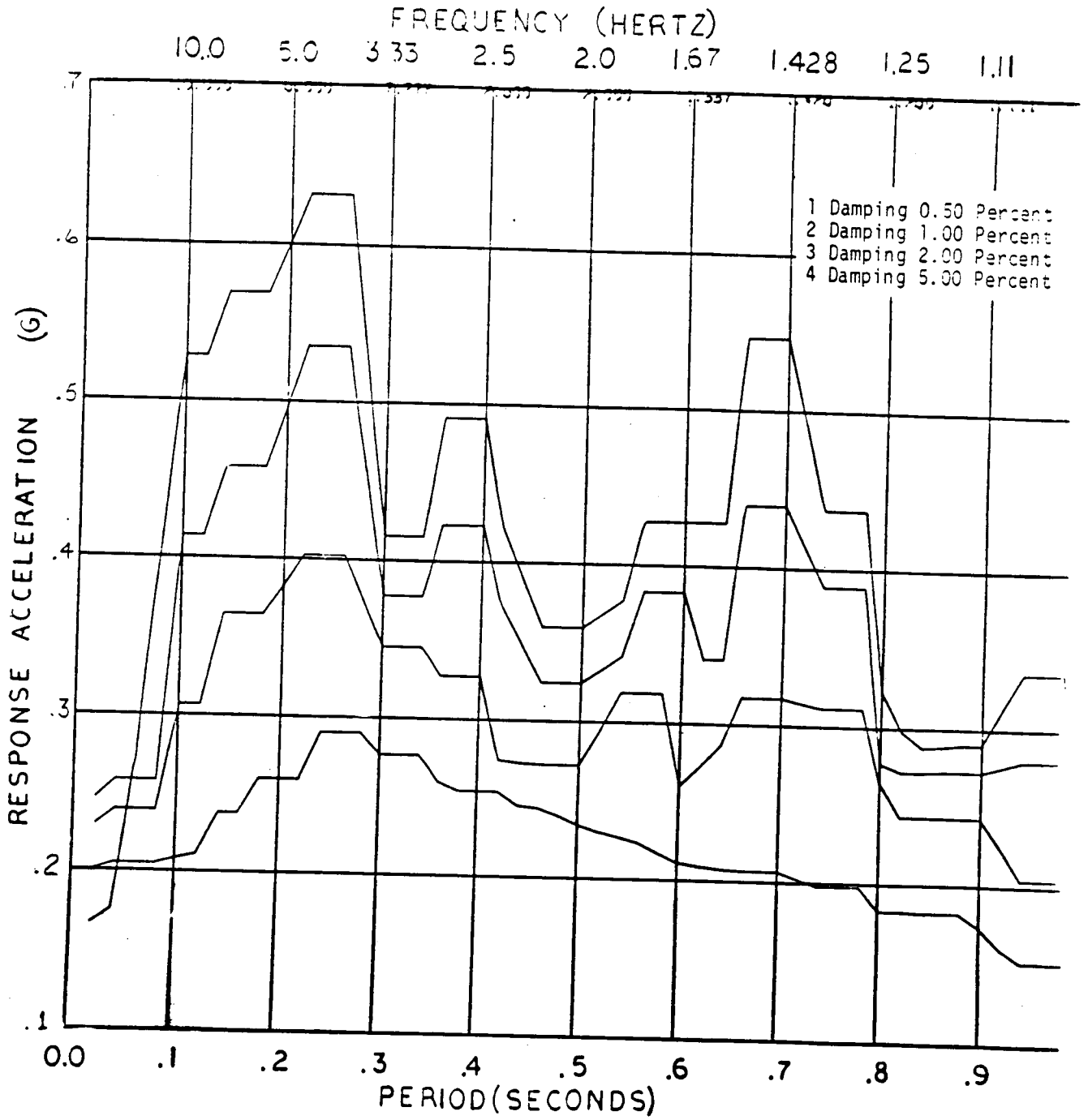


Figure 14 - Broadened DBE Response Spectra Associated with Inner Containment Structure, East-West Direction, Mass Point 5, Elevation 94'0"

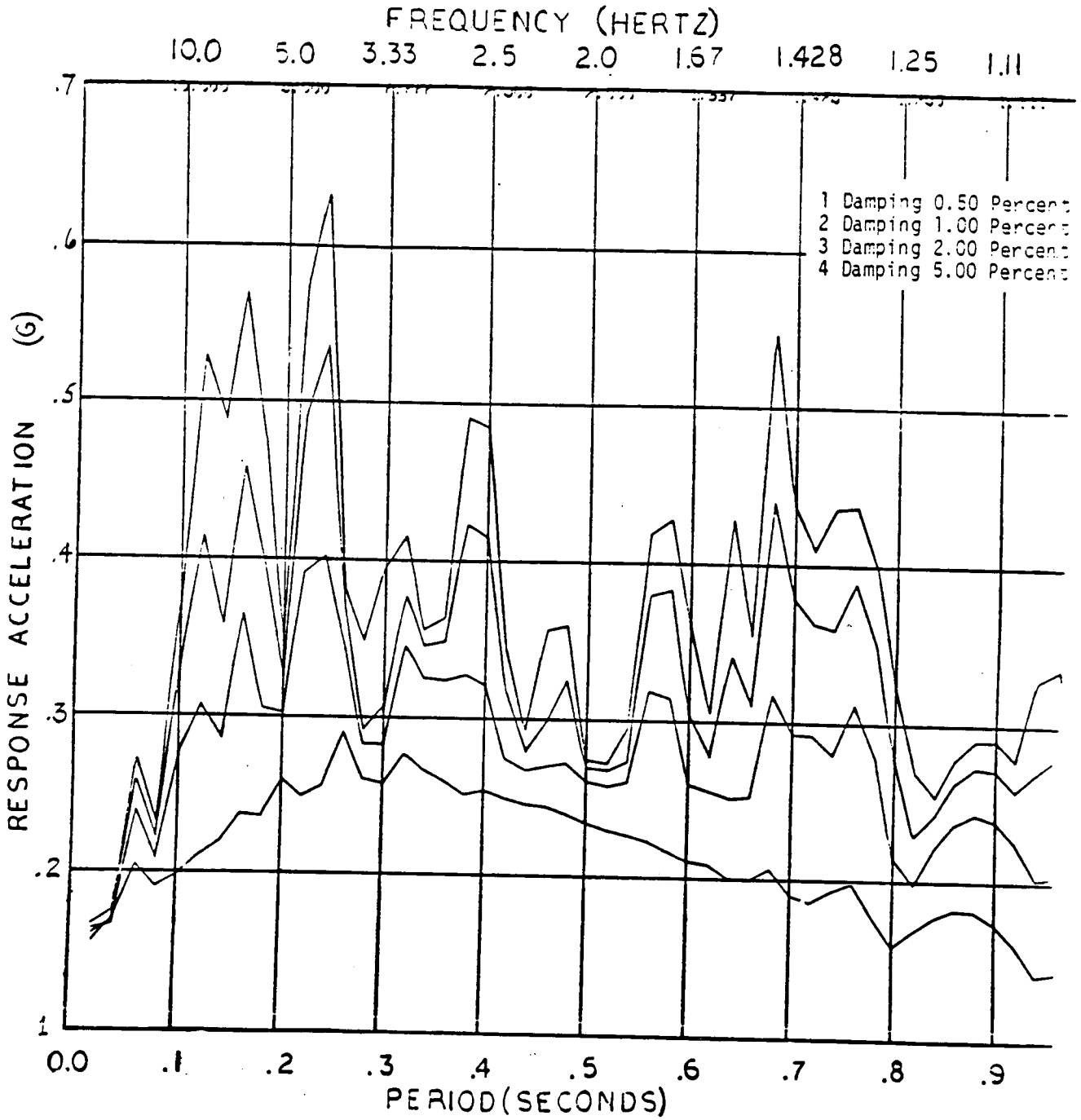


Figure 15 - Unbroadened DBE Response Spectra Associated with Inner Containment Structure, East-West Direction, Mass Point 5, Elevation 94'0"

Table 3
Indian Point Unit No. 3
Dynamic Characteristics
Inner Containment - North-South

Modes	1	2
Frequency	17.13	46.95
Mass Points	Mode Shapes	
1	0.000	0.000
2	0.291	0.575
3	0.513	0.650
4	0.768	0.303
5	1.000	-0.317
6	0.198	0.734
7	0.395	1.000
8	0.742	0.829
9	1.000	-0.317
Participation Factors	1.19	0.39

Table 4
Indian Point Unit No. 3
Dynamic Characteristics
Inner Containment - East-West

Modes	1	2
Frequency (Hz)	32.84	115.14
Mass Points	Mode Shapes	
1	0.000	0.000
2	-0.102	0.414
3	-0.294	0.926
4	-0.610	1.000
5	-1.000	0.213
Participation Factors	-0.58	0.17

4.3 Primary Auxiliary Building

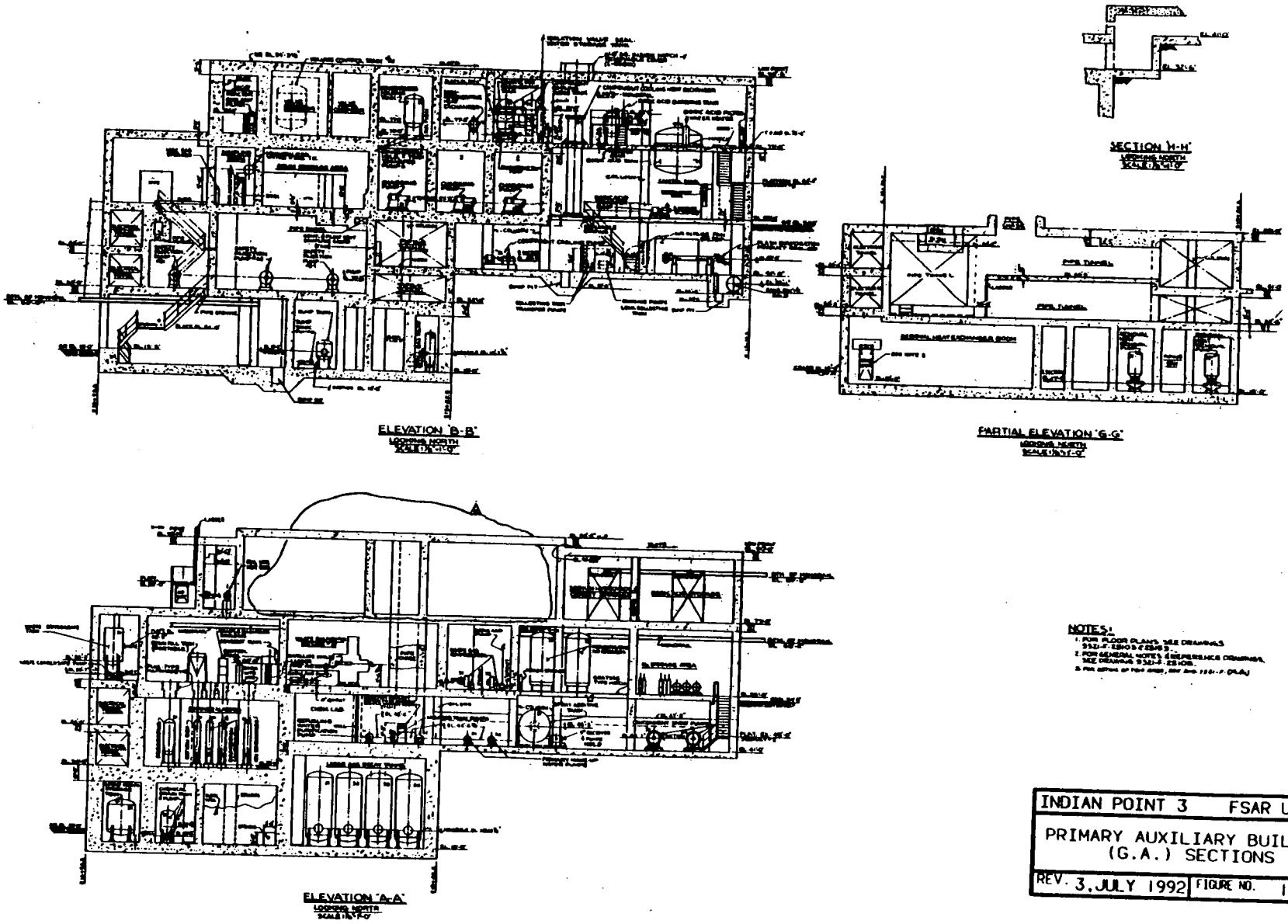
The Primary Auxiliary Building is a reinforced concrete structure. The finished ground level around the building is 54'. In modelling the building it was assumed that the section below 41' is stiff ("rigid"). Cross sectional view of the building are given in Figure 16, obtained from the plant FSAR Figure No. 1.2-6.

The building was modelled separately in the North-South and East-West directions. However, the same basic model represents both directions, as shown in Figure 17, with different member stiffnesses.

Floor response spectra associated with the DBE are given in Figures 18 to 21 (broadened and unbroadened) for mass point 4 which is at Elevation 90'. The dominant mode is at a frequency of approximately 14.5 Hz for both the North-South and East-West directions. The other modes are above 35 Hz. Given in Table 5 and 6 are the frequencies and lateral mode shape components and participation factors associated with the first two modes.

Given below is a summary of important key parameters associated with the mass point 4 horizontal spectra using the spectra peaks in the frequency region of 14.5 Hz.

Mass Point	Elevation	Ground ZPA	Floor ZPA	Damping	Peak Acc.	Ratio (6)/(4)	Ratio (6)/(3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4 (N-S)	90'0"	0.15g	0.15g	2%	0.60g	4.0	4.0
4 (N-S)	90'0"	0.15g	0.15g	5%	0.43g	2.9	2.9
4 (E-W)	90'0"	0.15g	0.15g	2%	0.70g	4.7	4.7
4 (E-W)	90'0"	0.15g	0.15g	5%	0.46g	3.1	3.1



INDIAN POINT 3	FSAR UPDATE
PRIMARY AUXILIARY BUILDING (G.A.) SECTIONS	
REV. 3, JULY 1992	FIGURE NO. 1.2-6

Figure 16 - Cross Sectional Views of Primary Auxiliary Building

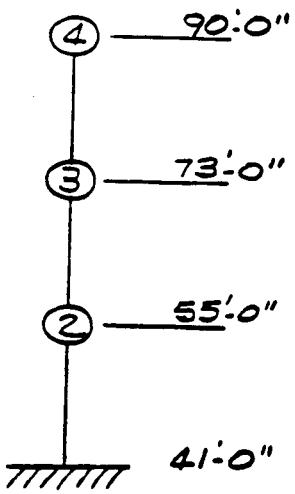


Figure 17 - Dynamic Model of Primary Auxiliary Building

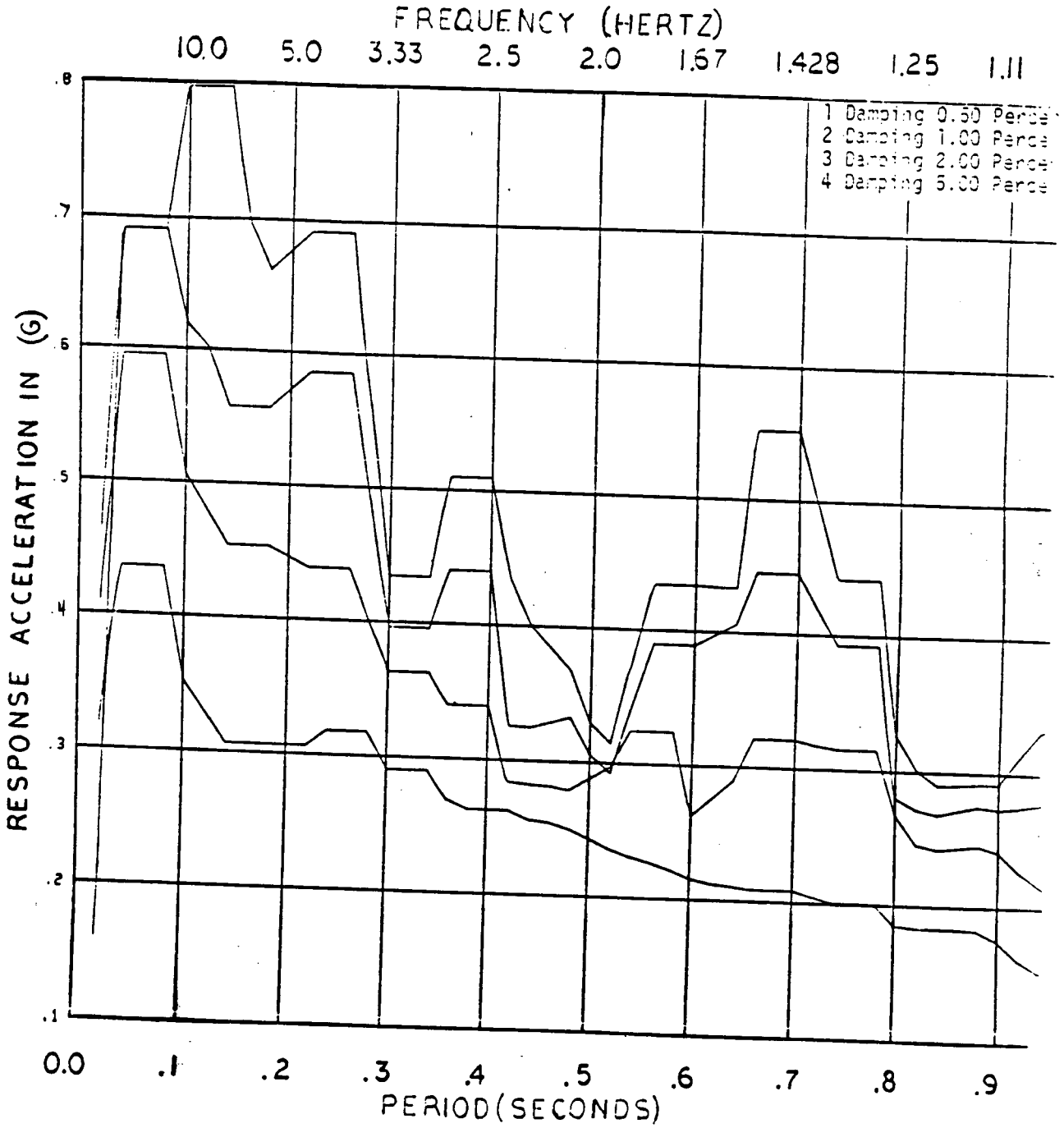


Figure 18 - Broadened DBE Response Spectra Associated with Primary Auxiliary Building, North-South Direction, Mass Point 4, Elevation 90'0"

