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ANALYSIS OF STRONG-MOTION DATA FROM THE MOUNT BORAH
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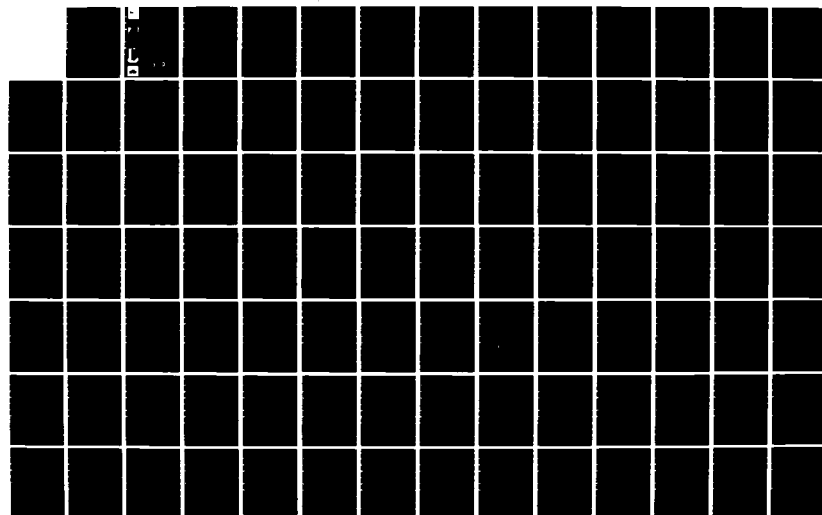
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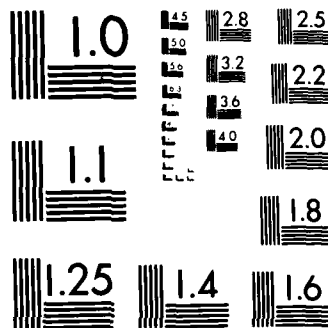
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US Army Corps
of Engineers

ANALYSIS OF STRONG-MOTION DATA FROM THE MOUNT BORAH, IDAHO, EARTHQUAKE OF 28 OCTOBER 1983

by

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May 1985

Final Report

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report presents an analysis of the strong-motion data from the Mount Borah, Idaho, earthquake of 28 October 1983, which occurred at latitude 44.046°N, 113.887°W and had a surface wave magnitude (M_s) of 7.3. Twenty-seven accelerograms recorded at Ririe, Lucky Peak, and Dworshak Dams were digitized. The raw digitized accelerograms were processed by the US Geological Survey, Engineering Seismology and Geology Branch, to provide baseline correction. Integrals and shock spectra are presented in graphic form.		

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20. ABSTRACT (Continued).

Based on the statistical analysis of the peak ground motions, acceleration (a), velocity (v), and displacement (d), it has been found that the average ratios of v/a , a_v/a_h (vertical maximum acceleration to horizontal maximum acceleration), and ad/v^2 are 0.089 sec, 0.58, and 3.17, respectively.

The epicentral distances to Ririe and Lucky Peak Dams are about the same (180 km). The amplification ratios of maximum accelerations on the crest to the maximum accelerations at the abutment for Lucky Peak Dam are 5.69, 4.01, and 3.76 for longitudinal (L), vertical (V), and transverse (T) components, respectively. However, the ratios for Ririe Dam are 2.05, 2.41, and 2.48 for L, V, and T components. The different ratios of the two dams are believed due to the different dam heights: 104 m for Lucky Peak Dam and 41.5 m for Ririe Dam. The data from Dworshak Dam, a concrete structure, are not appropriate for comparison with data from the other two dams, which are earth and rock-fill structures.

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PREFACE

This report was prepared during the period February-August 1984 by Mr. Frank K. Chang, Research Geophysicist, Earthquake Engineering and Geophysics Division (EE&GD), Geotechnical Laboratory (GL), US Army Engineer Waterways Experiment Station (WES). The study was sponsored by US Army Engineer District, Walla Walla, under IAO No. E8640047.

IOM-Towill (I/O Metrics Corporation and R. M. Towill Corporation), an automated laser line digitizing service, digitized the accelerograms. Dr. A. G. Brady and Mr. Peter Moak, US Geological Survey (USGS) provided the data correction and processing. The strong-motion data from the Idaho National Engineering Laboratory were provided by Mr. J. J. King, Engineer, EG&G, Idaho.

Preparation of the report was under the direction of Mr. Robert F. Ballard, Jr., EE&GD. General direction was provided by Dr. A. G. Franklin, Chief, EE&GD, and Dr. W. F. Marcuson III, Chief, GL.

COL Tilford C. Creel, CE, and COL Robert C. Lee, CE, were Commanders and Directors of WES during the period of this study and the preparation of this report. Mr. Fred R. Brown was Technical Director.

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CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report may be converted to SI (metric) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
feet	0.3048	metres
miles (US statute)	1.609347	kilometres

INTRODUCTION

1. On 28 October 1983, a major earthquake of Richter magnitude 6.9 ($m_b = 6.2$, $M_s = 7.3$) occurred at 8:06 a.m. MDT (14:06 UTC) in central Idaho (USGS, 1983). The geographic coordinates of the epicenter were 44.046°N, 113.887°W (USGS, 1983). The earthquake was centered west of Idaho's tallest peak, Mount Borah (el., 12,662 ft) and near the towns of Mackay (population 550), 30 km southeast of the epicenter, and Challis (population 800), 55 km northwest of the epicenter. Total damage from the earthquake was estimated at \$2.5 million and two people were killed. The earthquake was felt in Idaho, Washington, Montana, Oregon, Nevada, Wyoming, Utah, and Alberta and British Columbia in Canada.

2. The length of the surface rupture of the fault was about 40 km; maximum vertical offset of the fault was on the order of 3 m. The faulting occurred along a line of older ground displacement. Both ends of the fault showed clear evidence of the extension of this older faulting. A high level of vertical acceleration was associated with the faulting based on eyewitness accounts and on observation of building contents. Observation also indicated that the level of ground acceleration attenuated quickly and was not large in the towns of Mackay and Challis. This might explain why the damage in both Mackay and Challis was not as heavy as had been expected. Minor damage occurred in Salt Lake City, Utah, and Boise, Idaho.

STRONG-MOTION RECORDING

3. During the main shock, the Strong-Motion Instrumentation Program (SMIP), US Army Corps of Engineers, had 13 accelerographs on three dams, within a radius of about 410 km, in operation. These three dams are Lower Granite (earth and gravity dam, epicentral distance of 403 km), Dworshak (concrete dam, 330 km), and Lucky Peak (earth dam, 180 km). All three dams are located in the far field. They were not expected to record any meaningful ground motion. Three of the four accelerographs located at Dworshak were triggered, or were initiated because of electrical connection to another accelerograph which was triggered. The fourth accelerograph, located in the office building at the right abutment of the downstream site, did not trigger. It was not connected to a common starter. The data suggests that

the accelerograph at the upper gallery of the Dworshak Dam was triggered and this caused the recorders at two other locations on the project to operate. The five instruments located at the Lower Granite Dam were not triggered. The distance was too far away from the source to produce triggering level ground motion at this project.

4. The US Bureau of Reclamation (BuRec) has five accelerographs on Ririe Dam, a rock-fill dam located 179 km east of the epicenter, and an additional three on Black Canyon Dam, a concrete dam 198 km west of the epicenter. All five instruments at Ririe were triggered. The three at Black Canyon were not. One accelerograph, in the basement of the Boise, Idaho, Veterans Administration (VA) Hospital (189 km west of the epicenter), was not triggered.

5. The Idaho National Engineering Laboratory (INEL) is located approximately 90 km southeast of the epicenter. During the main shock, 13 accelerographs of INEL, operated by the US Department of Energy, recorded motion at ground level of amplitudes between 0.018 g (vertical component) to 0.078 g (horizontal component).

6. The INEL had one other instrument, located at Idaho Falls, which is 163 km from the epicenter. It was not triggered. The trigger level of the starters (checked on 7 November 1984) was 0.007 g, lower than the common setting of 0.01 g.

7. Unfortunately, no strong-motion instruments were located in the near-field or on the fault. The recorded maximum horizontal ground acceleration, at an epicentral distance of 90 km, was in the range of 0.025 to 0.078 g, while the vertical acceleration was in the range of 0.018 to 0.043 g.

OBJECTIVE OF THIS STUDY

8. The accelerographs have been in place on the Dworshak Dam (a concrete dam) and the Lucky Peak Dam (an earth dam) since 1972 and were installed by the U. S. Army Engineer District, Walla Walla, and on Ririe Dam (a rock-fill dam) where accelerographs were installed by the Bureau of Reclamation. Even though the maximum amplitude was not more than 0.06 g, documentation is desired. The dynamic analysis of Ririe Dam is planned under a separate project and the documentation and understanding of the observed earthquake strong-motion data should be an extremely valuable adjunct to that project.

It appears that 180 km was the critical distance for recording the ground motion for an instrument setting (threshold) of 0.01 g. Beyond the distance of 180 km, there were no instruments at ground level which were triggered by this earthquake.

INSTRUMENT CHARACTERISTICS

9. Table 1 shows the instrument characteristics of the accelerographs on Dworshak, Lucky Peak, and Ririe Dams. Table 2 shows their epicentral distance, height, crest elevation, instrument location, number of records obtained, and type of structure.

DATA DIGITIZATION AND PROCESSING

Digitization

10. The 27 accelerograms were digitized with a laser line digital machine by IOM-Towill of Santa Clara, Calif. The sample rate is 600 points per second. This rate has been adjusted to 200 points per second during the data processing.

Baseline correction

11. The basic concept of baseline correction is to subtract from the raw accelerogram a low-pass filtered version of the accelerogram, using Ormsby's filter (Ormsby, 1961) in which all frequencies higher than 0.07 Hz have been removed. The result is a high-pass filtered accelerogram from which low-frequency noise is eliminated. This is part of the standard routine processing of accelerograms (Hudson and others, 1971; and Trifunac and Lee, 1973). The general procedure of baseline correction for this report is the same as mentioned above except Ormsby's filter had been replaced by an equivalent Butterworth filter (USGS, 1976) and some minor changes. Details of these and other data processing procedures are discussed in a User's Manual for the computer code AGRAM by Converse (1983).

Data processing

12. The 27 corrected accelerograms, velocities, displacements, and their response spectra were processed by the Seismic Engineering and Geology Branch, USGS, using their standard routine computer program AGRAM and were stored on magnetic tape. Plots showing the corrected acceleration, velocity,

and displacement curves are shown in Appendix B. The uncorrected accelerograms are in Appendix A.

DATA PRESENTATION

13. Station, site location, coordinates, epicentral distances, azimuth from source to accelerograph site, instrument component, uncorrected maximum acceleration, corrected maximum acceleration, maximum particle velocity, maximum displacement, and ratio of a_d/v^2 , v/a , and a_v/a_h are listed in Table 3.

STRONG-MOTION PARAMETERS

14. The average ratio of a_v/a_h (vertical maximum acceleration to horizontal maximum acceleration) for this earthquake was 0.58. Chang (1983) found an a_v/a_h for the New Hampshire earthquake to be 0.83. Uwabe and others (1977) found the average ratios of a_v/a_h for Japan and the Western United States are 0.33 and 0.48, respectively. The value of 0.58 for this study is not far from the 0.48 value of the Western United States. Furthermore, the former is based only on the 18 horizontal data, while the latter is a mean of hundreds of data.

15. For most earthquakes of practical interest, Newmark and Rosenbluth (1971) give $a_d/v^2 = 5$ to 15. However, the average ratios of a_d/v^2 for 18 horizontal and 9 vertical accelerograms are 3.108 and 3.258, respectively. The ratio value for this earthquake is extremely low when compared with other earthquakes in the Western United States. However, this comparison may be unjustified, because there were not many strong-motion data recorded in this earthquake as mentioned earlier.

COMPARISONS OF GROUND MOTIONS AT RIRIE AND LUCKY PEAK DAMS

16. The epicentral distances at Ririe and Lucky Peak Dams are about the same (180 km). However, the directions and paths are different. Ririe is located east of the epicenter, while Lucky Peak Dam is southwest of the epicenter. The ratios or amplifications of maximum accelerations on the right to the maximum accelerations at the abutment for Lucky Peak Dam are

RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, UPPER TOWER, 10/28/83, 1406UTC 295(T)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER

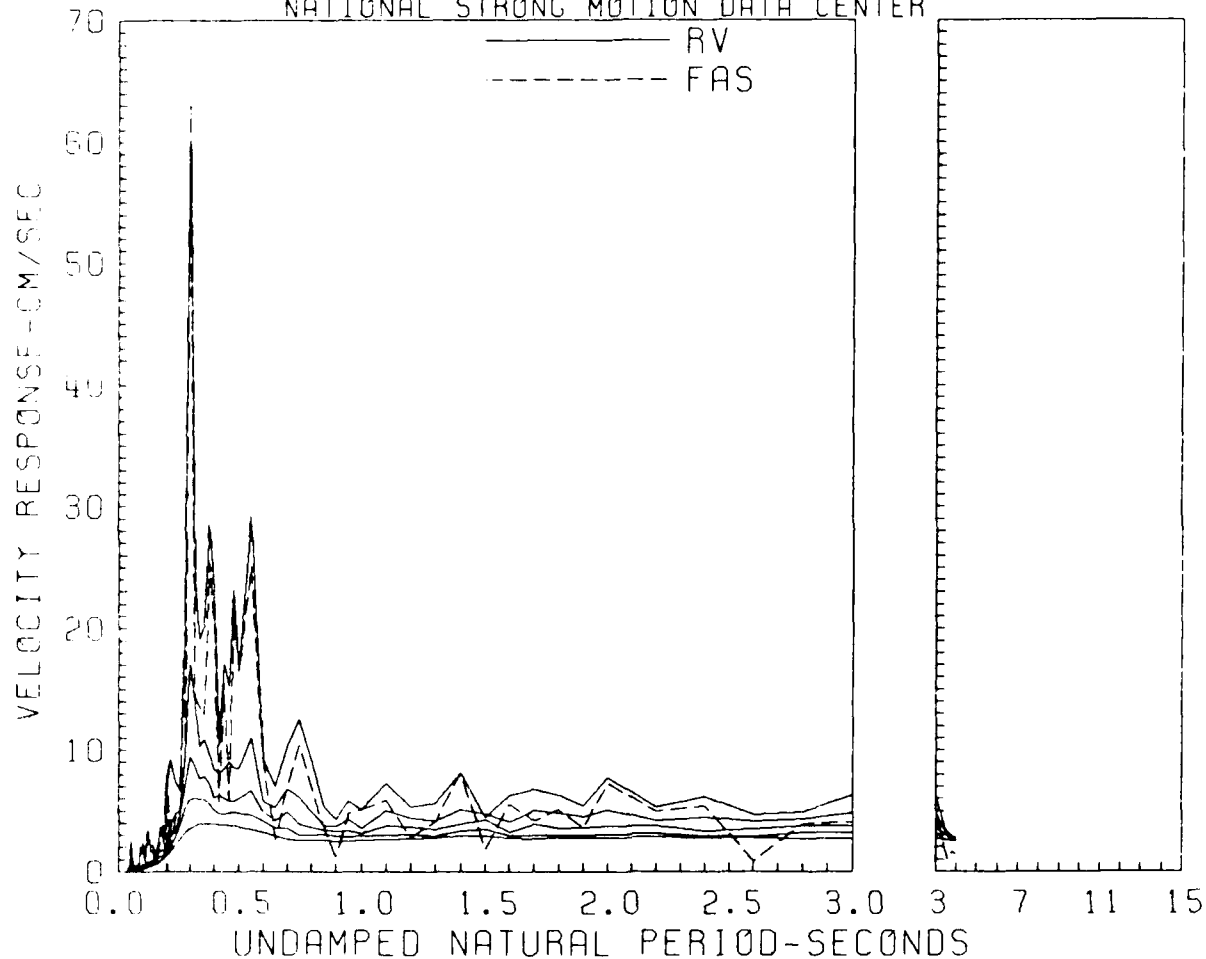


Figure 6c. Velocity response spectrum and Fourier amplitude spectrum at Upper Intake Tower, T-component, at Ririe Dam

RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, UPPER TOWER, 10/28/83, 1406UTC UP
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER

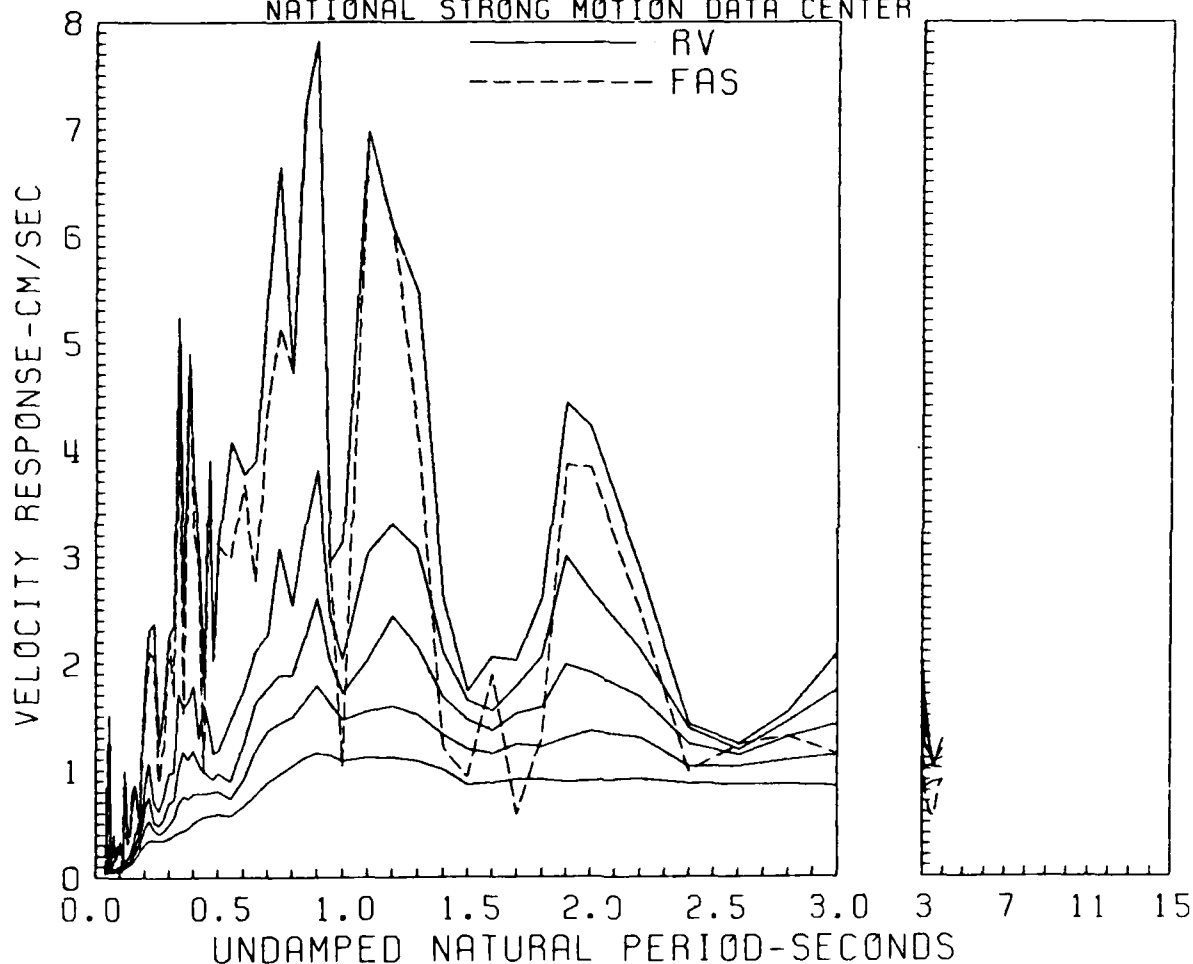


Figure 6b. Velocity response spectrum and Fourier amplitude spectrum at Upper Intake Tower, V-component, at Ririe Dam

RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, UPPER TOWER, 10/28/83, 1406UTC 25(L)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER

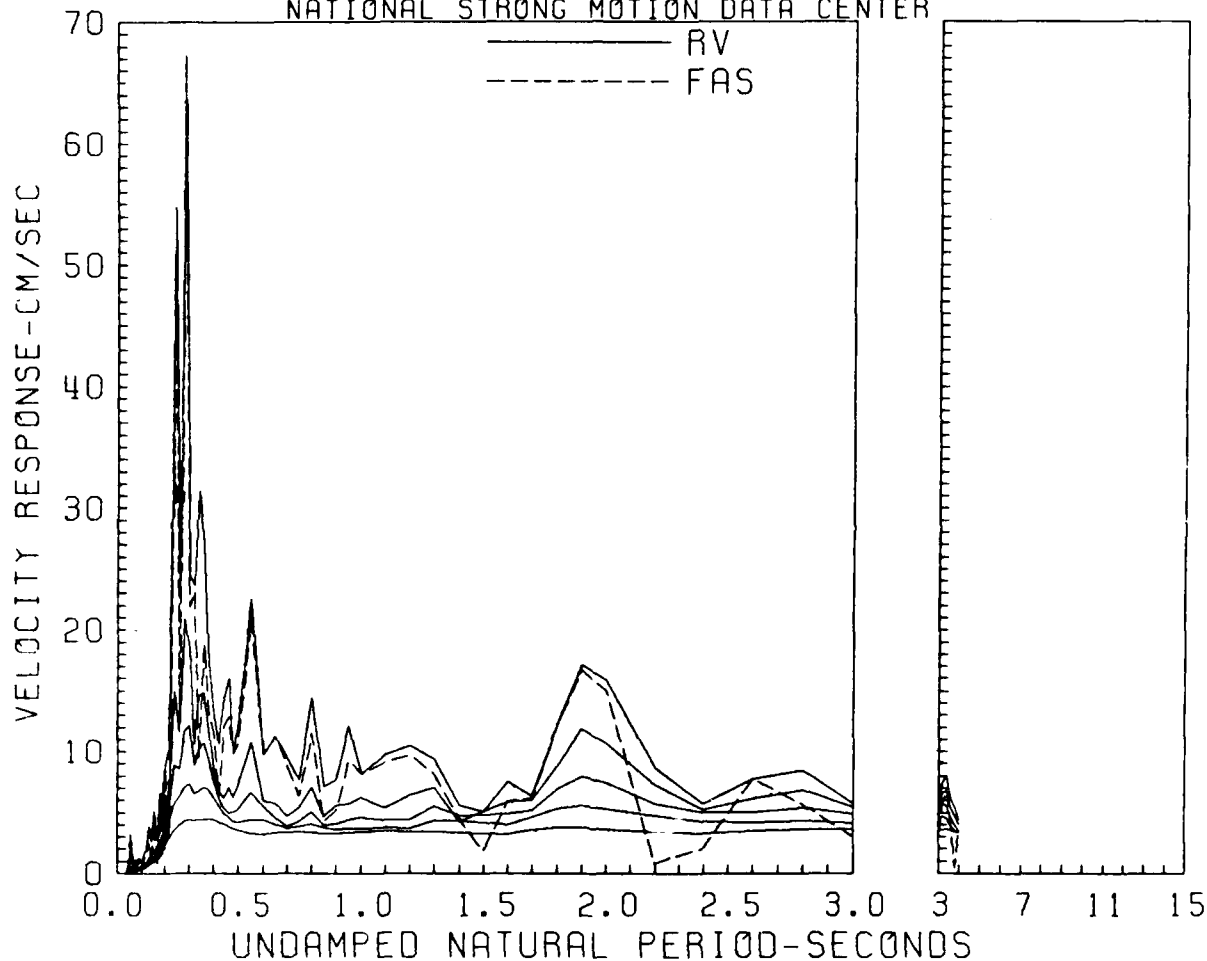


Figure 6a. Velocity response spectrum and Fourier amplitude spectrum at Upper Intake Tower, L-component, at Ririe Dam

RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, ABUTMENT, 10/28/83, 1406UTC 295(T)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER

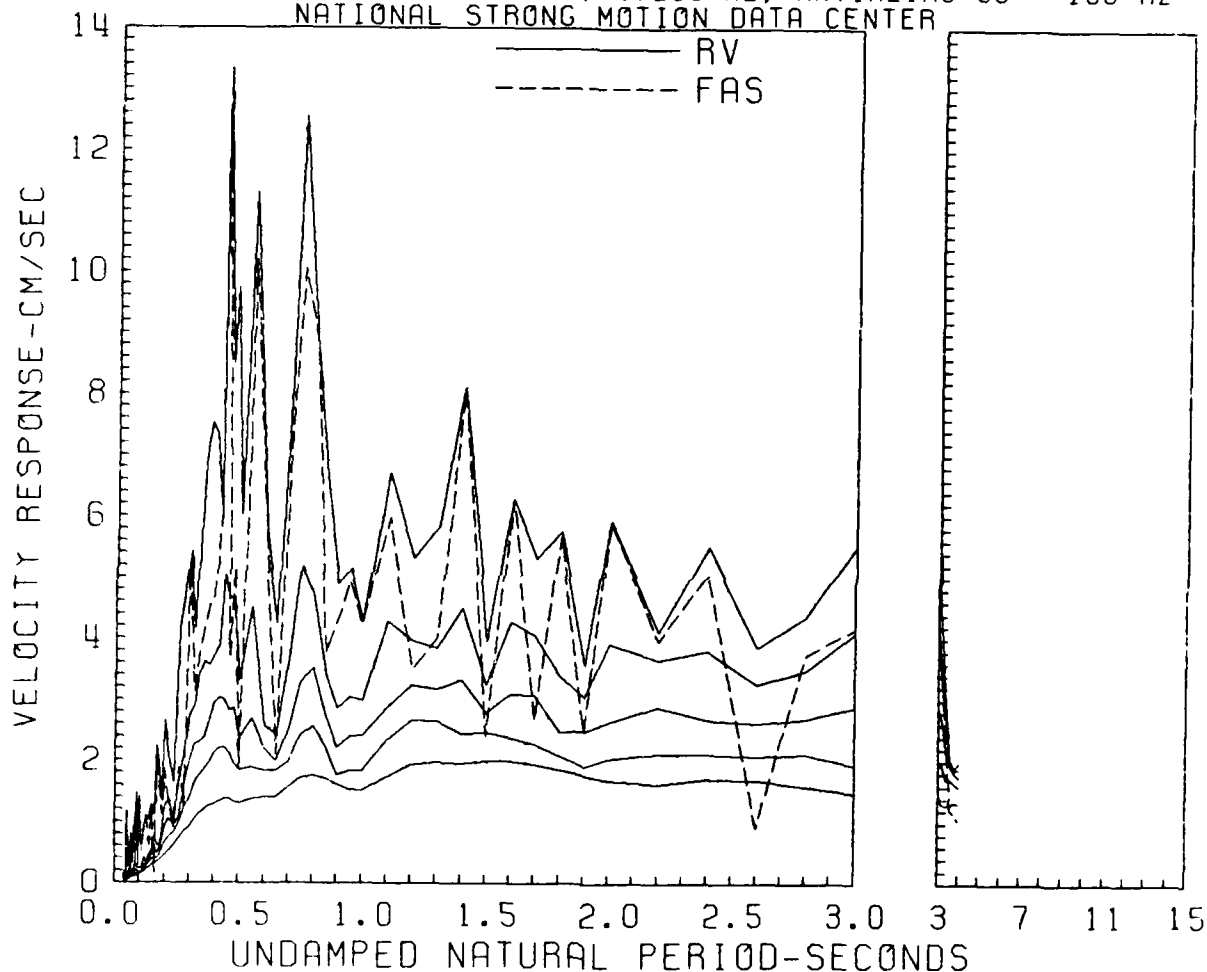


Figure 5c. Velocity response spectrum and Fourier amplitude spectrum at left abutment, T-component, at Ririe Dam

RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, ABUTMENT, 10/28/83, 1406UTC UP
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER

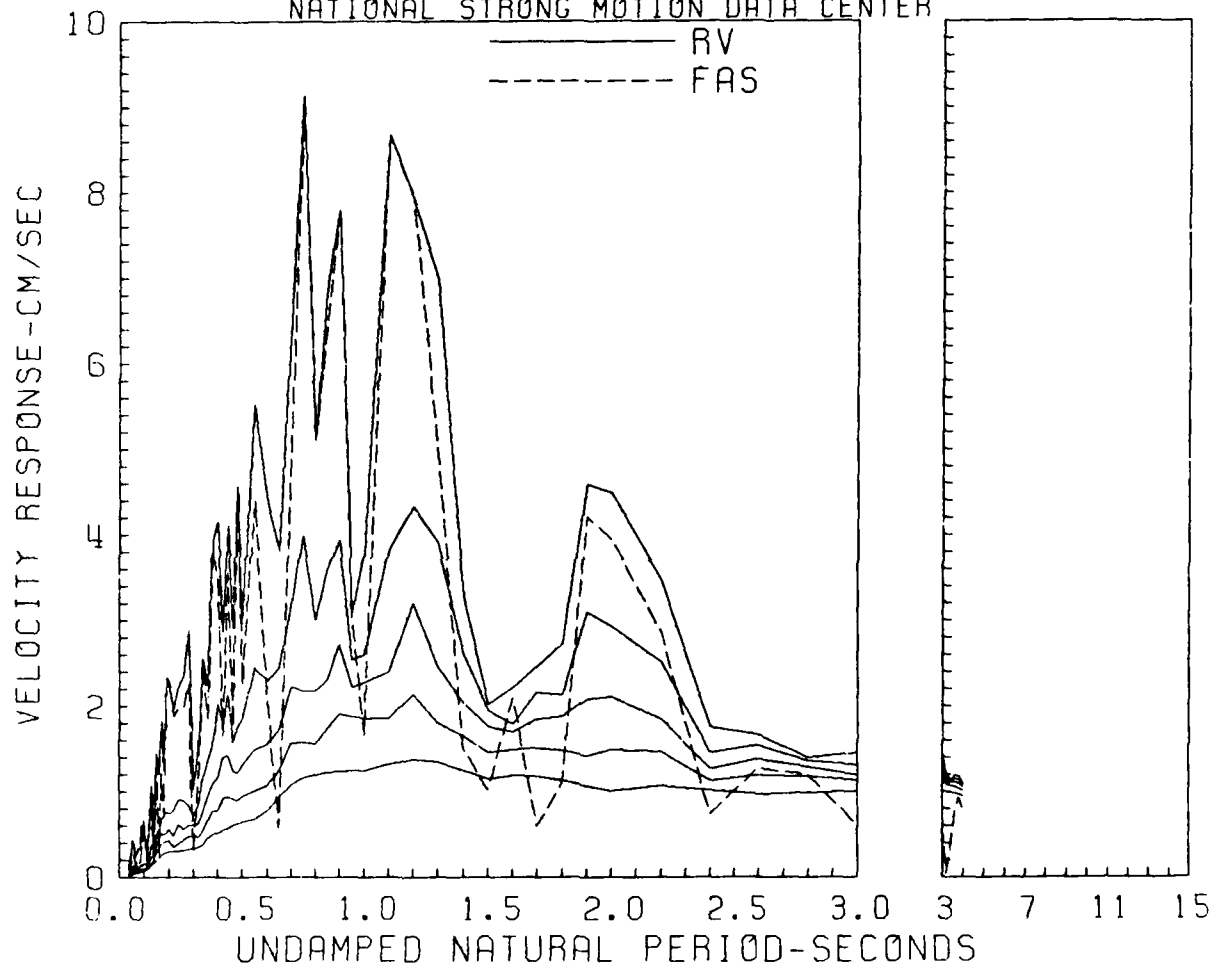


Figure 5b. Velocity response spectrum and Fourier amplitude spectrum at left abutment, V-component, at Ririe Dam

RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, ABUTMENT, 10/28/83, 1406UTC 25 (L)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER

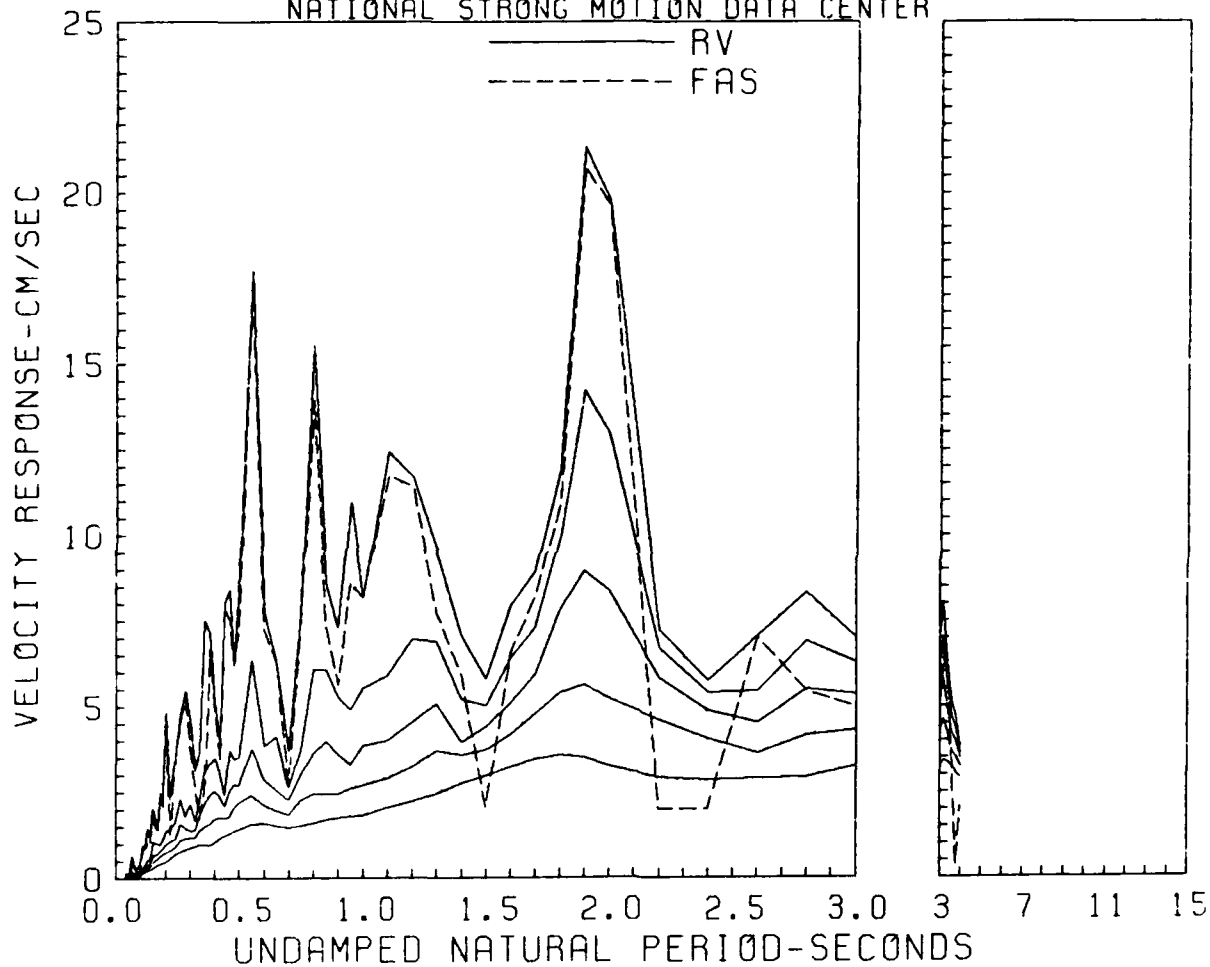


Figure 5a. Velocity response spectrum and Fourier amplitude spectrum at left abutment, L-component, at Ririe Dam

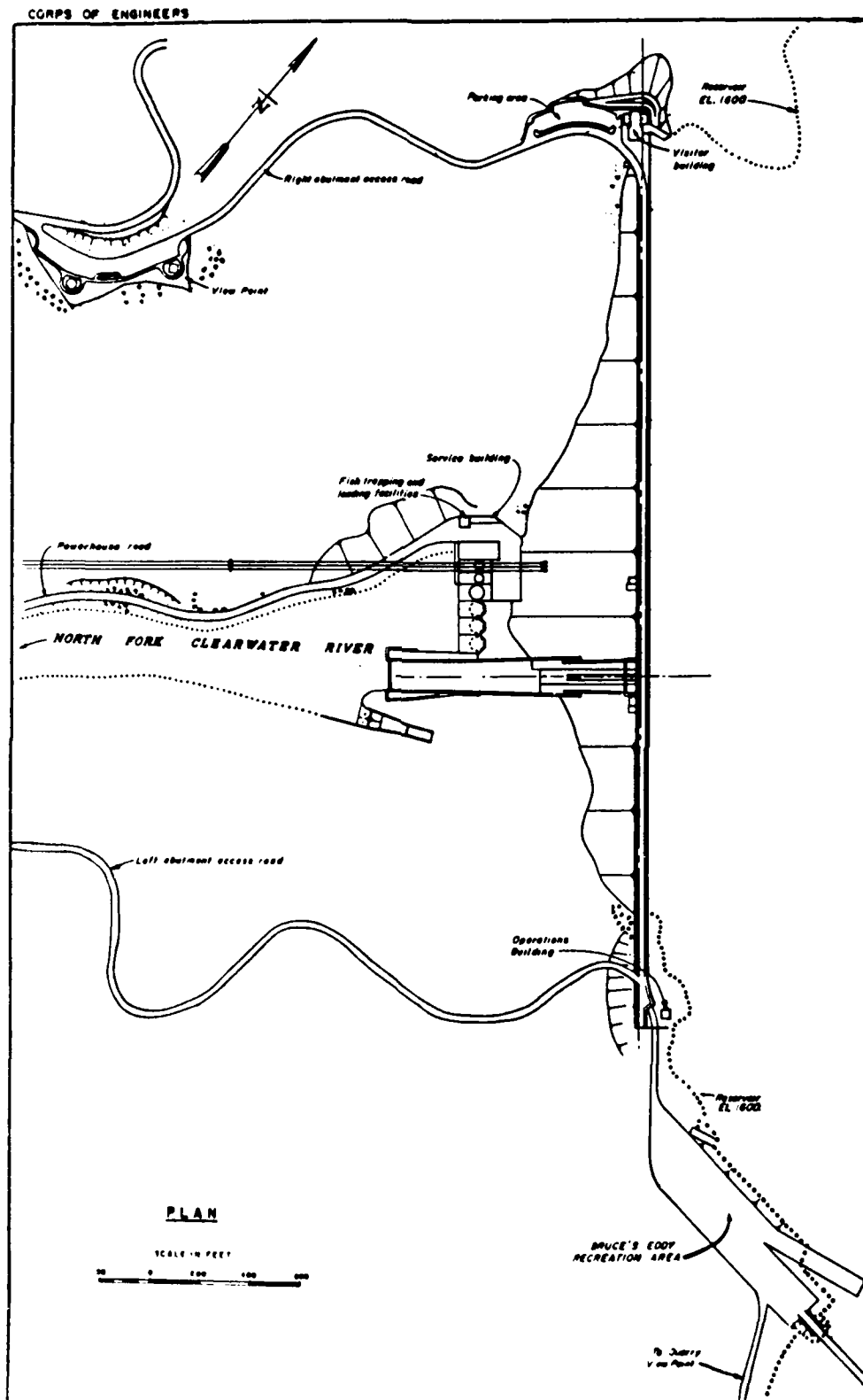


Figure 4. Plan view of Dworshak Dam

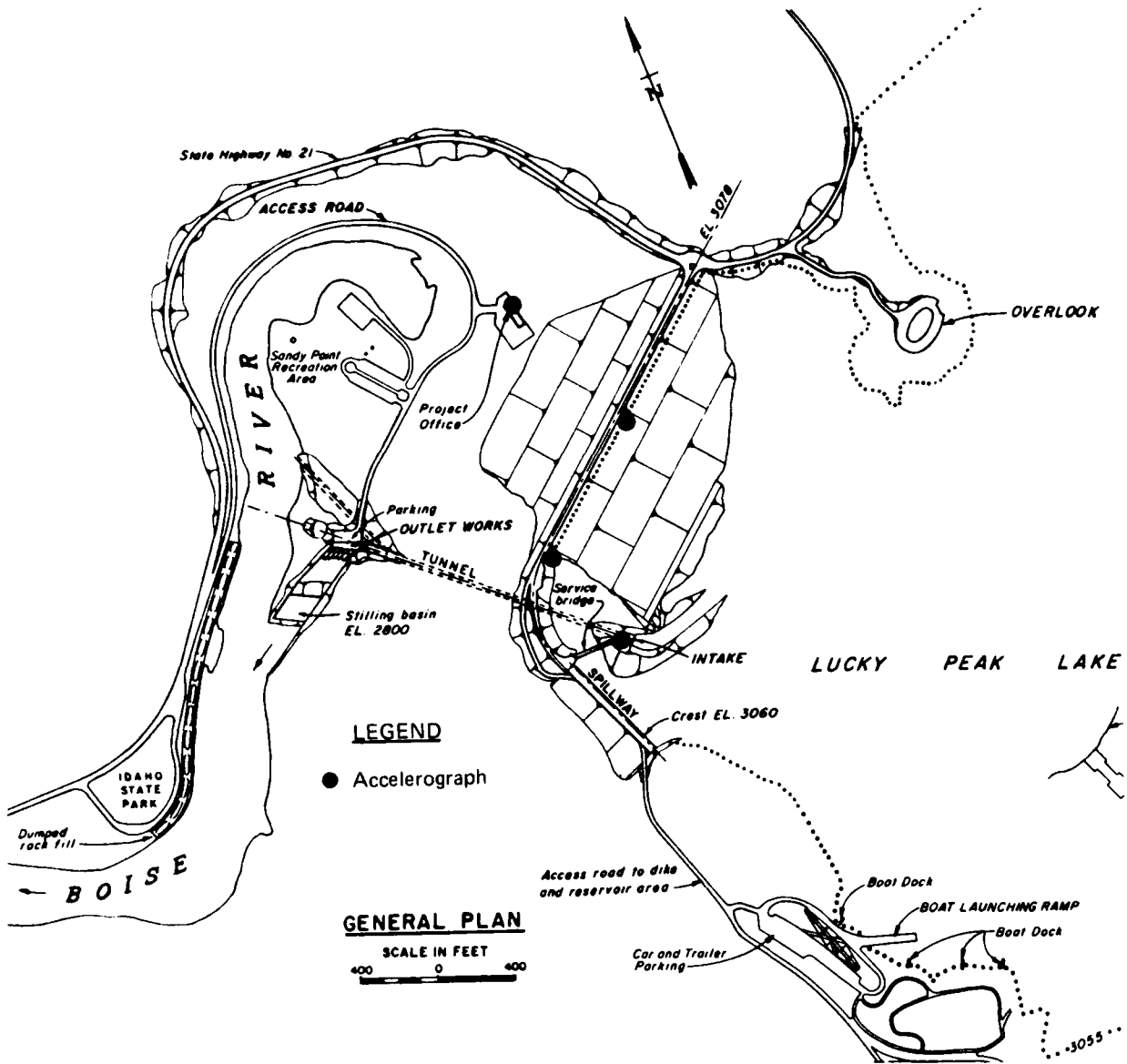


Figure 3. Accelerographic locations of Lucky Peak Dam

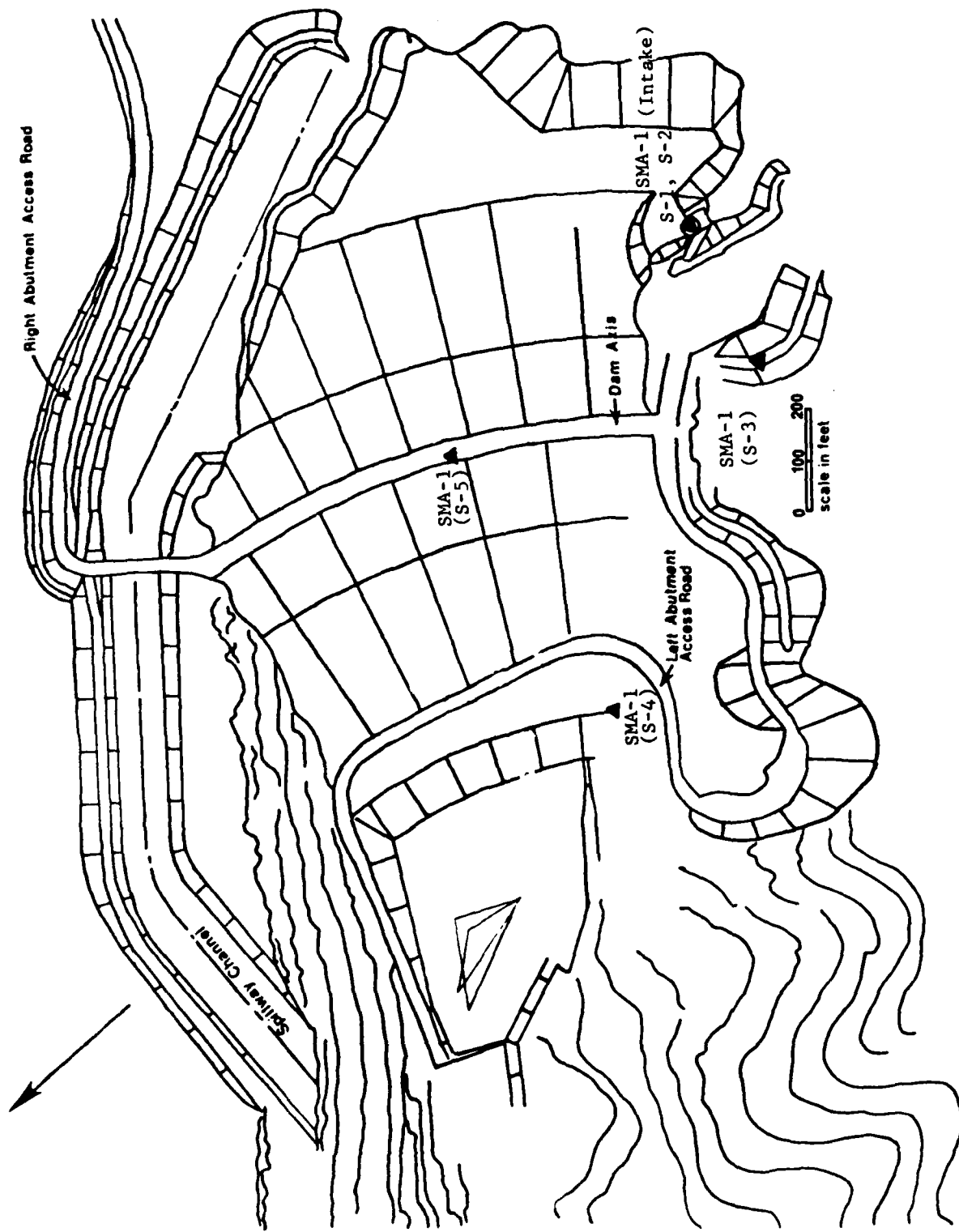


Figure 2. Plan view and accelerographic locations of Ririe Dam

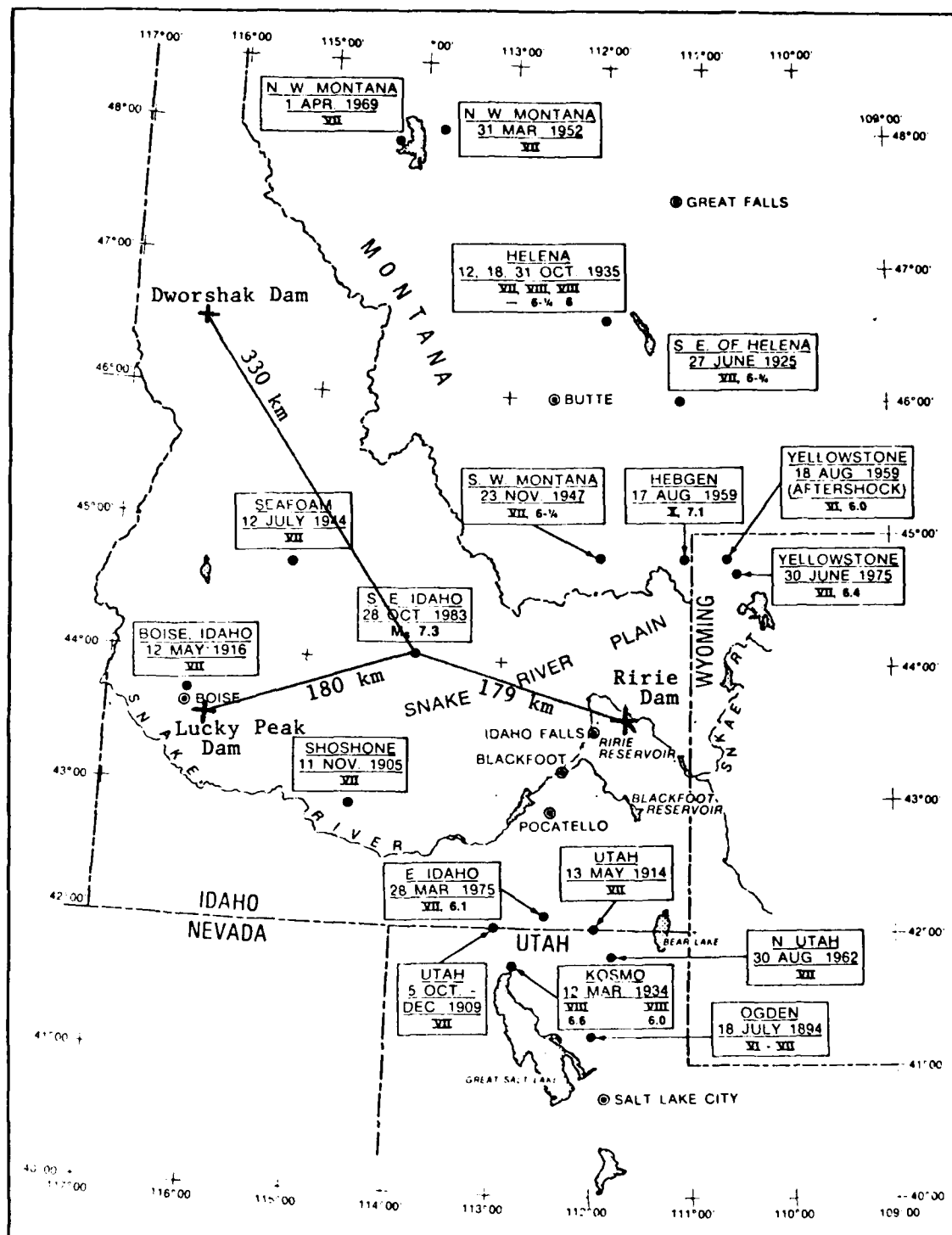


Figure 1. Locations of the epicenter of 28 October 1983 and the Ririe, Lucky Peak, and Dworshak Damsites.

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24. The resonant frequency of the intake at Ririe Dam determined from the amplification ratio of the horizontal velocity response spectra between the upper level of the intake and the left abutment was 3.5 Hz. The amplification ratio for the horizontal response spectra of the zero percent damping ratio was about 12 times higher for the upper level of the intake than the left abutment. This probably caused the slight damage on the upper level of the intake. In addition, the direction of the crack was in parallel to the longitudinal axis of the dam. There was no amplification for the vertical component.

LONG PERIOD MOTION AT RIRIE DAM

19. The predominant long period motion of 1.9 sec (0.52 Hz), which contains the highest energy, shows on the longitudinal and vertical components of all relative velocity response spectra at the abutment, crest, downstream (free field), lower and upper levels of the intake of Ririe Dam (Appendix C). They are Rayleigh waves. It may be the result of the original slow rupture of the faulting in the rock. The 1.9-sec period could also be found in the data from other recording sites, such as Lucky Peak Dam, Dworshak Dam, and INEL's network.

