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The Round Robin Program: Ground Motion in the Vicinity of the Potrillo Event ~~(C)~~ U

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Jerald W. Long

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THE ROUND ROBIN PROGRAM: GROUND MOTION IN THE VICINITY OF THE POTRILLO EVENT (C)

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ABSTRACT (C)

Surface motion was measured at seven stations on the Potrillo event for the Round Robin program, with all gages providing complete records. At one station there may be an error in calibration for two of the three gages. Analysis of signal arrival times showed an unusual trend with a constantly changing velocity between stations. With the exception of one station, the attenuation rate of the data fits a straight line very well. Analysis of spall by two different methods leaves the limit of spall in some doubt.

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PREFACE

If a nuclear detonation occurs too near the ground surface, there is a possibility of radioactive gases escaping into the atmosphere. All tests are planned to be conducted at sufficient depth to preclude such venting. If venting should occur despite these precautions, surface ground-motion information would be useful in investigations of the cause of venting. The Round Robin program was conceived and implemented to record surface motion. Data are reduced and presented even for shots that did not vent, because the information provided, together with that from other events, provides a better understanding of the effect of geologic structure on surface motion.

ACKNOWLEDGMENTS

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THE ROUND ROBIN PROGRAM: GROUND MOTION IN THE VICINITY OF THE POTRILLO EVENT

Introduction

Potrillo was detonated on June 21, 1973, at a depth of 1865 feet in Boring U7af at the Nevada Test Site. Seven Round Robin stations were located on a bearing of 180° at nominal distances of 50, 932, 2000, 3000, 3500, 4000, and 8000 feet. Station S-Z, at a distance of 50 feet, was oriented to respond only to vertical motion. All other stations were oriented to respond to vertical, radial, and tangential motion. The cannisters at the 3500- and 4000-ft stations were unusual in that they did not contain the normal vertical accelerometer and three velocity gages, one in each plane. Instead, these two cannisters contained three accelerometers, one in each plane. Data from these seven stations are permanently stored on Sandia tapes 16891 and 16647 and are plotted in the appendix. Table I lists times and amplitudes for the major peaks as well as the arrival times of the signal at each station. Table II lists gage location and elevation information.

Gage Performance

All gages recorded data continuously and where necessary were adjusted to allow velocity to return to zero and displacement to become constant. Overlays of vertical displacement at those stations having two or more vertical motion measurements show that in all cases the gages were in good agreement as to the motion seen (Figures 1 through 5). Unfortunately, only one vertical motion measurement was made at stations S-3500 and S-4000, and at station S-4000 there appears to have been some problem. A second vertical motion measurement at this station would have made the analysis of the problem easier and the conclusion more certain. The problem is that the vertical accelerometer appears to be reading about half of what would be expected and the radial accelerometer appears to be reading about double what would be expected. Evidence revealing this problem will be seen as we proceed with analysis of the data.

Signal Arrival Times

A plot of first signal arrival times versus slant range (Figure 6) reveals that the signal apparently did not follow the same path to each station because the velocity between stations constantly changed. This arrival time curve is unusual and is probably an indication of the geologic

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structure beneath the gage line. Unfortunately, a north-south geologic cross section is not presently available, but if it were the data would indicate the existence of a horst similar to that seen in the east-west geologic cross section shown in Figure 7.

Signal Characteristics

The change in signal at progressively farther ground ranges may be seen by examining Figures 8 through 14 where acceleration, velocity, and displacement in the vertical plane and velocity and displacement in the radial and tangential plane are plotted to a constant scale in each presentation. Close scrutiny of Figure 8, where the vertical accelerations are plotted, shows that spall certainly extended beyond station S-3500 and, if the amplitude of station S-4000 were double what it is, the -1 g acceleration would also be apparent at that station and would verify spalling past that point. An expansion of the acceleration record of station S-4000 (Figure 15) during this period verifies not only that there was the expected flat portion but that its amplitude was about 0.5 g, or just half of what would be expected.

The first acceleration peak at station S-932 is noticeably higher than the corresponding peak at station S-Z, a reversal of the trend normally seen. This phenomenon is possibly due to the direct signal and a refracted signal reaching that station at about the same time so as to produce an additive effect. The dual peaks during the positive acceleration phase at station S-Z and the fact that only one peak was seen during this period at station S-932 would tend to substantiate this theory.

At about 0.8 second an acceleration pulse may be seen at station S-Z and station S-932. There is a similar pulse at about 0.65 second at station S-2000. In each case, this pulse occurred at a time when the motion of the gage was still upward, precluding the possibility of this being a spall closure caused by the top spalled layer coming down. If this is a reflection from the bottom of the spalled layer, the times involved would put spall separation at a depth of over 1200 feet, an unlikely event. If the geologic cross section beneath the gage line were known, it might be possible to speculate on the cause of this pulse, but at this time the cause is unknown.

At about 1.28 second, a sharp spike may be seen at station S-932 with a corresponding spike at about 0.98 second at station S-2000. At station S-Z a very weak pulse may be seen at about 1.36 seconds, but since the displacement is around 40 inches at this time at that station, it is unlikely that this pulse is related to the other two. At about 1.7 seconds there is another pulse at station S-Z which appears to correspond better to the pulse at the other two stations even though there is no sharp spike at station S-Z. The absence of a sharp spike at station S-Z is not unusual and is probably caused by the high porosity of the material directly over the shot point due to the explosion. The pulses mentioned occur when the displacement curves show that the gages had fallen

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far enough so that they were at or near their original vertical position, thus indicating that this is the main spall closure signal received at the surface.

The "stacking" of radial velocity plots (Figure 11) shows that there is a definite similarity in the radial motions seen at all stations although there are also interesting differences prior to the peak velocities. Note that the radial velocity for station S-4000 is higher even than the velocity seen at station S-2000. Although there is only a little similarity in the tangential velocity traces (Figure 13), the amplitudes seen at station S-4000 are entirely credible in comparison with those seen at the other stations. Close examination of Figure 13 reveals that the trace at station S-3000 appears to be similar to the traces at station S-3500 and S-4000 except that it moves in the opposite direction. Since this could have been the result of an error in calibration, this possibility was checked; no error was found.

Signal Attenuation

Log-log plots of first vertical acceleration, velocity, and displacement peaks (Figure 16) show that except for station S-4000 and the acceleration peak at station S-932, the attenuation rate is well defined by the data. In an effort to determine why station S-4000 is so consistently different from what would be expected, all data reduction procedures and calibration values were reviewed. No errors were found. Log-log plots of first radial velocity and displacement peaks (Figure 17) show that except for station S-4000 the deviation from a straight-line fit is minimal. A log-log least squares fit to the vertical and radial data is shown on both figures with station S-4000 not included in the fit. It is perhaps important to note that the same gages used at station S-4000 were also used on Rio Blanco (before Potrillo) and Grove (after Potrillo), and analysis of the data in both cases showed the gages to be performing normally. In the case of the vertical accelerometer, doubling the amplitudes for station S-4000 gives values in line with the other stations. In the case of the radial accelerometer, the values for station S-4000 fall in line if the recorded amplitude is divided by 2.

Surface Motion

Hodographs of vertical versus radial displacement are presented in Figures 18 through 23, radial versus tangential displacement in Figures 24 through 29, and vertical versus tangential displacement in Figures 30 through 35. The vertical versus radial hodographs reveal the familiar arc seen as the gage moves up and away from the shot point during the first second after signal arrival. In this set of data, the arc is plainly visible at all stations, even the farthest station at a ground range of 8000 feet. Here again, however, the excessively high radial displacement and low vertical displacement at station S-4000 give the hodograph for that plane at that station an unusually

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elongated look (Figure 28). Hodographs for station S-2000 are also unusual in that there appears to be an excessive amount of residual tangential displacement (Figures 25 and 31).

Spall Analysis

Indications of spallation, or the parting of two or more of the near-surface layers above a contained underground explosion, have been noted on surface-motion records for many years and have led to the observation that if spall occurs beneath a surface-motion accelerometer, the gage normally records a period of free fall by reading a constant -1 g of acceleration for a period of time. In the case of the Potrillo event, this phenomenon may clearly be seen on all vertical acceleration records out through station S-3500. Station S-4000 also shows this phenomenon if an error was made somewhere, causing the vertical accelerometer at that location to read low by a factor of two. This method would indicate that spall occurred at least out past 3500 feet ground range and possibly beyond 4000 feet.

Another way to estimate the limit of spall is to compare signal arrival times at the various stations with the arrival time of the signal indicating that the spalled layers have come back together, the interpretation being that where the two curves become substantially parallel is the point at which spall ended. In Figure 36 these two factors are plotted versus ground range. In the case of stations S-4000 and S-8000, the end of the negative acceleration peak was used as the best indication of receival of a spall closure signal. This method would indicate that spall extended no further out than 4000 feet and possibly only as far out as 3000 feet.

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TABLE I

Signal Arrival Times and Major Peaks

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GAGE NO.	GAGE TYPE	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP
S-Z	AVHI ACCELERATION G S										
ARRIVAL TIME= .322		.3640	4.393E+00	.4265	8.757E-01	.4515	1.385E+00	.6615	-1.334E+00	.7955	1.300E+00
		.8165	-3.977E-01	.8405	-1.430E-01	.8765	-6.093E-01	[illegible]	-4.402E-01	1.1270	-4.920E-01
		1.3585	-5.251E-01	1.5410	-7.373E-01	1.8150	3.297E+00	1.9990	1.047E+00	1.9125	1.217E+00
		1.9250	9.197E-01	1.9765	1.811E+00	2.1335	-1.415E-01	2.1695	4.103E-01	2.2240	-2.264E-01
		2.2780	1.132E-01	2.6060	-6.933E-01	2.6925	-1.415E-01	2.7235	-3.537E-01	2.7705	2.832E-02
		2.7720	-1.415E-01								
S-Z	AVHI VELOCITY FT/SEC										
		.5355	1.172E+01	.7330	4.965E+00	.7985	5.076E+00	1.7155	-1.445E+01	2.2165	4.615E+00
		2.7935	-1.219E+00								
S-Z	AVHI DISPLACEMENT INCHES										
		1.0635	5.622E+01	1.3705	-2.802E+01	2.6320	-2.822E+00	3.5550	-1.667E+01		
S-Z	AVLO ACCELERATION G S										
ARRIVAL TIME= .319		.3715	5.149E+00	.4235	1.031E+00	.4535	1.405E+00	.7885	-1.011E+00	.7965	1.199E+00
		.8180	-3.702E-01	.8245	-2.455E-01	1.1765	-9.585E-01	1.3510	-5.035E-01	1.4520	-6.883E-01
		1.4665	-5.980E-01	1.5110	-7.743E-01	1.5485	-6.539E-01	1.5670	-7.098E-01	1.8145	3.327E+00
		1.9280	1.143E+00	1.9765	1.839E+00	2.1370	-4.350E-02	2.1705	2.769E-01	2.2450	-1.080E-01
		2.2820	5.108E-02	2.4390	-5.508E-01	2.4860	-4.304E-01	2.5300	-5.851E-01	2.8640	2.273E-01
		3.1740	-9.648E-02	3.5200	1.714E-01						
S-Z	AVLO VELOCITY FT/SEC										
		.5345	1.231E+01	.7340	5.960E+00	.8000	5.195E+00	1.7195	-1.539E+01	2.2175	5.011E+00
		2.7905	-1.237E+00								
S-Z	AVLO DISPLACEMENT INCHES										
		1.0532	5.702E+01	1.9695	-3.268E+01	2.6400	-5.275E+00	3.5600	-1.195E+01		
S-Z	UV VELOCITY FT/SEC										
ARRIVAL TIME= .331		.6395	1.306E+01	1.7205	-1.659E+01	2.2065	5.309E+00	2.7745	-1.507E+00		
S-Z	UV DISPLACEMENT INCHES										
		1.0405	5.876E+01	1.9685	-4.146E+01	2.6305	-1.306E+01	3.5705	-2.146E+01		
S-932	AVLO ACCELERATION G S										
ARRIVAL TIME= .373		.4265	7.199E+00	.6160	-1.015E+00	.8020	-8.339E-02	1.0755	-9.339E-01	1.2920	1.790E+01
		1.3095	-1.355E-01	1.3355	2.283E+00	1.4535	-8.465E-01	1.6140	1.317E-01	1.6530	9.552E-02
		1.7845	9.153E-01	1.8350	-2.894E-01	1.9520	9.295E-01	2.0185	-3.332E-01	2.1825	6.737E-01
		2.6085	-3.302E-01	2.6935	-3.129E-02						
S-932	AVLO VELOCITY FT/SEC										
		.4955	1.113E+01	1.2625	-9.078E+00	1.3975	-8.953E-01	1.6250	-4.344E+00	1.9110	-2.044E+00
		1.8530	-2.327E+00	1.9990	-1.362E-01	2.1005	-7.344E-01	2.4570	1.367E+00	2.3810	-4.974E-01
		3.8595	-4.515E-01	3.2995	-8.715E-01	3.9470	4.132E-01	4.5905	-1.522E-01	5.4151	3.963E-01
		5.9835	-9.823E-03	6.2360	1.495E-01						
S-932	AVLO DISPLACEMENT INCHES										
		.9345	3.348E+01	2.1645	-1.023E+01	2.6435	-1.629E+00	3.6170	-6.516E+00	4.4363	-1.457E+00
		4.8053	-1.889E+00	5.9570	1.645E+00	6.0145	1.441E+00	[illegible]	[illegible]		

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TABLE I (cont)

N409E

GAGE NO.	GAGE TYPE	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP
S-932 UV	VELOCITY FT/SEC										
ARRIVAL TIME= .384		.4835	1.230E+01	1.2805	-9.816E+00	1.3905	-7.365E-01	1.5195	-4.776E+00	1.8035	-2.394E+00
		1.8535	-2.696E+00	2.0015	-2.071E-01	2.1135	-8.773E-01	2.3535	2.133E+00	2.3935	-6.617E-01
		3.0535	-5.901E-01	3.3245	-1.109E+00	3.9365	8.056E-01	4.5345	-4.368E-01	5.3825	2.383E-01
		5.9855	-2.243E-01	6.2105	-1.045E-02	6.3355	-5.316E-02				
S-932 UV	DISPLACEMENT INCHES										
		.9365	3.661E+01	2.1685	-1.084E+01	2.7785	-1.514E+00	3.6295	-8.115E+00	4.2555	-4.231E+00
		4.9785	-6.556E+00	5.7555	-5.077E+00	6.4745	-5.774E+00				
S-932 UR	VELOCITY FT/SEC										
ARRIVAL TIME= .388		.5125	2.106E+00	.6405	2.034E+00	1.3245	7.744E+00	1.8895	-7.257E+00	2.3635	1.933E+00
		3.8015	-1.191E+00	4.3465	2.831E-01	4.7665	-2.781E-04	5.2535	4.868E-01	5.8155	-1.951E-01
		6.9175	2.875E-01	7.5105	-1.685E-01	7.9475	1.769E-01	8.7495	-1.730E-01	9.2105	9.713E-02
		9.5205	-1.508E-01								
S-932 UR	DISPLACEMENT INCHES										
		1.6295	5.612E+01	2.4365	2.411E+01	3.5425	3.942E+01	4.2045	3.400E+01	5.6645	3.817E+01
		6.6165	3.680E+01	7.2925	3.830E+01						
S-932 UT	VELOCITY FT/SEC										
ARRIVAL TIME= .378		.4585	2.438E-01	1.3615	-3.171E+00	1.7805	1.439E+00	1.8665	7.405E-01	1.9175	1.036E+00
		2.0685	2.600E-02	2.2735	9.731E-01	2.6665	-7.003E-01	2.8355	-1.987E-02	2.8775	-4.637E-02
		3.1945	4.295E-01	3.9225	-3.488E-01	4.6015	2.867E-01	4.9355	-8.795E-02	5.2615	1.532E-01
		6.1525	-2.277E-01	6.6285	2.478E-01	6.9705	-2.485E-02	7.8575	2.721E-01	8.2715	-1.579E-02
S-932 UT	DISPLACEMENT INCHES										
		.5475	1.582E-01	1.6115	-1.542E+01	2.5405	-8.323E+00	2.3315	-9.547E+00	3.7045	-6.945E+00
		4.3455	-8.813E+00	4.7905	-8.007E+00	5.0815	-8.133E+00	5.5935	-7.534E+00	6.4435	-8.747E+00
		6.9305	-7.935E+00	7.0565	-7.947E+00	8.2305	-6.751E+00				
S-2000AVLO	ACCELERATION G S										
ARRIVAL TIME= .455		.5350	3.756E+00	.6025	-6.546E-01	.6510	-4.753E-01	.9545	-8.441E-01	[illegible]	1.082E+01
		1.0135	-2.396E-01	1.0365	4.633E-01	1.0580	-1.412E-01	1.1575	7.135E-01	1.3085	-3.[illegible]12E-01
		1.3175	-2.180E-01	1.4045	-5.561E-01	1.4815	-2.385E-01	1.5205	-3.851E-01	1.5990	1.098E-01
		1.6360	-2.871E-03	1.6825	2.225E-01	1.7235	2.252E-03	1.7875	4.326E-01	1.8500	-3.361E-02
		1.8670	-2.871E-03	1.9700	-3.307E-01	2.2410	3.045E-01	2.3660	[illegible]E-02		
S-2000AVLO	VELOCITY FT/SEC										
		.5465	4.966E+00	.9705	-4.653E+00	.9940	-1.476E+00	1.0210	-1.621E+00	1.0480	-1.420E+00
		1.0800	-1.469E+00	1.2655	1.351E+00	1.5760	-1.770E+00	1.8400	-5.535E-01	2.0520	-1.802E+00
		2.4330	3.517E-01	2.5945	8.138E-03	2.9155	4.651E-01	3.4095	-3.551E-01	3.8795	4.723E-01
		4.6885	-4.290E-01	5.2085	1.261E-01						
S-2000AVLO	DISPLACEMENT INCHES										
		.7860	9.409E+00	1.1640	1.264E+00	1.3970	3.683E+00	2.2380	-8.374E+00	3.1631	-5.341E+00
		3.5820	-7.005E+00	4.1803	-4.945E+00	5.0315	-7.641E+00	5.8540	-6.[illegible]E+00	6.4555	-7.425E+00
		6.5205	-7.424E+00	8.7165	-1.039E+01	8.8405	-1.039E+01	9.7360	-1.134E+01		
S-2000UV	VELOCITY FT/SEC										
ARRIVAL TIME= .365		.5390	5.023E+00	.3691	-5.156E+00	1.2490	2.161E+00	1.6490	-1.511E+00	1.4300	-3.343E-01
		2.0470	-1.307E+00	2.3320	6.688E-01	2.6530	5.117E-02	2.9660	2.373E-01	3.3311	-7.815E-01
		4.0800	2.366E-01	4.4250	-1.714E-01	4.4850	-1.397E-01	4.7090	-2.376E-01	5.1500	2.313E-01
		6.1060	-1.289E-01	6.4580	1.157E-01						

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TABLE I (cont)

N408E

GAGE NO.	GAGE TYPE	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP
S-2000UV	DISPLACEMENT INCHES										
		.7640	8.574E+00	1.0820	9.024E-01	1.4240	6.285E+00	2.2450	-2.840E+00	3.0490	-1.535E-01
		3.6950	-3.808E+00	4.2880	-2.742E+00	4.9420	-3.992E+00	5.9480	-2.733E+00	6.2040	-3.197E+00
		6.8330	-2.792E+00								
S-2000UR	VELOCITY FT/SEC										
ARRIVAL TIME= .460		.5385	8.449E-01	.5765	6.148E-01	.7325	9.773E-01	.9595	6.379E-01	1.1145	4.140E+00
		1.7675	-3.943E+00	2.1115	-1.632E-01	2.2335	-5.025E-01	2.3115	6.240E-01	3.8715	-5.083E-01
		4.3395	-9.416E-02	4.5295	-2.495E-01	5.2175	2.280E-01	6.2145	-1.459E-01		
S-2000UR	DISPLACEMENT INCHES										
		1.5095	1.793E+01	2.5455	3.577E+00	3.2525	7.076E+00	4.8945	2.437E+00	5.5745	3.469E+00
		7.0655	2.235E+00	7.6875	2.932E+00	9.3725	2.001E+00				
S-2000UT	VELOCITY FT/SEC										
ARRIVAL TIME= .462		.5350	5.617E-01	.7370	-7.614E-01	.7620	-7.585E-01	1.0820	-9.487E-01	1.1940	-7.102E-01
		1.2160	-8.037E-01	1.2320	-7.427E-01	1.2450	-8.401E-01	1.2670	-7.456E-01	1.3160	-9.358E-01
		1.6810	5.984E-01	1.9340	-1.434E+00	2.1270	-9.581E-01	2.2590	-1.174E+00	2.3480	-9.611E-01
		2.7500	-1.717E+00	2.8590	-1.555E+00	2.8690	-1.596E+00	3.0560	-1.425E+00	3.2490	-1.546E+00
		4.3430	-3.881E-01								
S-2000UT	DISPLACEMENT INCHES										
		.5610	2.767E-01	1.5880	-7.895E+00	1.7710	-7.129E+00	5.0710	-4.535E+01	5.2260	-4.593E+01
		7.4280	-4.894E+01	8.3470	-4.862E+01	9.3300	-4.933E+01	9.9350	-4.831E+01		
S-3000AVLO	ACCELERATION G S										
ARRIVAL TIME= .525		.6035	2.157E+00	.6930	-1.024E+00	.7395	4.253E+00	.7720	-9.534E-01	.8085	8.385E-01
		.8275	-3.251E-01	.8570	-6.561E-02	.8980	-3.163E-01	.9280	1.350E-01	.9470	-7.735E-02
		1.0600	4.403E-01	1.0835	3.239E-01	1.1130	5.200E-01	1.3385	-4.623E-01	1.5345	-4.196E-02
		1.5670	-1.526E-01	1.6250	4.049E-01	1.8650	-3.163E-01	2.0105	2.014E-01		
S-3000AVLO	VELOCITY FT/SEC										
		.6160	3.272E+00	.7375	-3.972E-01	.7505	7.791E-02	.7990	-1.110E+00	.8195	-8.388E-01
		.9195	-1.413E+00	.9405	-1.357E+00	.9615	-1.387E+00	1.2720	1.439E+00	1.5890	-9.166E-01
		1.7440	3.576E-01	1.9755	-9.074E-01	2.0965	-4.920E-01	2.1715	-6.172E-01	2.5415	4.705E-01
		2.7810	1.268E-01	2.9850	3.703E-01	3.4460	-4.624E-01	4.3710	4.155E-01	4.5590	-2.827E-01
		5.7835	1.679E-01	6.2395	-1.158E-01	6.6195	2.199E-01	7.0880	-3.217E-02		
S-3000AVLO	DISPLACEMENT INCHES										
		.7250	3.497E+00	1.1195	-8.132E-01	1.4270	2.502E+00	1.6730	8.286E-01	1.8320	1.279E+00
		2.3340	-1.897E+00	3.1420	7.453E-01	3.7195	-1.206E+00	4.3910	9.665E-01	4.9150	-4.933E-02
		6.0060	1.365E+00	6.3370	1.007E+00	6.9980	2.017E+00	7.4250	1.931E+00	9.2700	2.477E+00
		9.6115	1.993E+00								

TABLE I (cont)

N408E

GAGE NO.	GAGE TYPE	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP
S-3000UV	VELOCITY FT/SEC										
ARRIVAL TIME= .537		.6155	3.701E+00	.7195	-1.196E+00	.8295	-9.354E-01	.9155	-1.513E+00	1.2685	1.662E+00
		1.5875	-1.159E+00	1.7415	3.630E-01	1.9655	-1.010E+00	2.0965	-5.165E-01	2.1605	-7.027E-01
		2.5495	5.636E-01	2.7695	1.539E-01	2.9535	4.332E-01	3.4585	-5.909E-01	4.0415	4.332E-01
		4.5245	-3.768E-01	5.6675	1.353E-01	6.2215	-2.185E-01	6.5725	1.911E-01	7.0335	-1.069E-01
		7.6705	9.872E-02	9.4455	-1.069E-01						
S-3000UV	DISPLACEMENT INCHES										
		.7265	4.049E+00	1.1125	-4.012E-01	1.4255	3.471E+00	1.6825	1.308E+00	1.8315	1.721E+00
		2.3325	-1.812E+00	3.1375	1.233E+00	3.7255	-1.076E+00	4.3805	1.030E+00	4.9765	-3.469E-01
		5.9535	4.593E-01	6.4395	-2.760E-01	6.9135	4.067E-01	7.4695	-1.545E-02	9.2945	3.865E-01
		9.7815	-1.735E-02								
S-3000UR	VELOCITY FT/SEC										
ARRIVAL TIME= .550		.6545	6.143E-01	.7145	5.969E-01	1.0905	3.465E+00	1.6285	-4.180E+00	1.9795	5.185E-01
		2.2485	-6.452E-01	2.7675	7.451E-01	3.0125	1.088E-01	3.2395	6.361E-01	3.5455	-1.353E-01
		3.6055	-8.733E-02	4.1765	-6.147E-01	5.0285	2.003E-01	6.9695	-3.270E-01	7.4315	3.049E-01
S-3000UR	DISPLACEMENT INCHES										
		1.3255	1.528E+01	1.8965	8.635E-02	2.1135	1.099E+00	2.4485	-2.841E-01	3.4565	4.633E+00
		4.3885	1.552E+00	6.3915	2.552E+00	7.2295	8.412E-01	7.9765	2.133E+00		
S-3000UT	VELOCITY FT/SEC										
ARRIVAL TIME= .552		.7405	1.422E-01	.8215	-1.988E-01	.8575	-1.711E-01	.9365	-3.554E-01	.9695	-3.278E-01
		1.1475	-1.047E+00	1.5435	1.239E+00	2.0715	-4.614E-01	2.2285	-2.487E-01	2.2685	-2.993E-01
		2.4645	4.656E-01	2.7725	-3.040E-01	3.0445	-5.515E-02	3.1945	-1.611E-01	3.7435	6.176E-01
		4.2445	-4.330E-01	4.4935	-1.391E-01	4.5915	-2.947E-01	5.1735	1.568E-01	5.3595	-4.447E-03
		5.6945	3.688E-01	6.8965	-2.302E-01	7.6075	2.766E-01	9.1735	-1.657E-01	9.6135	1.568E-01
S-3000UT	DISPLACEMENT INCHES										
		.7865	1.268E-01	1.3135	-2.922E+00	1.8215	1.425E+00	2.3615	-4.626E-01	2.6315	3.771E-01
		3.3715	-1.051E+00	4.0235	1.602E+00	4.9955	-1.078E+00	6.0485	8.972E-01	7.2965	-1.055E+00
		8.3375	6.855E-01	9.4515	-4.520E-01						
S-3500AV	ACCELERATION G S										
ARRIVAL TIME= .559		.6375	1.450E+00	.6835	-9.647E-01	.7765	1.021E+00	.7920	-1.694E-01	.9105	6.115E-01
		.8675	-2.417E-01	.8995	3.608E-01	.9550	-3.188E-01	1.0200	2.259E-01	1.0545	-5.506E-03
		1.1270	4.042E-01	1.1305	1.921E-01	1.2375	3.319E-01	1.4400	-3.333E-01	1.5185	1.005E-01
		1.5595	-1.164E-01	1.6050	8.125E-02	1.6210	3.305E-02	1.6620	2.451E-01	1.7825	-1.212E-01
		1.8195	-5.853E-02	1.8830	-2.851E-01	2.0300	1.969E-01	2.1340	-3.443E-02	2.1680	1.859E-02
		2.2250	-6.049E-02	2.3390	1.612E-01	2.4475	6.483E-02	2.4990	1.227E-01	2.6290	-1.135E-01
		2.6930	-2.193E-02	2.7355	-5.567E-02	2.8425	7.923E-02	2.8680	4.073E-02	2.9055	9.375E-02
		3.0260	-4.121E-02	3.0430	-7.467E-03	3.1265	-9.905E-02	3.1490	-4.121E-02	3.1965	-7.013E-02
		3.5315	5.037E-02								
S-3500AV	VELOCITY FT/SEC										
		.6475	2.367E+00	.7685	-9.053E-01	.7880	-6.237E-01	.7990	-6.635E-01	.8275	-3.482E-01
		.8855	-6.111E-01	.9185	-3.934E-01	.9305	-8.450E-01	1.2460	1.367E+00	1.4995	-2.951E-01
		1.5360	-2.261E-01	1.5425	-3.259E-01	1.7400	2.503E-01	1.9880	-8.214E-01	2.1135	-3.795E-01
		2.2395	-4.424E-01	2.5465	4.334E-01	2.7885	6.854E-02	2.9580	3.524E-01	3.4845	-2.904E-01
		4.1965	3.157E-01	4.6605	-2.055E-01	5.0410	2.155E-02	5.1930	-3.097E-02	5.4875	1.303E-01

TABLE I (cont)

N408E

GAGE NO.	GAGE TYPE	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP
S-3500AV	DISPLACEMENT INCHES										
		.7325	2.251E+00	1.1395	-4.168E-01	1.4520	1.969E+00	1.6725	1.352E+00	1.8390	1.635E+00
		2.3335	-1.167E+00	3.2050	1.068E+00	3.7795	-7.940E-02	4.4940	1.693E+00	5.2505	1.109E+00
		5.9565	1.847E+00	6.4640	1.422E+00	7.1675	1.925E+00	7.5110	1.666E+00	7.8985	1.895E+00
		9.8325	1.430E+00								
S-3500AR	ACCELERATION G S										
ARRIVAL TIME= .567		.6410	2.912E-01	.6880	-1.734E-02	.7150	1.479E-02	.7640	-4.340E-02	.7760	5.713E-01
		.7935	2.221E-01	.8180	3.458E-01	.8375	8.390E-02	.8850	2.585E-01	.9370	1.843E-02
		1.0345	3.967E-01	1.1205	-1.634E-01	1.1495	-7.032E-03	1.2415	-4.908E-01	1.3510	-4.035E-01
		1.4260	-4.544E-01	1.7630	5.276E-01	2.0725	-1.925E-01	2.1305	-1.125E-01	2.2040	-1.707E-01
		2.3495	1.312E-01	2.3905	9.117E-02	2.4445	1.821E-01	2.6170	-8.341E-02	2.7625	1.639E-01
		2.8755	-3.613E-02	2.8960	-7.032E-03	2.9750	-1.161E-01	3.0800	4.389E-02	3.1425	-1.067E-02
		3.2790	5.116E-02	3.4075	-1.016E-01	3.6505	2.570E-02	3.7205	-3.613E-02		
S-3500AR	VELOCITY FT/SEC										
		.6750	4.201E-01	.7305	4.140E-01	1.0855	2.436E+00	1.6280	-3.032E+00	1.9910	4.749E-01
		2.2875	-6.635E-01	2.5435	1.709E-01	2.6770	-9.339E-03	2.8475	4.599E-01	3.0460	1.048E-01
		3.3365	3.596E-01	3.6345	-1.180E-01	3.6890	-9.874E-02	4.1860	-5.186E-01	4.6830	1.319E-01
		5.3715	-2.232E-02	5.6245	1.451E-01	5.9525	-1.614E-01	6.2565	6.537E-02	7.0595	-3.083E-01
		7.5700	1.928E-01	8.2965	-9.517E-02	8.5370	-8.470E-03	8.8455	-2.097E-01	9.3150	7.861E-02
S-3500AR	DISPLACEMENT INCHES										
		1.3415	1.111E+01	1.8930	-6.619E-01	2.1115	1.539E-01	2.4750	-1.563E+00	2.6595	-1.319E+00
		2.6310	-1.321E+00	3.5185	1.095E+00	4.5080	-2.189E+00	5.3290	-1.452E+00	5.4325	-1.469E+00
		5.7610	-1.144E+00	6.1150	-1.566E+00	6.4240	-1.407E+00	7.3400	-2.737E+00	8.0995	-1.680E+00
		9.1440	-2.903E+00								
S-3500AT	ACCELELATION G S										
ARRIVAL TIME= .568		.6345	-5.730E-02	.6420	1.472E-02	.6485	-1.173E-01	.6940	3.073E-02	.7165	1.472E-02
		.7755	5.209E-01	.7855	-2.214E-01	.8070	1.148E-01	.8285	-5.330E-02	.8705	7.474E-02
		.8935	6.274E-02	.9325	9.875E-02	.9160	-4.330E-02	.9480	1.148E-01	1.0605	-9.287E-03
		1.1315	1.968E-01	1.2015	-1.653E-01	1.4090	-5.930E-02	1.4985	-1.933E-01	1.5955	9.875E-02
		1.7310	-6.131E-02	1.8545	2.048E-01	2.2145	-1.593E-01	2.3060	-7.331E-02	2.3525	-1.033E-01
		2.5530	7.674E-02	2.6135	2.873E-02	2.7230	7.274E-02	2.8135	-3.330E-02	2.9175	1.872E-02
		3.0270	-5.730E-02	3.1170	5.674E-02	3.1735	7.169E-04	3.2530	3.873E-02	3.3305	-2.929E-02
		3.3850	6.719E-03	3.6390	-9.732E-02	3.9635	1.125E-01	4.1260	1.072E-02	4.1903	5.474E-02
		4.4205	-6.931E-02	4.5740	5.073E-02						
S-3500AT	VELOCITY FT/SEC										
		.6655	-1.183E-01	.7805	1.216E-01	.8005	4.261E-02	.8200	7.249E-02	.8465	4.242E-02
		.9035	1.634E-01	.9245	1.510E-01	1.1510	6.133E-01	1.5515	-7.463E-01	1.6740	-5.235E-01
		1.7560	-6.344E-01	2.0870	6.734E-01	2.4600	-3.949E-01	2.7875	1.129E-01	3.0690	-3.167E-03
		3.2943	1.744E-01	3.7805	-6.231E-01	4.2995	2.790E-01	4.4980	3.194E-02	4.6525	1.878E-01
		4.9210	-1.123E-02	5.0690	4.377E-02	5.2425	-7.481E-02	5.3730	-1.126E-02	6.0750	-2.595E-01
		6.9850	4.147E-01	7.5095	-3.952E-01	8.0110	-6.714E-02				
S-3500AT	DISPLACEMENT INCHES										
		.7680	-1.508E-01	1.2925	1.439E+00	1.8905	-1.757E+00	2.2950	2.994E-01	2.7190	-7.831E-01
		3.0565	-4.716E-01	3.0810	-4.722E-01	3.5070	9.501E-02	4.0455	-2.213E+00	5.1575	-7.249E-01
		6.4520	-2.981E+00	7.2490	-7.236E-01	8.5770	-2.993E+00	9.3855	-2.437E+00		