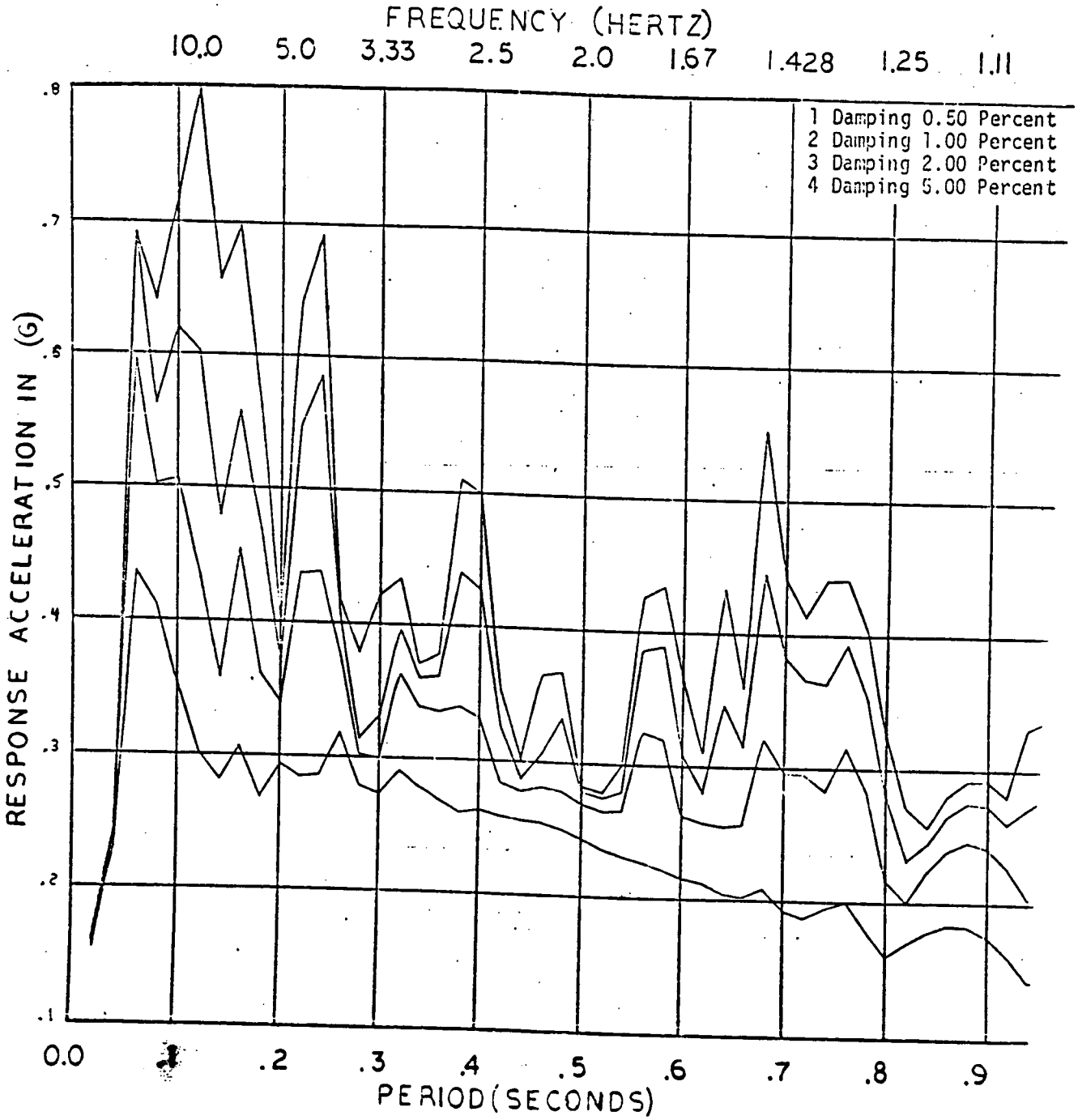


Figure 19 - Unbroadened DBE Response Spectra Associated with Primary Auxiliary Building, North-South Direction Mass Point 4, Elevation 90'0"

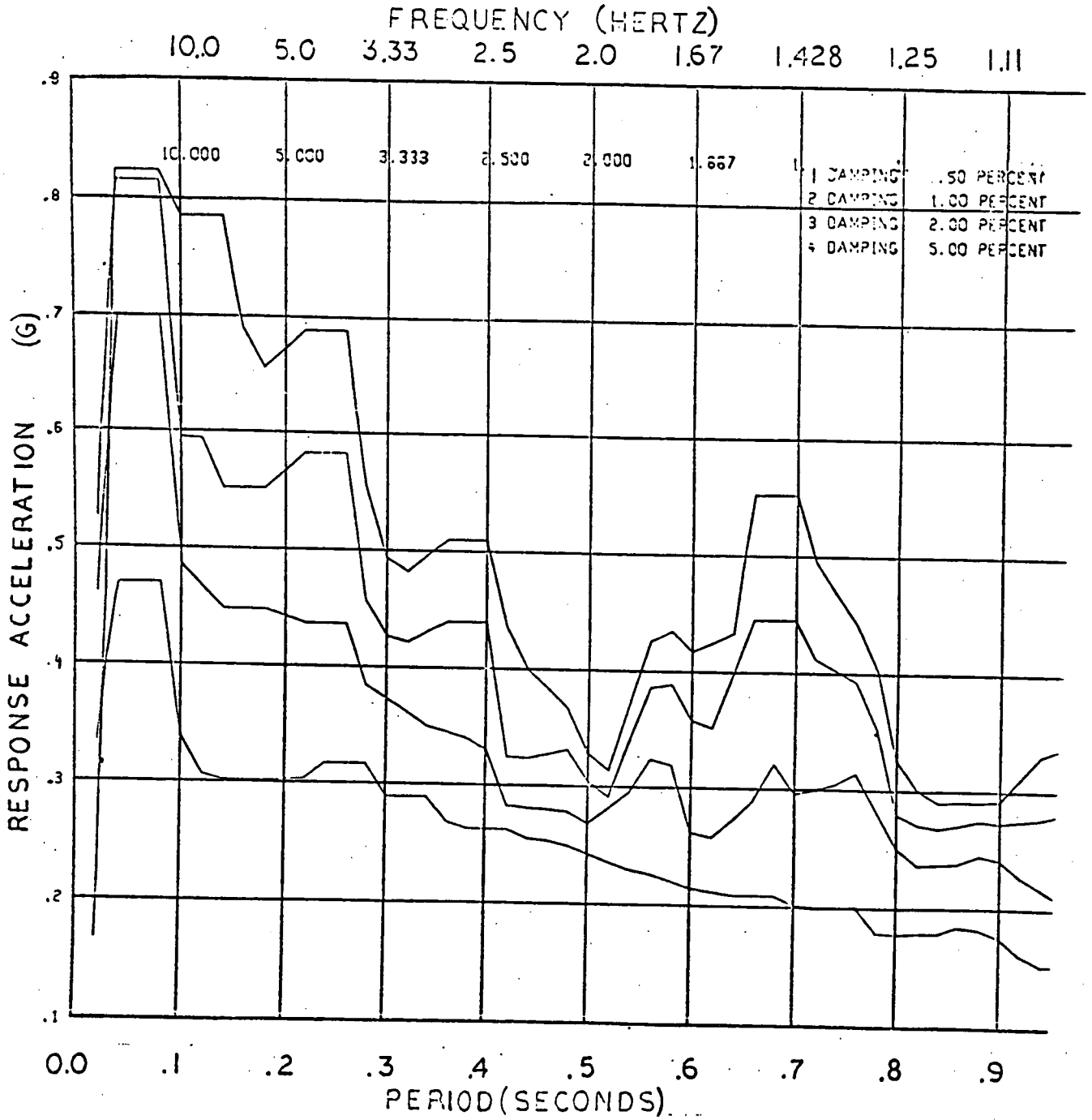


Figure 20 - Broadened DBE Response Spectra Associated with Primary Auxiliary Building, East-West Direction Mass Point 4, Elevation 90'0"

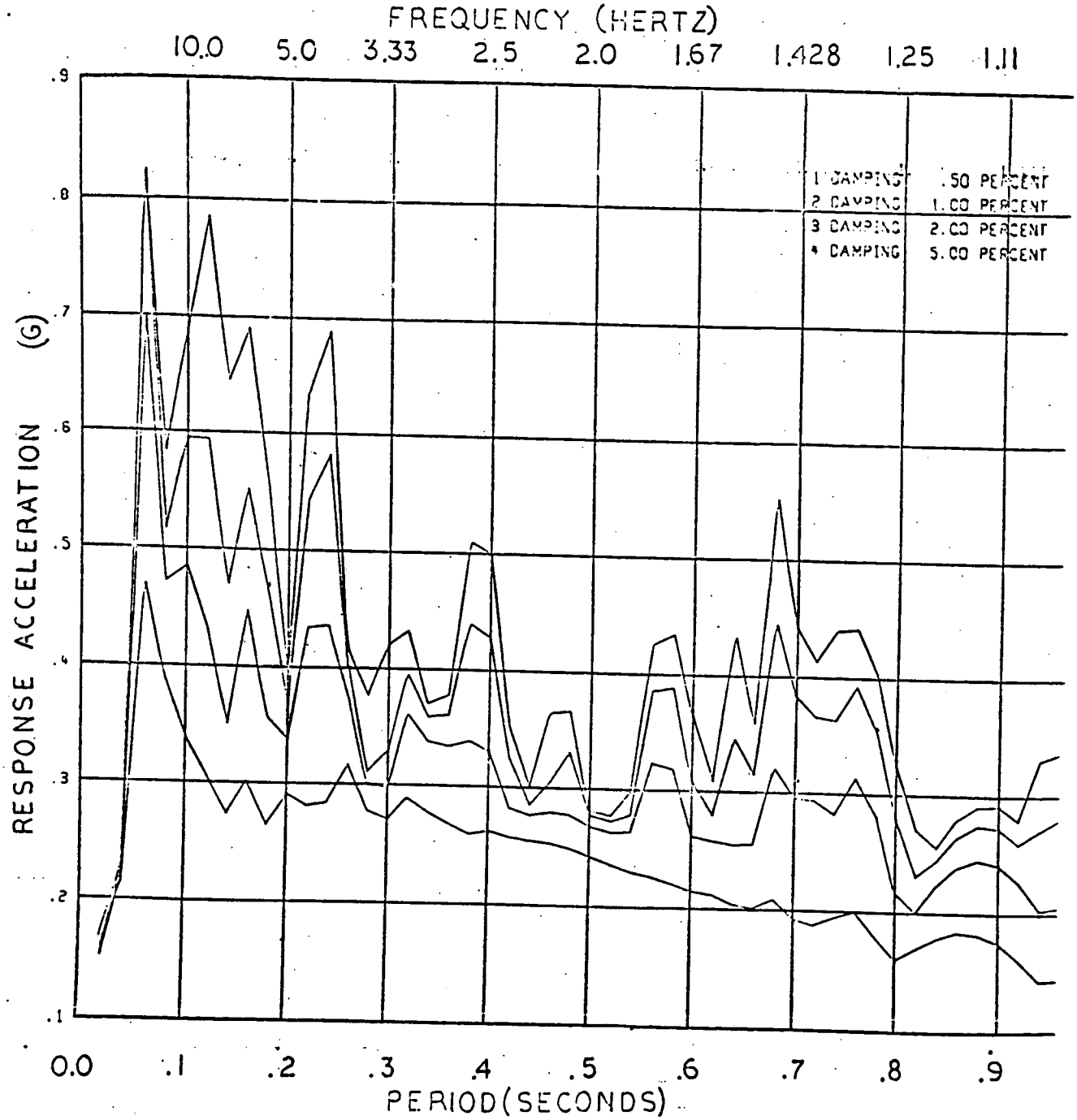


Figure 21 - Unbroadened DBE Response Spectra Associated with Primary Auxiliary Building, East-West Direction Mass Point 4, Elevation 90'0"

Table 5
Indian Point Unit No. 3
Dynamic Characteristic
Primary Auxiliary Building - North-South

Modes		1	2
Frequency (Hz)		14.30	37.35
	Mass Points	Mode Shapes	
	1	0.000	0.000
	2	0.463	-0.874
	3	0.818	-0.243
	4	1.000	1.000
Participation Factors		1.27	-0.36

Table 6
Indian Point Unit No. 3
Dynamic Characteristic
Primary Auxiliary Building - East-West

Modes		1	2
Frequency (Hz)		14.68	38.00
	Mass Points	Mode Shapes	
	1	0.000	0.000
	2	0.392	-0.906
	3	0.804	-0.311
	4	1.000	1.000
Participation Factors		1.28	-0.40

4.4 Control and Diesel Generator Building

The Control and Diesel Generator Building is of concrete construction whose foundation is at Elevation 15'. A cross sectional view of the building is shown in Figure 22.

Two separate lump mass dynamic models were used for the North-South and East-West directions. These models are shown in Figure 23.

Floor response spectra associated with the DBE are given in Figures 24 to 27 (broadened and unbroadened) for mass point 4 which is at Elevation 70'. The dominant modes are in a frequency range between 10 to 14 Hz. Given in Table 7 and 8 are the frequencies and lateral mode shape components and participation factors associated with the significant modes.

Given below is a summary of important key parameters associated with the mass point 4 horizontal spectra for the frequency region of dominant response.

Mass Point	Elevation	Ground ZPA	Floor ZPA	Damping	Peak Acc.	Ratio (6)/(4)	Ratio (6)/(3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
4 (N-S)	70'0"	0.15g	0.25g	2%	1.15g	4.6	7.7
4 (N-S)	70'0"	0.15g	0.25g	5%	0.85g	3.4	5.7
4 (E-W)	70'0"	0.15g	0.22g	2%	0.85g	3.9	5.7
4 (E-W)	70'0"	0.15g	0.22g	5%	0.60g	2.7	4.0

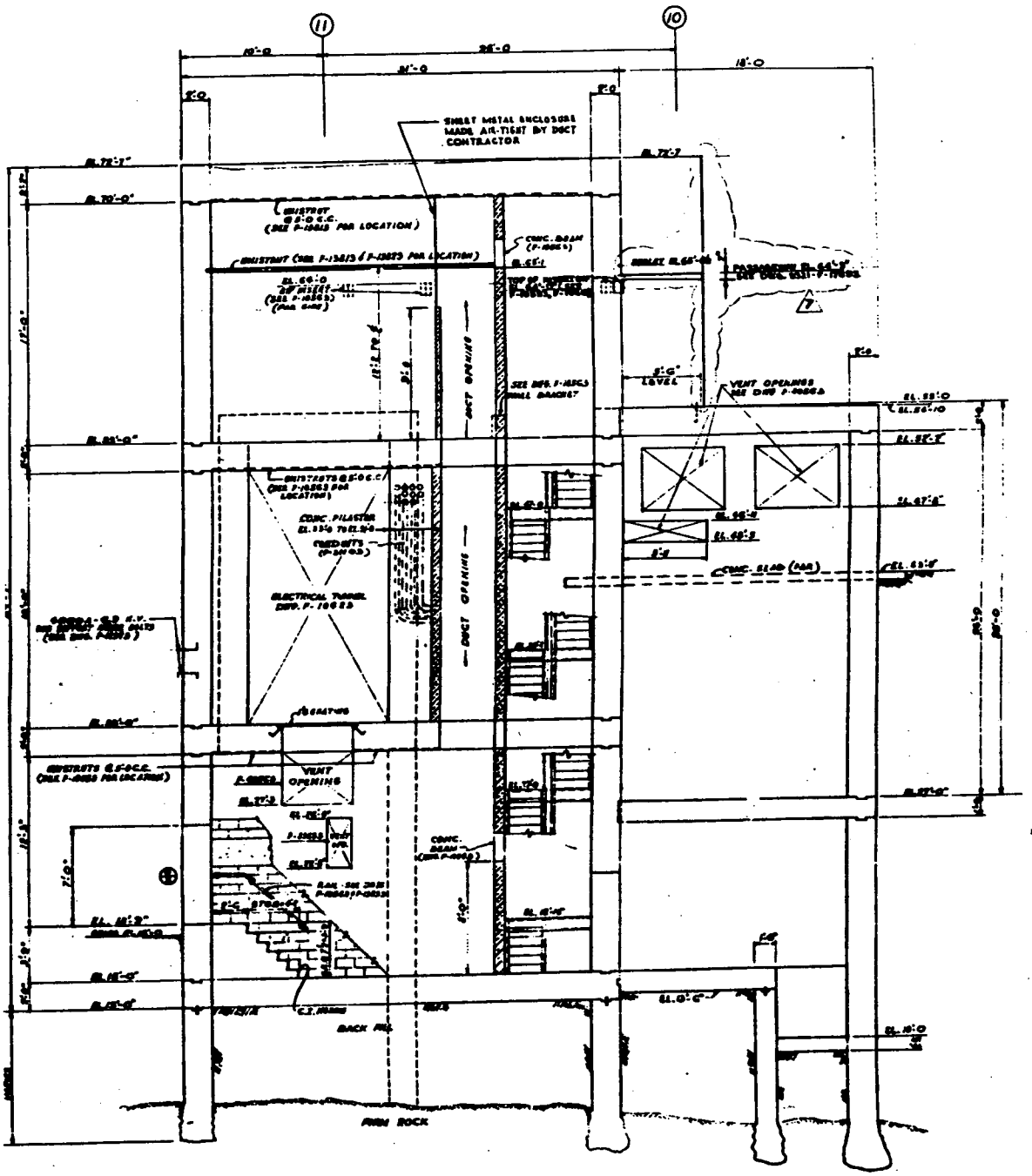
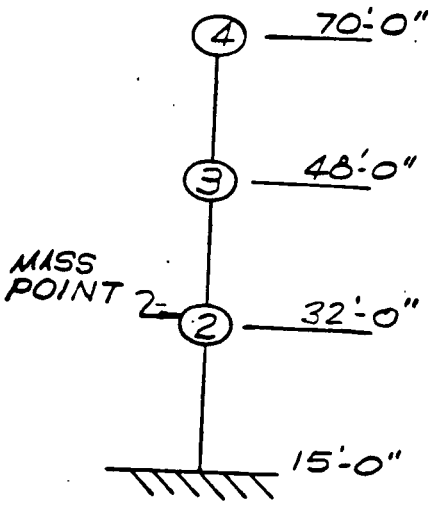
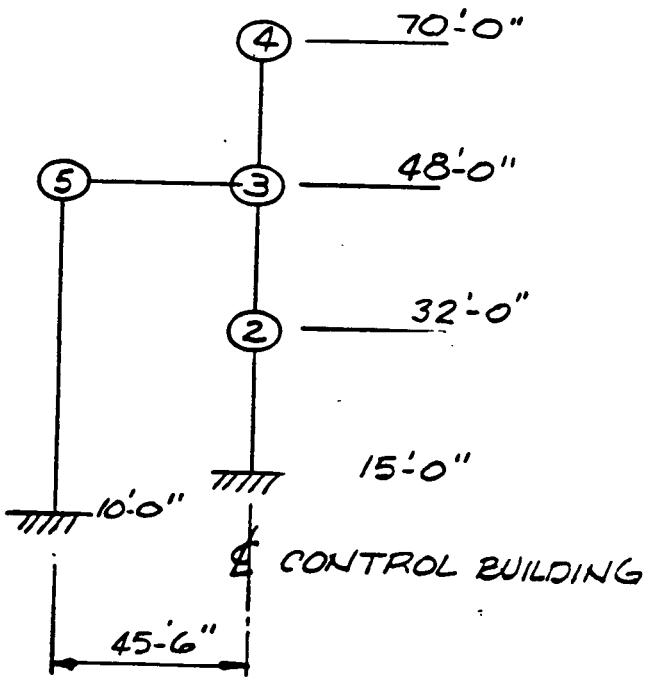