SUMMARY

20. There were no near-field strong-motion records for this Mount Borah, Idaho, earthquake of 28 October 1983, which occurred at latitude 44.06°N , longitude 113.88°W . At about 90 km southeast of the epicenter, 13 accelerographs operated by the Idaho National Engineering Laboratory recorded the main shock. The peak ground accelerations were in the range of 0.018 g (vertical component) to 0.078 g (horizontal component).

21. This study was based on 27 components of accelerograms (18 horizontal and 9 vertical) recorded at Ririe Dam (15 components), Lucky Peak Dam (9 components), and Dworshak Dam (3 components). Ririe, Lucky Peak, and Dworshak Dams were 179 km, 180 km, and 330 km away from the epicenter, respectively. The highest ground acceleration was only 69.71 cm/sec^2 recorded at the center crest of Lucky Peak Dam. This will not affect the internal damage of the dams.

22. Based on the results of the statistical analysis of the peak ground motions of the 27 components, i.e., peak acceleration (a), peak velocity (v), and peak displacement (d), the average ratios of v/a , a_v/a_h , and ad/v^2 were 0.089 sec, 0.58, and 3.1, respectively.

23. The amplification ratios of the maximum acceleration on the crest to the maximum acceleration at the abutment for Lucky Peak Dam were 5.69 (L), 4.01 (V), 3.76 (T) and 2.05 (L), 2.41 (V), 2.48 (T) for Ririe Dam. Both epicentral distances were about the same. However, the height for the Lucky Peak Dam was 104 m, while the height of Ririe Dam was 51.5 m. Therefore, the height of the Lucky Peak Dam might be the cause of its higher amplification ratios.

5.69 (L), 4.01 (V), and 3.76 (T). The ratios (amplifications) of maximum accelerations on the crest to the abutment for Ririe Dam are 2.05 (L), 2.41 (V), and 2.48 (T). The elevation of instrument location at the crest is about the same as the elevation of instrument location at the abutment for both dams. Lucky Peak and Ririe Dams are 104 m and 51.5 m high, respectively. The greater height of the Lucky Peak Dam might be responsible for the higher ratio or higher acceleration on its crest. Because Lucky Peak and Ririe Dams are far away from the epicenter, the resulting small ground motions certainly did not cause internal damage to the dams.

AMPLIFICATION, DAMAGE AND NATURAL FREQUENCY OF THE INTAKE , RIRIE DAM

17. It is worth noting that at Ririe Dam the horizontal accelerations recorded at the upper level of the intake tower are amplified and the vertical acceleration not. The ratios of L, V, T components for the upper level to the lower level of the intake tower are 4.55, 1.04, and 3.52, respectively.

18. During the main shock, the five accelerographs located on the crest, left abutment, downstream, and the lower and upper levels of the intake were triggered. Although the ground motions were small, a crack (a shift of about 2.5 cm (+) to the left for the bridge relative to the intake) at the joint between the upper level of the intake and the service bridge was reported. Since the elevations and the locations of both accelerographs at the upper intake and the abutment are very close, a comparison of the relative velocity response spectra or Fourier amplitude spectra between the upper level of the intake tower and the abutment sheds some light on the differential movement that must have occurred. Figures 5 (a, b, and c) and 6 (a, b, and c) show the relative velocity response spectra and the Fourier amplitude spectra for the upper level and the abutment, respectively. A resonant frequency of 3.5 Hz appears on both horizontal components (L and T) of the upper intake tower. The amplification ratio for zero percent damping of the horizontal response spectra is about 12 times greater for the upper level of the intake tower than for the abutment. This high amplification of 3.5 Hz on the horizontal components may be the cause of the crack on the upper level of the intake by the horizontal motion. The direction of the crack was parallel to the dam axis. Thus, the resonant condition of the intake shows that its natural frequency was also 3.5 Hz.

Table 1
Instrument Characteristics for the Mt. Borah Peak Earthquake, 10/28/1983, 14:06UTC (07:06 MST)

Code	Coordinates	Type and Serial No.	Instrument Station No. and Location	Component ^a Direction	Period ^a T ₀ (sec)	Sens. ^a (cm/g)	Damp. ^a % Crit.
UMD	46.52N, 116.29W	SMA-1 #582	No. 2222, Dworshak Dam Upper gallery (rm.4) (el 488.6 m)	L 141°	0.040	1.90	0.60
				V up	0.039	1.82	0.59
				T 51°	0.039	1.82	0.61
		SMA-1 #390	No. 2222, Dworshak Dam Middle gallery (rm.3) (el 384.0 m)	L 141°	0.038	1.78	0.53
				V up	0.039	1.81	0.53
				T 51°	0.042	2.31	0.57
		SMA-1 #391	No. 2222, Dworshak Dam Lower gallery (rm.1) (el 298.7 m)	L 141°	0.0	1.70	0.57
				V up	0.0	1.61	0.59
				T 51°	0.0	1.65	0.57
		SMA-1 #625†	No. 2222, Dworshak Dam Right abutment (el 487.7 m)	L 141°	0.035	1.80	0.61
				V up	0.038	1.97	0.59
				T 51°	0.035	1.88	0.57
LYD	43.53N, 116.05W	SMA-1 #621	No. 2213, Lucky Peak Dam Left abutment (el 935 m)	L 229°	0.055	3.60	0.59
				V up	0.055	3.68	0.57
				T 139°	0.055	3.90	0.59
		SMA-1 #637	No. 2213, Lucky Peak Dam Intake upper level (el 937 m)	L 229°	0.040	1.77	0.57
				V up	0.039	1.83	0.57
				T 139°	0.040	1.88	0.57
		SMA-1 #638	No. 2213, Lucky Peak Dam Center crest (el 938 m)	L 229°	0.040	1.83	0.59
				V up	0.040	1.83	0.59
				T 139°	0.040	1.77	0.59
		SMA-1 #620†	No. 2213, Lucky Peak Dam Downstream (el 869 m)	L 229°	0.050	3.60	0.57
				V up	0.050	4.24	0.57
				T 139°	0.050	3.80	0.57
RTD	43.59N, 111.75W	SMA-1 #623 (S-1)	No. 2254, Ririe Dam Intake lower level (el 1528 m)	L 025°	0.056	1.95	0.60
				V up	0.057	1.85	0.60
				T 295°	0.056	1.95	0.60
		SMA-1 #636 (S-2)	No. 2254, Ririe Dam Intake upper level (el 1562.6 m)	L 025°	0.039	1.85	0.60
				V up	0.039	1.80	0.60
				T 295°	0.038	1.70	0.60
		SMA-1 #619 (S-3)	No. 2254, Ririe Dam Abutment (el 1569.7 m)	L 025°	0.059	2.00	0.60
				V up	0.057	1.80	0.60
				T 295°	0.055	1.78	0.60
		SMA-1 #618 (S-4)	No. 2254, Ririe Dam Downstream (el 1511.5 m)	L 025°	0.057	1.90	0.60
				V up	0.057	1.80	0.60
				T 295°	0.059	2.00	0.60
		SMA-1 #511 (S-5)	No. 2254, Ririe Dam Center crest (el 1563 m)	L 025°	0.039	2.05	0.60
				V up	0.039	1.82	0.60
				T 295°	0.039	1.98	0.60

^a The component direction is that of pendulum motion for the trace to be deflected "upward" on the record, as described in the Notes.

^{aa} Periods, sensitivities, and damping values are obtained from the regularly updated list of Strong-Motion Station Instrumental Data.

† Did not trigger; not connected to common start.

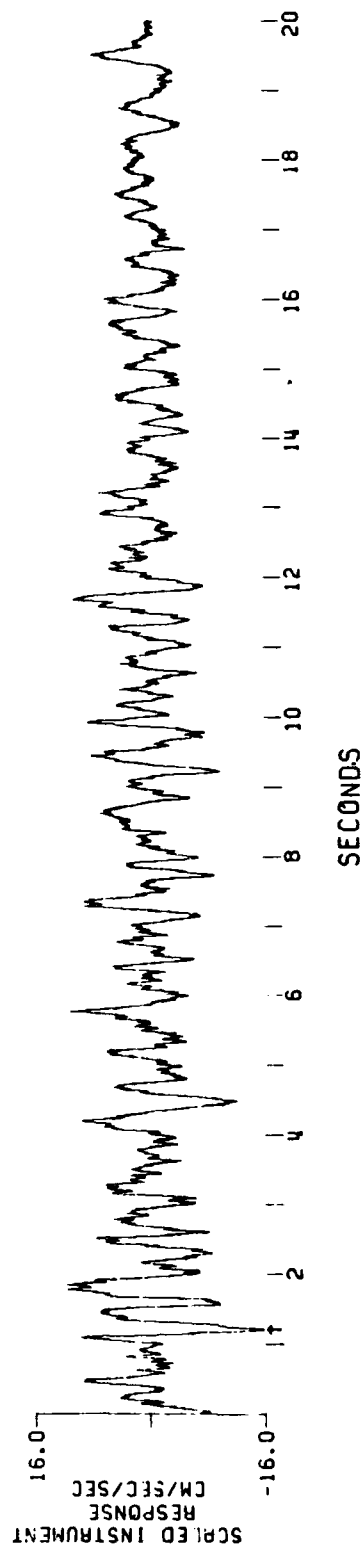
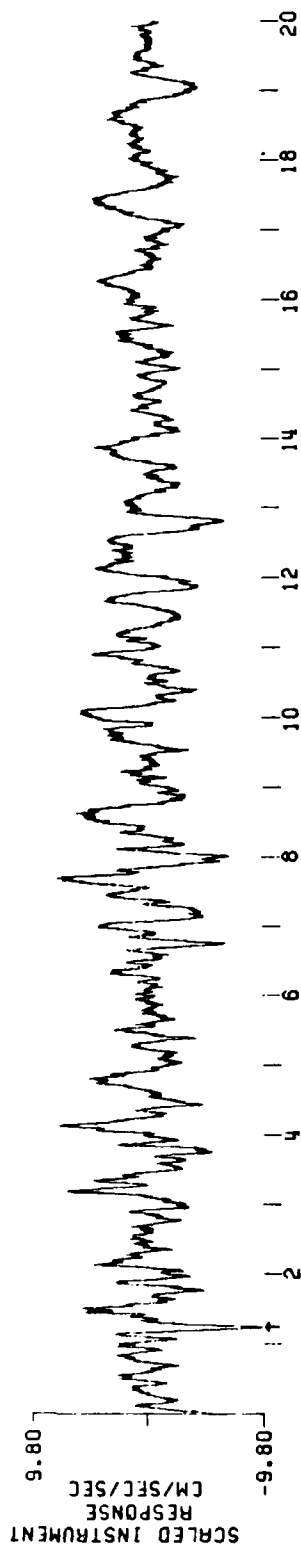
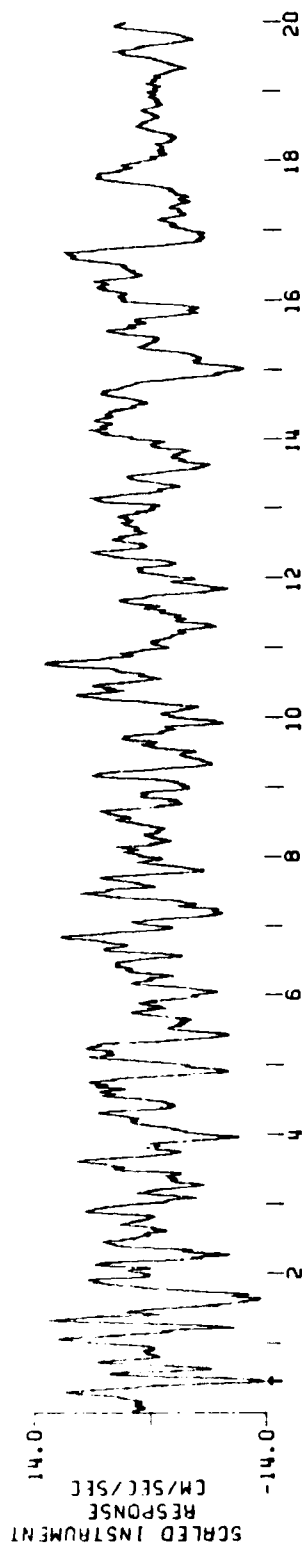
Table 2
Sites of Strong-Motion Records

Owner	Recording Site	Epicentral Distance km	Height of Dam, m	Top Elevation of Crest msl, m	Location of Recording Instrument	Number of Records	Type of Structure
CE	Dworshak Dam	330	219	492	SMA-582 Upper gallery (rm.4) (488.6 m)	3-comp	Concrete dam
					SMA-390 Middle gallery (rm.3) (384.0 m)	Barely triggered	
					SMA-391 Lower gallery (rm.1) (298.7 m)	Barely triggered	
CE	Lucky Peak Dam	179	104	938	(SMA-621) Left abutment (935 m)	3-comp.	Earth dam
					(SMA-637) Intake tower (937 m)	3-comp.	
					(SMA-638) Dam crest (938 m)	3-comp.	
Burec	Ririe Dam	180	51.5	1563	(SMA-623) Lower tower (1528 m)	3-comp.	Rock-fill dam
					(SMA-636) Upper tower (1562.4 m)	3-comp.	
					(SMA-619) Abutment (1569.7 m)	3-comp.	
					(SMA-618) Downstream (1511.5 m)	3-comp.	
					(SMA-511) Center crest (1565 m)	3-comp.	

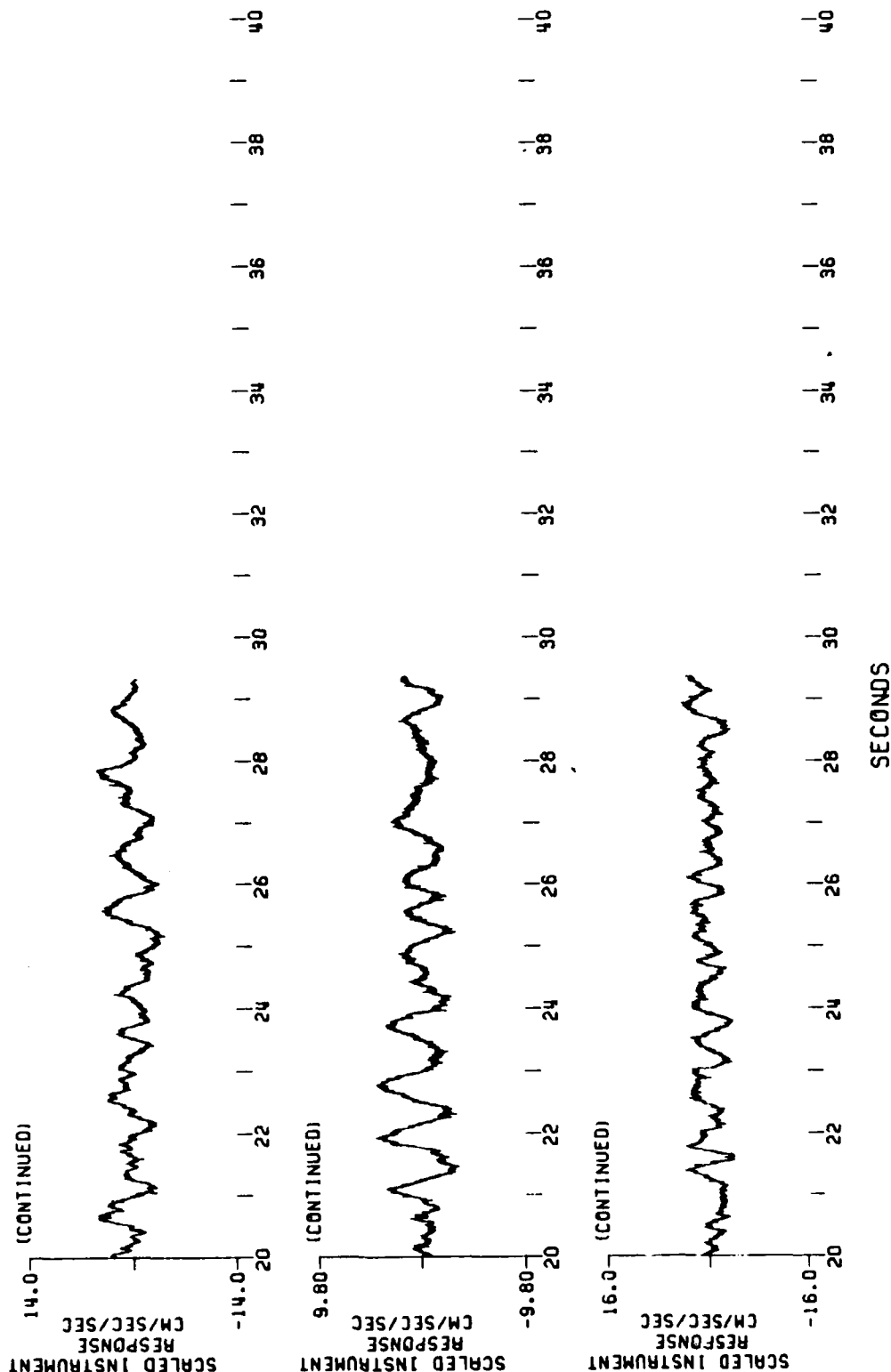
APPENDIX A

UNCORRECTED ACCELEROGRAMS

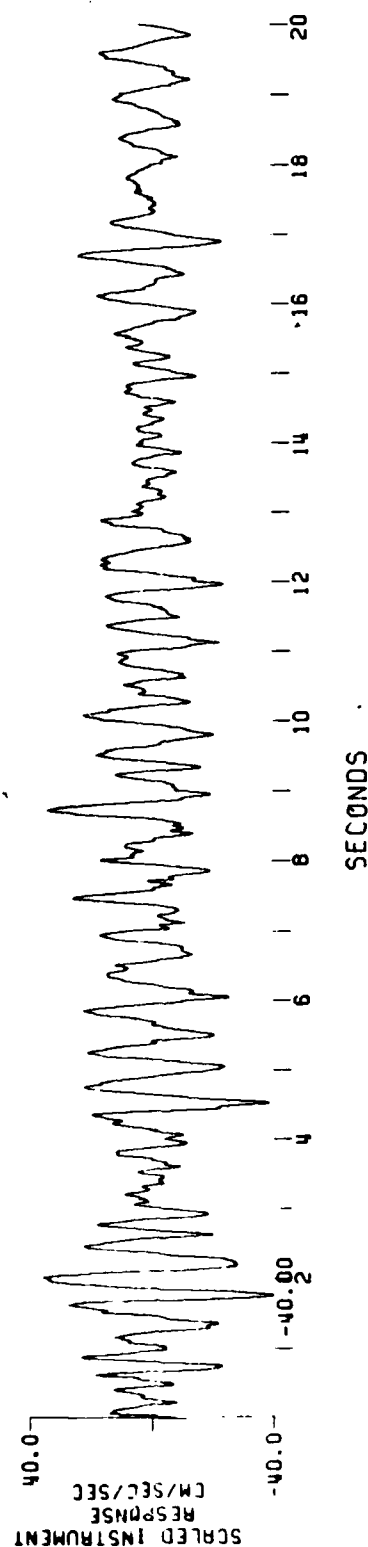
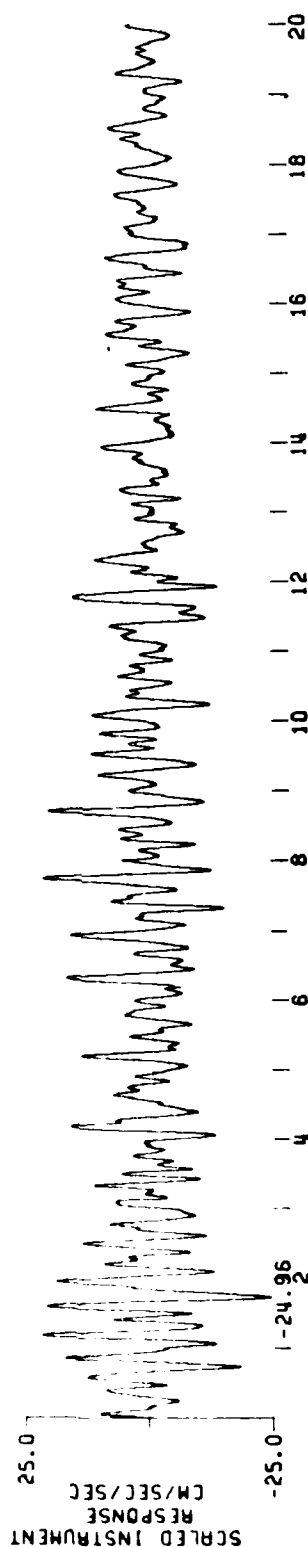
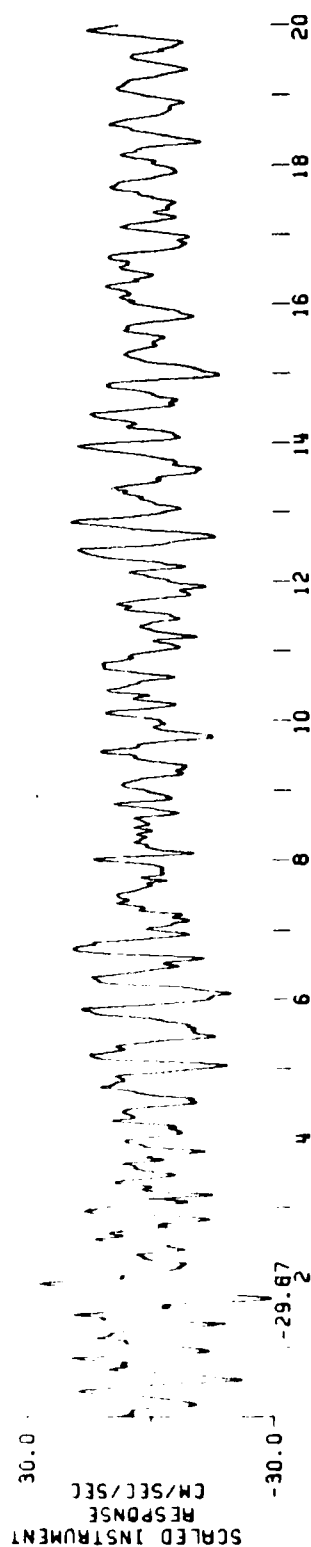
UNCORRECTED ACCELEROGRAM
 PIRIE DAM ABUTMENT
 25 DEGREES UP, 295 DEGREES
 EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 PEAK VALUES (CM/SEC/SEC): -13.69 -9.75 -15.81



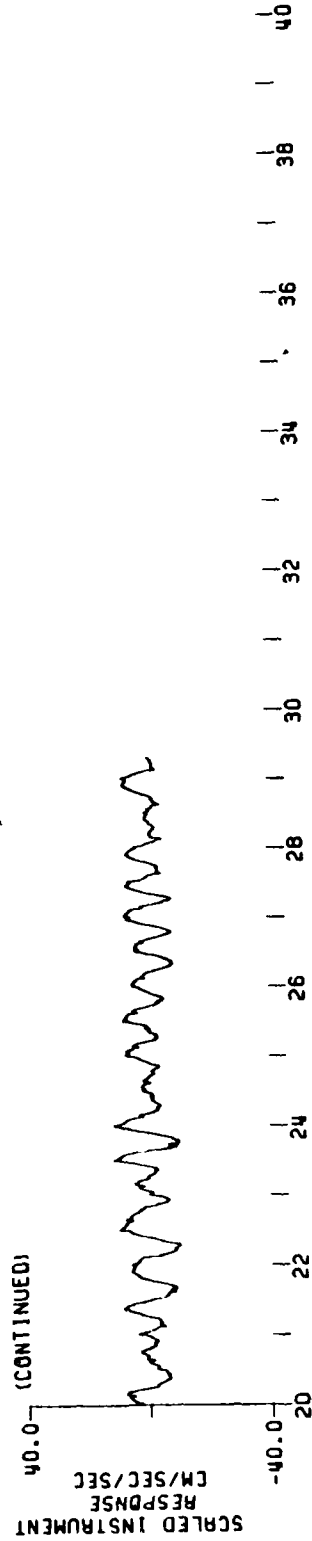
UNCORRECTED ACCELEROGRAM
 AIRIE DAM ABUTMENT
 25 DEGREES UP 295 DEGREES
 EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 PEAK VALUES (CM/SEC/SEC): -13.89 -9.75 -15.81



RIRIE DAM, CREST
25 DEGREES UP, 295 DEGREES
EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC

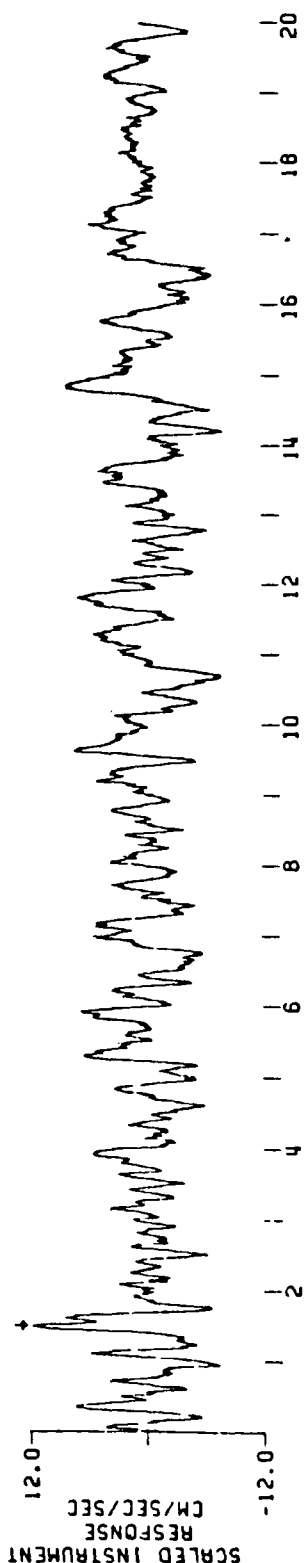
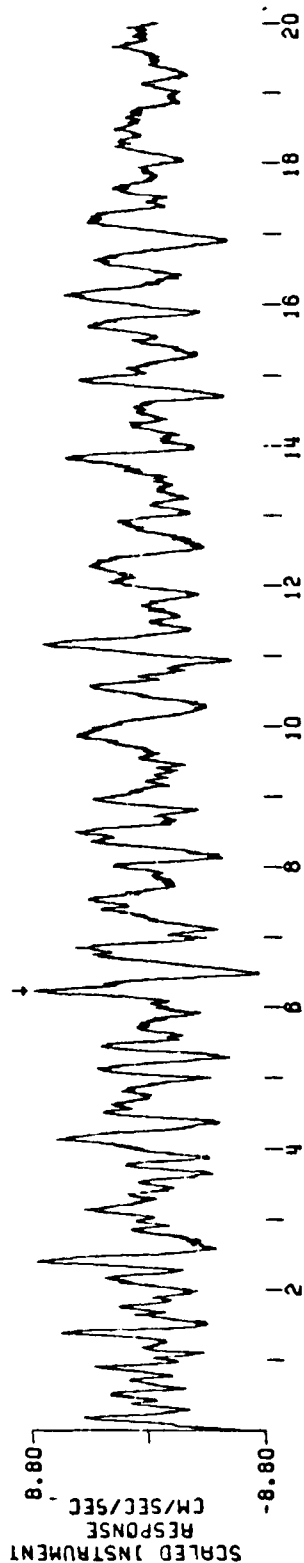
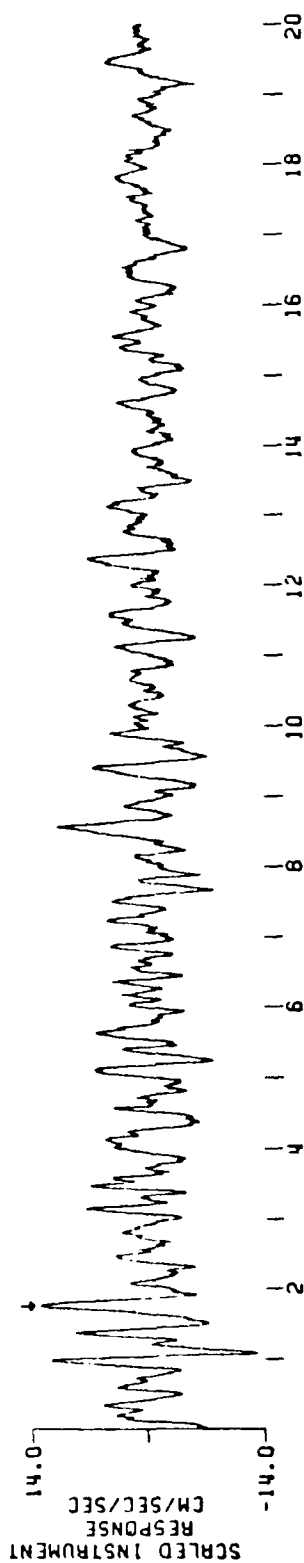


RIRIE DAM, CREST
25 DEGREES UP, 295 DEGREES
EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC



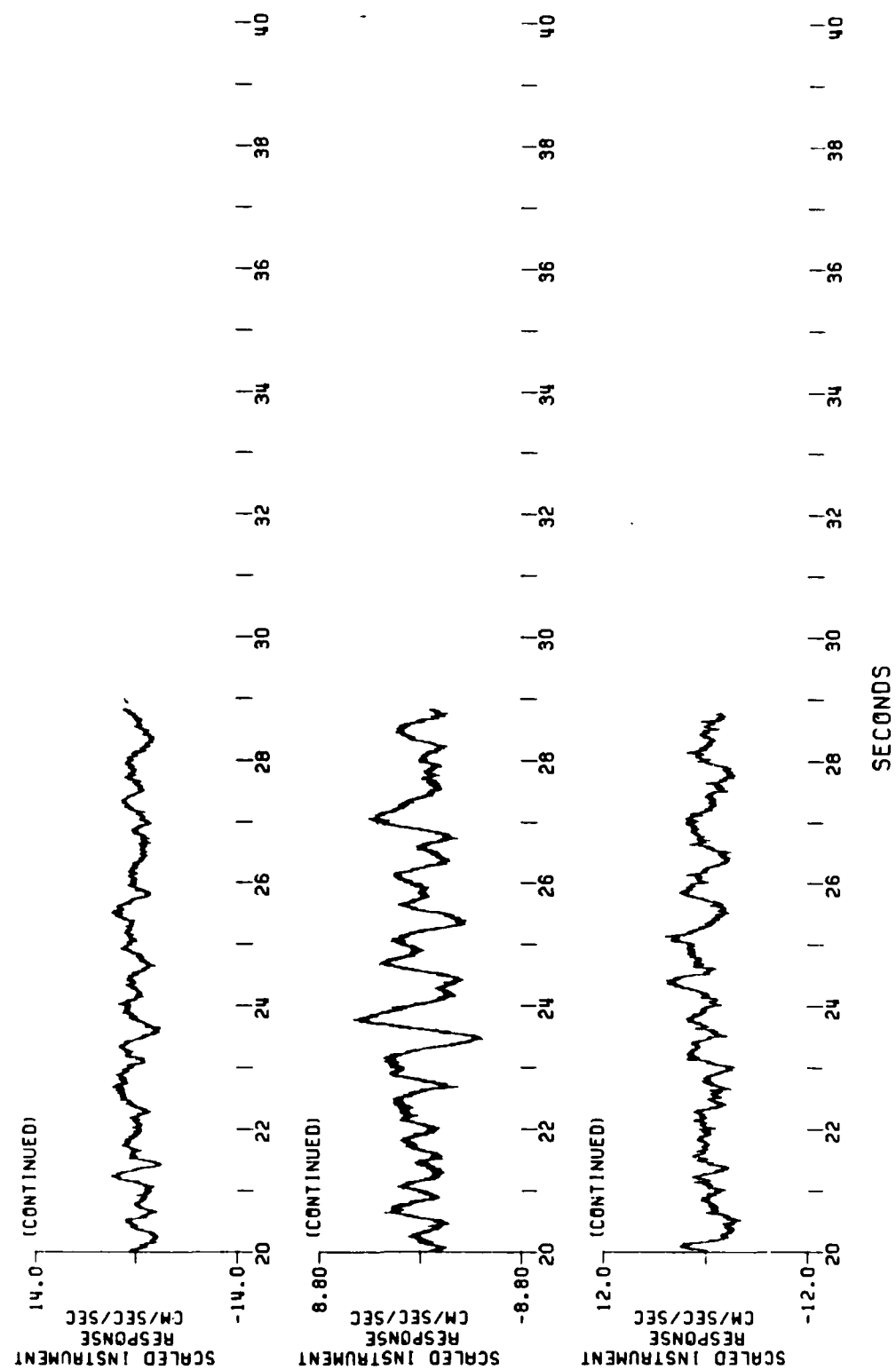
UNCORRECTED ACCELEROGRAM

RIE DAM, DOWNSTREAM
237 DEGREES, UP, 147 DEGREES
EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
PEAK VALUES (CM/SEC/SEC): 13.07 8.76 11.83

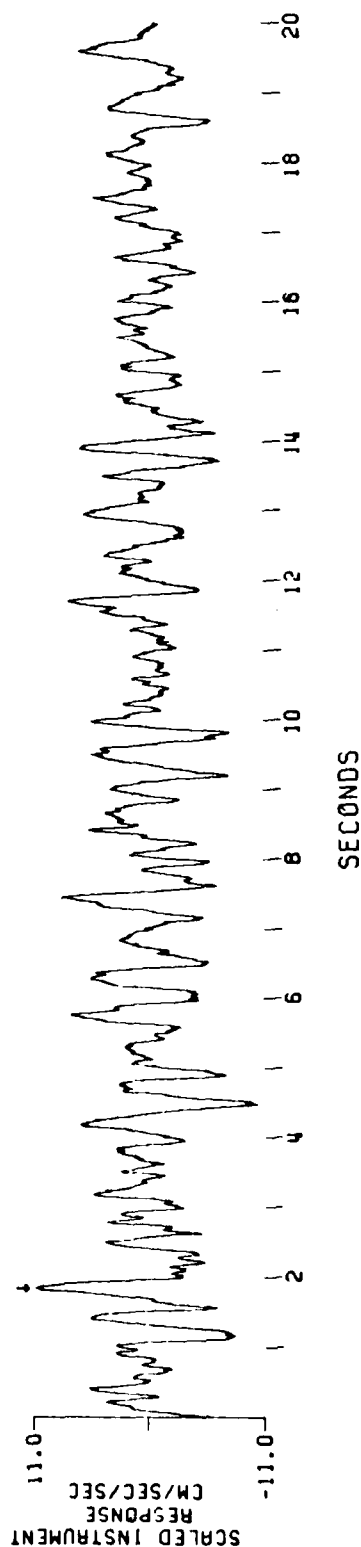
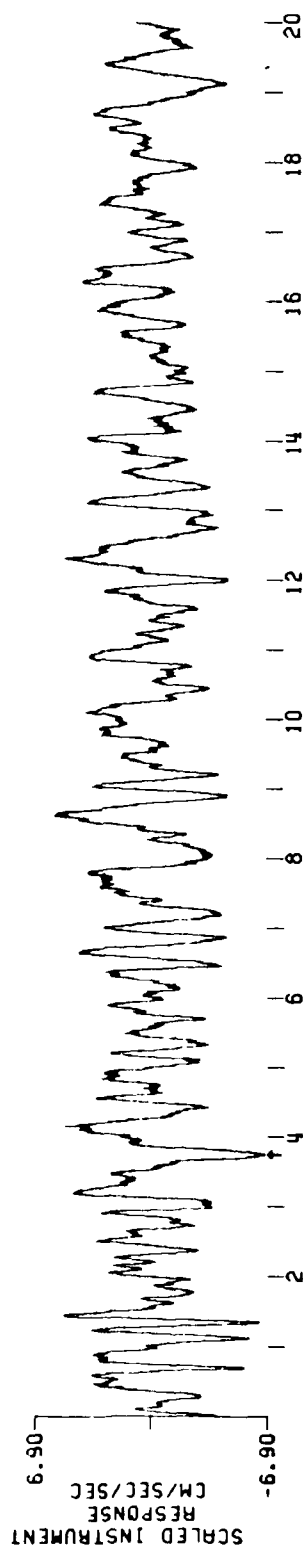
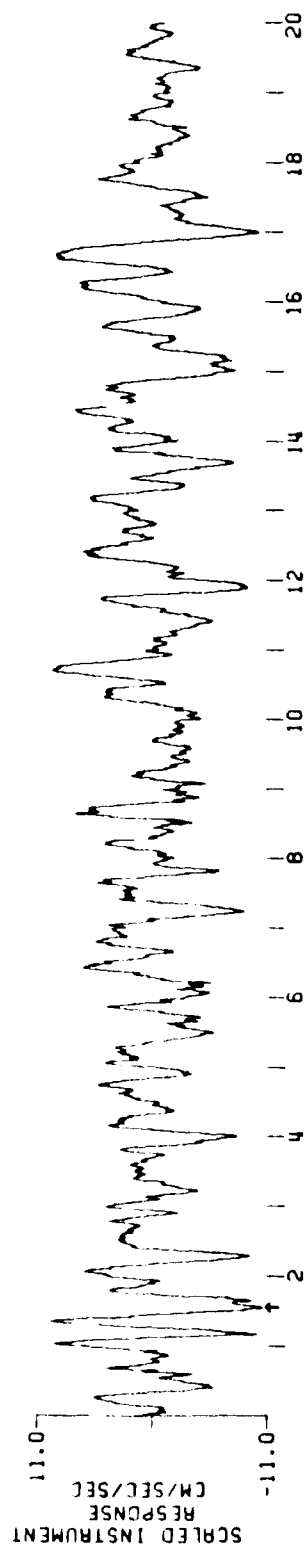


SECONDS

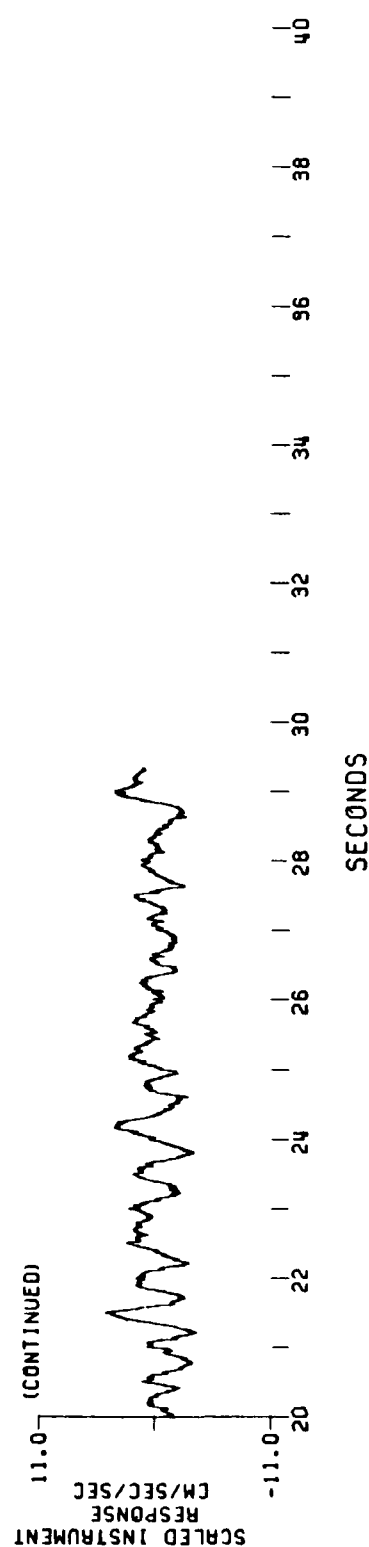
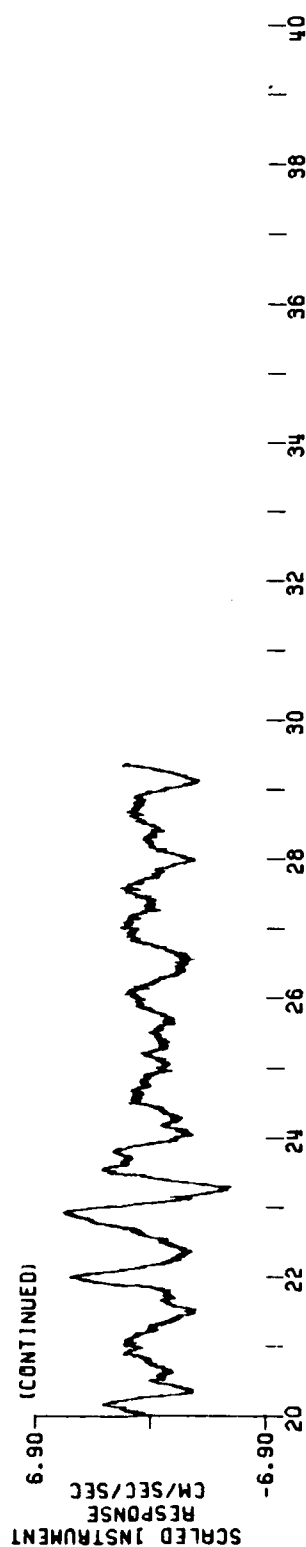
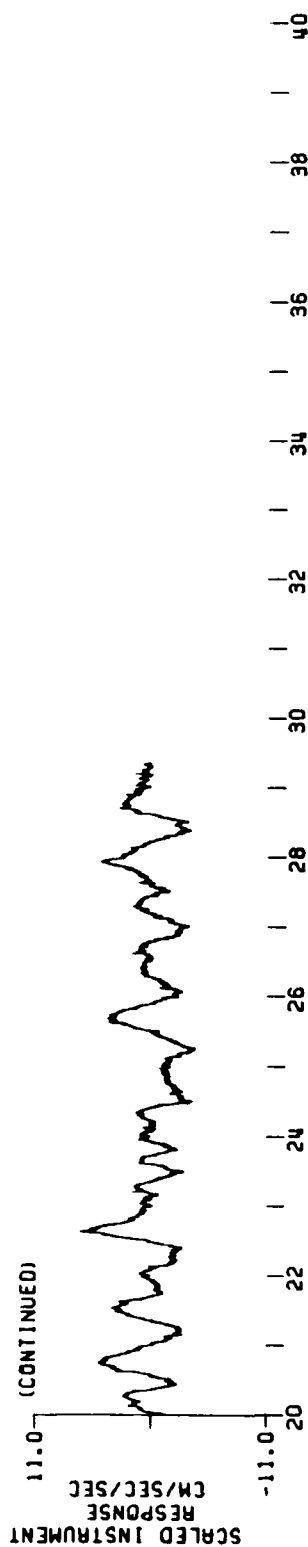
UNCORRECTED ACCELEROGRAM
 RIRIE DAM, DOWNSTREAM
 237 DEGREES, UP, 147 DEGREES
 EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 PEAK VALUES (CM/SEC/SEC): 13.07 8.76 11.83



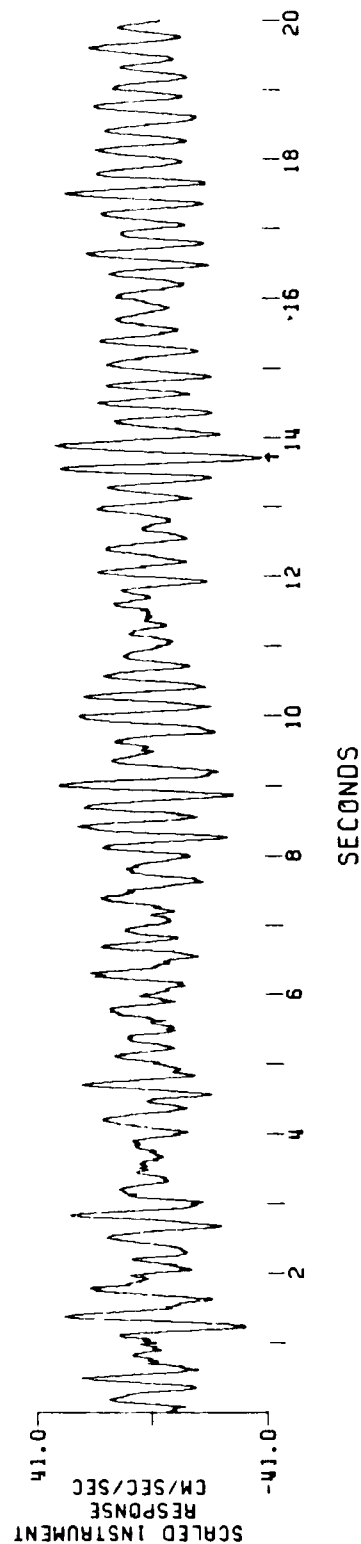
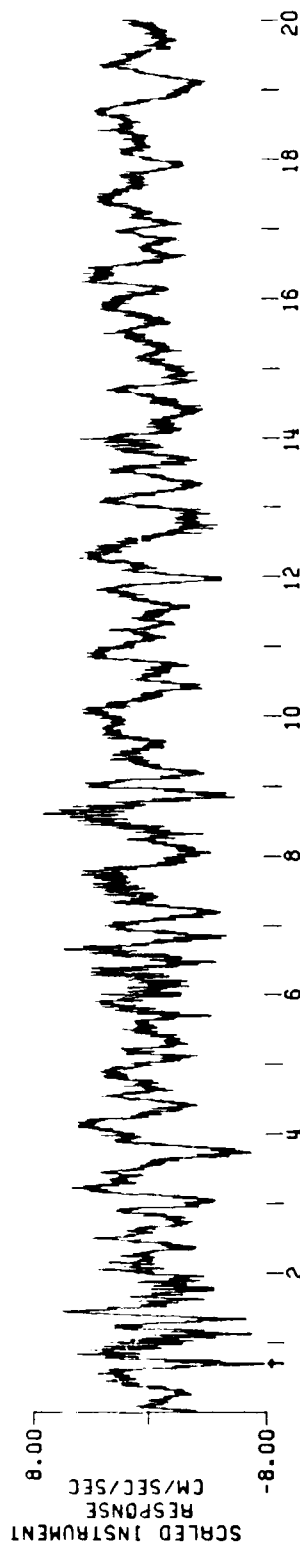
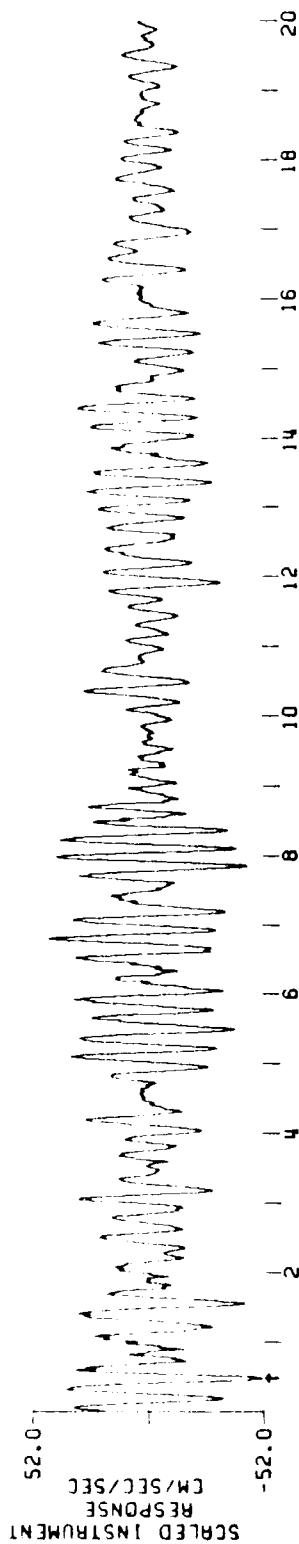
UNCORRECTED ACCELEROGRAM
 RIRIE DAM, LOWER TOWER
 25 DEGREES UP 295 DEGREES
 EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 PEAK VALUES (CM/SEC/SEC): -10.66 -6.82 10.83



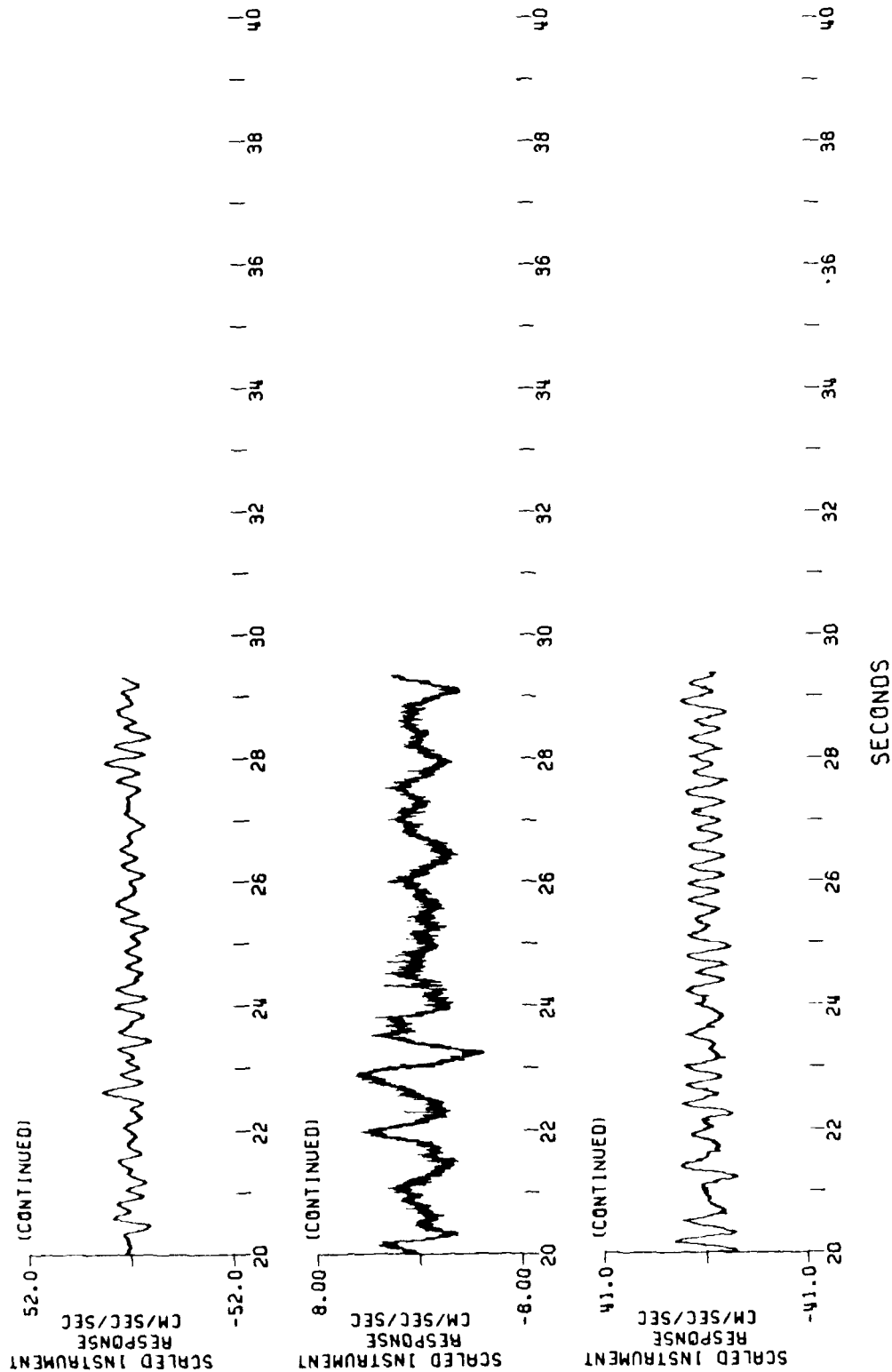
UNCORRECTED ACCELEROGRAM
 RIALE DAM, LOWER TOWER
 25 DEGREES UP 295 DEGREES
 EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 PEAK VALUES (CM/SEC/SEC): -10.66 -6.82 10.83