TABLE I (cont)

GAGE NO.	GAGE TYPE	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP
S-4000AV	ACCELERATION G S										
ARRIVAL TIME= .576		.6475	5.325E-01	.7005	-5.299E-01	.7815	-1.626E-02	.8095	-3.321E-01	.8450	4.727E-01
		.8730	-8.095E-02	.8905	1.416E-01	.9105	2.559E-02	.9385	7.506E-02	.9790	-4.670E-02
		1.0000	4.271E-02	1.0540	-1.532E-01	1.1255	2.672E-01	1.1745	1.798E-02	1.2090	1.264E-01
		1.2335	8.267E-02	1.2545	1.207E-01	1.3210	-1.817E-02	1.3590	1.037E-02	1.4305	-1.133E-01
		1.4975	-3.339E-02	1.5105	-6.953E-02	1.5240	-3.148E-02	1.5510	-1.038E-01	1.6040	2.940E-02
		1.6380	-4.290E-02	1.7280	8.837E-02	1.8060	-7.144E-02	1.8545	-2.958E-02	1.9630	-1.628E-01
		2.0735	7.125E-02	2.1090	1.227E-02	2.1635	7.506E-02	2.2480	-4.849E-03	2.2855	4.842E-02
		2.3915	2.559E-02	2.3895	7.315E-02	2.4495	2.179E-02	2.4985	5.793E-02	2.6960	-7.144E-02
		2.9280	9.218E-02	3.0905	-4.670E-02						
S-4000AV	VELOCITY FT/SEC										
		.6665	1.032E+00	.8250	-6.193E-01	.8645	-2.917E-01	.8915	-3.209E-01	.9635	-1.550E-01
		1.0700	-3.523E-01	1.3080	3.853E-01	1.6575	-6.155E-02	1.7645	8.864E-02	2.0345	-4.876E-01
		2.6010	2.321E-01	2.8900	-7.891E-02	3.0245	1.645E-01				
S-4000AV	DISPLACEMENT INCHES										
		.7365	9.031E-01	1.1505	-4.406E-01	1.5575	6.644E-01	1.7135	5.926E-01	1.8230	6.629E-01
		2.4040	-1.034E+00	2.7955	-3.952E-01	2.9255	-4.646E-01	3.2275	-1.195E-01	4.0750	-9.103E-01
		4.5660	-1.893E-01	5.2610	-8.577E-01						
S-4000AR	ACCELERATION G S										
ARRIVAL TIME= .577		.6590	3.182E-01	.6820	4.748E-02	.7000	8.898E-02	.7105	6.491E-02	.7810	2.234E-01
		.8025	2.369E-02	.8420	4.077E-01	.8660	8.514E-02	.9215	4.596E-01	.9525	2.484E-01
		1.0015	5.652E-01	1.0250	4.500E-01	1.0615	6.055E-01	1.1125	-2.740E-01	1.1895	3.521E-02
		1.3790	-9.384E-01	1.4190	-8.846E-01	1.4855	-9.538E-01	1.5635	-2.221E-01	1.6080	-2.[illegible]E-01
		1.7115	4.769E-01	1.7315	4.250E-01	1.8375	1.009E+00	1.9345	2.503E-01	1.9905	5.633E-01
		2.0625	-2.493E-01	2.0980	-1.931E-01	2.1575	-3.623E-01	2.1885	-2.394E-01	2.2200	-2.663E-01
		2.3705	1.754E-01	2.3900	1.639E-01	2.4595	3.021E-01	2.5835	-1.223E-01	2.6965	7.746E-02
		2.7160	5.441E-02	2.7840	1.850E-01	2.8620	4.097E-02	2.9065	1.197E-01	3.0010	-6.465E-02
		3.0625	1.216E-02	3.1570	-1.530E-01	3.3285	1.812E-01	3.4350	-7.425E-02	3.4470	-5.313E-02
		3.5355	-1.703E-01	3.6290	-4.160E-02	3.7220	-1.664E-01	3.9345	-3.968E-02	3.8805	-6.081E-02
		4.0570	3.137E-02	4.1515	-7.425E-02	4.2320	1.216E-02	4.2970	-2.432E-02	4.5095	2.426E-01
		4.7665	-8.961E-02	4.9210	3.329E-02	5.0015	-3.968E-02	5.1335	1.485E-01	5.3175	-8.001E-02
		5.4300	4.283E-02	5.8040	-1.242E-01	6.1215	1.197E-01	6.4300	-4.737E-02	6.7525	3.329E-02
		6.9415	-1.011E-01	7.4345	7.159E-02	8.7260	-1.127E-01	9.1465	1.120E-01		
S-4000AR	VELOCITY FT/SEC										
		1.0915	4.256E+00	1.1785	3.785E+00	1.1985	3.793E+00	1.6630	-5.211E+00	2.0345	9.216E-01
		2.3225	-1.103E+00	2.5445	1.967E-01	2.6365	-2.463E-03	2.9430	8.574E-01	3.0540	7.111E-01
		3.0725	7.125E-01	3.2300	2.737E-01	3.3965	8.603E-01	4.1295	-7.599E-01	4.0795	-7.322E-01
		4.3140	-9.477E-01	4.6625	2.033E-01	5.0315	-1.810E-01	5.2465	4.548E-01	5.4390	1.753E-01
		5.5465	2.542E-01	5.9700	-5.453E-01	6.2725	1.423E-01	6.6805	-2.796E-02	6.8060	4.414E-02
		7.0940	-4.921E-01	7.8715	4.907E-01	8.3490	-1.739E-02	8.5175	1.262E-01	9.8600	-6.443E-01
		9.3070	3.296E-01	9.5420	1.353E-01	9.9715	5.584E-01				
S-4000AR	DISPLACEMENT INCHES										
		1.3910	1.373E+01	1.9615	-1.349E+00	2.1575	-9.747E-02	2.4925	-2.776E+00	2.6280	-2.594E+00
		2.6445	-2.594E+00	3.6925	3.750E+00	4.5570	-3.280E+00	4.7925	-2.313E+00	5.1080	-3.430E+00
		5.7665	-1.493E+00	6.1345	-3.157E+00	6.8500	-2.823E+00	7.4785	-5.050E+00	9.2910	-2.344E+00
		8.3925	-2.157E+00	8.6160	-2.157E+00	9.1155	-4.376E+00				

TABLE I (cont)

H408E

GAGE NO.	GAGE TYPE	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP
S-4000AT	ACCELERATION G S										
ARRIVAL TIME= .586		.6100	-1.570E-02	.6295	-4.356E-03	.6445	-1.494E-02	.6940	1.151E-02	.7240	-2.592E-03
		.7385	7.106E-03	.7575	9.345E-04	.7860	2.562E-02	.8365	-3.962E-02	.8855	4.943E-02
		.9250	4.461E-03	.9670	4.855E-02	1.0505	-1.141E-02	1.1215	7.147E-02	1.2120	-8.371E-02
		1.2735	-3.785E-02	1.3080	-4.530E-02	1.4030	-6.119E-03	1.5395	-6.872E-02	1.5565	-5.814E-02
		1.5740	-6.519E-02	1.6455	3.268E-02	1.7730	-2.992E-02	1.9025	9.840E-02	1.9915	8.470E-02
		1.9645	9.087E-02	1.9960	8.331E-02	2.0120	9.439E-02	2.0915	-1.053E-02	2.1290	2.386E-02
		2.2670	-8.900E-02	2.3390	-1.494E-02	2.4180	-5.726E-02	2.4820	-7.883E-03	2.5190	-1.679E-02
		2.6320	2.650E-02	2.6795	7.106E-03	2.7585	3.356E-02	2.8175	1.681E-02	2.8415	2.298E-02
		2.9220	-2.552E-02	3.0370	7.106E-03	3.0870	-4.355E-03	3.1270	1.063E-02	3.1885	-1.141E-02
		3.2460	3.580E-03	3.2870	-4.356E-03	3.4070	3.797E-02	3.5135	-3.786E-02	3.5610	-2.552E-02
		3.6515	-4.932E-02	4.0155	4.414E-02	4.1190	1.063E-02	4.1655	2.033E-02	4.2160	7.106E-03
		4.2435	1.328E-02	4.3840	-1.229E-02	4.4340	2.698E-03	4.4785	-9.646E-03	4.5920	1.681E-02
		4.7680	-1.317E-02	4.9975	1.151E-02	5.1505	-1.582E-02	5.2250	-3.474E-03	5.2325	-9.646E-03
		5.3585	1.151E-02	5.4495	-7.883E-03	5.5370	4.461E-03	5.5655	-5.237E-03	5.6490	4.461E-03
		5.8585	-2.287E-02	6.4150	3.532E-02	6.5115	4.461E-03	6.6270	2.396E-02	6.6570	1.063E-02
		6.8135	2.121E-02	7.2445	-3.962E-02	7.5525	7.106E-03	7.6095	-1.711E-03	7.7180	1.151E-02
		7.7450	7.106E-03	7.9150	2.033E-02	8.1660	-9.646E-03	8.4390	7.988E-03	8.6595	-7.001E-03
		9.1260	1.592E-02	9.3535	-2.904E-02	9.3940	-1.053E-02	9.4350	-2.023E-02	9.5995	6.225E-03
S-4000AT	VELOCITY FT/SEC										
		.6725	-2.103E-02	1.0140	1.274E-01	1.0770	1.134E-01	1.1780	2.606E-01	1.8305	-2.994E-01
		2.1635	3.091E-01	2.5425	-1.435E-01	2.8885	5.821E-02	2.9790	2.586E-02	3.4510	1.361E-01
		3.8430	-2.163E-01	4.6950	7.427E-02	6.1845	-1.765E-01	6.9560	2.227E-01	7.5245	-1.396E-01
S-4000AT	DISPLACEMENT INCHES										
		1.3340	6.350E-01	1.9535	-6.568E-01	2.3745	2.782E-01	2.7900	-1.779E-01	3.6030	3.209E-01
		4.1510	-5.391E-01	5.5070	-5.848E-02	6.4750	-9.695E-01	7.2750	2.484E-01	7.9940	-5.676E-01
		9.4870	-1.379E-02								
S-8000AVLO	ACCELERATION G S										
ARRIVAL TIME= .860		.9120	4.321E-01	.9500	-4.534E-01	1.0365	2.293E-01	1.0770	-2.115E-01	1.1380	-2.039E-02
		1.1735	-1.647E-01	1.2145	1.590E-01	1.2310	1.083E-01	1.2525	2.527E-01	1.3110	-9.450E-02
		1.3855	1.629E-01	1.4695	-7.110E-02	1.5080	1.551E-01	1.5590	-7.500E-02	1.6220	9.663E-02
		1.6870	-1.647E-01	1.7230	4.982E-02	1.7735	-1.062E-01	1.8280	5.372E-02	1.8595	-8.870E-04
		1.9620	4.592E-02	2.0080	-3.209E-02	2.0530	1.083E-01	2.1585	-1.413E-01	2.2430	-3.993E-02
		2.2720	-5.940E-02	2.3565	9.663E-02	2.4415	-3.209E-02	2.5095	6.543E-02	2.6010	-3.989E-02
		2.6500	-8.870E-04	2.6770	-2.039E-02	2.7460	3.422E-02	2.7830	-8.698E-03	2.8260	9.273E-02
		2.8470	7.323E-02	2.8650	1.122E-01	2.9195	-2.819E-02	3.0425	5.086E-02	3.1080	-7.005E-02
		3.1760	1.966E-02	3.2190	-3.105E-02	3.2265	-1.155E-02	3.2610	-6.226E-02	3.3760	1.966E-02
		3.4160	-3.105E-02	3.4905	6.647E-02	3.5660	-7.648E-03	3.5975	2.746E-02	3.7715	-6.615E-02
		4.0395	5.866E-02	4.2495	-6.226E-02						
S-8000AVLO	VELOCITY FT/SEC										
		.9330	5.907E-01	1.0110	-1.731E-01	1.0545	1.360E-03	1.1350	-5.133E-01	1.2915	-7.483E-02
		1.3310	-1.415E-01	1.4395	1.986E-01	1.4875	1.353E-01	1.5405	2.339E-01	1.5840	2.253E-01
		1.6510	3.509E-01	1.7125	1.518E-01	1.7460	1.825E-01	1.8435	3.410E-02	1.9320	1.594E-01
		2.0260	1.518E-01	2.0880	2.757E-01	2.3140	-2.973E-01	2.4290	-1.437E-01	2.4770	-1.583E-01
		2.5390	-9.973E-02	2.7060	-1.956E-01	2.9045	7.170E-02	2.9470	5.107E-02	3.0780	1.667E-01
		3.1625	7.250E-02	3.1880	7.488E-02	3.4300	-7.473E-02	3.6770	1.058E-01	3.8911	-1.070E-01
		4.1360	5.596E-02	4.3375	-1.363E-01	4.9600	1.036E-01	5.5445	-1.520E-01	4.0260	1.175E-01

TABLE I (cont)

N403E

GAGE NO.	GAGE TYPE	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP	PEAK TIME	PEAK AMP
S-8088AYLO	DISPLACEMENT INCHES										
		.9830	3.158E-01	1.3850	-6.500E-01	2.1775	9.796E-01	2.8645	-3.836E-01	3.2795	2.733E-02
		3.4920	-1.012E-01	3.7830	1.592E-01	4.0455	-4.478E-02	4.2125	2.734E-02	4.6235	-3.823E-01
		5.4845	2.522E-01	6.1665	-4.388E-01	6.7815	7.153E-03	7.3150	-2.474E-01	7.5880	-1.633E-01
		7.8315	-2.522E-01	8.2790	1.515E-01	8.8010	-1.774E-01	9.1670	8.881E-03	9.5275	-1.826E-01
S-8088UV	VELOCITY FT/SEC										
ARRIVAL TIME= .871		.9305	5.691E-01	1.0105	-2.206E-01	1.0555	-1.235E-02	1.1925	-5.417E-01	1.2885	-9.913E-02
		1.3275	-1.946E-01	1.4305	1.959E-01	1.4935	1.005E-01	1.5355	2.567E-01	1.5765	1.693E-01
		1.6445	3.174E-01	1.7095	9.178E-02	1.7475	1.438E-01	1.8095	5.003E-03	1.9945	1.699E-01
		2.0255	1.265E-01	2.0785	2.827E-01	2.3225	-3.074E-01	2.4115	-1.338E-01	2.4765	-2.033E-01
		2.5475	-9.045E-02	2.6735	-1.946E-01	2.8985	1.091E-01	2.9405	5.737E-02	3.0655	1.872E-01
		3.1565	6.575E-02	3.2005	9.178E-02	3.3555	-8.178E-02	3.6735	1.265E-01	3.8875	-1.339E-01
		4.1325	8.083E-02	4.3995	-1.535E-01	4.9805	1.329E-01	5.6395	-1.735E-01	6.5575	2.323E-01
S-8088UV	DISPLACEMENT INCHES										
		.9825	3.868E-01	1.3875	-7.441E-01	2.1795	6.816E-01	2.8585	-6.511E-01	3.2805	-1.846E-01
		3.4905	-3.034E-01	3.7815	-5.681E-02	4.0395	-2.611E-01	4.2105	-1.450E-01	4.6035	-5.524E-01
		5.4655	1.048E-01	6.1515	-5.639E-01	6.7935	-7.084E-02	7.8395	-3.994E-01	9.2735	-1.984E-02
		8.8105	-3.528E-01								
S-8088UR	VELOCITY FT/SEC										
ARRIVAL TIME= .883		.9475	8.526E-02	1.0265	2.749E-02	1.1025	9.859E-02	1.1775	-3.472E-02	1.2285	-3.618E-03
		1.2705	-4.806E-02	1.3675	2.008E-01	1.4695	-1.414E-01	1.7665	6.229E-01	1.8905	3.563E-01
		1.9305	3.785E-01	2.3735	-6.657E-01	2.6145	1.341E-01	2.8875	-3.102E-01	3.3735	4.185E-01
		3.4345	3.563E-01	3.5955	4.719E-01	4.0525	-1.361E-01	4.2615	5.498E-02	4.3515	-2.056E-02
		4.5555	1.039E-01	4.7985	-2.116E-01	4.8435	-1.983E-01	5.0625	-3.849E-01	5.6045	2.016E-01
		5.7145	1.572E-01	5.8005	2.283E-01	6.0265	1.305E-01	6.0555	1.572E-01	6.3985	-7.833E-02
		6.5225	-7.231E-03	6.8635	-1.583E-01	7.0095	-7.833E-02	7.1965	-1.716E-01	7.9425	2.372E-01
		8.5945	-1.805E-01	9.2325	1.527E-01	9.7245	-1.894E-01				
S-8088UR	DISPLACEMENT INCHES										
		1.1635	2.085E-01	1.2995	1.668E-01	1.4335	3.566E-01	1.5715	2.043E-01	2.1215	2.277E+00
		2.5555	3.658E-01	2.7025	5.029E-01	3.1335	-5.646E-01	3.9255	2.102E+00	4.2085	1.868E+00
		4.6645	2.143E+00	5.3585	3.353E-01	6.2865	1.999E+00	7.5025	6.254E-01	9.2675	1.923E+00
		9.0095	1.047E+00	9.4345	1.493E+00						
S-8088UT	VELOCITY FT/SEC										
ARRIVAL TIME= .887		.9445	8.165E-02	1.0525	-1.299E-02	1.1185	4.560E-02	1.2185	-2.338E-01	1.2775	-7.609E-02
		1.3355	-2.699E-01	1.5085	3.025E-01	1.5715	1.177E-01	1.6075	1.853E-01	1.7975	-9.861E-02
		1.8435	-3.976E-03	2.0065	-2.338E-01	2.2455	1.492E-01	2.2865	1.177E-01	2.3355	1.985E-01
		2.5795	-2.428E-01	2.6355	-1.752E-01	2.7265	-2.789E-01	2.8255	-3.102E-02	2.8615	-9.053E-02
		3.0065	1.402E-01	3.0425	9.367E-02	3.2885	3.656E-01	3.6695	-3.525E-01	3.8765	-2.651E-02
		3.9395	-6.707E-02	3.9665	-3.102E-02	4.1165	-1.842E-01	4.5115	2.754E-01	4.7445	-4.453E-02
		4.9365	3.070E-01	5.3895	-2.293E-01	5.6015	-4.003E-02	5.7595	-2.244E-01	5.9335	-1.257E-01
		6.0085	-1.572E-01	6.1885	-2.651E-02	6.2115	-5.355E-02	6.7095	3.295E-01	7.1553	-1.257E-01
		7.4135	1.856E-02	7.7855	-2.654E-01	8.5165	1.533E-01	8.7025	9.066E-02	9.0525	2.484E-01
		9.5185	-2.428E-01	9.8585	-6.256E-02						
S-8088UT	DISPLACEMENT INCHES										
		1.1545	8.965E-02	1.4015	-3.551E-01	1.7625	2.576E-01	2.1375	-1.633E-01	2.5025	2.731E-01
		2.9325	-4.895E-01	3.5075	7.958E-01	4.2575	-5.923E-01	4.6535	1.739E-01	4.7785	1.433E-01
		5.2125	9.394E-01	6.2815	-6.094E-01	6.9935	1.239E+01	7.3945	8.824E-01	7.4485	9.983E-01
		8.1595	-2.800E-01	9.3435	1.609E+00						

TABLE II

Gage Locations and Elevation Information

Station	Coordinates (ft) North	Coordinates (ft) East	Ground Range (ft)	Slant Range (ft)	Elevation (ft MSL)
Boring U7af	853100	686500	-	-	4200
S-Z	853050	688500	50	1865	4200
S-932	852168	686500	932	2094	4190
S-2000	851101	686500	1999	2754	4171
S-3000	850101	686500	2999	3556	4155
S-3500	849601	686500	3499	3990	4147
S-4000	849101	686500	3999	4437	4142
S-8000	845102	686500	7998	8235	4105

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[redacted]

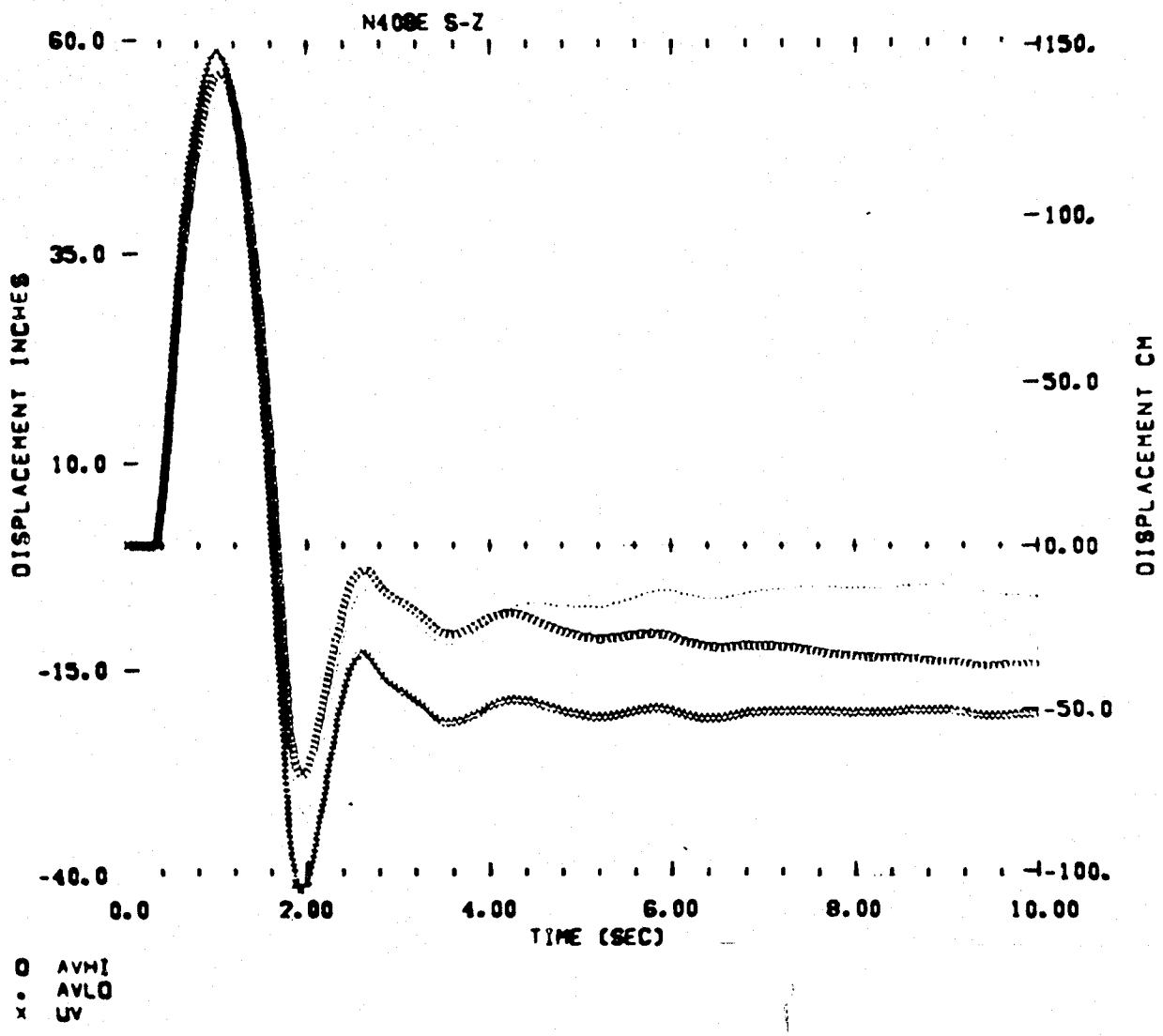

Figure 1. Overlay of vertical displacements for station S-Z.

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[redacted]

[redacted]

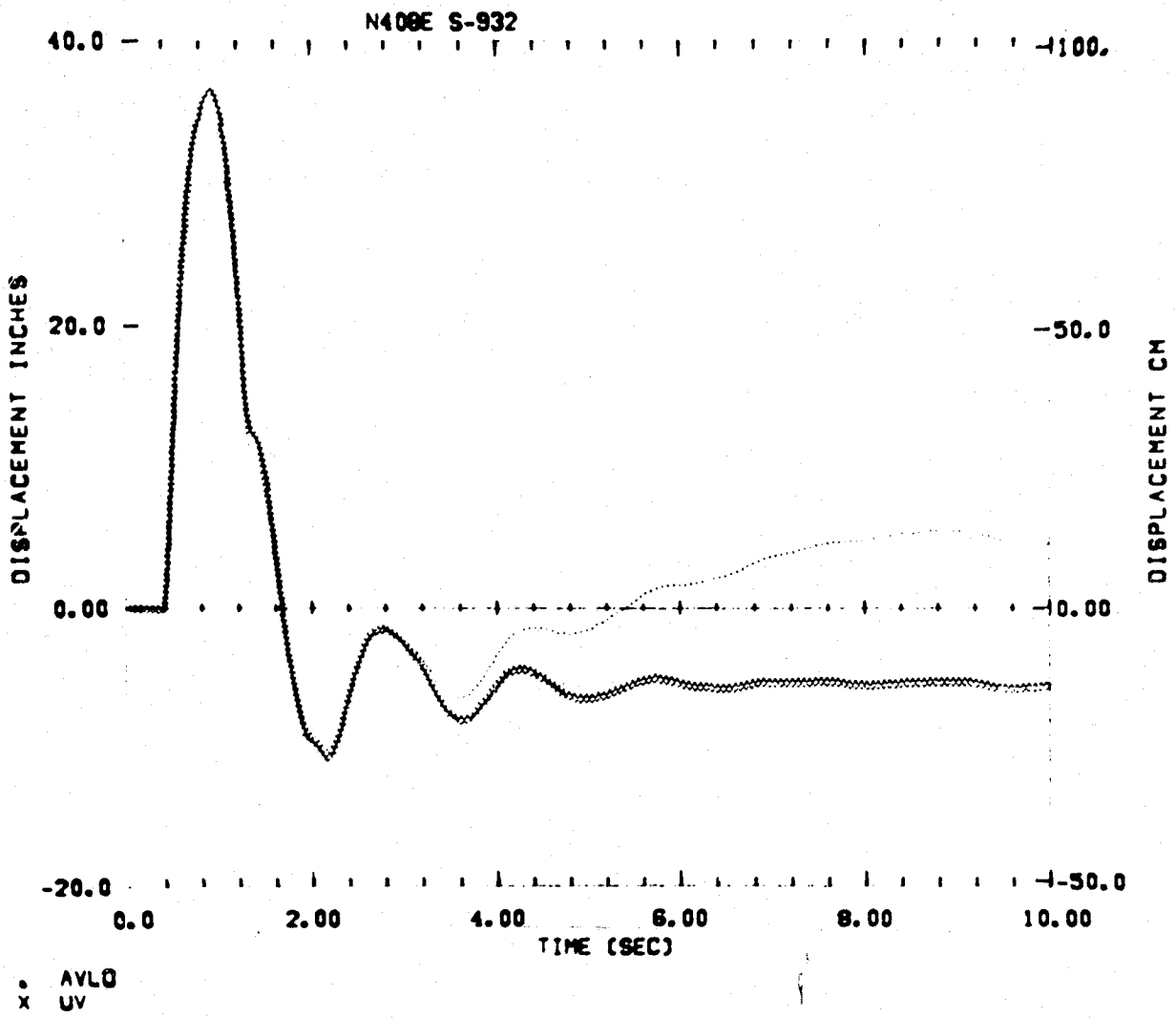

Figure 2. Overlay of vertical displacements for station S-932.

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[redacted]

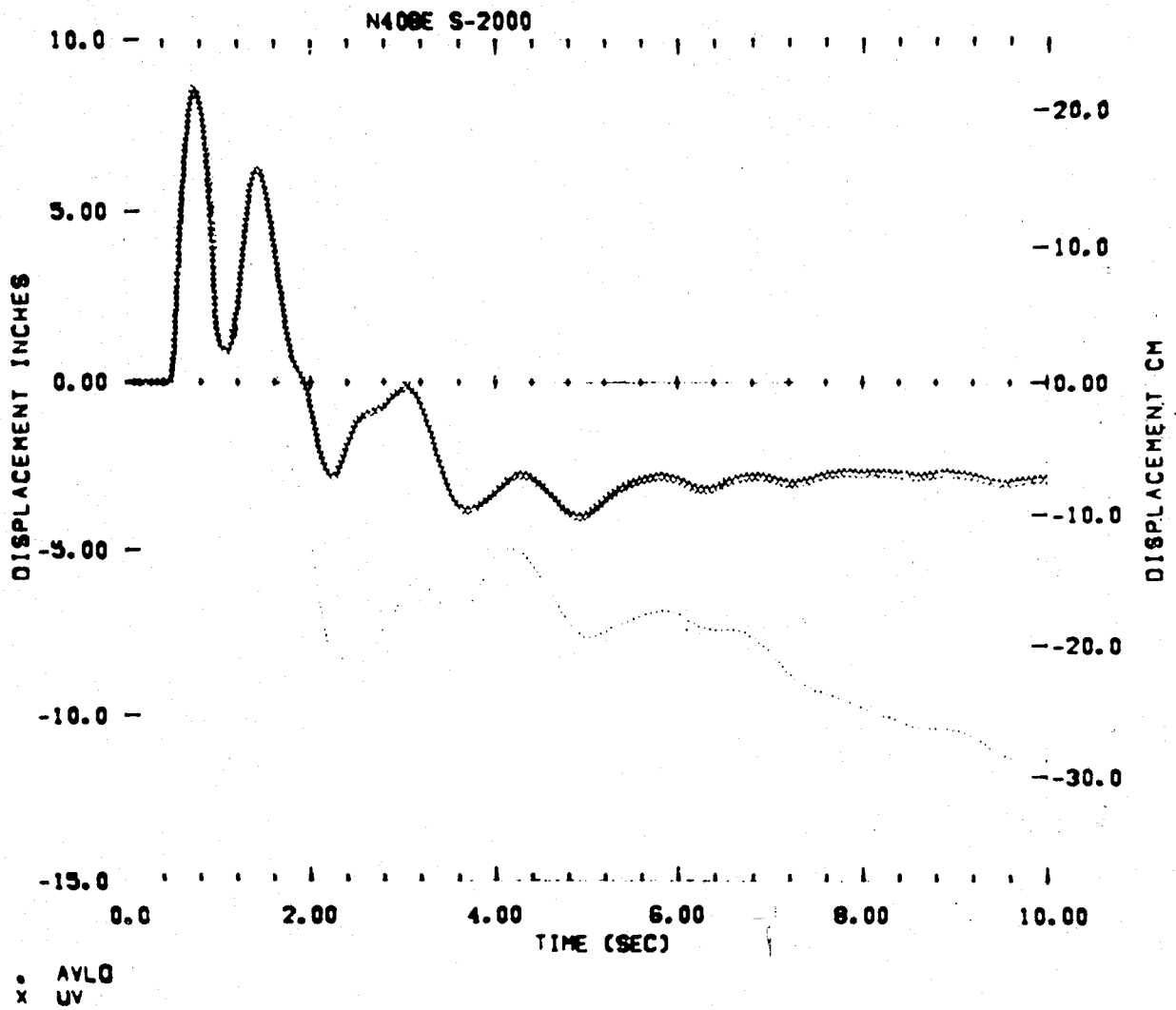

Figure 3. Overlay of vertical displacements for station S-2000.