Figure 22 - Cross Sectional View of Control & Diesel Building



North-South Direction



East-West Direction

Figure 23 - Dynamic Models of Control & Diesel Building

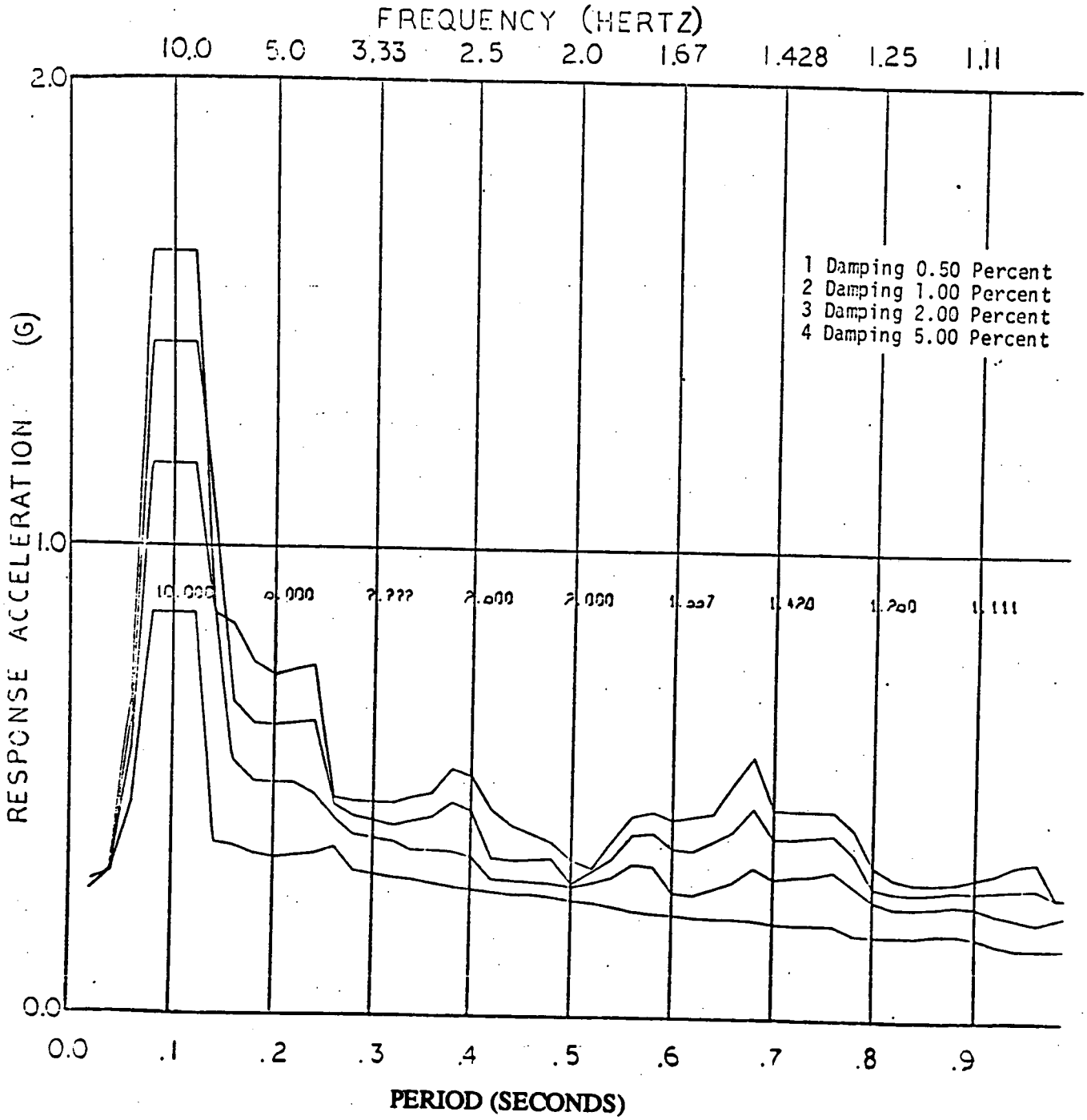


Figure 24 - Broadened DBE Response Spectra Associated with Control & Diesel Generator Building, North-South Direction, Mass Point 4, Elevation 70'0"

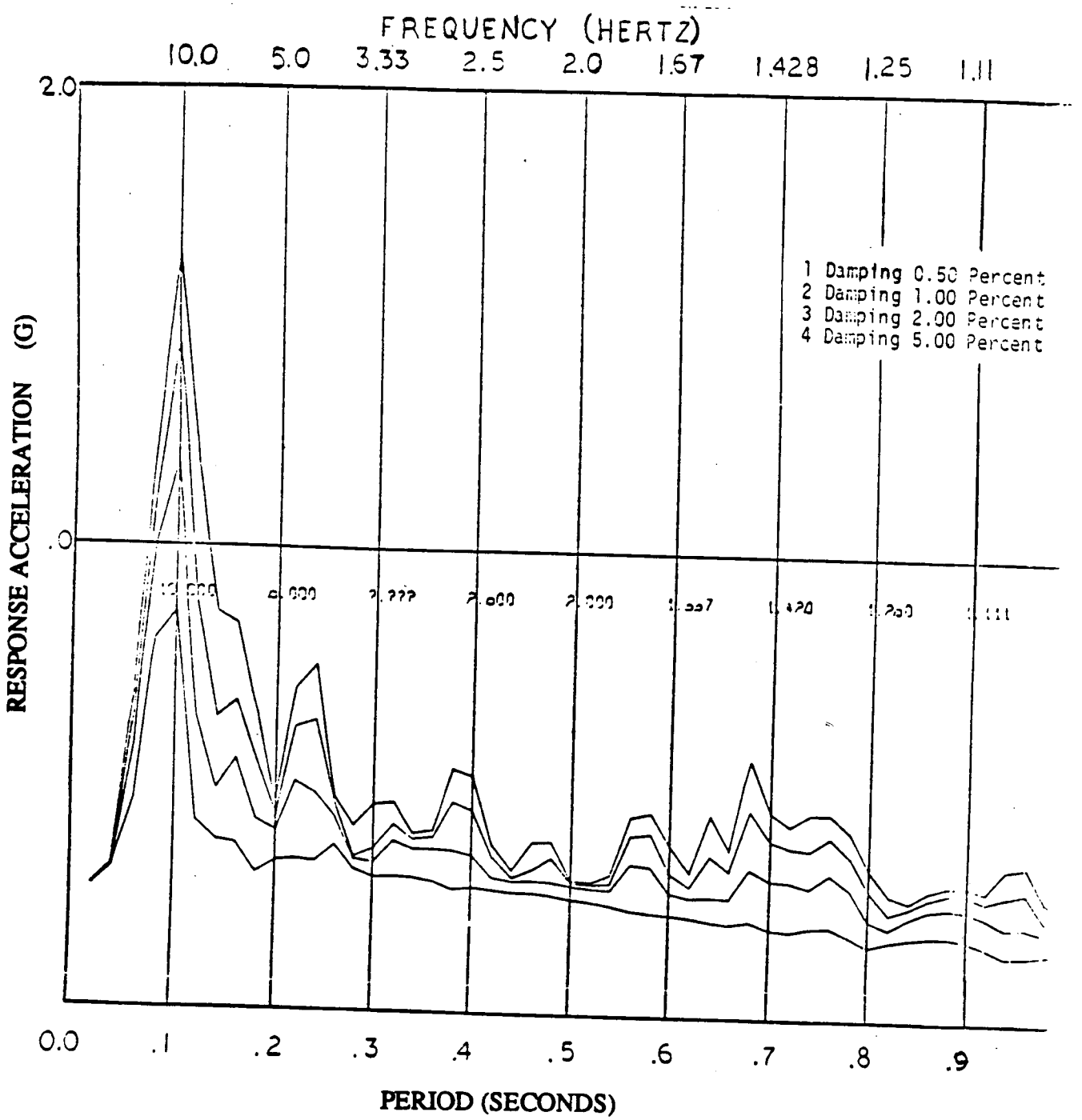


Figure 25 - Unbroadened DBE Response Spectra Associated with Control & Diesel Generator Building, North-South Direction, Mass Point 4, Elevation 70'0"

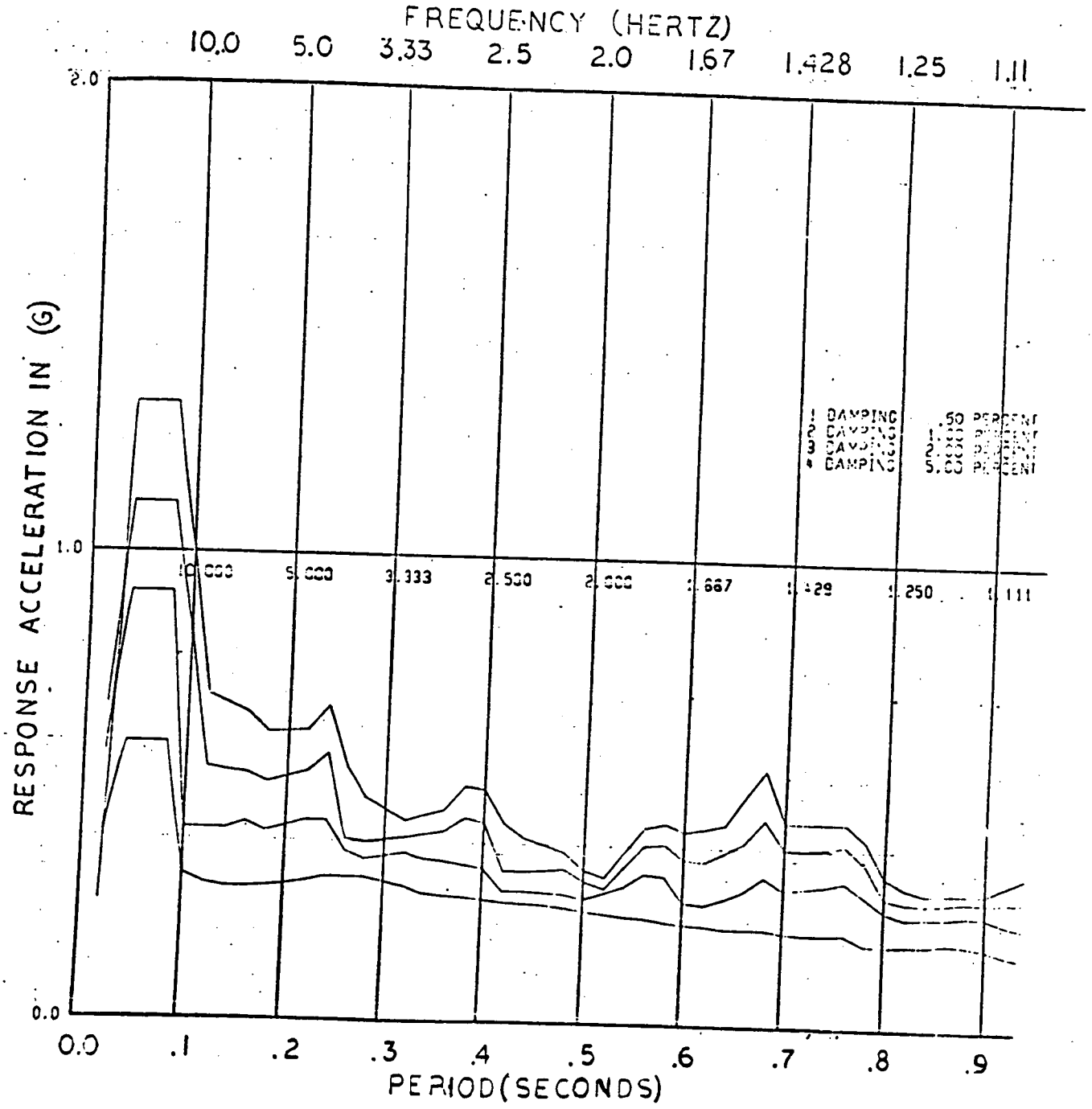


Figure 26 - Broadened DBE Response Spectra Associated with Control & Diesel Generator Building, East-West Direction, Mass Point 4, Elevation 70'0"

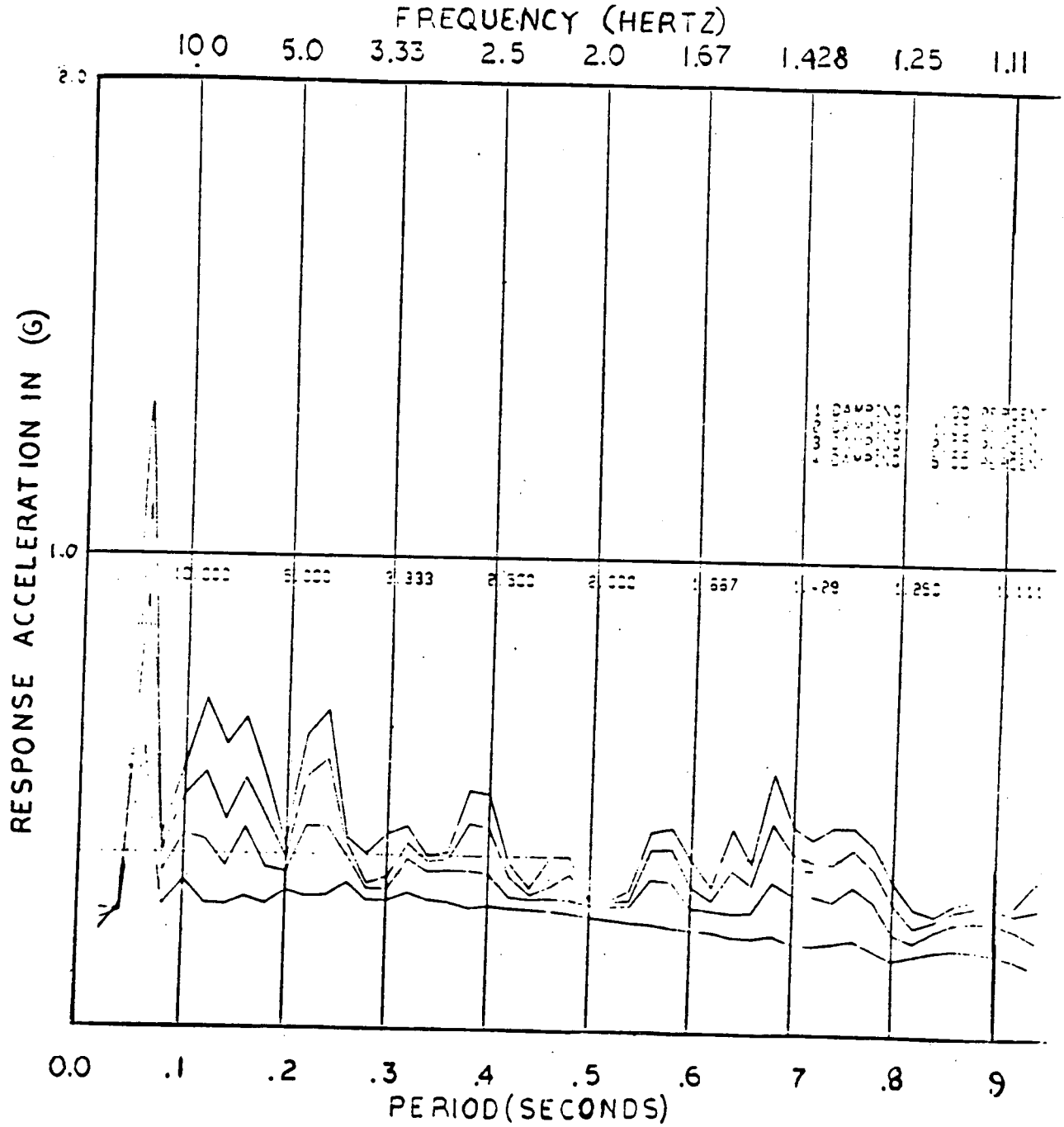


Figure 27 - Unbroadened DBE Response Spectra Associated with Control & Diesel Generator Building, East-West Direction, Mass Point 4, Elevation 70'0"

Table 7
Indian Point Unit No. 3
Dynamic Characteristics
Control & Diesel Generator Building - North-South

Modes		1	2	3
Frequency (Hz)		11.72	22.78	43.45
	Mass Points		Mode Shapes	
	1	0.000	0.000	0.000
	2	0.215	0.736	1.000
	3	0.406	1.000	-0.549
	4	1.000	-0.998	0.329
Participation Factors		1.51	0.55	0.14

Table 8
Indian Point Unit No. 3
Dynamic Characteristics
Control & Diesel Generator Building - East-West

Modes		1	2	3
Frequency (Hz)		13.18	17.48	29.60
	Mass Points		Mode Shapes	
	1	0.000	0.000	0.000
	2	0.055	0.399	0.025
	3	0.101	0.714	0.098
	4	0.123	1.000	0.685
	5	1.000	-0.157	-1.000
Participation Factors		1.18	1.06	-0.01

4.5 Fan House Building

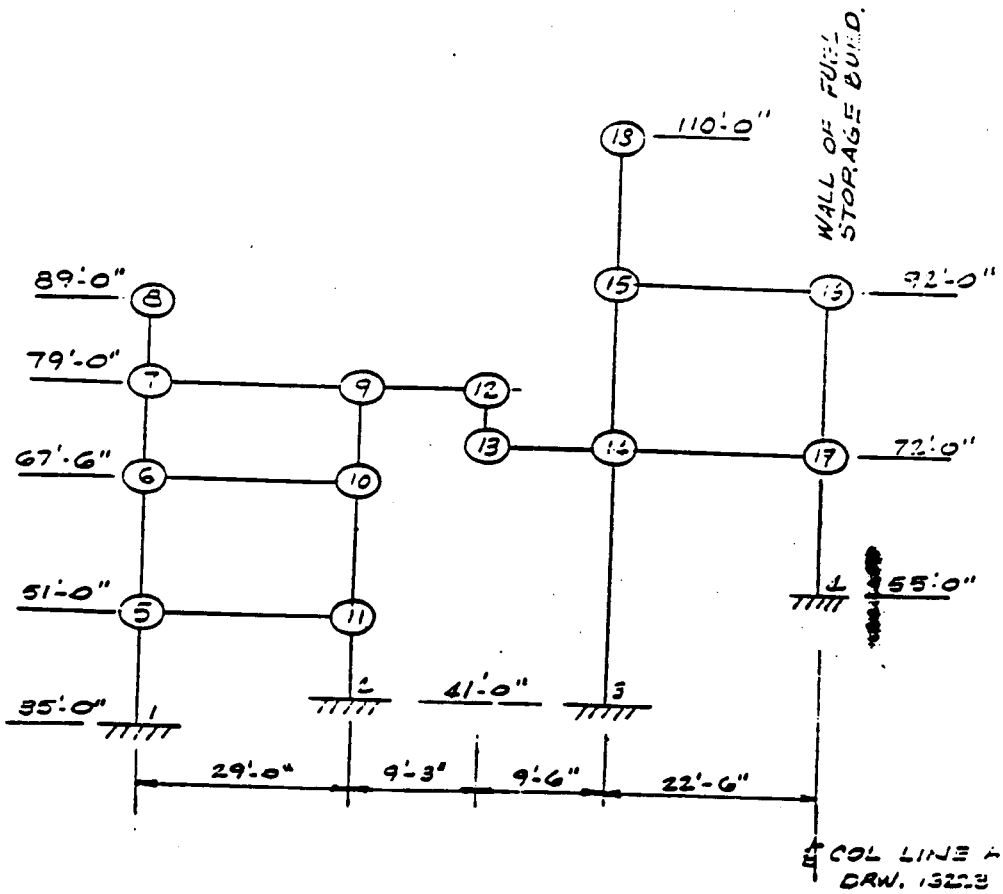
The Fan House Building is primarily of concrete construction, located next to the fuel storage building.

Two separate lump mass dynamic models were used for the North-South and East-West directions. As shown in Figure 28, the East-West model is in the plane of the paper, and the North-South model is a grid model with the response normal to the plane of the paper.