UNCORRECTED ACCELEROGRAM
 RIATIE DAM, UPPER TOWER
 25 DEGREES UP, 295 DEGREES
 EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 PEAK VALUES (CM/SEC/SEC): -51.53 -7.98 -40.54



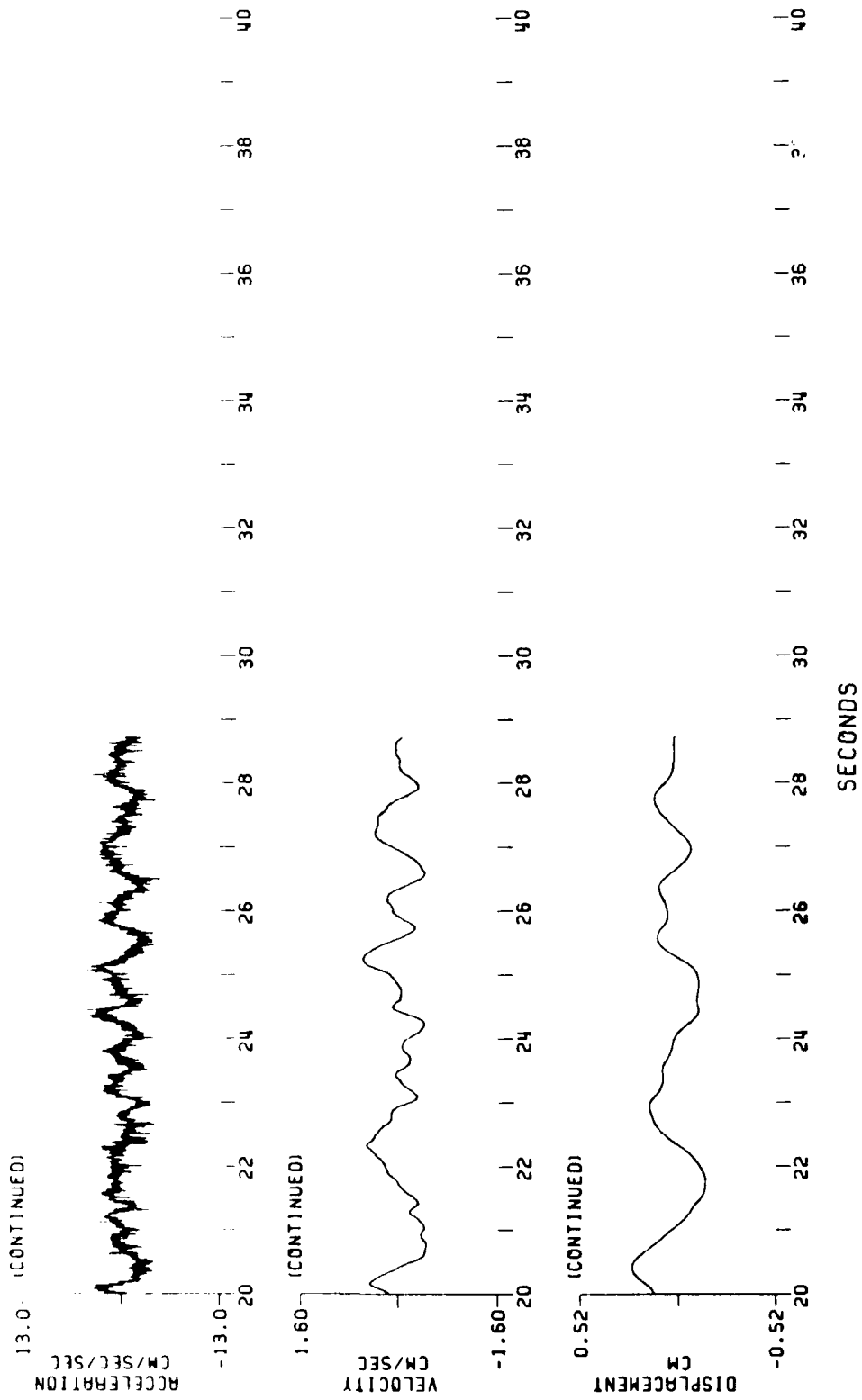
UNCORRECTED ACCELEROGRAM
 RAJAH DAM, UPPER TOWER
 25 DEGREES UP 295 DEGREES
 EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 PEAK VALUES (CM/SEC/SEC): -51.53 -7.98 -40.54



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 AIRIE DAM, DOWNSTREAM
 147 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

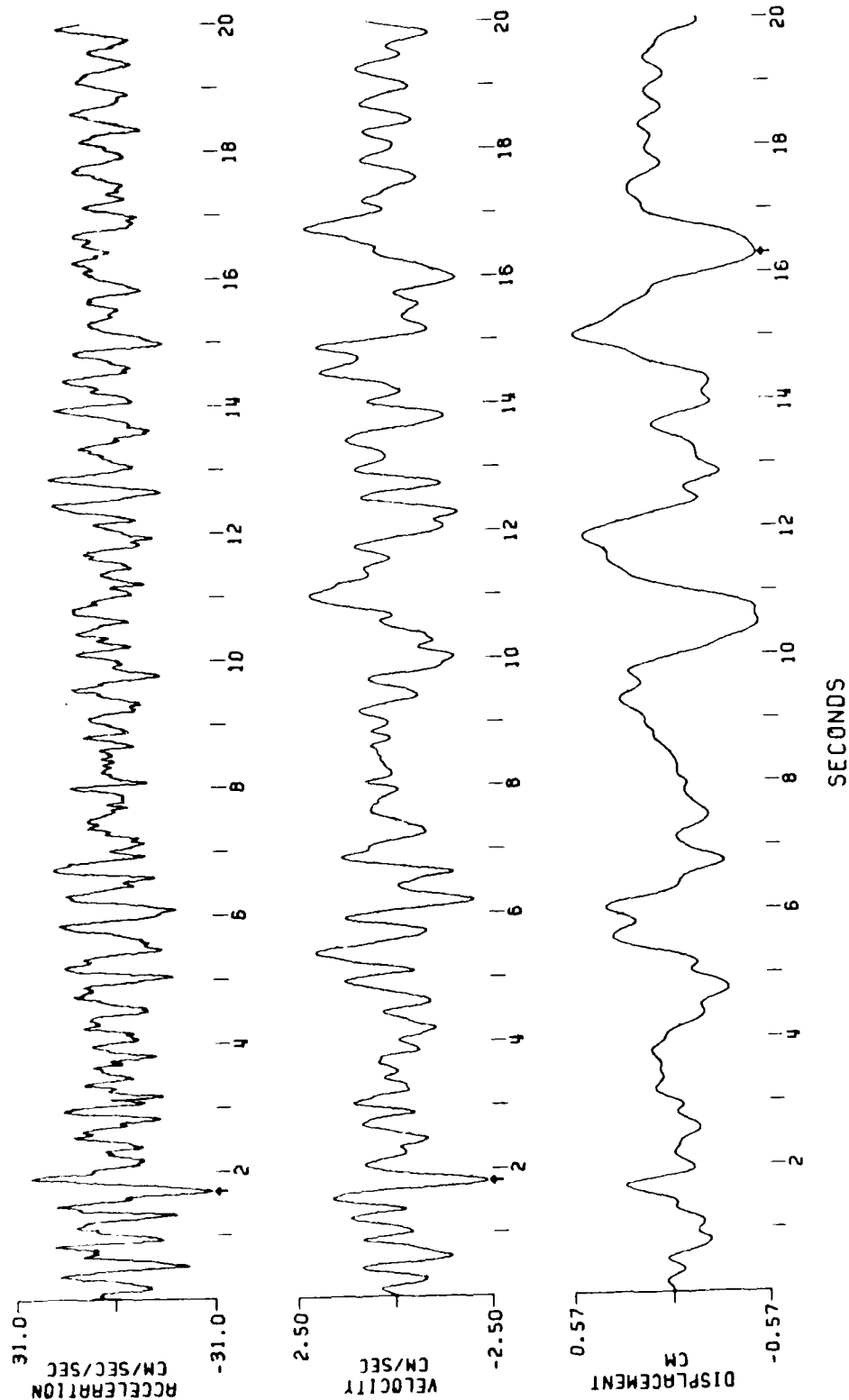
PEAK VALUES: ACCEL=12.59 CM/SEC/SEC, VELOCITY=-1.59 CM/SEC, DISPL=0.51 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIRIE DAM, CREST
 25 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

PEAK VALUES: ACCEL=-30.09 CM/SEC/SEC, VELOCITY=-2.41 CM/SEC, DISPL=-0.56 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS

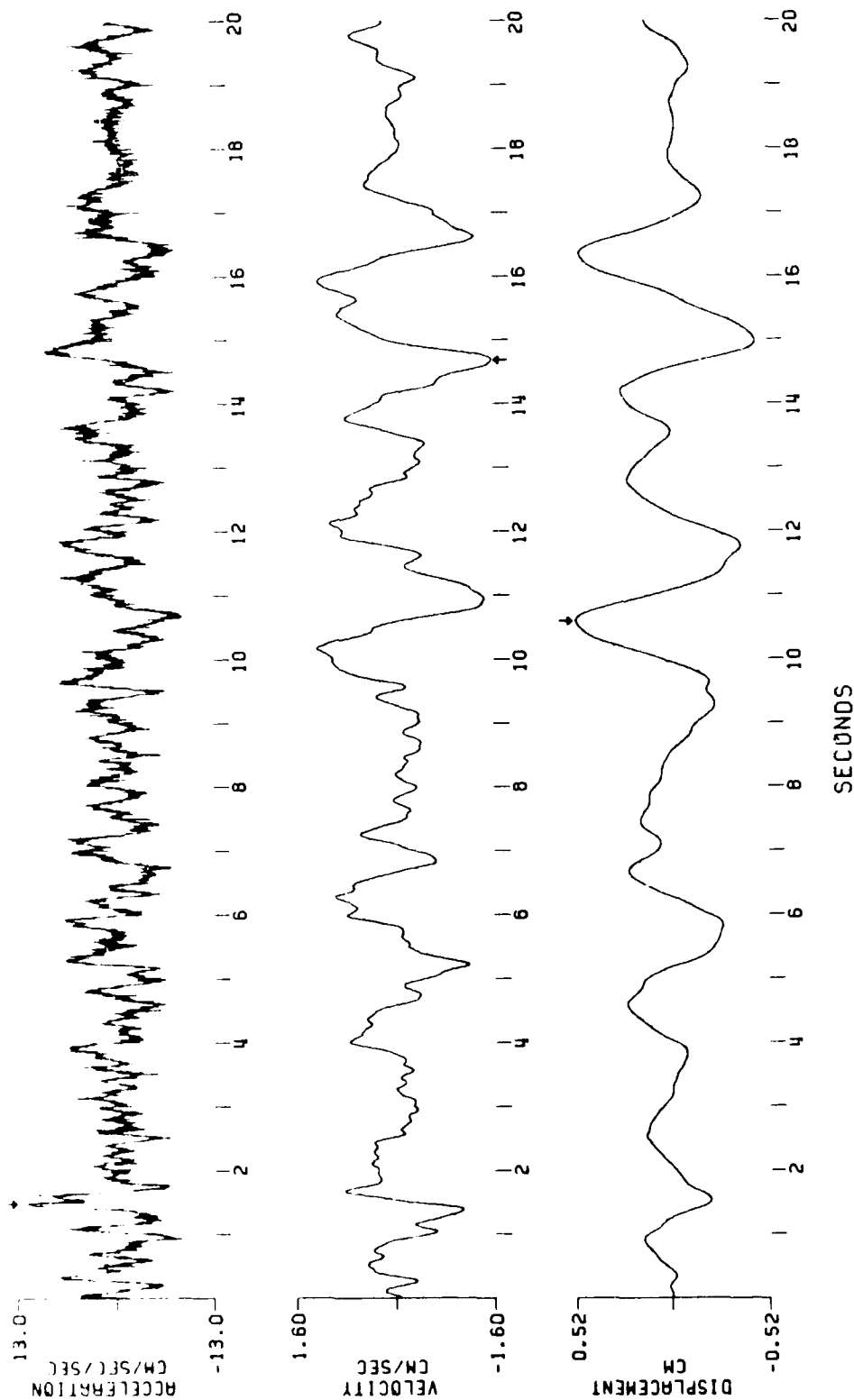
PIRIE CAM, DOWNSTREAM

147 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC

BUTTERWORTH AT .25 HZ, ORDER 2

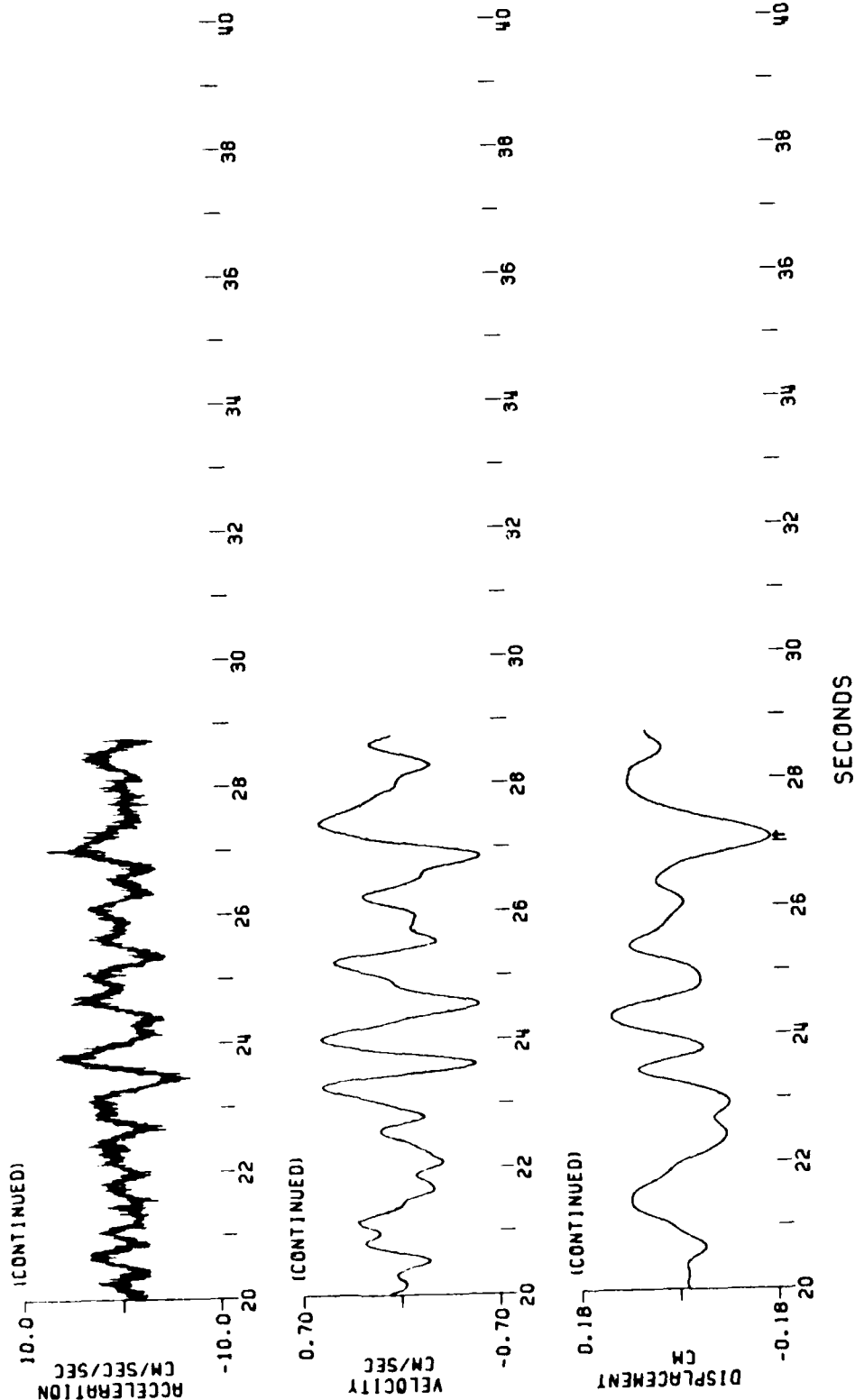
PEAK VALUES: ACCEL=12.59 CM/SEC/SEC, VELOCITY=-1.59 CM/SEC, DISPL=0.51 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
AIRIE DAM, DOWNSTREAM
UP

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
BUTTERWORTH AT 25 HZ ORDER 2

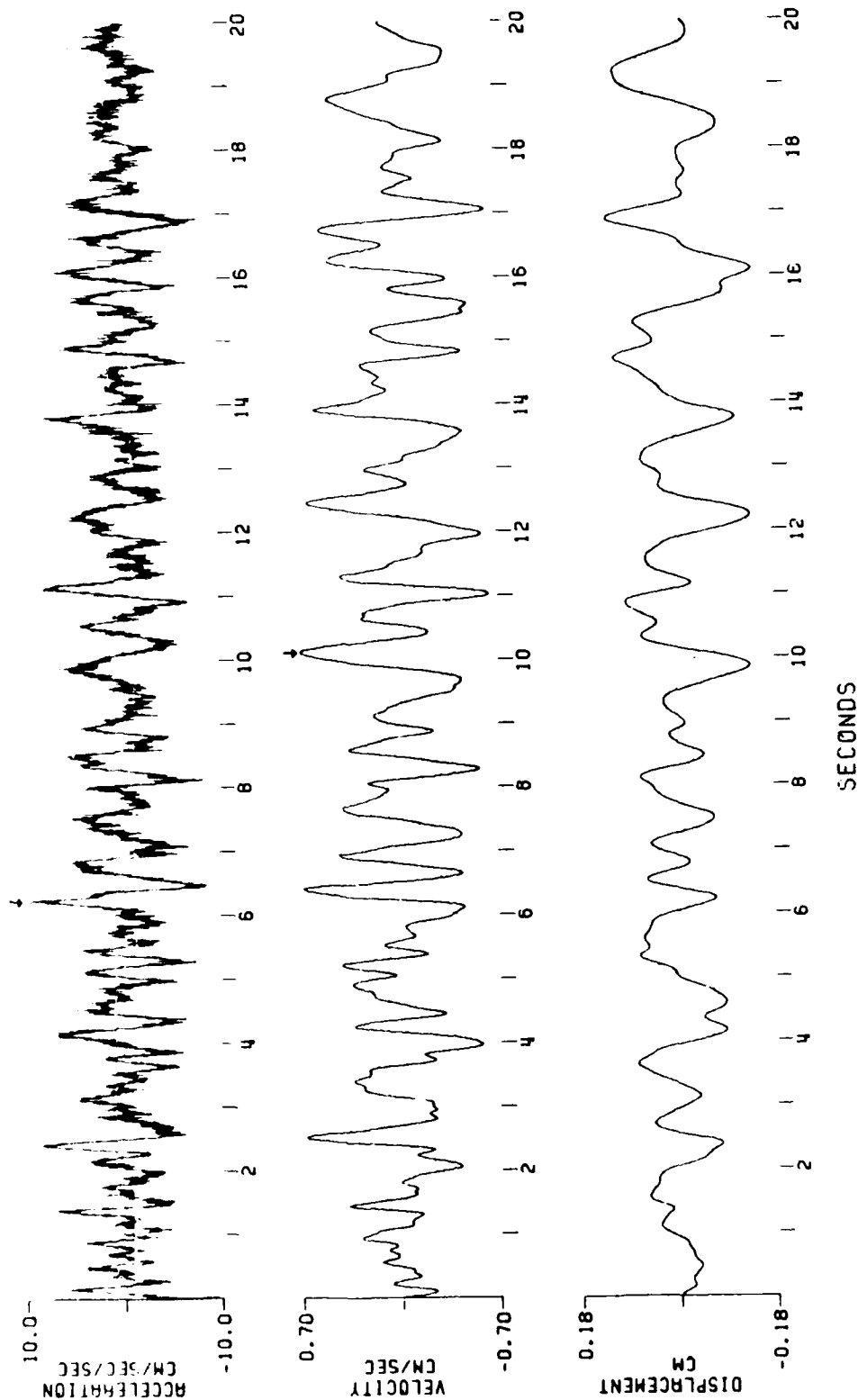
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CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIRIE DAM, DOWNSTREAM

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ ORDER 2

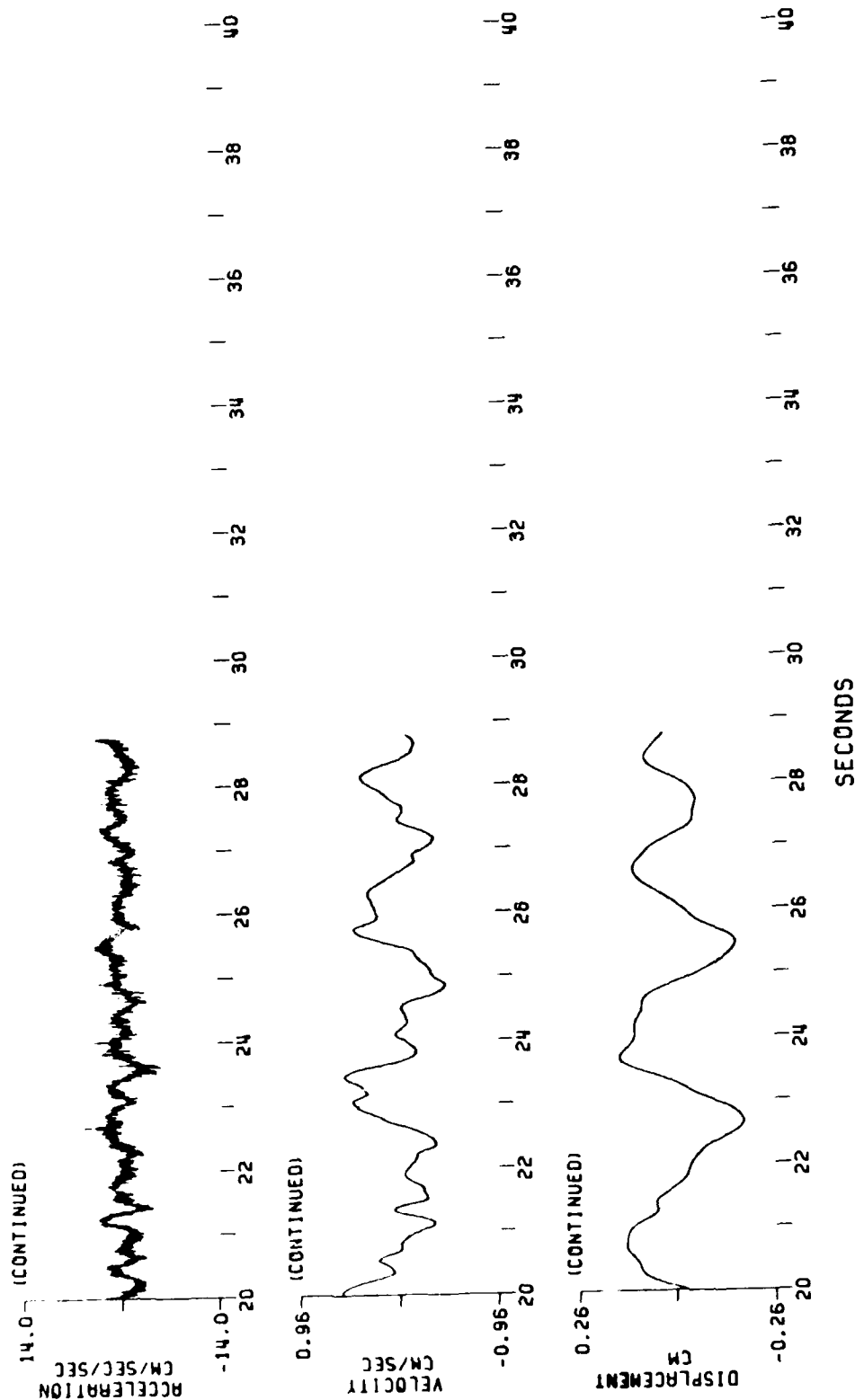
PEAK VALUES: ACCEL=9.93 CM/SEC/SEC, VELOCITY=0.70 CM/SEC. DISPL=-0.18 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIRIE DAM, DOWNSTREAM
 237 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

PEAK VALUES: ACCEL=-13.67 CM/SEC/SEC, VELOCITY=-0.95 CM/SEC, DISPL=-0.26 CM



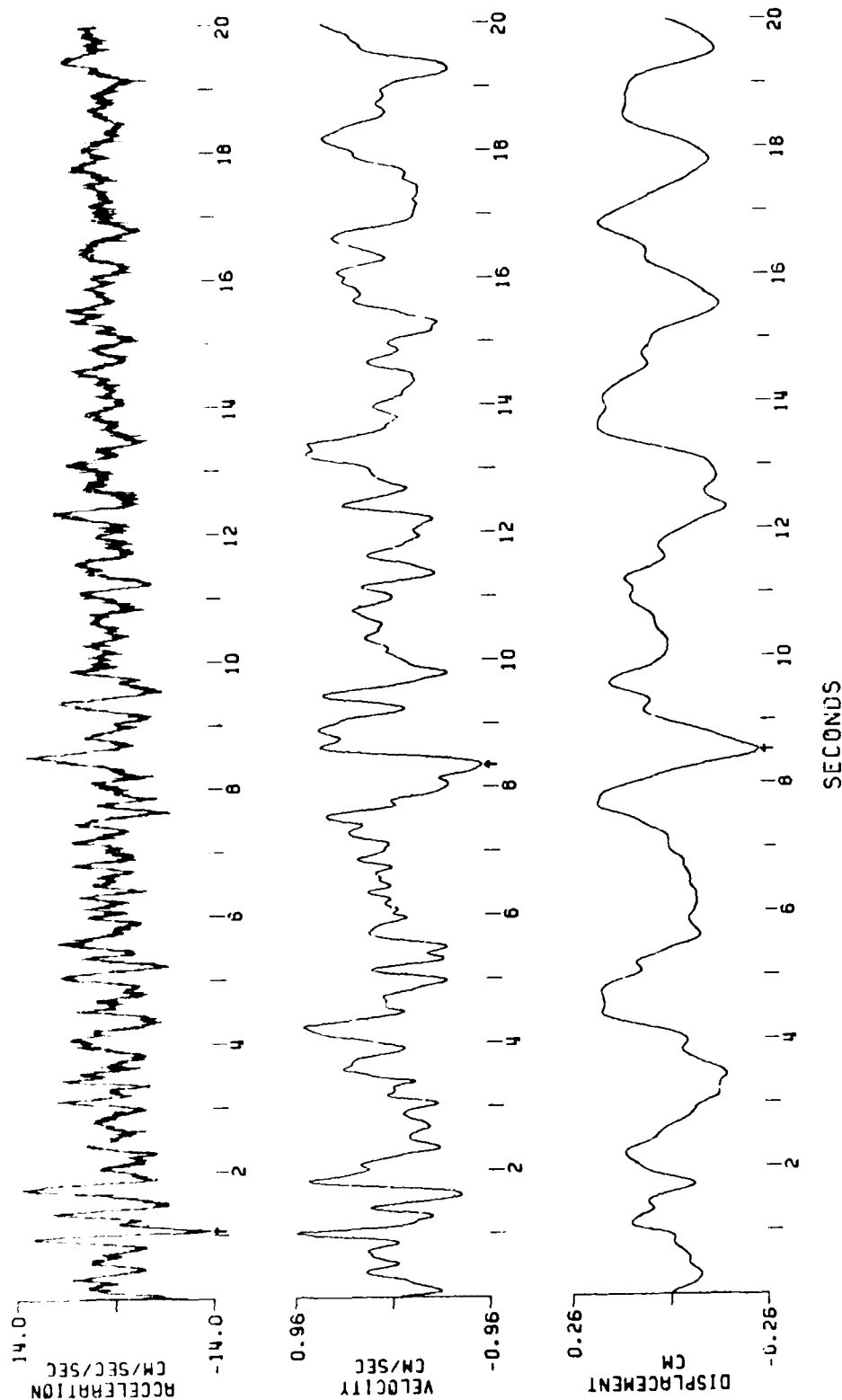
CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIRIE DAM, DOWNSTREAM

237 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC

BUTTERWORTH AT 25 HZ, ORDER 2

PEAK VALUES: ACCEL=-13.67 CM/SEC/SEC, VELOCITY=-0.95 CM/SEC, DISPL=-0.26 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS

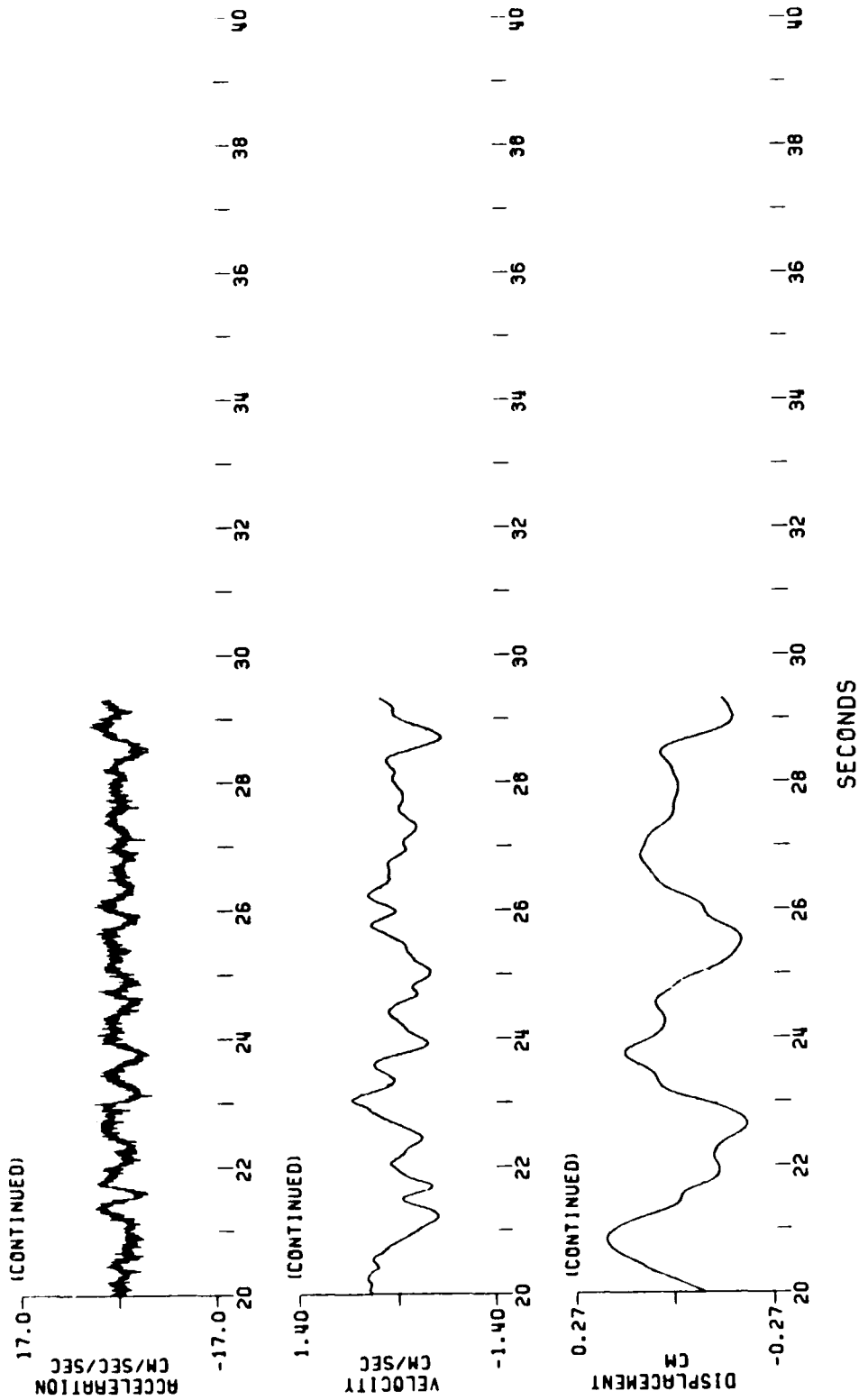
RIRIE DAM, ABUTMENT

295 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC

BUTTERWORTH AT .25 HZ ORDER 2

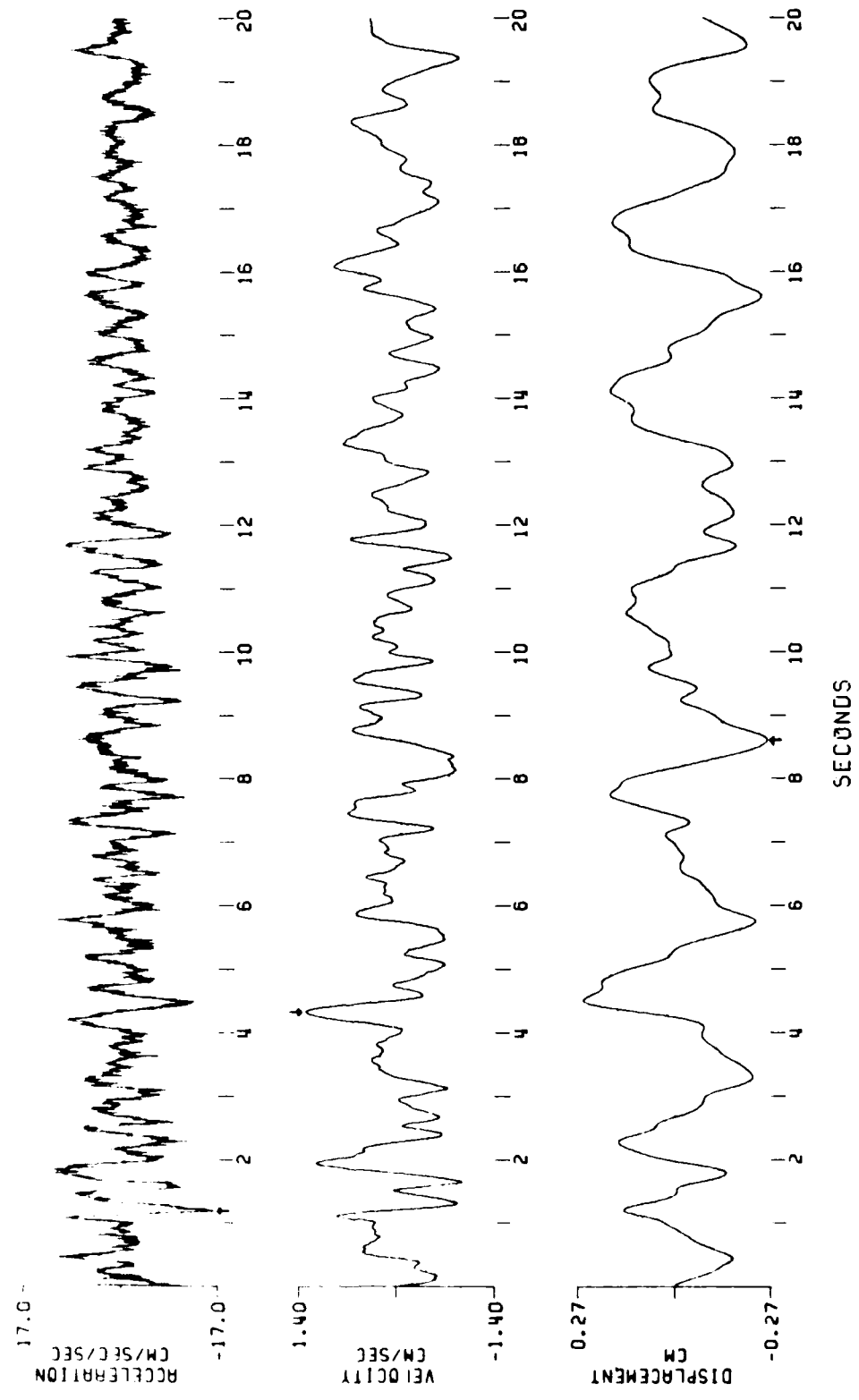
PEAK VALUES: ACCEL=-16.34 CM/SEC/SEC, VELOCITY=1.30 CM/SEC, DISPL=-0.26 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
RIJE DAM ABUTMENT
295 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
BUTTERWORTH AT .25 HZ ORDER 2

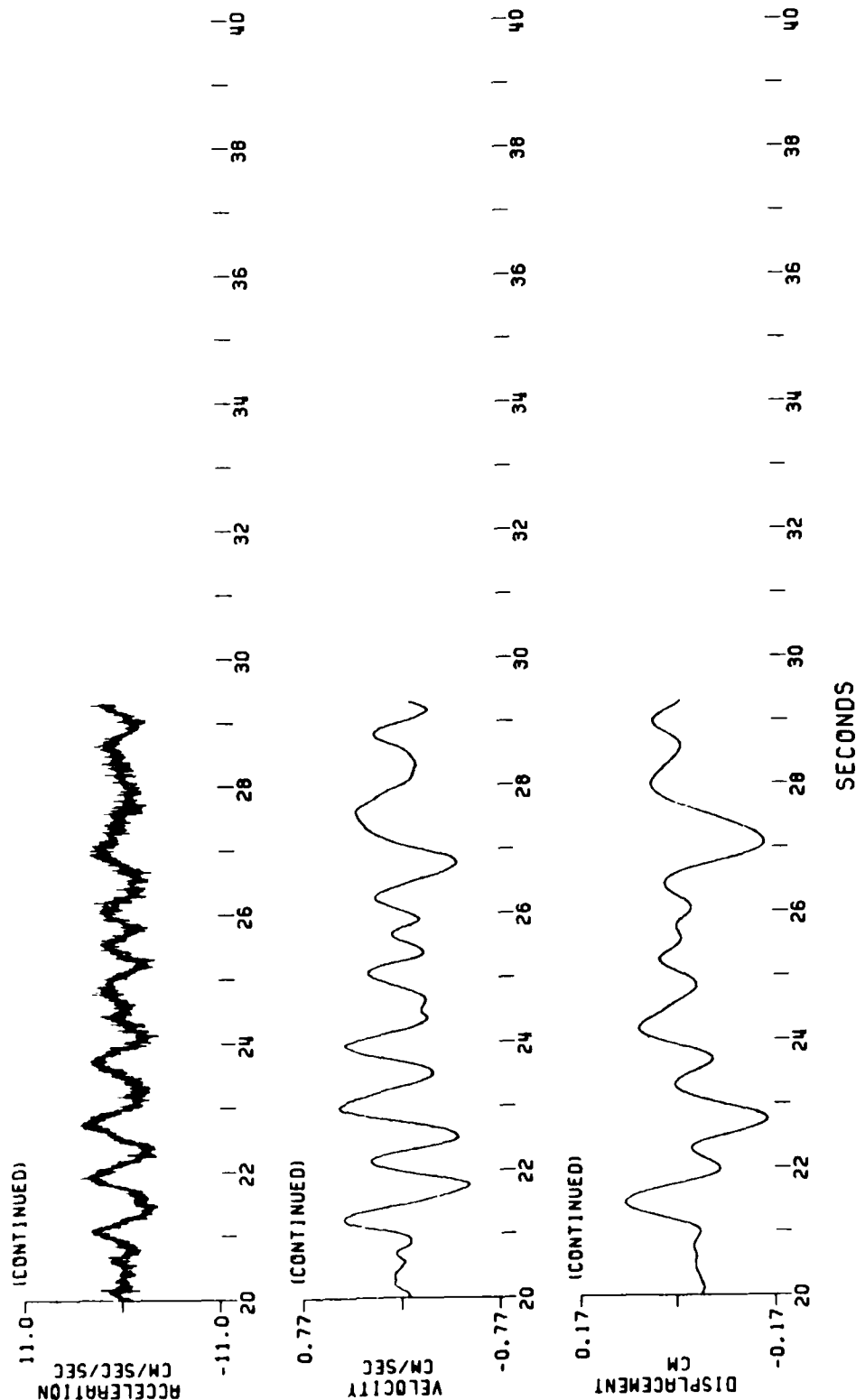
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CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
RIRIE DAM, ABUTMENT^{UP}

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
BUTTERWORTH AT .25 HZ ORDER 2

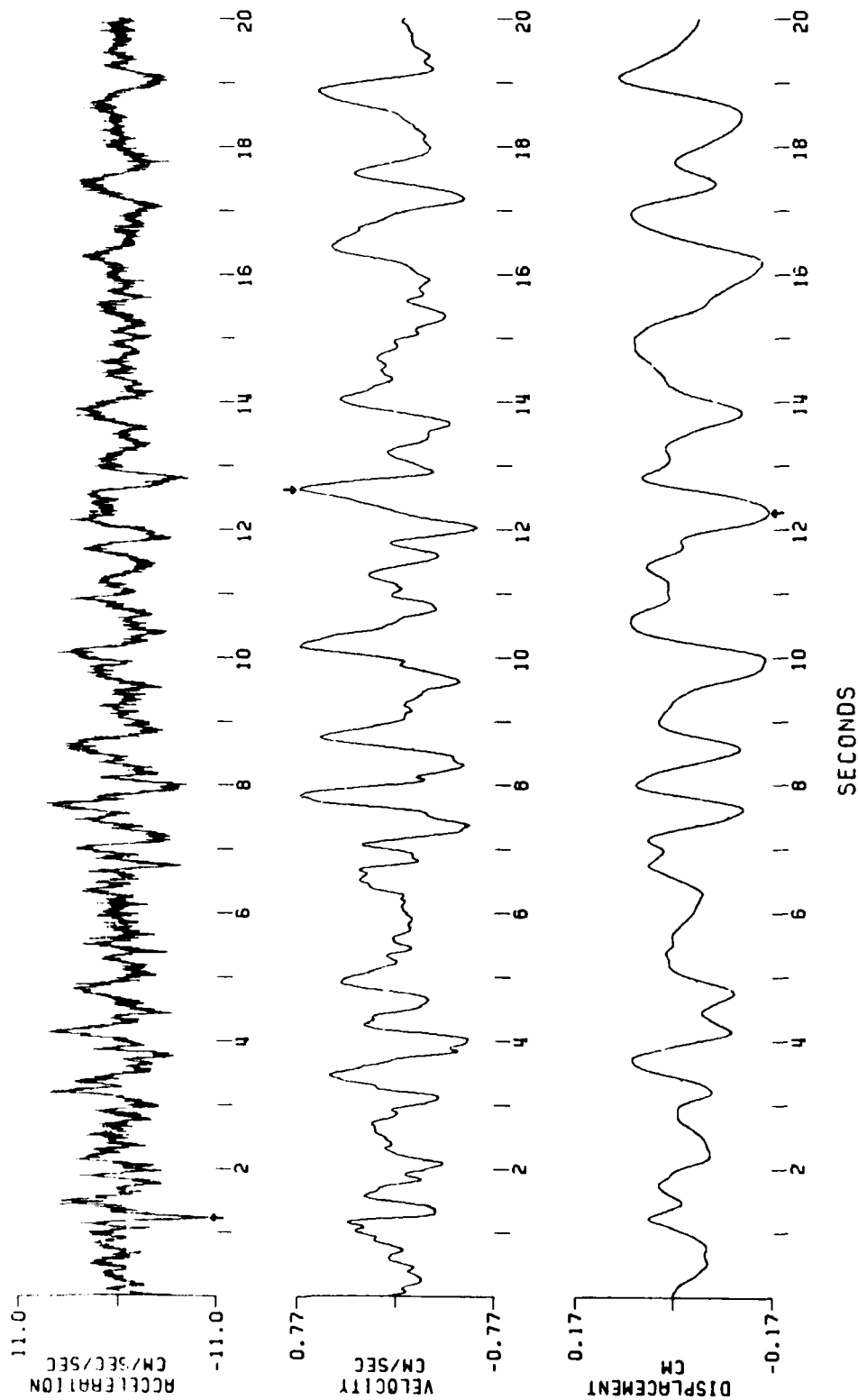
PEAK VALUES: ACCEL=-10.06 CM/SEC/SEC, VELOCITY=0.76 CM/SEC, DISPL=-0.16 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SFS
 AIRIE DAM, ABUTMENT^{UP}

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ ORDER 2

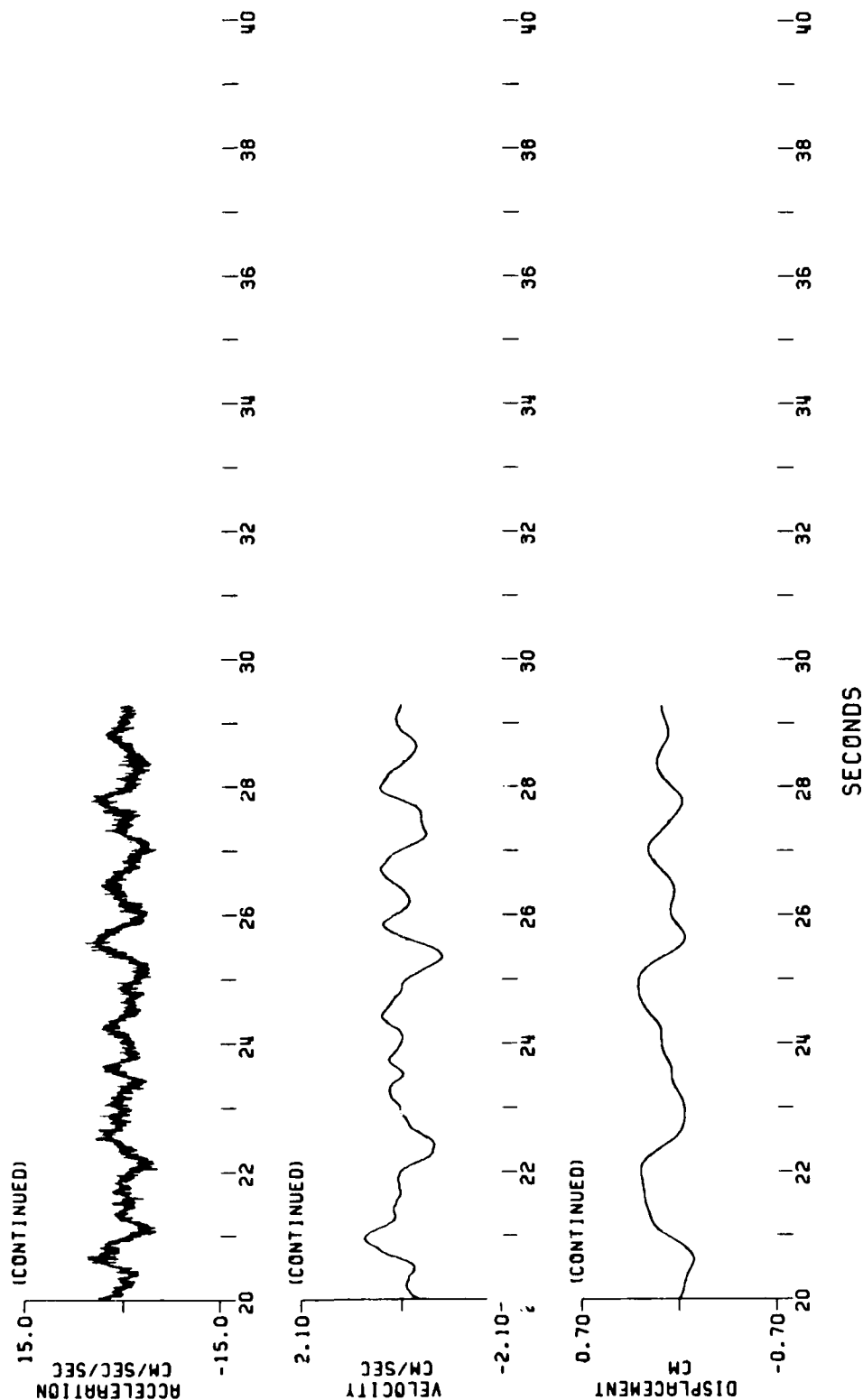
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CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIRIE DAM, ABUTMENT
 25 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

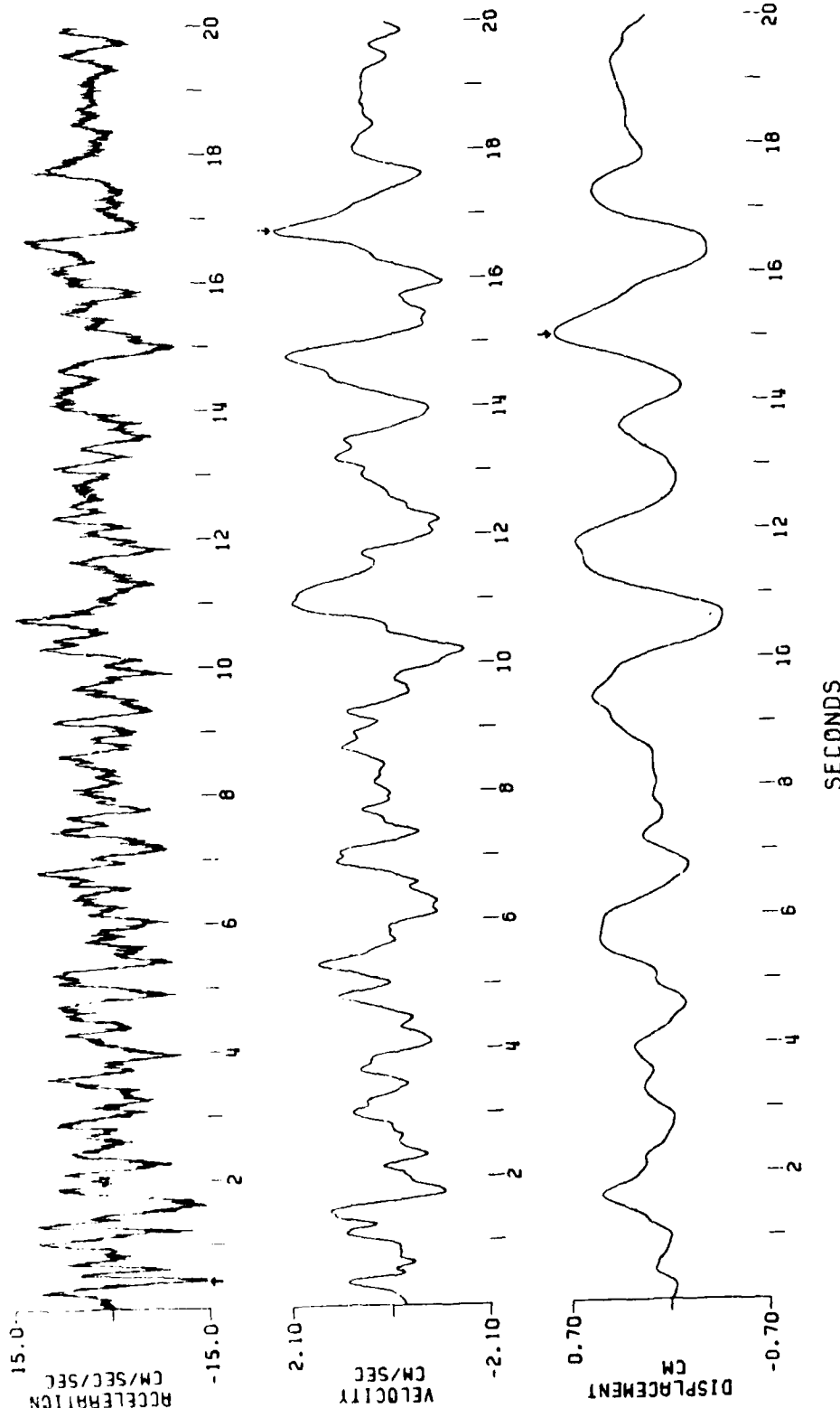
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CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIRIE DAM, ABUTMENT
 25 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT 25 HZ, ORDER 2

