

Woodward-Clyde Consultants

PRELIMINARY REPORT ON GEOLOGIC
DRILLING AND INVESTIGATION
SONGS UNITS 2 AND 3
SAN ONOFRE, CALIFORNIA

Prepared for

Southern California Edison
P. O. Box 800
Rosemead, California 91770

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Woodward-Clyde Consultants

July 1, 1980
Project No. 41299I

Southern California Edison
P.O. Box 800
Rosemead, California 91770

Attention: Mr. Gene Hawkins

Gentlemen:

Subject: PRELIMINARY REPORT ON GEOLOGIC DRILLING
AND INVESTIGATION
SONGS UNITS 2 AND 3
SAN ONOFRE, CALIFORNIA

We have completed the vibratory coring work offshore Songs Units 2 and 3. The work was conducted under the direction of Messers Gene Hawkins and Jerry McNey of Southern California Edison. This report provides the coring logs and a preliminary report on the field operations. Additional interpretation will be done as needed and the results of this interpretation, together with the sample age dates, will be reported at a later date.

We hope this meets the project needs at this time. If you have any questions, please call at your convenience.

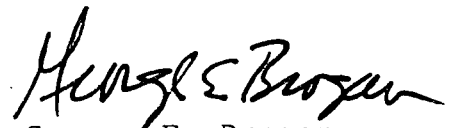
Very truly yours,



John A. Barneich
Associate

JAB/GEB

Enclosures



George E. Brogan
Associate



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Appendix A: Logs of Vibratory Cores

1.0 Introduction

Vibratory cores were obtained at six selected locations offshore from San Onofre, California. The core locations are shown on Figure 1. This program was conducted under the direction of Southern California Edison. Geologic interpretations are to be made by Southern California Edison on the basis of the results of the vibratory coring work. The purpose of this report is to present the vibratory core logs and to provide a brief description of the field operations. Additional operational details are being kept on file by Woodward-Clyde Consultants.

2.0 Project Organization and Staffing

The program was conducted under the direction of Messers. Gene Hawkins and Jerry McNey of Southern California Edison. Messers, John Barneich, Opjit Ghuman and Kul Bhushan from Woodward-Clyde Consultants coordinated and supervised the effort.

The vessel M/V Calcasieu belonging to Ocean Services, Inc. was mobilized in San Pedro for the vibratory coring work. Oceanmasters International Inc. provided the vessel Ocean Command as the crew boat. Woodward-Clyde Consultants operated the vibratory coring unit, logged the cores, and provided the navigation. Personnel from Woodward-Clyde Consultants involved in the vibratory coring operation were: Marv Iverson and Don Dibel (vibracore operators), Dave Schug (geologist), Bob Beer and Don McElman (navigation).

3.0 Vibratory Coring

3.1 Field Operations

Sampling unit consists of a seafloor-supported quadruped frame with a vibrator - drill pipe assembly. The vibrator is

-2-

operated by air supplied from a shipboard compressor and is mounted on a 40-ft long drill pipe. The drill pipe consists of a standard 4-in. pipe with a cutting shoe and a sample retainer at the bottom. Samples are recovered in a removable 3-1/2-in. diameter plastic liner.

The unit is also equipped for jetting in materials where full 40 ft penetration is not achieved in a single run. The water for jetting is supplied by a shipboard fire pump.

The sampling operation was carried out from the vessel M/V Calcasieu supplied by Ocean Services Inc., Long Beach.

Electronic navigation was provided using a Motorola Mini-Ranger III positioning system. This is a short range (20 nautical miles) line-of-sight system. The basic Mini-Ranger consists of a range console, receiver-transmitter, and omnidirectional antenna installed on the boat. Two or three reference transponders are located at surveyed ground points. The measured ranges to the transponders are directly displayed in meters. The accuracy of the ranges is ± 3 meters at 20 nautical miles. The actual accuracy of the system is a function of the ranges and the angle of intersection of the two range lines. Conventional trilateration techniques are used to reduce the data. For the sampling program, two transponder stations were located along the coastline.

The boat was maneuvered using reference anchor locations which were calculated based on anchor cable lengths. A three-point mooring system was used to maintain position.

The vibratory coring assembly was carried horizontally

-3-

suspended alongside the boat from two A-frames. After anchoring the boat on location, the bottom end of the corer was released so that the coring assembly was suspended vertically from the A-frame. The corer was lowered to the seafloor using a 20-ton capacity hoist. The air hoses connected to the vibrator were lowered along with the corer. After the corer was seated on the seafloor, the air compressor was started to begin the coring. The penetration rate was recorded on a strip chart recorder. The air supply to the vibrator was stopped when no further penetration occurred. The core barrel was pulled out of the seafloor and the coring unit was retrieved. The bottom end of the coring unit was pulled with an air tugger so as to bring the unit into a horizontal position and the liner was removed. The liner was cut at the point where the core stopped and the length of the core was measured and recorded. The recovered core (inside the liner) was then cut into convenient lengths (3 to 4 ft); logged by a geologist; capped and sealed at both ends; marked and stored. In all cases, full penetration to the desired depth could not be achieved on the first run. For each succeeding run, the liner, cutting shoe and sample retainer were reassembled, the coring unit was lowered to the seafloor, and the core barrel was advanced by jetting to a depth close to the bottom of the penetration achieved in the preceding run. After jetting to the desired depth, the vibratory coring operation was carried out as described previously. The number of runs at each site ranged between 2 and 5 and the maximum penetration achieved ranged between 25 and 44.1 ft.

A total of six sites were sampled, five on Line No. 1, and one on Line No. 2. Lines 1 and 2 refer to geophysical lines run by Fugro (Line 1) and Woodward-Clyde Consultants (Line

-4-

2). The location of the sites are shown on Figure 1. A summary of the vibratory coring operation is given on Table 1.

3.2 Summary of Cores.

The six offshore borings, advanced utilizing the vibratory coring unit, penetrated to depths ranging from 25.5 to 44.1 ft. In these intervals the materials encountered were mainly sands and silty sands with two of the cores (1-1 and 1-3) containing zones of clay and clayey silt.