Floor response spectra associated with the DBE are given in Figures 29 to 32 (broadened and unbroadened) for mass point 8 which is at Elevation 89'. The dominant modes are in a frequency range between 7 to 13 Hz. Given in Tables 9 and 10 are the frequencies and lateral mode shape components and participation factors associated with the significant modes.

Given below is a summary of important key parameters associated with the mass point 8 horizontal spectra for the frequency region of dominant response.

Mass Point	Elevation	Ground ZPA	Floor ZPA	Damping	Peak Acc.	Ratio (6)/(4)	Ratio (6)/(3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
8 (N-S)	89'0"	0.15g	0.25g	2%	1.17g	4.7	7.8
8 (N-S)	89'0"	0.15g	0.25g	5%	0.82g	3.3	5.5
8 (E-W)	89'0"	0.15g	0.17g	2%	1.14g	6.7	7.6
8 (E-W)	89'0"	0.15g	0.17g	5%	0.67g	3.9	4.5



Note: North-South Model Response is normal to the plane of the paper.

Figure 28 - Dynamic Model of Fan House in East-West and North-South Directions

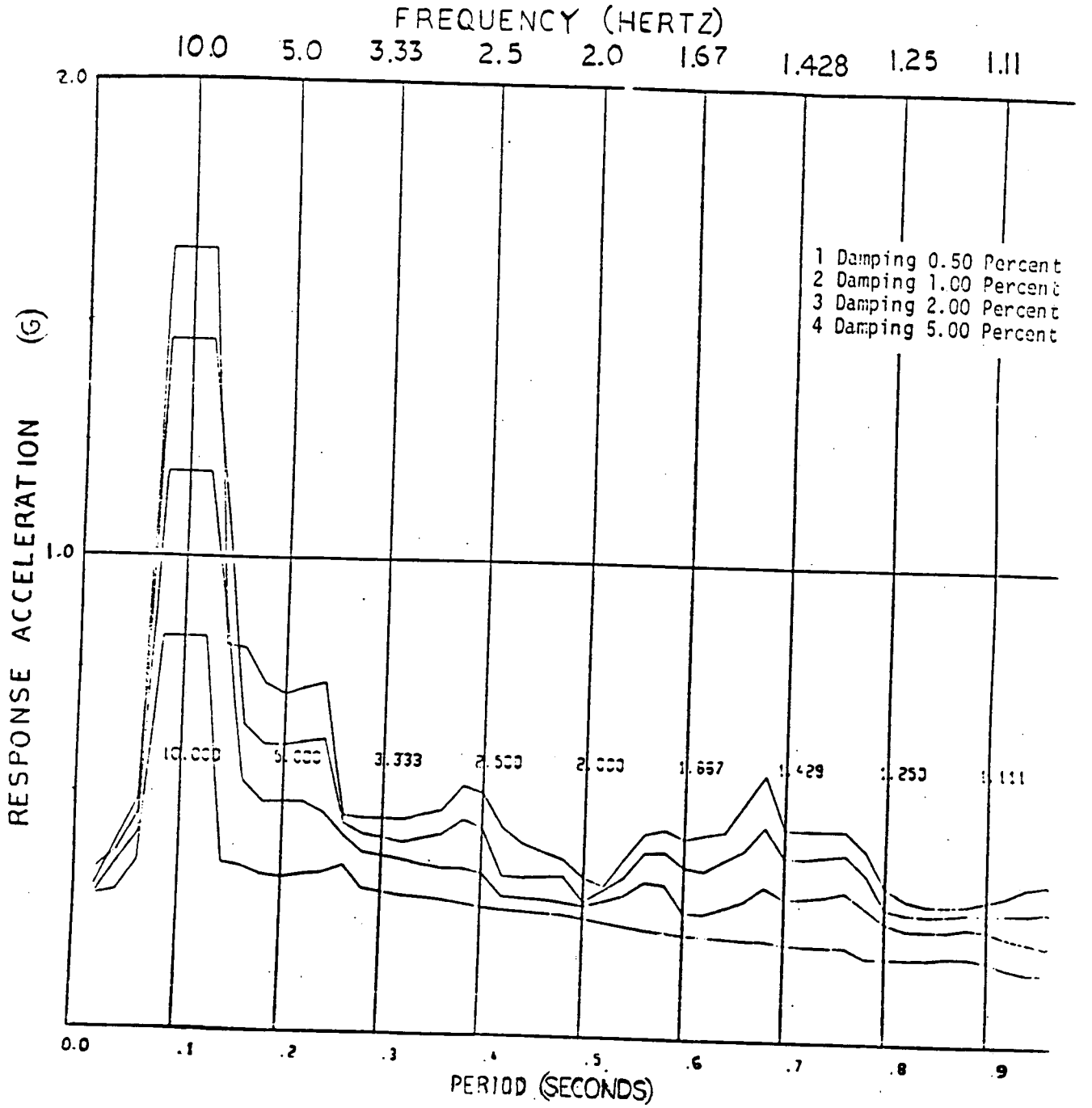


Figure 29 - Broadened DBE Response Spectra Associated with Fan House, North-South Direction, Mass Point 8, Elevation 89'0"

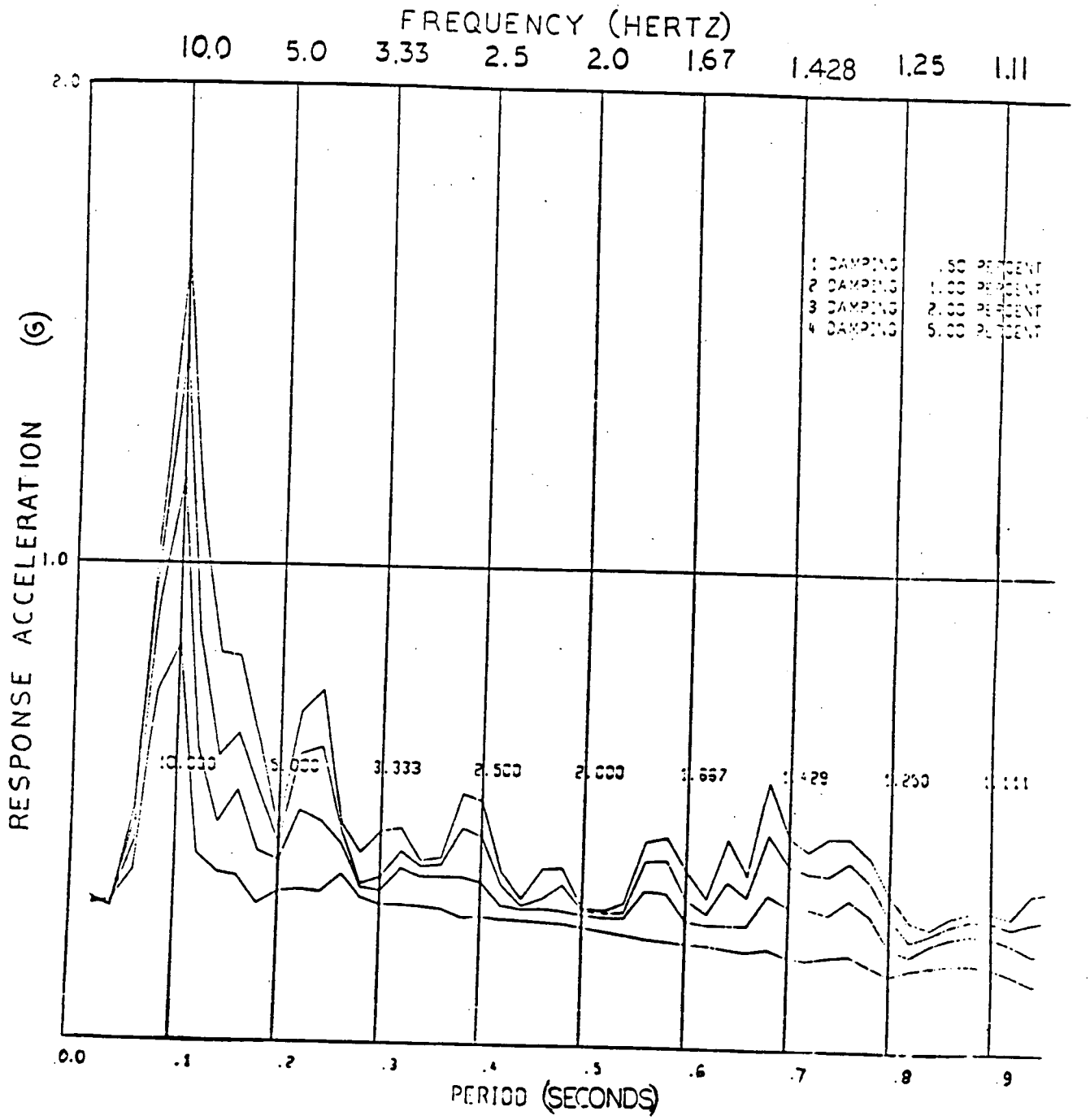


Figure 30 - Unbroadened DBE Response Spectra Associated with Fan House, North-South Direction, Mass Point 8, Elevation 89'0"

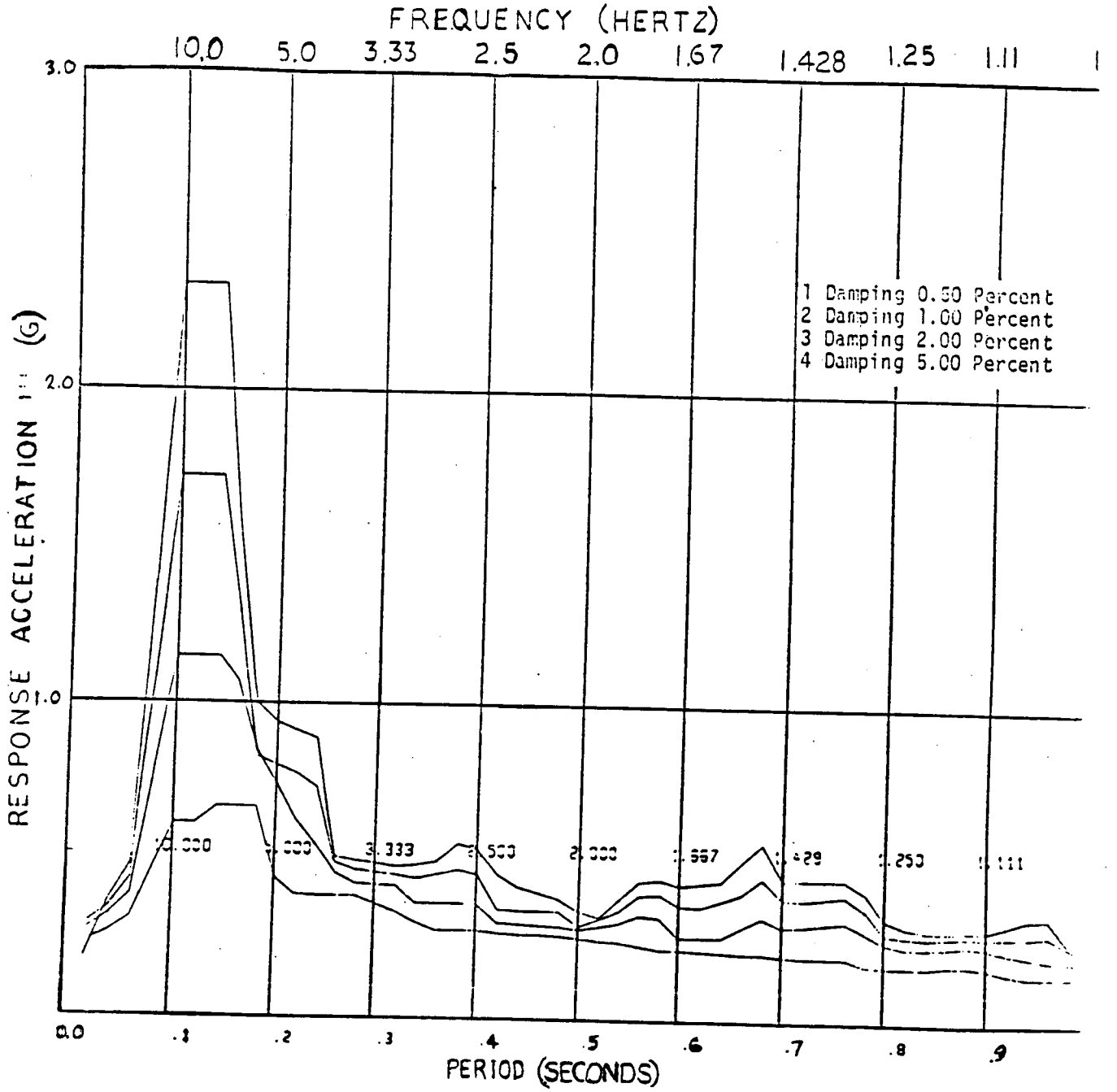


Figure 31 - Broadened DBE Response Spectra Associated with Fan House, East-West Direction, Mass Point 8, Elevation 89'0"

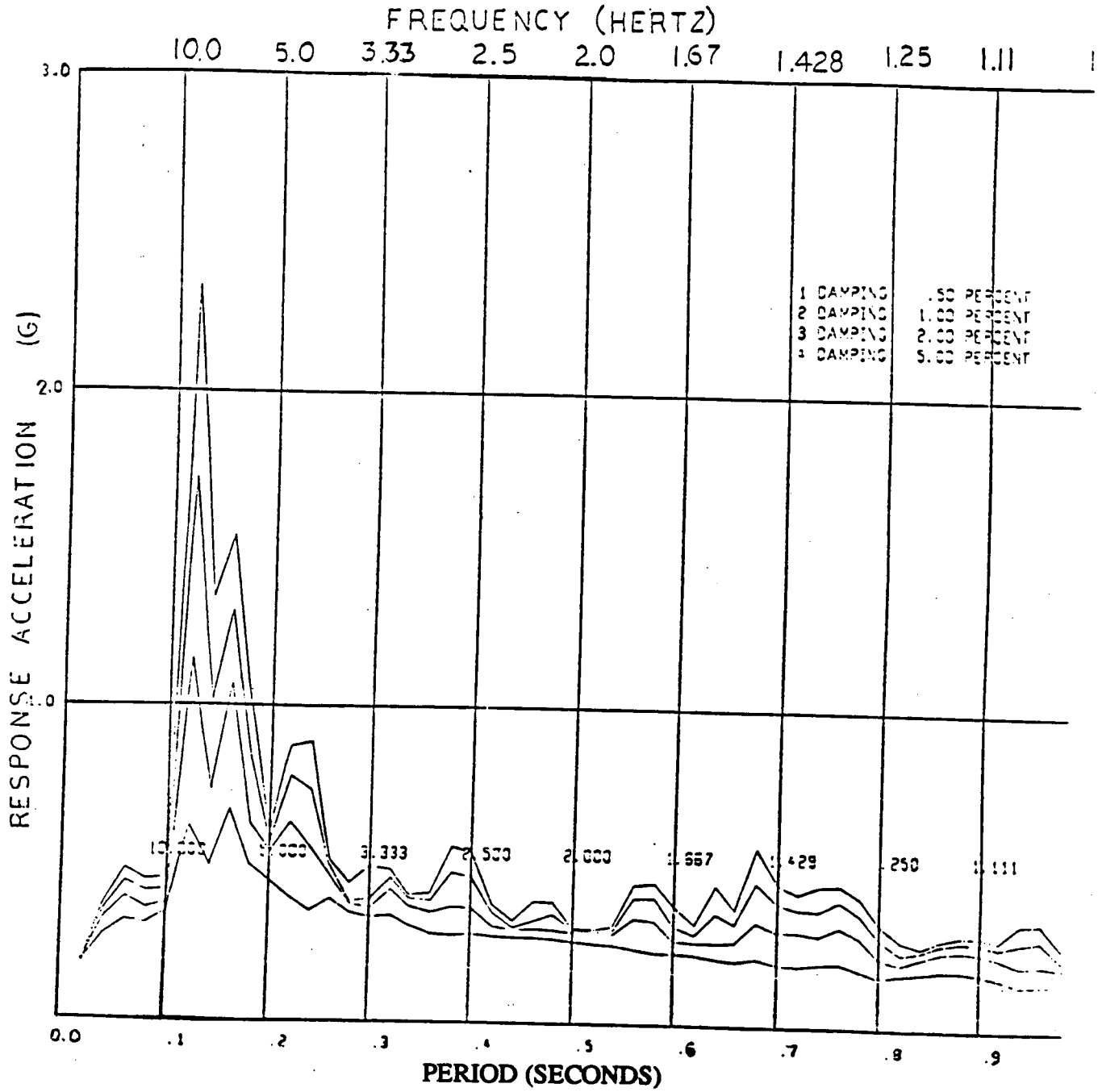


Figure 32 - Unbroadened DBE Response Spectra Associated with Fan House, East-West Direction, Mass Point 8, Elevation 89'0"

Table 9
Indian Point Unit No. 3
Dynamic Characteristics
Fan House - North-South

Modes	1	2	3	4	5
Frequency (Hz)	2.74	8.19	11.57	11.76	21.34
Mass Points		Mode Shapes			
1	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000
5	-0.000	-0.006	0.209	0.105	-0.002
6	-0.001	-0.015	0.549	0.273	-0.014
7	-0.001	-0.020	0.832	0.406	-0.040
8	-0.001	-0.023	1.000	0.487	-0.053
9	0.011	0.426	0.541	-0.473	-0.231
10	0.007	0.261	0.326	-0.303	-1.000
11	0.001	0.034	0.042	-0.039	-0.221
12	0.017	0.574	0.393	-0.683	-0.170
13	0.017	0.480	0.135	-0.267	-0.241
14	0.013	0.336	0.061	-0.129	-0.096
15	0.040	0.657	-0.090	0.120	0.418
16	0.001	0.008	-0.010	0.016	-0.079
17	0.000	0.004	-0.006	0.008	-0.028
18	1.000	1.000	-0.586	1.000	-0.244
Participation Factors	0.30	1.30	1.20	0.40	-0.60

Table 10
Indian Point Unit No. 3
Dynamic Characteristics
Fan House - East-West

Modes		1	2	3	4
Frequency (Hz)		4.20	6.93	8.39	13.20
	Mass Points		Mode Shapes		
	1	0.000	0.000	0.000	0.000
	2	0.000	0.000	0.000	0.000
	3	0.000	0.000	0.000	0.000
	4	0.000	0.000	0.000	0.000
	5	0.008	0.064	0.152	0.463
	6	0.014	0.108	0.253	0.707
	7	0.017	0.136	0.318	0.860
	8	0.019	0.152	0.357	1.000
	9	0.021	0.153	0.336	0.643
	10	0.015	0.117	0.267	0.642
	11	0.006	0.049	0.116	0.352
	12	0.022	0.156	0.337	0.571
	13	0.024	0.157	0.315	0.139
	14	0.025	0.160	0.315	0.062
	15	0.075	0.399	0.593	-0.890
	16	0.069	0.399	0.615	-0.983
	17	0.024	0.146	0.261	-0.212
	18	-1.000	1.000	-1.000	0.180
Participation Factors		-0.40	0.96	1.40	0.58

4.6 Intake Structure

The Intake Structure foundation is located below grade at Elevation (-)27'. General arrangement drawings of the Intake Structure foundation are given in Figures 33 & 34. They were obtained from the Plant FSAR Figure No.s 10.2-27 and 10.2-28.

The lumped mass dynamic model is shown in Figure 35 applicable for both the North-South and East-West directions.