PEAK VALUES: ACCEL=-14.66 CM/SEC/SEC, VELOCITY=2.07 CM/SEC, DISPL=0.69 CM

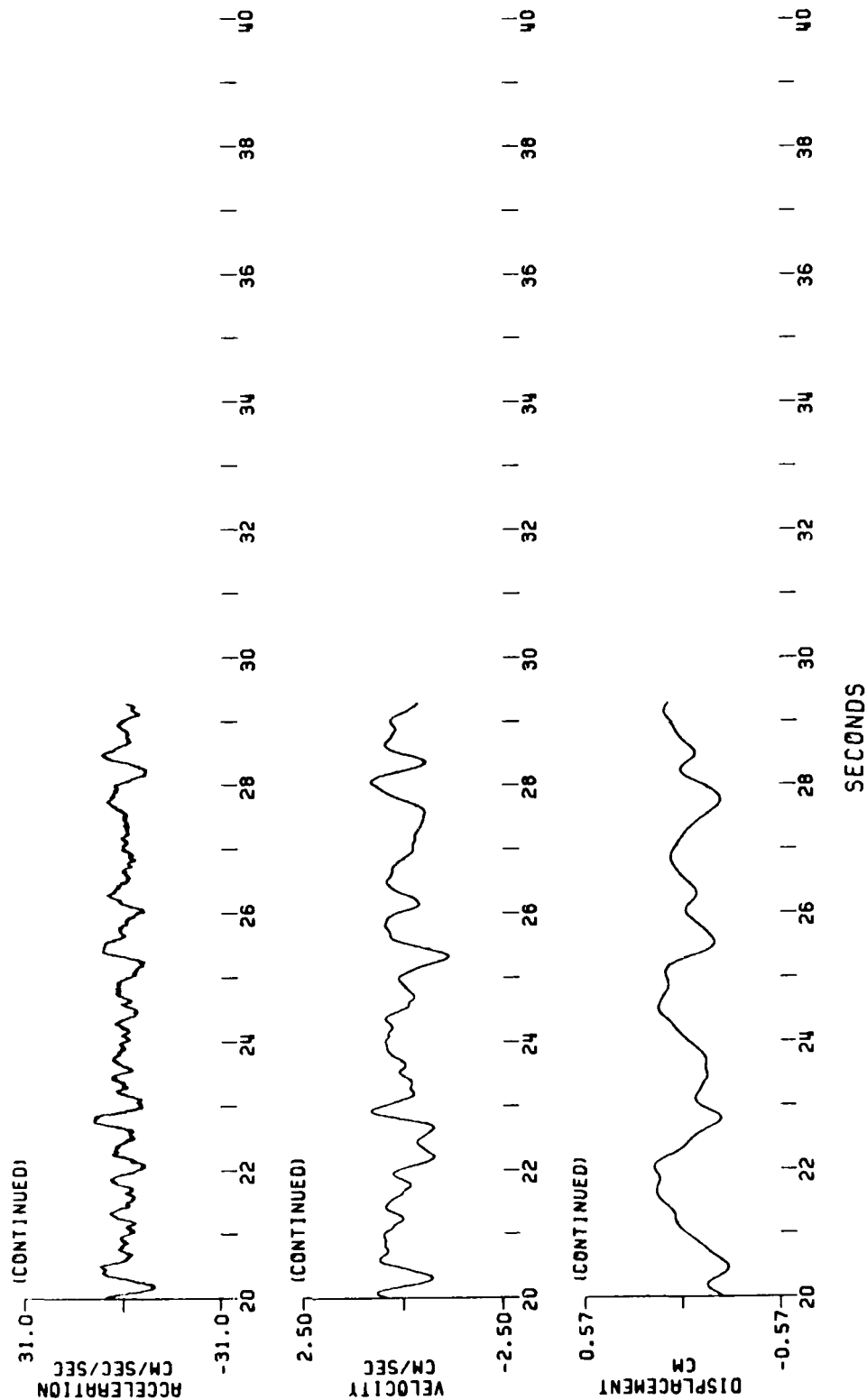


APPENDIX B
CORRECTED ACCELEROGRAMS

CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 AIRIE DAM, CREST
 25 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

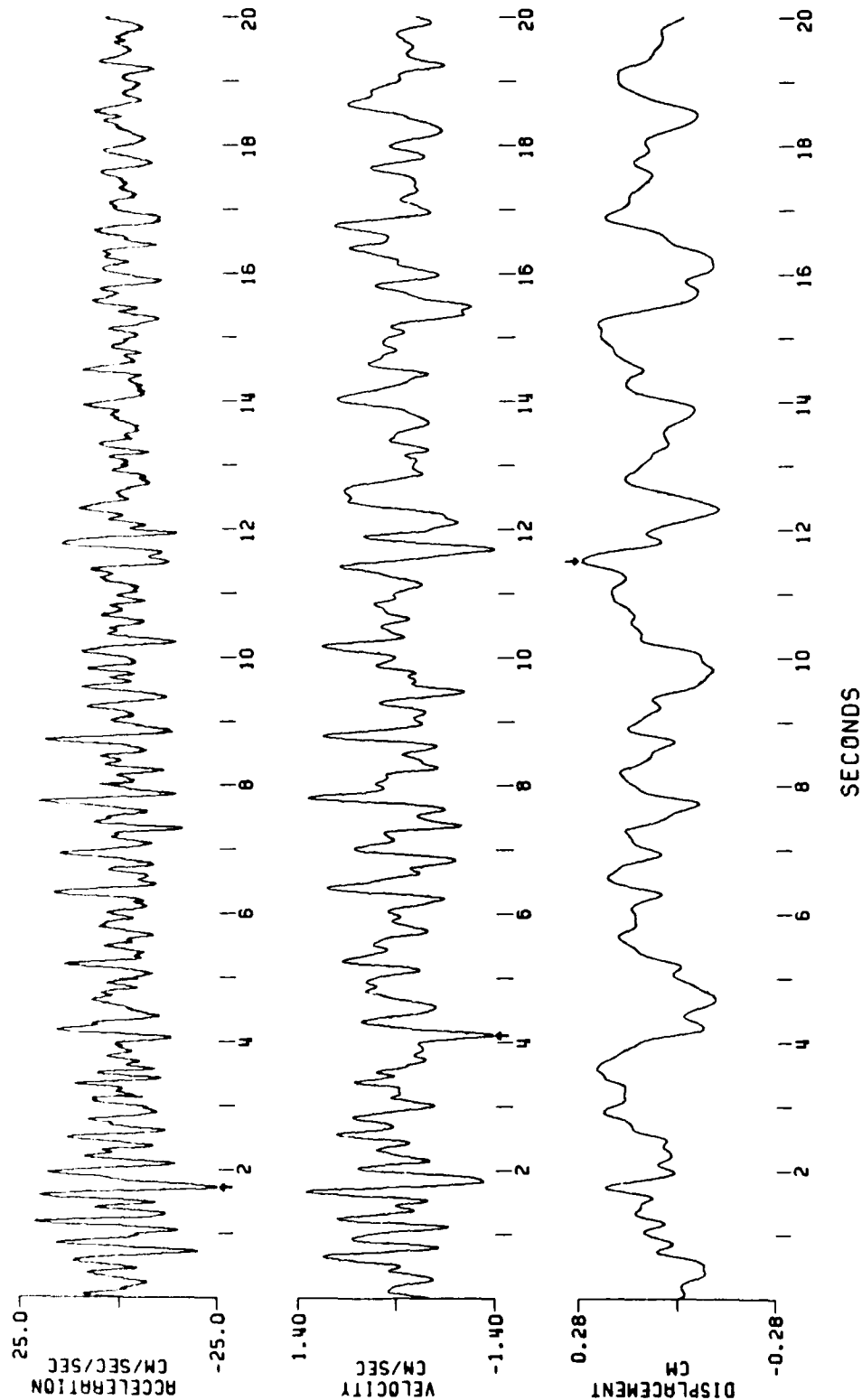
PEAK VALUES: ACCEL=-30.09 CM/SEC/SEC, VELOCITY=-2.41 CM/SEC, DISPL=-0.56 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 AIRIE DAM, CREST

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH ST. 25 HZ ORDER 2

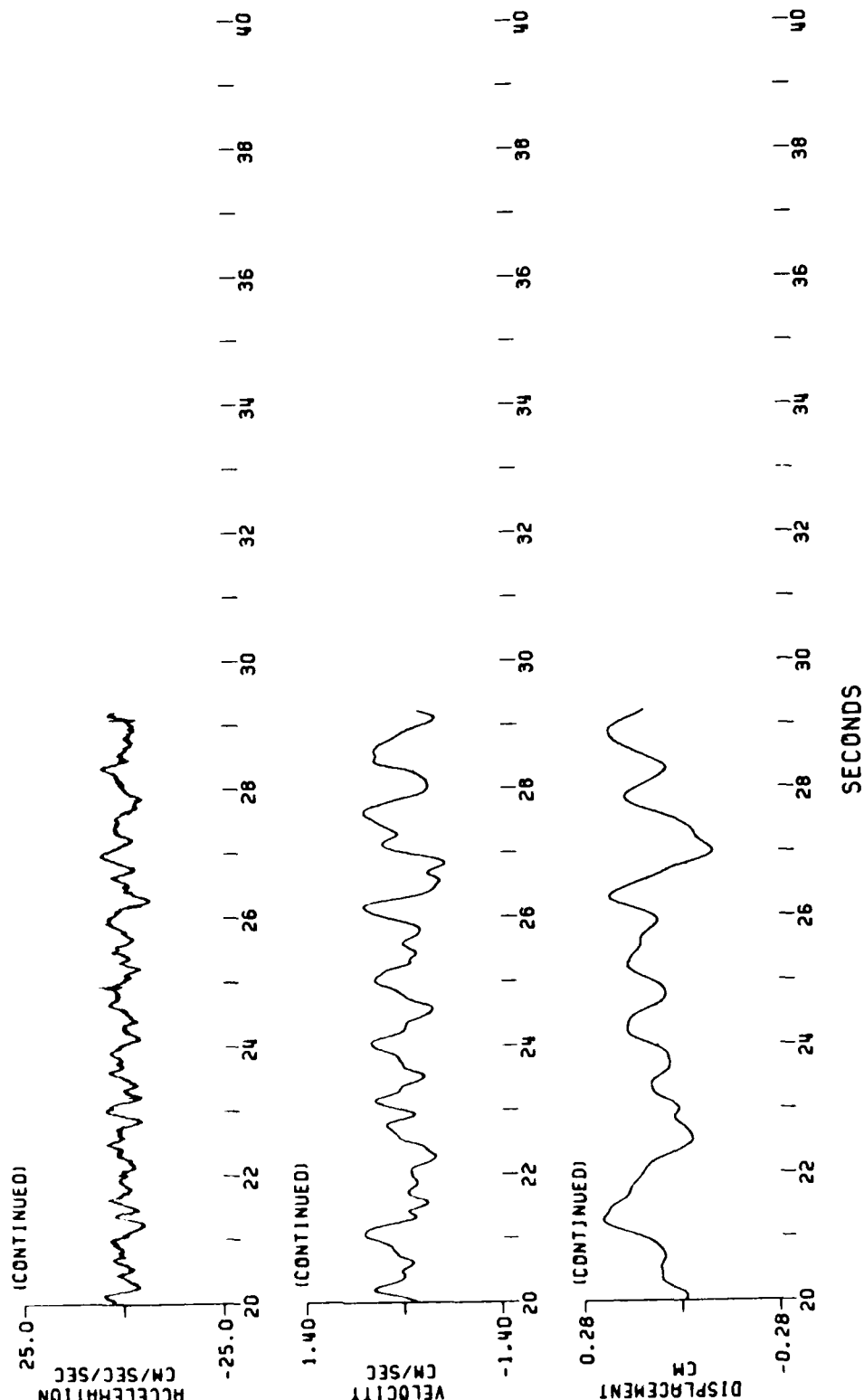
PEAK VALUES: ACCEL=-24.90 CM/SEC/SEC, VELOCITY=-1.35 CM/SEC, DISPL=0.28 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIRIE DAM, CREST
 UP

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT 25 HZ ORDER 2

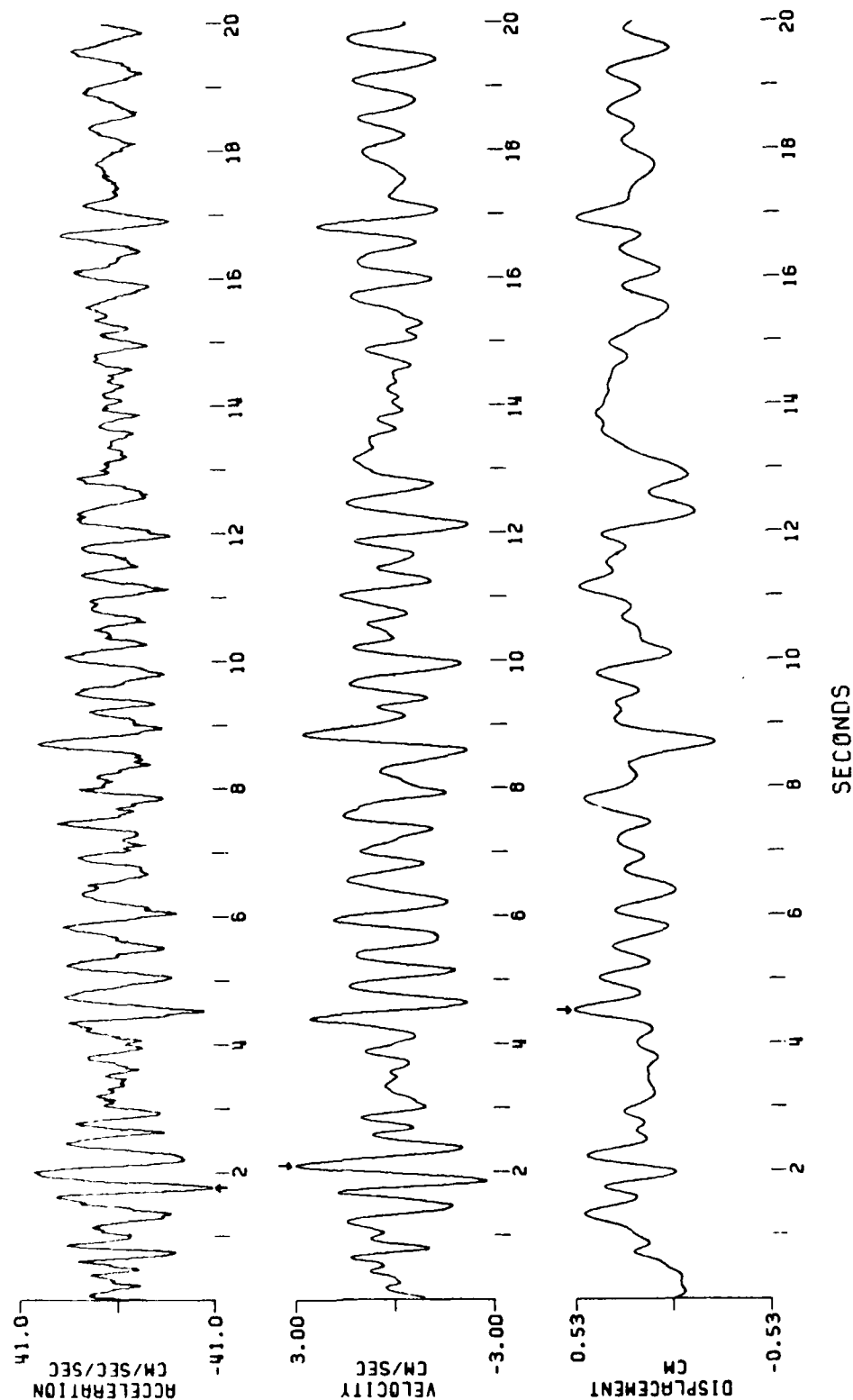
PEAK VALUES: ACCEL=-24.90 CM/SEC/SEC, VELOCITY=-1.35 CM/SEC, DISPL=0.28 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIRIE DAM, CREST

295 DEGREES
 EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

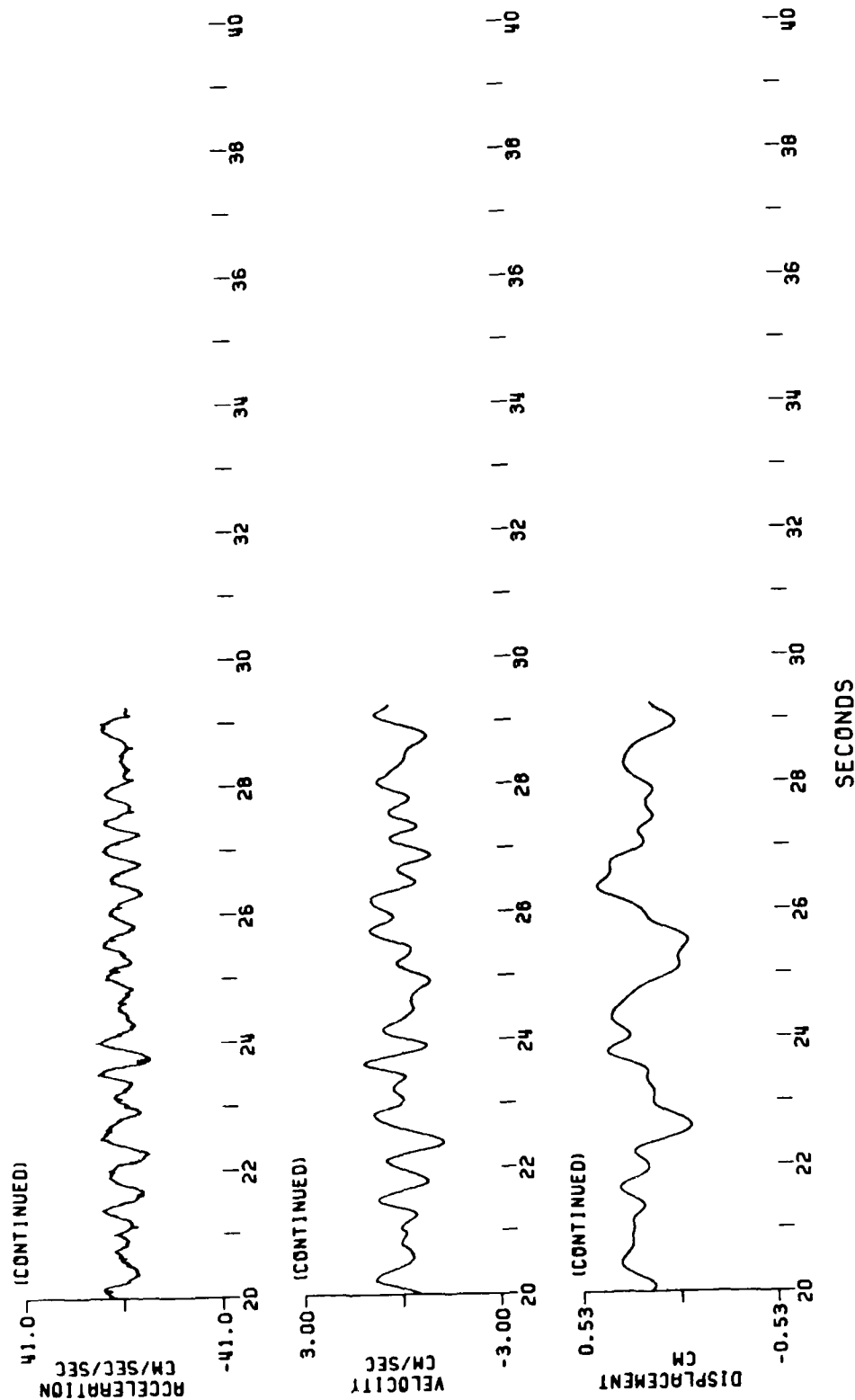
PEAK VALUES: ACCEL=-40.52 CM/SEC/SEC, VELOCITY=2.99 CM/SEC, DISPL=0.53 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIRIE DAM, CREST

295 DEGREES
 EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

PEAK VALUES: ACCEL=-40.52 CM/SEC/SEC, VELOCITY=2.99 CM/SEC, DISPL=0.53 CM



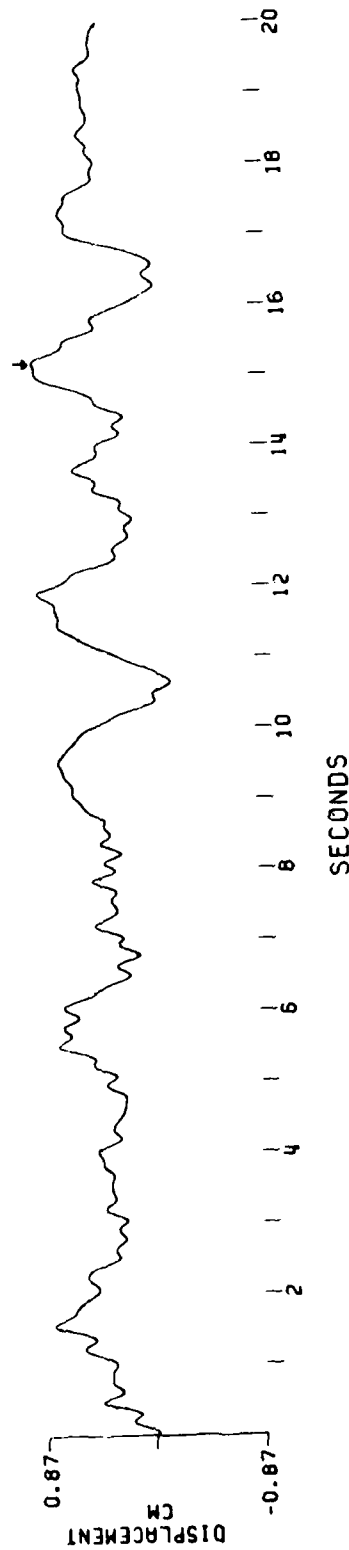
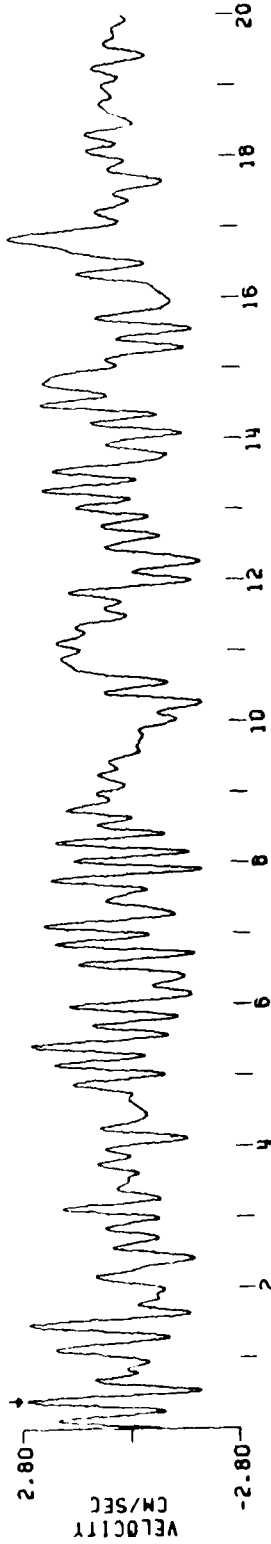
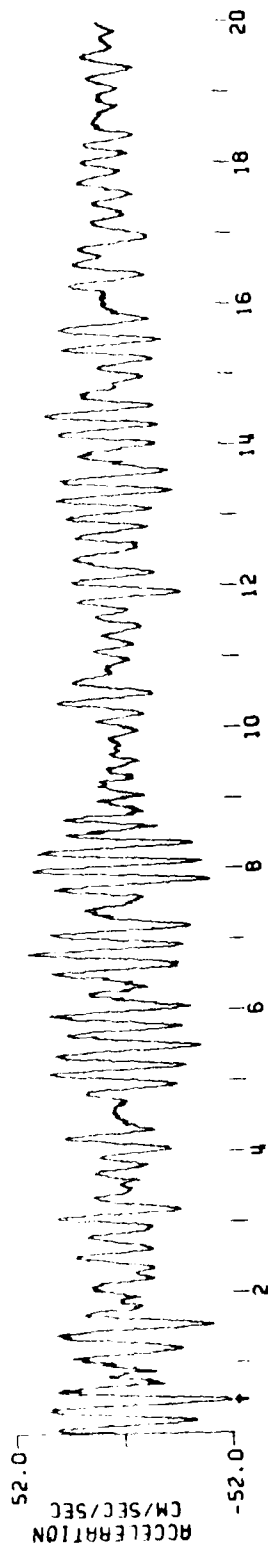
CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 AIRIE DAM UPPER TOWER

25 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC

BUTTERWORTH AT .25 HZ, ORDER 2

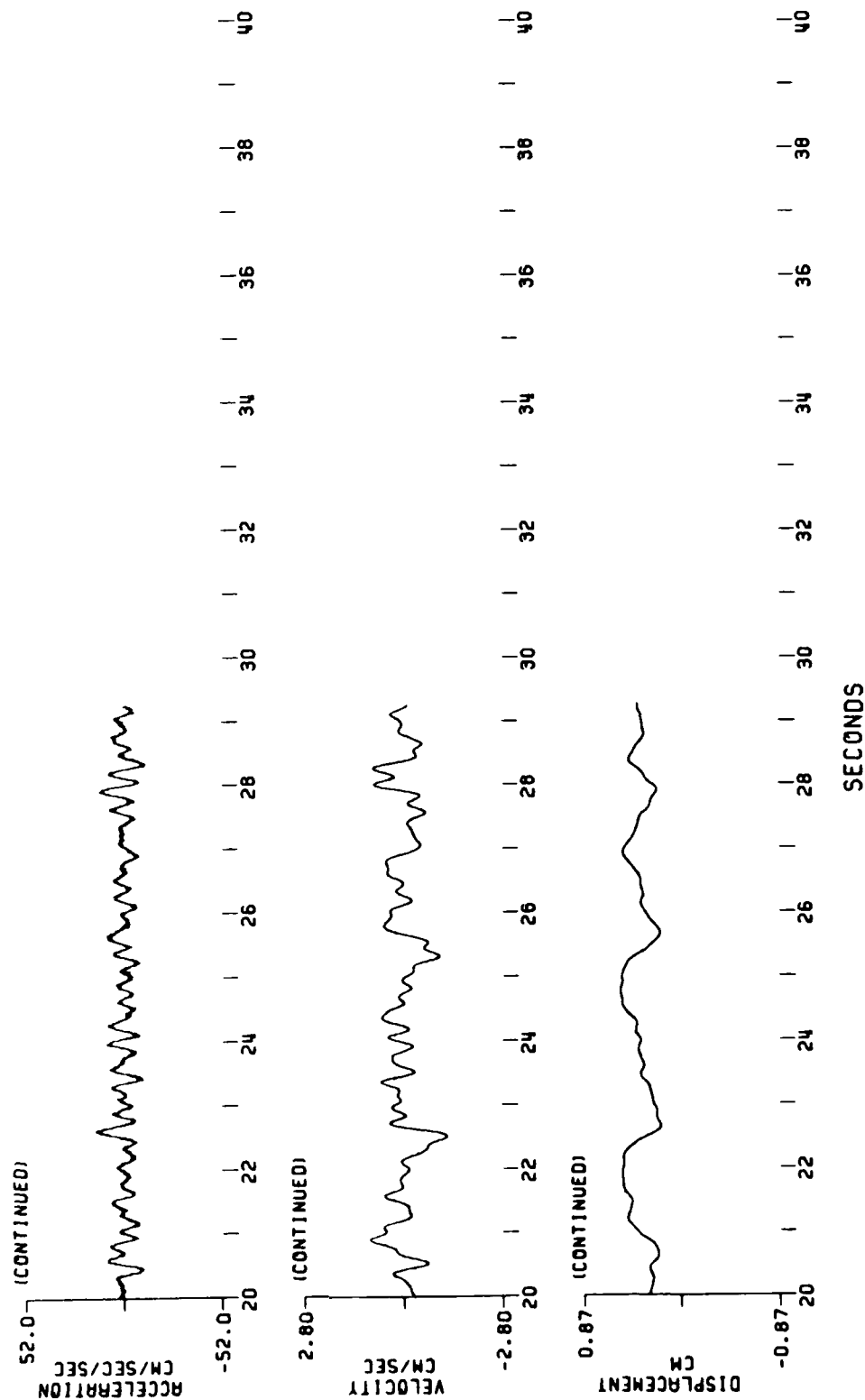
PEAK VALUES: ACCEL=-51.31 CM/SEC/SEC, VELOCITY=2.71 CM/SEC, DISPL=0.87 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIAE DAM, UPPER TOWER
 25 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT 25 HZ, ORDER 2

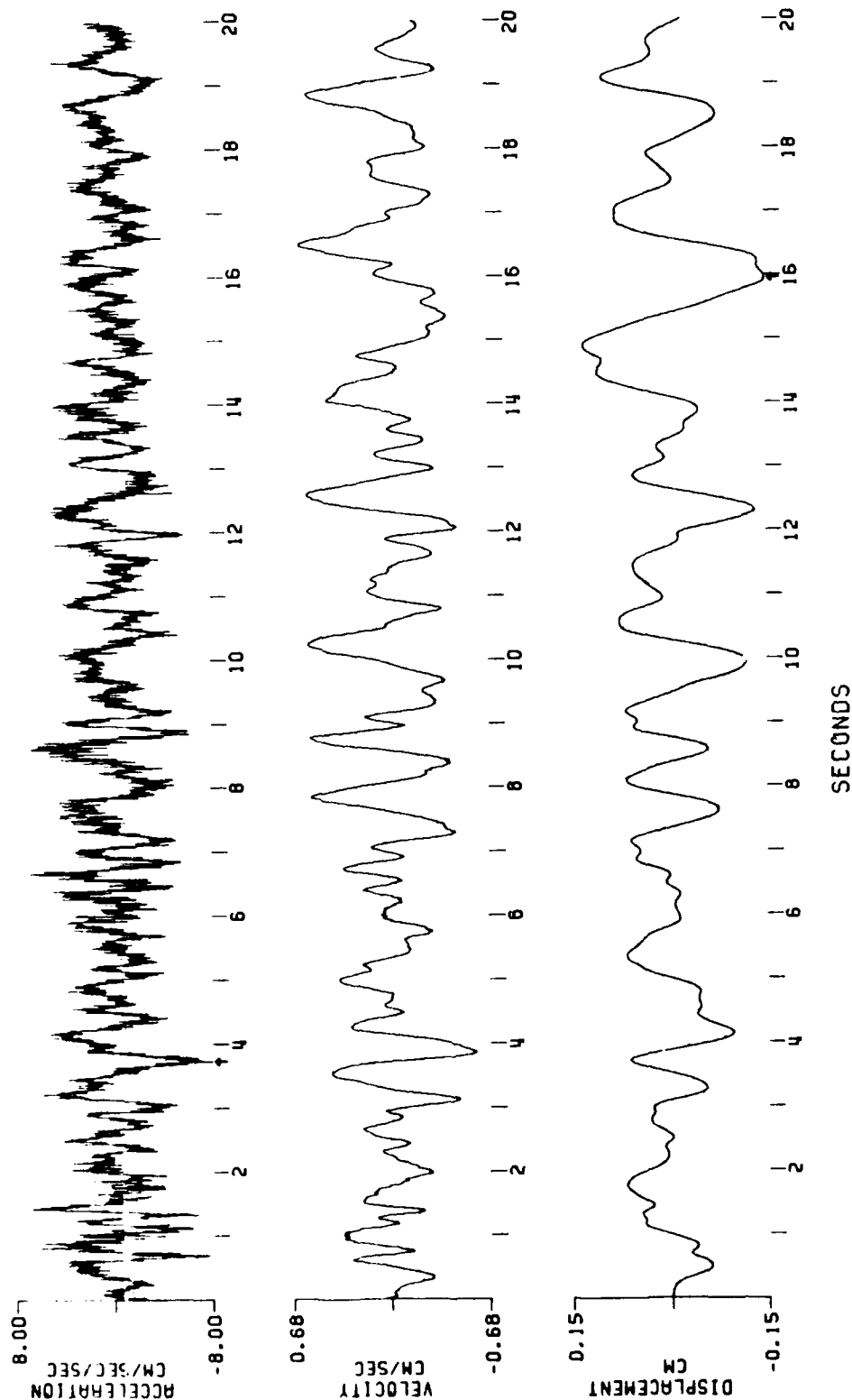
PEAK VALUES: ACCEL=-51.31 CM/SEC/SEC, VELOCITY=2.71 CM/SEC, DISPL=0.87 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIAE DAM, UPPER TOWER

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC

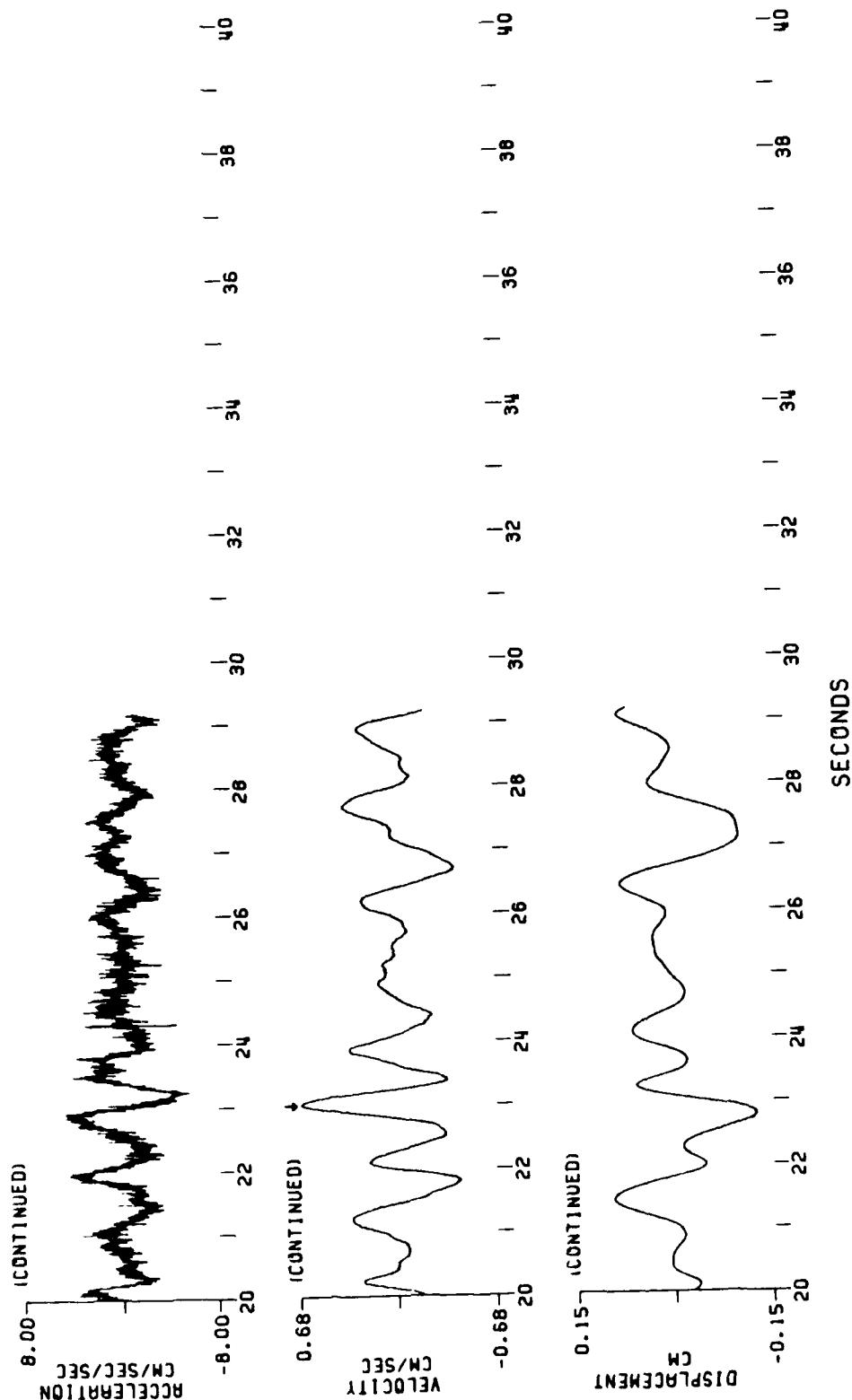
PEAK VALUES: ACCEL=-7.95 CM/SEC/SEC, VELOCITY=0.67 CM/SEC, DISPL=-0.15 CM
 BUTTERWORTH AT 25 HZ, ORDER 2



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIAE DAM, UPPER TOWER

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT 25 HZ, ORDER 2

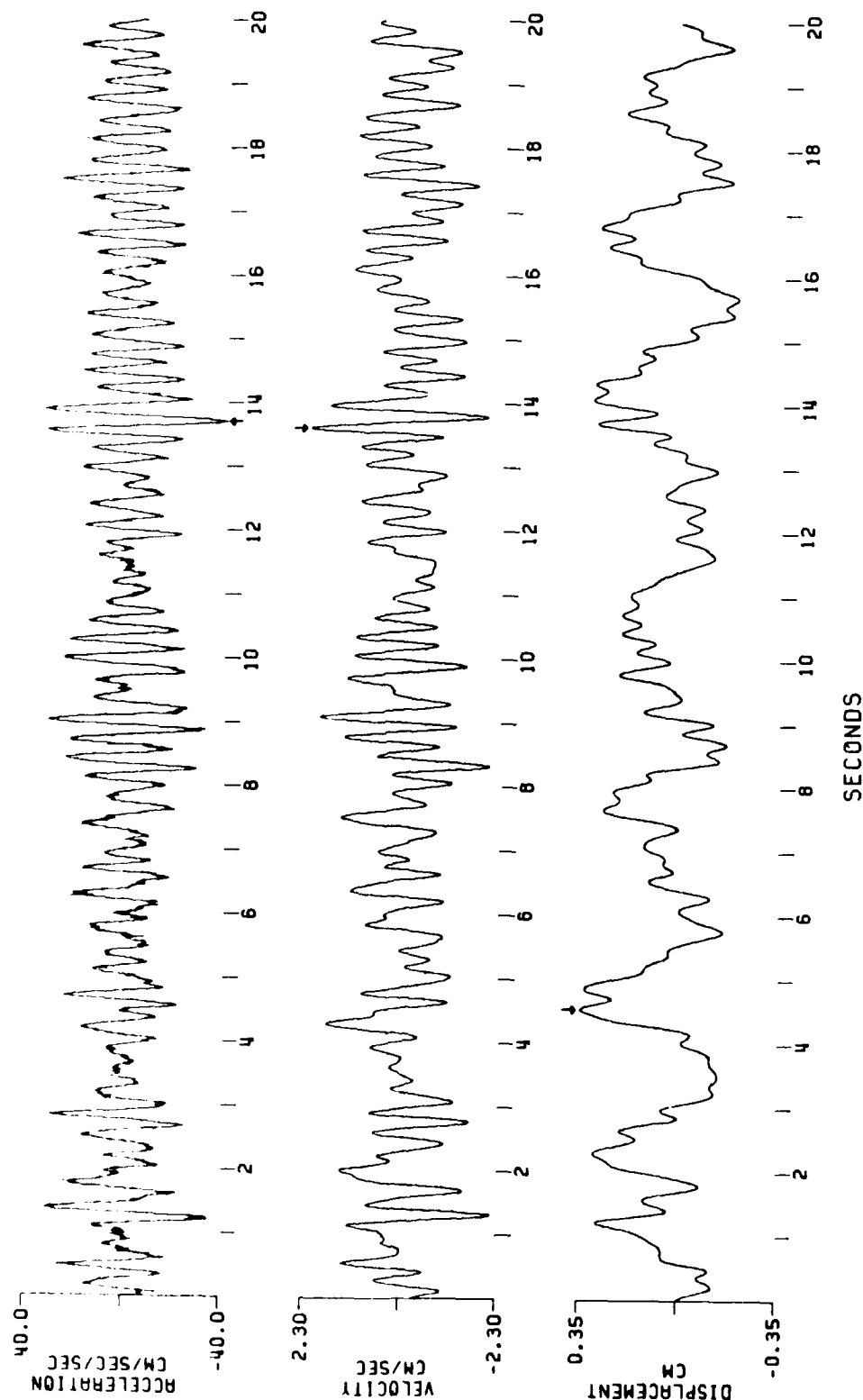
PEAK VALUES: ACCEL=-7.95 CM/SEC/SEC, VELOCITY=0.67 CM/SEC, DISPL=-0.15 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIRIE DAM, UPPER TOWER

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ ORDER 2

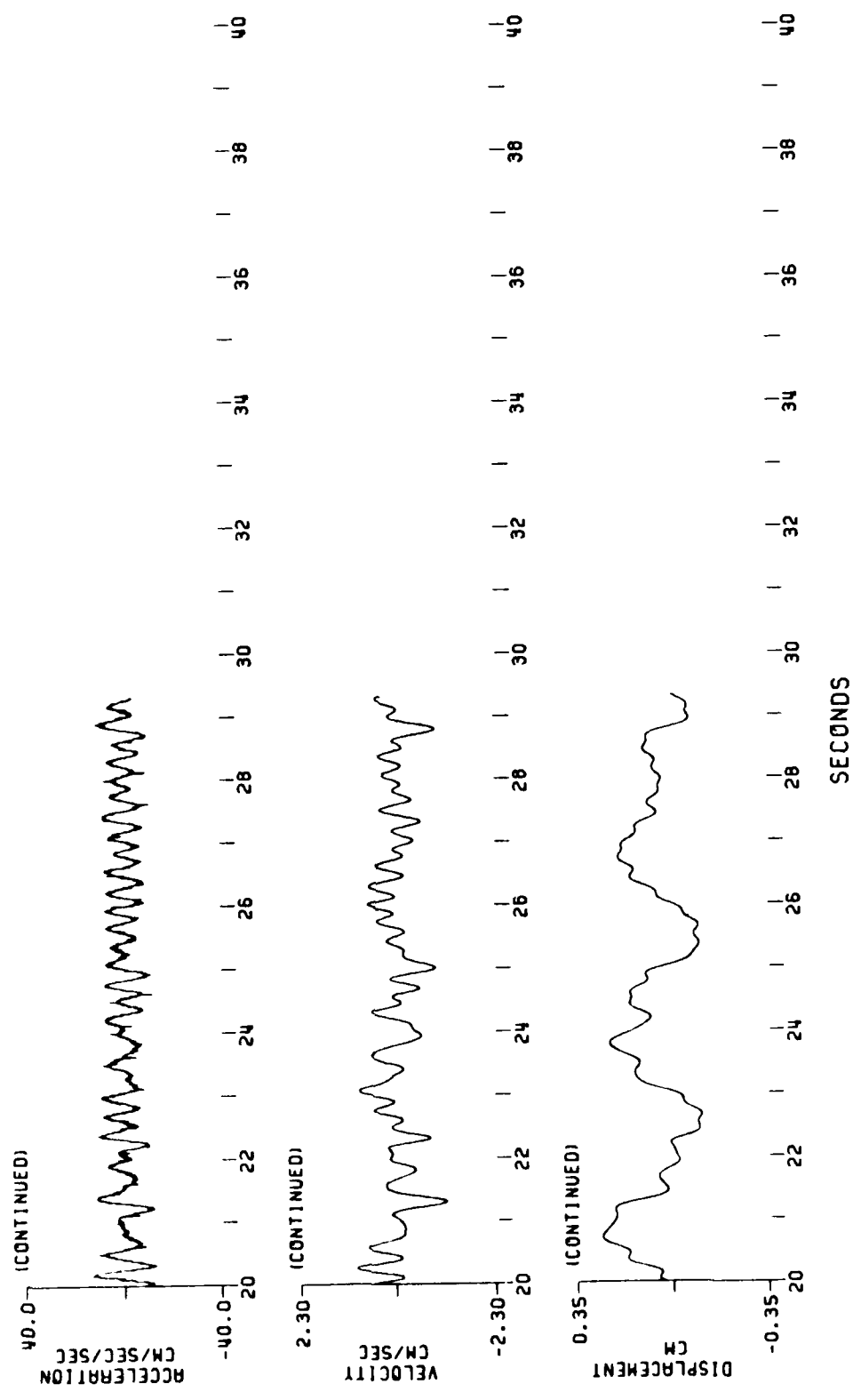
PEAK VALUES: ACCEL=-39.90 CM/SEC/SEC, VELOCITY=2.26 CM/SEC, DISPL=0.35 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 AIRIE DAM, UPPER TOWER

295 DEGREES
 EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

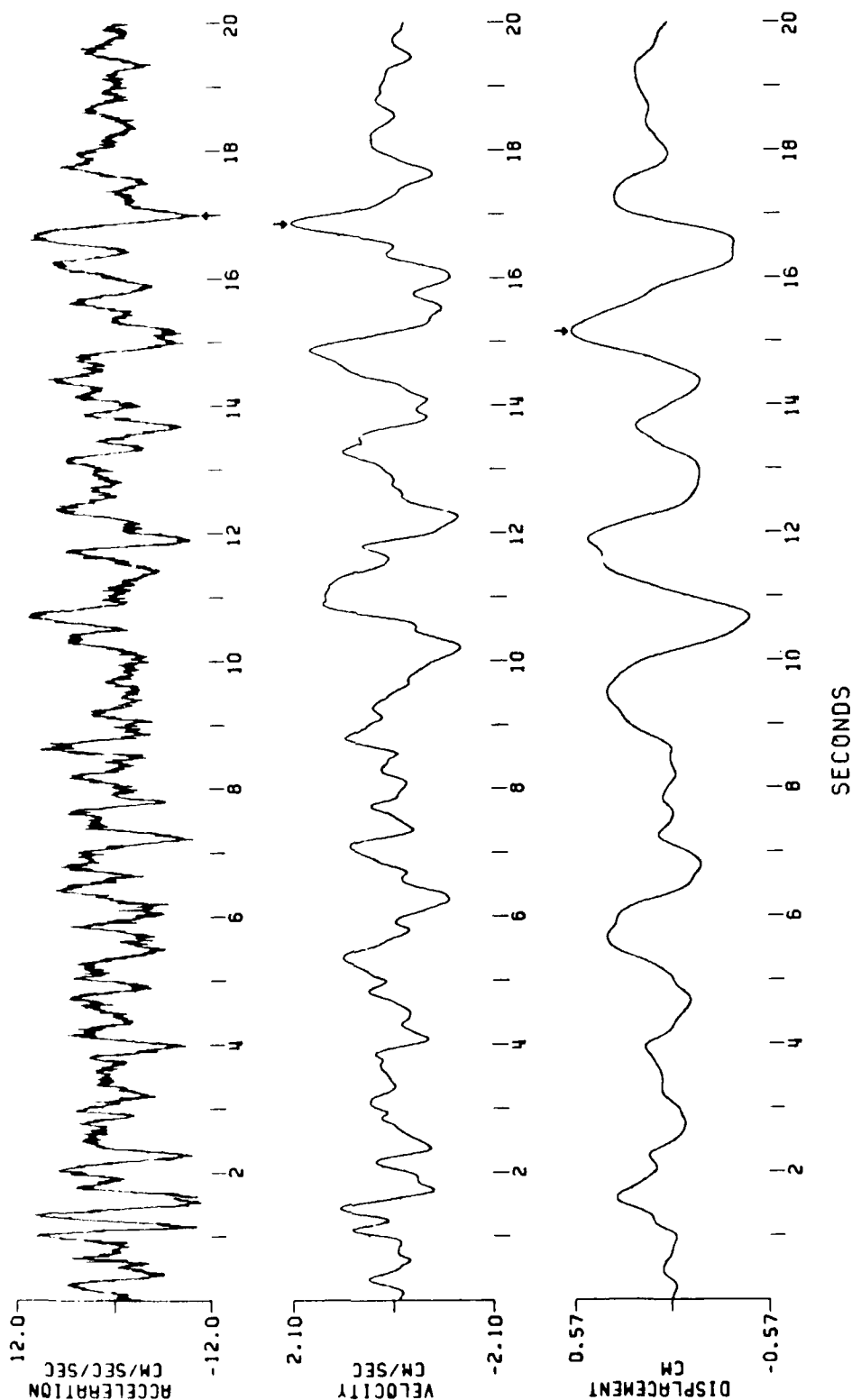
PEAK VALUES: ACCEL=-39.90 CM/SEC/SEC, VELOCITY=2.26 CM/SEC, DISPL=0.35 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 AIRIE DAM, LOWER TOWER
 25 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

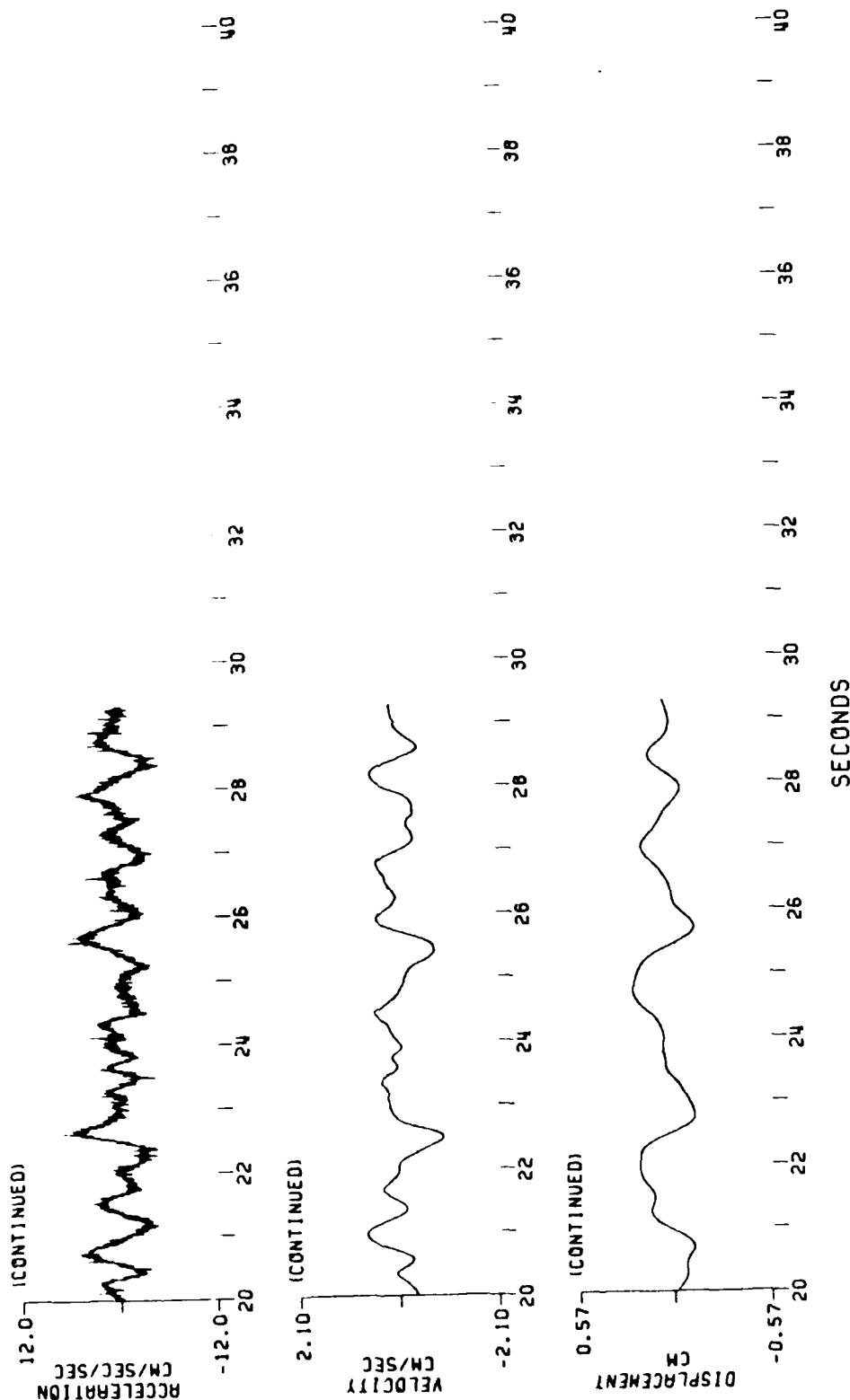
PEAK VALUES: ACCEL=-11.28 CM/SEC/SEC, VELOCITY=2.04 CM/SEC, DISPL=0.57 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIAE DAM LOWER TOWER
 25 DEGREES