The sandy sections of the cores were mainly fine grained with dark greenish gray colors, containing variable amounts of silt. Cores 1-1, 1-2, 1-4 and 2-1 contained intervals of coarser grained sands ranging from fine to coarse grained and having a yellow gray to olive gray color.

The clayey intervals recovered in the cores were greenish black in color, and were found to be from 22.4 to 24.0 ft in core 1-1, and from approximately 38.0 ft to the bottom (at 39.5 ft) in core 1-3.

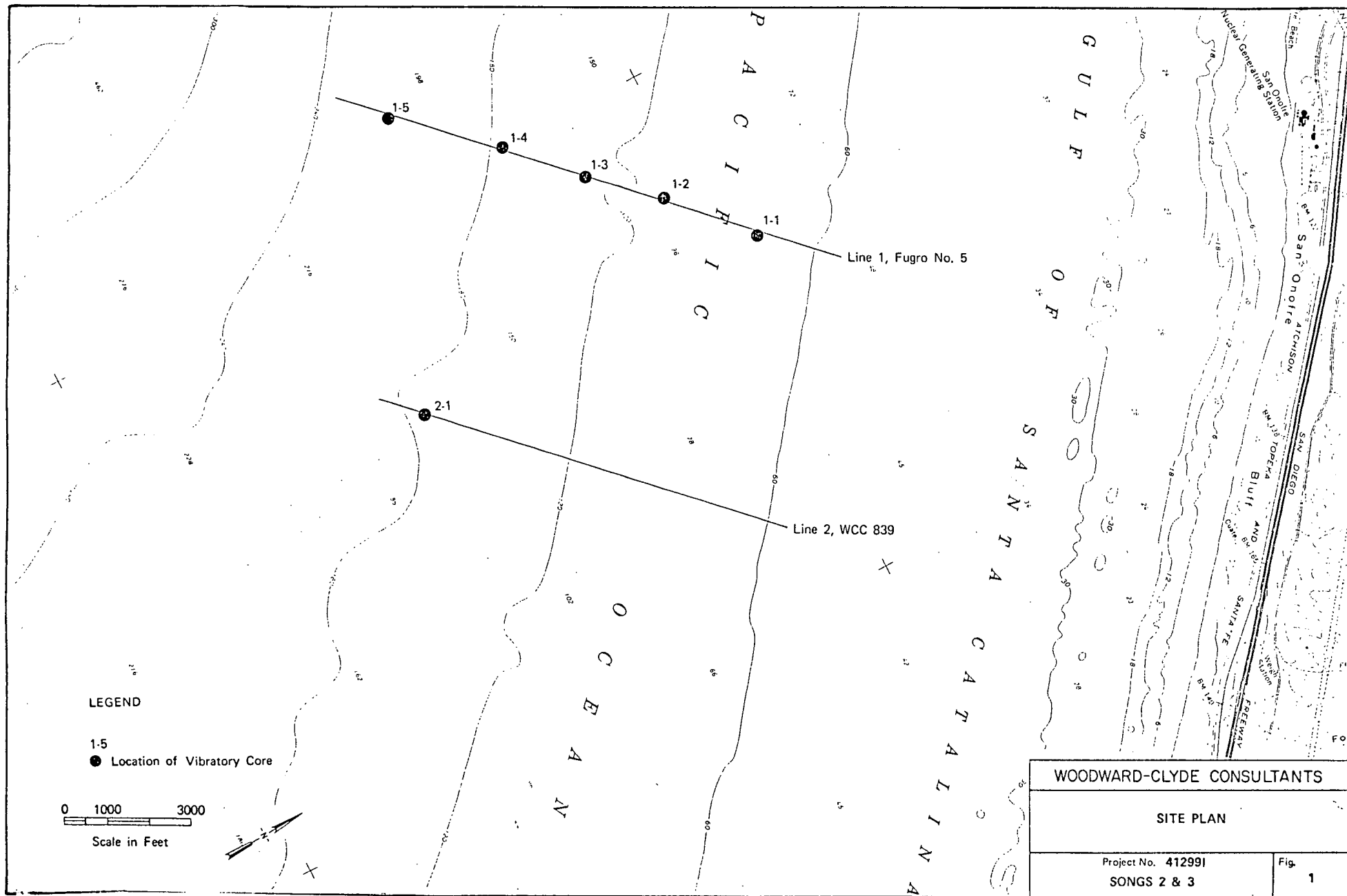
Fossils and other organic debris, such as wood and carbonaceous fragments, were also encountered in the cores. All of the cores contained random shells and shell fragments and all the cores excepting 2-1 had small horizons which were rich enough in organic debris that it was possible to collect a sample potentially large enough for age dating. These organic rich horizons were mainly encountered from 0 to 25 ft, with the exception of core 1-5 which had an abundance of organically rich material as deep as 38.5 ft.

Detailed logs of the cores are presented in Appendix A.

TABLE 1

SUMMARY OF VIBRATORY CORING

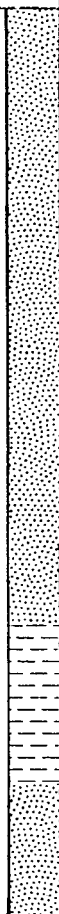
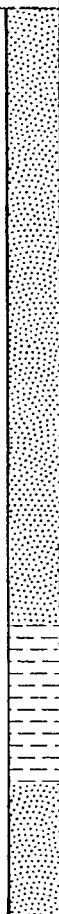
<u>CORE NO.</u>	<u>RUN NO.</u>	<u>PENETRATION BELOW SEAFLOOR, FEET</u>		<u>RECOVERY, FEET</u>	<u>APPROXIMATE WATER DEPTH, FEET</u>
		<u>FROM</u>	<u>TO</u>		
1-1	1	0	7.0	6.0	72
	2	5.0	25.5	20.1	72
1-2	1	0	22.4	22.4	100
	2	21.0	34.8	11.3	100
	3	32.0	39.5	6.5	100
1-3	1	0	22.4	24.4	125
	2	19.0	24.0	8.0	125
	3	25.0	30.8	9.2	125
	4	31.0	39.5	8.5	125
1-4	1	0	20.0	22.0	165
	2	16.0	23.0	9.0	165
	3	22.0	31.0	4.0	165
	4	31.0	39.5	10.0	165
1-5	1	0	21.5	21.5	200
	2	21.0	32.0	11.0	200
	3	31.0	35.8	5.0	200
	4	36.0	39.5	3.0	200
2-1	1	0	18.0	20.0	165
	2	19.5	30.0	11.0	165
	3	30.0	34.5	5.5	165
	4	35.0	39.3	4.5	165
	5	40.0	44.1	4.0	165