Floor response spectra associated with the DBE are given in Figures 36 to 39 (broadened and unbroadened) for mass point 3 which is at Elevation 15'. The dominant mode frequencies are approximately 12 Hz in the North-South direction, and 18.5 Hz in the East-West direction. Given in Tables 11 and 12 are the frequencies, lateral mode shapes, and participation factors associated with the significant modes.

Given below is a summary of important key parameters associated with mass point 3 horizontal response spectra for the frequency region of dominant response.

Mass Point	Elevation	Ground ZPA	Floor ZPA	Damping	Peak Acc.	Ratio (6)/(4)	Ratio (6)/(3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
3 (N-S)	15'0"	0.15g	0.20g	2%	0.78g	3.9	5.2
3 (N-S)	15'0"	0.15g	0.20g	5%	0.55g	2.8	3.7
3 (E-W)	15'0"	0.15g	0.19g	2%	0.74g	3.9	4.9
3 (E-W)	15'0"	0.15g	0.19g	5%	0.53g	2.8	3.5

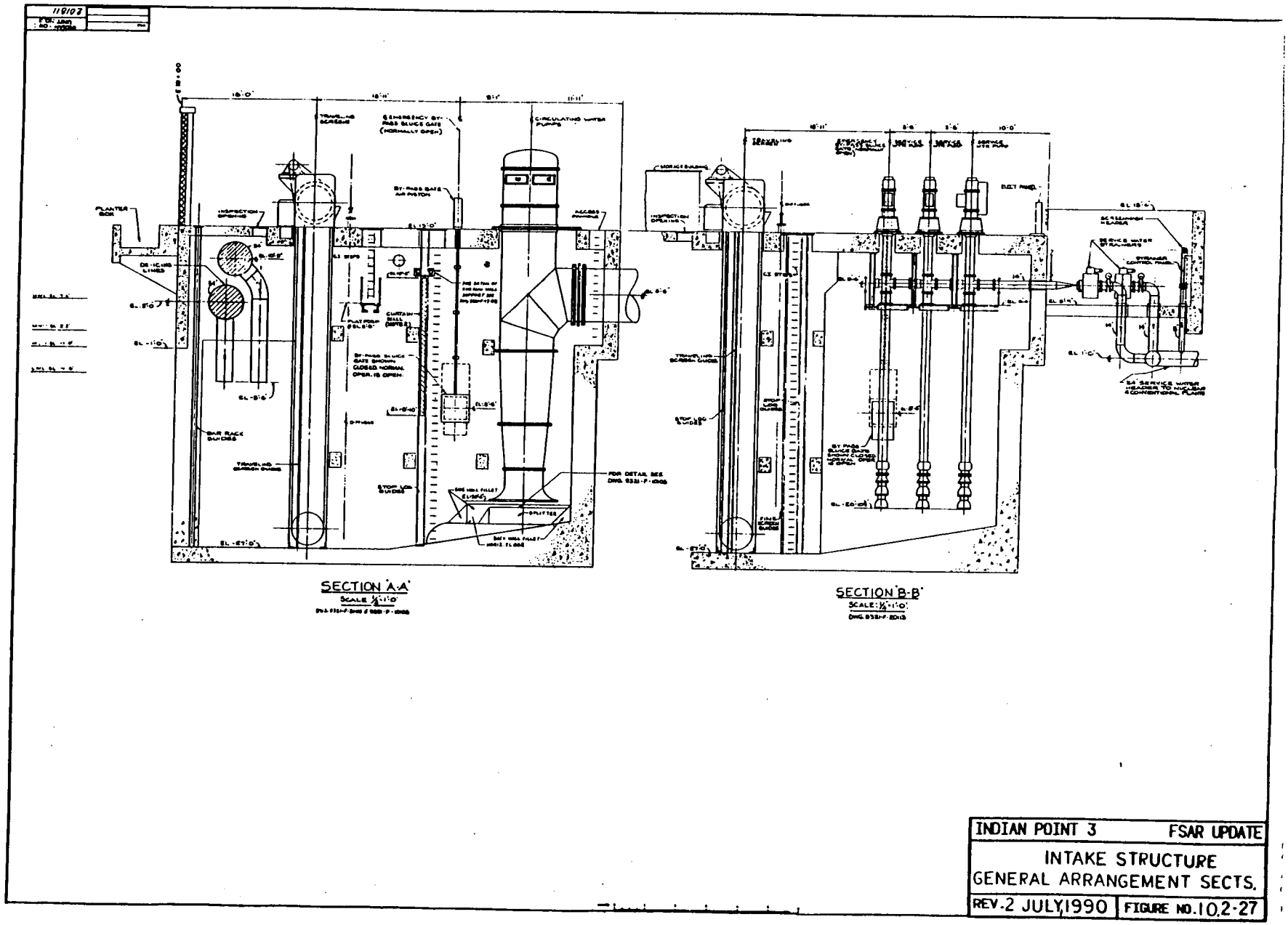


Figure 33 - Intake Structure General Arrangement Sections

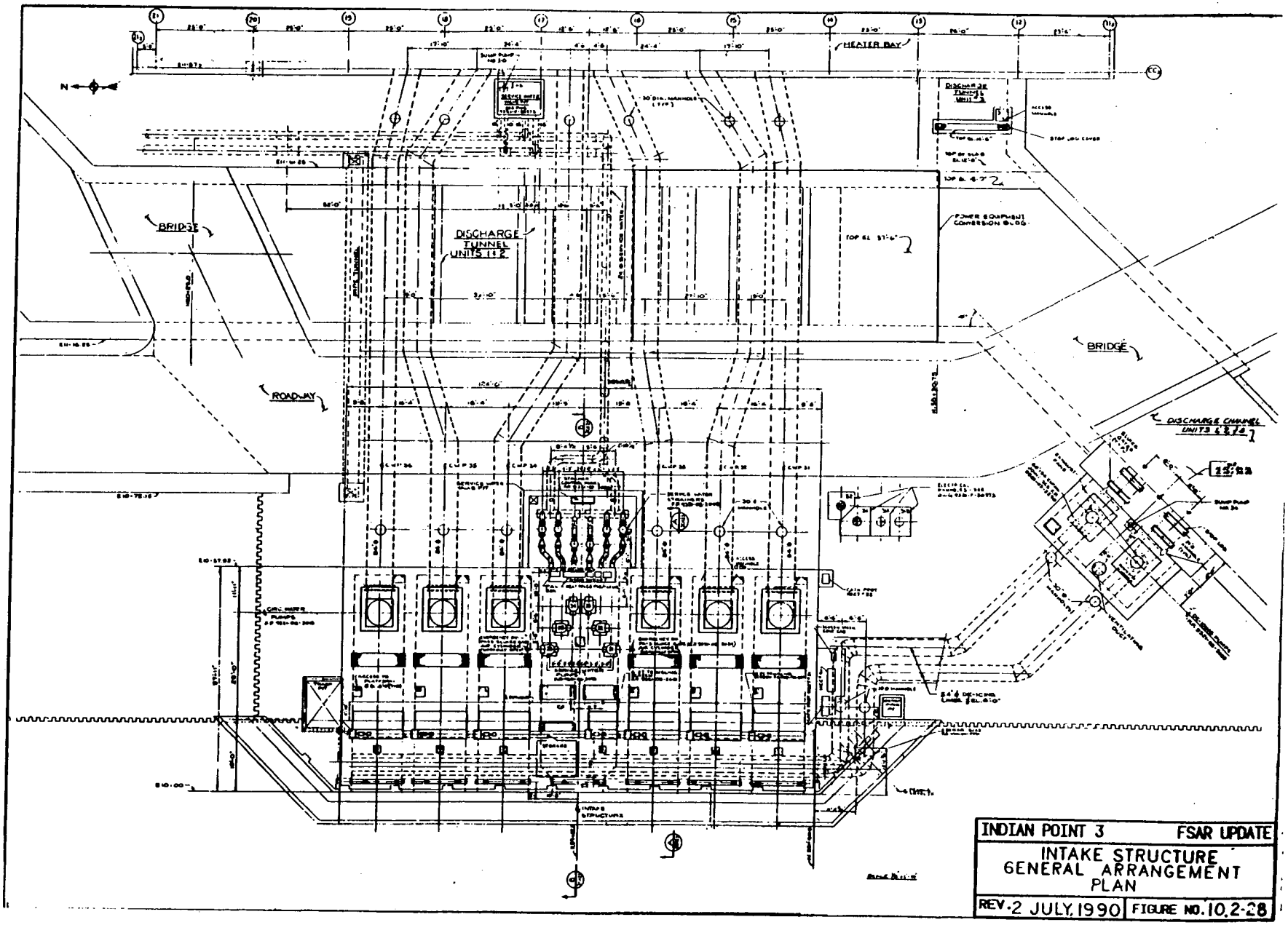


Figure 34 - Intake Structure General Arrangement Plan

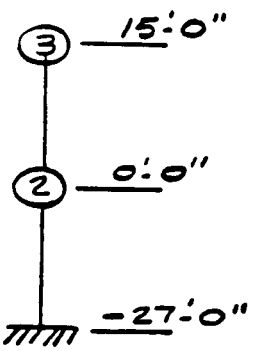


Figure 35 - Dynamic Model of Intake Structure

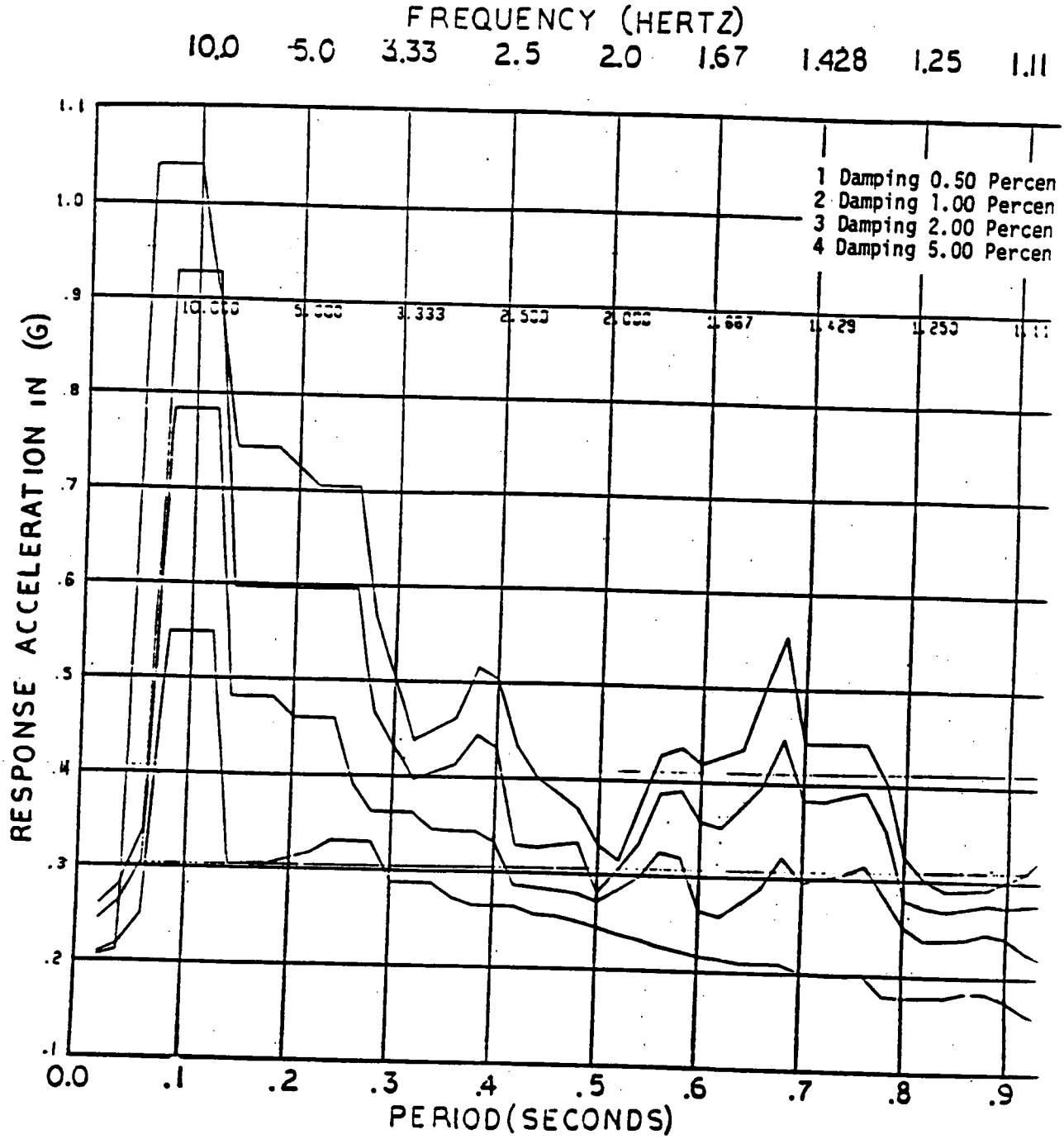


Figure 36 - Broadened DBE Response Spectra Associated with Intake Structure, North-South Direction, Mass Point 3, Elevation 15'0"

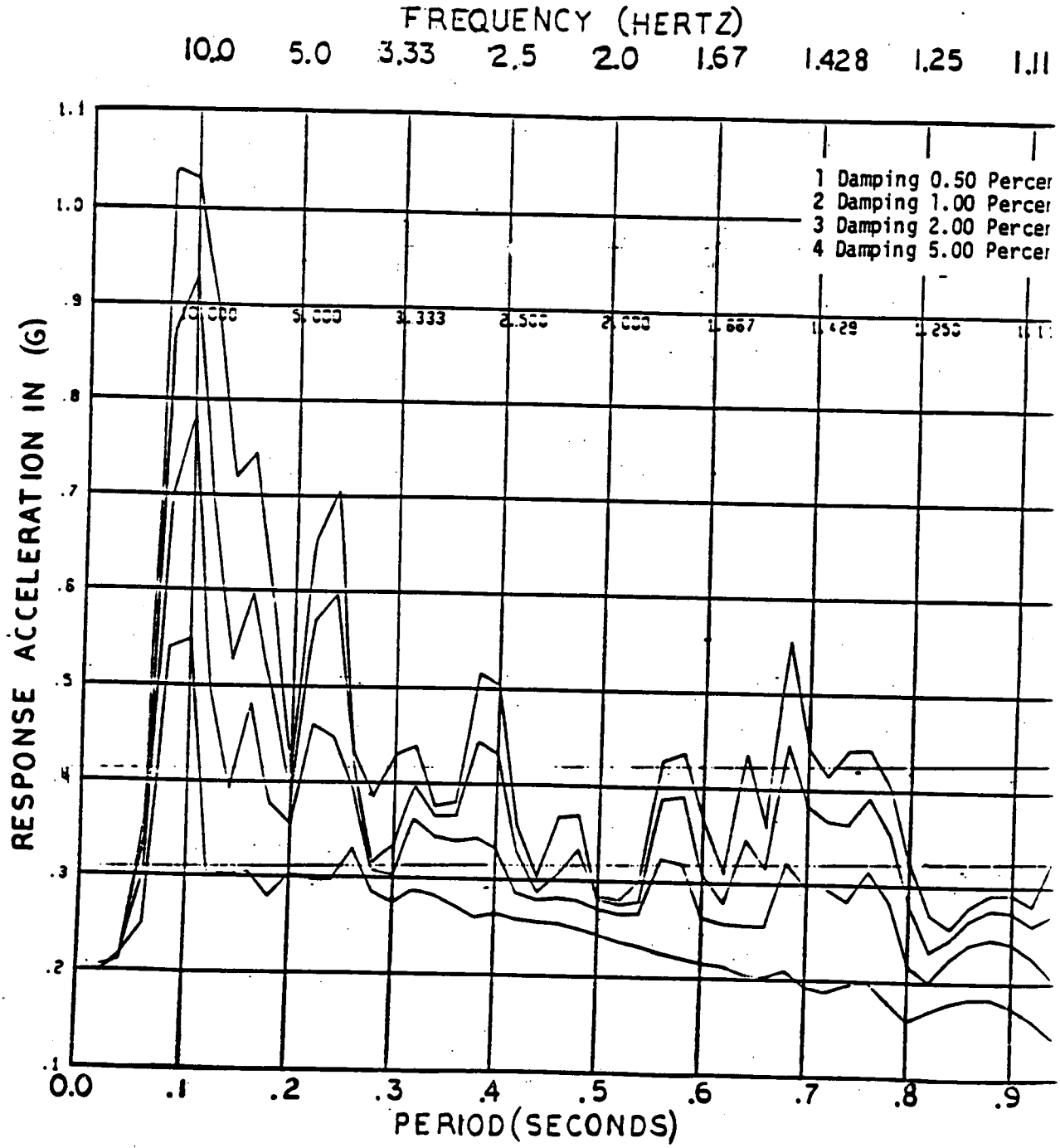


Figure 37 - Unbroadened DBE Response Spectra Associated with Intake Structure, North-South Direction, Mass Point 3, Elevation 15'0"

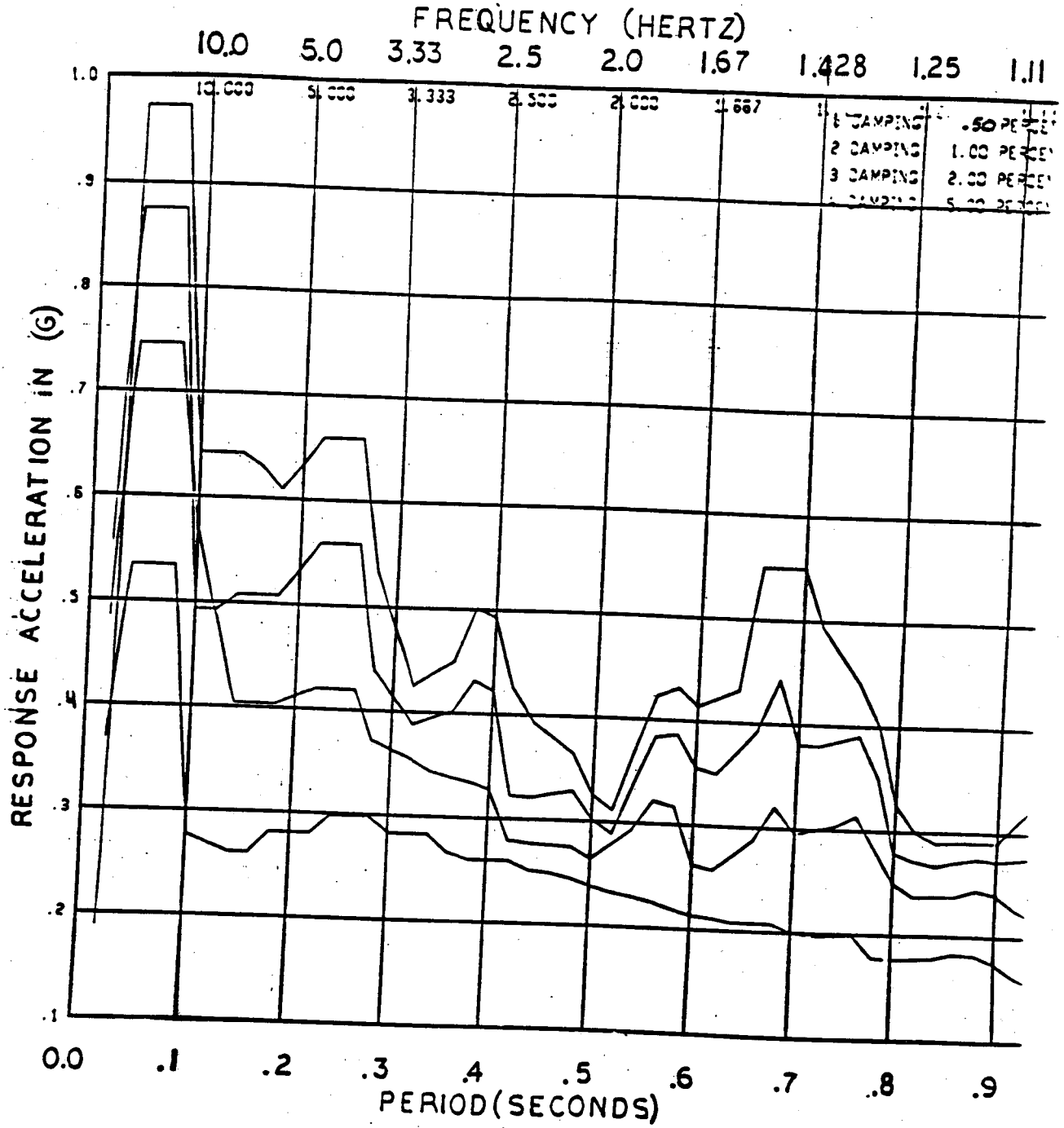


Figure 38 - Broadened DBE Response Spectra Associated with Intake Structure, East-West Direction, Mass Point 3, Elevation 15'0"