[redacted]

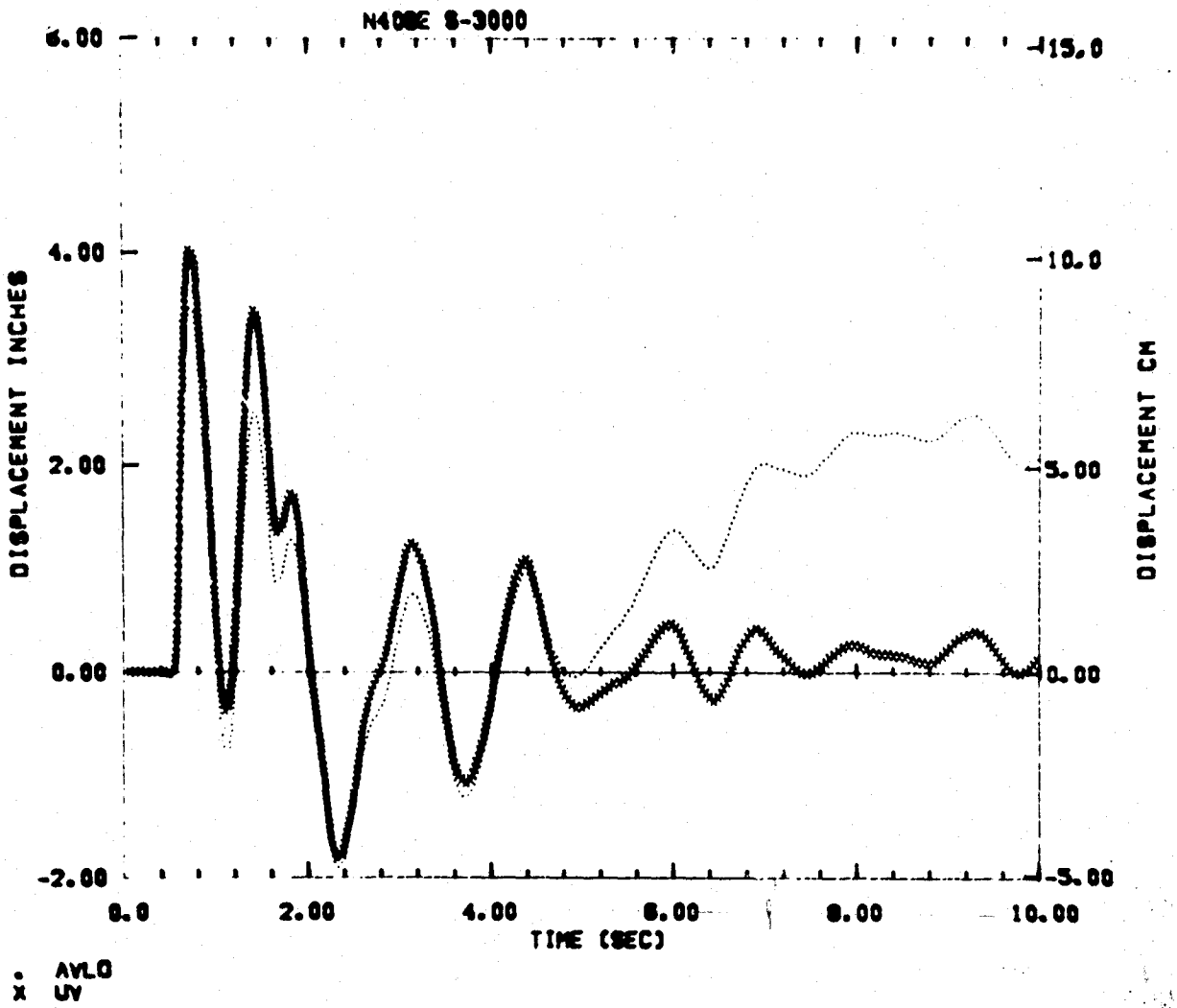

Figure 4. Overlay of vertical displacements for station S-3000.

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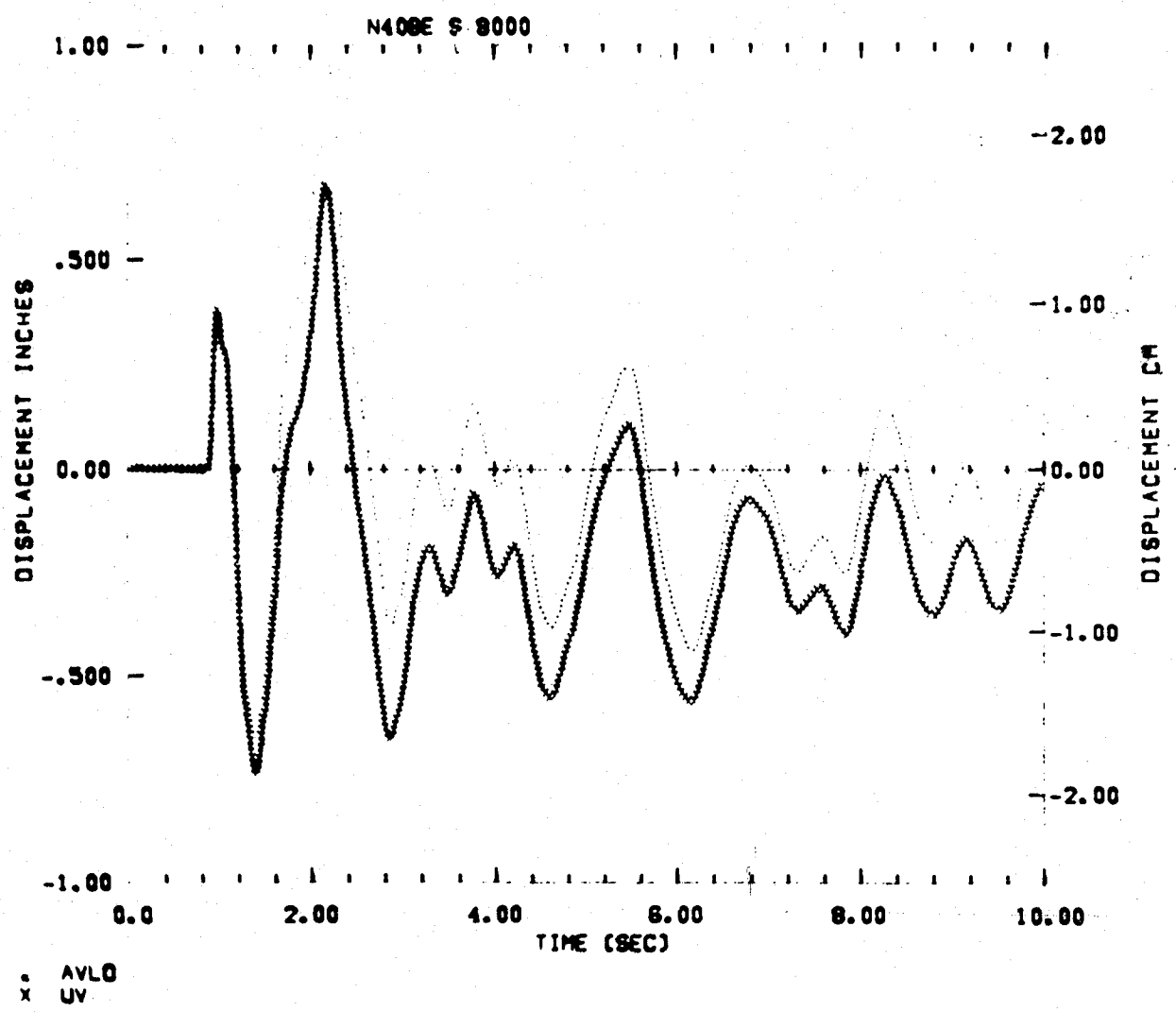

Figure 5. Overlay of vertical displacements for station S-8000.

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[redacted]

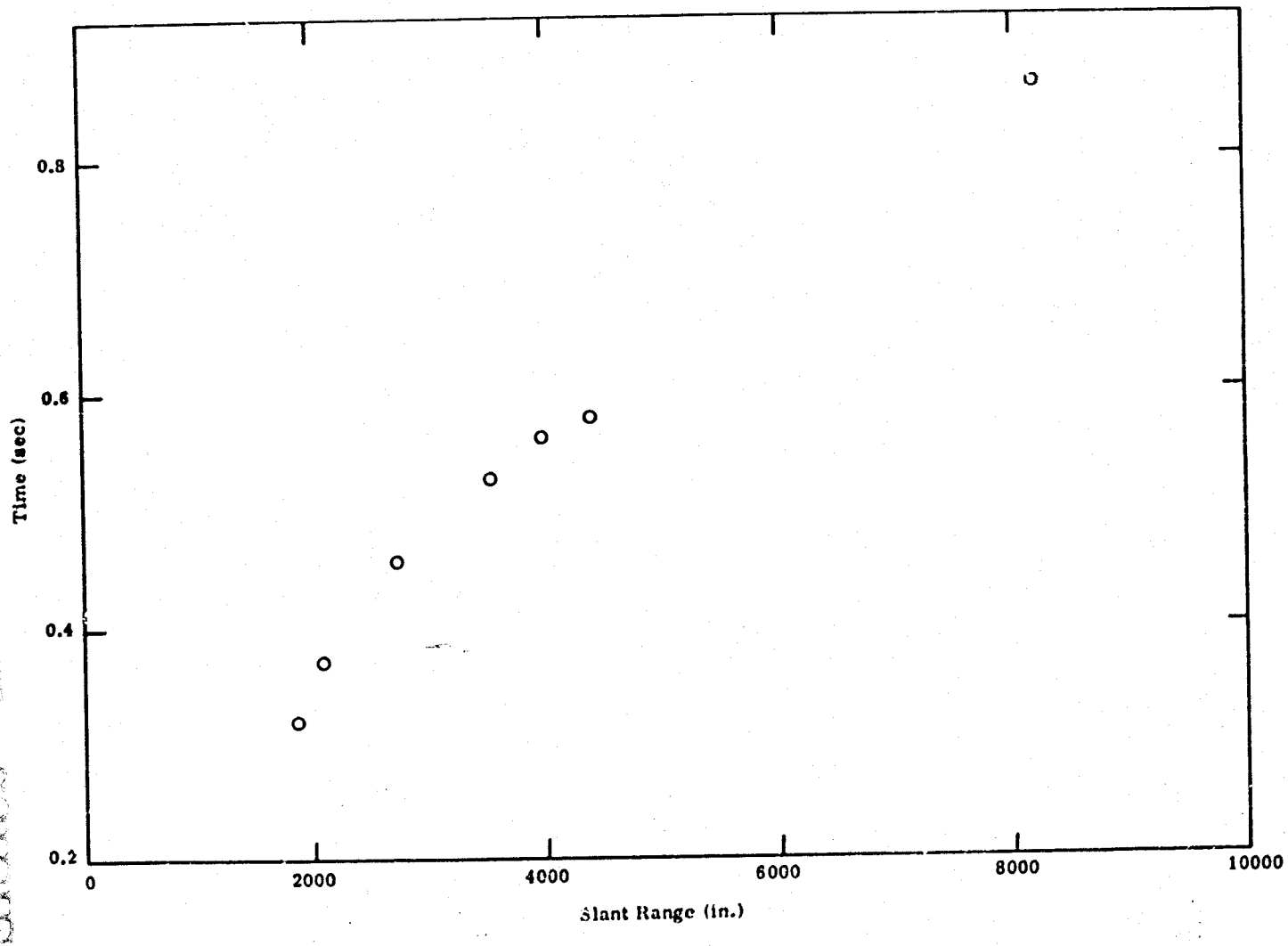

Figure 6. First signal arrival time vs slant range.

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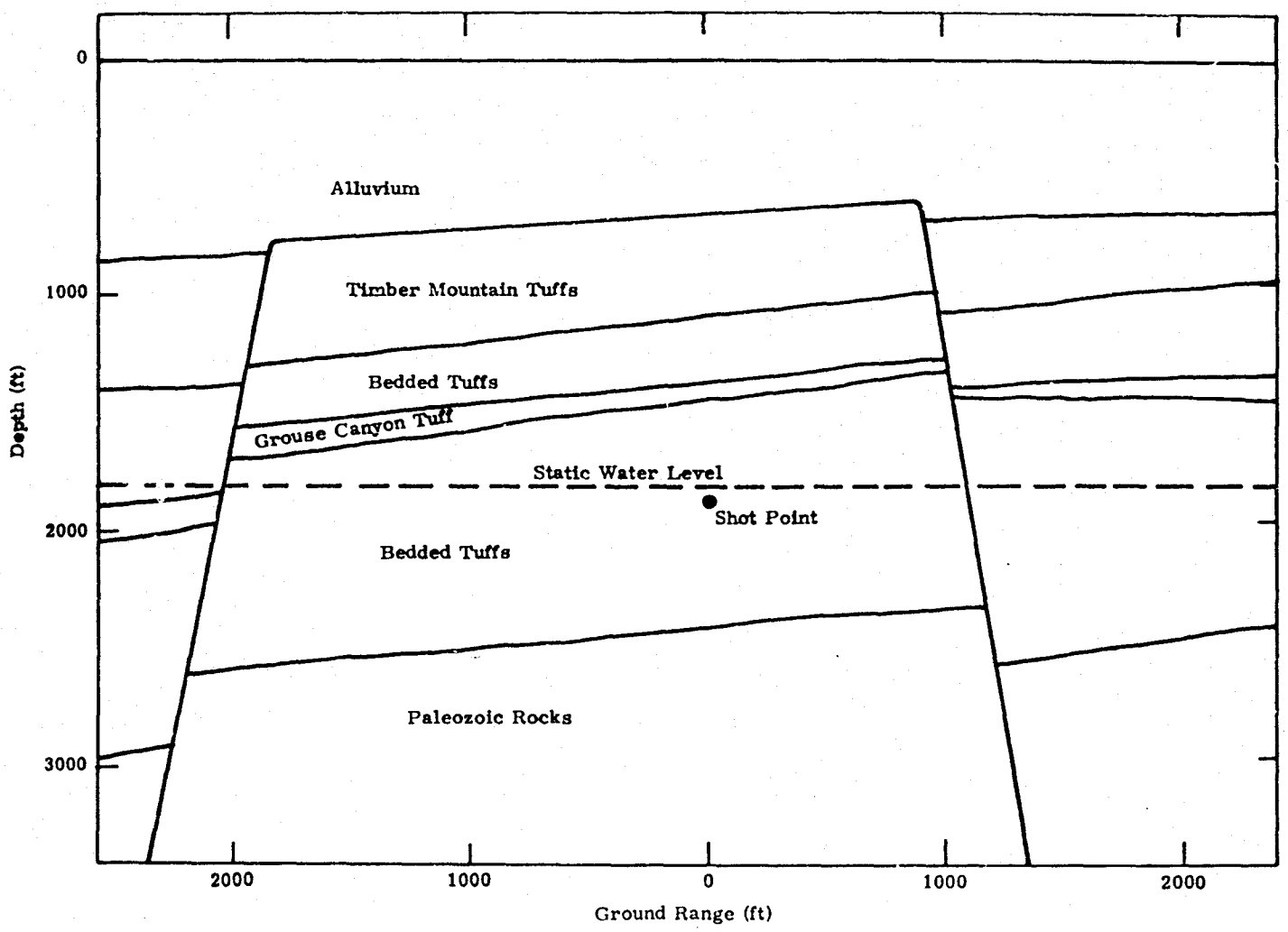

Figure 7. East-west geologic cross section.

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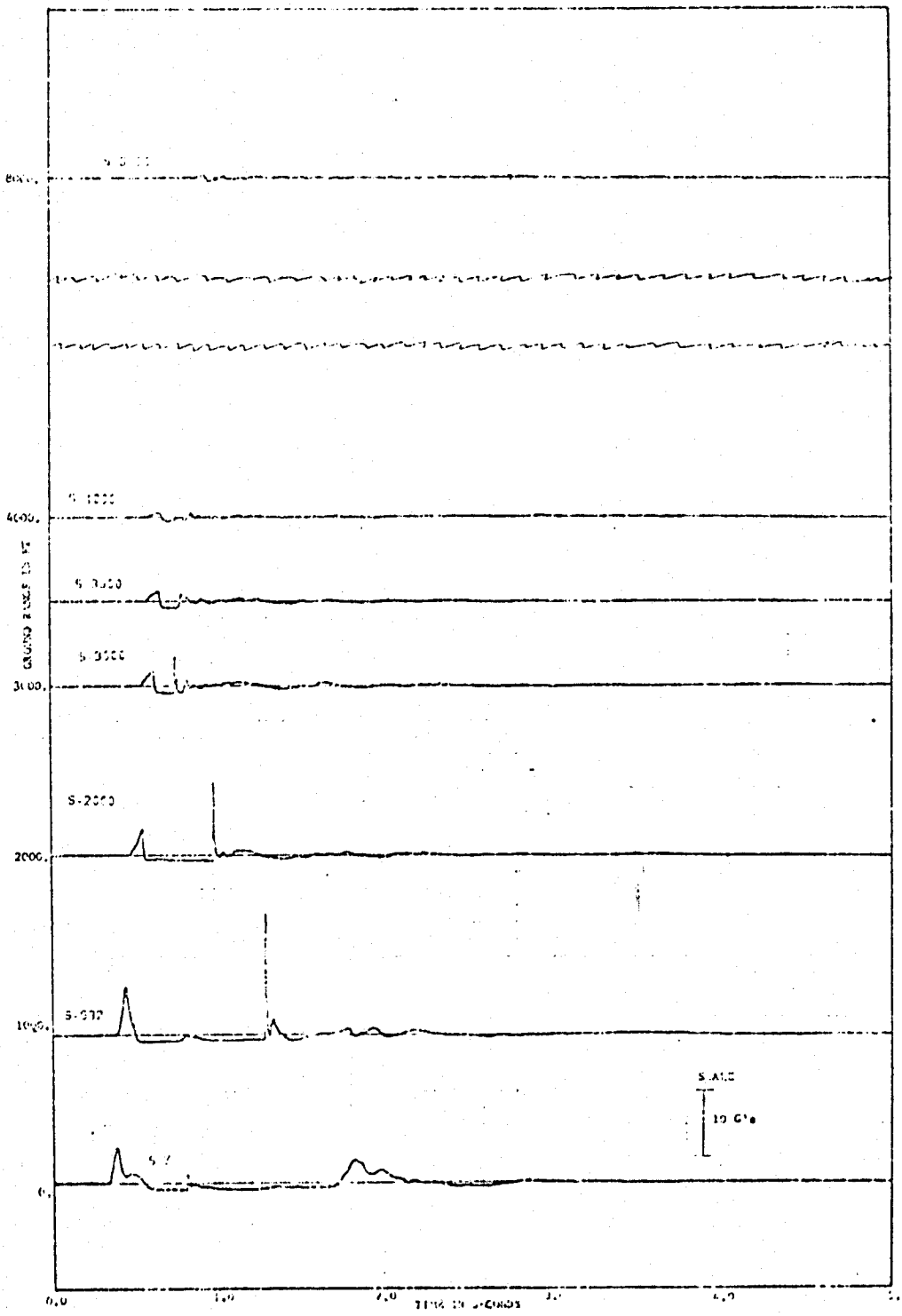

Figure 8. Vertical accelerations as measured by low-range accelerometers.

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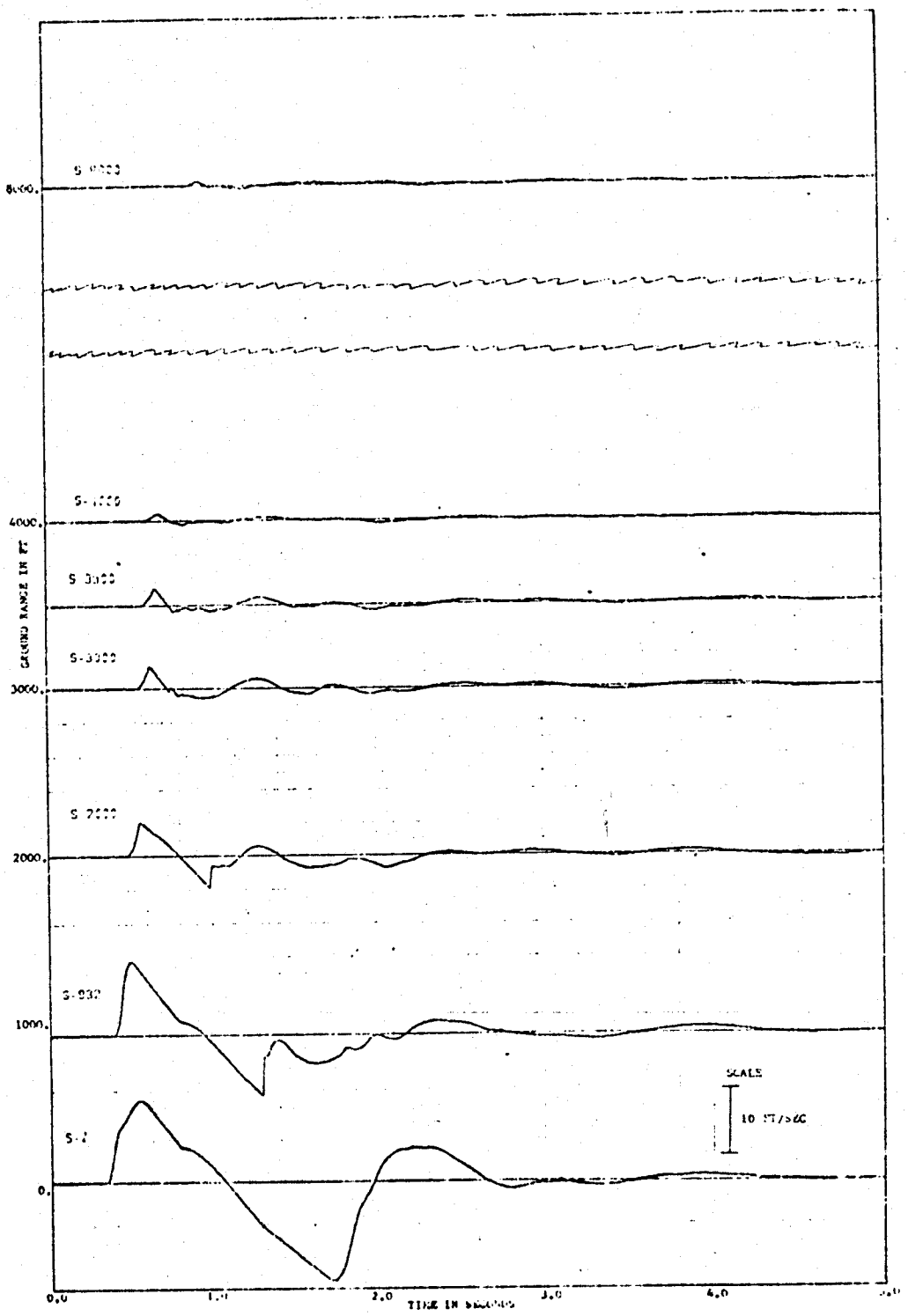

Figure 9. Vertical velocities as derived from low-range accelerometers.

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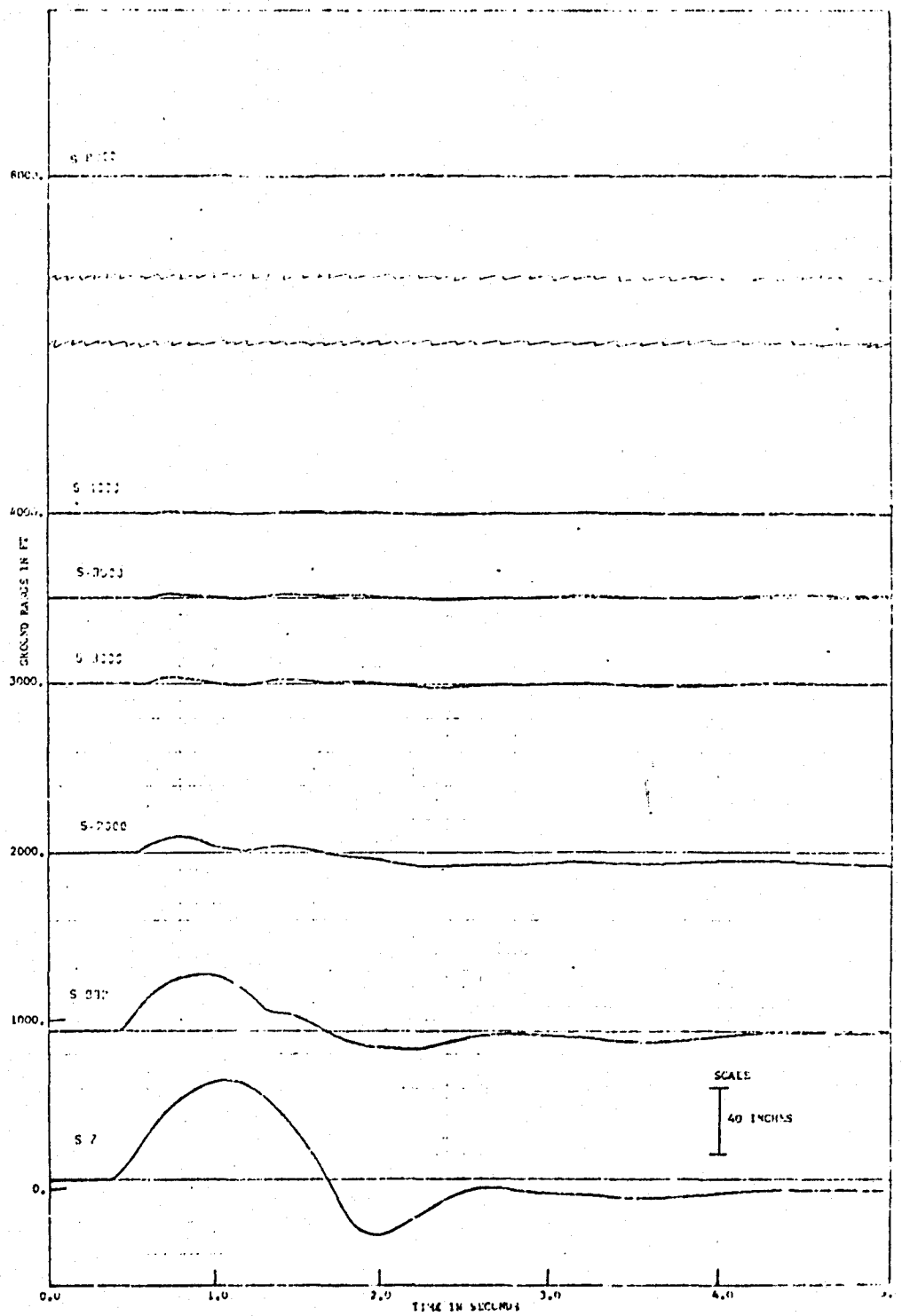

Figure 10. Vertical displacements as derived from low-range accelerometers.

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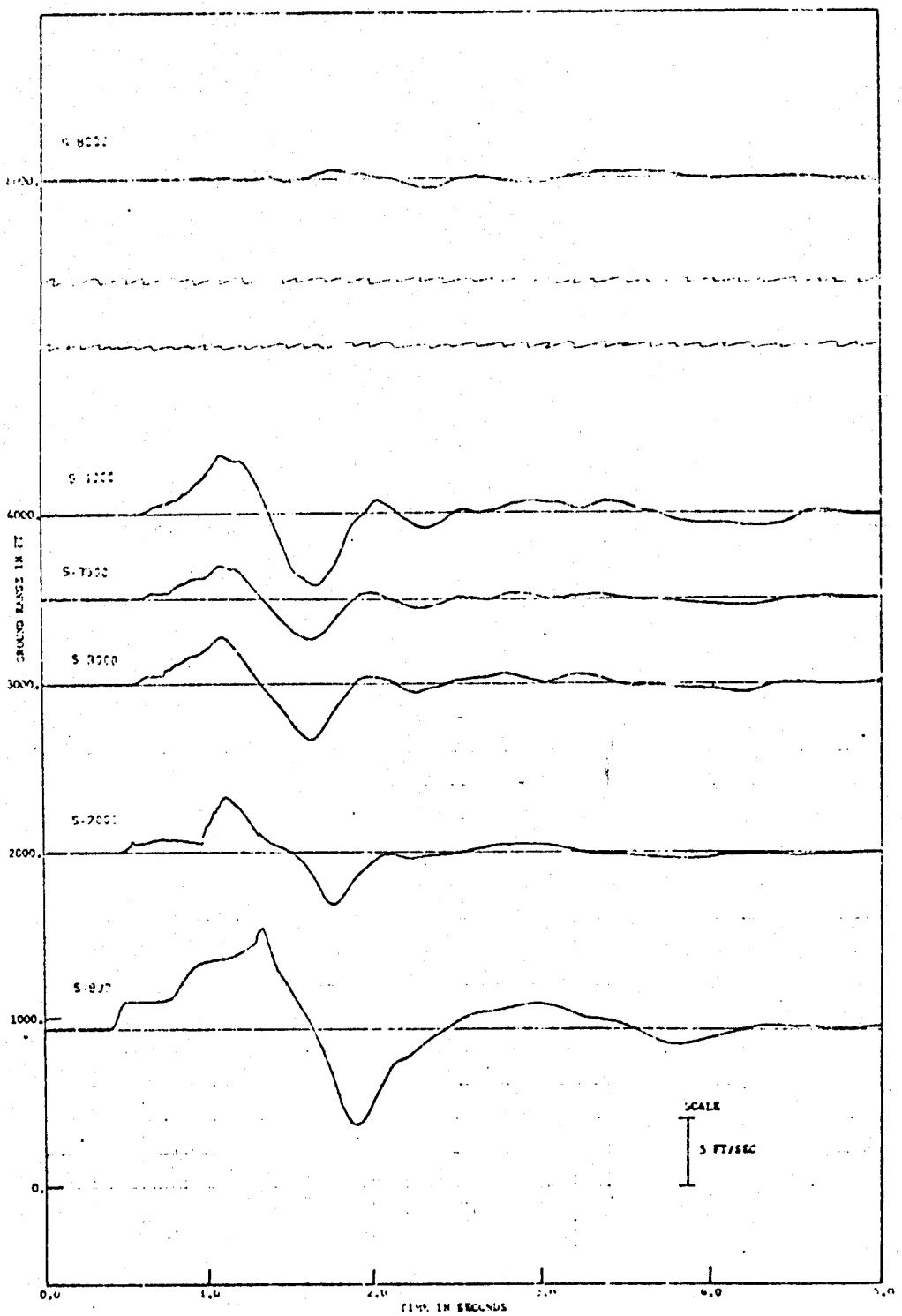

Figure 11. Radial velocities.