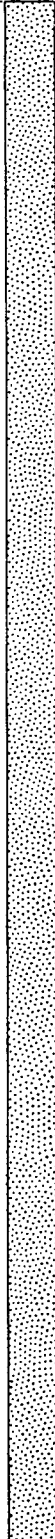
APPENDIX A
LOGS OF VIBRATORY CORES

BORING LOCATION		SONGS OFFSHORE - E-1,597,186; N-427,655		ELEVATION AND DATUM		Water Depth 72'	
DRILLING AGENCY		WCC		DRILLER		Iverson	
DRILLING EQUIPMENT				DATE STARTED		6-7-80	
DATE FINISHED		6-8-80		COMPLETION DEPTH		25.5'	
SIZE AND TYPE OF CASING		4" Plastic		NO. OF SAMPLES		DIST.	
DRILLING METHOD		VIBRATORY CORE		WATER ELEV.		FIRST	
CORE BARREL		LENGTH		BIT		LOGGED BY:	
						CHECKED BY:	


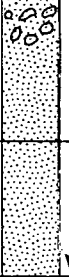


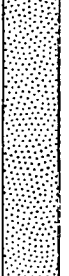
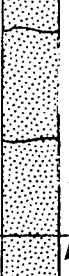
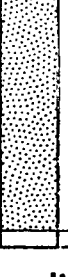

DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
1	Sand, dark greenish gray, 5GY4/1, very fine grained, well sorted, micaceous, organic odor, random shell fragments and some complete shells (sample 1 taken at 2.2'). SP				
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					


DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	RQD
17	Sand, dark greenish gray, 5GY4/1, very fine grained, well sorted, micaceous, occasional pebbles. SP		2		2
18	Abundant shells and shell fragments from 15.8' to 16.5'.				
19	Grades to medium grained sand at 17.8'.				
20	Grades to coarse grained sand at 19.0', light yellowish gray, 5Y6/2, subangular grains, moderately well sorted, occasional pebbles. SP				
21					
22	Grades to medium grained sand, medium gray, N5, well sorted Clay at 22.4', greenish black, 5G2/1, very plastic and sticky. CL				
23			2		
24	Sand at 24', dark greenish gray, 5GY4/1, fine grained, slightly clayey. SC				
25					
26	Bottom of Hole at 25.5'				
27					
28					
29					
30					
31					
32					
33					
34					
35					

BORING LOCATION		SONGS OFFSHORE - E-1,595,807; N-426,123		ELEVATION AND DATUM		Water Depth 100'	
DRILLING AGENCY		WCC		DRILLER		Iverson	
DRILLING EQUIPMENT				DATE STARTED		6-8-80	
SIZE AND TYPE OF CASING		4" Plastic		COMPLETION DEPTH		39.5'	
DRILLING METHOD		VIBRATORY CORE		NO OF SAMPLES		DIST.	
CORE BARREL		LENGTH		BIT		UNDIST.	
						CORE	
				WATER ELEV.		FIRST	
				LOGGED BY:		JW/BN	
				CHECKED BY:			

DEPTH (FEET)	DESCRIPTION	ROCK CORE					
		Sketch	Run No.	Recov. ft.	Sample No.		
1	<u>SAND</u> , dark greenish gray, 5GY4/1, very fine grained, well sorted, micaceous, random shell fragments and some whole shells. SP.		1				
2							
3							
4							
5							
6							
7							
8							
9	Broken, nearly complete, pelecypod shell at 9.2'.						3
10							
11	Complete gastropod at 11.4'.						4
12							
13	Shells and shell fragments at 14.5'.						7
14							
15							
16							



DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
17	<u>SAND</u> , dark greenish gray, 5GY4/1, very fine grained, well sorted, micaceous, very slightly clayey. SP		1		
18					
19	Pebbles, shells, and shell fragments from 19.6' to 20.0'.				6
20	Charcoal fragments and a pelecypod at 20.7'.				-5-
21					
22					
23					
24	Becomes fine grained at 23.7'. Large pebbles at 23.9'. Becomes fine to medium grained at 24'.				
25	Rounded pebbles at 25.4'. Becomes coarse grained at 25.5'.				
26	Becomes fine grained at 25.9'.				
27	Becomes medium grained at 27.1'. Becomes fine grained at 27.5'.				
28	Becomes fine to medium grained at 27.7'.				
29					
30	<u>SAND</u> , olive gray, 5YR4/2, fine to medium grained, sub-angular, well sorted, micaceous. SP				
31	<u>SAND</u> , olive gray, 5YR4/2, fine grained, well sorted, micaceous. SP				
32					
33	Grades to fine medium grained at 33.4'				
34	Grades to fine grained at 33.7'				
35					

DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
36	<u>SAND</u> , olive gray, 5YR4/2, fine grained, micaceous. SP		3		
37	Grades to medium grained at 36.3'. Abrupt change to fine grained at 36.7'. Rounded pebble (3/8") at 37.4'.				
38	No recovery from 38.5 to 39.5'.				
39					
40	End of hole. 1-2				