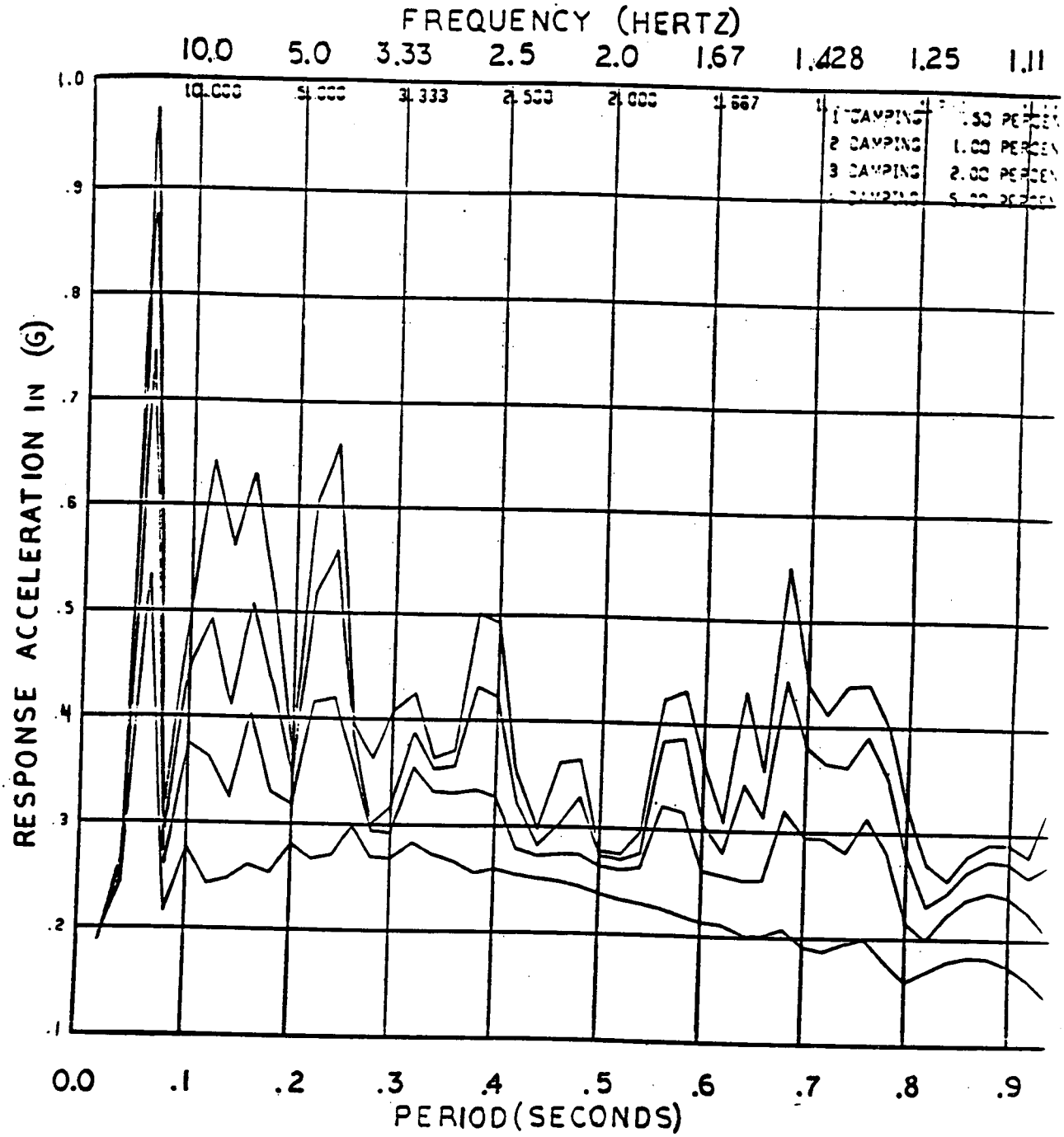


Figure 39 - Unbroadened DBE Response Spectra Associated with Intake Structure, East-West Direction, Mass Point 3, Elevation 15'0"

Table 11
Indian Point Unit No. 3
Dynamic Characteristic
Intake Structure - North-South

Modes		1	2	3
Frequency (Hz)		12.29	19.11	46.98
	Mass Points		Mode Shapes	
	1	0.000	0.000	0.000
	2	0.826	1.000	0.868
	3	1.000	0.439	-1.000
Participation Factors		1.05	0.07	0.08

Table 12
Indian Point Unit No. 3
Dynamic Characteristic
Intake Structure - East-West

Modes		1	2
Frequency (Hz)		18.40	49.84
	Mass Points	Mode Shapes	
	1	0.000	0.000
	2	0.682	1.000
	3	1.000	-0.309
Participation Factors		1.10	0.23

4.7 Spent Fuel Pit

The Spent Fuel Pit is part of the Fuel Storage Building. It is constructed of reinforced concrete and is founded on rock. The steel superstructure above the pit (above Elevation 95'0") encloses the pit and supports the fuel cask handling crane. This superstructure was designed as a Class III structure. The Spent Fuel Pit is shown in Figures 40 and 41. They are obtained from the plant FSAR Figure No.'s 5.1-6 and 1.2-7.

The dynamic model, applicable for both the North-South and East West directions is shown in Figure 42. Mass points 2 to 5 represent the Spent Fuel Pit.

Floor response spectra associated with the DBE are given in Figures 43 to 46 (broadened and unbroadened) for mass point 5 which is at Elevation 95'. The dominant modes are above 20 Hz for both directions. Given in Tables 13 and 14 are the frequencies, lateral mode shape components, and participation factors associated with the significant modes.

Given below is a summary of important key parameters for the mass point 5 horizontal response spectra associated with the frequency region of dominant response.

Mass Point	Elevation	Ground ZPA	Floor ZPA	Damping	Peak Acc.	Ratio (6)/(4)	Ratio (6)/(3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
5 (N-S)	95'0"	0.15g	0.17g	2%	0.52g	3.1	3.5
5 (N-S)	95'0"	0.15g	0.17g	5%	0.36g	2.1	2.4
5 (E-W)	95'0"	0.15g	0.17g	2%	0.48g	2.8	3.2
5 (E-W)	95'0"	0.15g	0.17g	5%	0.36g	2.1	2.4

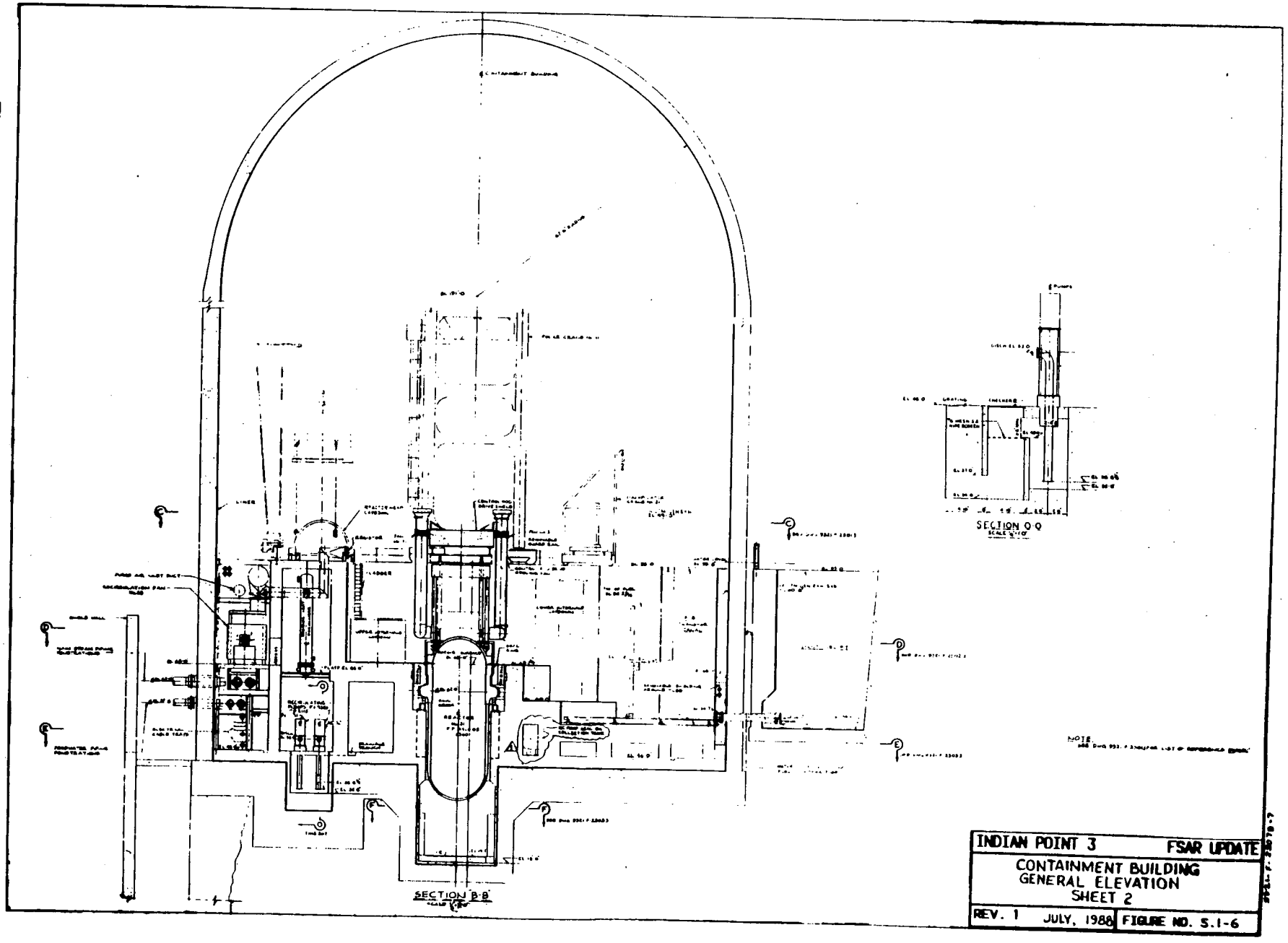


Figure 40 - Location of Spent Fuel Pit in Relation to Containment

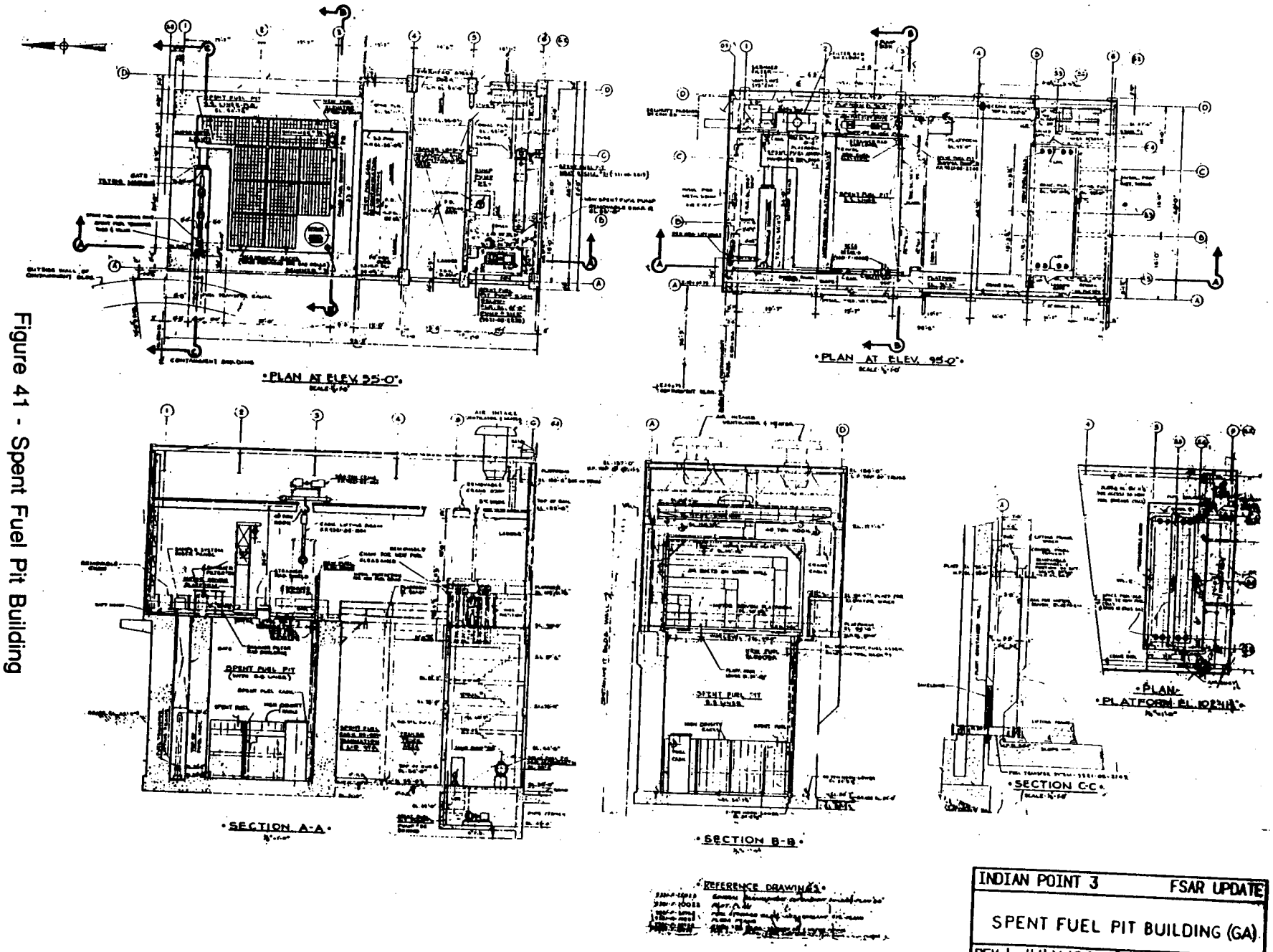


Figure 41 - Spent Fuel Pit Building

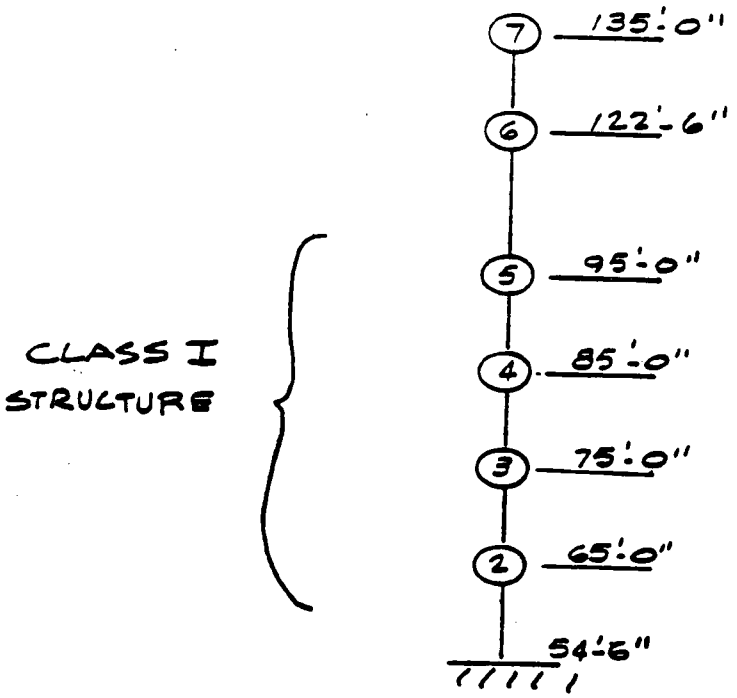


Figure 42 - Dynamic Model of Spent Fuel Pit

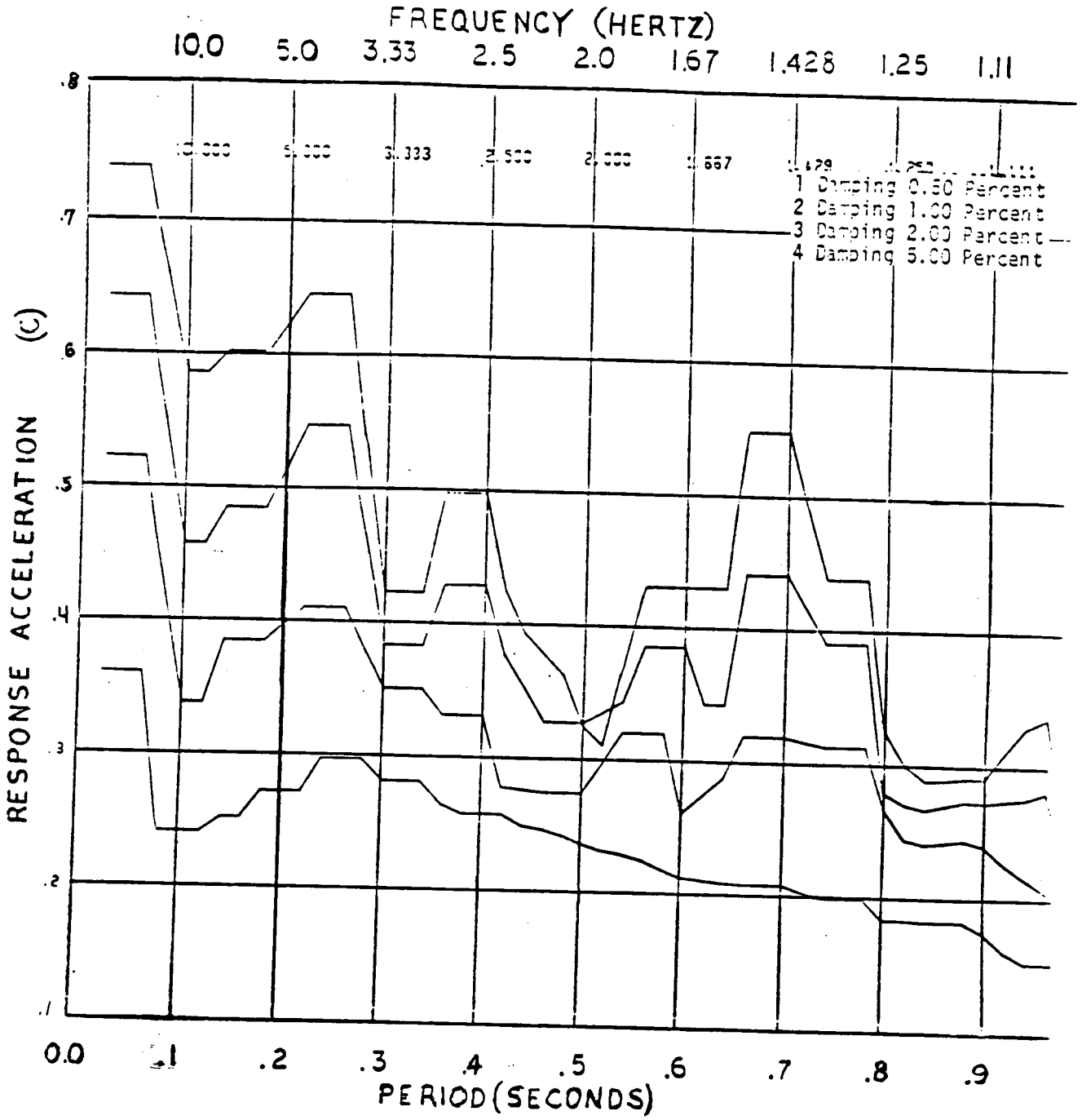


Figure 43 - Broadened DBE Response Spectra Associated with Spent Fuel Pit, North-South Direction, Mass Point 5, Elevation 95'0"