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

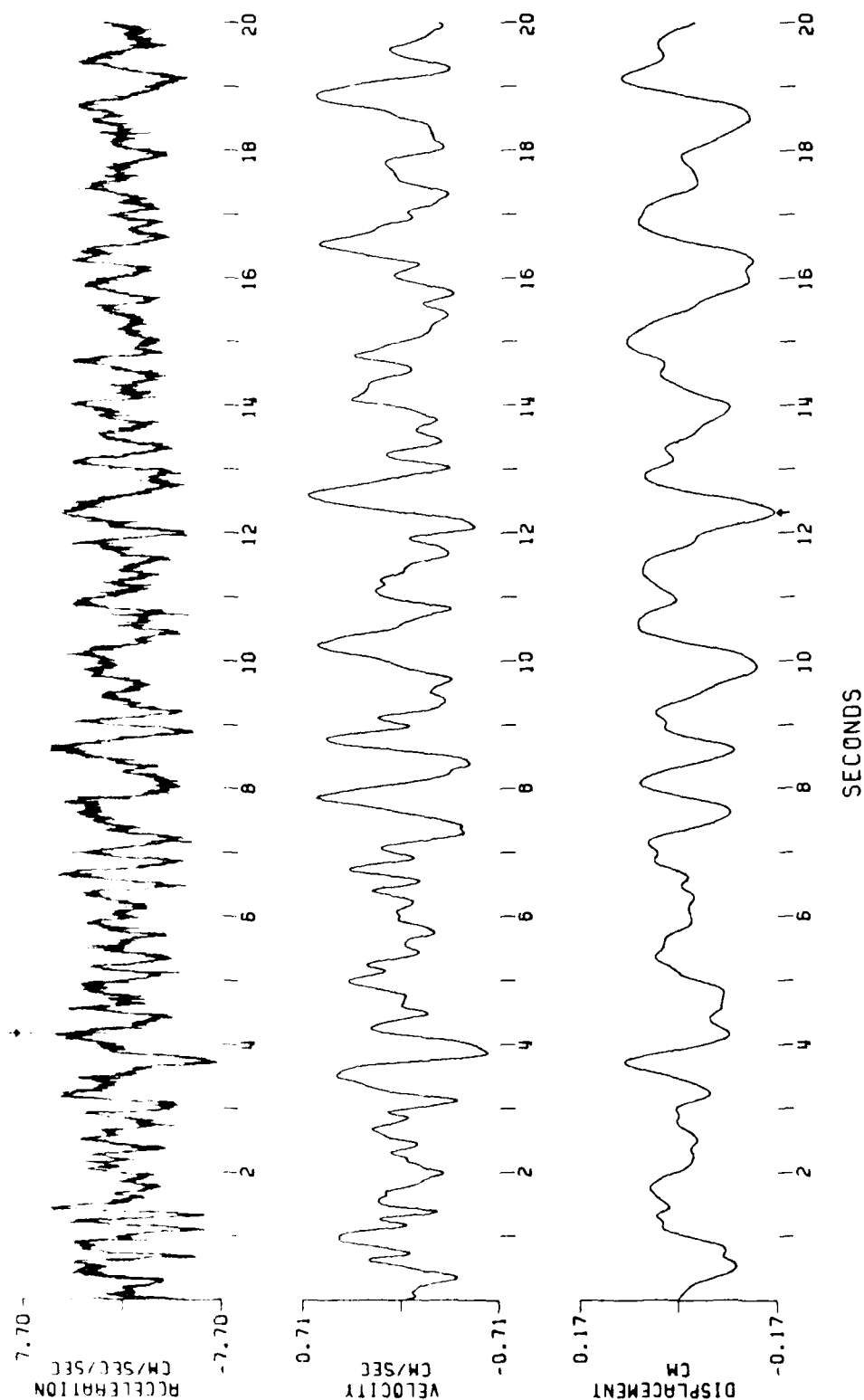
PEAK VALUES: ACCEL=-11.28 CM/SEC/SEC, VELOCITY=2.04 CM/SEC, DISPL=0.57 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIRIE DAM, LOWER TOWER

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT .25 HZ ORDER 2

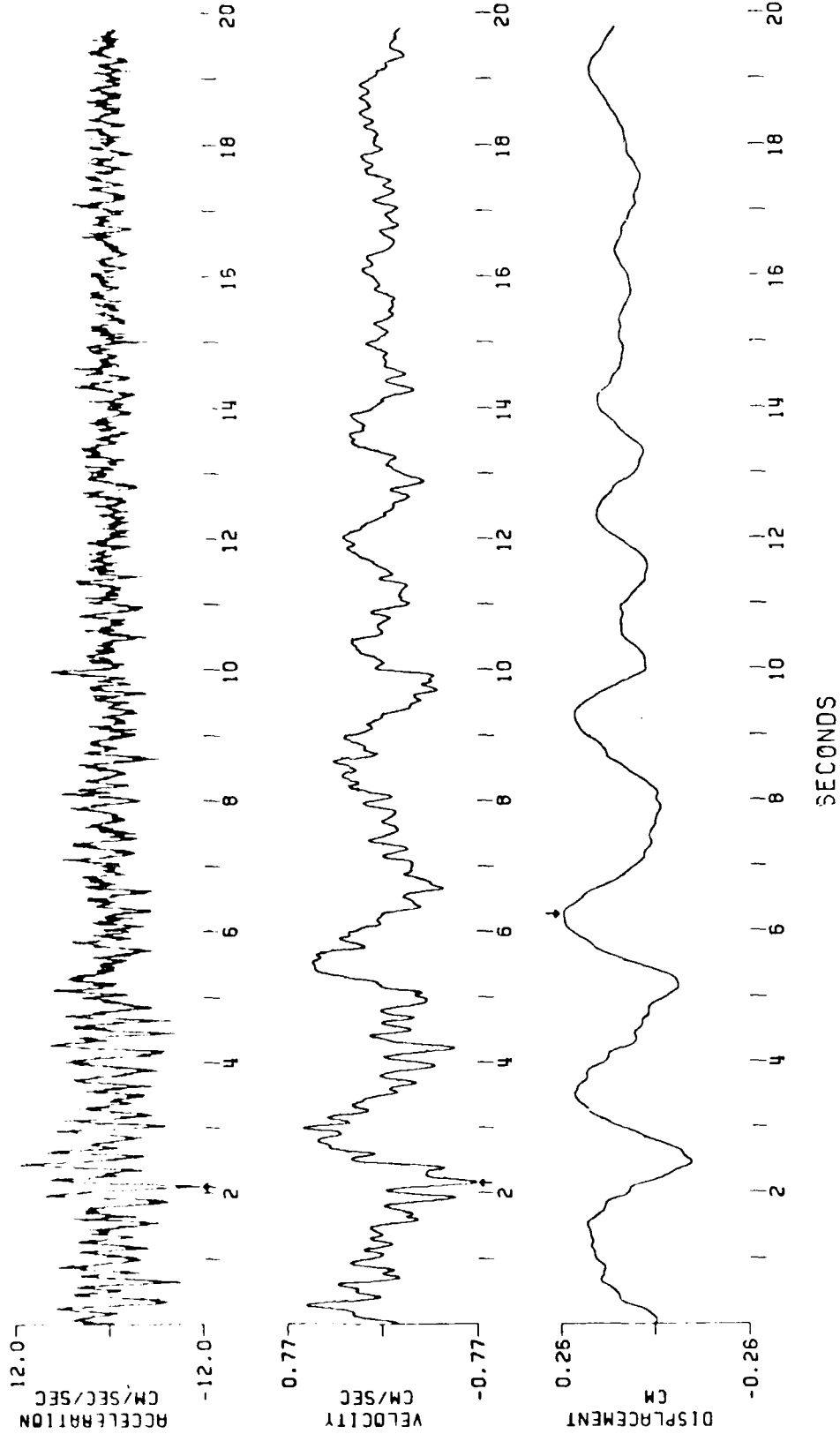
PEAK VALUES: ACCEL=7.67 CM/SEC/SEC, VELOCITY=0.70 CM/SEC, DISPL=-0.16 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 DWORSHAK DAM, UPPER GALLERY

141 DEGREES
 EARTHQUAKE OF 28 OCTOBER 1983, 1406UTC
 BUTTERWORTH AT .25 HZ; ORDER 2

PEAK VALUES: ACCEL=-11.65 CM/SEC/SEC, VELOCITY=-0.76 CM/SEC, DISPL=0.25 CM

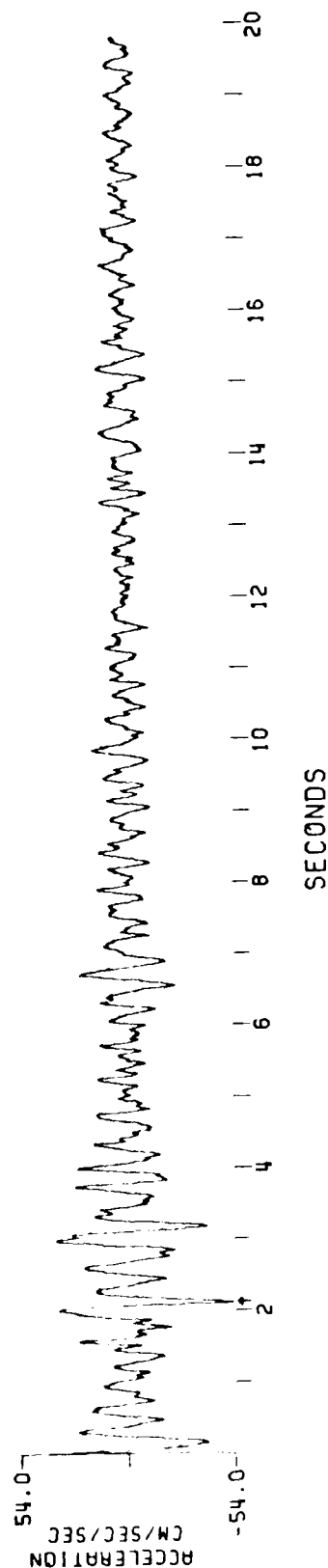
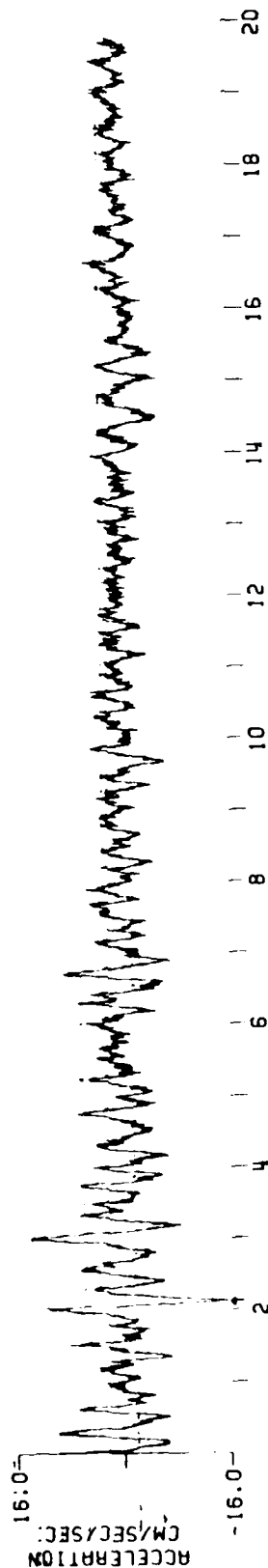
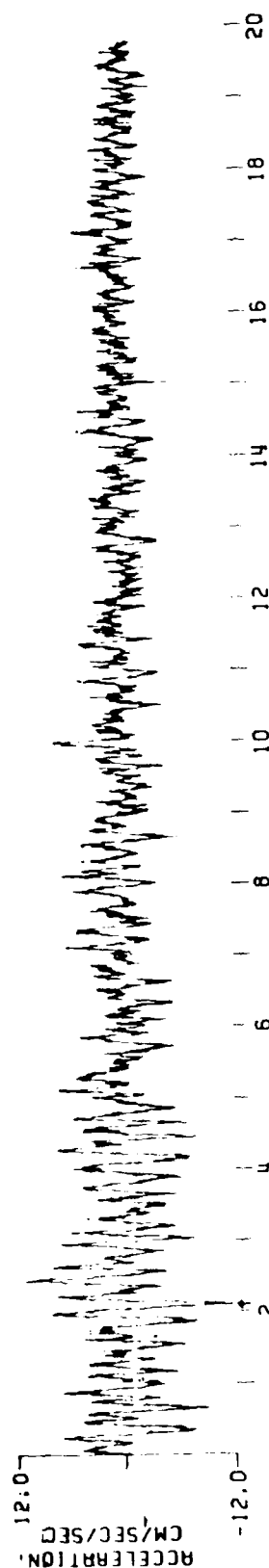


INSTRUMENT CORRECTED ANTI-ALIASED ACCELERATION 200.00 SPS

OWORSHAK DAM, UPPER GALLERY
141 DEGREES UP, 51 DEGREES

EARTHQUAKE OF 28 OCTOBER 1983, 1406UTC

PEAK VALUES (CM/SEC/SEC): -11.80 -15.47 -53.84



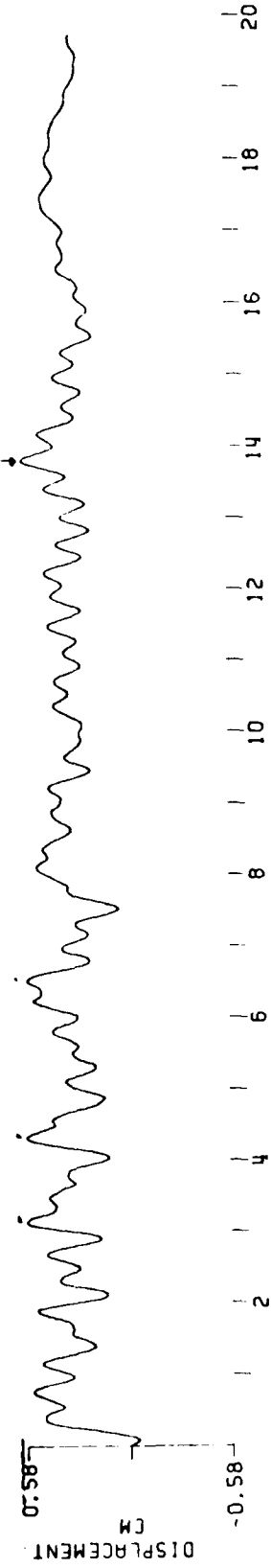
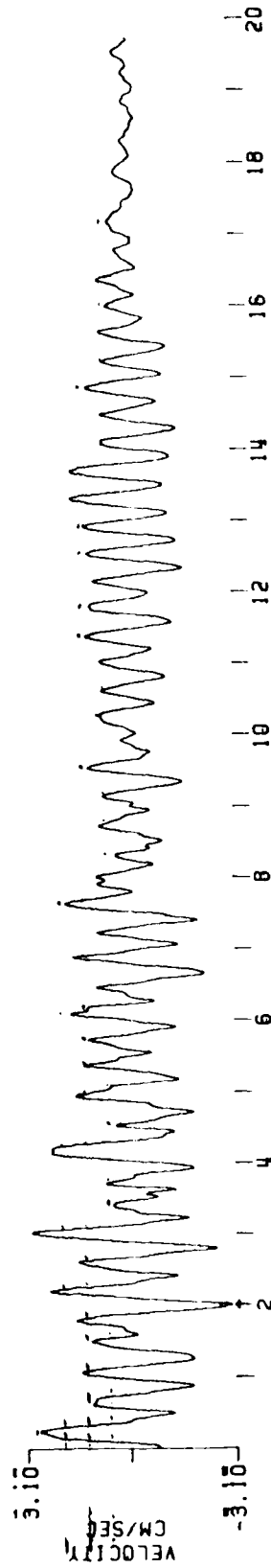
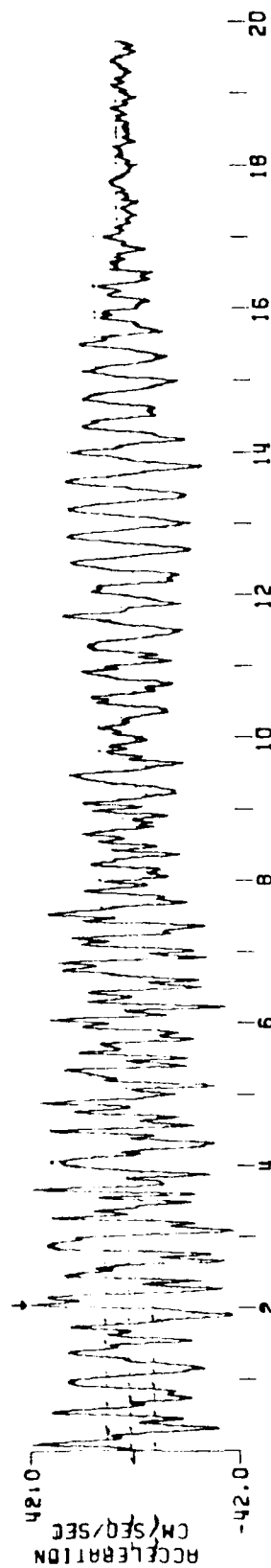
SECONDS

CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
LUCKY DAM, INTAKE TOWER

139 DEGREES

EARTHQUAKE OF 28 OCTOBER 1983 1406UTC

BUTTERWORTH AT .25 HZ, ORDER 2
PEAK VALUES: ACCEL=41.40 CM/SEC/SEC, VELOCITY=-3.01 CM/SEC, DISPL=0.58 CM

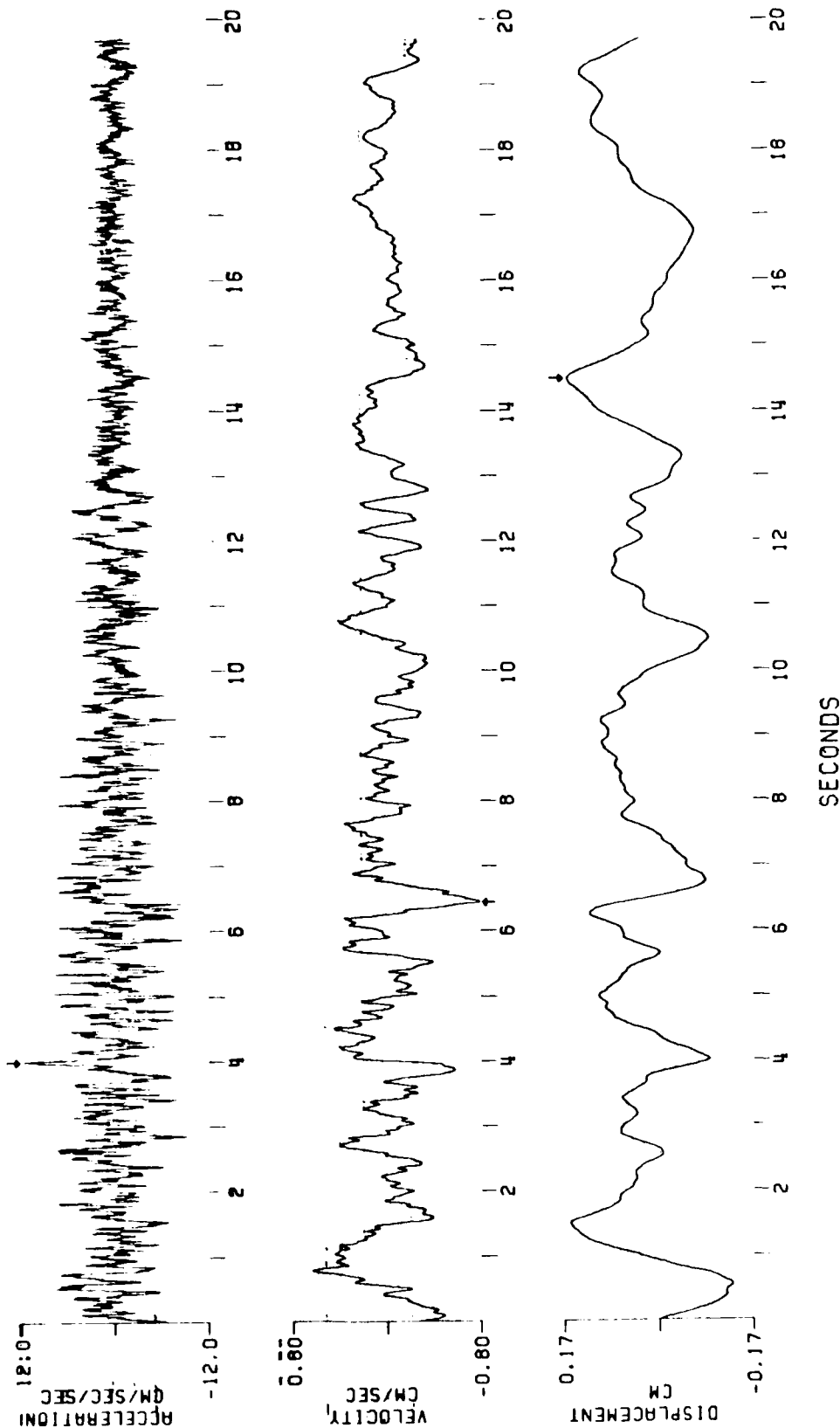


SECONDS

CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS LUCKY PEAR DAM, INTAKE TOWER

EARTHQUAKE OF 28 OCTOBER 1983
BUTTERWORTH AT 0.25 HZ, ORDER 2 1-06UTC

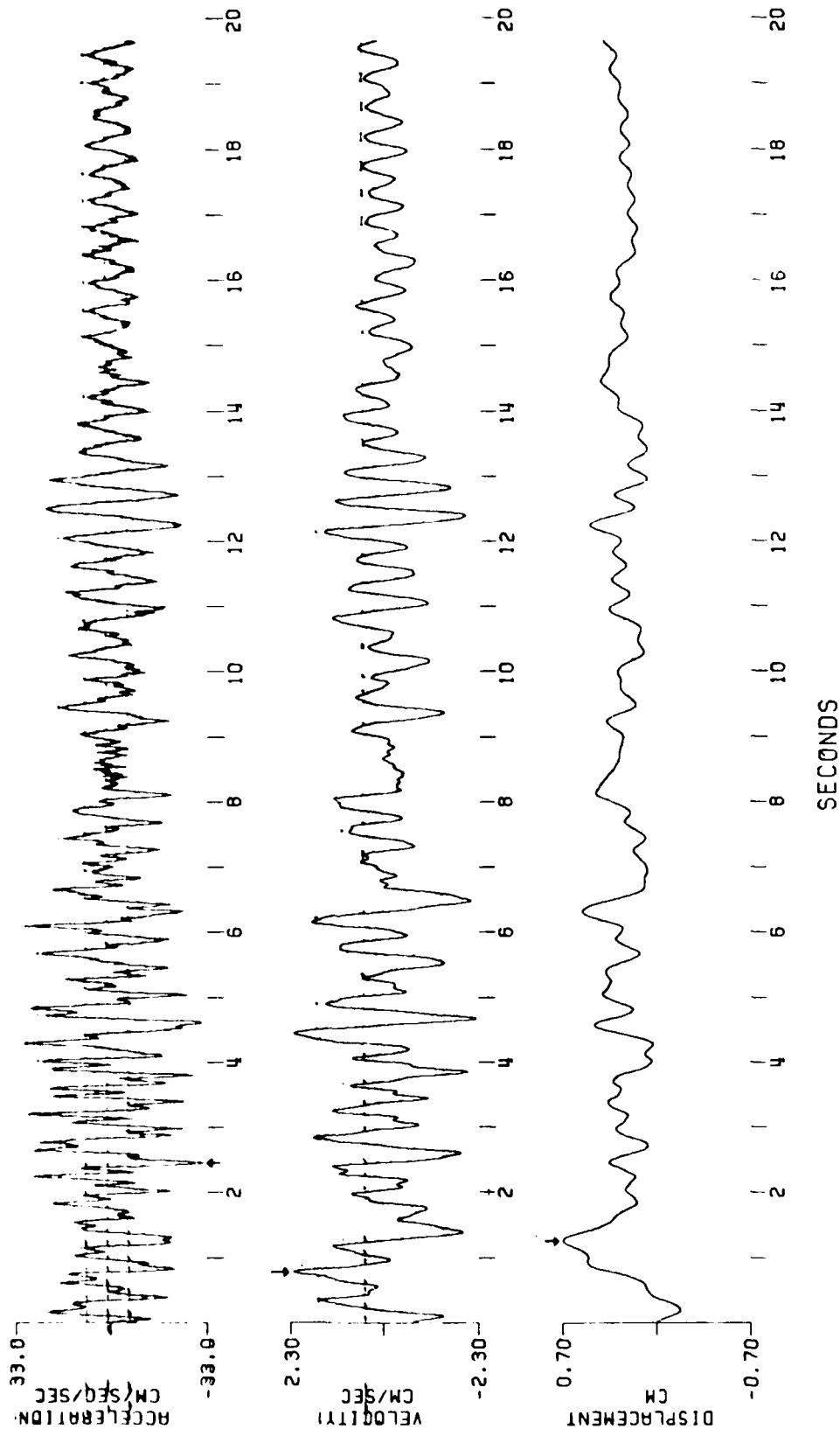
PEAK VALUES: ACCEL=11.73 CM/SEC/SEC, VELOCITY=-0.79 CM/SEC, DISPL=0.16 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
LUCKY DAM, INTAKE TOWER

229 DEGREES
EARTHQUAKE OF 28 OCTOBER 1983 1406UTC
BUTTERWORTH AT 25 HZ. ORDER 2

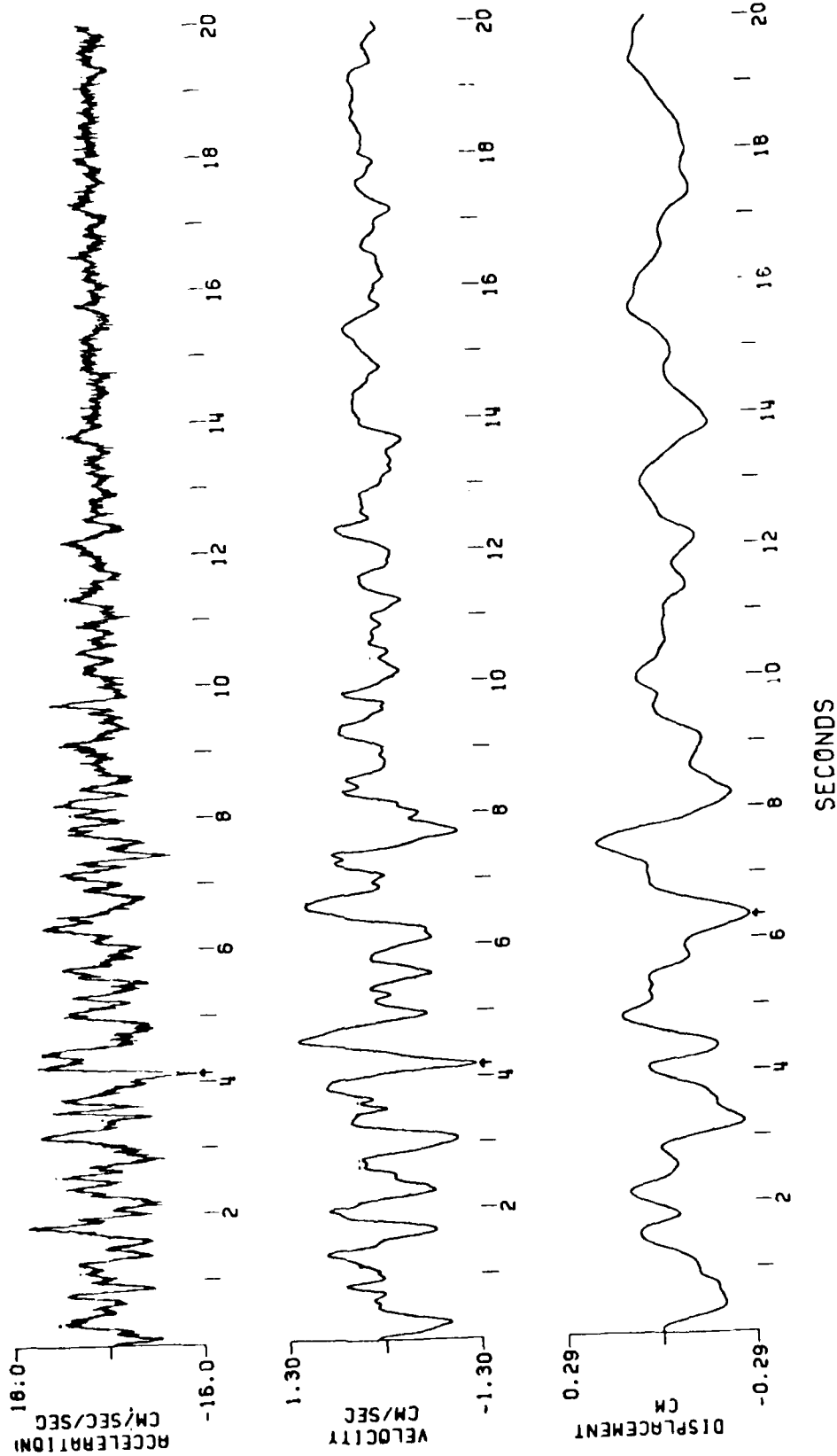
PEAK VALUES: ACCEL=-32.11 CM/SEC/SEC. VELOCITY=2.25 CM/SEC. DISPL=0.70 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 LUCKY PEAK DAM LEFT ABUT
 139 DEGREES

EARTHQUAKE OF 28 OCTOBER 1983 1406UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

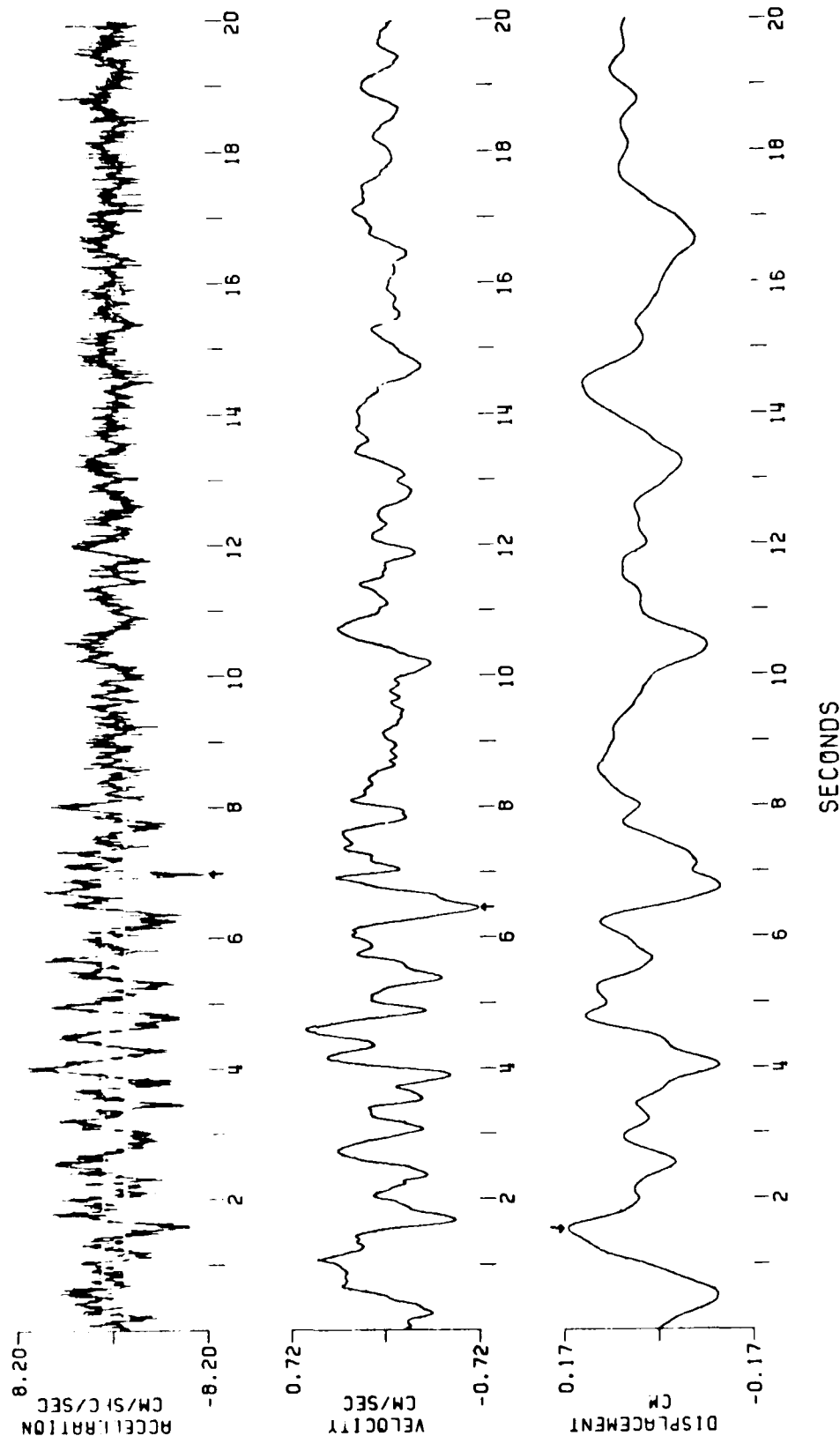
PEAK VALUES: ACCEL=-15.50 CM/SEC/SEC, VELOCITY=-1.28 CM/SEC, DISPL=-0.29 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
LUCKY PEAK DAM, LEFT ABUT

EARTHQUAKE OF 28 OCTOBER 1983, 1406UTC
BUTTERWORTH AT .25 HZ, ORDER 2

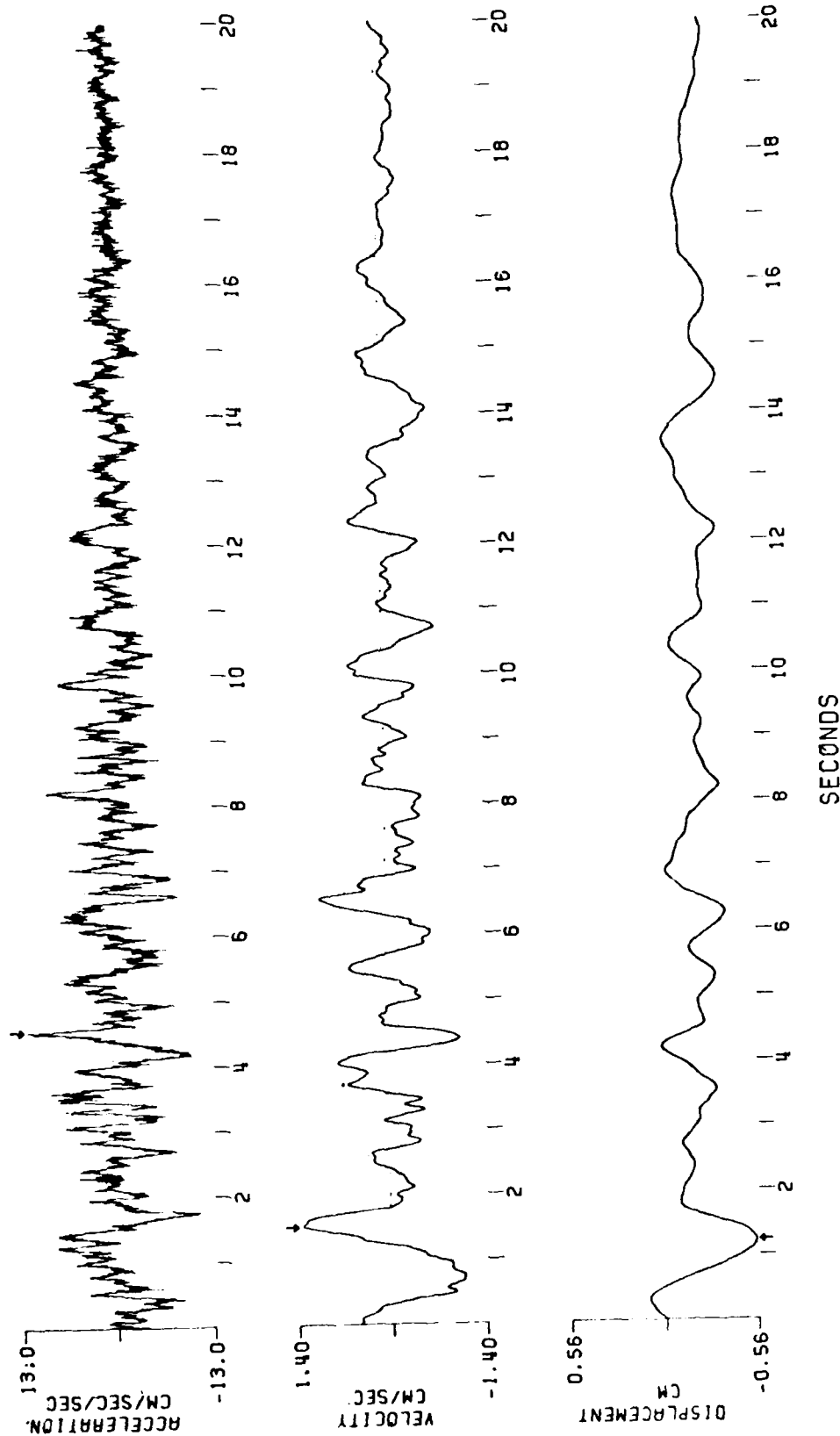
PEAK VALUES: ACCEL=-8.16 CM/SEC/SEC, VELOCITY=-0.72 CM/SEC, DISPL=0.16 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 LUCKY PEAK DAM, LEFT ABUT

EARTHQUAKE OF 28 OCTOBER 1983, 1406UTC
 BUTTERWORTH AT 25 HZ, ORDER 2

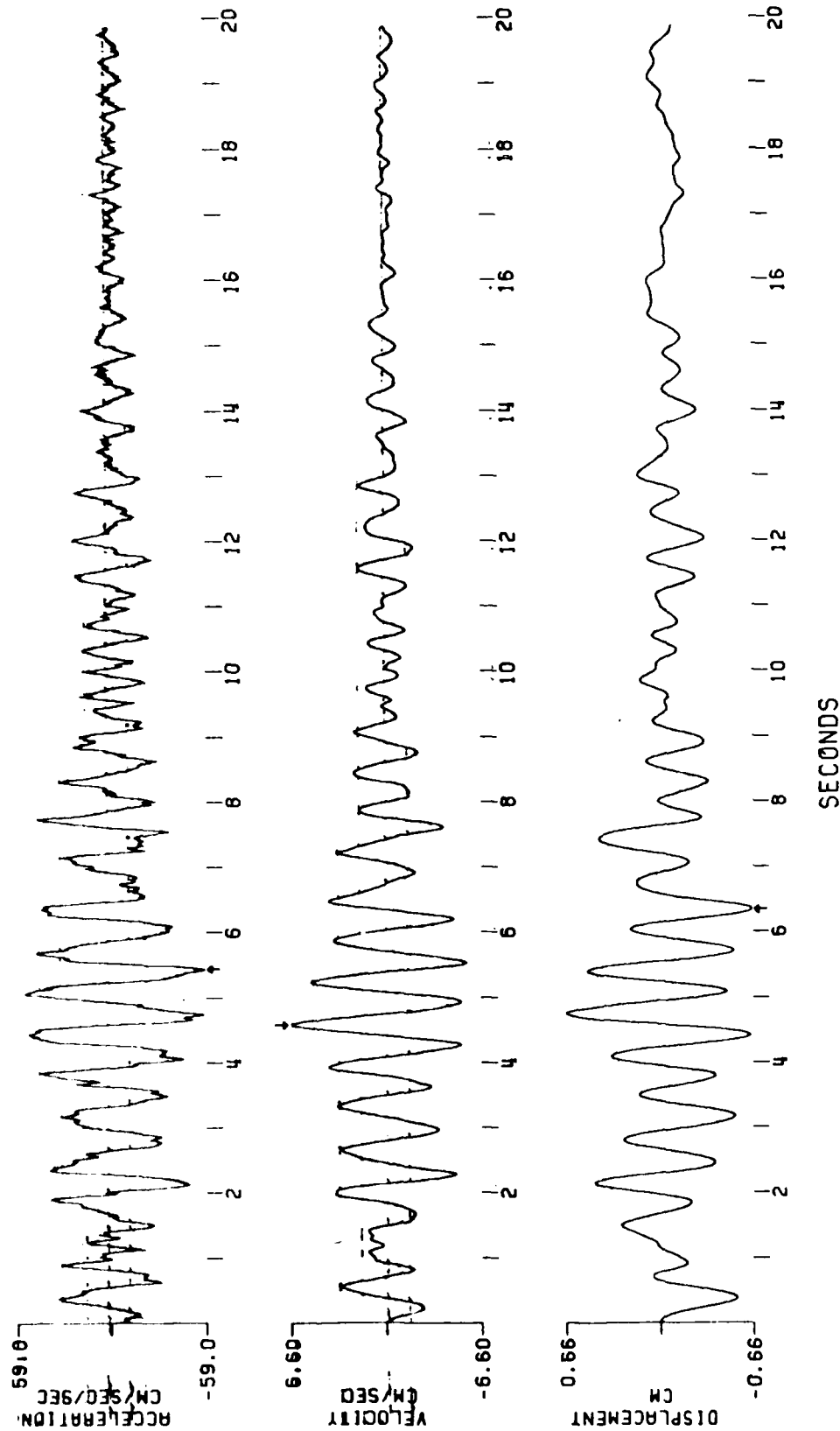
PEAK VALUES: ACCEL=12.25 CM/SEC/SEC, VELOCITY=1.35 CM/SEC, DISPL=-0.55 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 LUCKY DAM, CENTER CREST
 139 DEGREES

EARTHQUAKE OF 28 OCTOBER 1983, 1406UTC
 BUTTERWORTH AT .25 HZ; ORDER 2

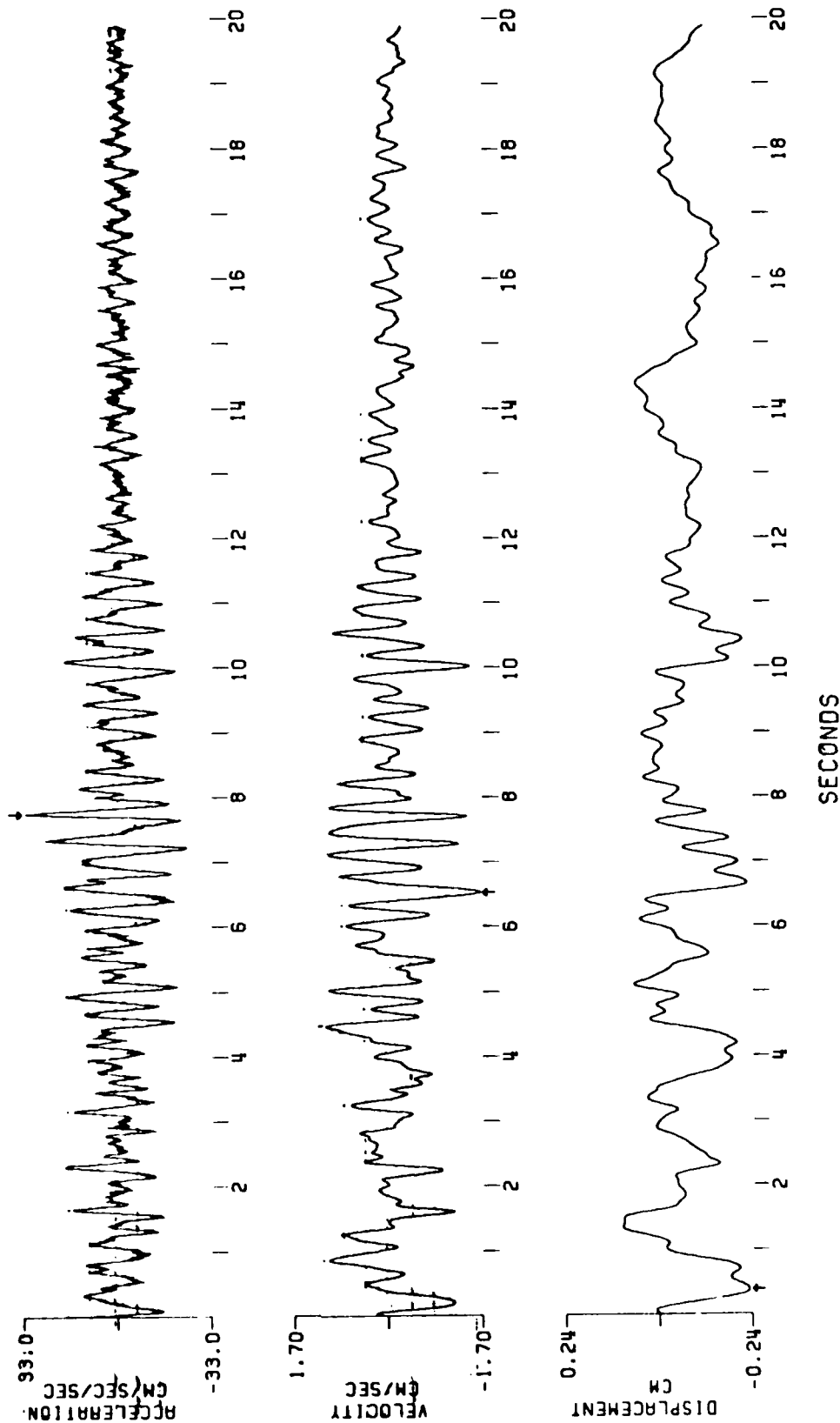
PEAK VALUES: ACCEL=-58.35 CM/SEC/SEC, VELOCITY=6.53 CM/SEC, DISPL=-0.65 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 LUCKY PEAK DAM, CENTER CREST

EARTHQUAKE OF 28 OCTOBER 1983, 1406UTC
 BUTTERWORTH AT 25 HZ ORDER 2

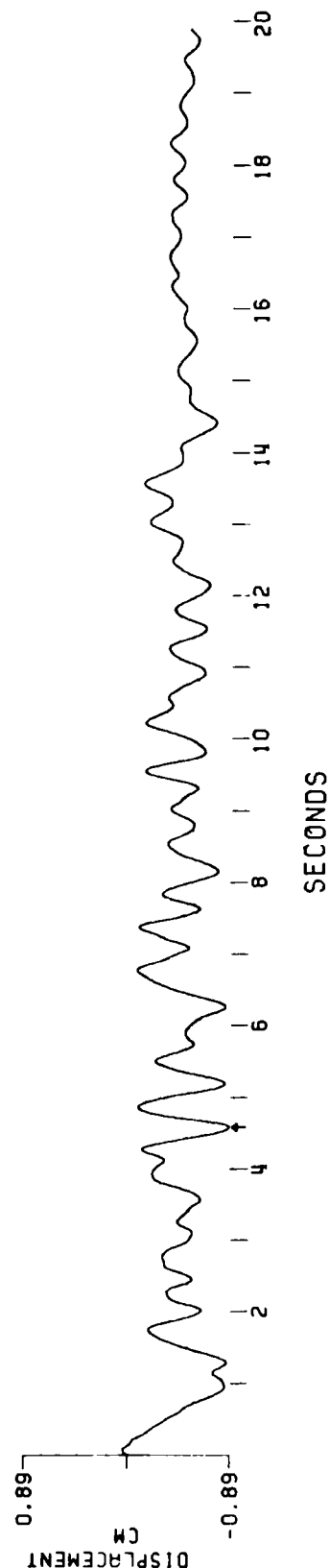
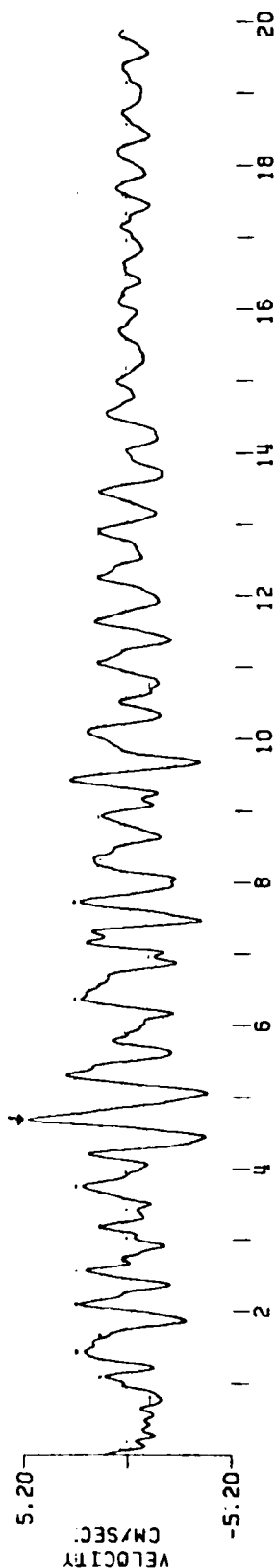
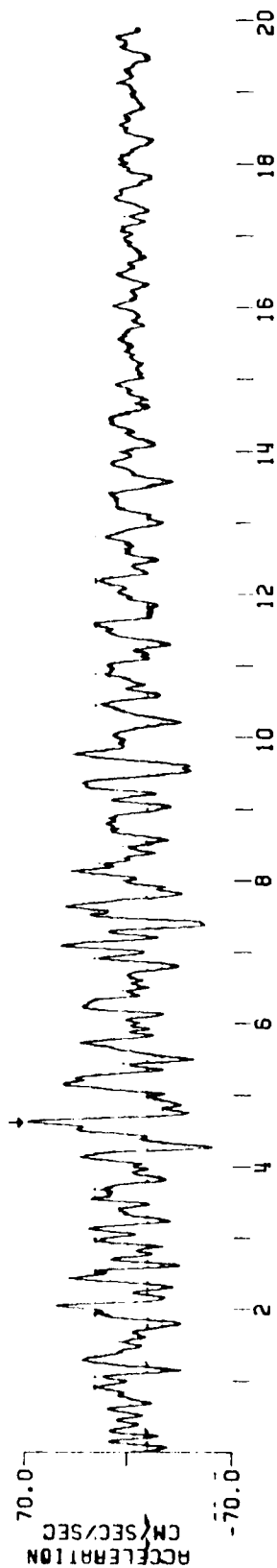
PEAK VALUES: ACCEL=32.71 CM/SEC/SEC, VELOCITY=-1.65 CM/SEC, DISPL=-0.23 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 LUCKY PEAK DAM CENTER CREST
 229 DEGREES

EARTHQUAKE OF 28 OCTOBER 1983, 1406UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