BORING LOCATION SONGS OFFSHORE - E-1,594,479; N-424,709		ELEVATION AND DATUM Water Depth 125'	
DRILLING AGENCY WCC	DRILLER Iverson	DATE STARTED 6-10-80	DATE FINISHED 6-10-80
DRILLING EQUIPMENT		COMPLETION DEPTH 39.5'	ROCK DEPTH
SIZE AND TYPE OF CASING 4" Plastic		NO. OF SAMPLES	DIST. UNDIST. CORE
DRILLING METHOD VIBRATORY CORE		WATER ELEV. FIRST	COMPL. 24 HRS.
CORE BARREL	LENGTH	BIT	LOGGED BY: JW/BN
		CHECKED BY:	

DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
1	SAND, silty, dark greenish gray, 5GY4/1, very fine grained, micaceous, random shell fragments. SM				
2					
3					
4	Abundant shells and shell fragments.				8
5					
6					
7					
8					
9	scattered shells				9
10					
11					
12					
13					
14					
15					
16					



DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
17	SAND, silty, dark greenish gray, 5GY4/1, very fine grained, micaceous, random shell fragments. SM		1		10
18	organic matter				11
19	organic matter, shells				13
20					12
21	crab leg		2		14
22					
23					
24	no recovery at 24.0' to 25.0'.				
25			3		15
26	gastropod, pelecypod				
27	becomes fine grained				
28					
29			4		
30					
31	no recovery at 30.8' to 31.0'.				
32					
33					
34	SAND, dark gray N3, fine grained, well sorted, micaceous, small laminae of mica. SP				
35					


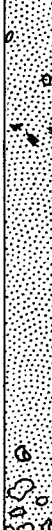
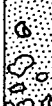



DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
36	Gradational change to clayey silt, grayish black, N2. Clayey silt, olive black, 5YR2/1, slightly micaceous. ML		4		
37					
38					
39					
40	Bottom of hole. 1-3				


BORING LOCATION SONGS OFFSHORE - E-1,593,040; N-423,369		ELEVATION AND DATUM Water Depth 165'	
DRILLING AGENCY WCC	DRILLER Iverson	DATE STARTED 6-11-80	DATE FINISHED 6-12-80
DRILLING EQUIPMENT		COMPLETION DEPTH 39.5'	ROCK DEPTH
SIZE AND TYPE OF CASING 4" Plastic		NO. OF SAMPLES	DIST. UNDIST. CORE
DRILLING METHOD VIBRATORY CORE		WATER ELEV. FIRST	COMPL. 24 HRS.
CORE BARREL	LENGTH	BIT	LOGGED BY: CHECKED BY:

DEPTH (FEET)	DESCRIPTION	ROCK CORE		
		Sketch	Run No.	Recover. ft. Sample No.
1	SAND, silty, olive black, 5Y2/1, very fine grained, mica- ceous, a few scattered shell fragments. SM			
2	Shells and shell fragments at 2.2' to 2.6'.			16
3	Shells from 3.9' to 4.4'.			
4				17
5				
6	Shells at 6.1'.			18
7	Gastropods at 7.1'.			19
8				
9	Shells at 9.2'.			20
10				
11				
12	Organic matter at 12.1'.			21
13				
14				
15				
16				



DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
17	SAND, olive gray 5Y5/1, medium grained, subangular, moderately well sorted, scattered pebbles up to 1/4". SP		1		
18	SAND, olive gray 5Y4/1, fine to coarse grained, subangular, poorly sorted, slightly micaceous, SP, from 17.9 to 18.2.				
19	SAND, dark yellow gray 5Y7/1, medium to coarse grained, subangular, moderately sorted, occasional rounded pebbles to 3/4", SP, from 18.2' to 18.4'.				
20	SAND, olive gray, 5Y4/1, fine grained, moderately sorted, micaceous, some scattered pebbles. SP				
21	Organic matter at 21.1'.		2		22
22					
23					
24					
25	Gastropod at 24.6'. Concentration of rounded pebbles up to 1" from 25.0' to 25.4'.		3		23
26					
27					
28					
29			4		
30					
31					
32	SAND, medium light gray, N6, as above with small blebs and discontinuous lenses of sand which contain little mica.				
33	Slightly coarser grained, interval from 33.0' to 33.6'.				
34					
35					

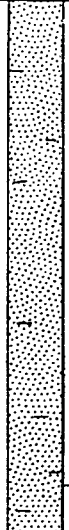

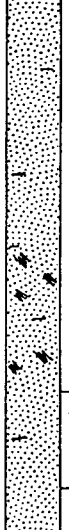




DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
36	<u>SAND</u> , olive gray, 5Y4/1, fine grained, subangular, well sorted, micaceous. SP		4		
37	Small rounded pebbles at 36.3'.				
38	Scattered shell fragments at 37.3'.				
39					
40	Bottom of Hole 1-4 at 39.5'.				



BORING LOCATION SONGS OFFSHORE - E-1,591,165; N-421,269		ELEVATION AND DATUM		Water Depth 200'	
DRILLING AGENCY WCC		DRILLER Iverson		DATE STARTED 6-12-80	
DRILLING EQUIPMENT		COMPLETION DEPTH		DATE FINISHED 6-12-80	
SIZE AND TYPE OF CASING 4" Plastic		NO. OF SAMPLES		ROCK DEPTH	
DRILLING METHOD VIBRATORY CORE		DIST. FIRST		UNDIST. CORE	
CORE BARREL		LENGTH		WATER ELEV. 24 HRS.	
BIT		LOGGED BY: JW/BN		CHECKED BY:	

DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
1	SAND, silty, olive gray, 5YR3/2, very fine grained, micaceous, scattered shell fragments. SM		1		
2					
3					
4					
5					
6					
7					
8	Organic debris at 7.9' Gradual color change to olive black, 5YR2/1, from 8.0' to 8.5'.		1		25
9					
10					
11					
12					
13					
14					
15					
16					

DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
17	<u>SAND</u> , silty, olive black, 5YR2/1, very fine grained, micaceous, scattered shell fragments. SM		1		
18					
19					
20			2		26
21	No recovery from 21.5' to 22.0'.				
22	Scattered organic debris from 22.0' to 27.0'.				
23			3		27
24	Organic matter at 23.9'.				
25					
26			4		28
27					
28					
29	Organic matter at 29.7'.		5		29
30	Organic matter at 30.6'.				
31					
32			6		
33					
34	Organic matter at 33.8'.				
35					











DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
36	<u>SAND</u> , silty, olive black, 5YR2/1, very fine grained, micaceous, scattered shell fragments. SM		3		
37					
38	Organic matter in concretion at 38.4'.		4		32
39	Organic matter at 38.5'.				31
40	Bottom of hole 1-5 at 39.5'.				