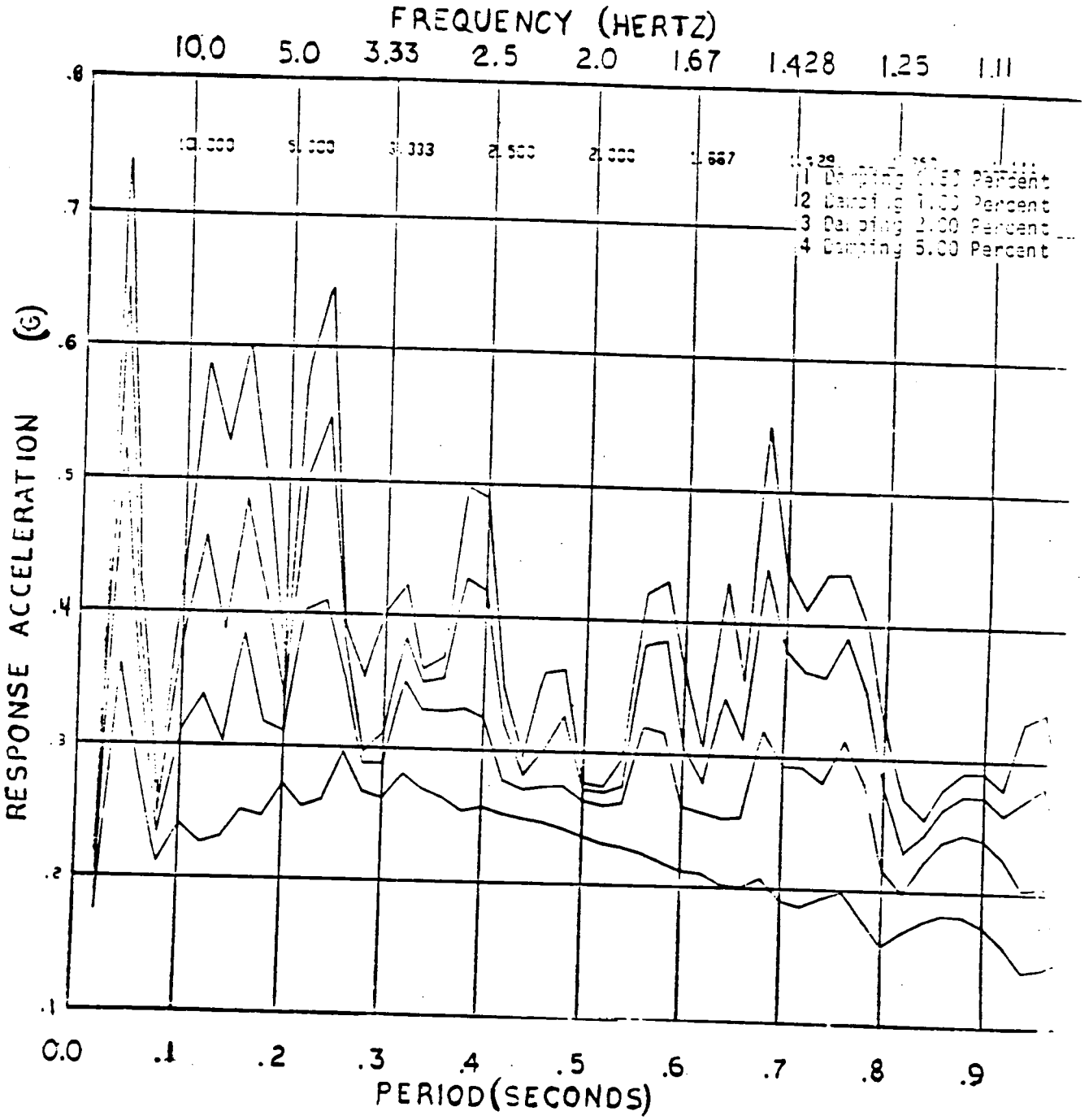


Figure 44 - Unbroadened DBE Response Spectra Associated with Spent Fuel Pit, North-South Direction, Mass Point 5, Elevation 95'0"

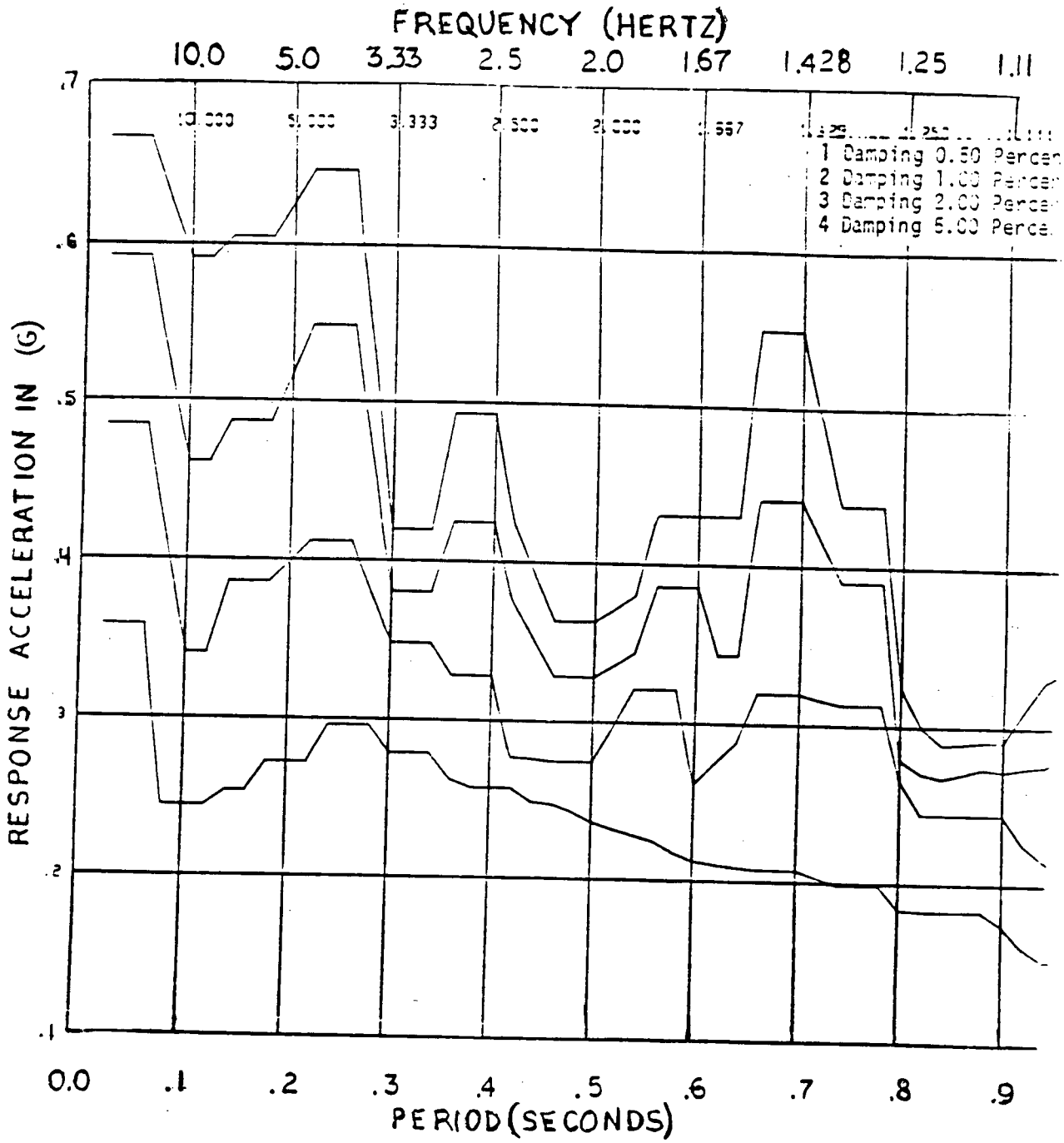


Figure 45 - Broadened DBE Response Spectra Associated with Spent Fuel Pit, East-West Direction, Mass Point 5, Elevation 95'0"

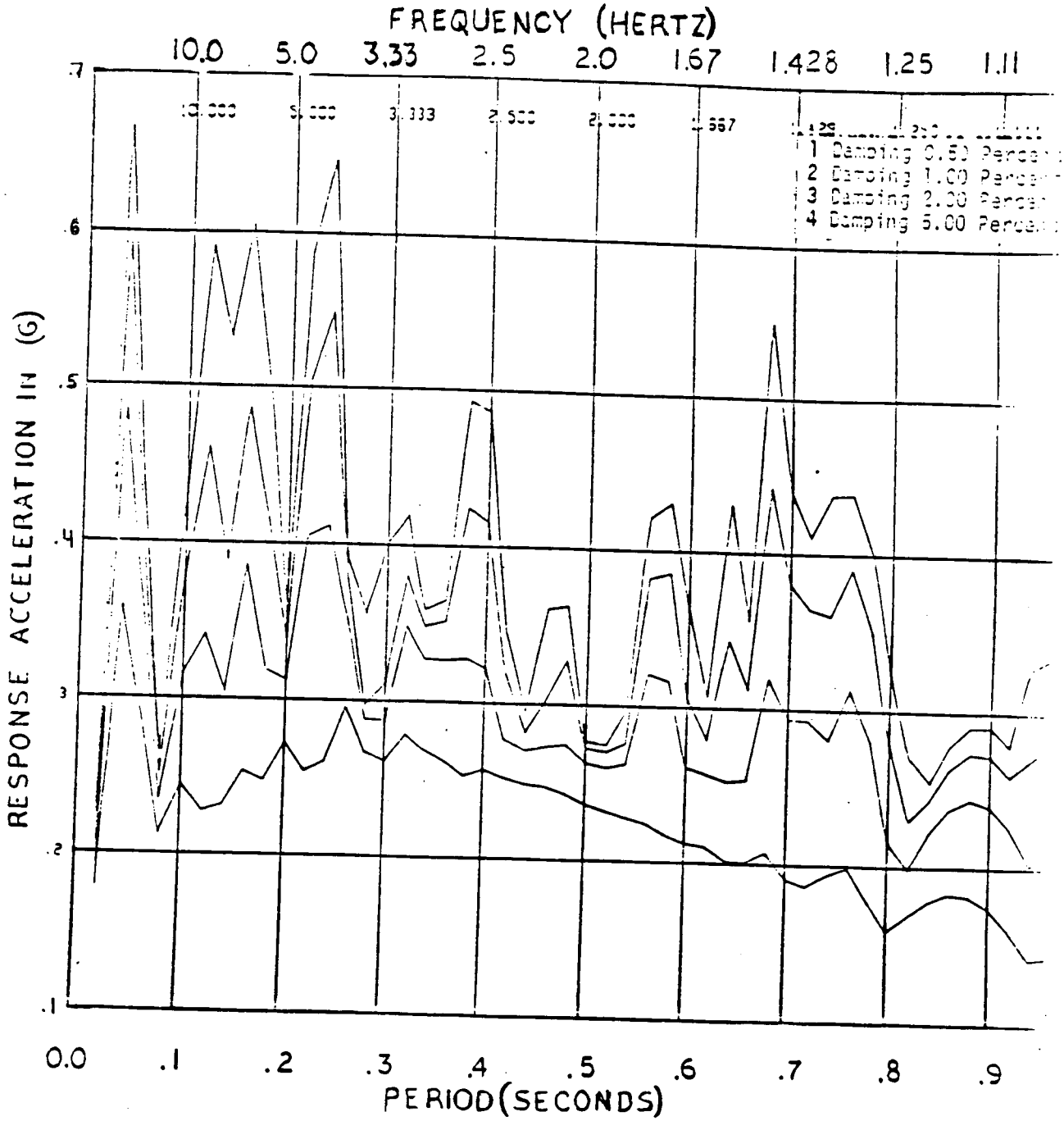


Figure 46 - Unbroadened DBE Response Spectra Associated with Spent Fuel Pit, East-West Direction, Mass Point 5, Elevation 95'0"

Table 13
Indian Point Unit No. 3
Dynamic Characteristic
Spent Fuel Pit - North-South

Modes		1	2
Frequency (Hz)		24.13	61.39
	Mass Point	Mode Shapes	
	1	0.000	0.000
	2	0.246	0.971
	3	0.548	1.000
	4	0.808	0.136
	5	1.000	-0.965
	6	-0.046	0.006
	7	0.006	-0.000
Participation Factors		1.31	0.38

Table 14
Indian Point Unit No. 3
Dynamic Characteristic
Spent Fuel Pit - East-West

	1	2
	23.48	60.42
Mass Points	Mode Shapes	
1	0.000	0.000
2	0.253	-0.955
3	0.533	-1.000
4	0.797	-0.165
5	1.000	0.927
6	-0.052	-0.006
7	0.015	0.000
Participation Factors	1.32	-0.38

4.8 Shield Wall

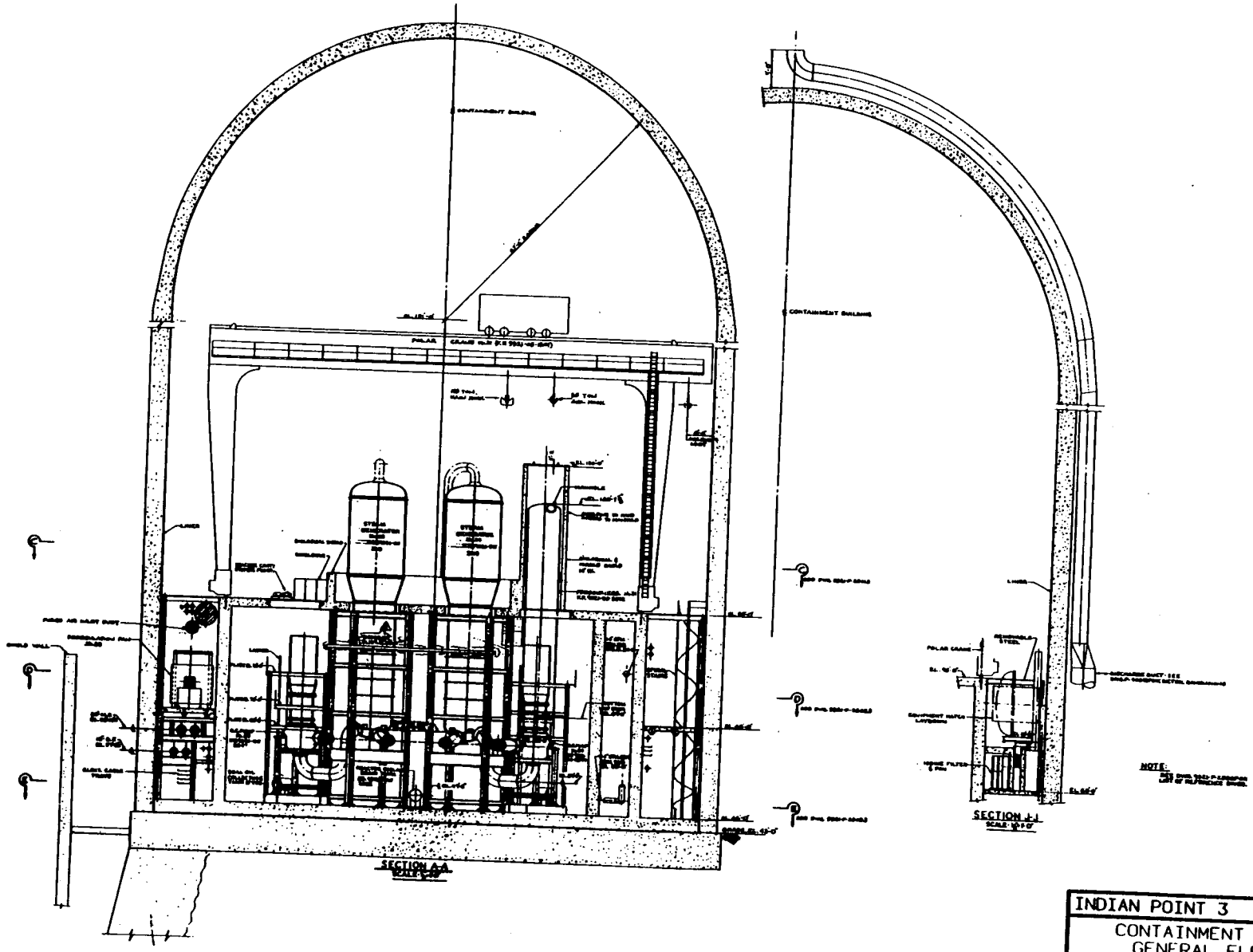
The Shield Wall is of concrete construction located outside of the Containment Structure. Its foundation is at Elevation 7'0". The location of the Shield Wall is shown in Figure 47 as defined by the plant FSAR Figure No. 5.1-5.

The dynamic model is shown on Figure 48. The North-South model responds in the plane of the paper; whereas, the East-West model is a grid model responding normal to the plane of paper.

Floor response spectra associated with the DBE are given in Figures 49 to 52 (broadened and unbroadened) for mass point 2 which is at Elevation 78'0". The dominant mode frequencies are approximately 3 Hz for the East-West direction, and 15 Hz for the North-South direction. Given in Tables 15 and 16 are the frequencies, lateral mode shapes, and participation factors associated with the significant modes.

Given below is a summary of important key parameters for the mass point 2 spectra associated with the frequency region of dominant response.