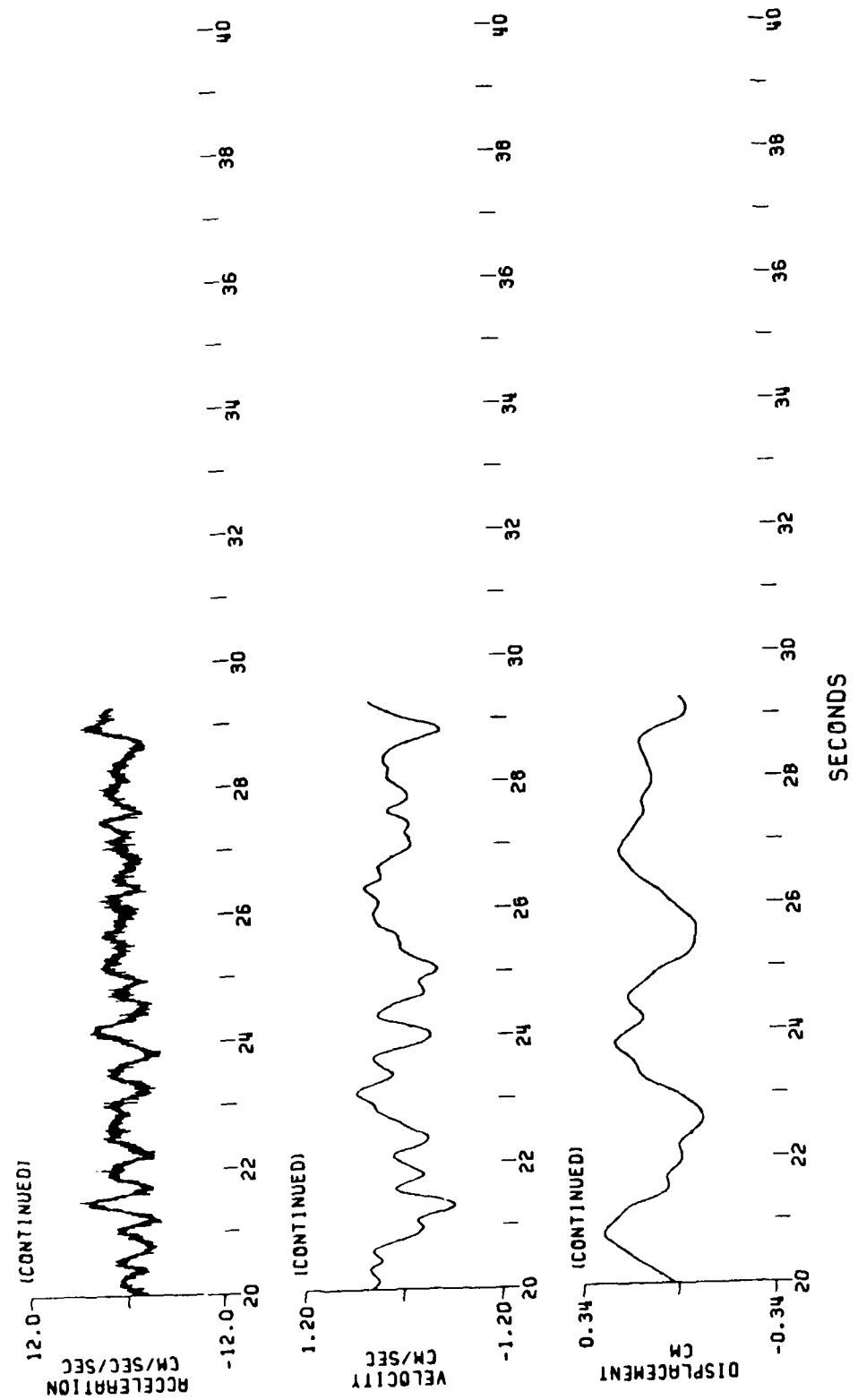
PEAK VALUES: ACCEL=69.71 CM/SEC/SEC, VELOCITY=5.10 CM/SEC, DISPL=-0.88 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIATE DAM, LOWER TOWER

295 DEGREES
 EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT 25 HZ ORDER 2

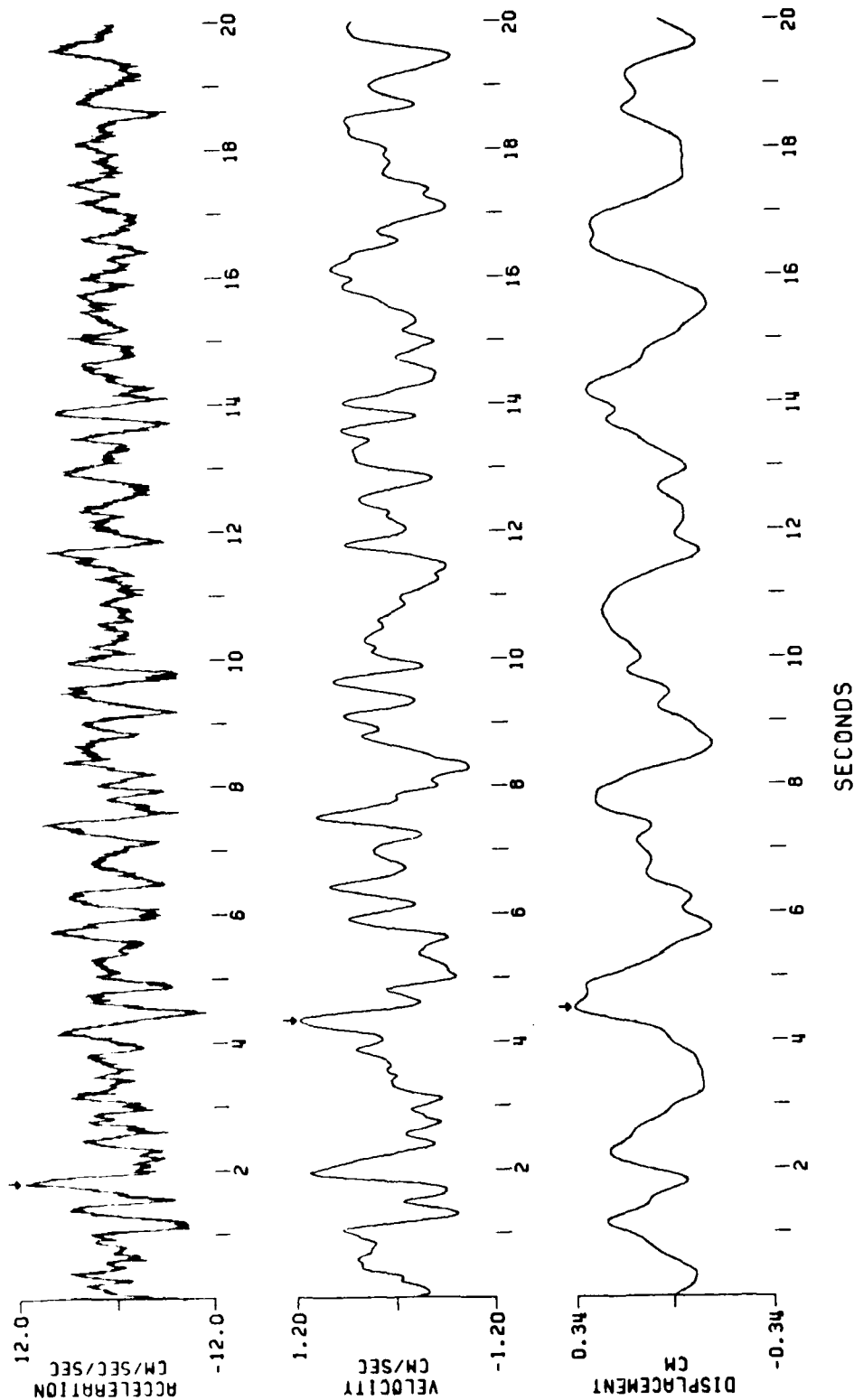
PEAK VALUES: ACCEL=11.32 CM/SEC/SEC, VELOCITY=1.15 CM/SEC, DISPL=0.34 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
RIÁIE DAM, LOWER TOWER
295 DEGREES

EARTHQUAKE OF OCTOBER 28 1983 1406 UTC
BUTTERWORTH AT .25 HZ, ORDER 2

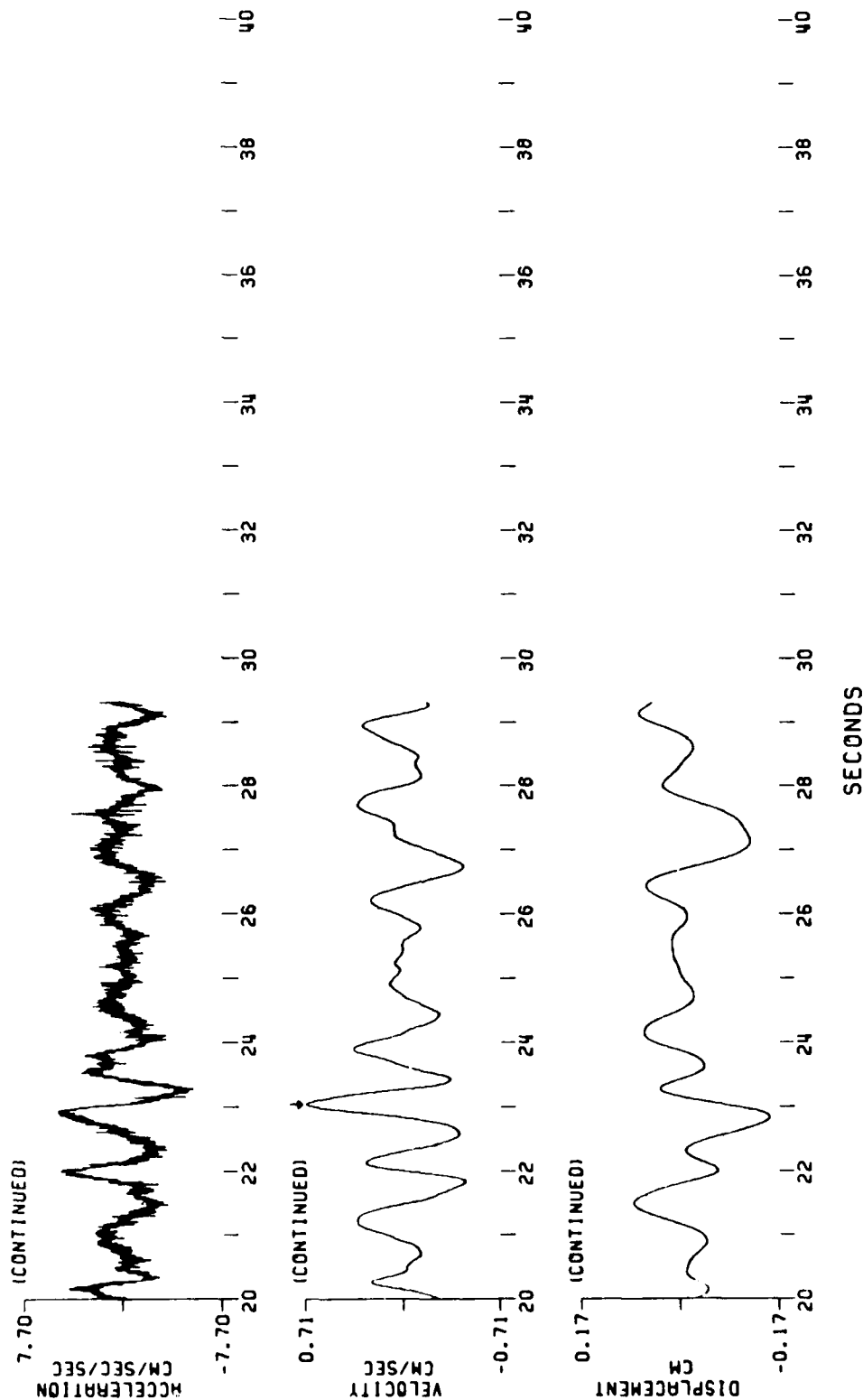
PEAK VALUES: ACCEL=11.32 CM/SEC/SEC, VELOCITY=1.15 CM/SEC, DISPL=0.34 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 RIAE DAM, LOWER TOWER

EARTHQUAKE OF OCTOBER 28, 1983 1406 UTC
 BUTTERWORTH AT 25 HZ ORDER 2

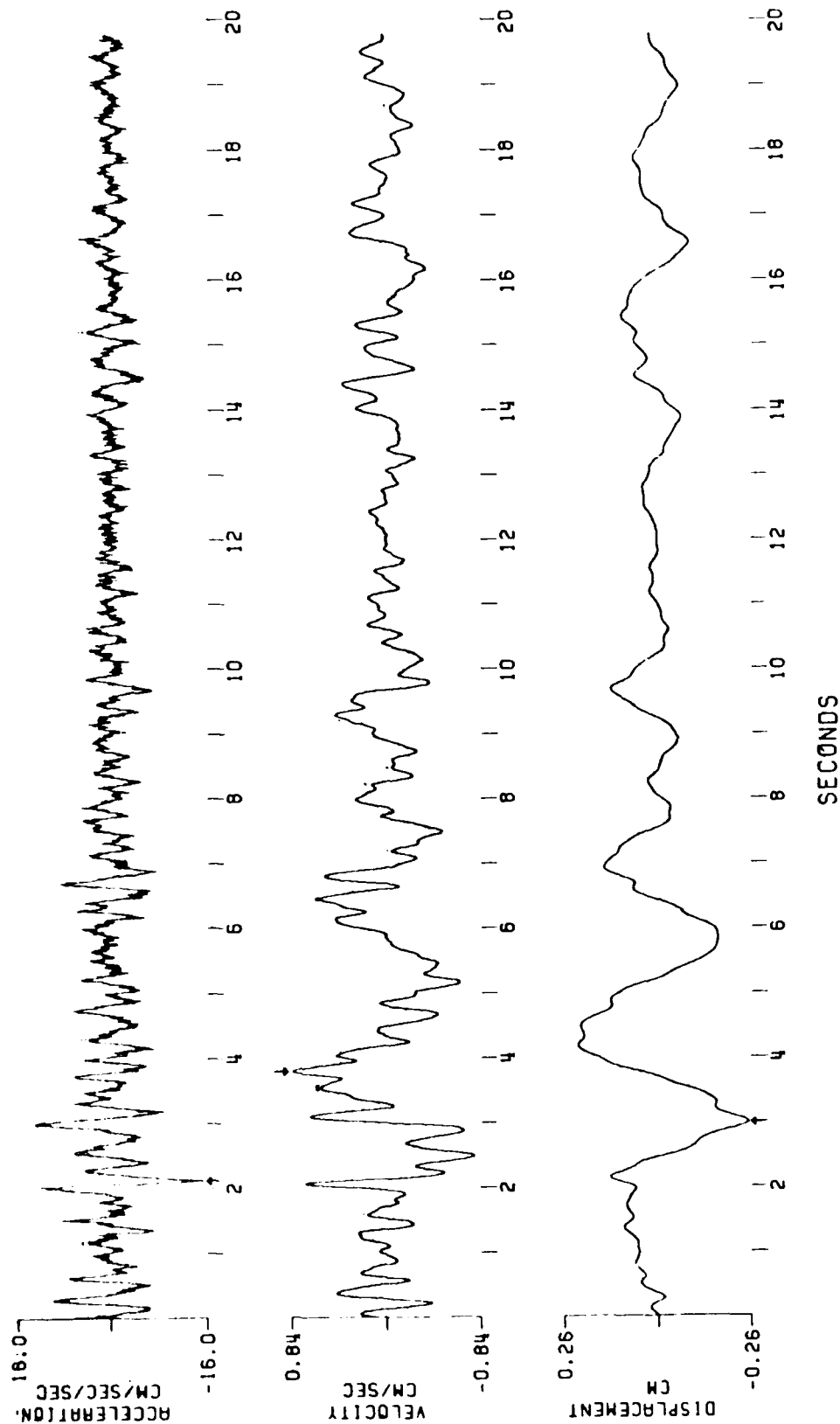
PEAK VALUES: ACCEL=7.67 CM/SEC/SEC. VELOCITY=0.70 CM/SEC. DISPL=-0.16 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
 DWORSHAK DAM, UPPER GALLERY

EARTHQUAKE OF 28 OCTOBER 1983, 1406UTC
 BUTTERWORTH AT .25 HZ, ORDER 2

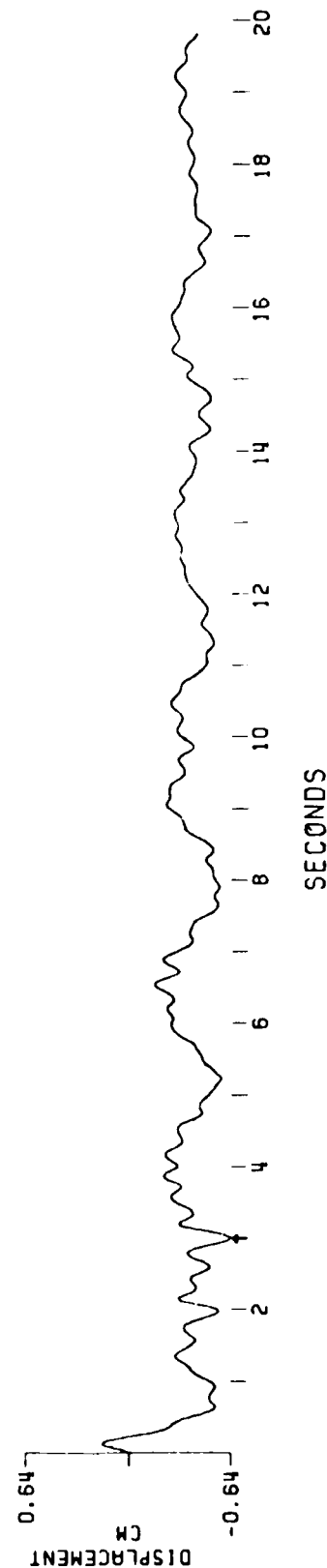
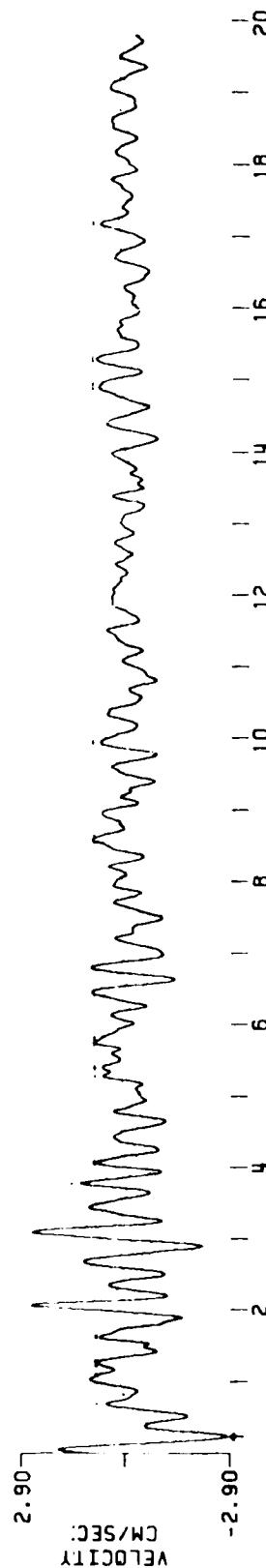
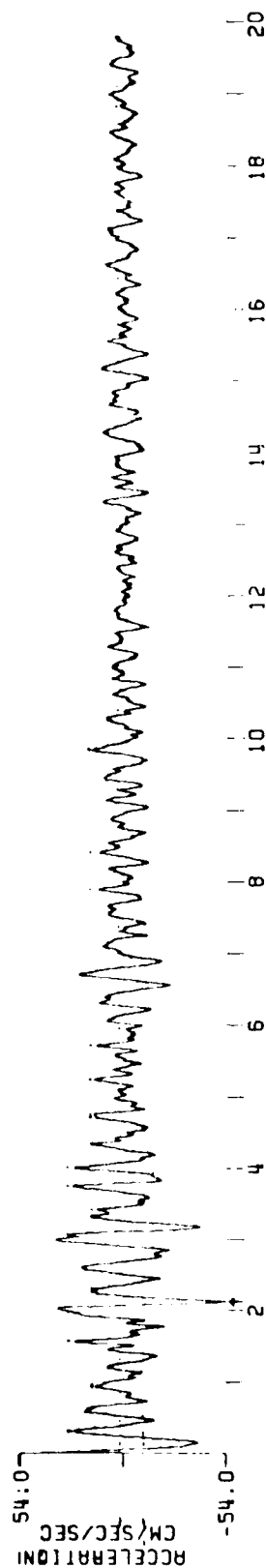
PEAK VALUES: ACCEL=-15.46 CM/SEC/SEC, VELOCITY=0.83 CM/SEC, DISPL=-0.25 CM



CORRECTED ACCELERATION, VELOCITY, AND DISPLACEMENT 200.00 SPS
DWARSHAK DAM, UPPER GALLERY

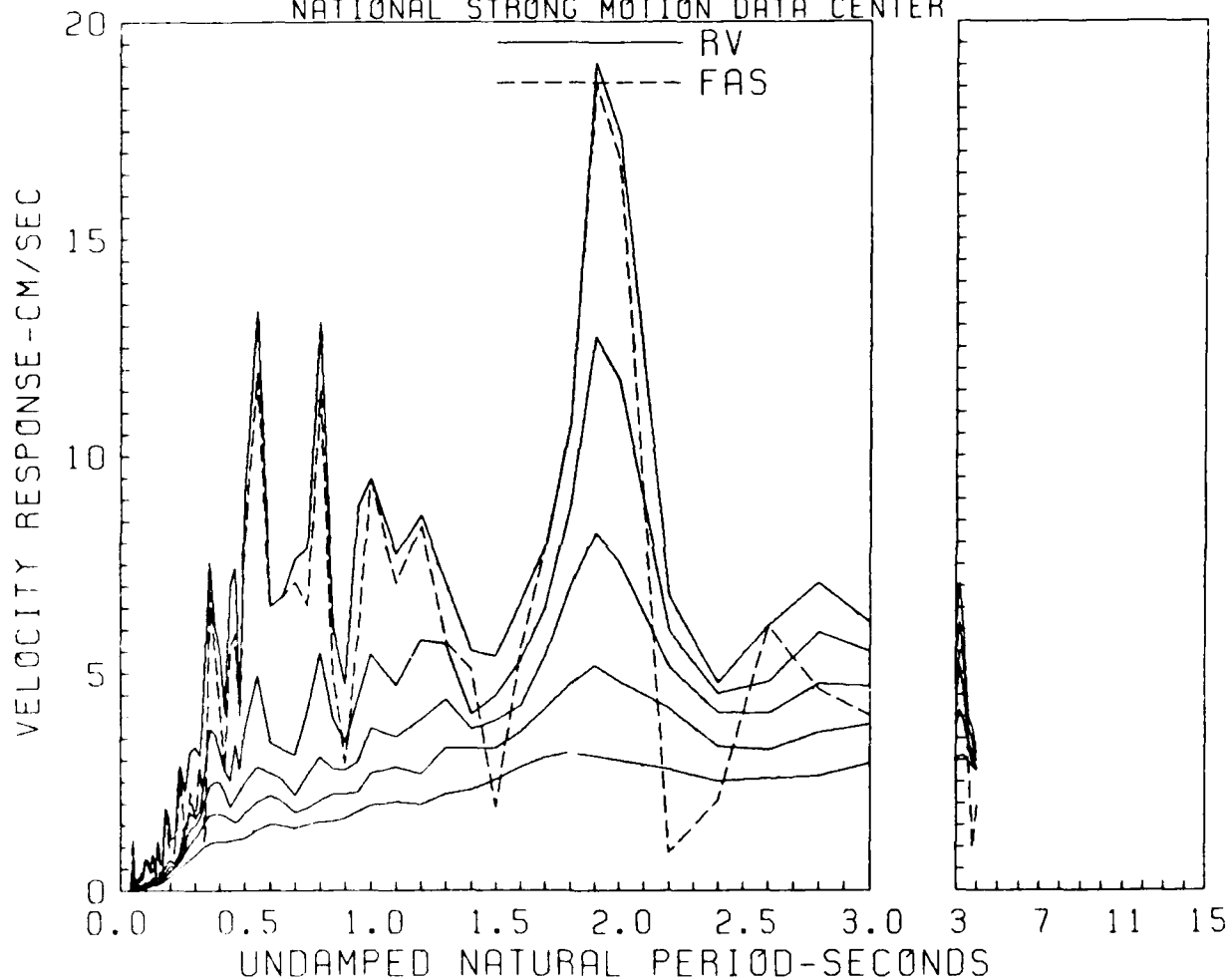
EARTHQUAKE OF 28 OCTOBER 1983, 1406UTC
BUTTERWORTH AT .25 HZ, ORDER 2

PEAK VALUES: ACCEL=-53.85 CM/SEC/SEC, VELOCITY=-2.83 CM/SEC, DISPL=-0.63 CM

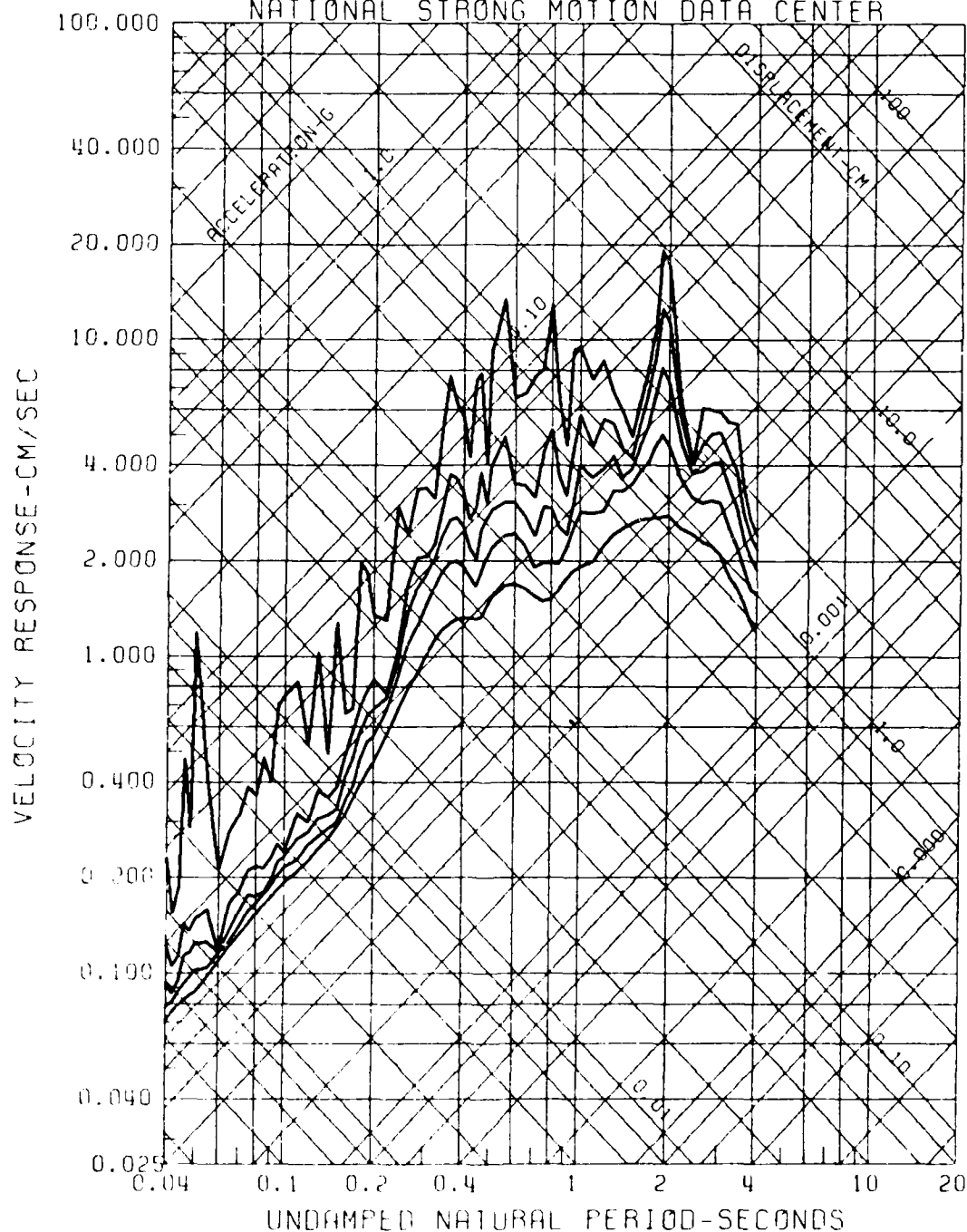


APPENDIX C
RESPONSE SPECTRA OF RIRIE DAM

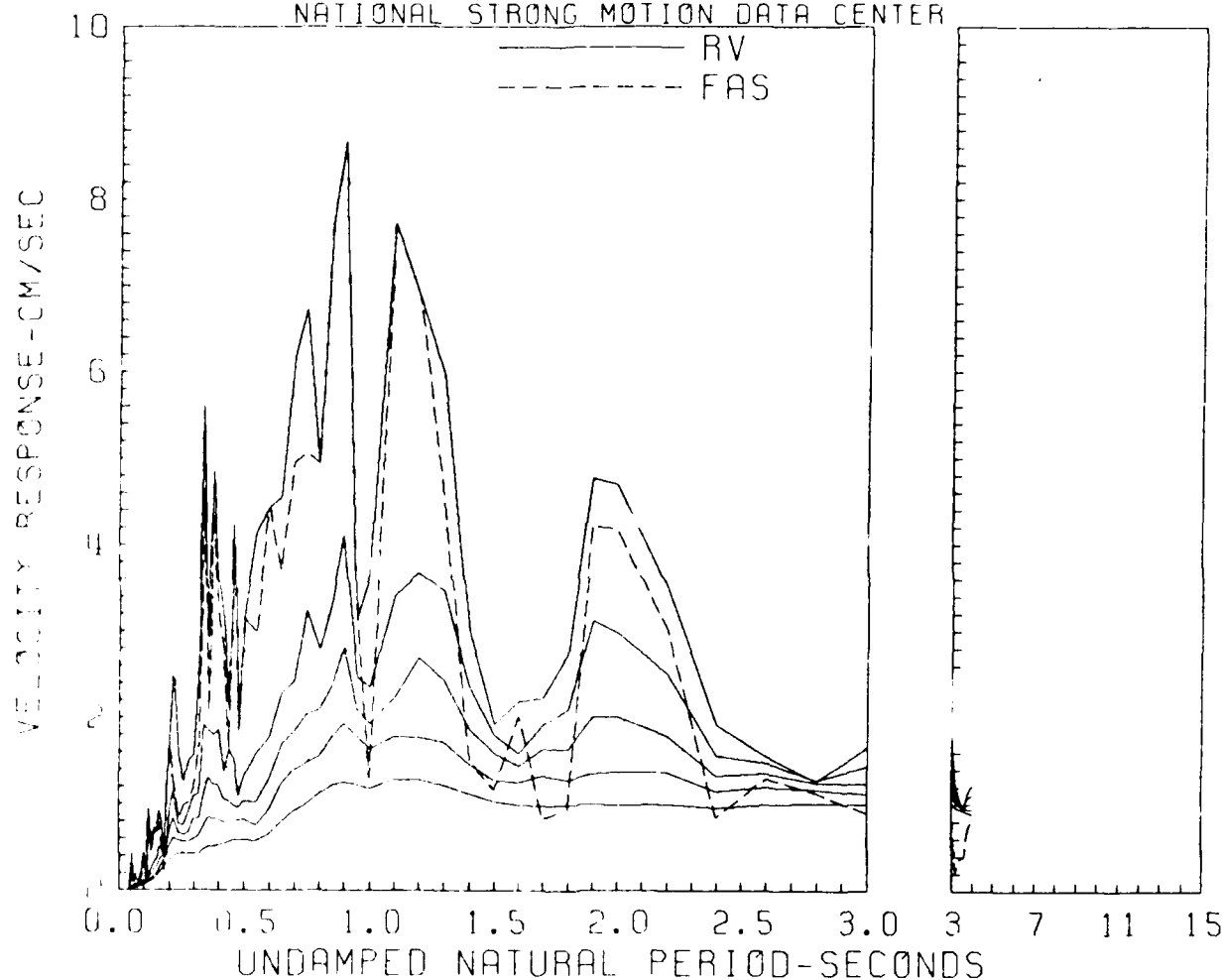
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC 25
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



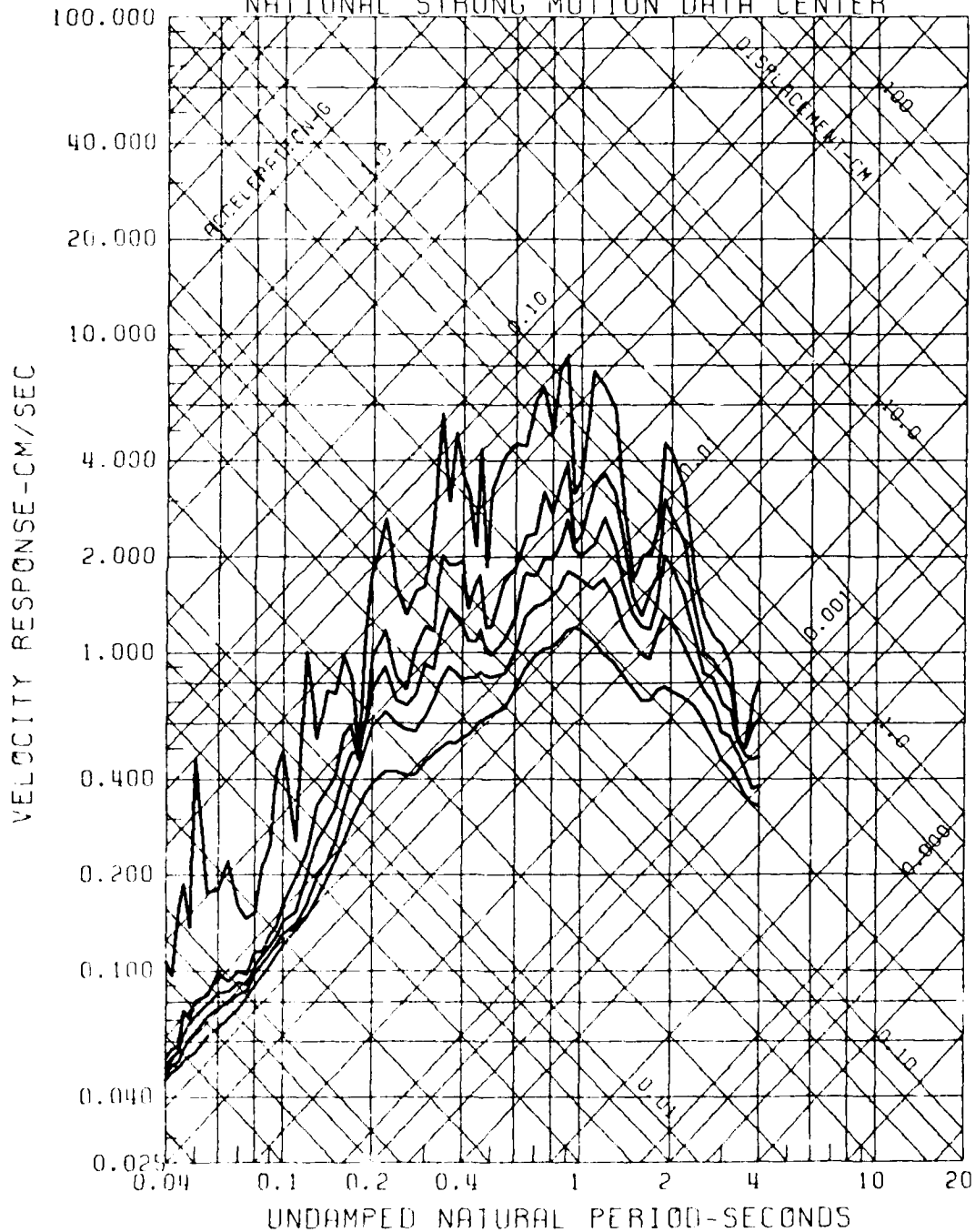
RESPONSE SPECTRA
 RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC 25
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



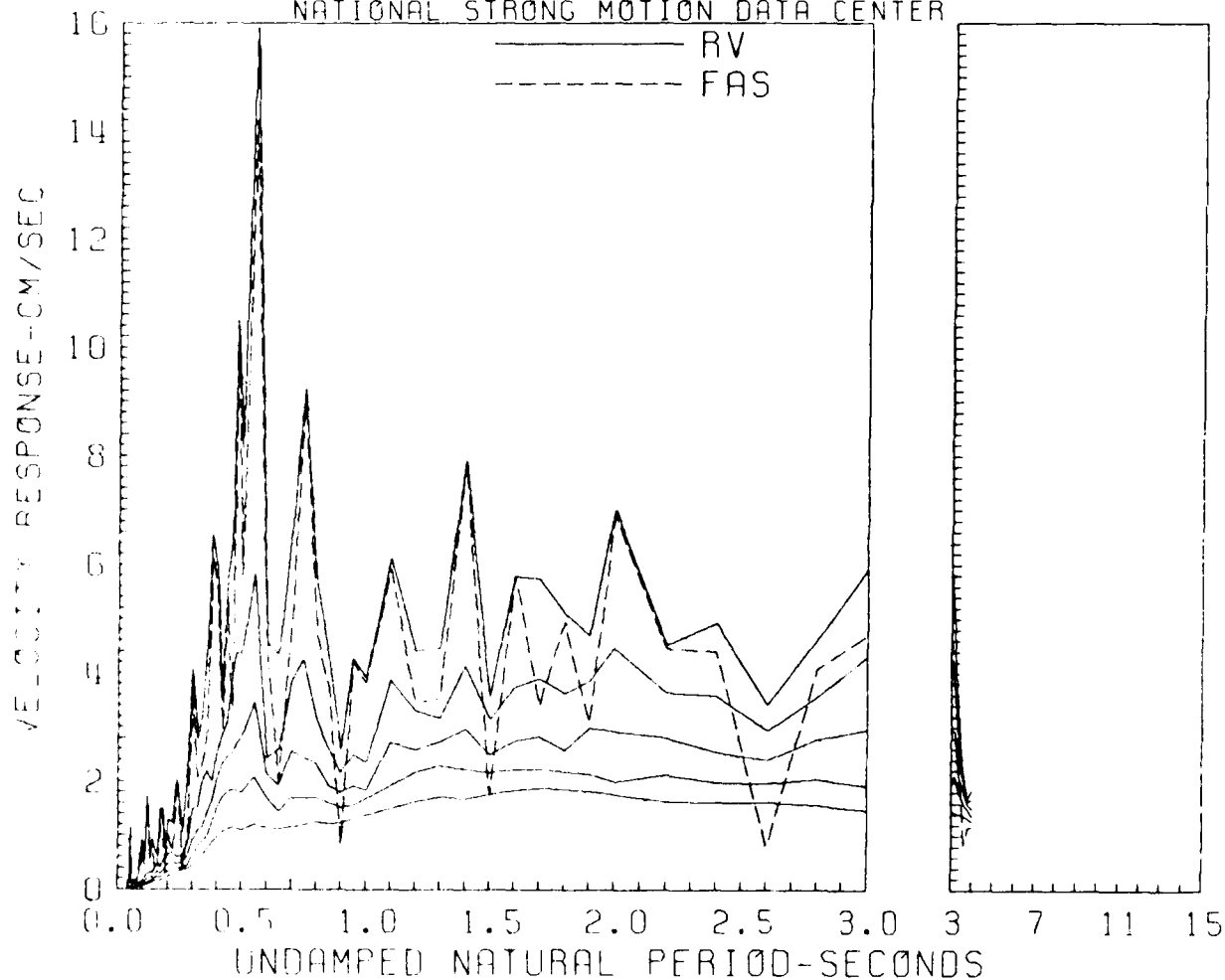
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC UP
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



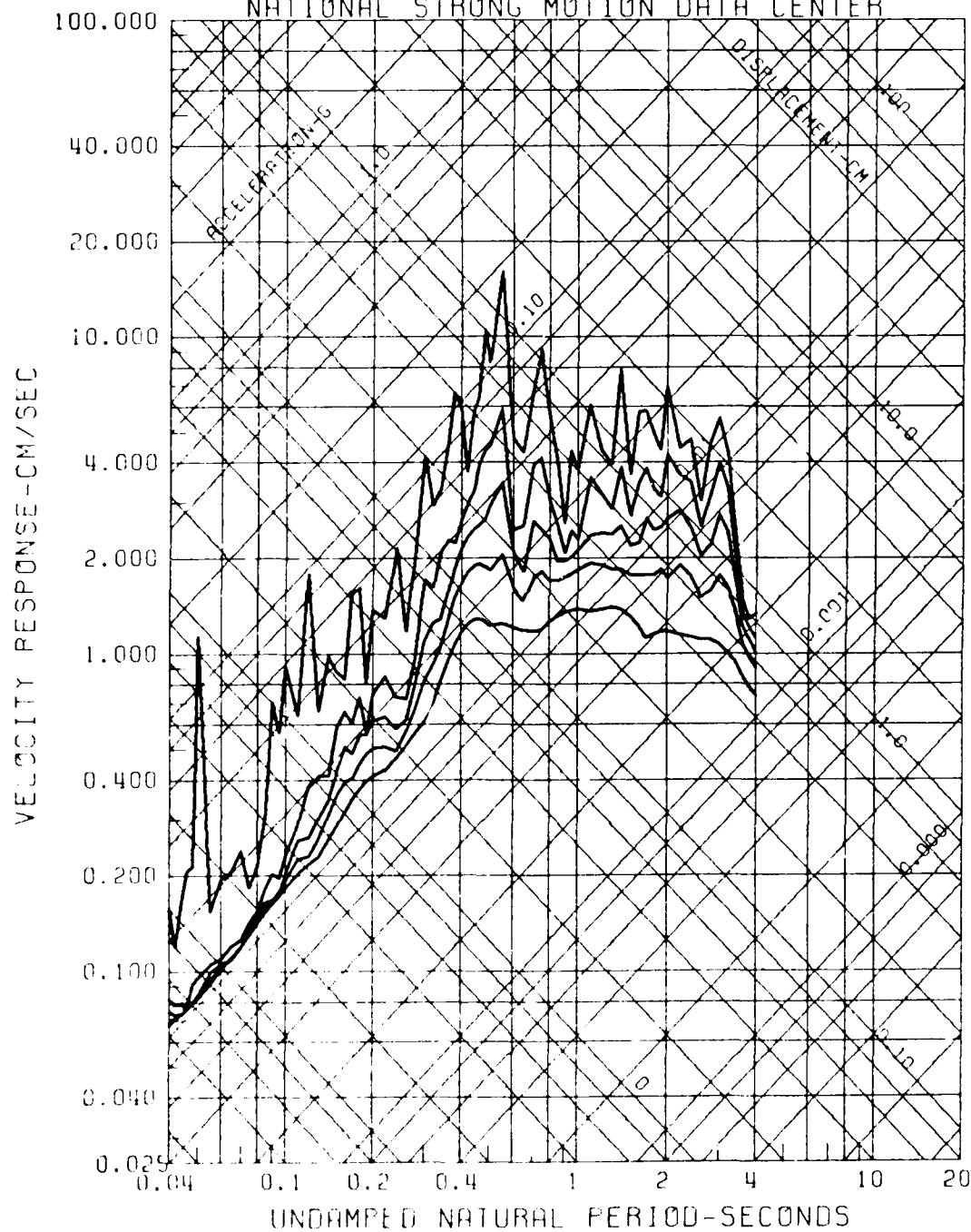
RESPONSE SPECTRA
 RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC UP
 0, 2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



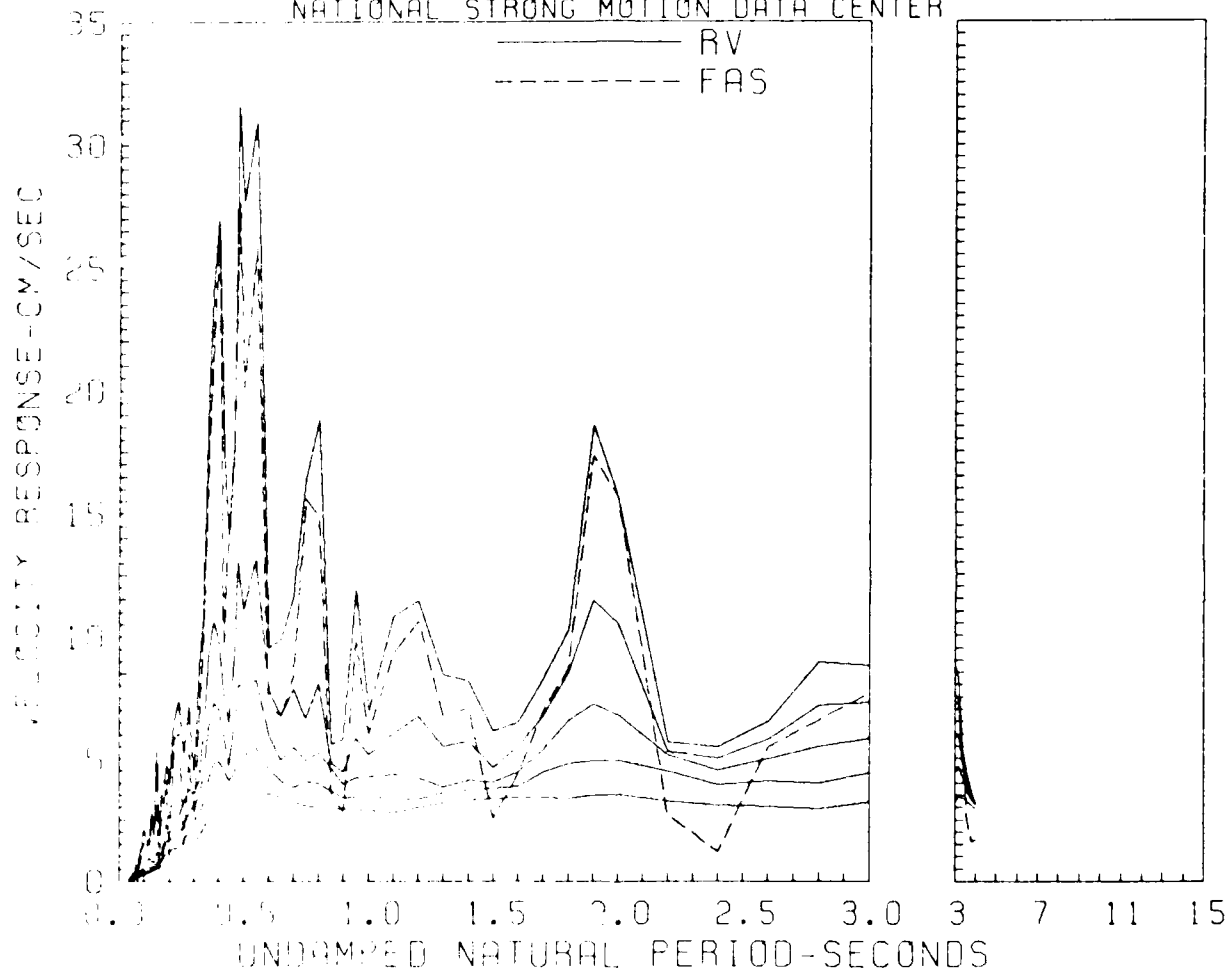
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC 295(T)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



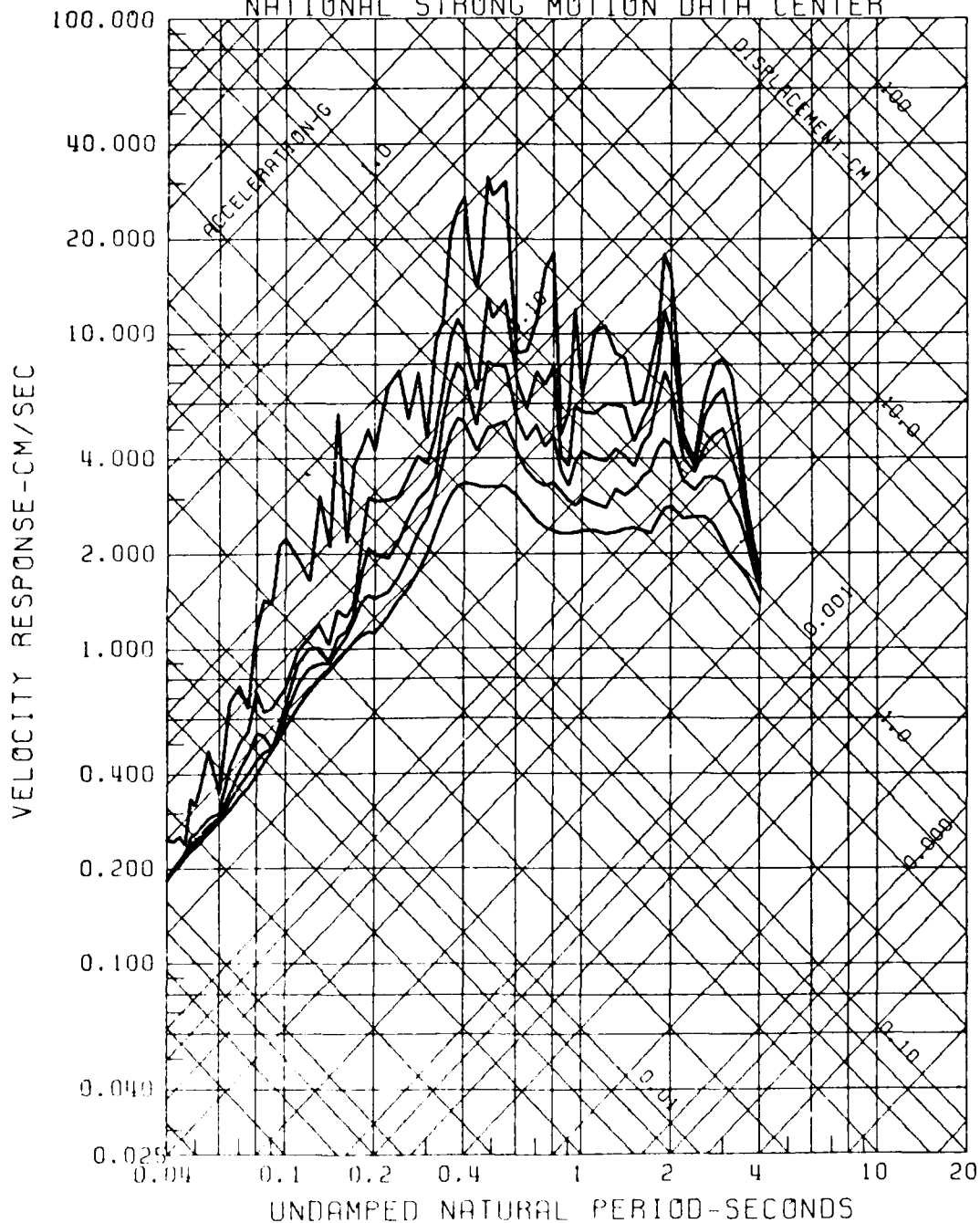
RESPONSE SPECTRA
 RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC 295 (T)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