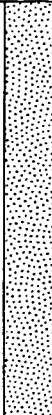
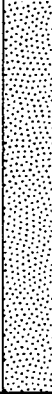
BORING LOCATION SONGS OFFSHORE - E-1,597,740; N-418,851		ELEVATION AND DATUM Water Depth 165'	
DRILLING AGENCY WCC	DRILLER Iverson	DATE STARTED 6-13-80	DATE FINISHED 6-14-80
DRILLING EQUIPMENT		COMPLETION DEPTH 44.1'	ROCK DEPTH
SIZE AND TYPE OF CASING 4" Casing		NO OF SAMPLES	DIST. UNDIST. CORE
DRILLING METHOD VIBRATORY CORE		WATER ELEV. FIRST	COMPL. 24 HRS.
CORE BARREL	LENGTH	BIT	LOGGED BY: JW/BN
			CHECKED BY:

DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
1	<u>SAND</u> , silty, olive gray, 5YR3/2, very fine to fine grained, subangular, micaceous, random shell fragments. SM				
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15	<u>SAND</u> , olive gray, 5YR4/2, medium to coarse grained, subangular, moderately sorted, slightly micaceous, shell fragments. SP				
16	<u>SAND</u> , olive gray, 5YR3/2, fine grained, subangular, poorly to moderately sorted, slightly silty, micaceous. SP				



DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
17	Starting at 15.7' - <u>SAND</u> , olive gray, 5YR4/2, medium to coarse grained, sub-angular, moderately to poorly sorted, slightly micaceous, numerous shell fragments, numerous rounded pebbles. SP.		1		
18	<u>SAND</u> , olive gray at 17.1', 5YR4/1, fine grained, subangular, well sorted, micaceous. SP				
19	no recovery at 18.0' to 19.5'.		No Recovery		
20					
21	<u>SAND</u> , olive gray, 5YR4/2, medium to coarse grained, sub-angular, moderately sorted, micaceous, numerous rounded pebbles to 1 1/2" in diameter. SP		2		
22	<u>SAND</u> , olive gray, 5YR4/1, fine grained, subangular, well sorted, micaceous. SP				
23	<u>SAND</u> , olive gray, 5YR4/2, medium grained, subangular, well sorted, micaceous, occasional sub-rounded pebbles to 1/4" in diameter. SP				
24	<u>SAND</u> , olive gray at 24.3' to 24.5', 5YR4/1, fine grained, subangular, well sorted, micaceous. SP				
25	<u>SAND</u> , olive gray, at 24.5', 5YR4/2, medium grained, sub-angular, well sorted, micaceous. SP				
26	<u>SAND</u> at 25.2' becomes fine to medium grained.				
27					
28	<u>SAND</u> , olive gray, 5YR4/1, fine grained, subangular, well sorted, micaceous. SP				
29	From 28.7' to 29.3' vertical stringers of coarse grained sand.				
30					
31	Organic matter.				
32					
33					
34					
35	no recovery at 34.5' to 35.0'				



DEPTH (FEET)	DESCRIPTION	ROCK CORE			
		Sketch	Run No.	Recov. ft.	Sample No.
36	<u>SAND</u> , olive gray, 5YR4/1, fine grained, subangular, well sorted, micaceous. SP		4		
37	From 36.2' to 38.2' - blebs of whitish sand deficient in mica, up to 1/2" in diameter.				
38					
39	no recovery at 39.3' to 40.0'.				
40			5		
41					
42					
43					
44	Bottom of hole 2-1 at 44.1'.				



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TABLE 361.65-1

Summary of Assumptions, Bases, and Conservatism for Source Modeling and Empirical Approaches