Mass Point	Elevation	Ground ZPA	Floor ZPA	Damping	Peak Acc.	Ratio (6)/(4)	Ratio (6)/(3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2 (N-S)	78'0"	0.15g	0.21g	2%	0.80g	3.8	5.3
2 (N-S)	78'0"	0.15g	0.21g	5%	0.52g	2.5	3.5
2 (E-W)	78'0"	0.15g	0.41g	2%	2.16g	5.3	14.4
2 (E-W)	78'0"	0.15g	0.41g	5%	1.25g	3.1	8.3



INDIAN POINT 3	FSAR UPDATE
CONTAINMENT BUILDING GENERAL ELEVATION SHEET 1	
REV. 2, JULY 1992	FIGURE NO. 5.1-5

Figure 47 - Location of Shield Wall

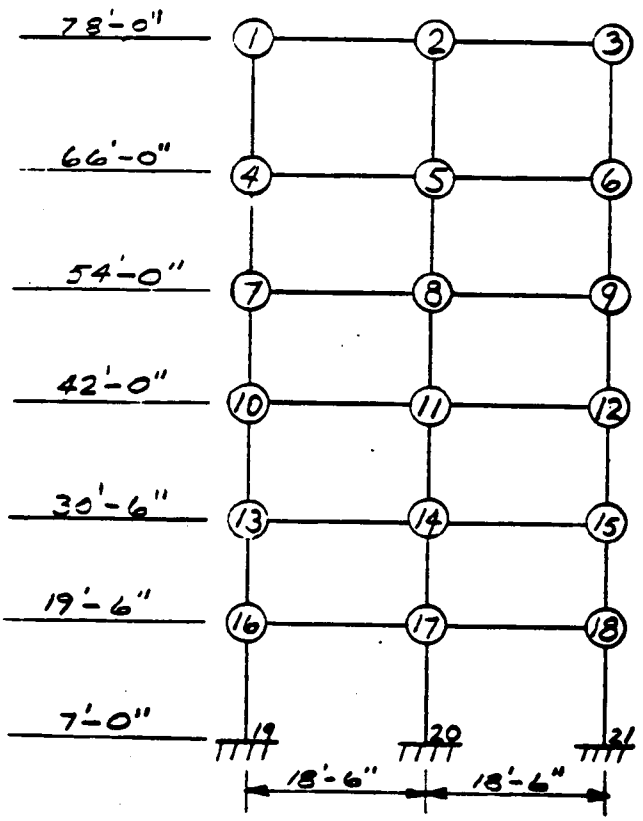


Figure 48 - Dynamic Model of Shield Wall

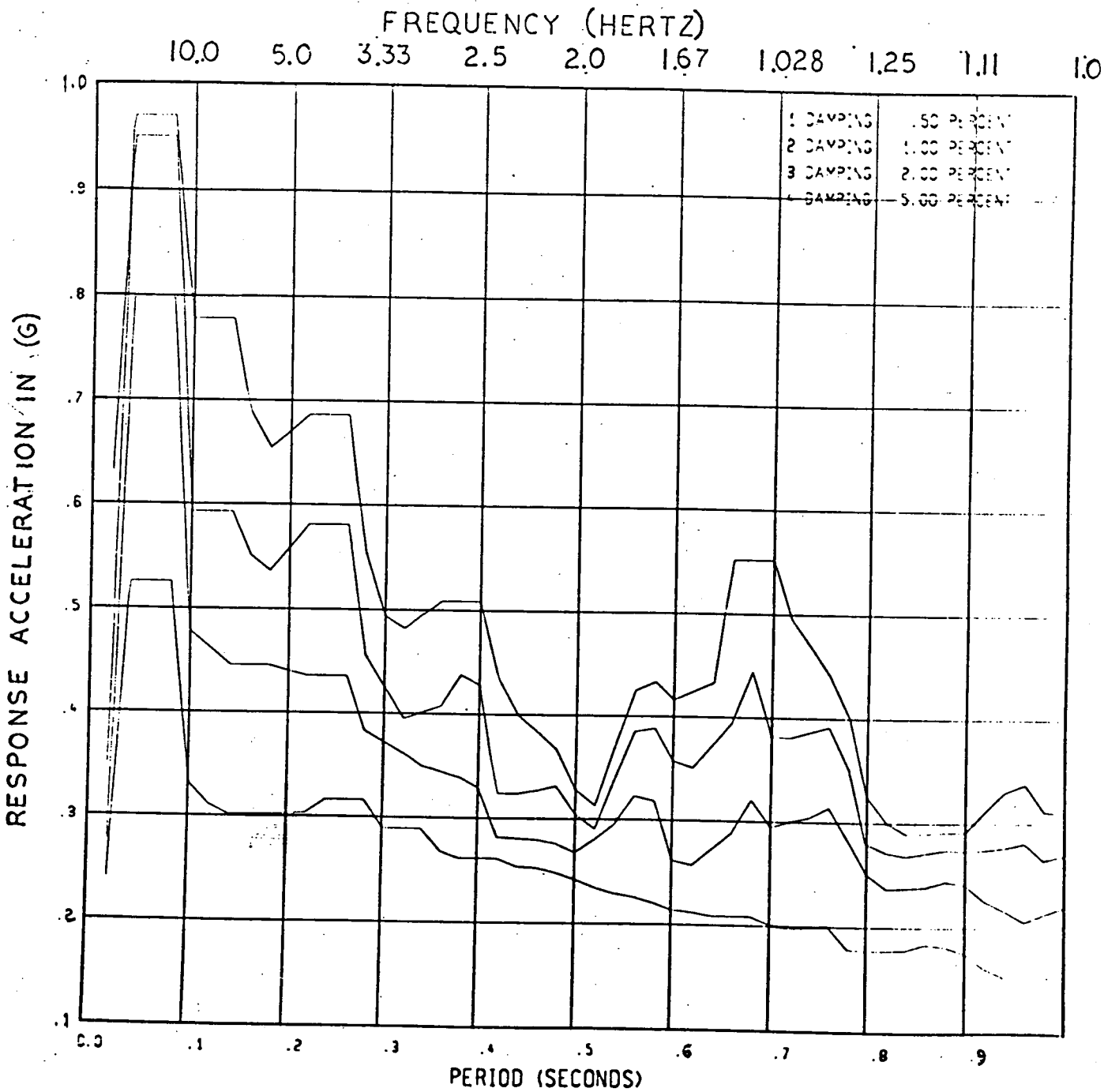


Figure 49 - Broadened DBE Response Spectra Associated with Shield Wall, North-South Direction, Mass Point 2, Elevation 78'0"

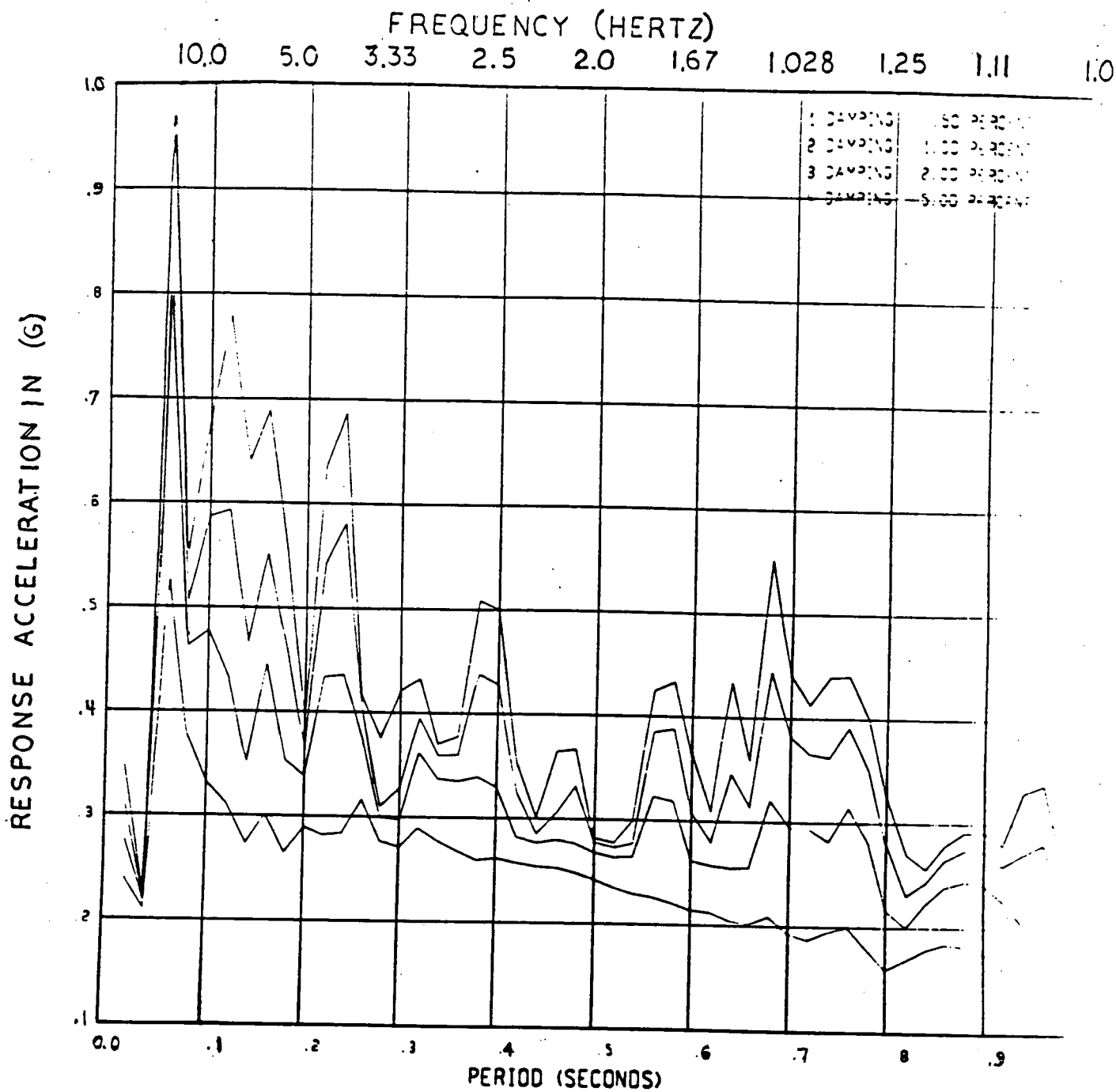


Figure 50 - Unbroadened DBE Response Spectra Associated with Shield Wall, North-South Direction, Mass Point 2, Elevation 78'0"

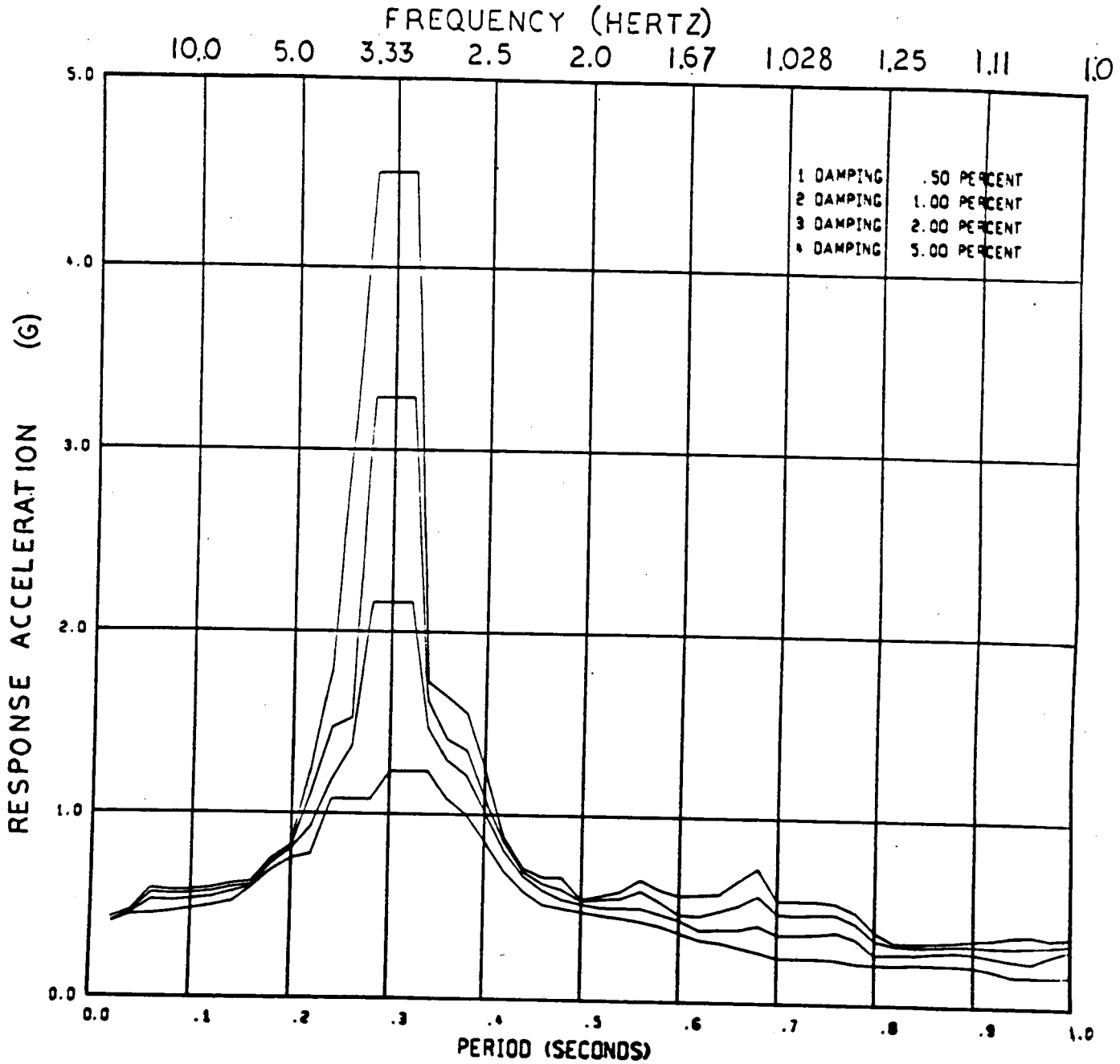


Figure 51 - Broadened DBE Response Spectra Associated with Shield Wall, East-West Direction, Mass Point 2, Elevation 78'0"

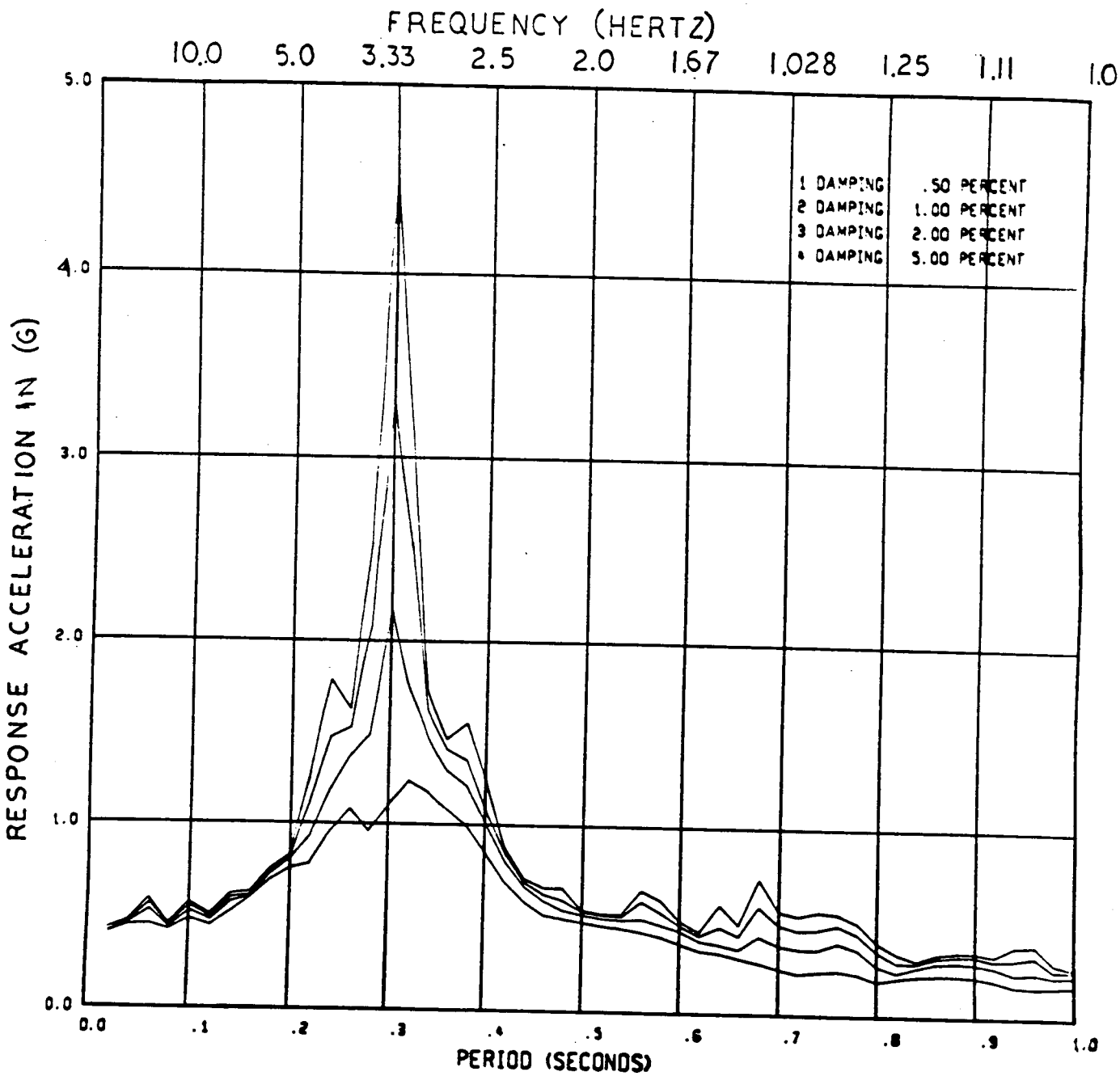


Figure 52 - Unbroadened DBE Response Spectra Associated with Shield Wall, East-West Direction, Mass Point 2, Elevation 78'0"

Table 15
Indian Point Unit No. 3
Dynamic Characteristics
Shield Wall - North South Direction

Modes		1	2
Frequency (Hz)		14.95	52.18
	Mass Points	Mode Shapes	
	1	1.000	-1.000
	2	0.993	-0.921
	3	1.000	-1.000
	4	0.735	-0.172
	5	0.734	-0.172
	6	0.735	-0.172
	7	0.447	0.582
	8	0.447	0.567
	9	0.447	0.582
	10	0.175	0.804
	11	0.176	0.791
	12	0.175	0.804
	13	0.048	0.700
	14	0.050	0.691
	15	0.048	0.700
	16	0.004	0.424
	17	0.004	0.420
	18	0.004	0.424
Participation Factors		1.23	0.34

Table 16
Indian Point Unit No. 3
Dynamic Characteristics
Shield Wall - East West Direction

Modes		1	2	3	4
Frequency (Hz)		3.35	7.74	17.02	19.26
	Mass Points		Mode Shapes		
	1	1.000	-1.000	-0.500	-0.909
	2	1.000	0.000	1.000	-0.909
	3	1.000	1.000	-0.500	-0.909
	4	0.584	-0.691	-0.387	0.768
	5	0.584	0.000	0.774	0.768
	6	0.584	0.691	-0.387	0.768
	7	0.224	-0.332	-0.215	1.000
	8	0.224	0.000	0.429	1.000
	9	0.224	0.332	-0.215	1.000
	10	0.011	-0.030	-0.027	0.120
	11	0.011	0.000	0.054	0.120
	12	0.011	0.030	-0.027	0.120
	13	-0.008	0.009	0.002	-0.041
	14	-0.008	0.000	-0.005	-0.041
	15	-0.008	-0.009	0.002	-0.041
	16	-0.001	0.003	0.000	-0.021
	17	-0.001	0.000	-0.001	-0.021
	18	-0.001	-0.003	0.000	-0.021
Participation Factors		1.35	0.00	-0.00	0.49

5.0 References

1. Joung, K.S., K.E. Rouch, S.H. Telander, D.S. Totten, "Seismic Testing of Switchgear and Control Equipment," paper T72-537-9, presented at the IEEE PES Summer Meeting, San Francisco, Calif., July 9-14, 1972.