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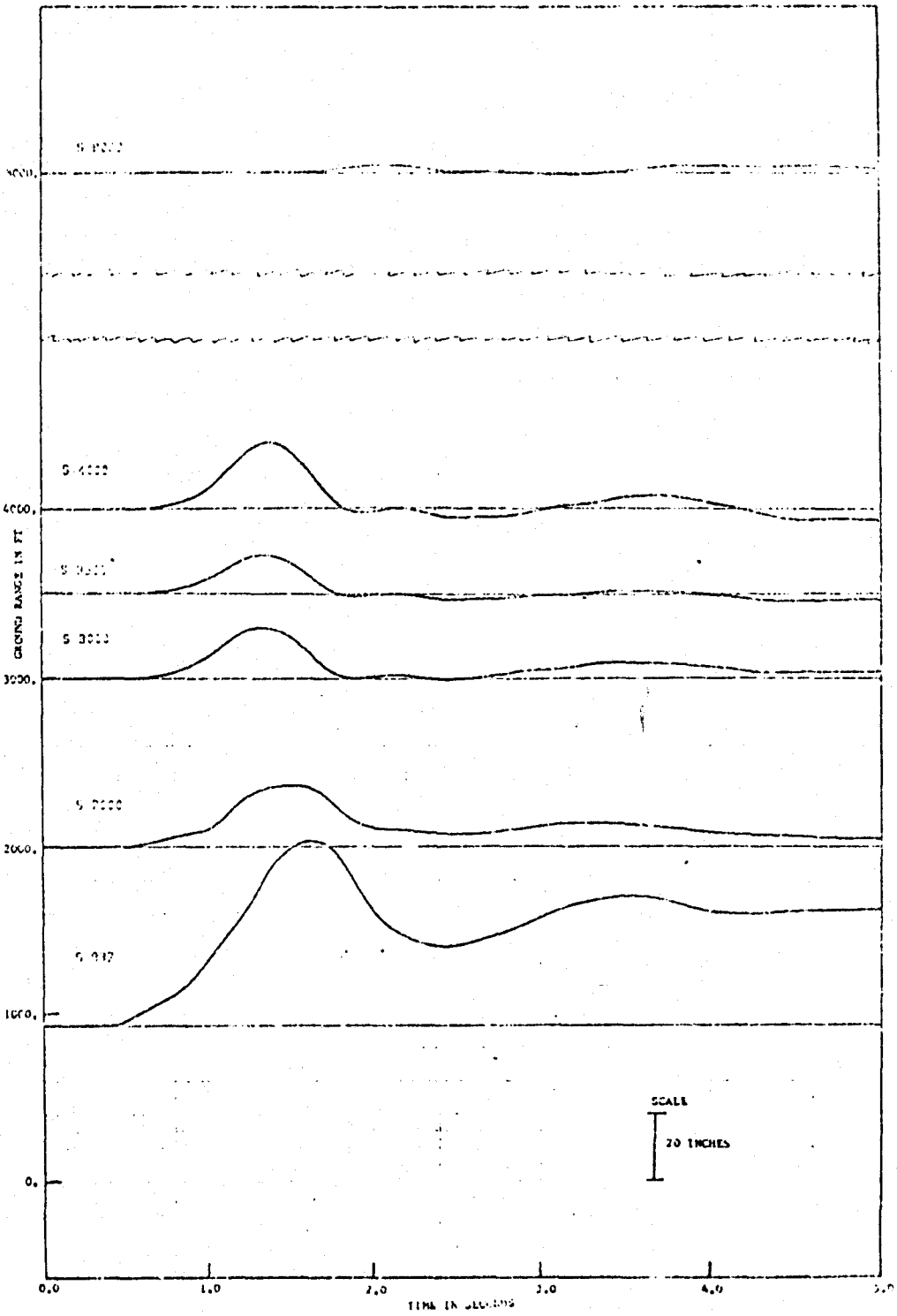

Figure 12. Radial displacements.

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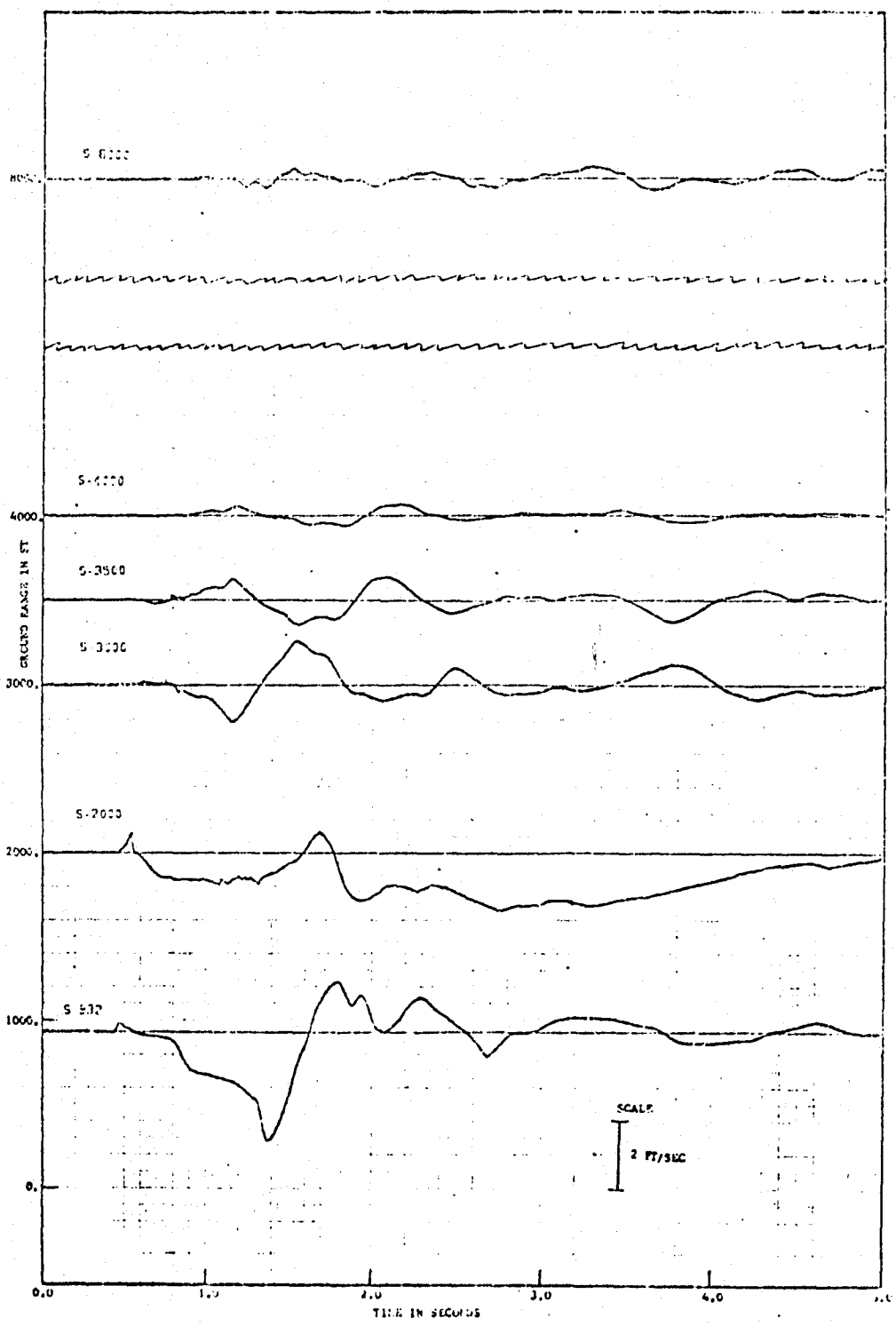

Figure 13. Tangential velocities.

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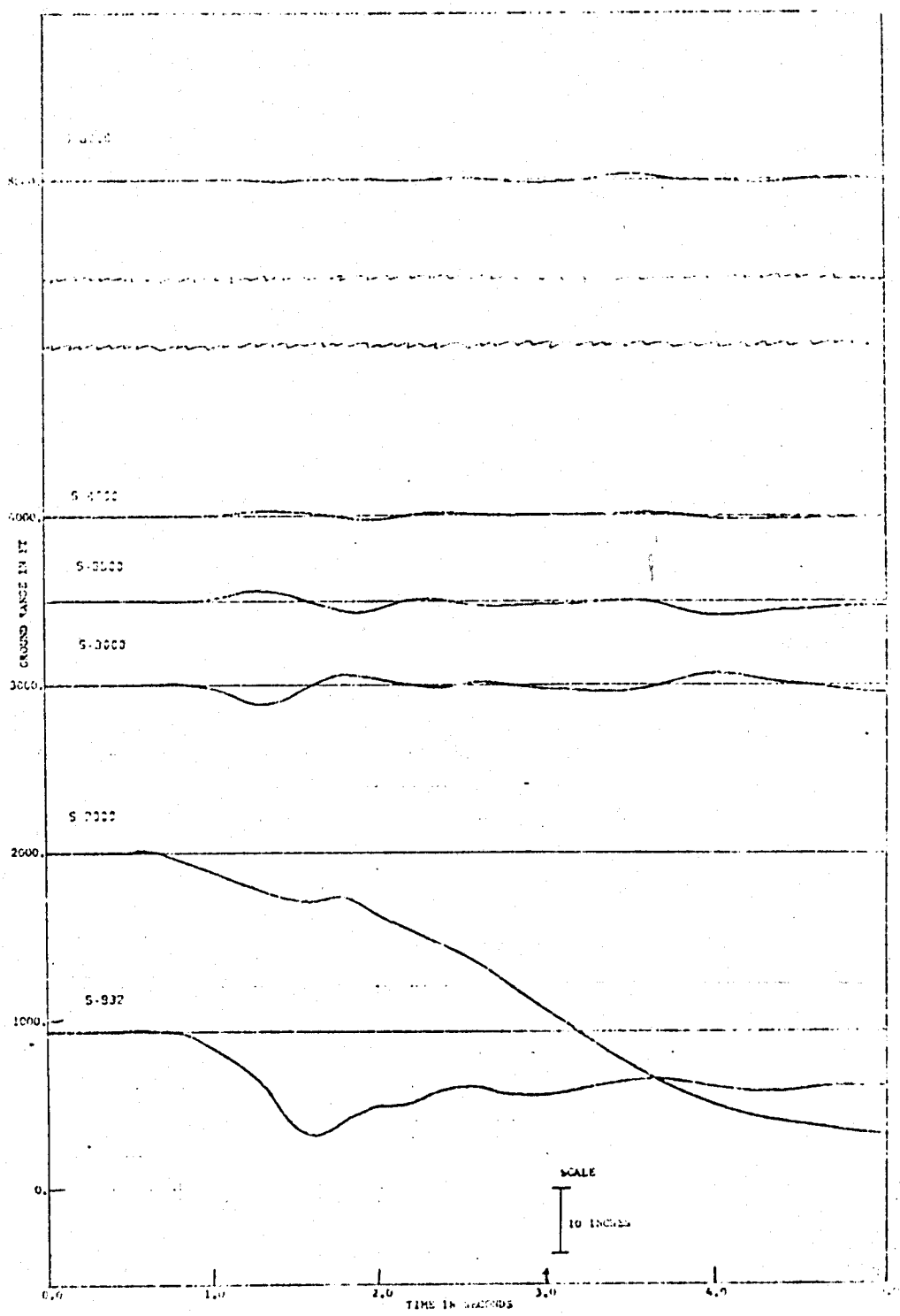

Figure 14. Tangential displacements.

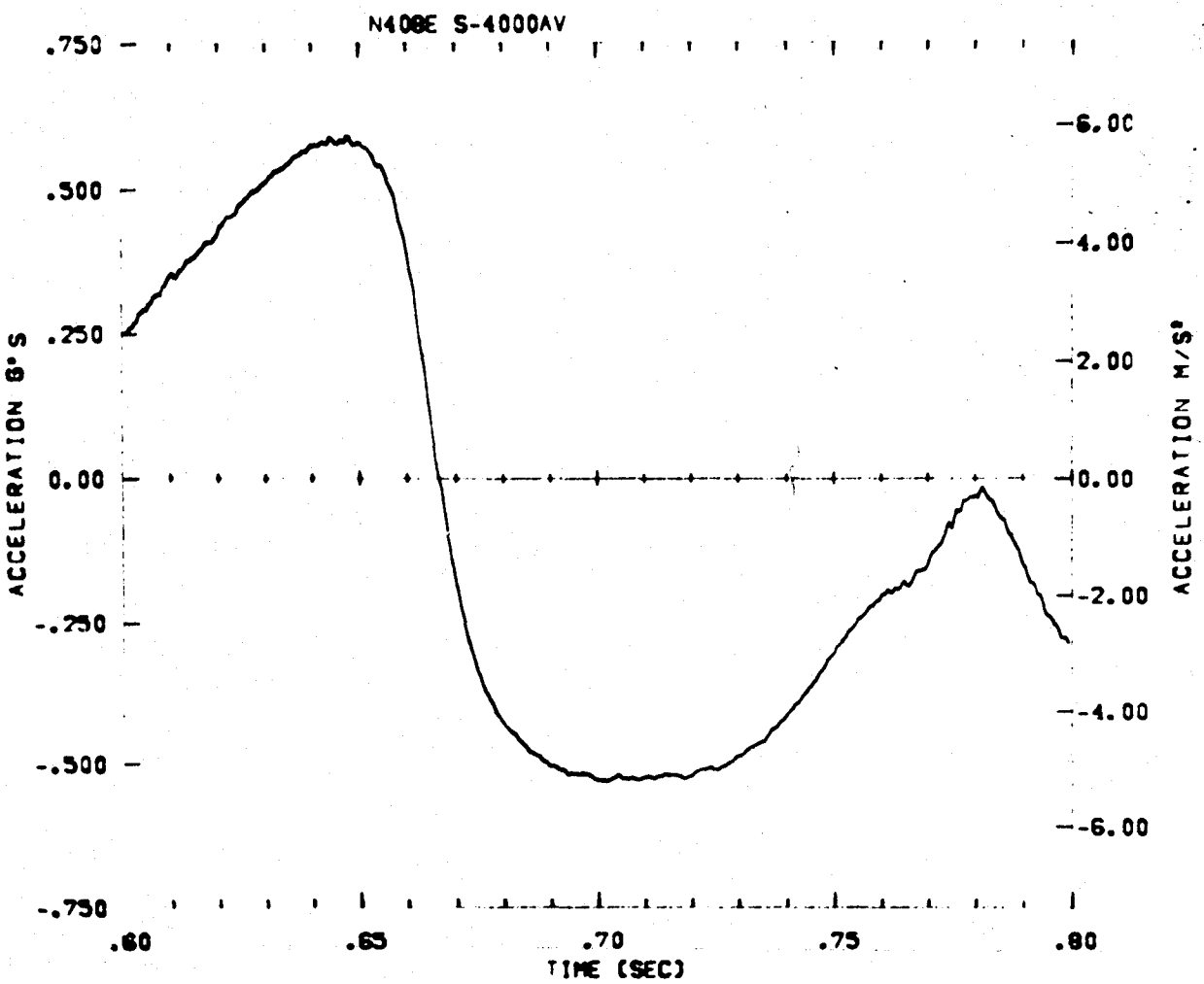

Figure 15. Expansion of acceleration trace at station S-4000 showing flat area where other stations are reading -1 g.

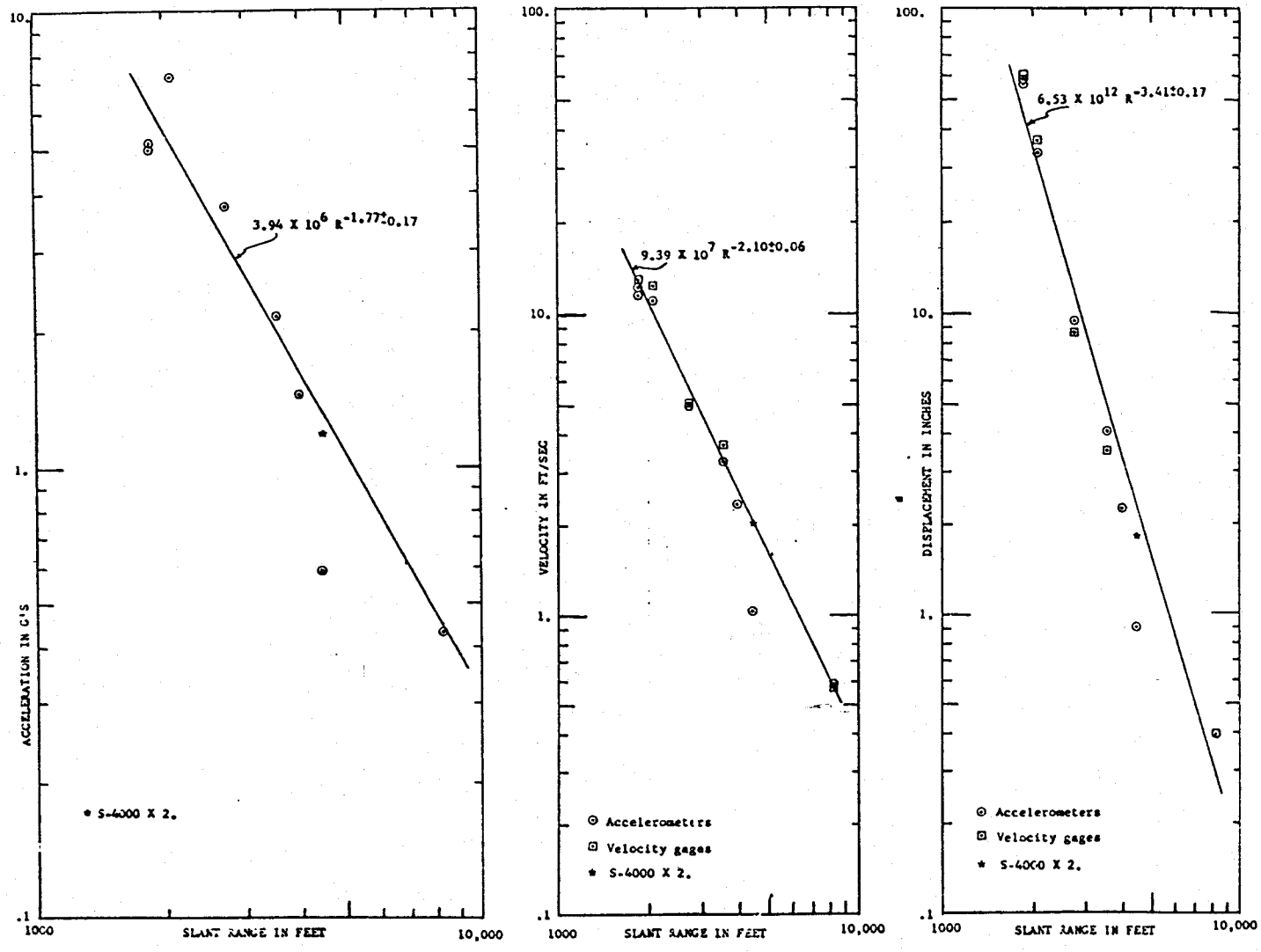

Figure 16. Attenuation rates of vertical acceleration, velocity, and displacement. Station S-4000 was not used in the determination of the line shown.

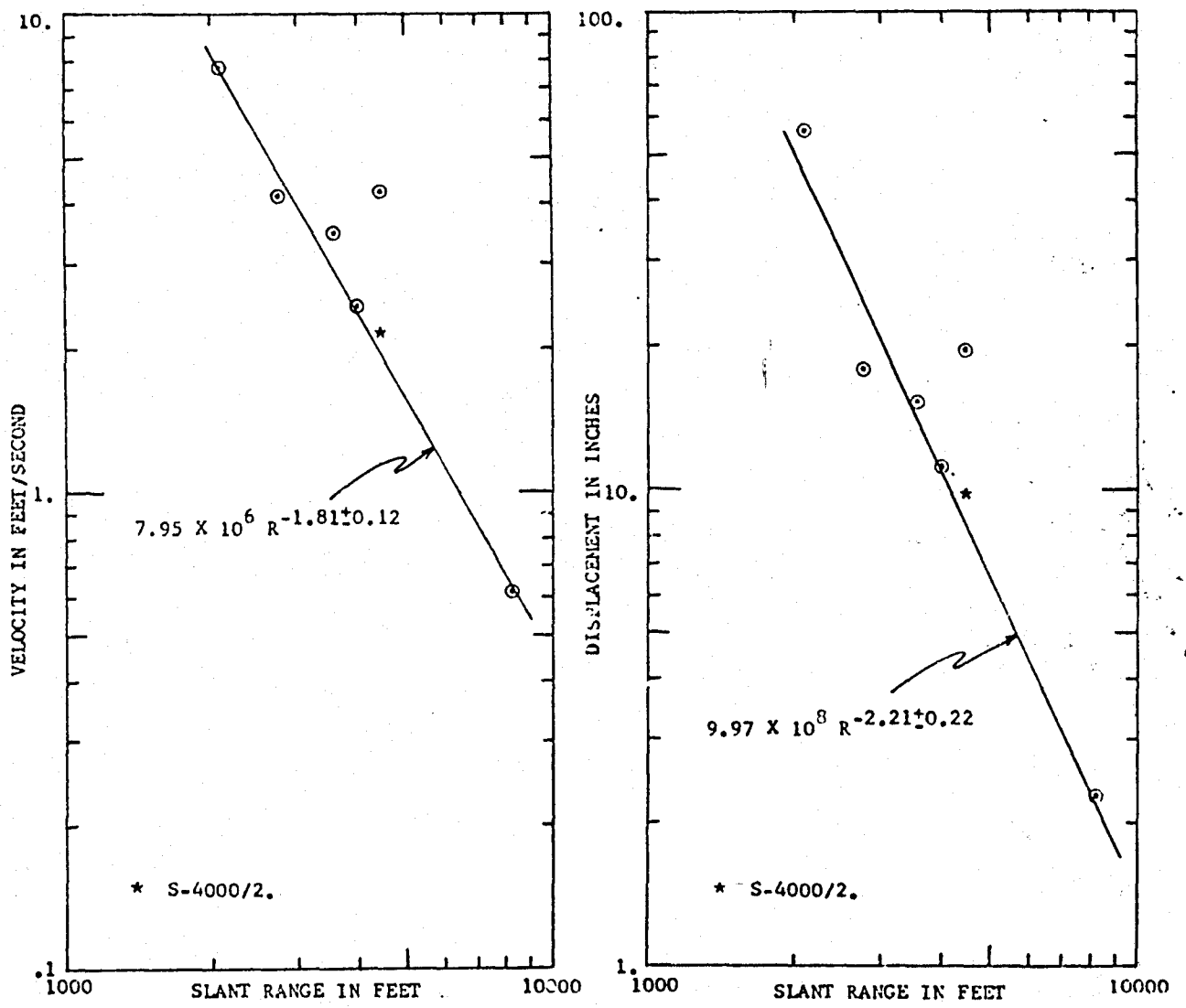

Figure 17. Attenuation rates of radial velocity and displacement. Station S-4000 was not used in the determination of the line shown.

[redacted]

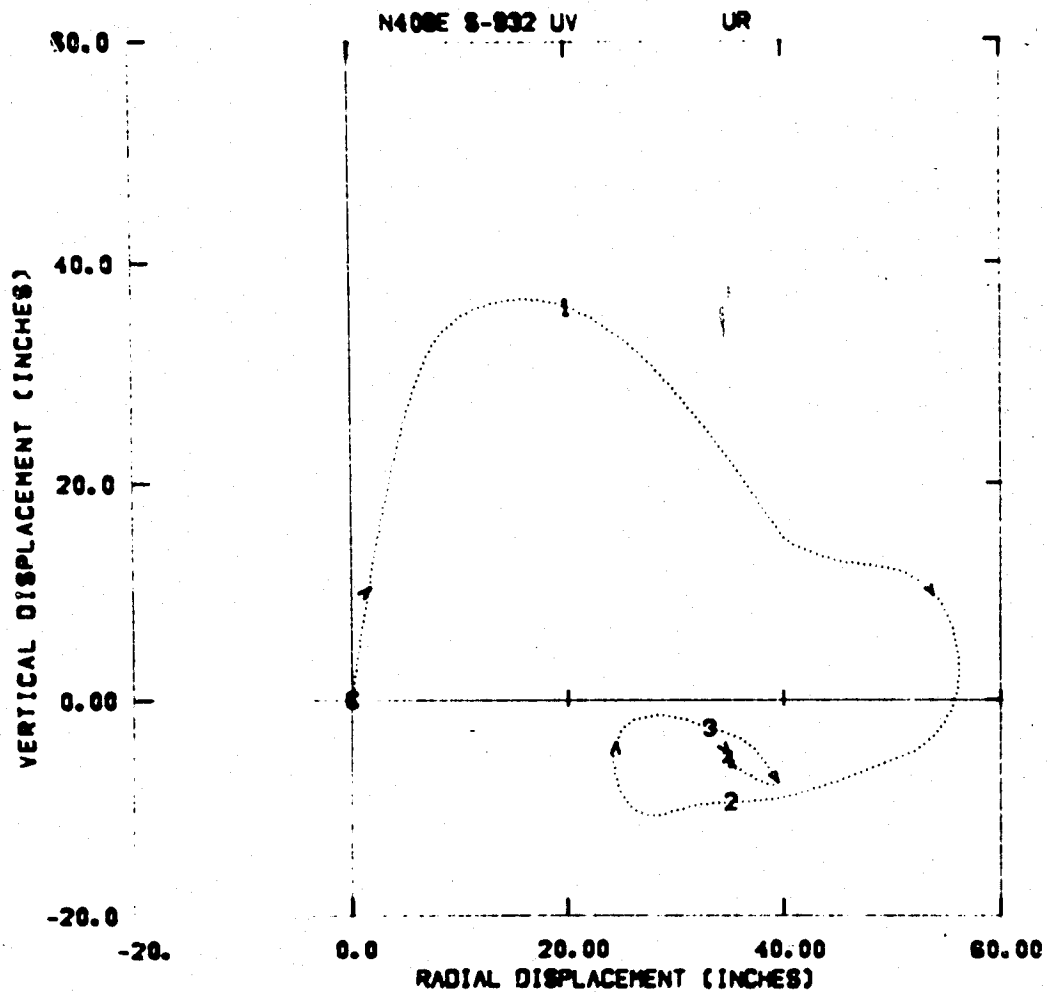

Figure 18. Station S-932 vertical vs radial displacement hodograph. Numbers are every second; arrows are on half-seconds.

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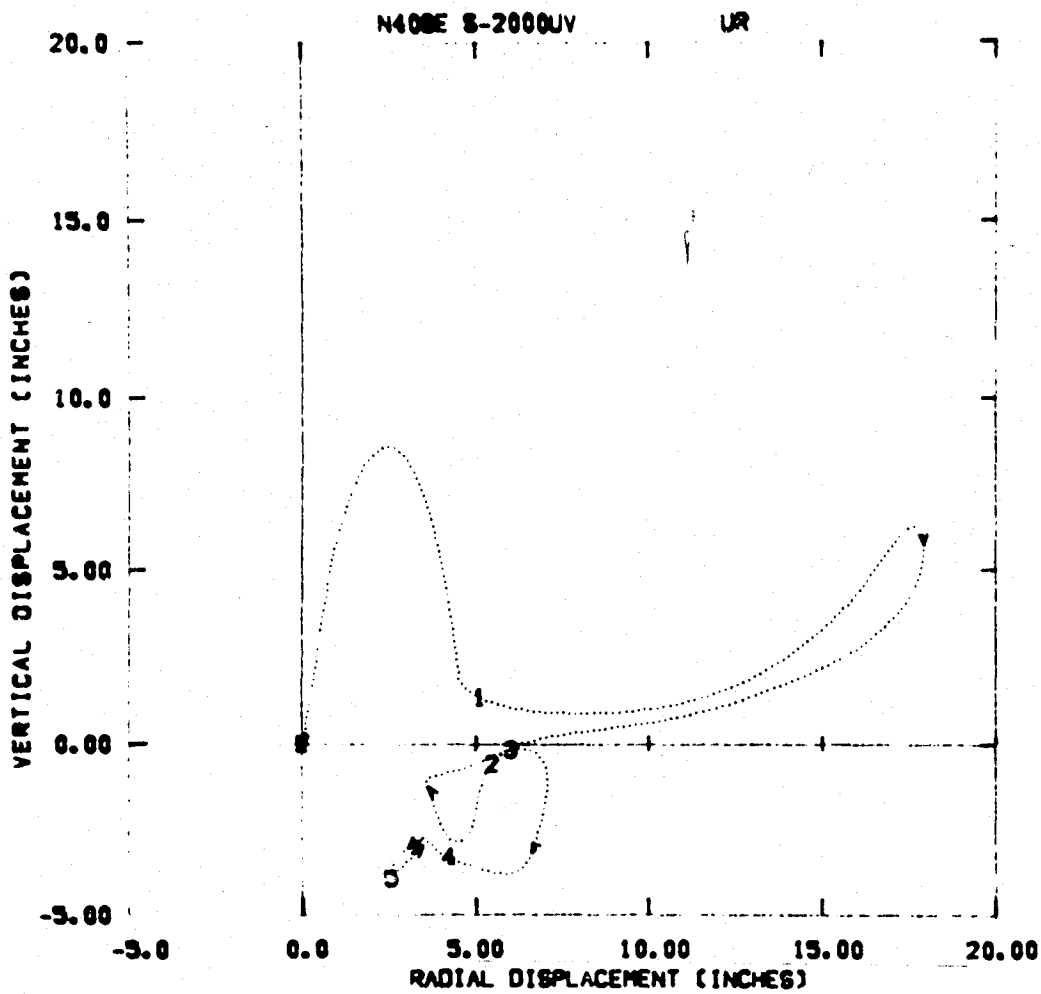

Figure 19. Station S-2000 vertical vs radial displacement hodograph. Numbers are every second; arrows are on half-seconds.

[redacted]

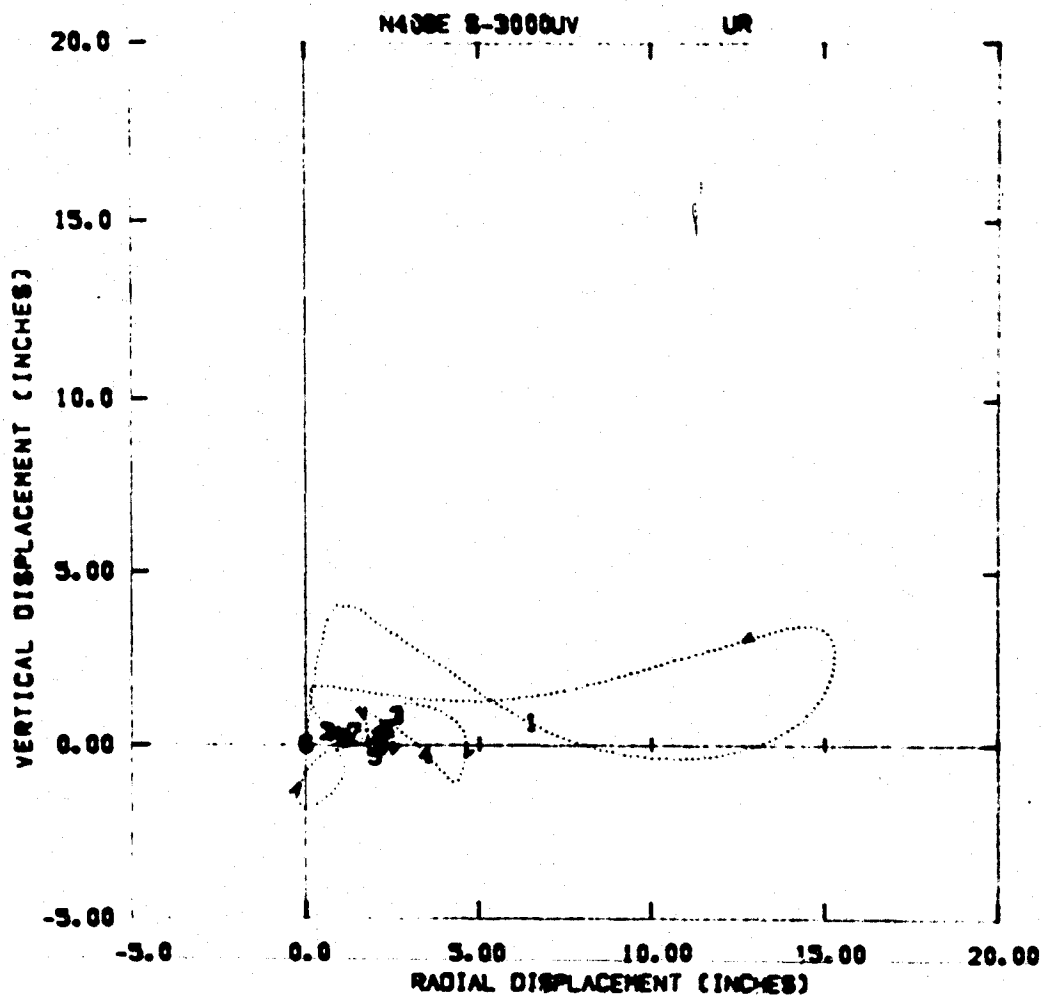

Figure 20. Station S-3000 vertical vs radial displacement hodograph. Numbers are every second; arrows are on half-seconds.