PARAMETERS	SOURCE MODELING			EMPIRICAL APPROACH		
	Assumptions	Basis	Conservatism and Validity	Assumptions	Basis	Conservatism and Validity
Geology/Earth Structure	Vertically stratified, viscoelastic earth. No approximations arise in propagating waves through the idealized representation of the earth.	Field measurements (seismic surveys) and generic data.	Actual properties were used as determined from seismic surveys. Lower material attenuation was used than for Imperial Valley modeling.	Ground motion is influenced by local site geology.	Observations during past earthquakes (e.g., Seed, Muraka, Lysmer, Idriss, [1975], and Seed, Ugas, Lysmer [1976]).	Data set used consisted of recordings obtained from western U.S. sites having local geology generally similar to SONGS.
Fault Processes	Vertical, strike-slip rupture that spreads from the hypocenter at a speed of slightly less than the shear-wave velocity. Irregularities in the rupture process are suitably modeled by random perturbations.	Generic earthquake studies and simulations of recorded ground motions for past earthquakes using the most complete description of rupture process currently available.	Results of repetitious simulations were used to determine the effects of random processes that are included in the source modeling to approximate perturbations or irregularities in actual earthquake rupture.	--	The data set included earthquakes from both strike slip and thrust type faulting.	-- Ground motions were reasonably conservatively extrapolated for $M_s 7$ earthquake (response to Q 361.54).
Magnitude	The size of rupture and fault offset are directly related to seismic moment (M_0) and surface-wave magnitude (M_s).	M_0 and M_s characterize fault capability. Local magnitude (M_L) is determined from computed ground motion.	Seismic moment and M_s are at or greater than the upper limits of capability for the OZD.	For the SONGS site which is at a significant distance of 8 km from OZD, the ground motion is influenced by the magnitude of the earthquake.	Available data	
Stress Drop	Stress drop was extracted from fault offset, fault configuration and earth structure and was estimated to be 100 bars for the evaluation.	The average stress drop for inter-plate earthquakes is about 30 bars (Kanamori and Anderson, 1975).	Stress drop used (100 bars) is greater than what is reasonably expected for a large earthquake along the OZD (note that less than 30 bars occurred in the 1933 Long Beach earthquake, WCC 1979).	Ground motion is influenced by stress drop.	Effects of high stress drop were incorporated in the selected data set.	Results were strongly influenced by the San Fernando earthquake for which the estimated stress drop is 200 bars. This value significantly exceeds the stress drop of less than 30 bars estimated for an event on the OZD based on 1933 Long Beach earthquake.
Proximity	Attenuation of ground motion with distance is modeled using an exact simulation of viscoelastic waves in a vertically stratified earth.	The earthquake model has been calibrated and validated against near-field data recorded over the distance range of interest.	Ground motion was modeled at SONGS, 8 km from the OZD.	Ground motions attenuate with distance from fault. The attenuation relationship used was of the form: $a = b_1 e^{b_2 M} (R + C[M])^{-b_3}$ where R = significant distance from fault M = magnitude of earthquake b_1, b_2, b_3 , and C are coefficients	Study of observed data.	The definition of distance used in the analysis was conservative. (response to Q 361.62).
Focusing	Recorded strong motion data contain effects due to directivity and rupture focusing.	Simulated ground motion is significantly focussed in the direction of rupture.	Most extreme rupture configuration (focusing) is used for SONGS analyses results.	Ground motion is influenced by focusing.	Effects of focusing were incorporated in the selected data set.	The ground motion data used were recorded under condition of focusing that would tend to increase measured ground motion. Thus, focusing effects were conservatively included.
Judgment/Experience	--	--	The site specific results are based on the most complete and rigorous simulation of earthquake processes currently available. The resulting spectrum at SONGS is in reasonable agreement with spectra in the same distance range for the recent Imperial Valley earthquake.	--	--	The approach resulted in estimates for ground motion which were conservative with respect to the available strong motion recordings including those obtained during the 1979 Imperial Valley earthquake.

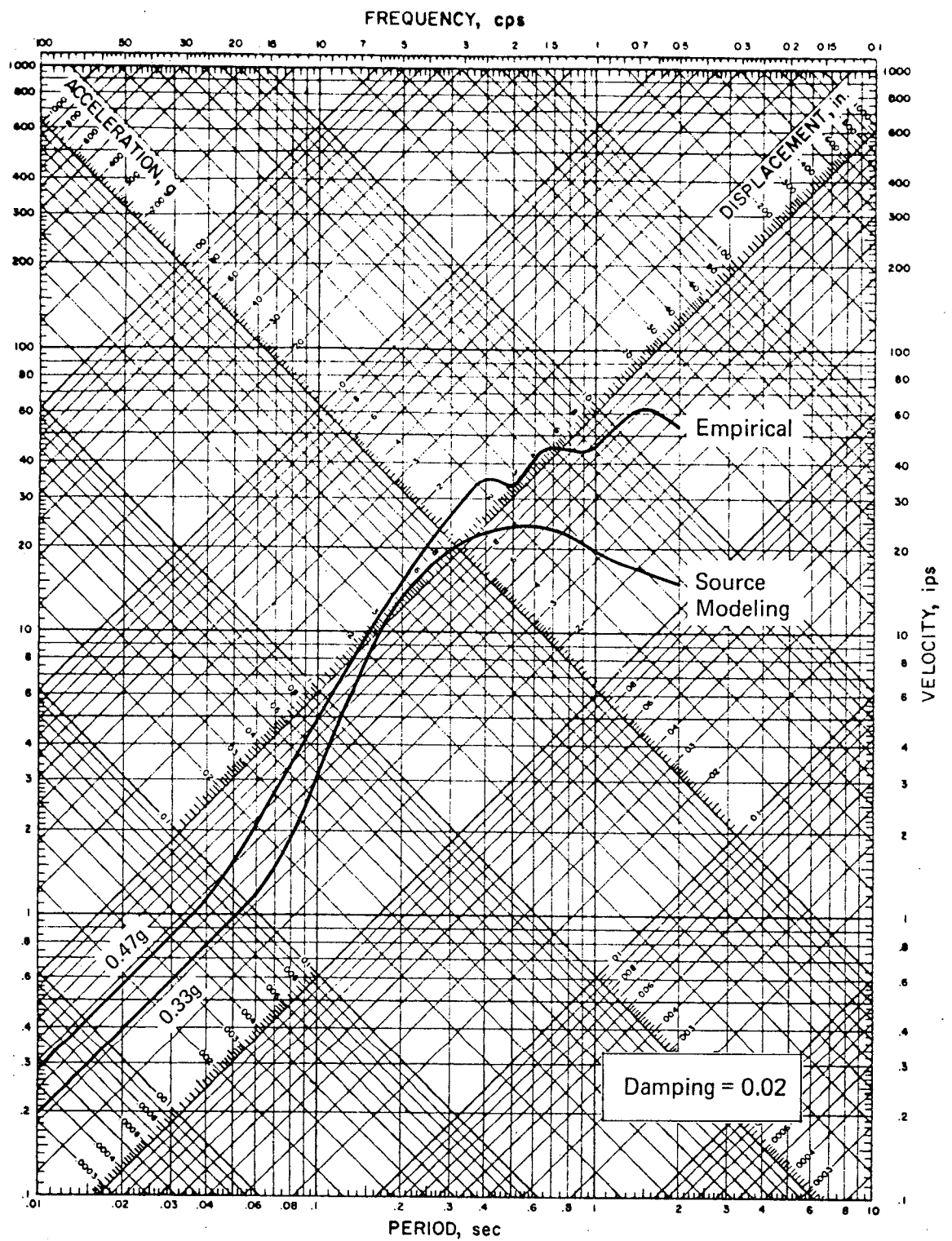


Fig. 361.65-1 — Comparison of the Mean Instrumental Response Spectra for Damping = 0.02