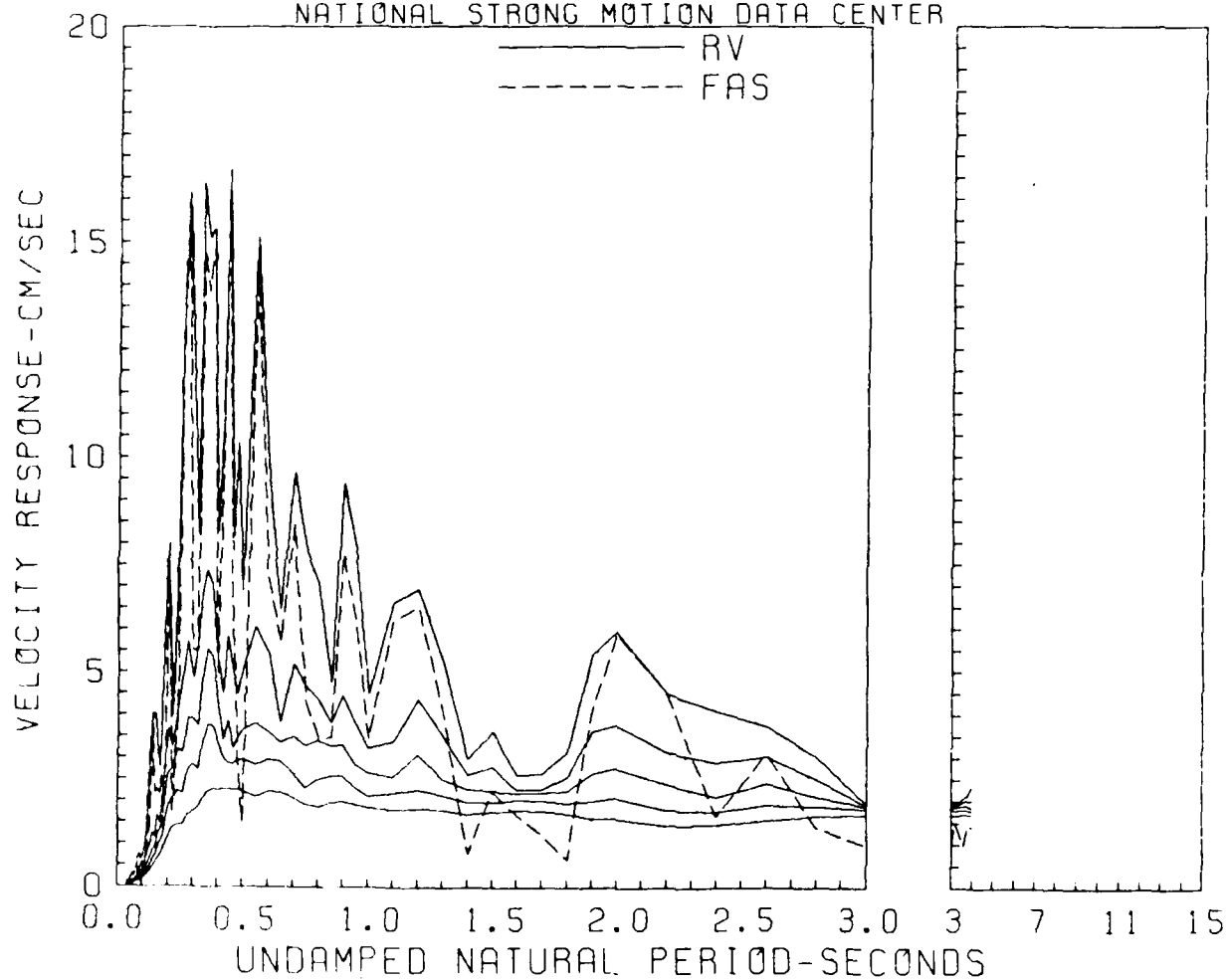
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, CREST, 10/28/83, 1406UTC 25 (L)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



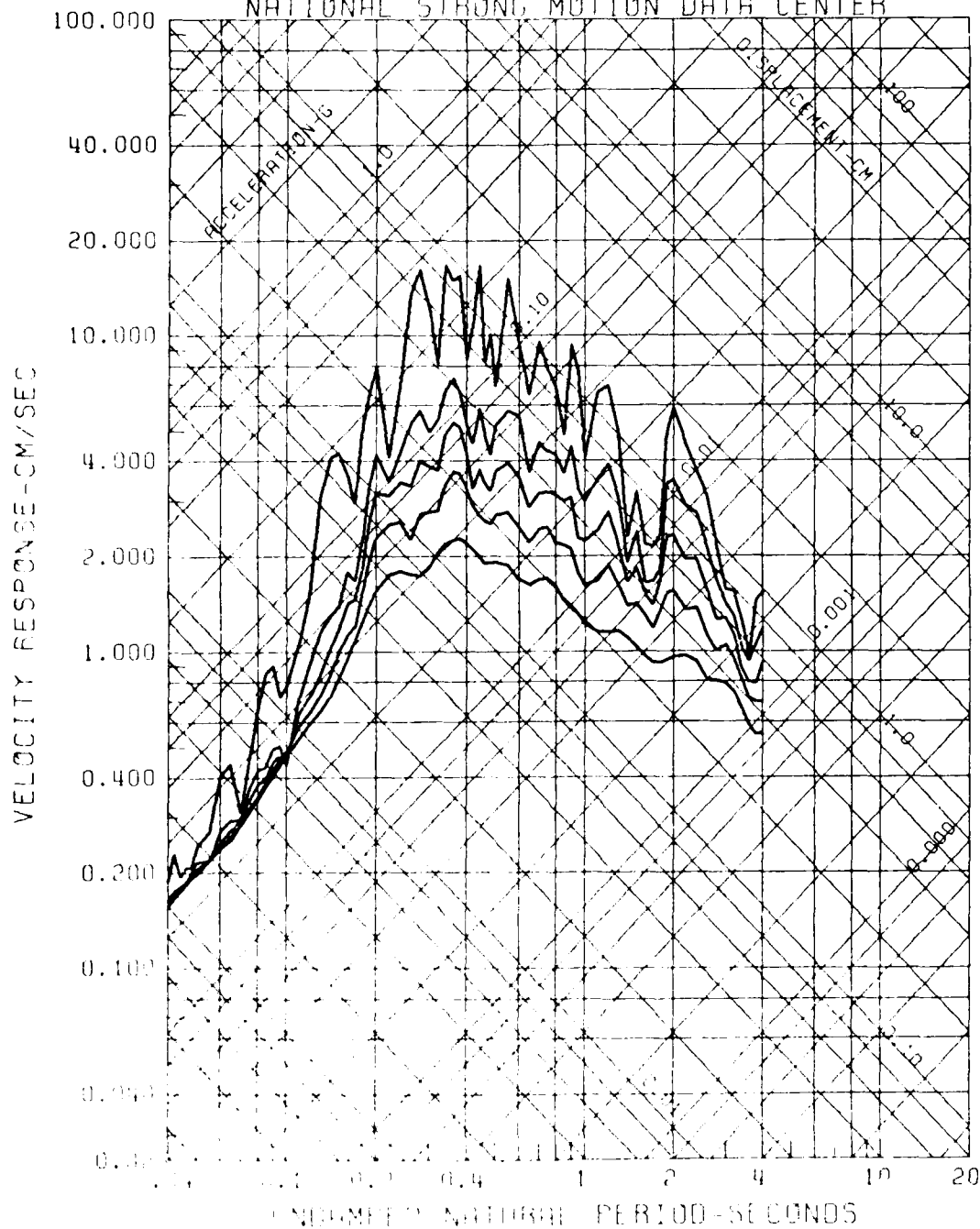
RESPONSE SPECTRA
 RIRIE DAM, CREST, 10/28/83, 1406UTC 25
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



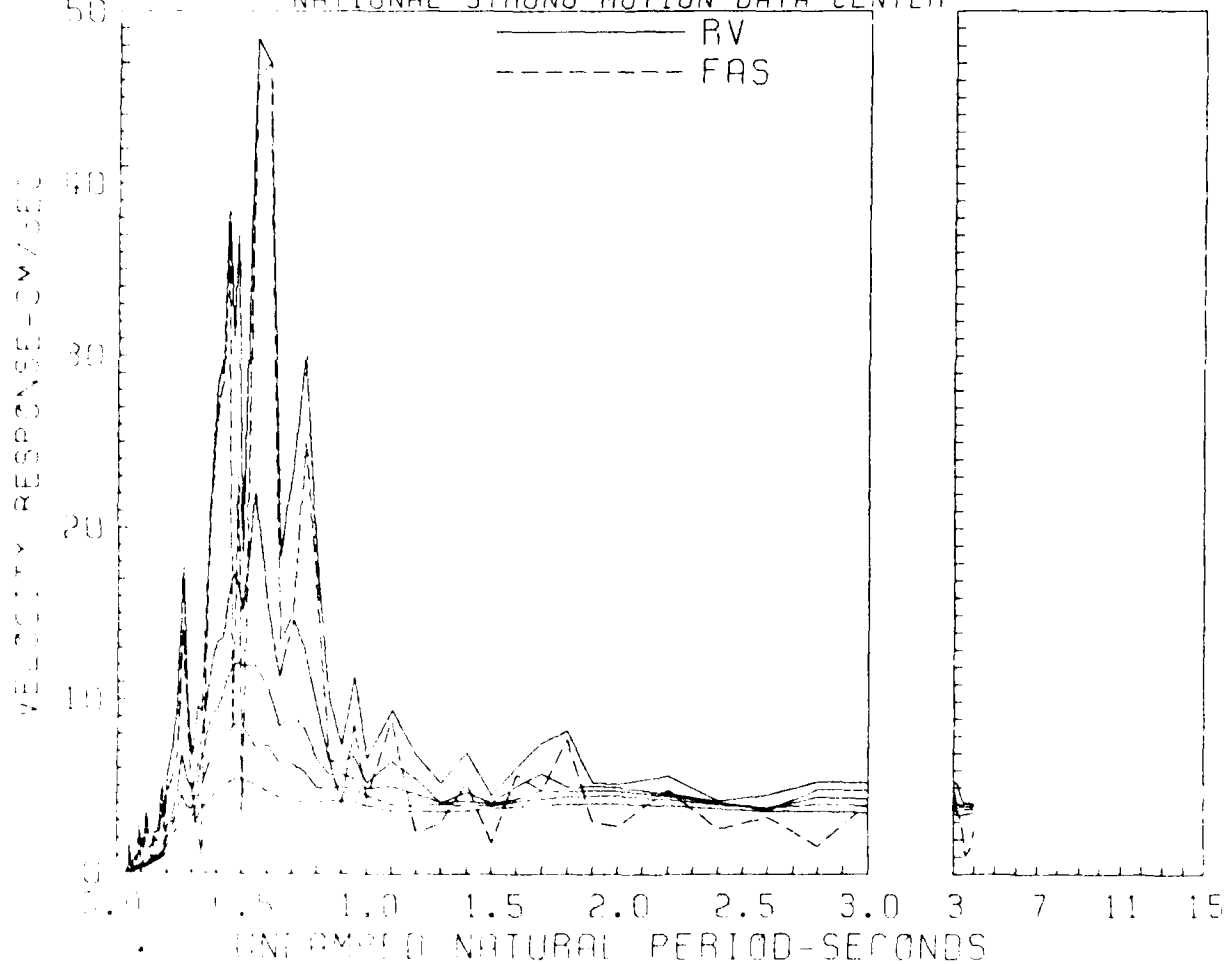
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, CREST, 10/28/83, 1406UTC UP
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



RESPONSE SPECTRA
 RIRIE DAM, CREST, 10/28/83, 1406UTC U
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



RELATIVE VELOCITY RESPONSE SPECTRUM
 BIRIE DAM, CREST, 10/28/83, 1406UTC 295
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 50% NATIONAL STRONG MOTION DATA CENTER



ANALYSIS OF STRONG-MOTION DATA FROM THE MOUNT BORAH
IDAHO EARTHQUAKE OF 28 OCTOBER 1983(U) ARMY ENGINEER
WATERWAYS EXPERIMENT STATION VICKSBURG MS GEOTE.
F K CHANG MAY 85 WES/MP/GL-85-12 F/G 8/11

2/2

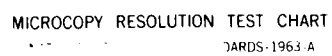
UNCLASSIFIED

F K CHANG MAY 85 WES/MP/GL-85-12

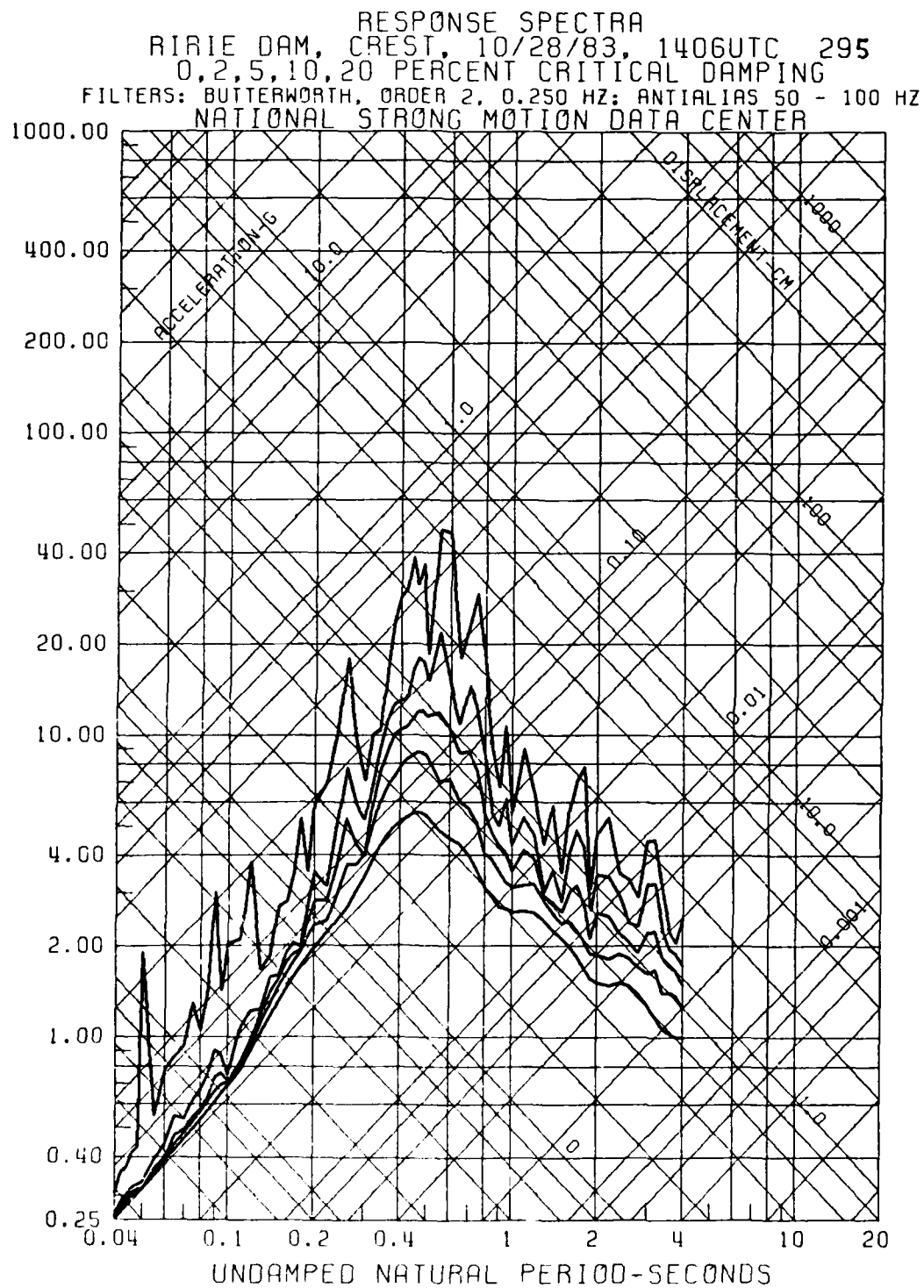
F/G 8/11

NL

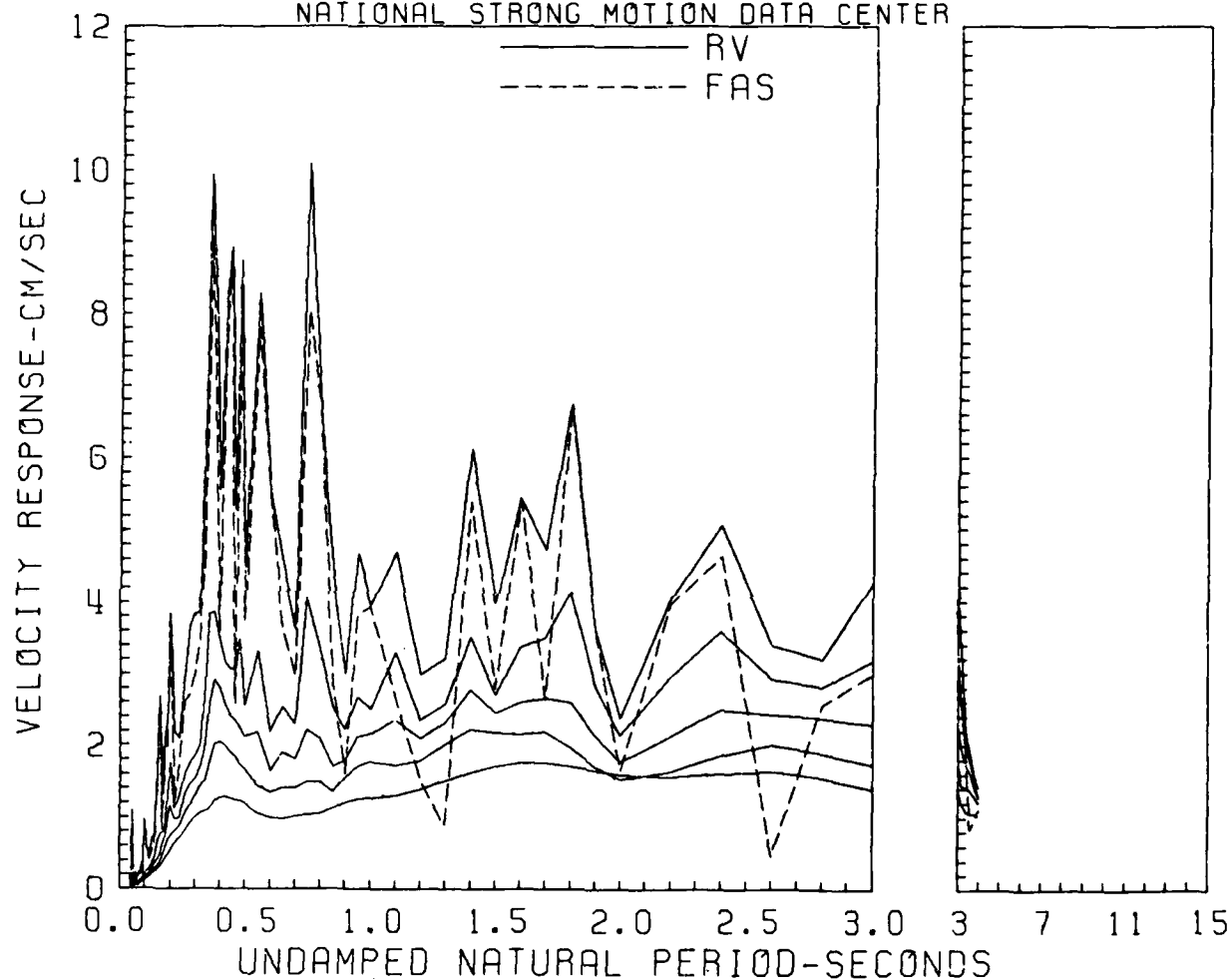
Envi-
- we
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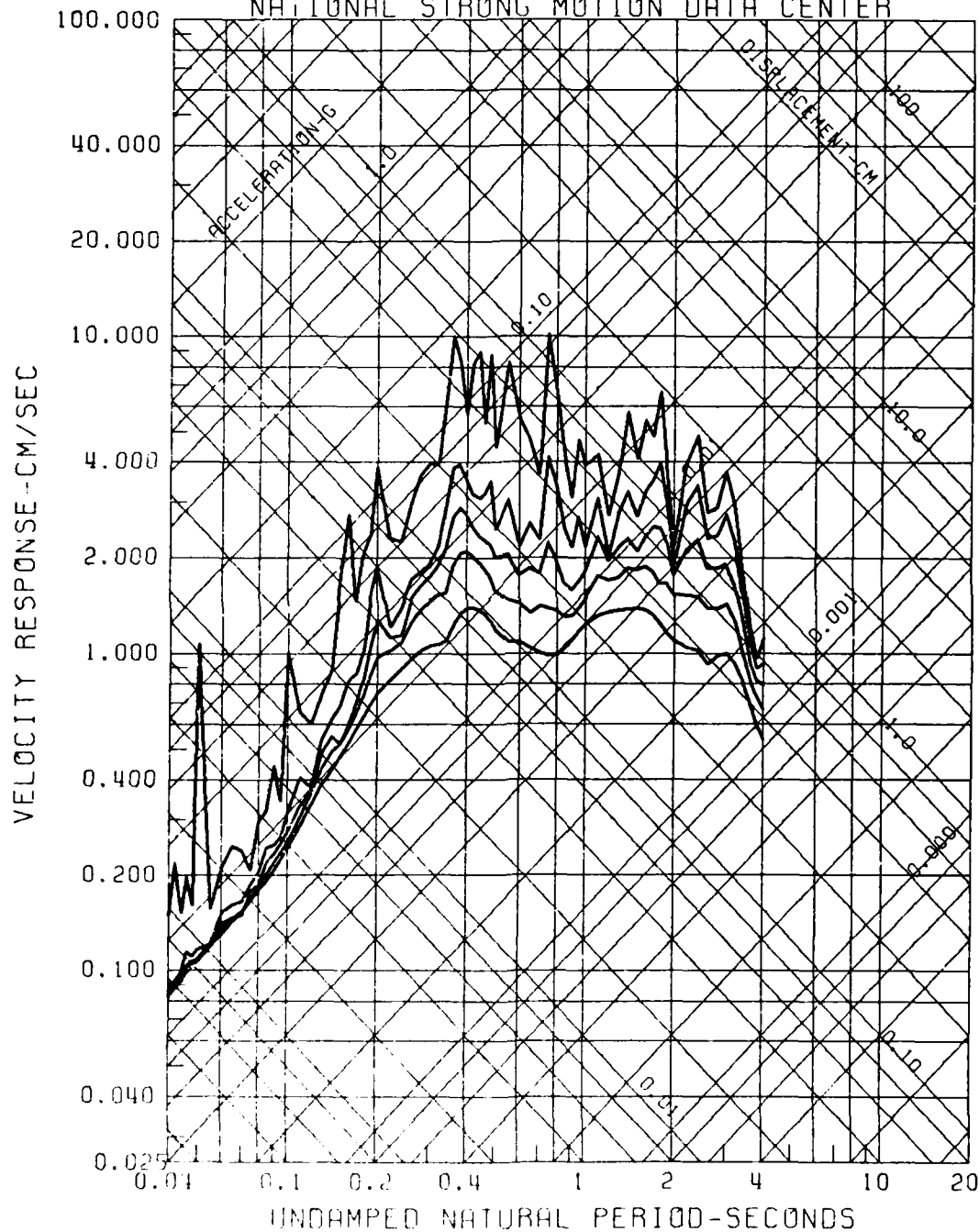
MICROCOPY RESOLUTION TEST CHART
NBS-1963-A



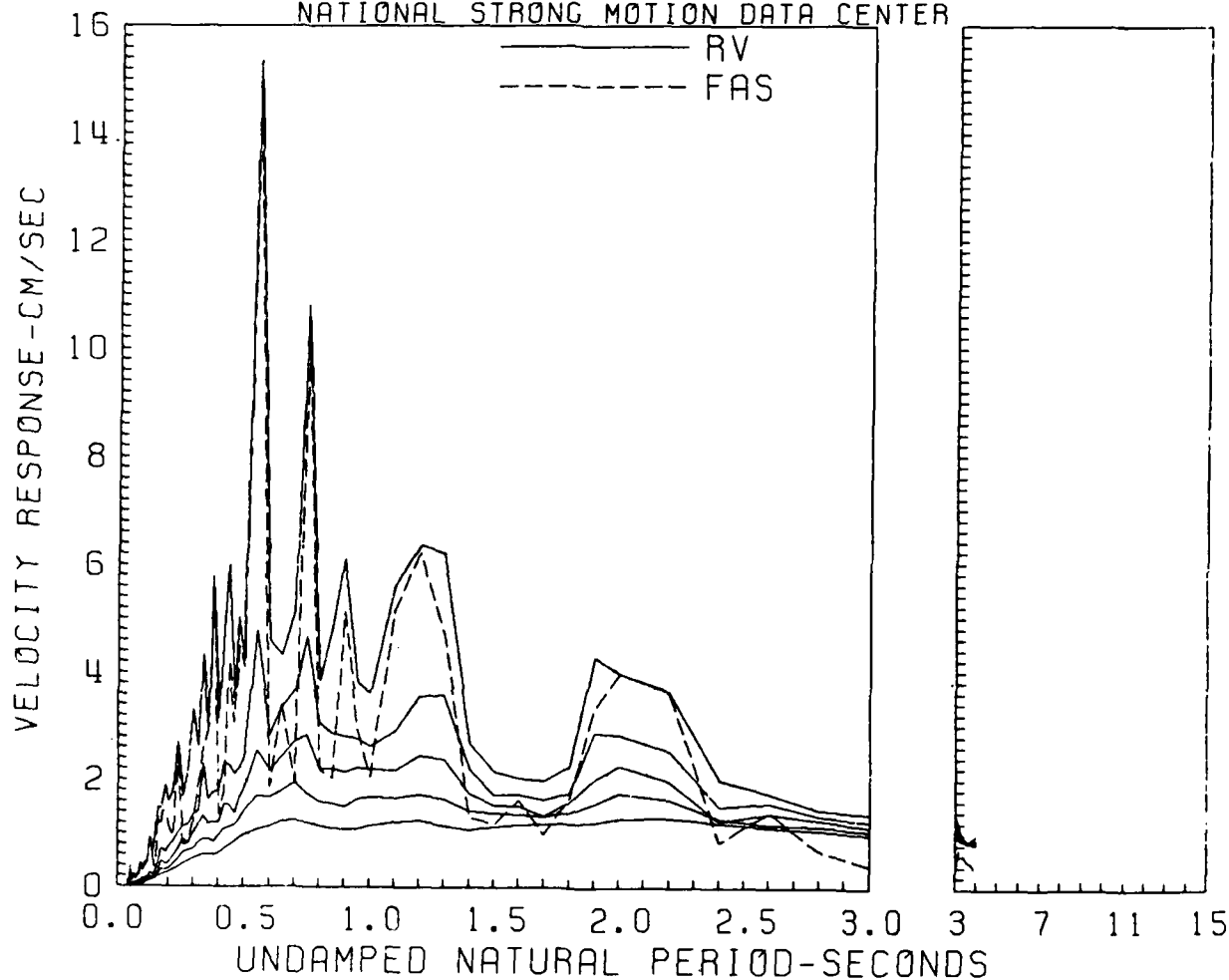
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, DOWNSTREAM, 10/28/83, 1406UTC 237(L)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



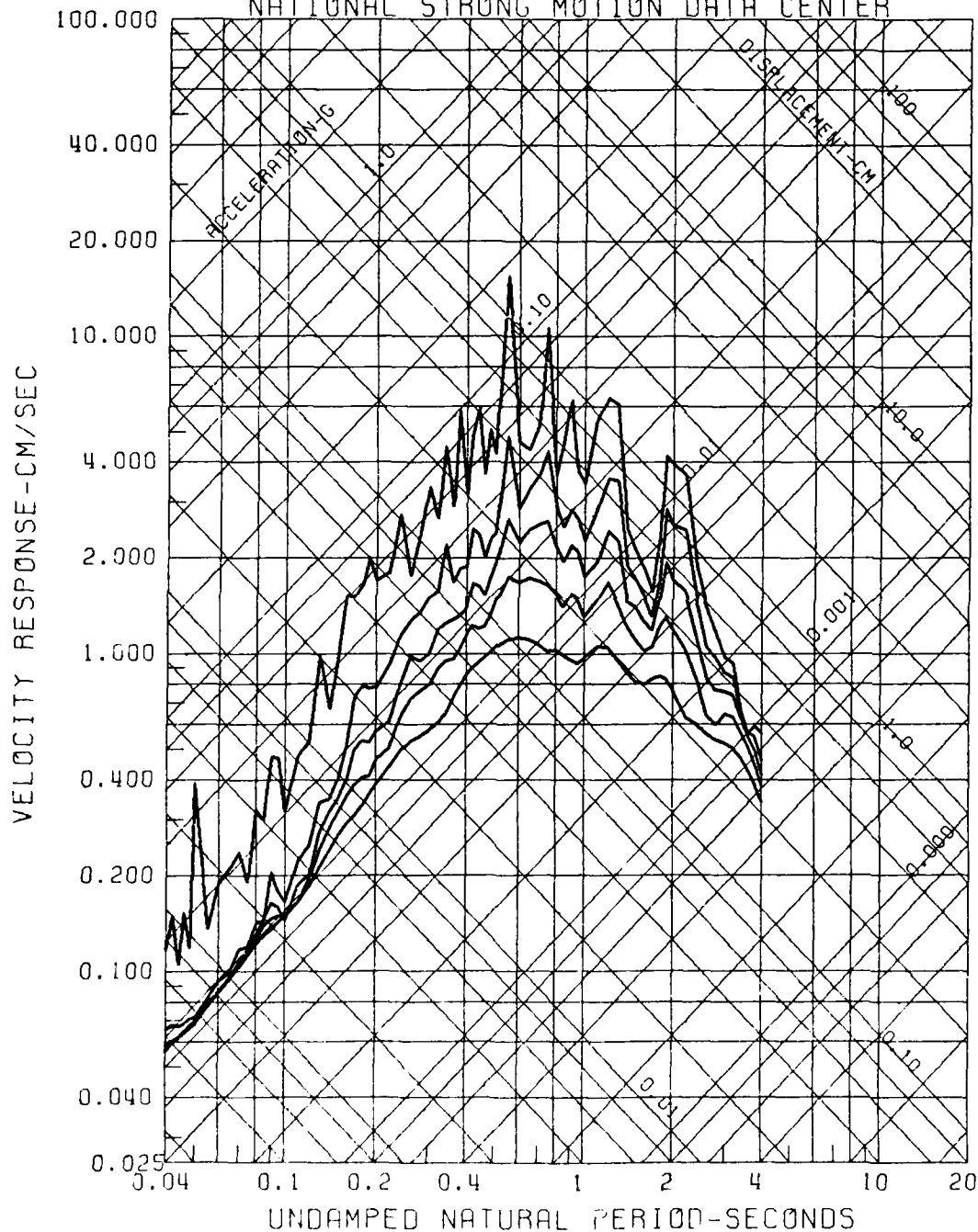
RESPONSE SPECTRA
 RIRIE DAM, DOWNSTREAM, 10/28/83, 1406UTC 237(L)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



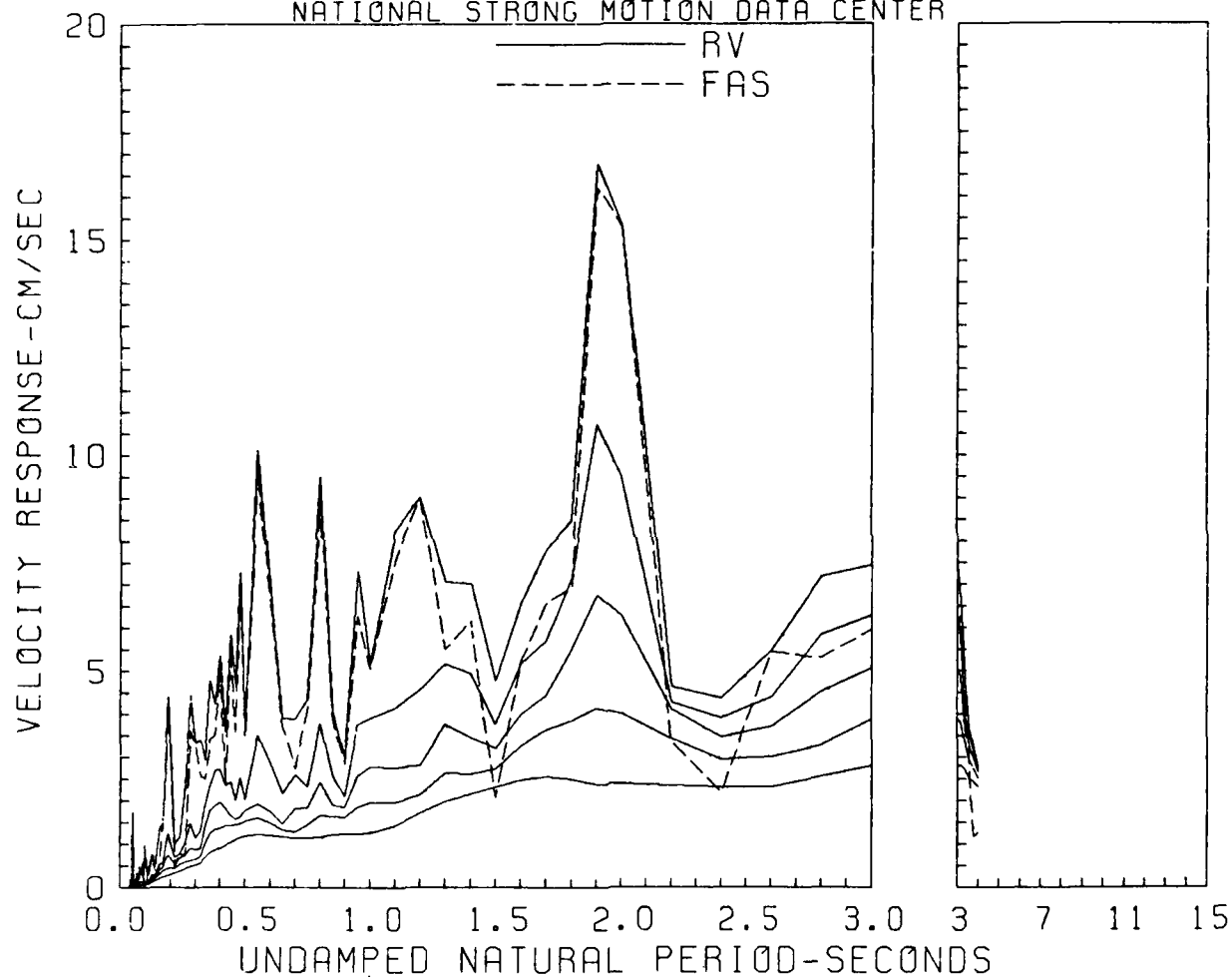
RELATIVE VELOCITY RESPONSE SPECTRUM
RIRIE DAM, DOWNSTREAM, 10/28/83, 1406UTC UP
0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
NATIONAL STRONG MOTION DATA CENTER



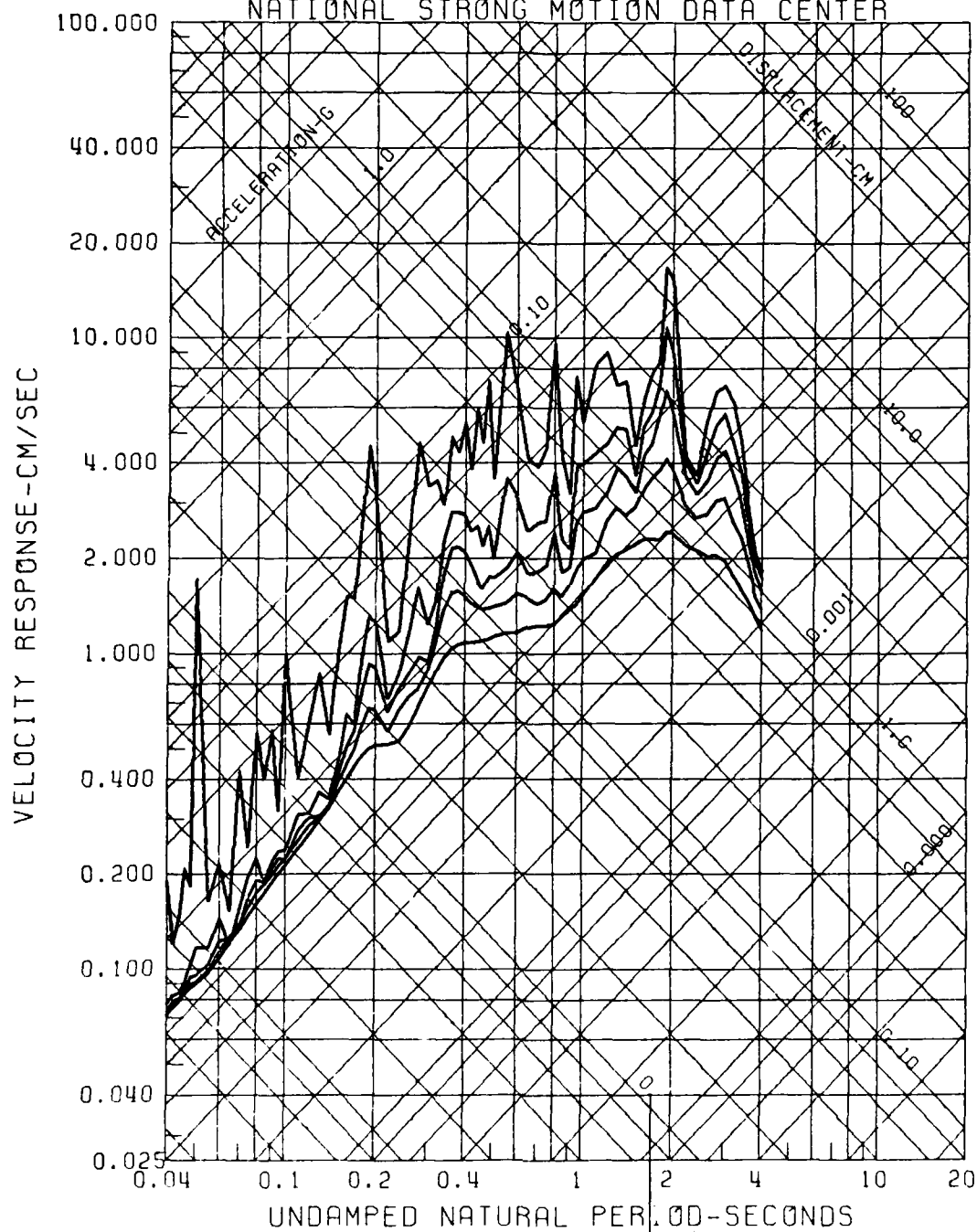
RESPONSE SPECTRA
 RIRIE DAM, DOWNSTREAM, 10/28/83, 1406UTC UP
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



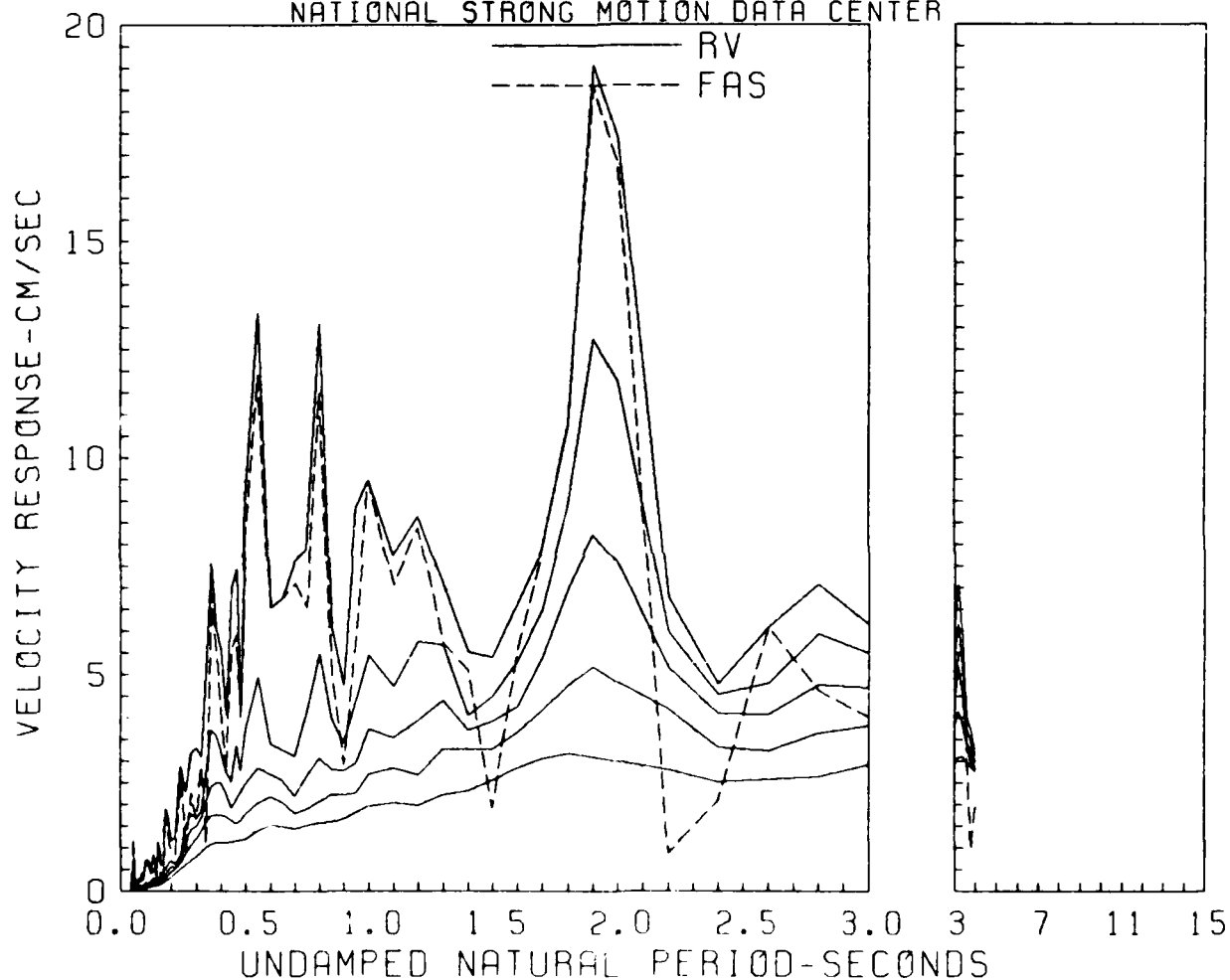
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, DOWNSTREAM, 10/28/83, 1406UTC 147(T)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



RESPONSE SPECTRA
 RIRIE DAM, DOWNSTREAM, 10/28/83, 1406UTC 147 (T)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC 25
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC 25

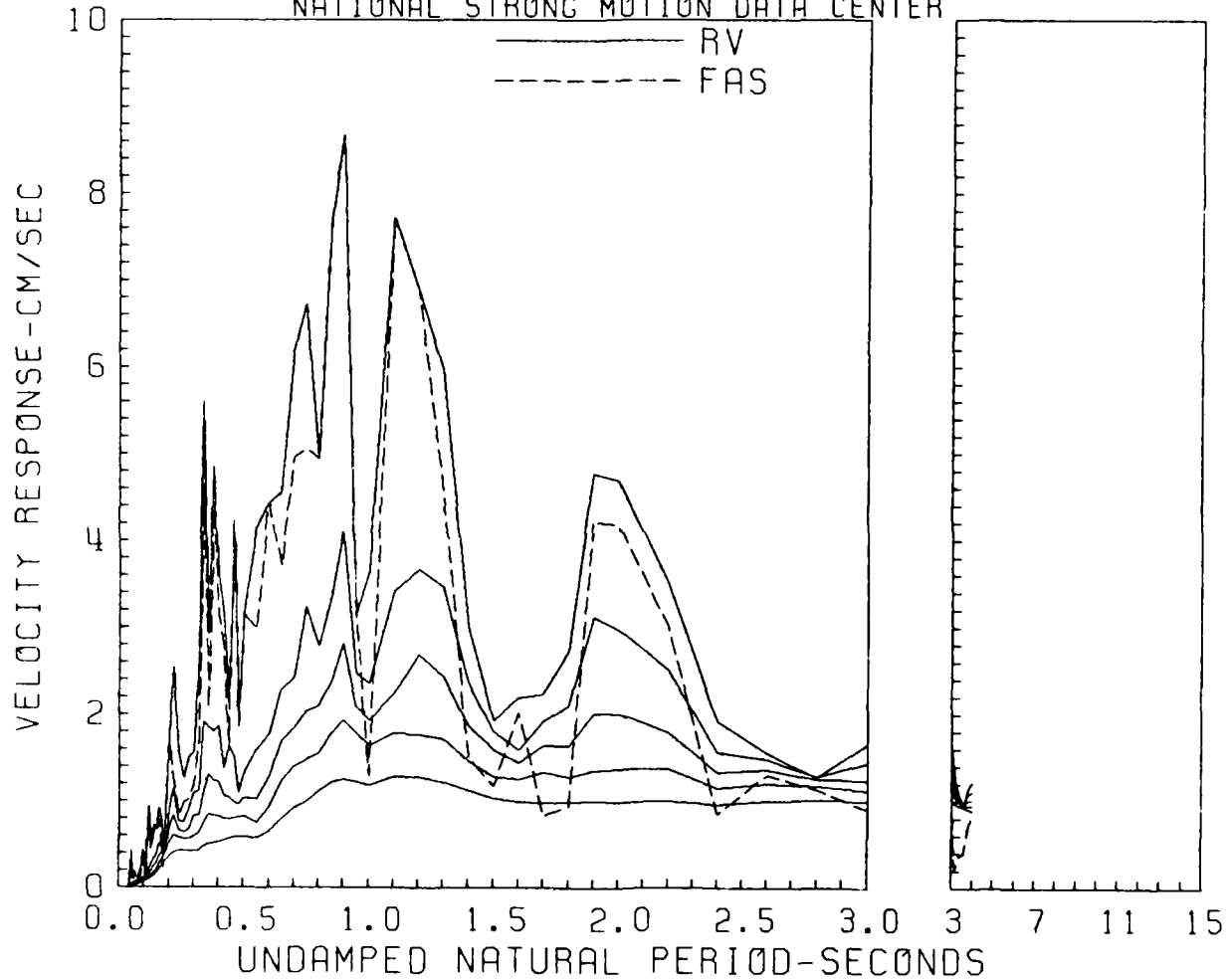
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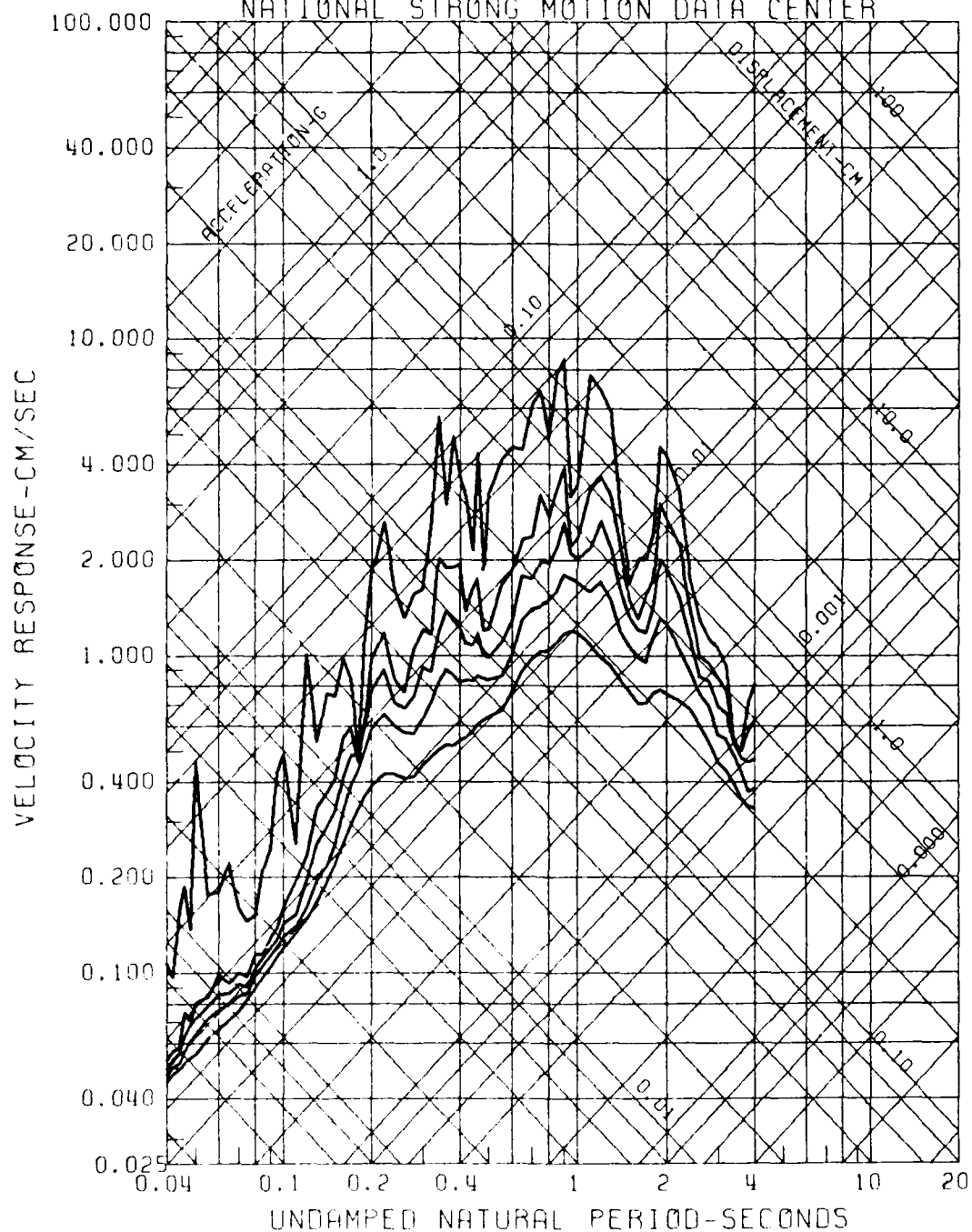
NATIONAL STRONG MOTION DATA CENTER



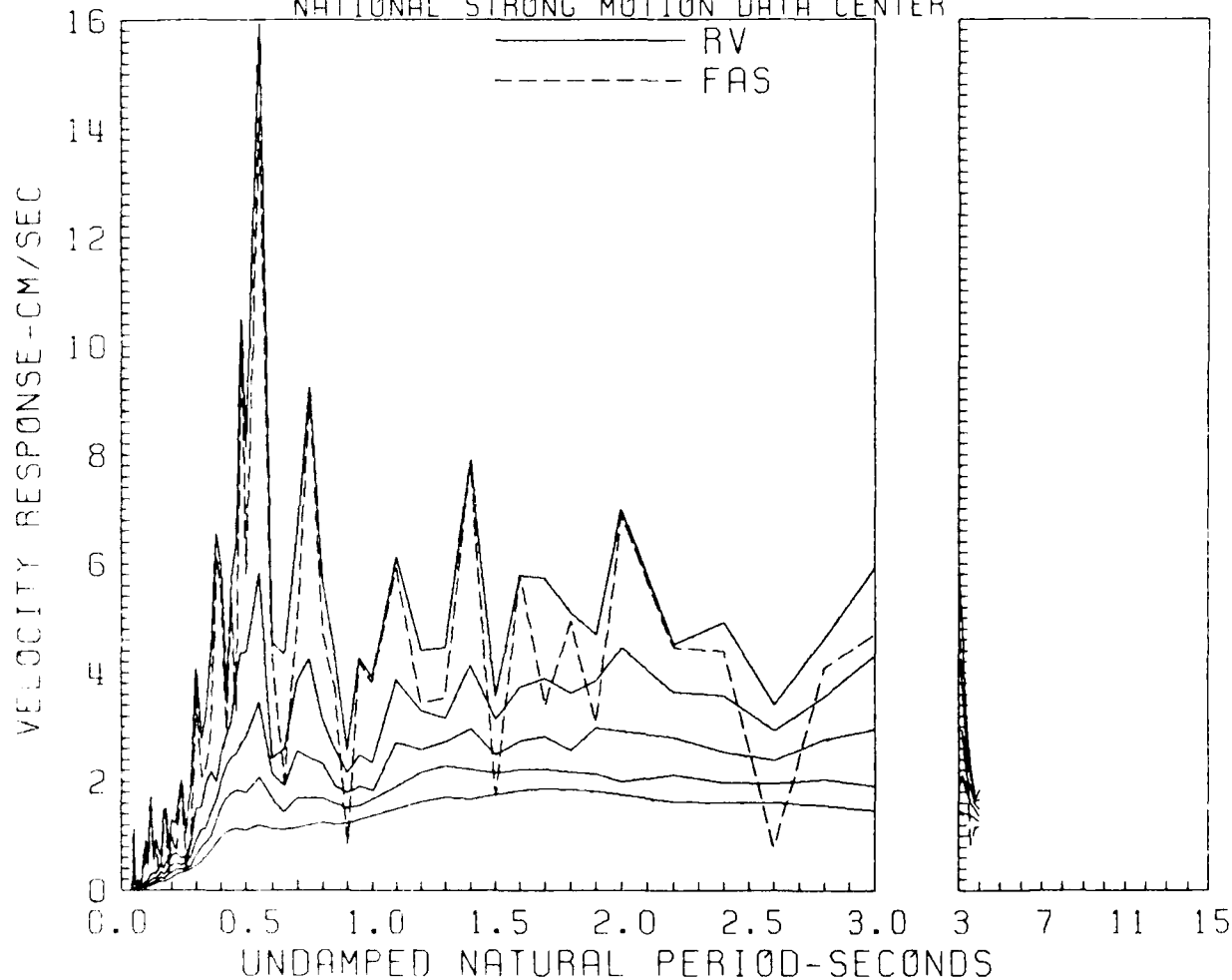
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC UP
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