[redacted]

[redacted]

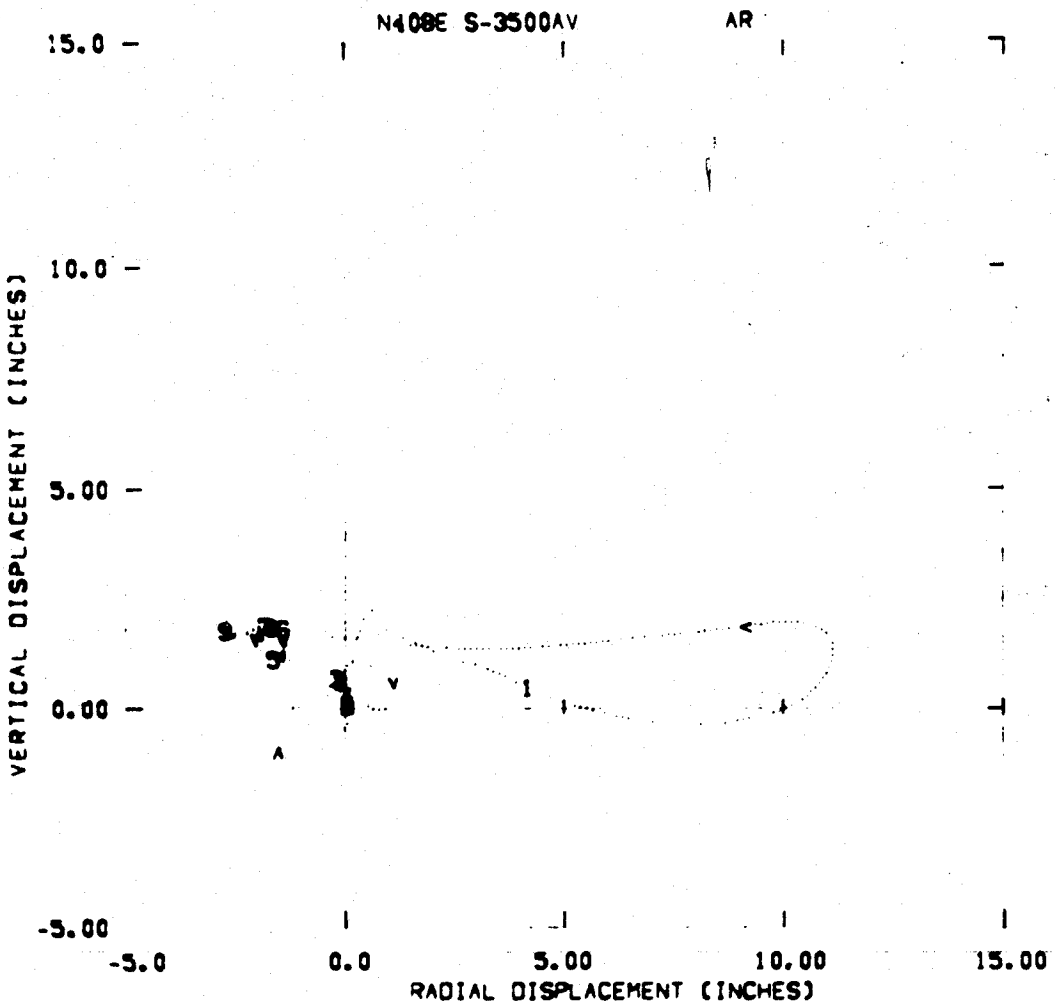

Figure 21. Station S-3500 vertical vs radial displacement hodograph. Numbers are every second; arrows are on half-seconds.

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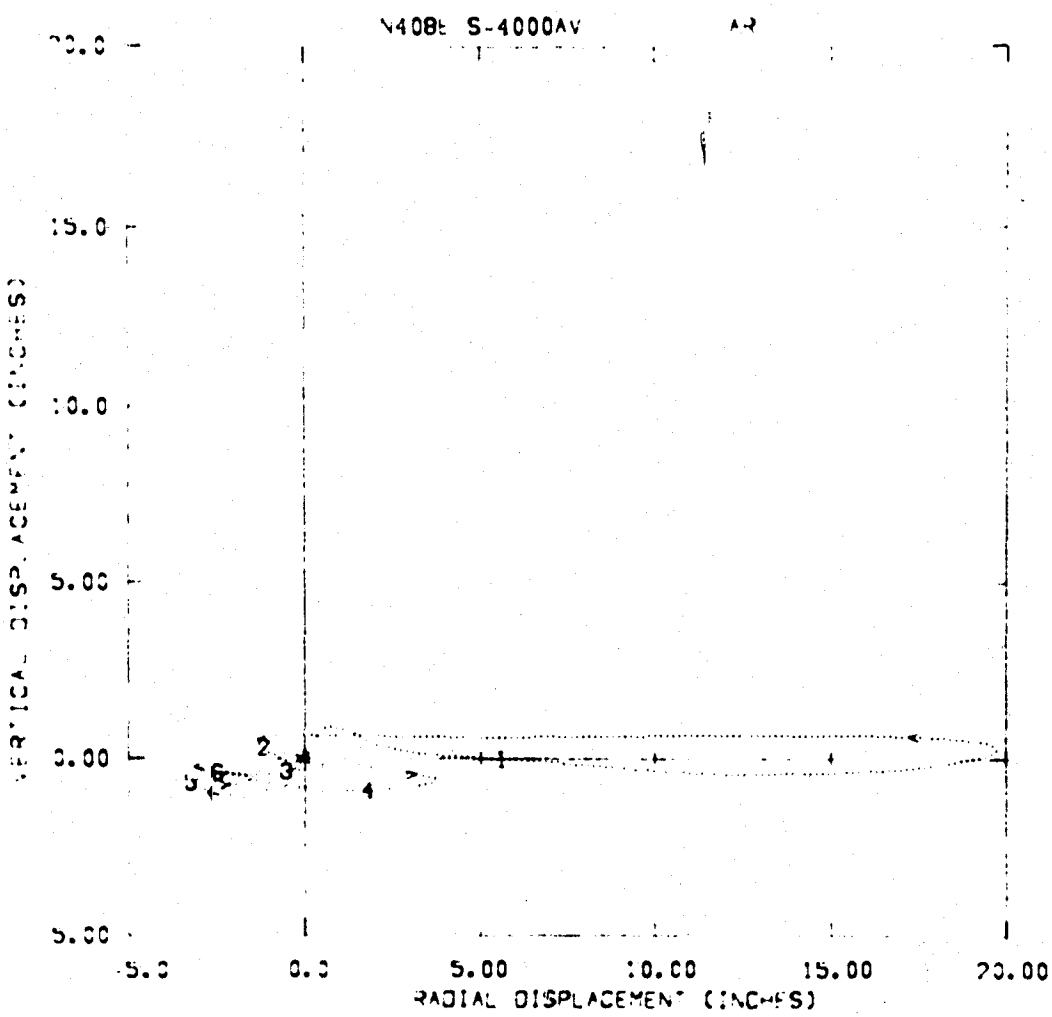

Figure 22. Station S-4000 vertical vs radial displacement hodograph. Numbers are every second; arrows are on half-seconds.

[redacted]

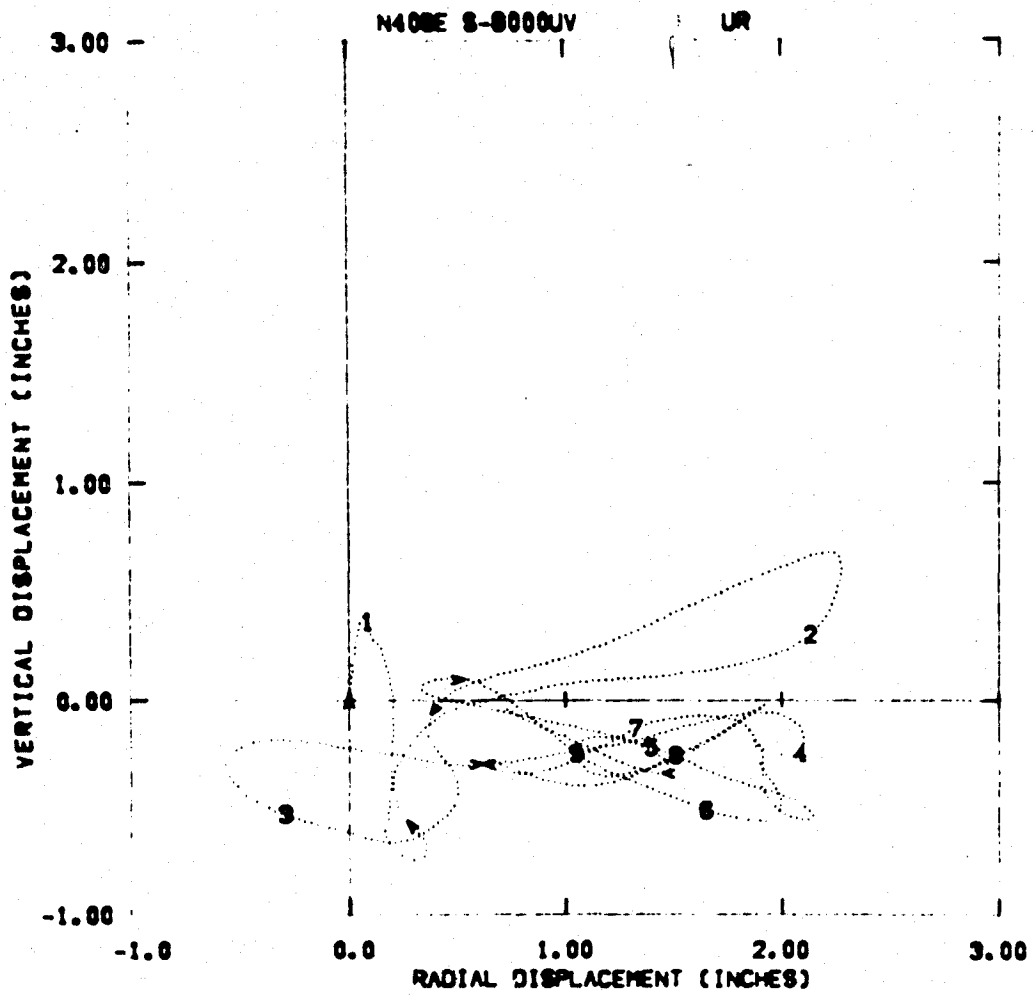

Figure 23. Station S-8000 vertical vs radial displacement hodograph. Numbers are every second; arrows are on half-seconds.

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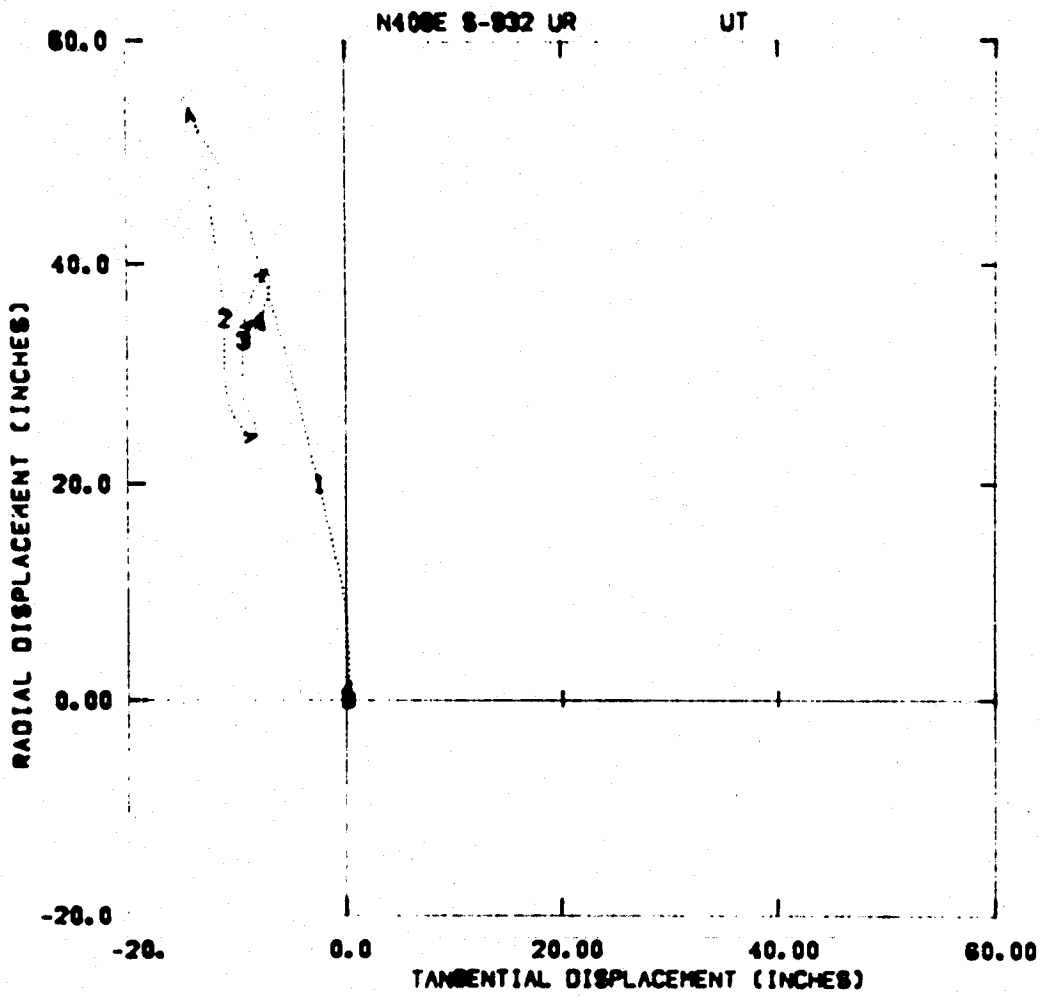

Figure 24. Station S-932 radial vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

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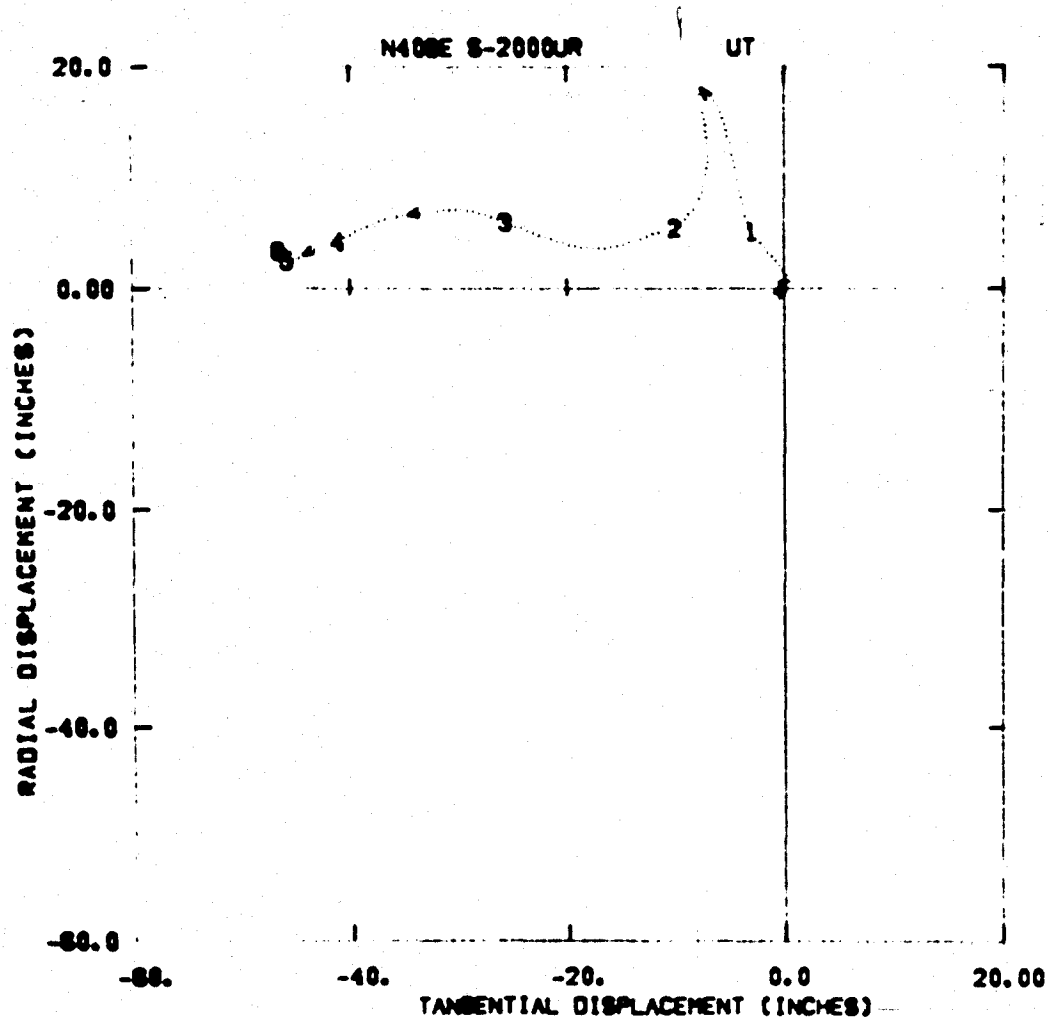

Figure 25. Station S-2000 radial vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

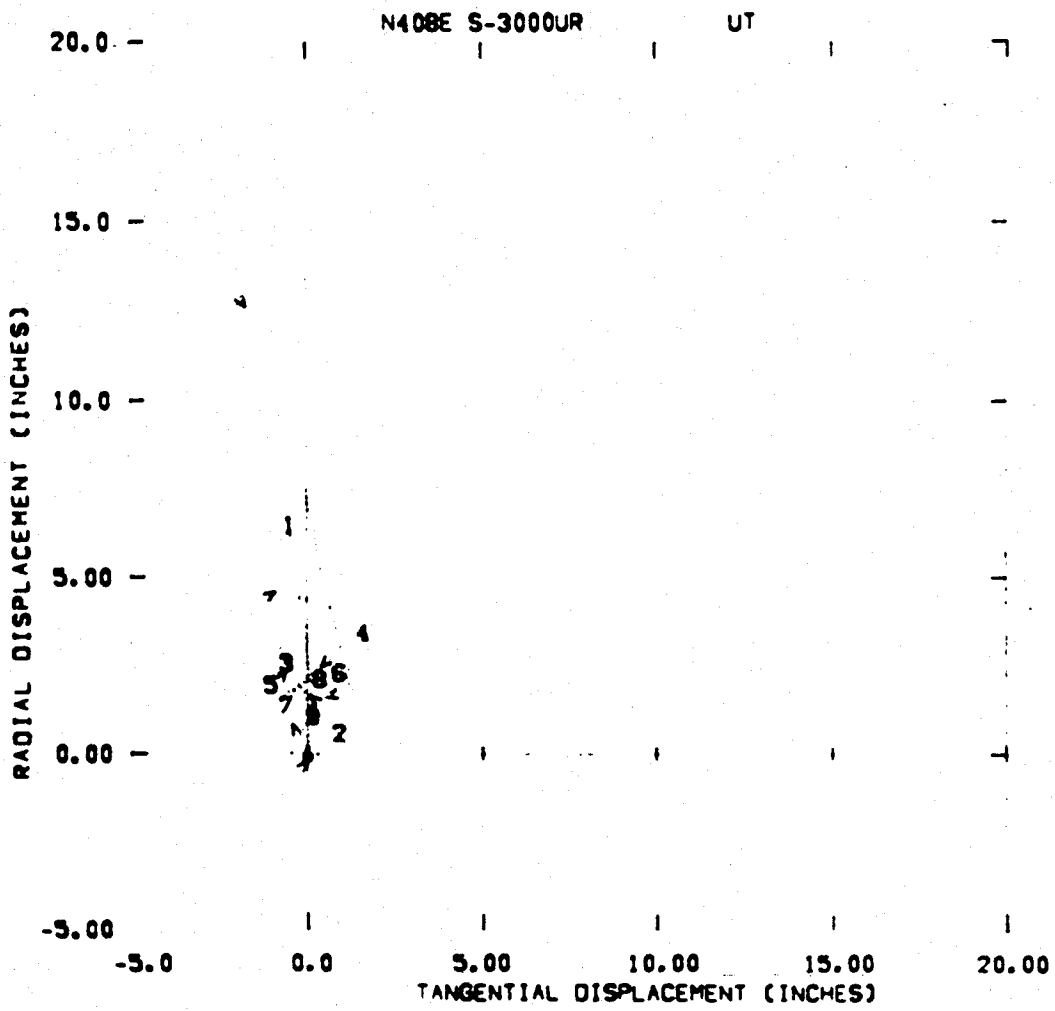

Figure 26. Station S-3000 radial vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

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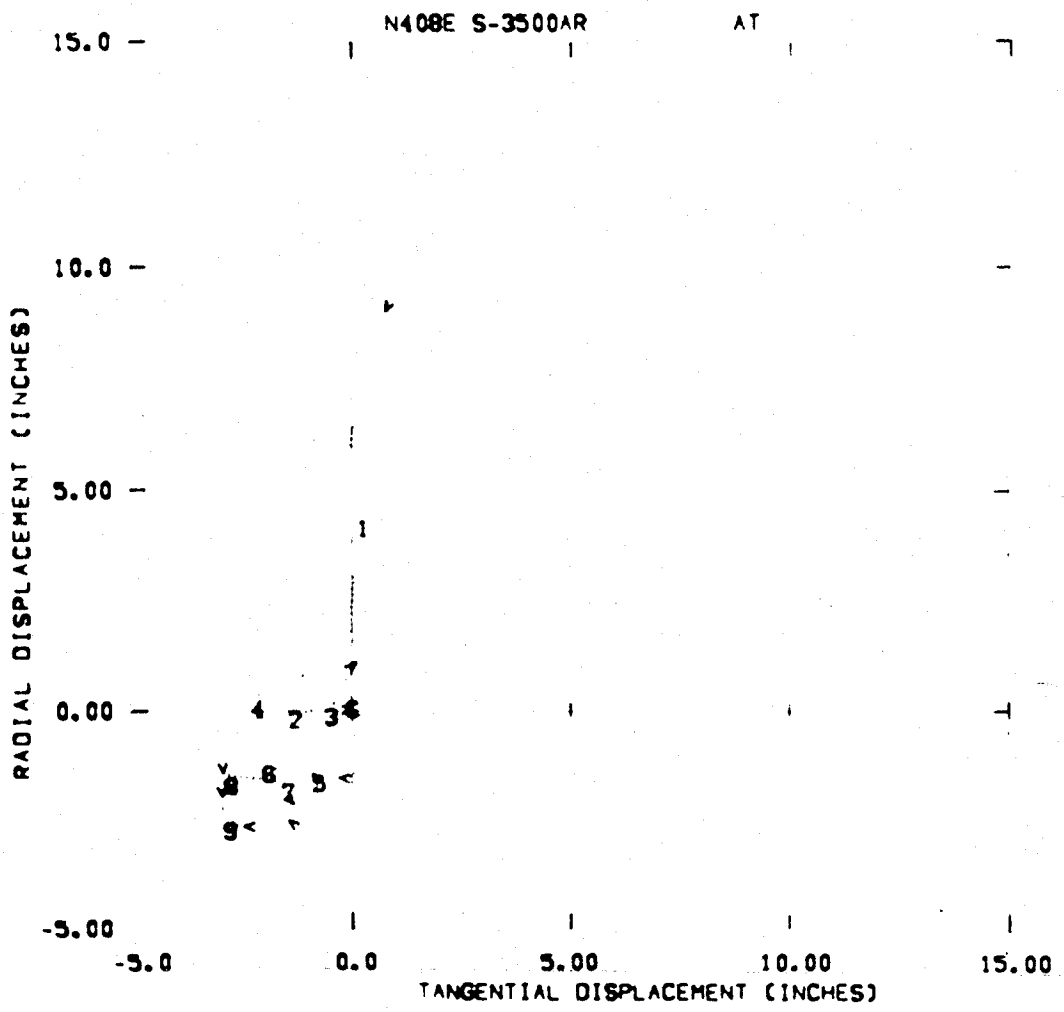

Figure 27. Station S-3500 radial vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

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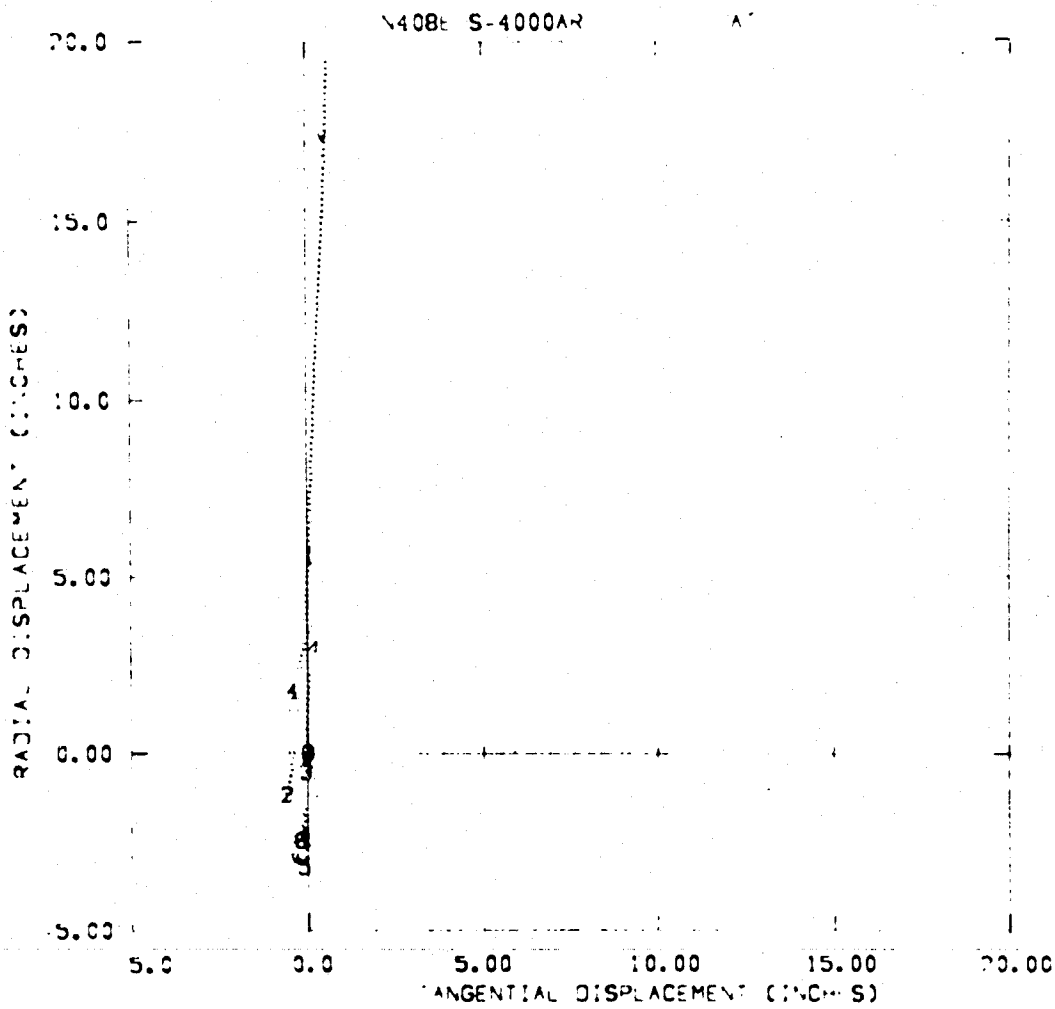

Figure 28. Station S-4000 radial vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

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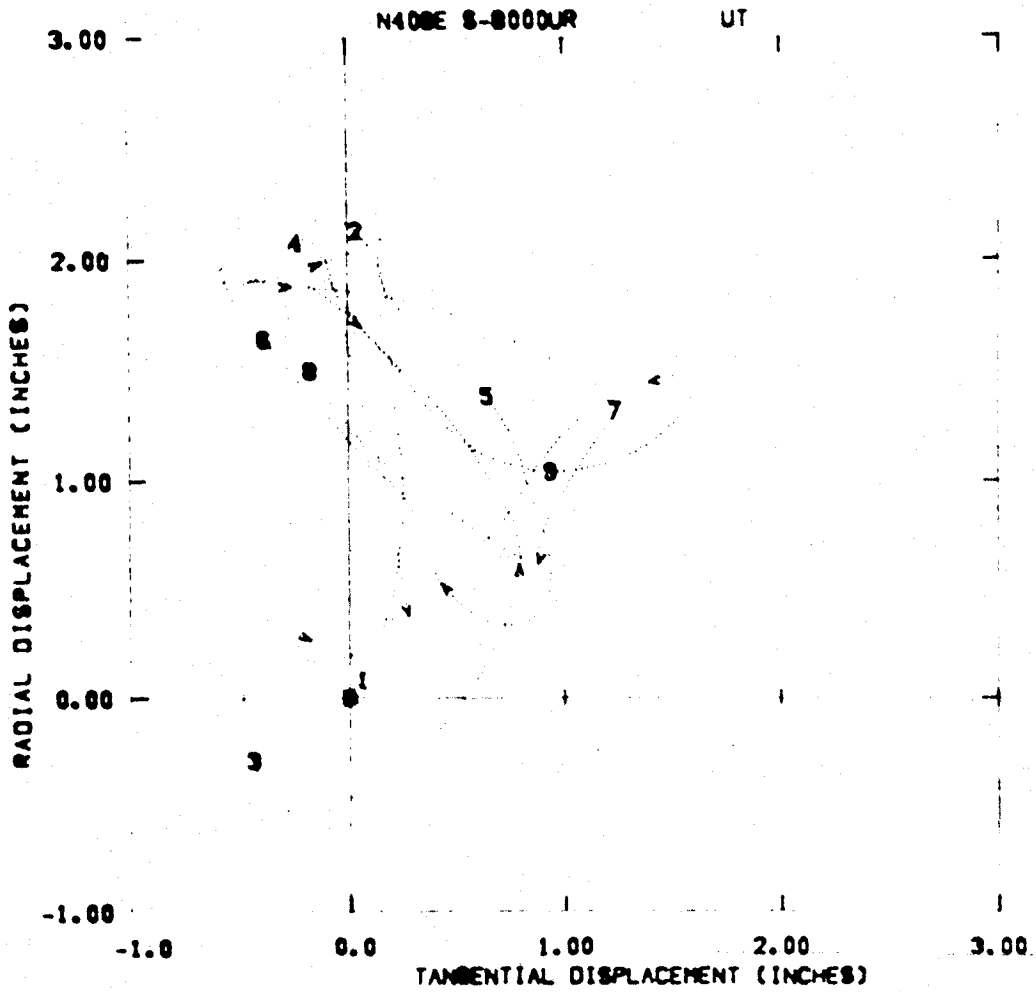

Figure 29. Station S-8000 radial vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

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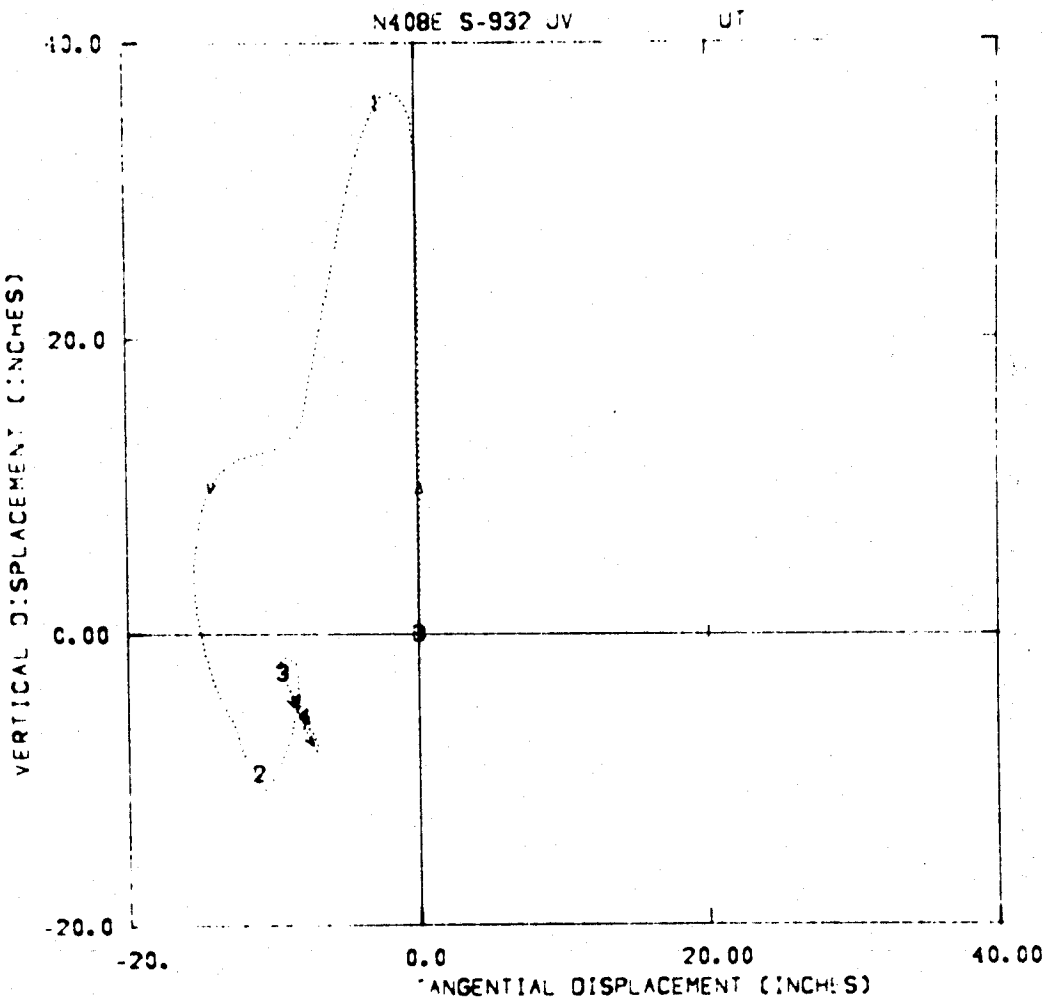