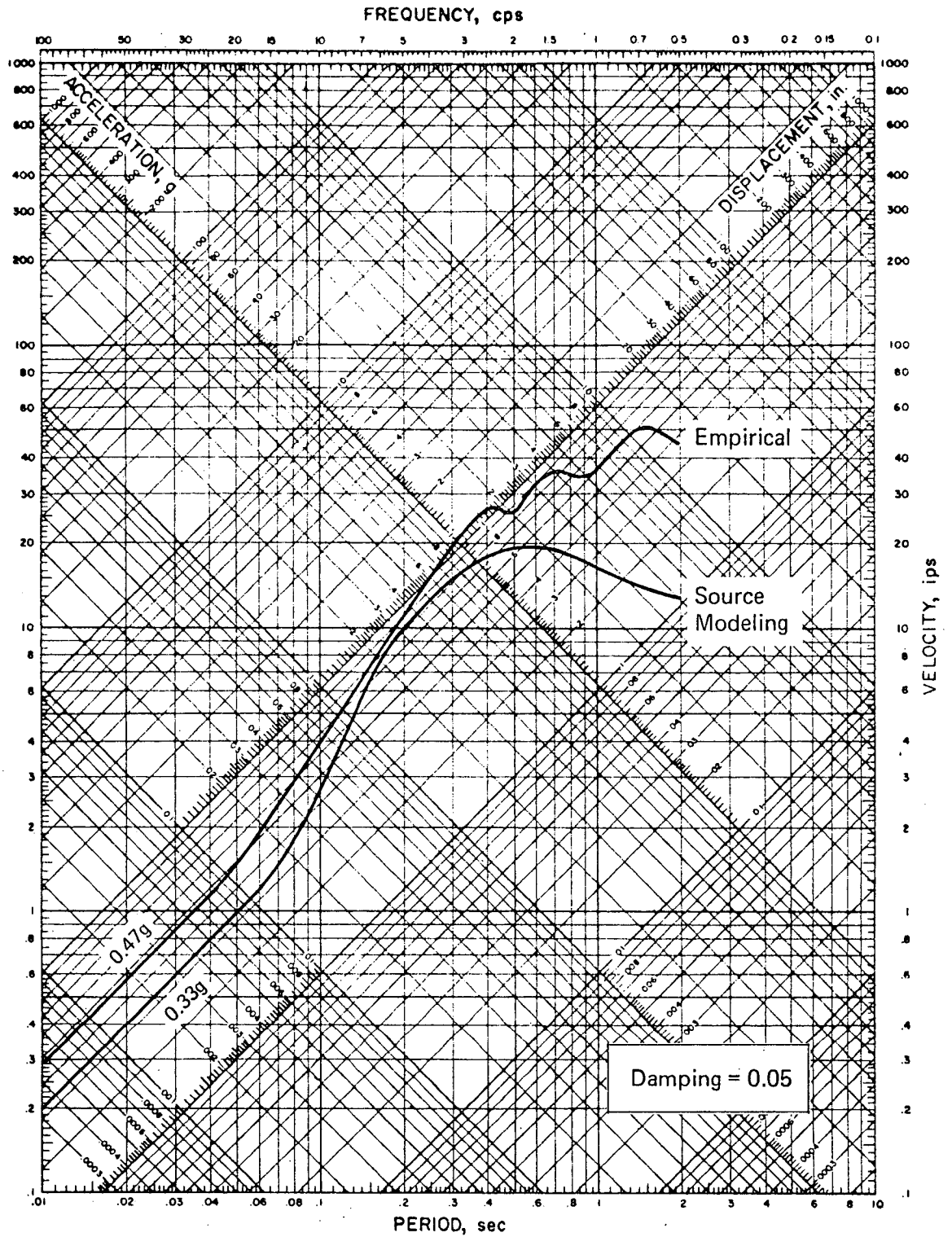


Fig. 361.65-2 – Comparison of the Mean Instrumental Response Spectra for Damping = 0.05