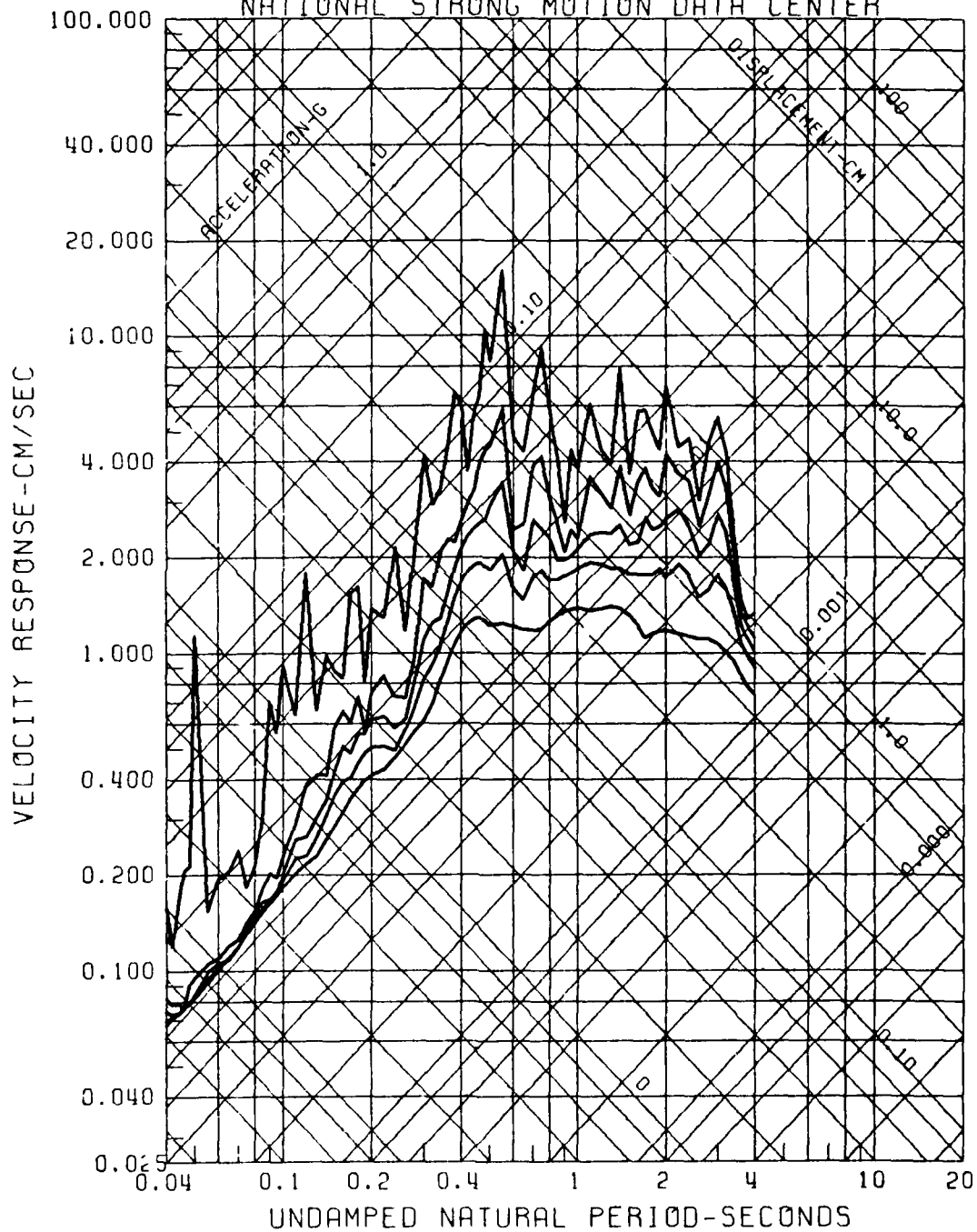
RESPONSE SPECTRA
 RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC UP
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



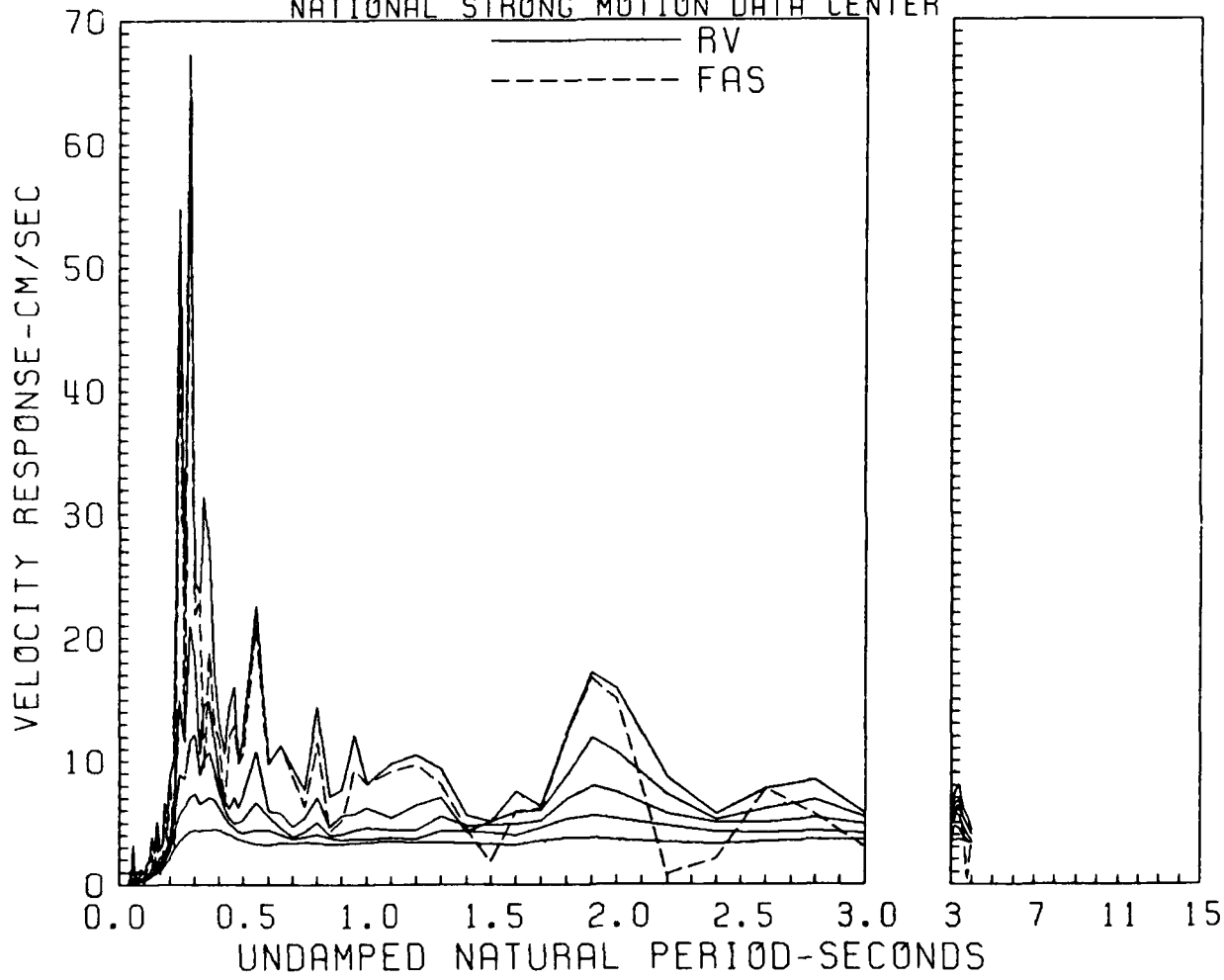
RELATIVE VELOCITY RESPONSE SPECTRUM
RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC 295(T)
0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
NATIONAL STRONG MOTION DATA CENTER



RESPONSE SPECTRA
 RIRIE DAM, LOWER TOWER, 10/28/83, 1406UTC 295 (T)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



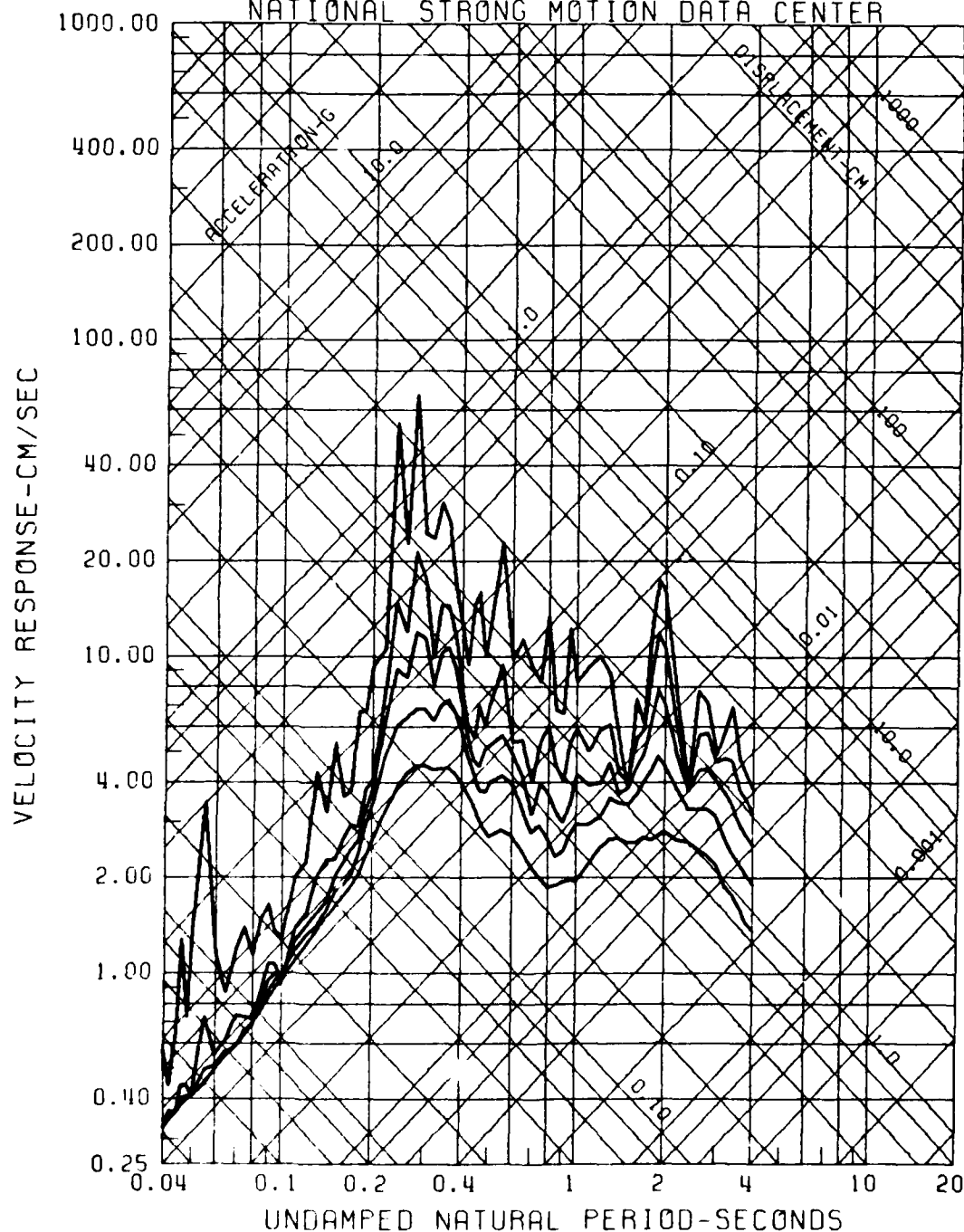
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, UPPER TOWER, 10/28/83, 1406UTC 25(L)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



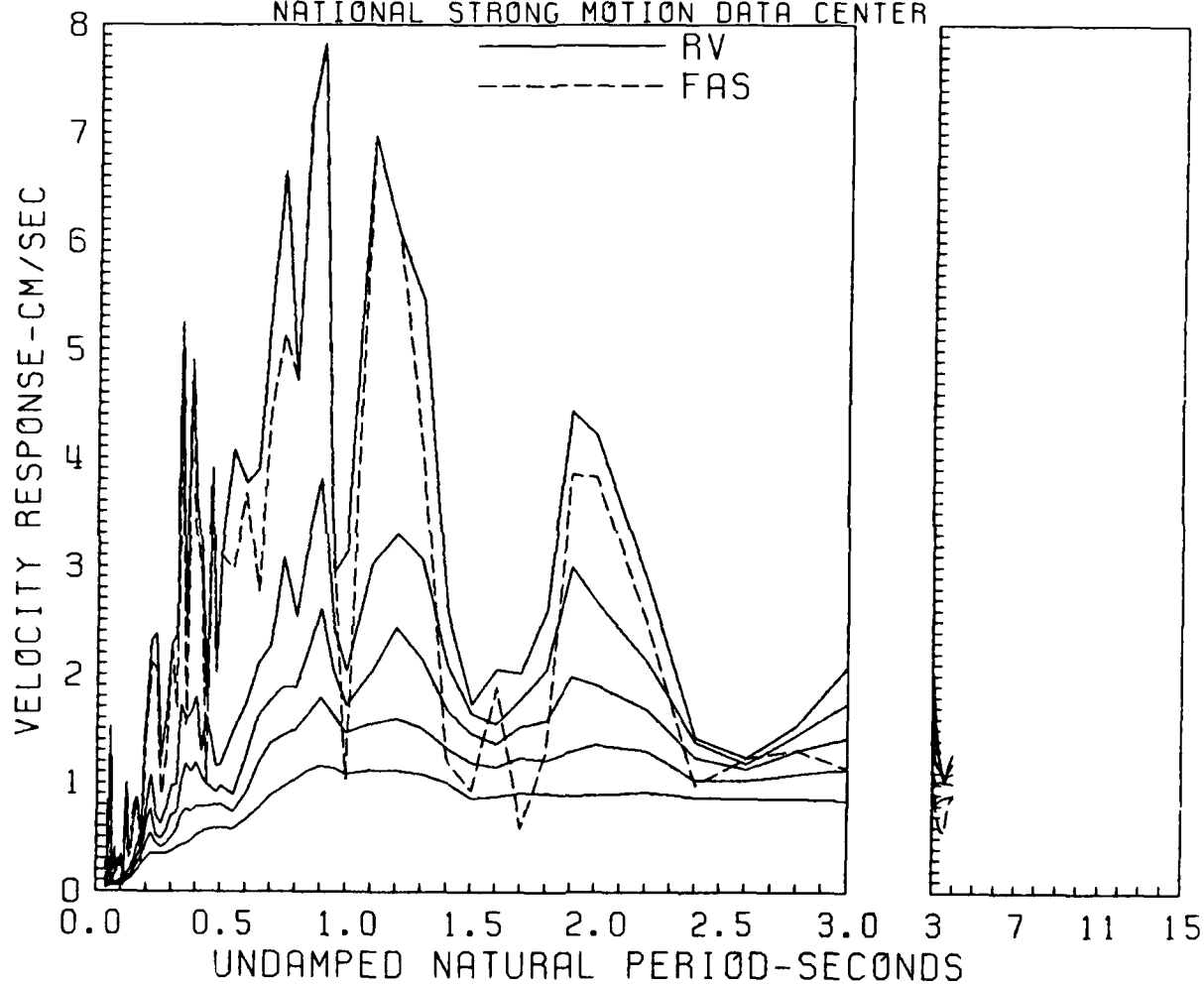
RESPONSE SPECTRA
 RIRIE DAM, UPPER TOWER, 10/28/83, 1406UTC 25(L)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING

FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ

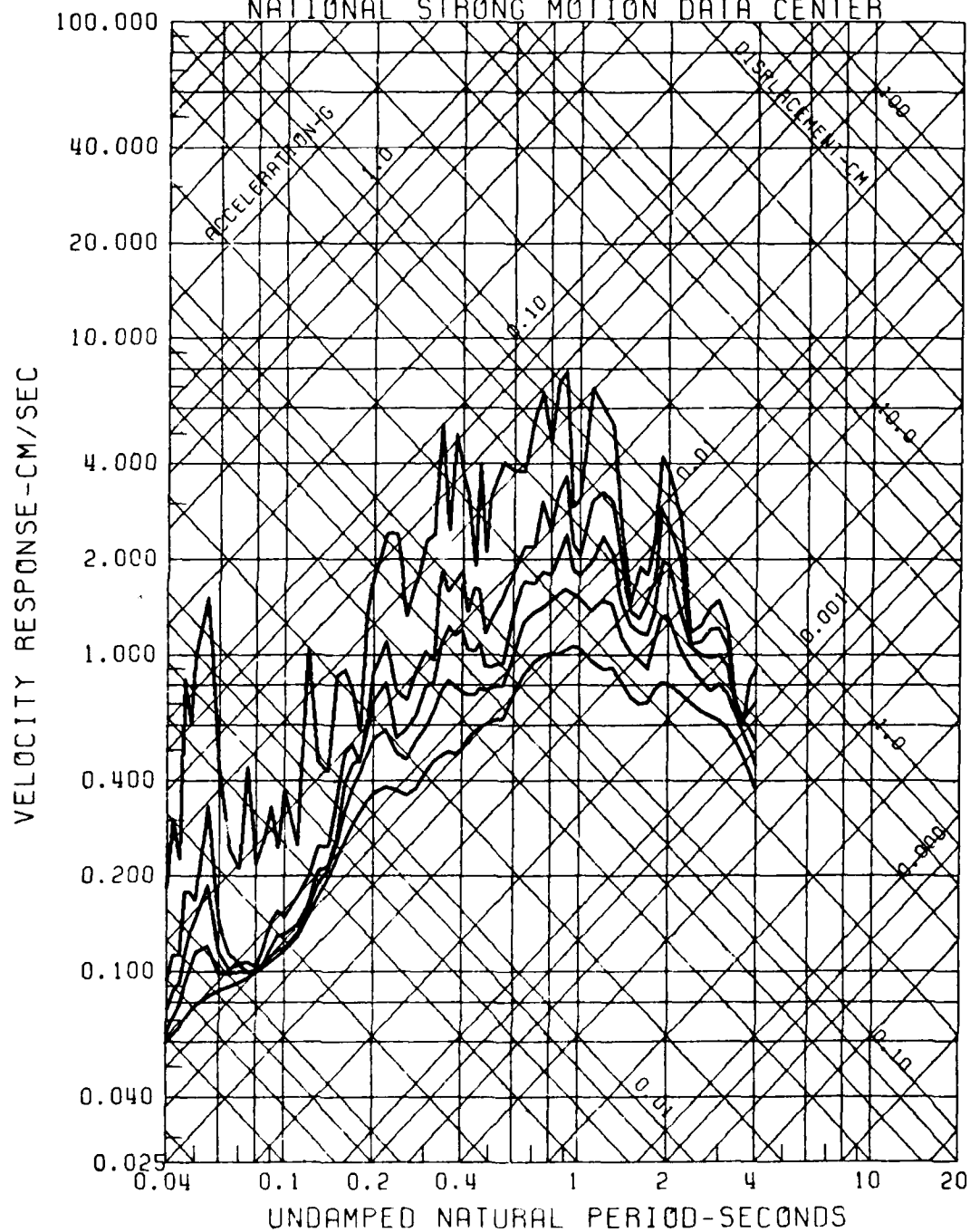
NATIONAL STRONG MOTION DATA CENTER



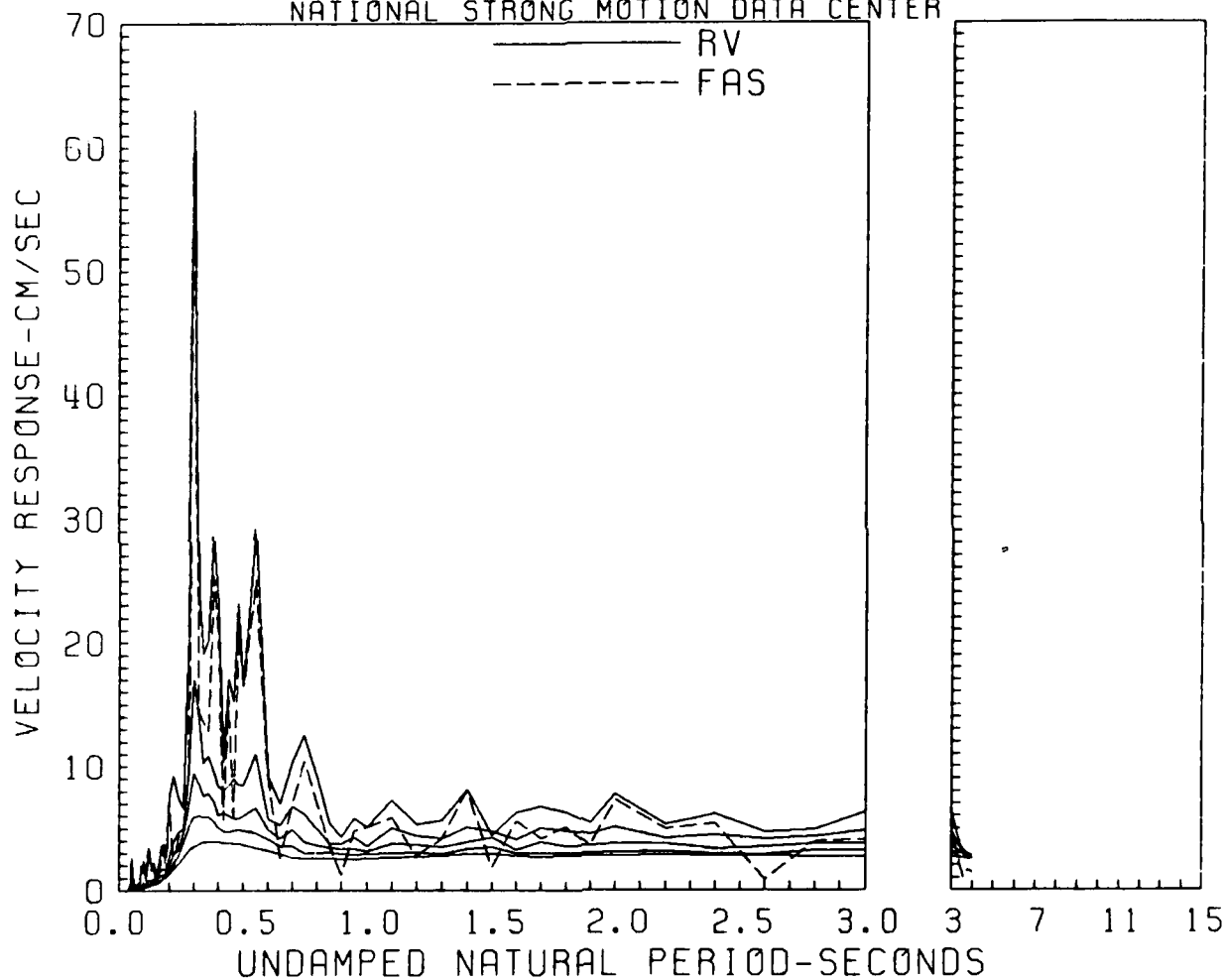
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, UPPER TOWER, 10/28/83, 1406UTC UP
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



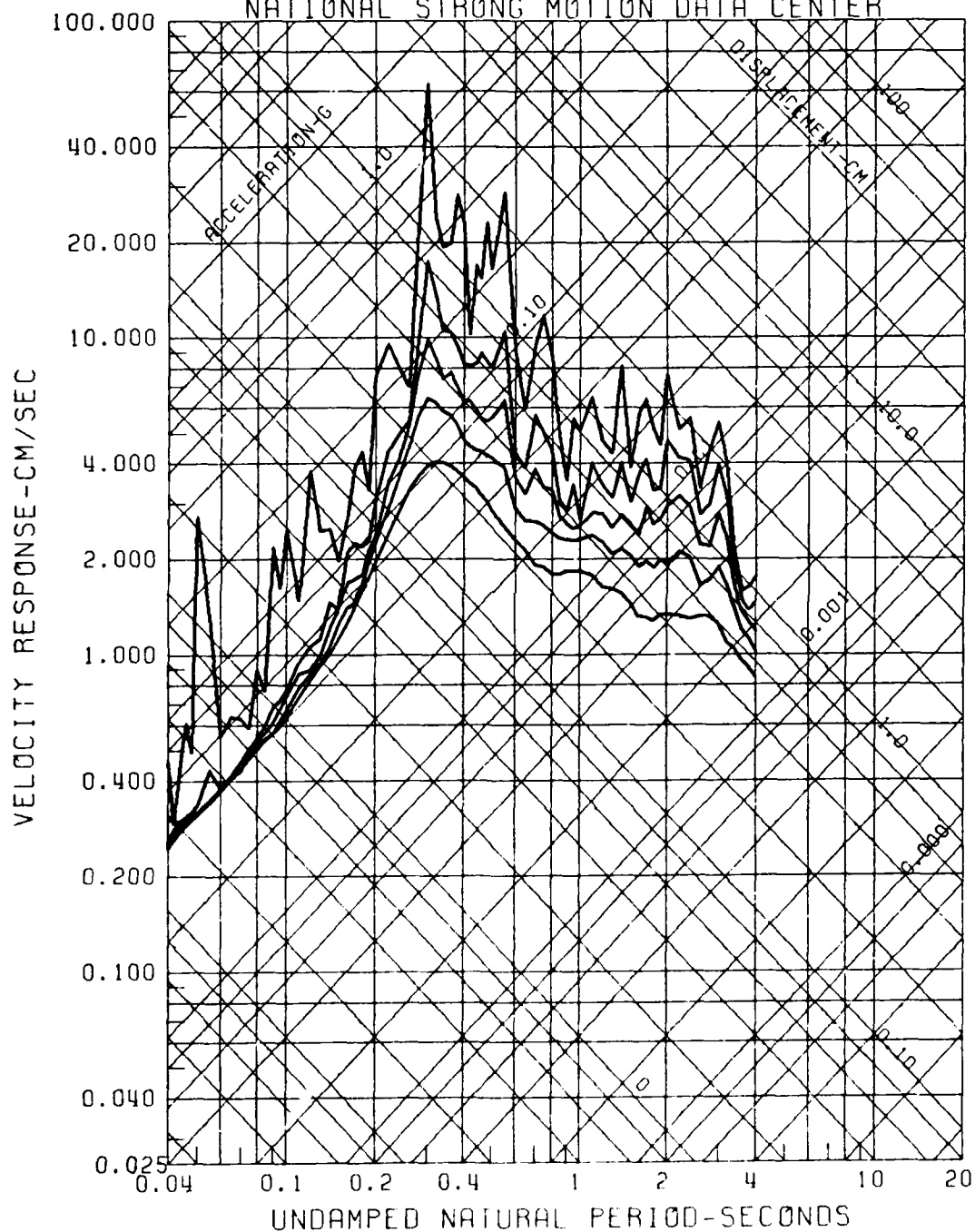
RESPONSE SPECTRA
 RIRIE DAM, UPPER TOWER, 10/28/83, 1406UTC UP
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



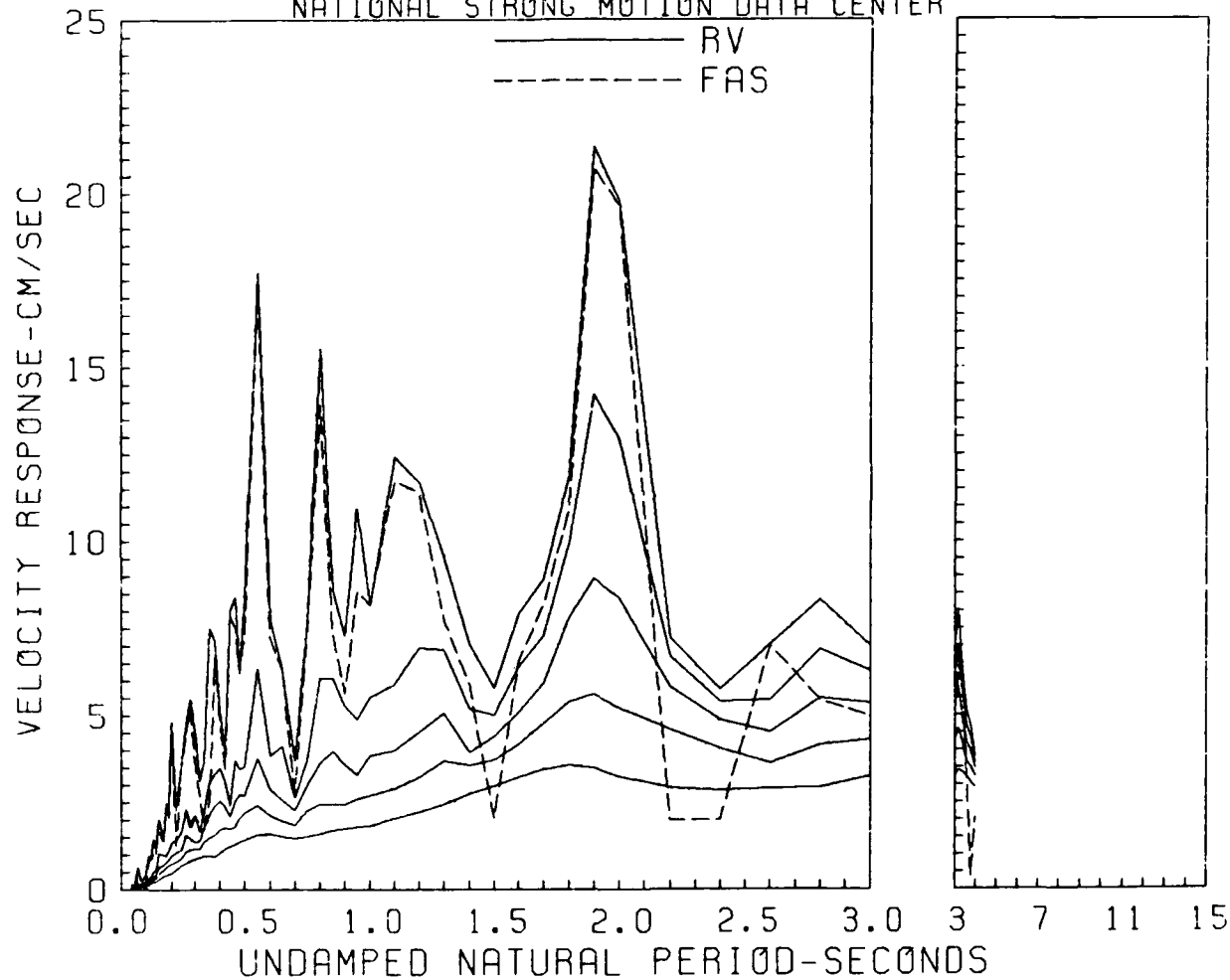
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, UPPER TOWER, 10/28/83, 1406UTC 295
 0, 2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



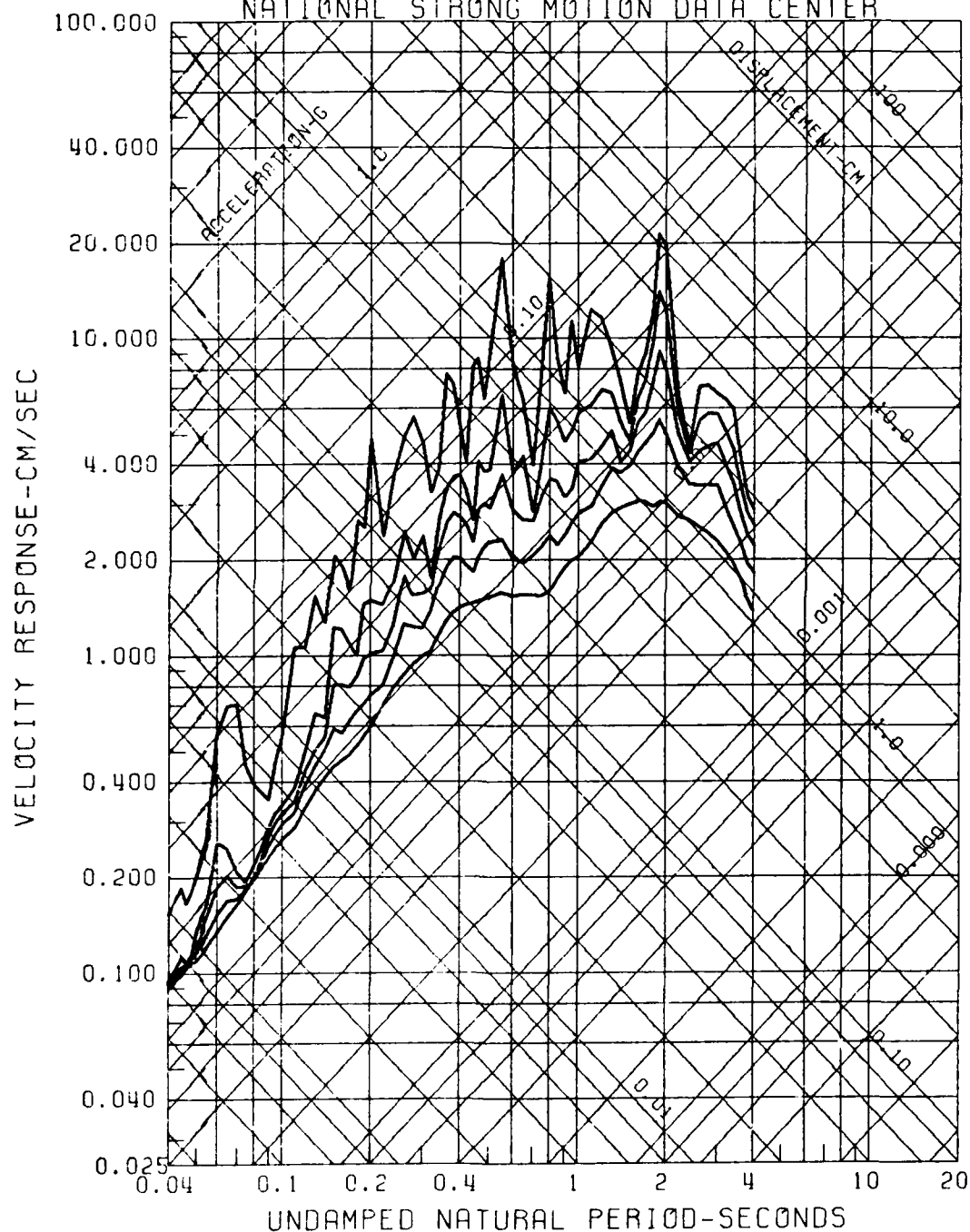
RESPONSE SPECTRA
 RIRIE DAM, UPPER TOWER, 10/28/83, 1406UTC 295(T)
 0.2,5,10,20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



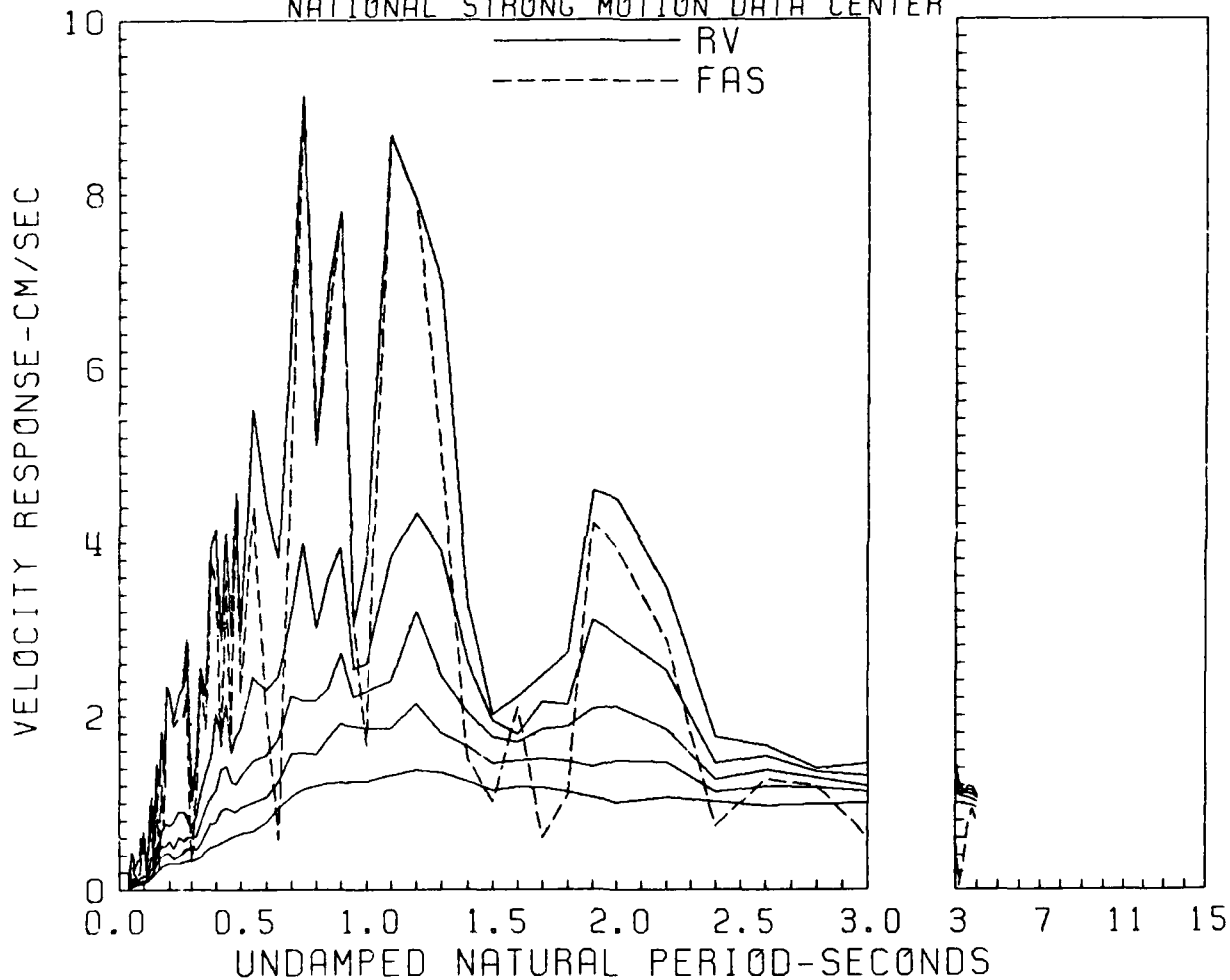
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, ABUTMENT, 10/28/83, 1406UTC 25 (L)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



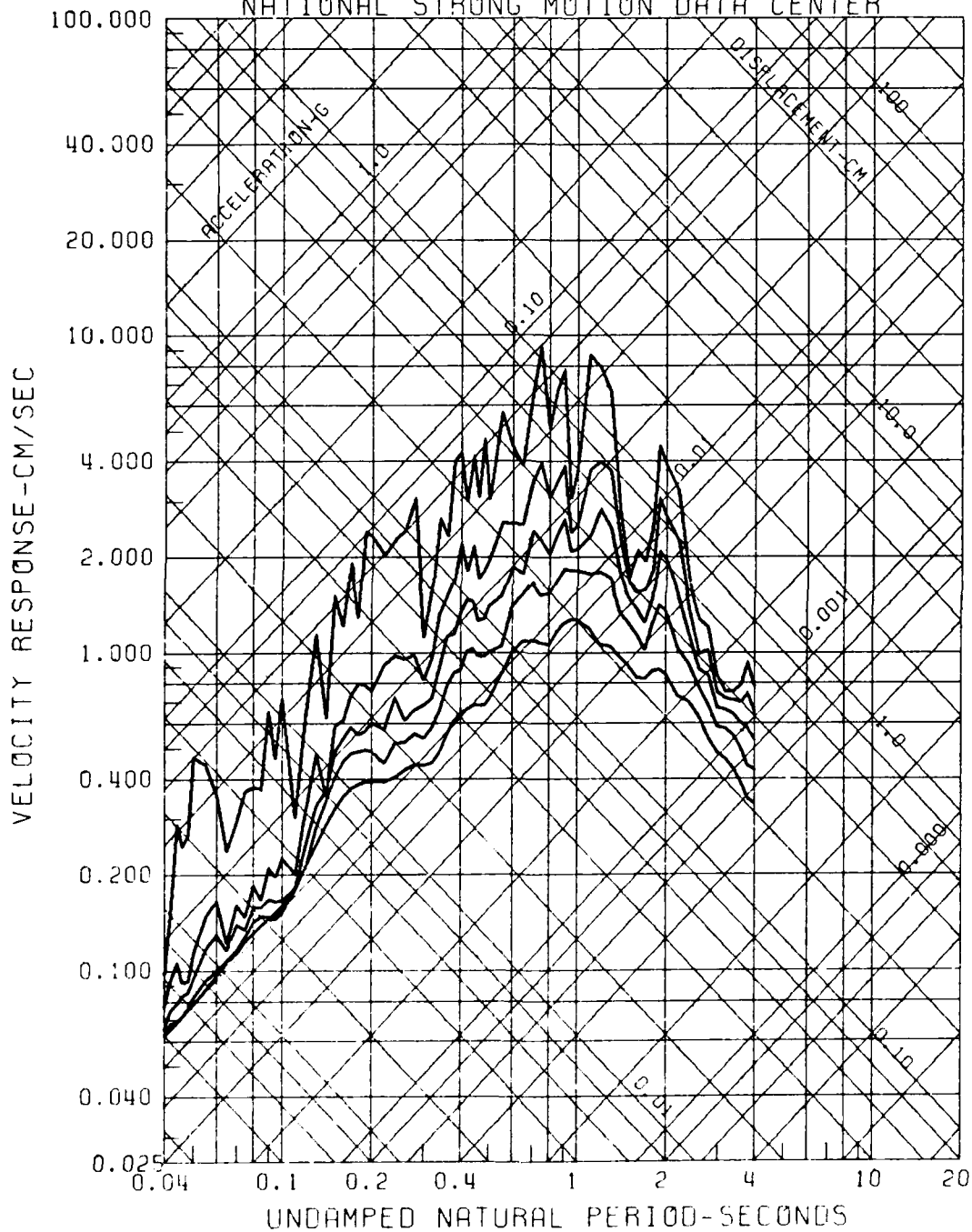
RESPONSE SPECTRA
 RIRIE DAM, ABUTMENT, 10/28/83, 1406UTC 25(L)
 0.2,5,10,20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



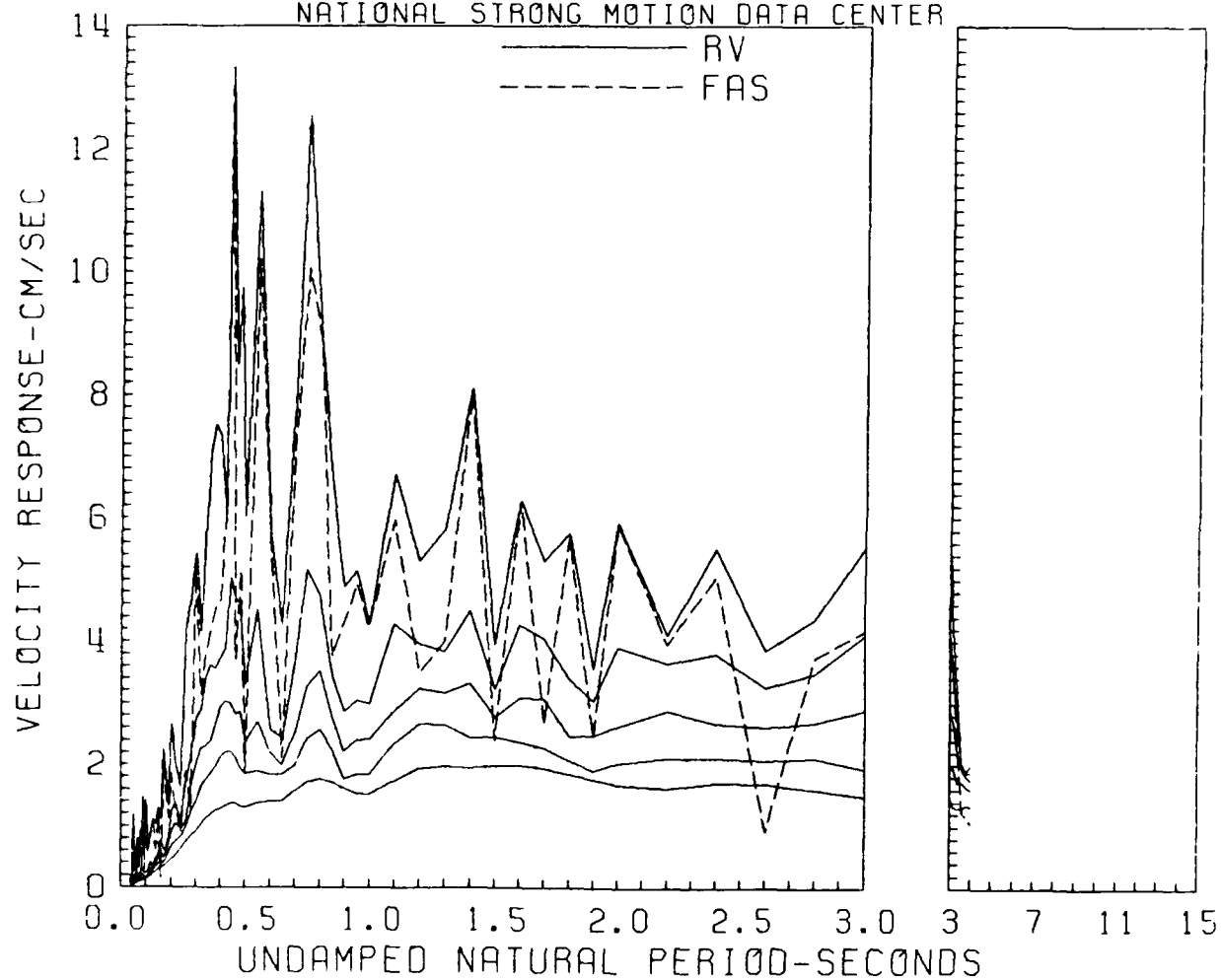
RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, ABUTMENT, 10/28/83, 1406UTC UP
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 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



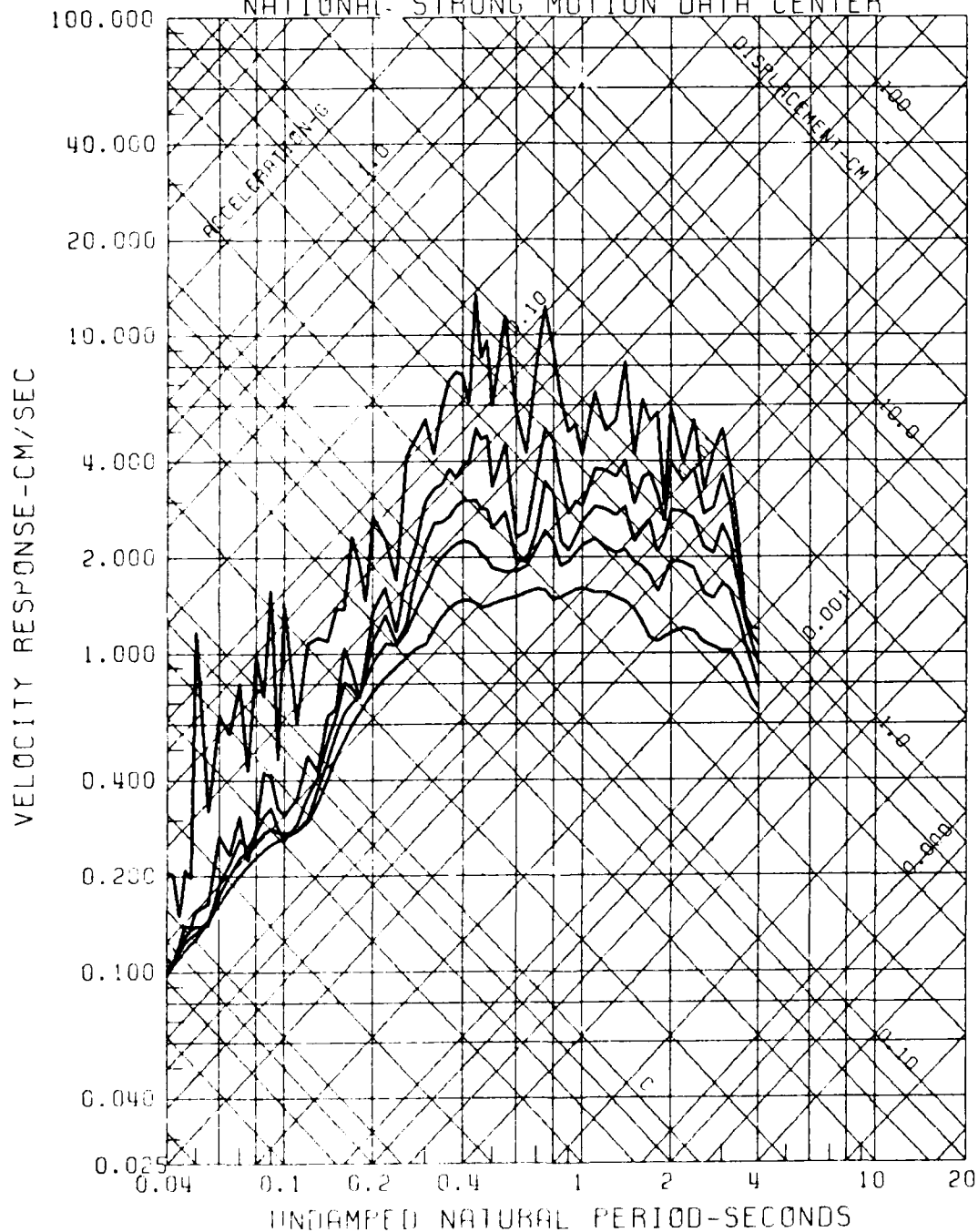
RESPONSE SPECTRA
 RIRIE DAM, ABUTMENT, 10/28/83, 1406UTC UP
 0,2,5,10,20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



RELATIVE VELOCITY RESPONSE SPECTRUM
 RIRIE DAM, ABUTMENT, 10/28/83, 1406UTC 295(T)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
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RESPONSE SPECTRA
 RIRIE DAM, ABUTMENT, 10/28/83, 1406UTC 295(T)
 0.2, 5, 10, 20 PERCENT CRITICAL DAMPING
 FILTERS: BUTTERWORTH, ORDER 2, 0.250 HZ; ANTIALIAS 50 - 100 HZ
 NATIONAL STRONG MOTION DATA CENTER



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