Figure 30. Station S-932 vertical vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

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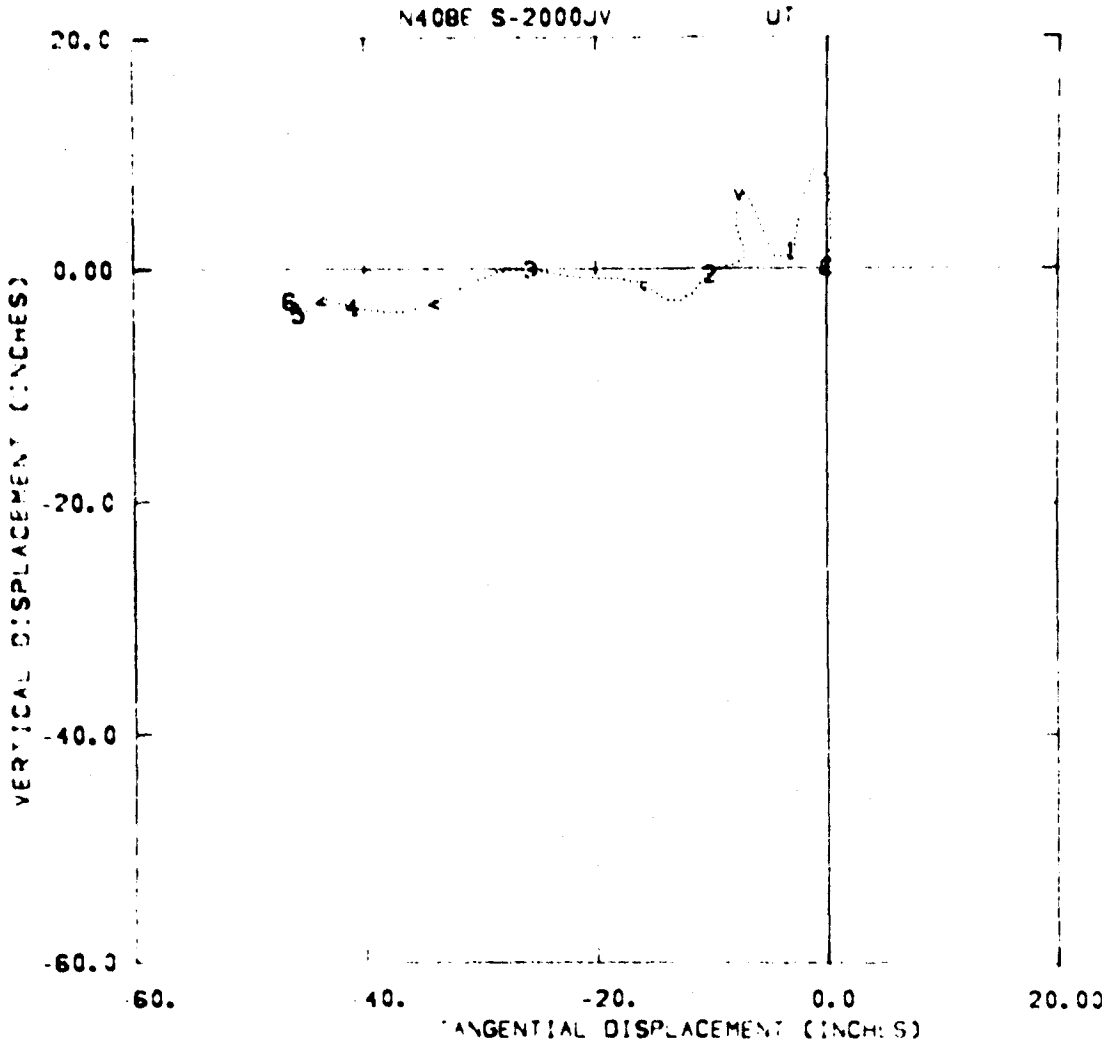

Figure 31. Station S-2000 vertical vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

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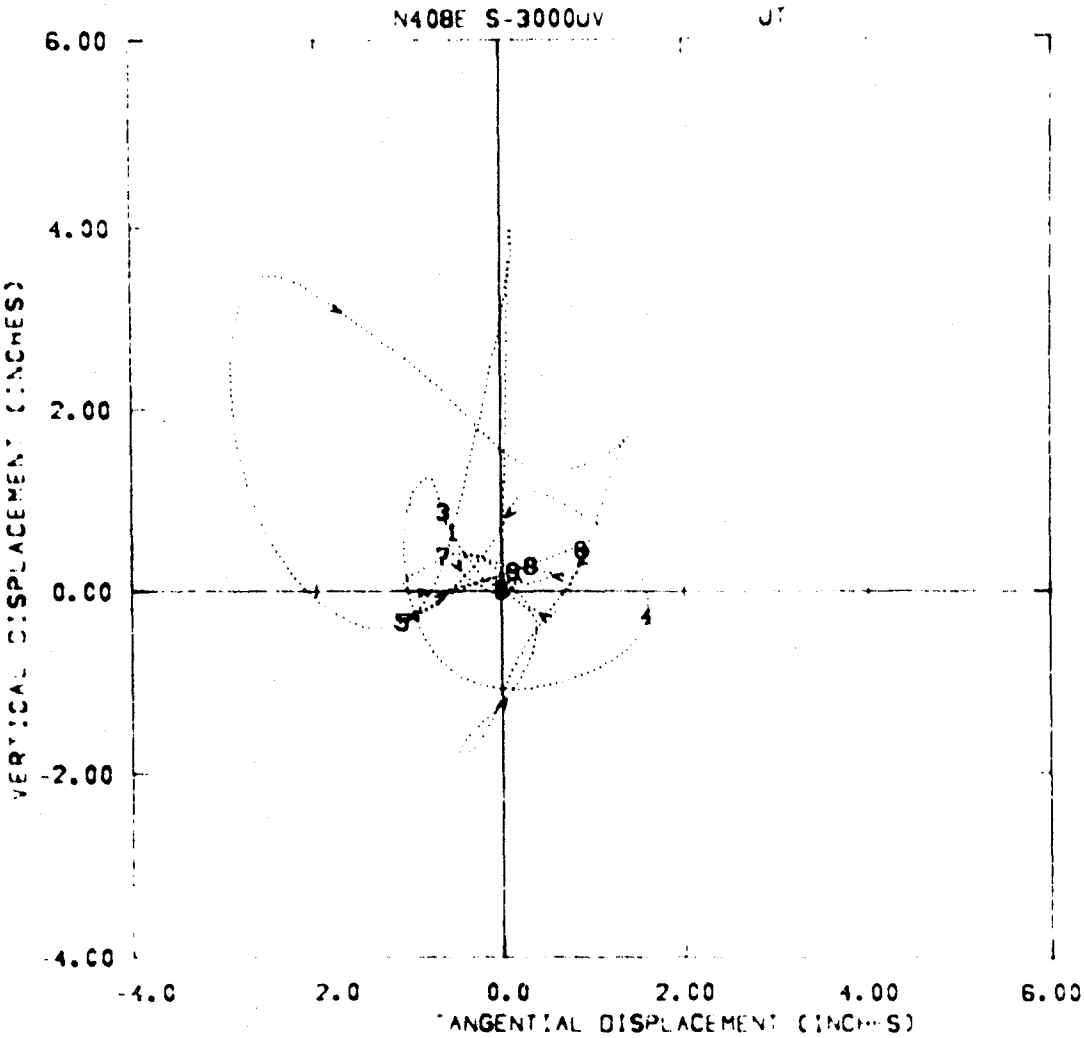

Figure 32. Station S-3000 vertical vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

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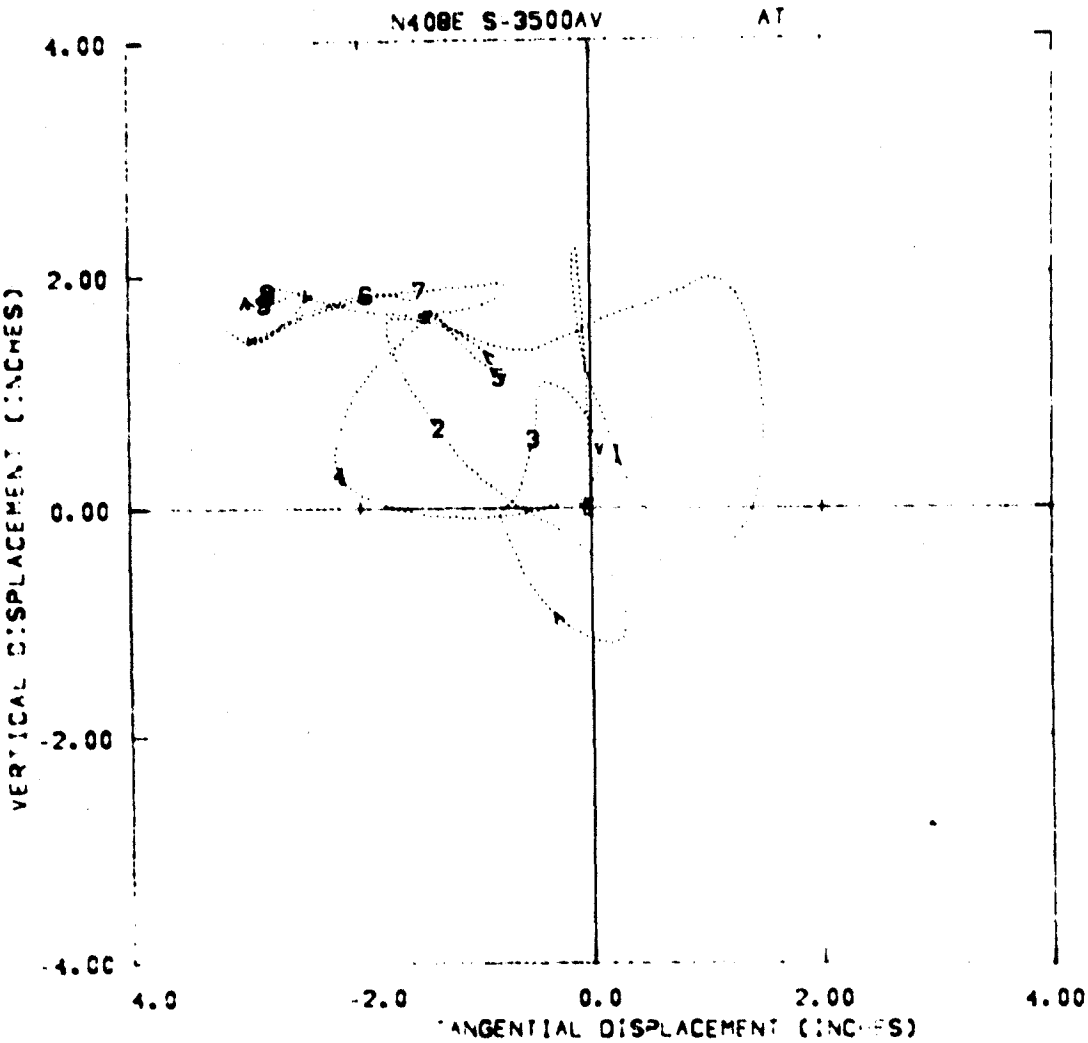

Figure 33. Station S-3500 vertical vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

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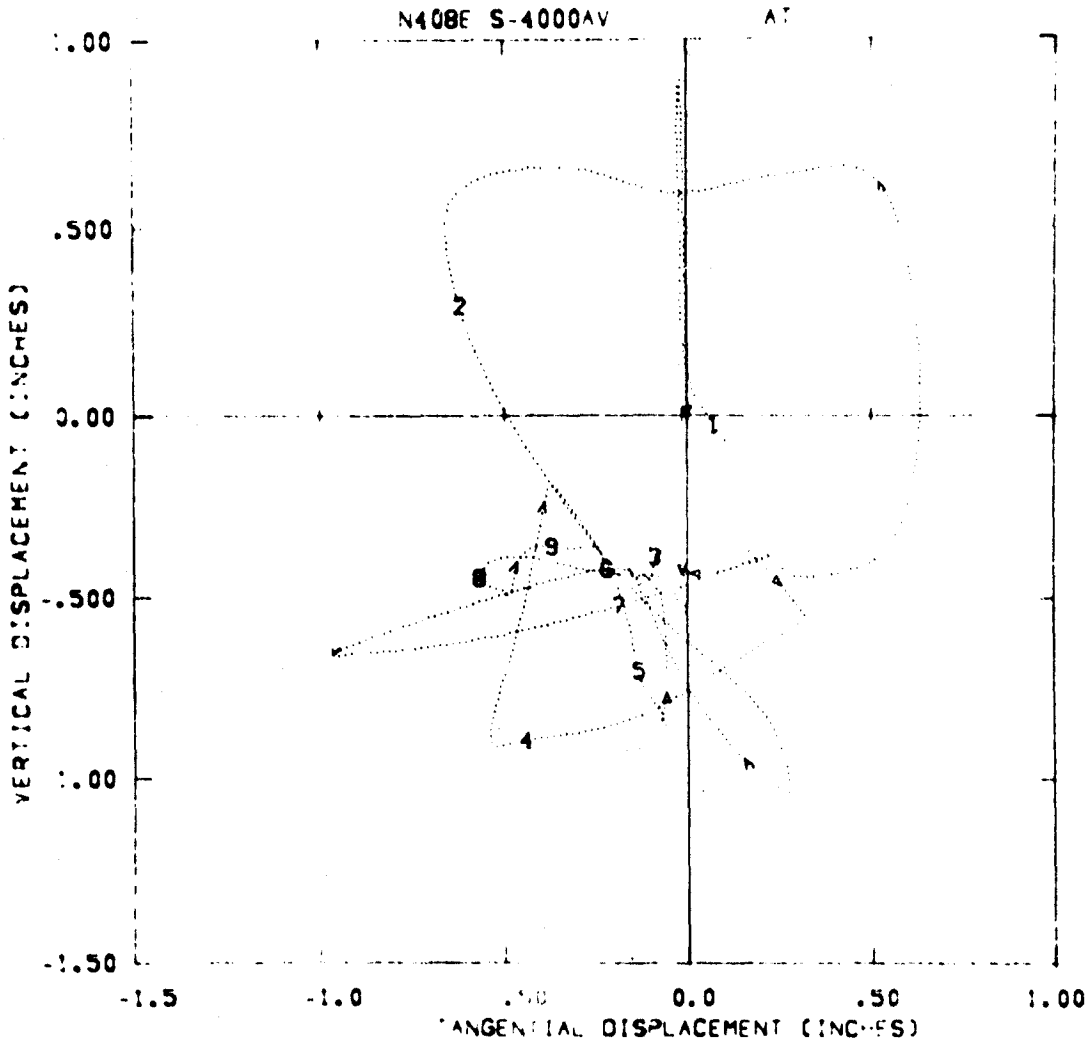

Figure 34. Station S-4000 vertical vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

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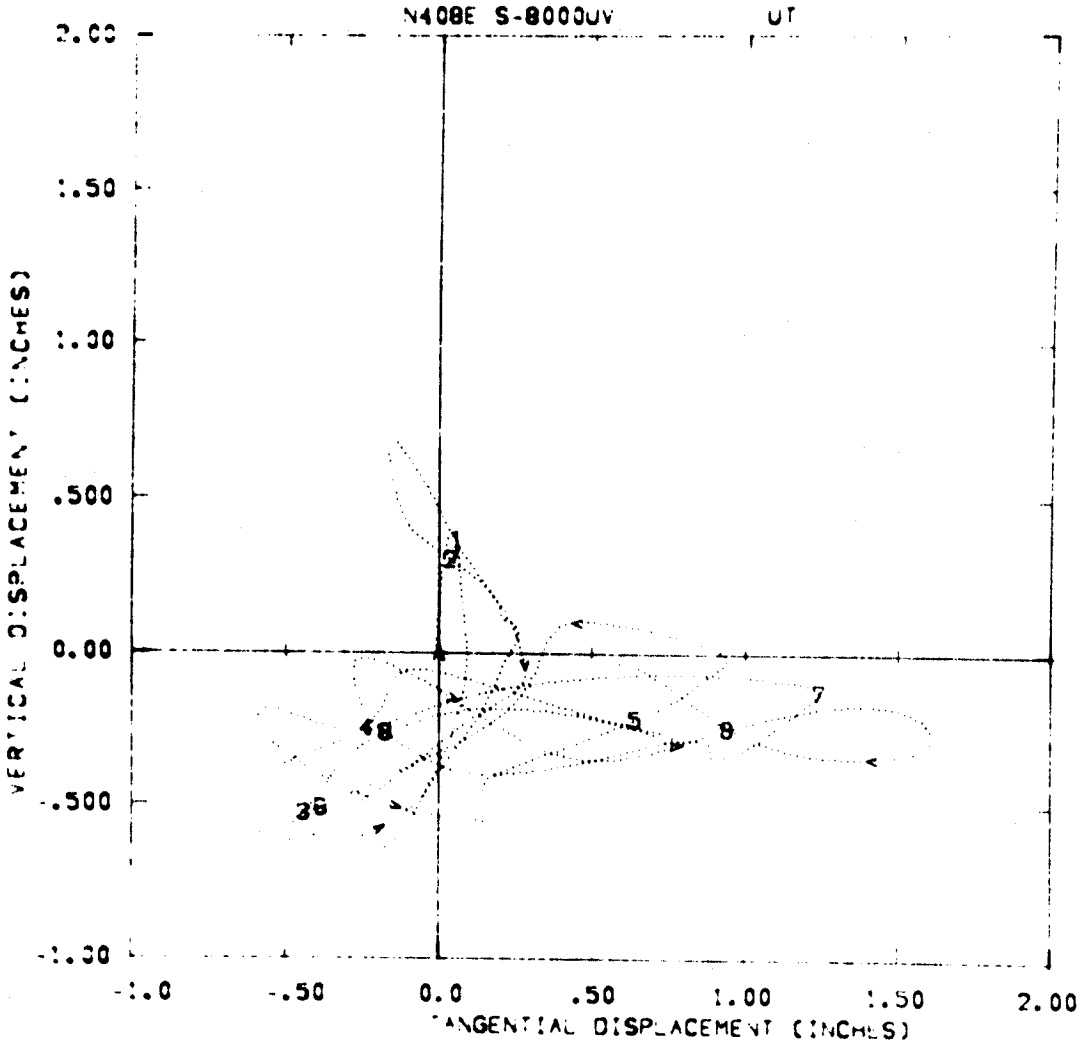

Figure 35. Station S-8000 vertical vs tangential displacement hodograph. Numbers are every second; arrows are on half-seconds.

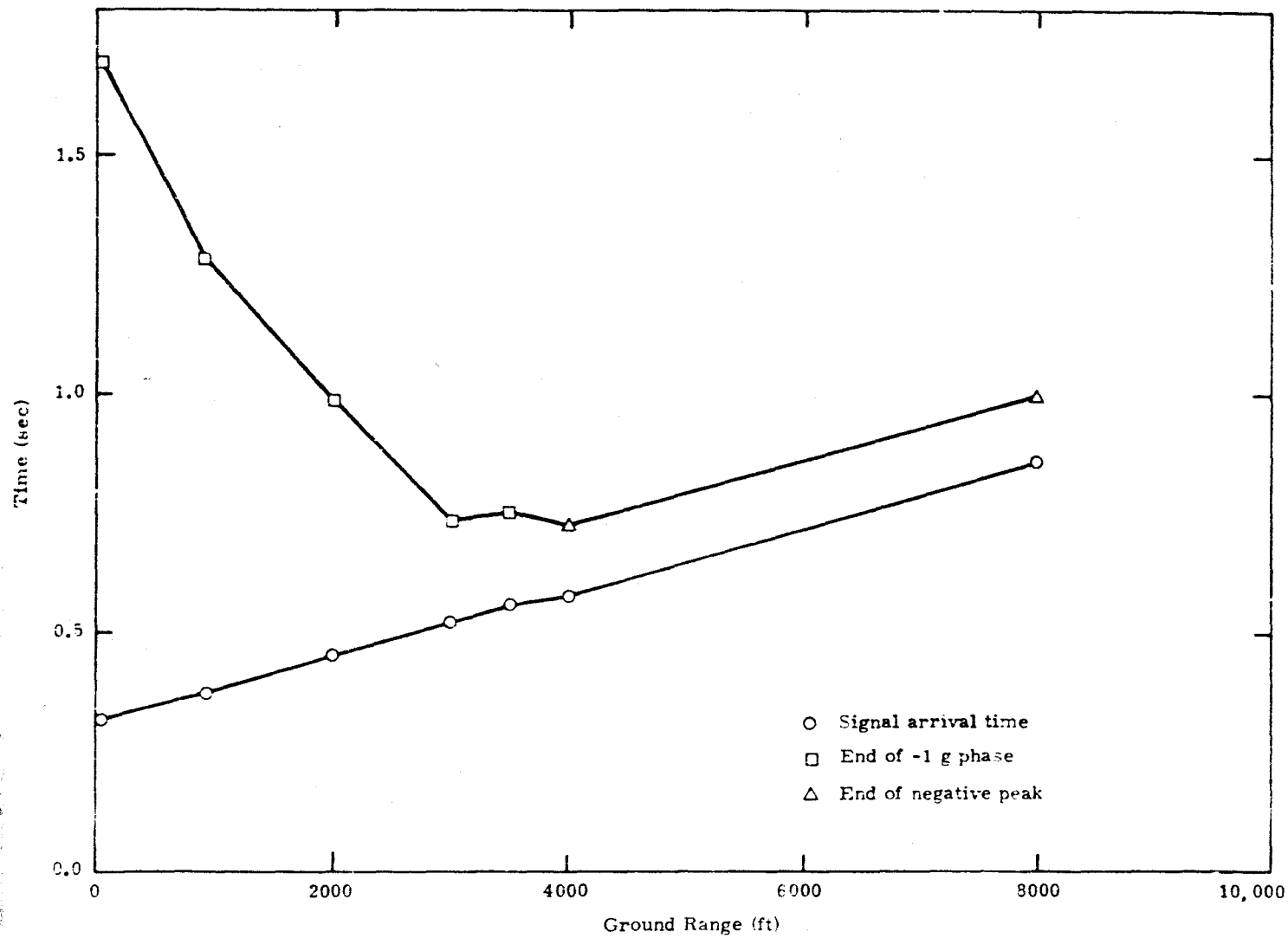

Figure 36. Comparison of arrival times with spall closure signals.

APPENDIX

DATA FROM STATION

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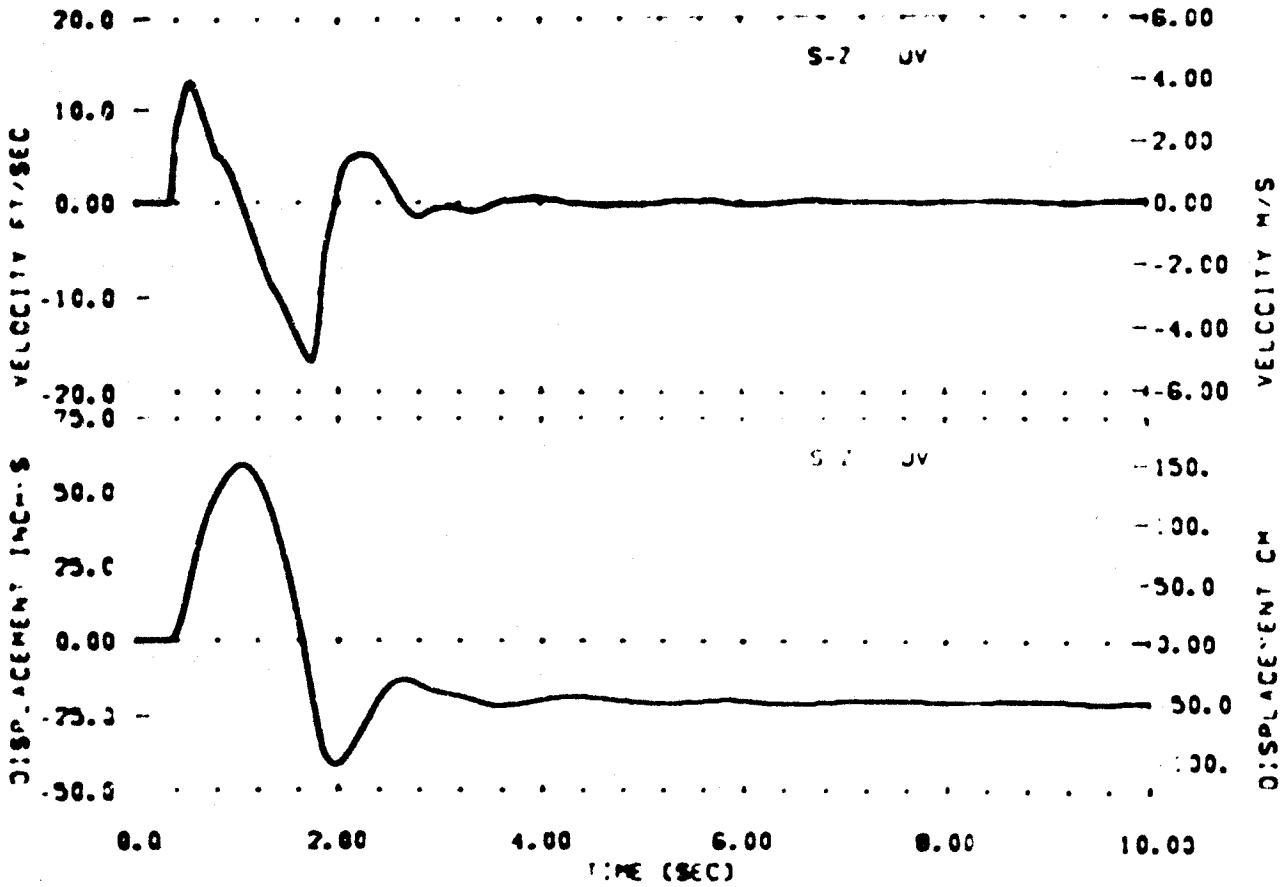

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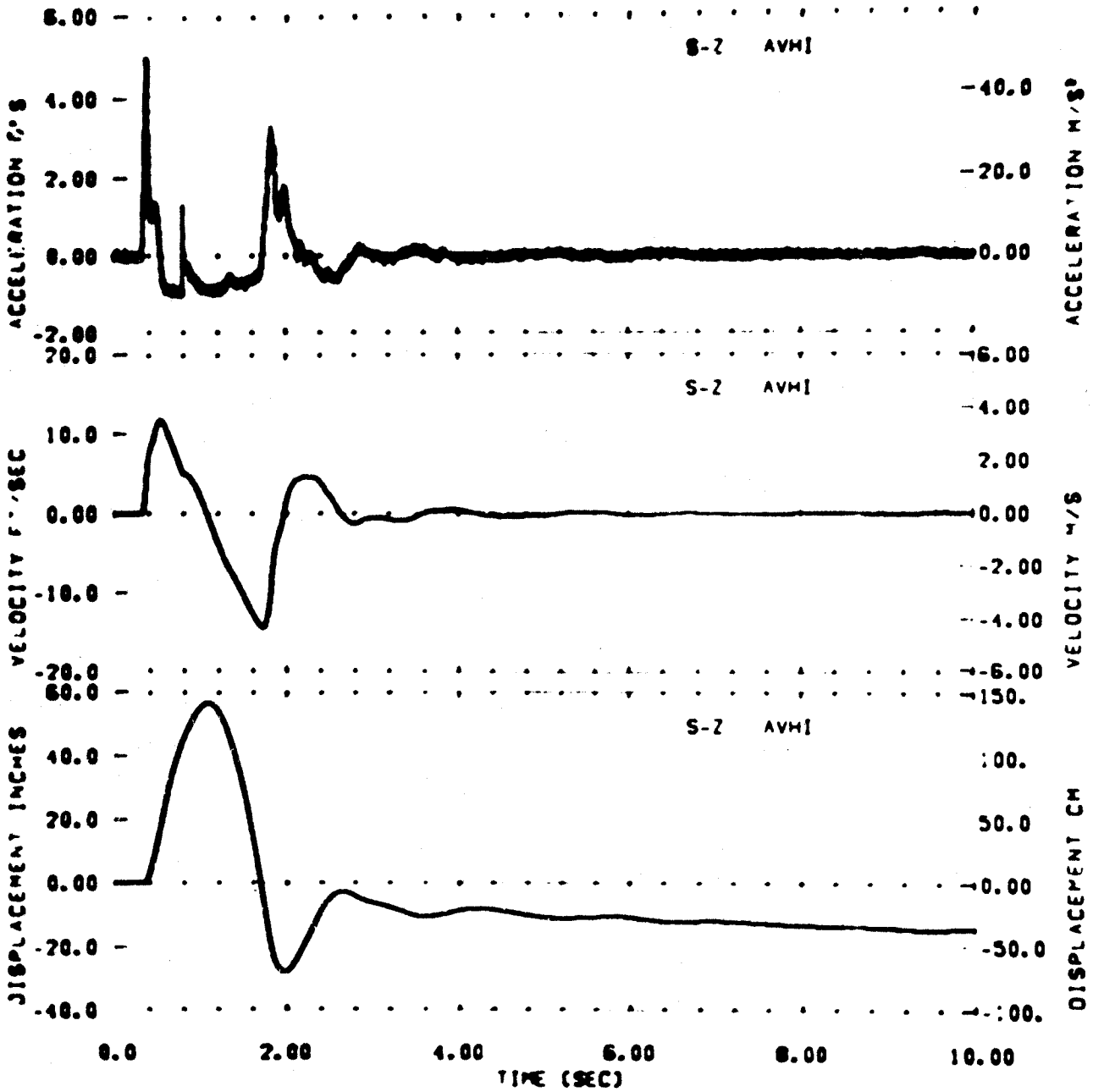
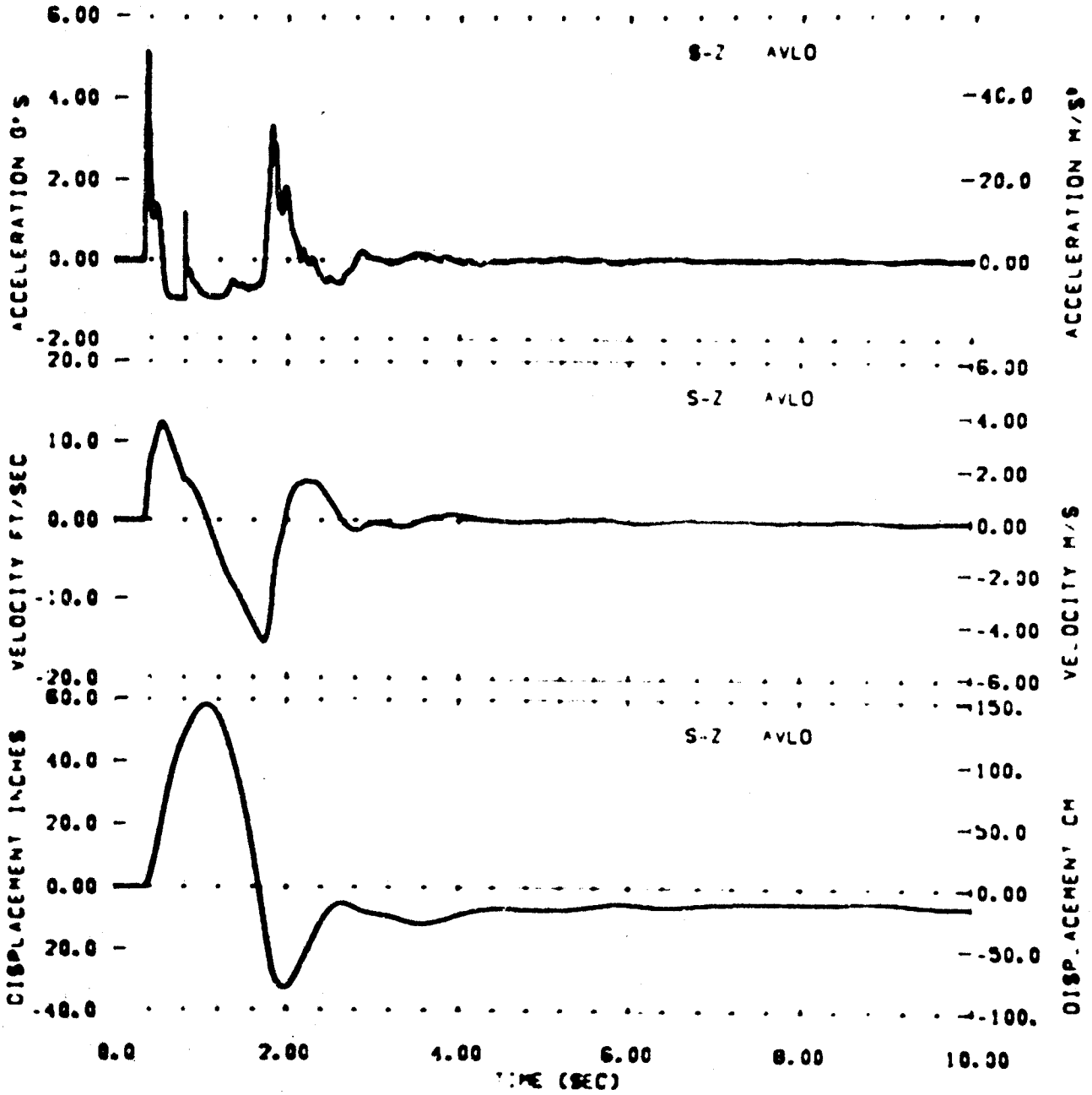