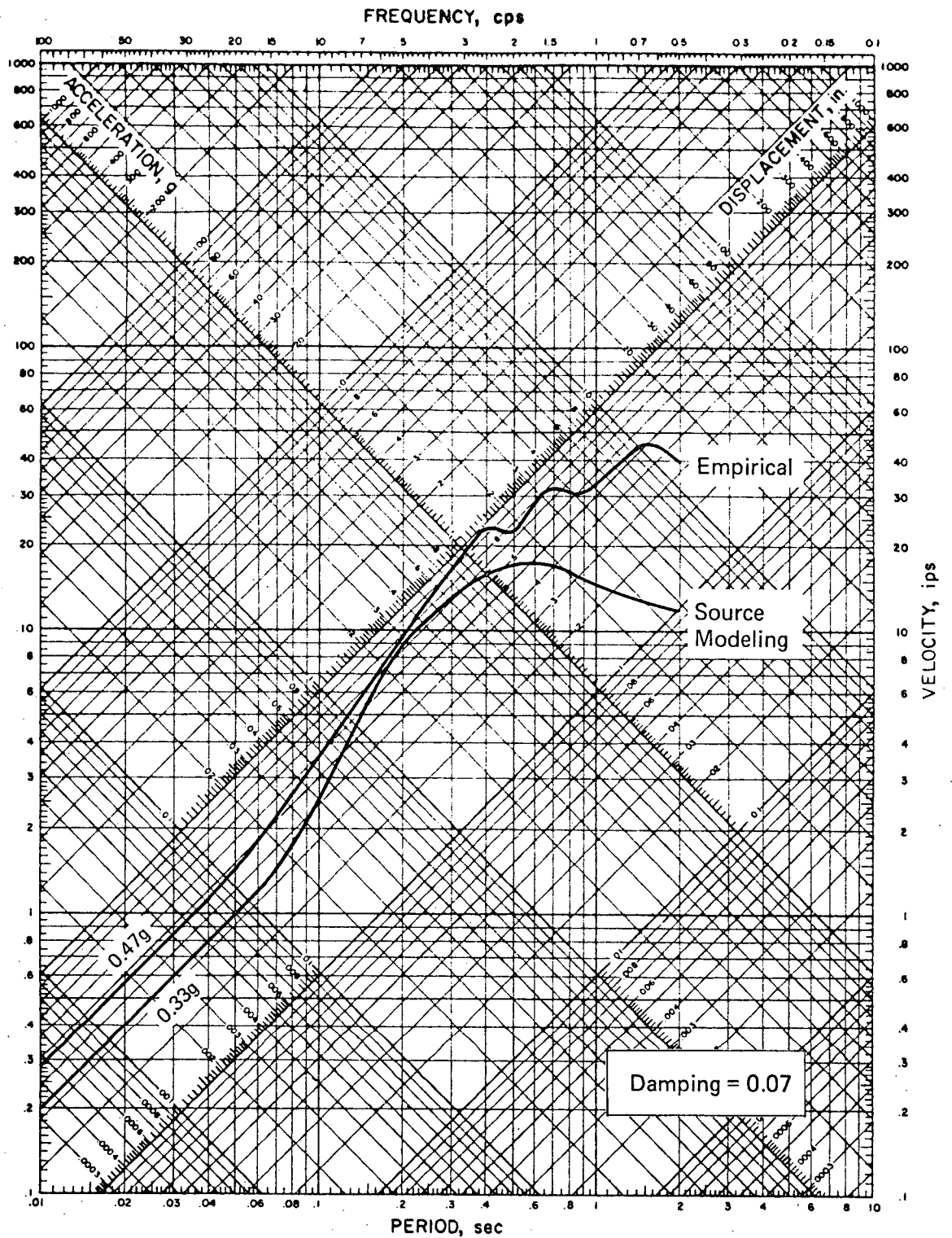


Fig. 361.65-3 — Comparison of the Mean Instrumental Response Spectra for Damping = 0.07

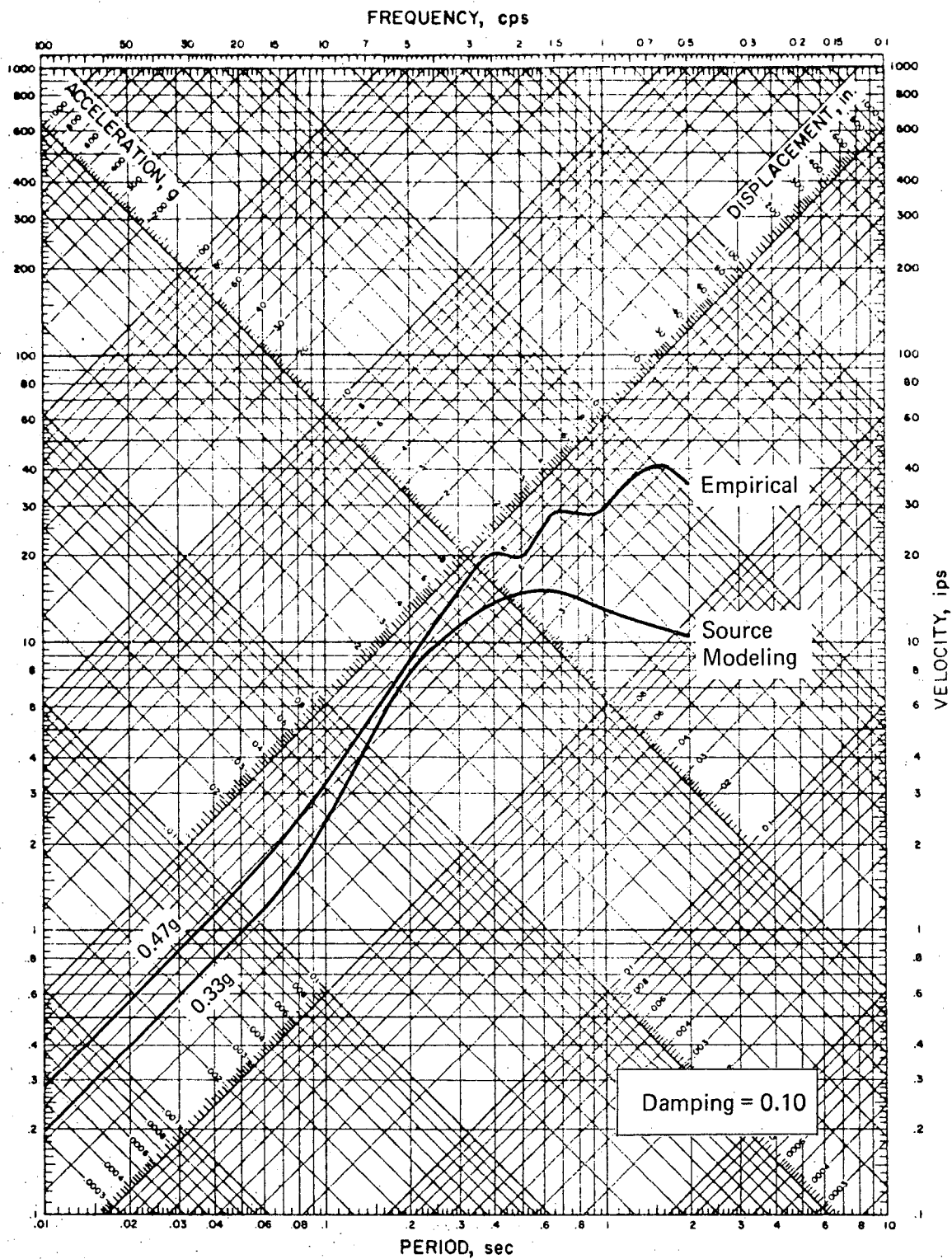


Fig. 361.65-4 — Comparison of the Mean Instrumental Response Spectra for Damping = 0.10

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