S-Z AVHI
ACCELERATION G'S
ACCELERATION M/S²
S-Z AVHI
VELOCITY FT/SEC
VELOCITY M/S
S-Z AVHI
DISPLACEMENT INCHES
DISPLACEMENT CM
TIME (SEC)

[redacted]



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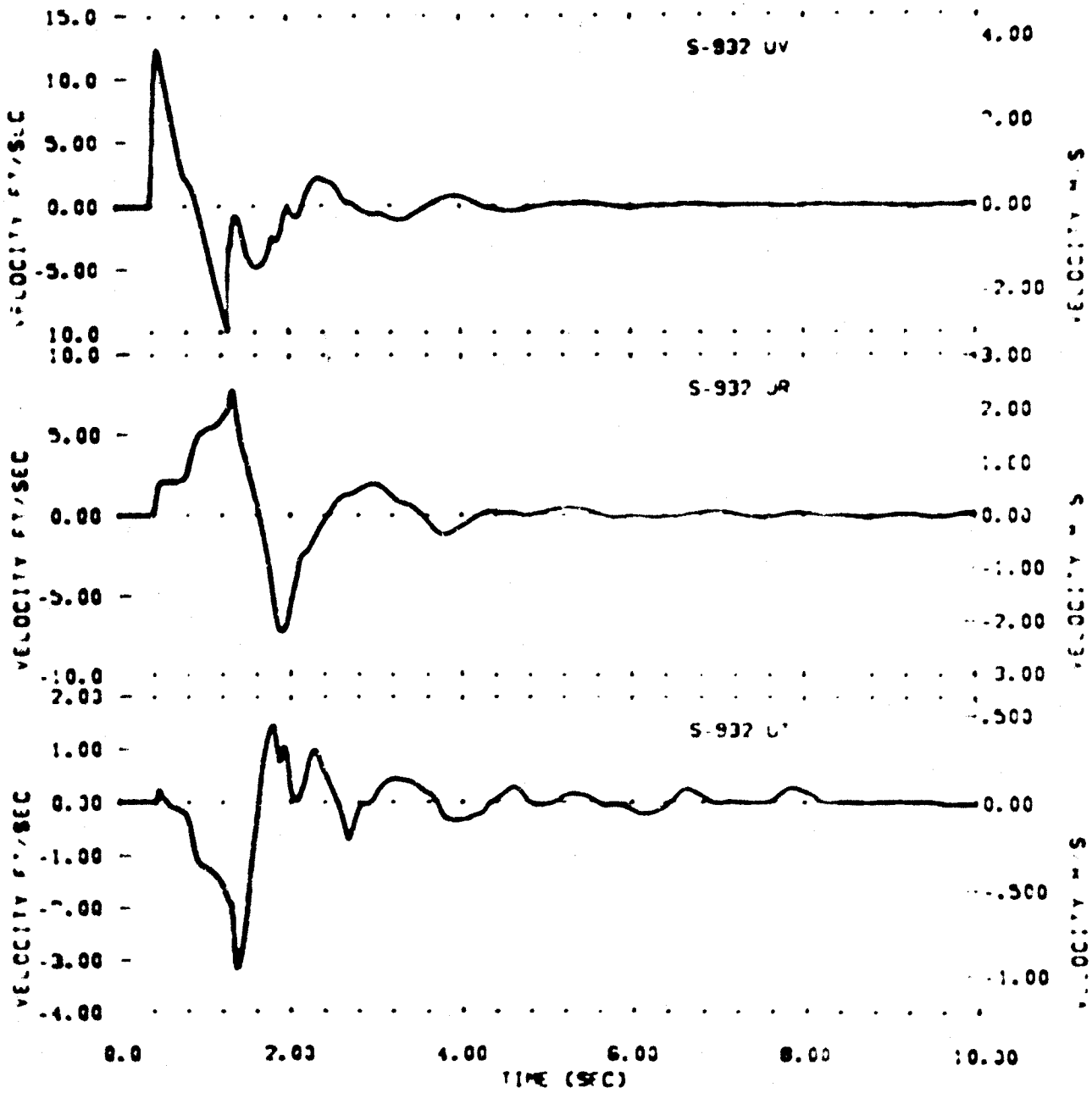

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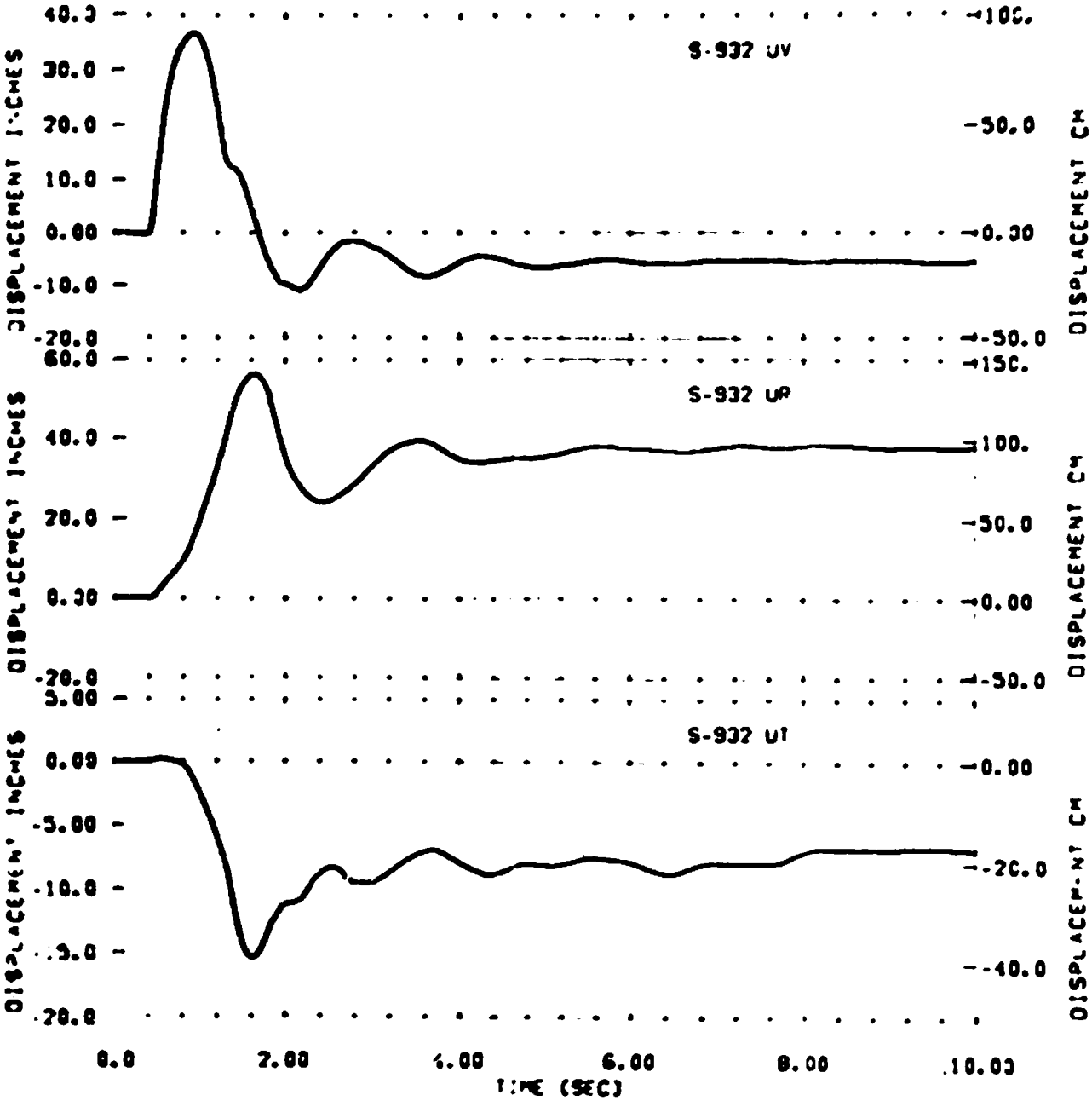

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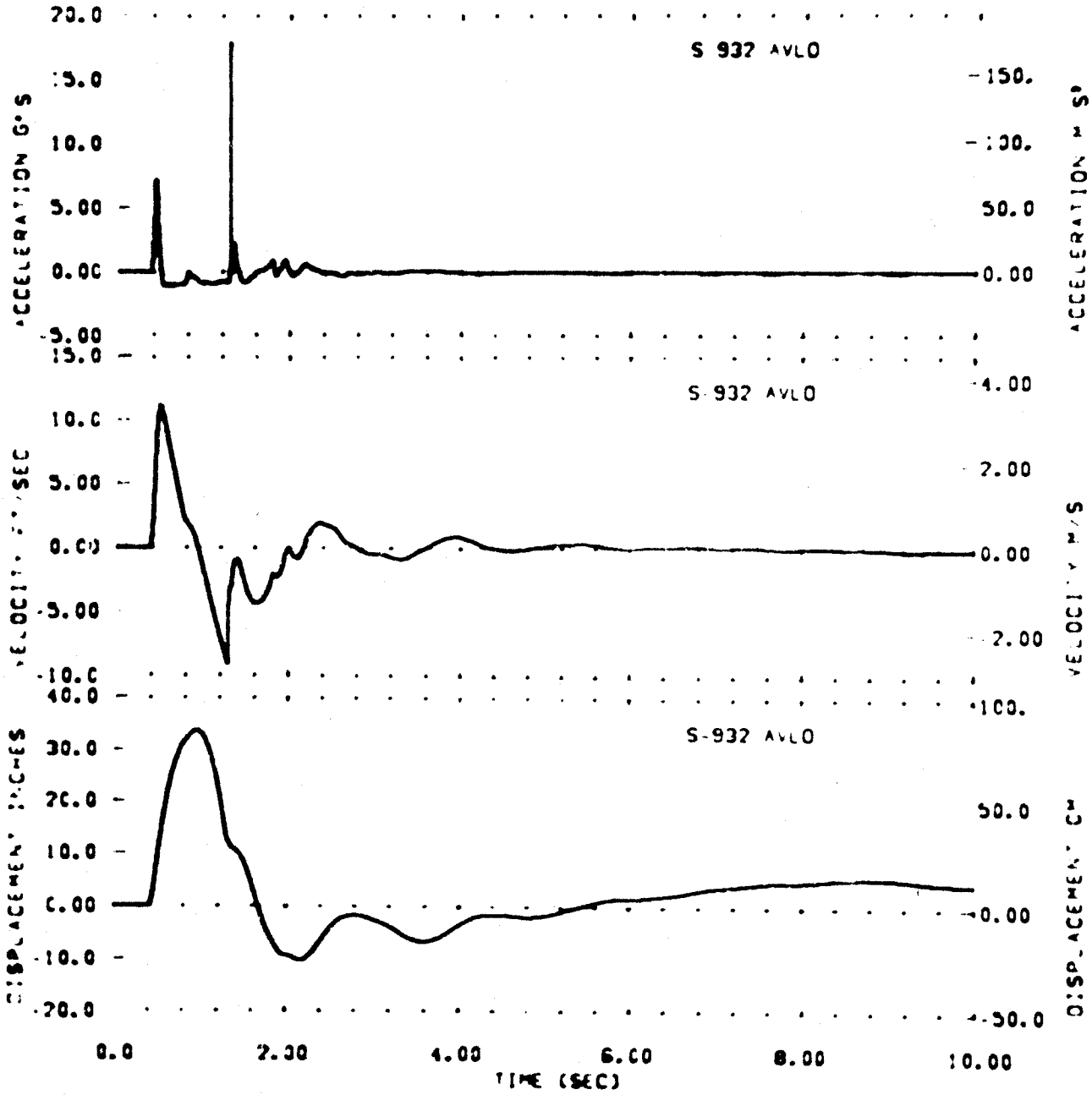

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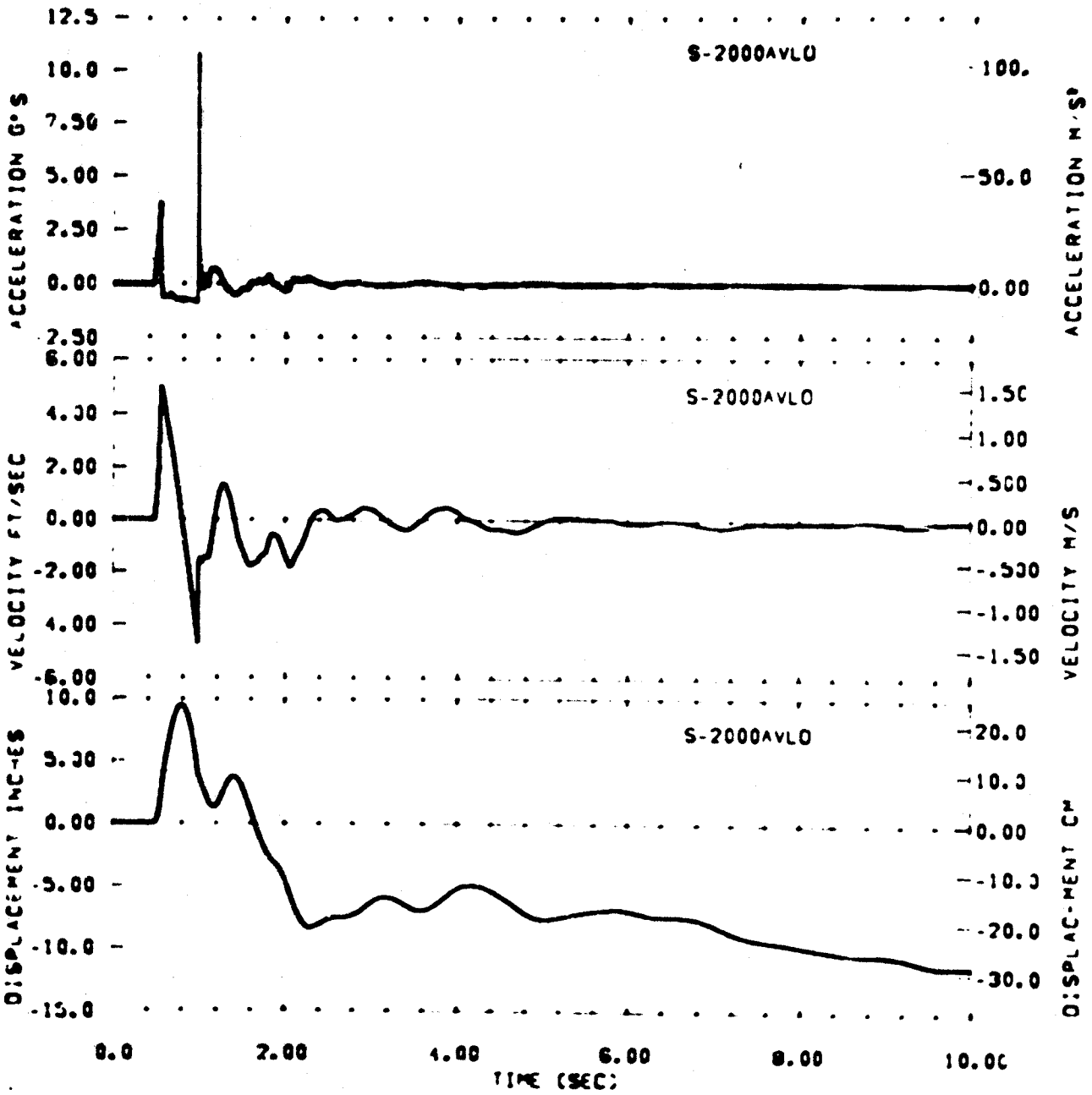

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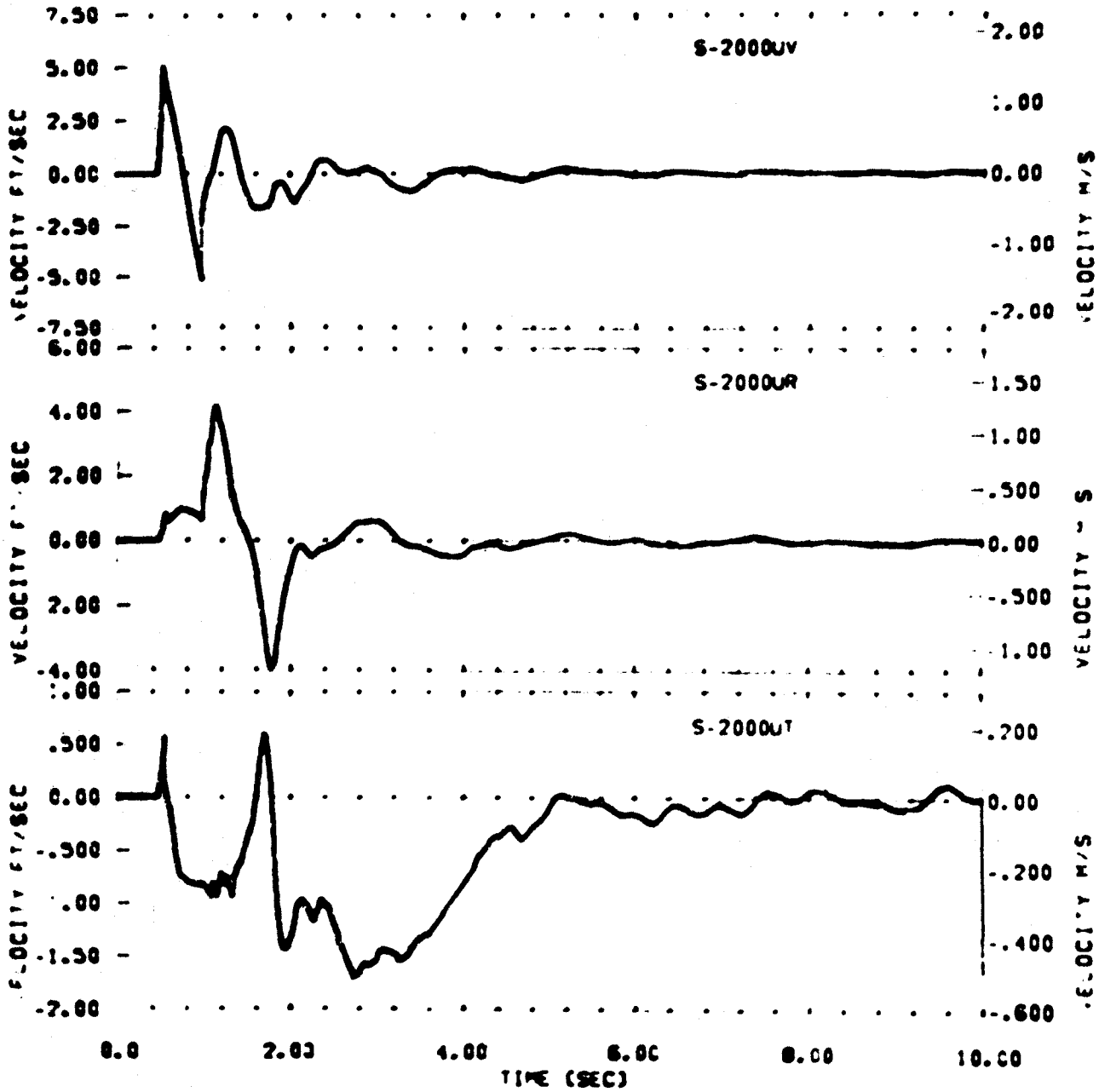
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S-2000UR
S-2000UT
VELOCITY FT/SEC
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4.00
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10.00

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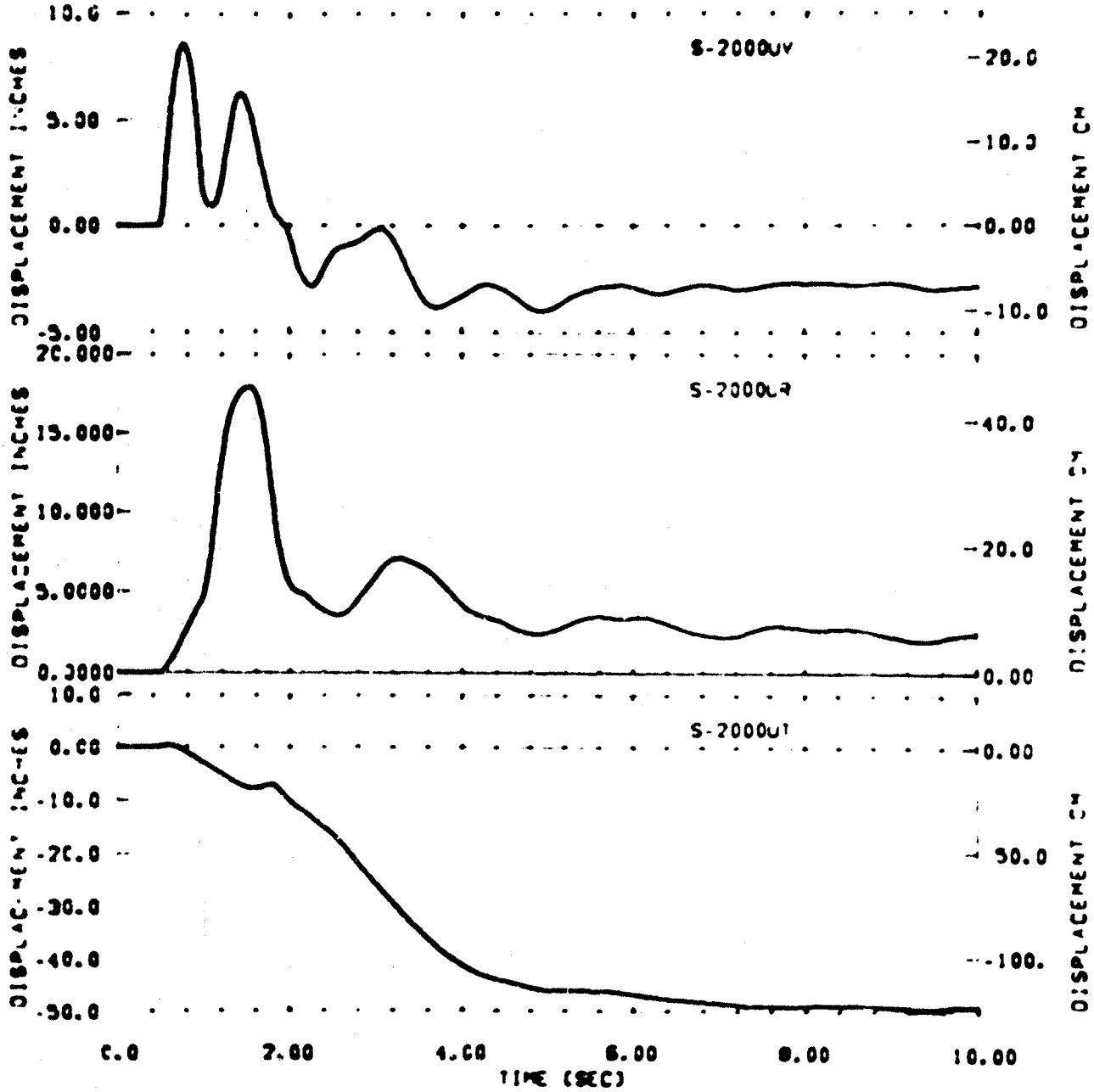

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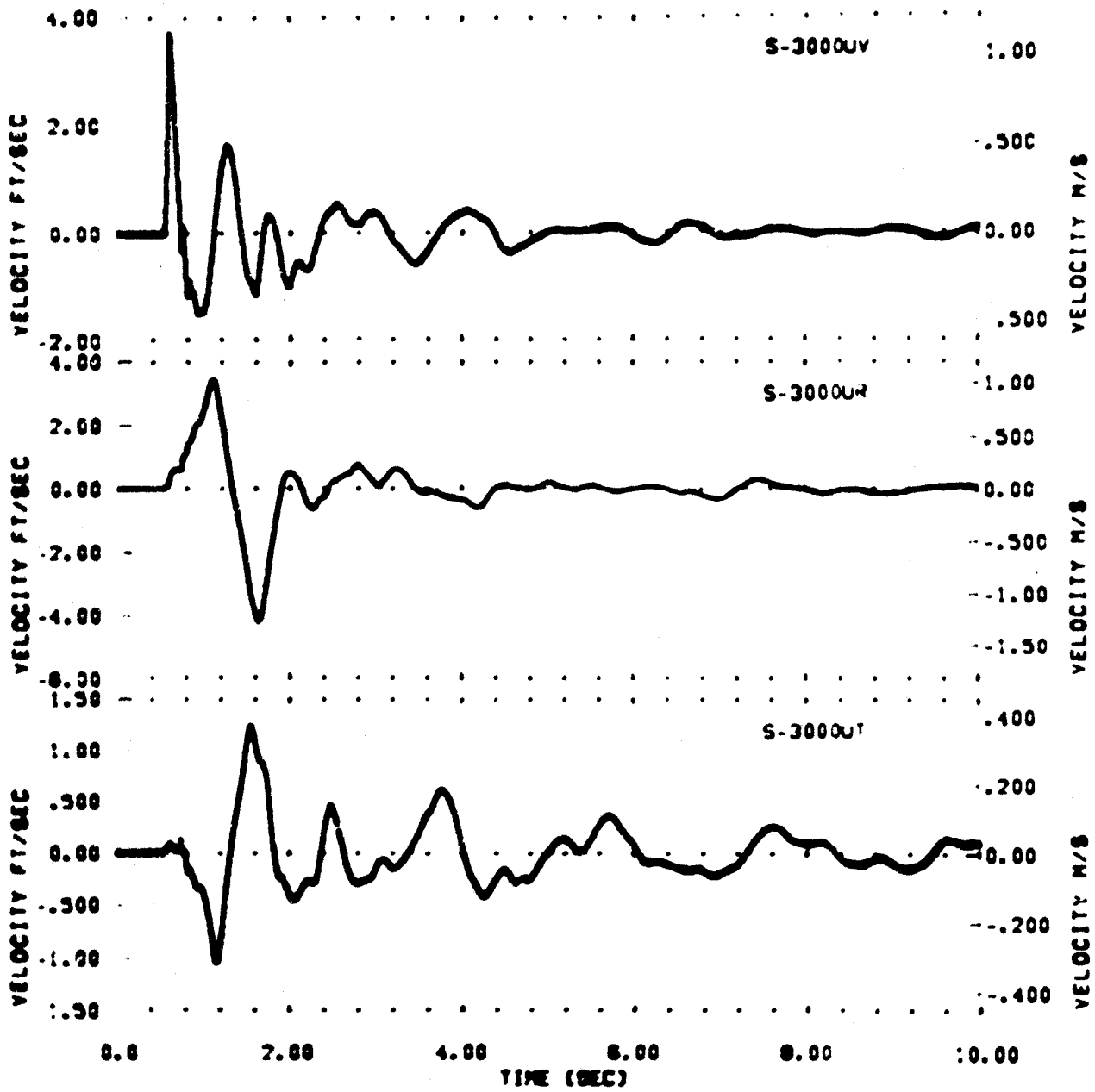
S-3000UV
S-3000UW
S-3000UT
VELOCITY FT/SEC
VELOCITY M/S
TIME (SEC)
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2.00
0.00
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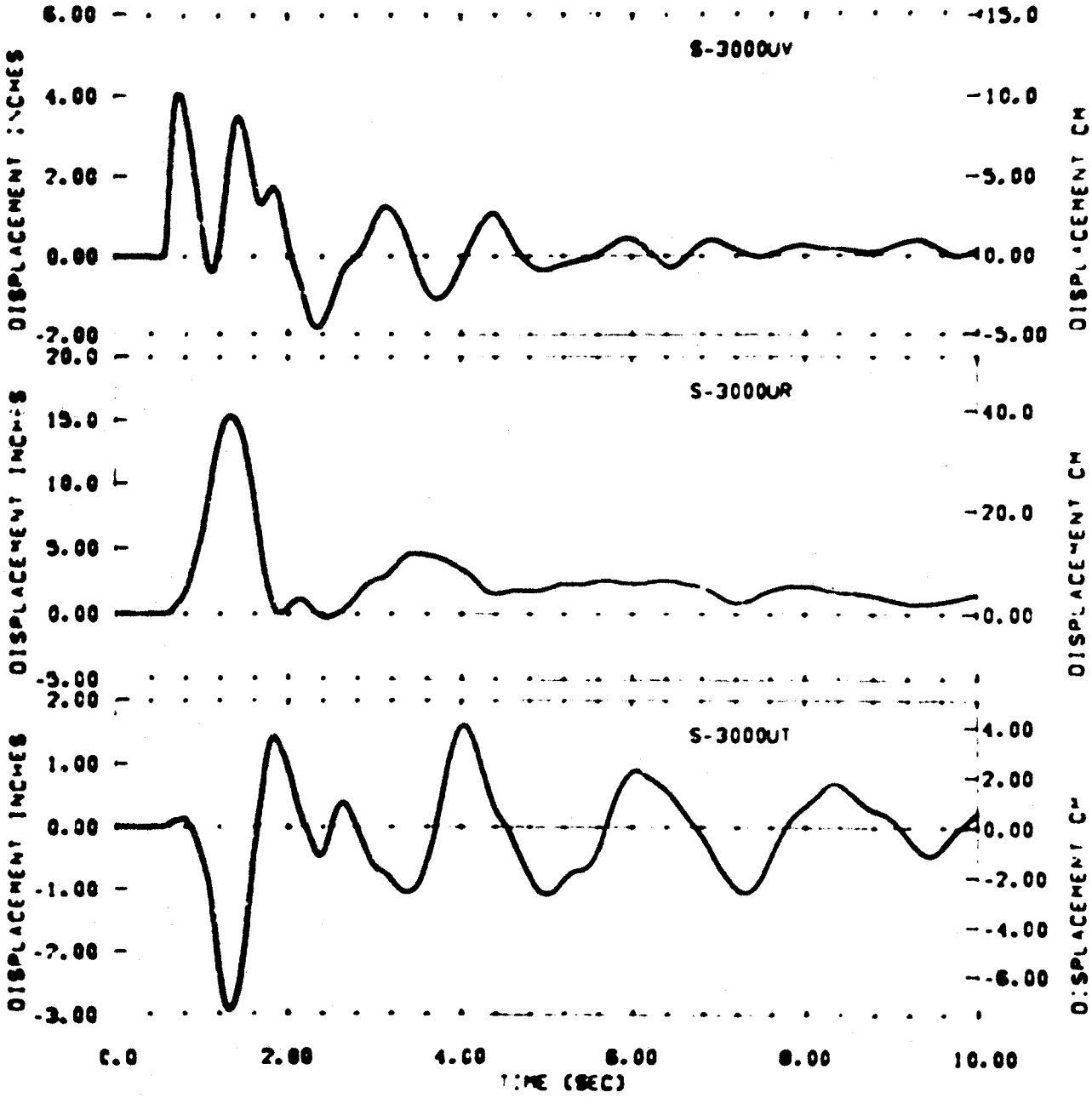

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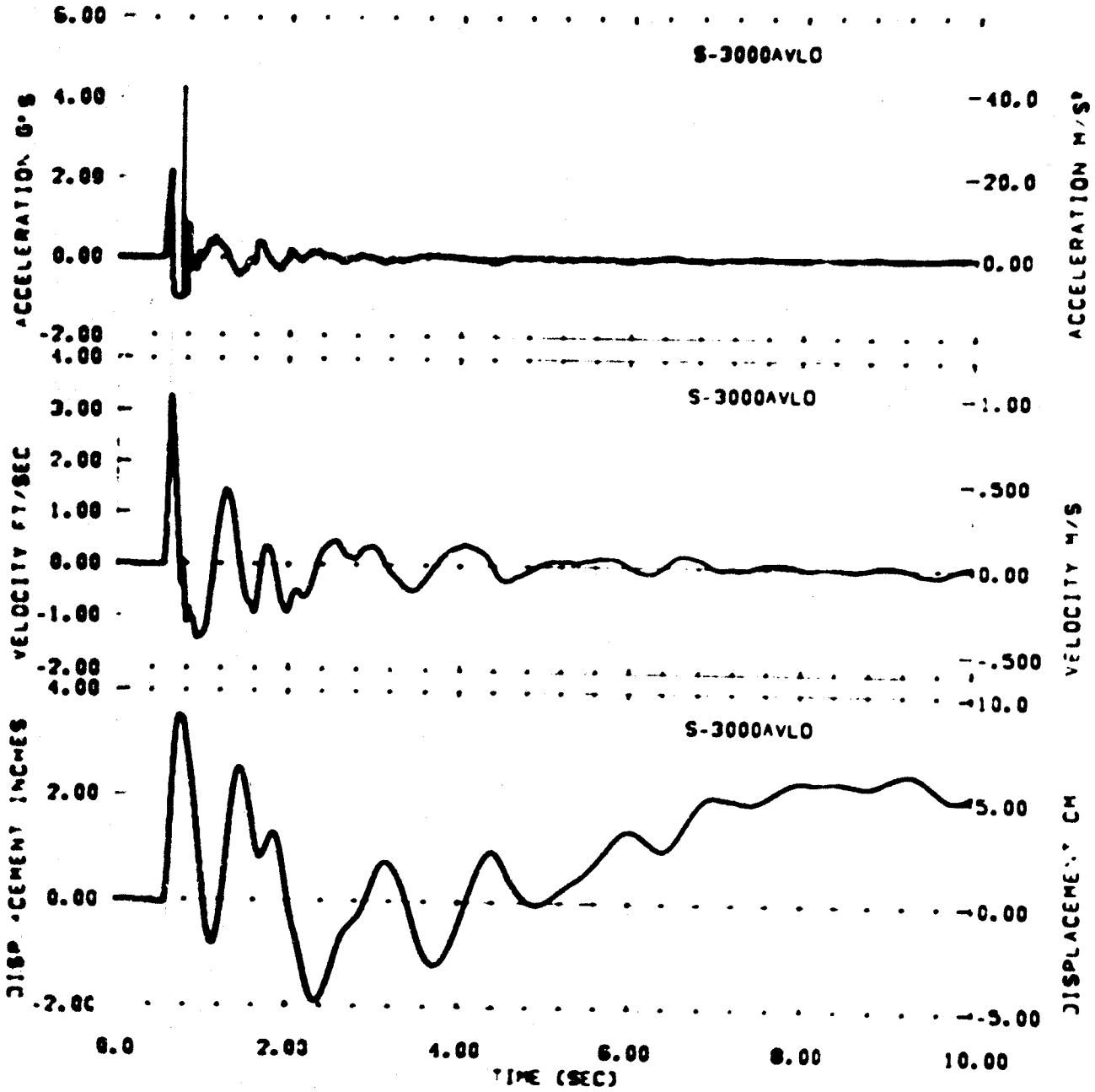

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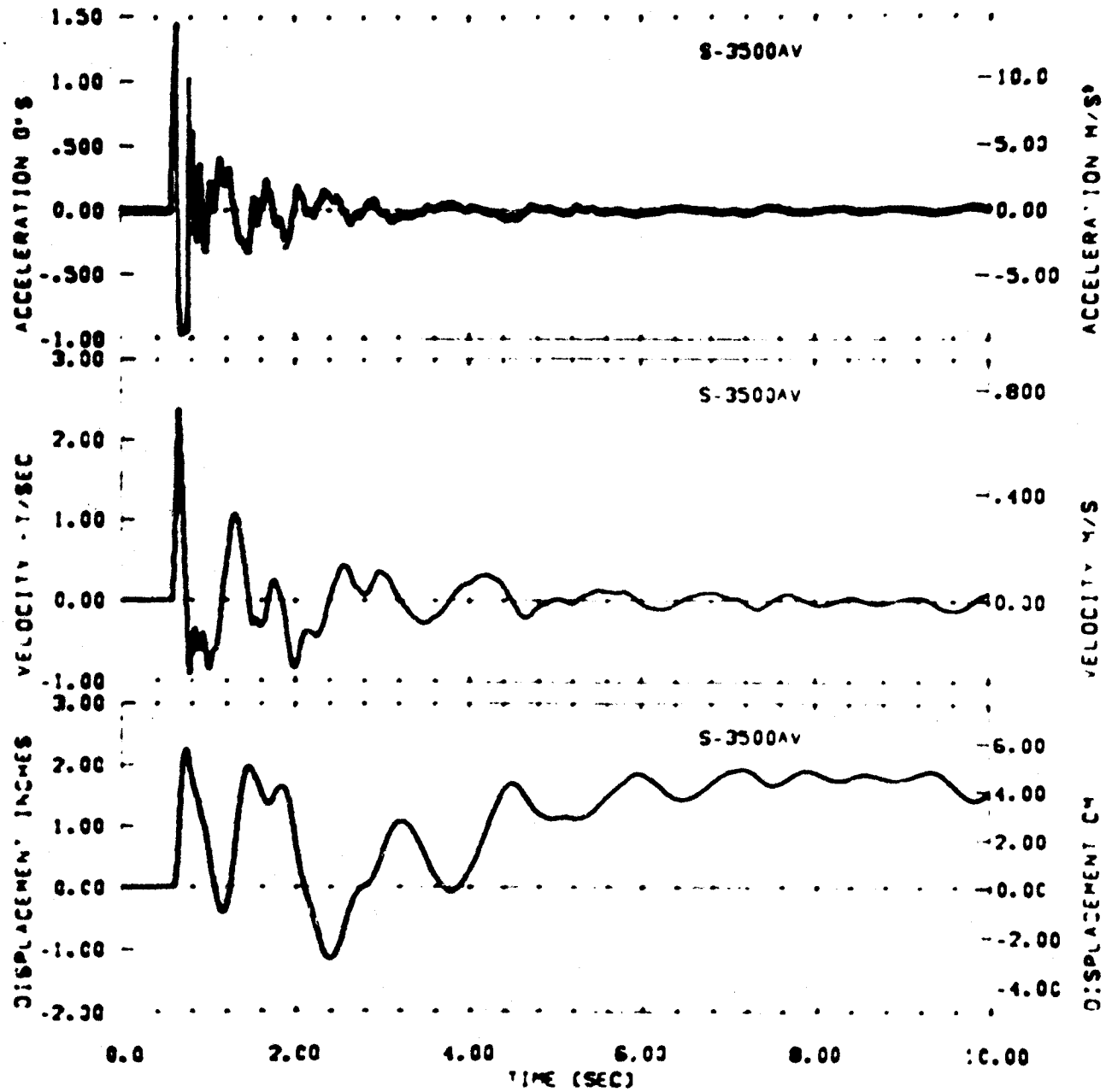

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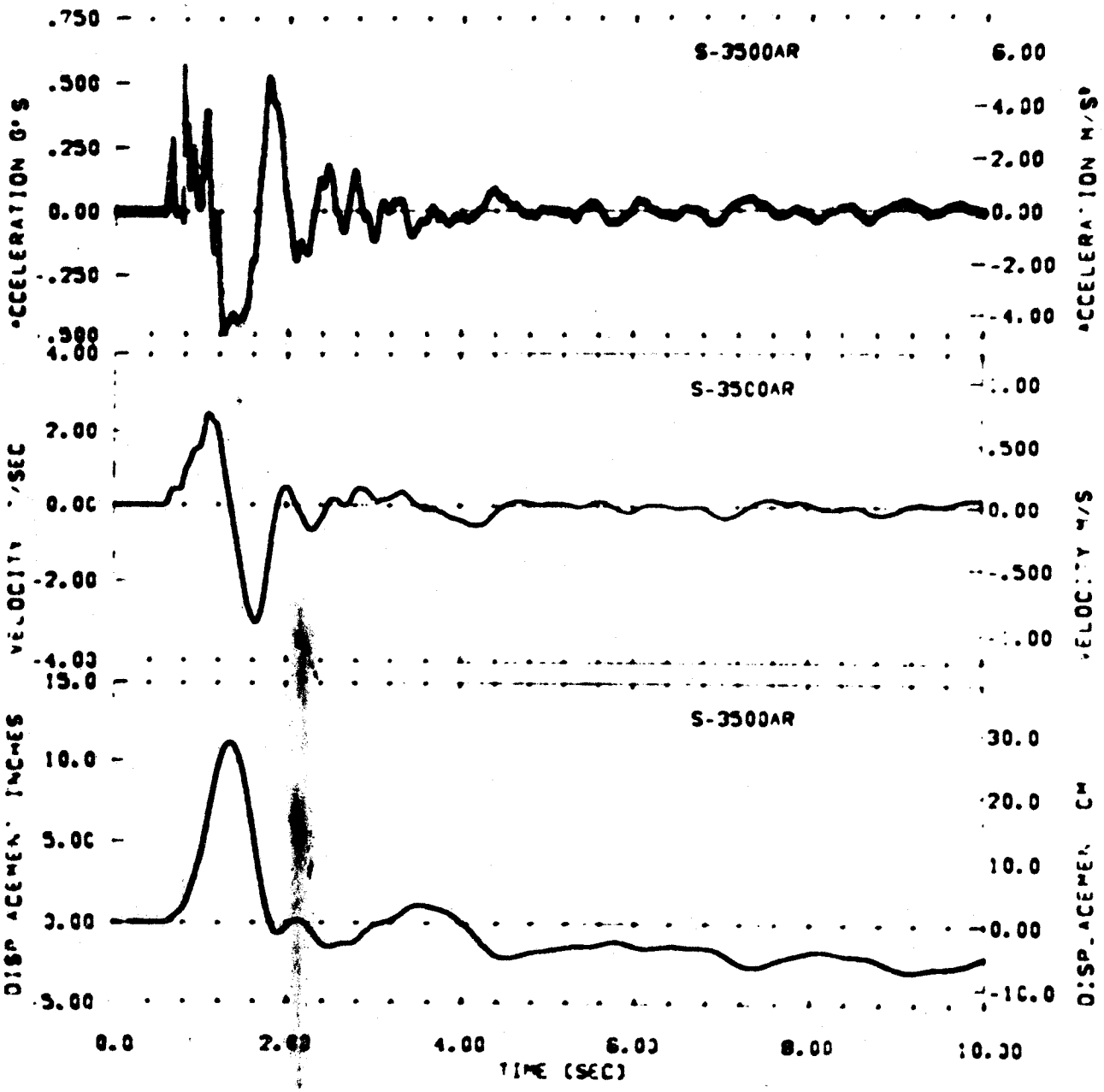

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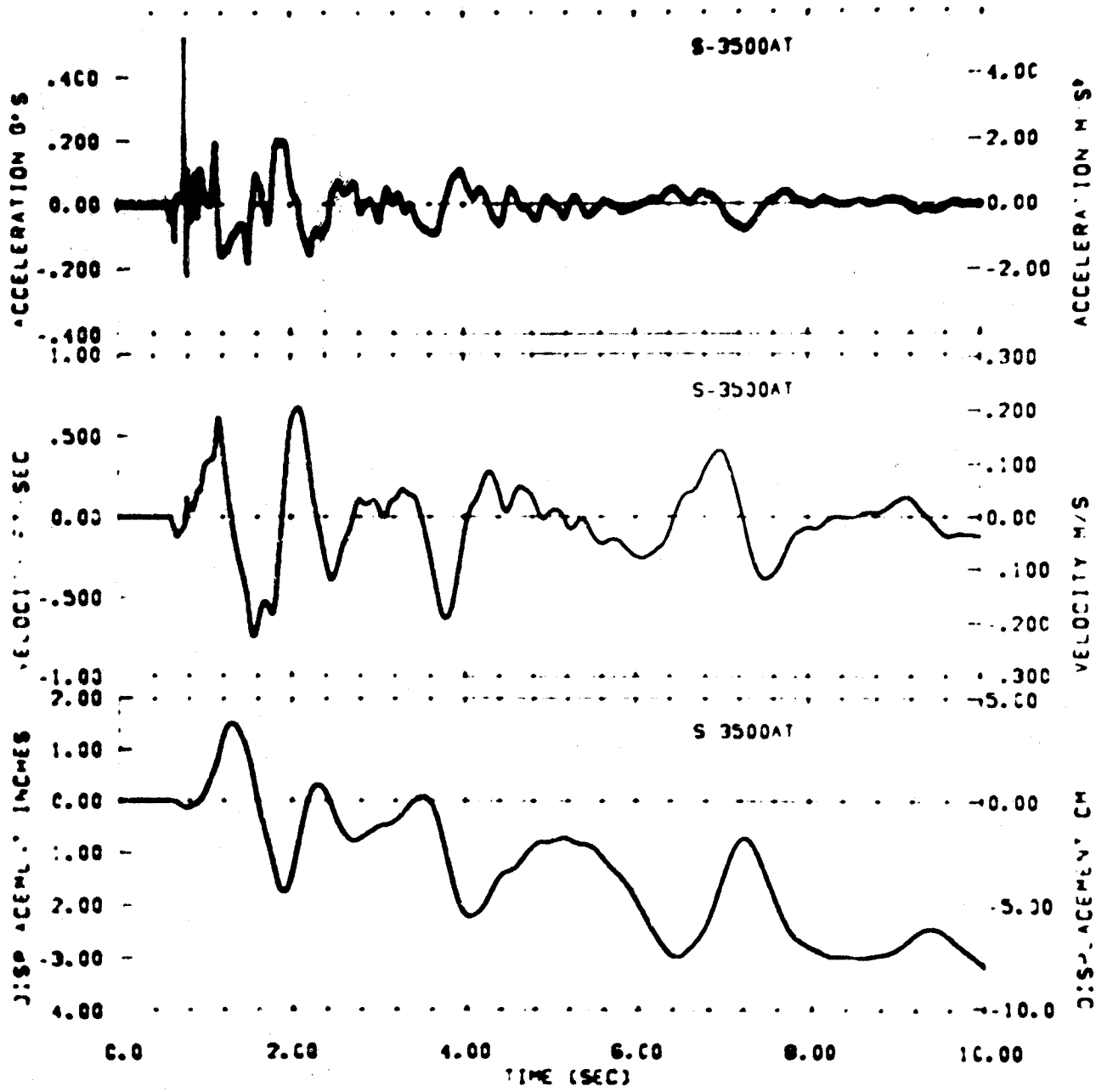

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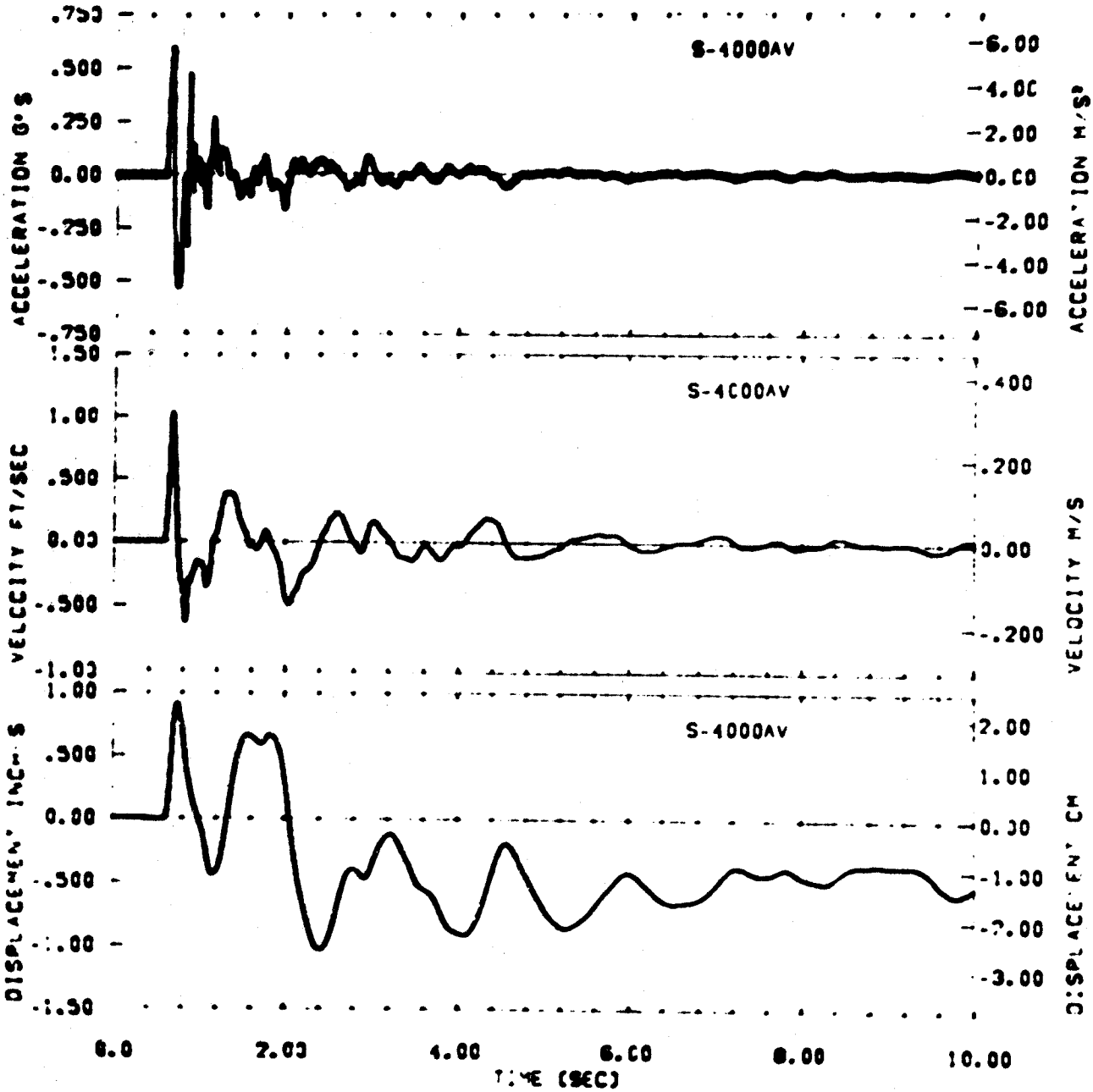

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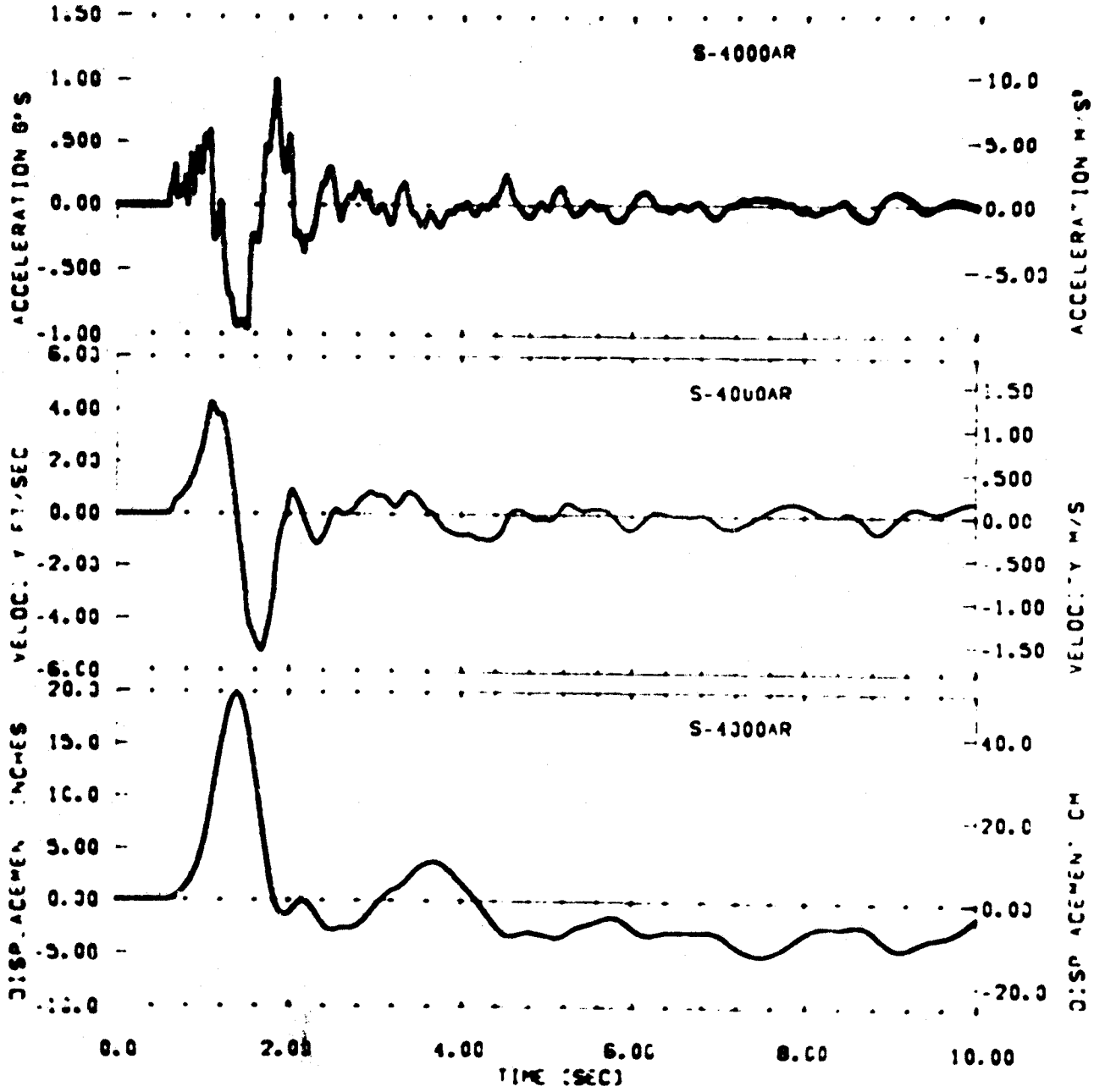

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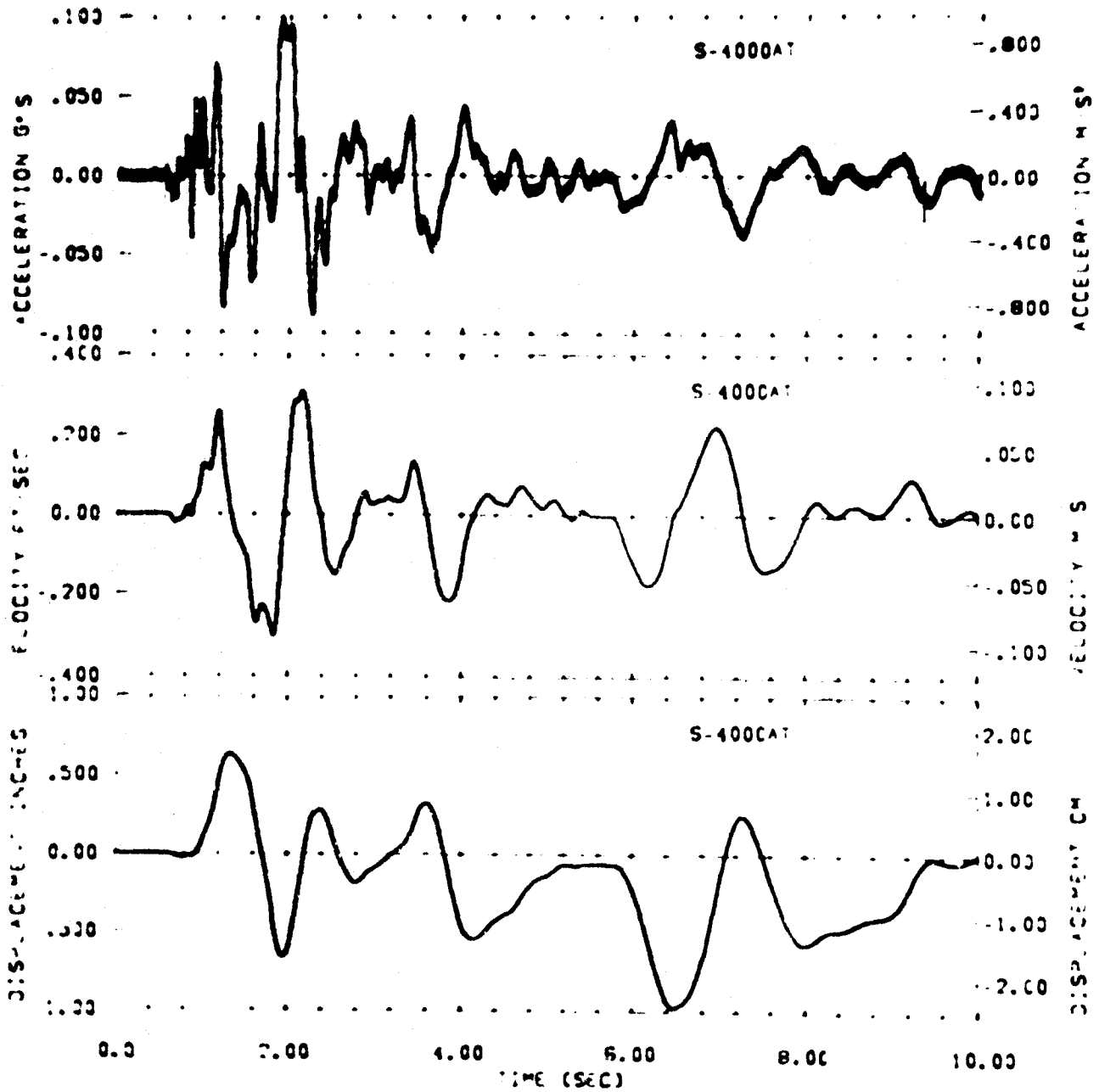

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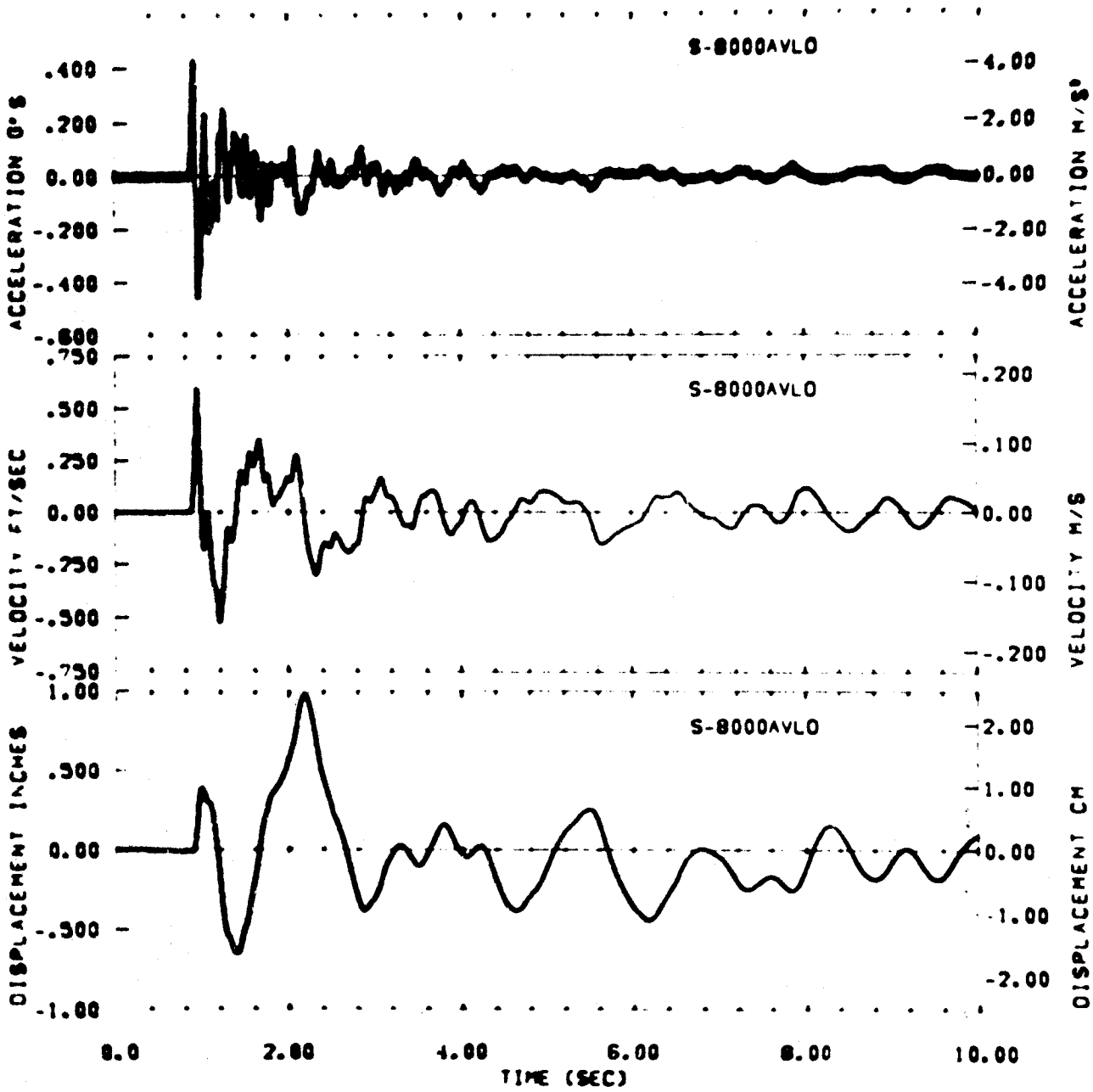

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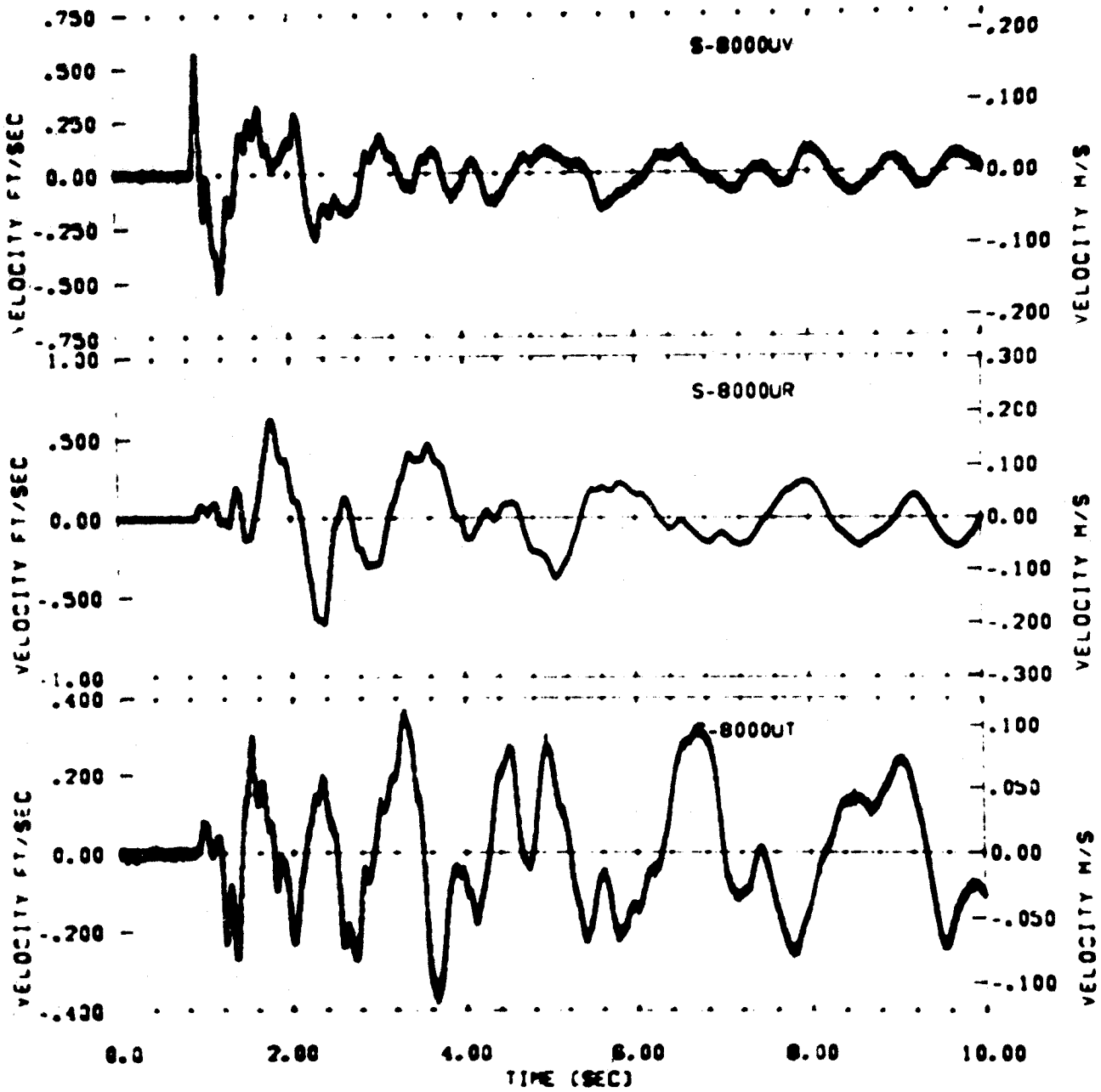

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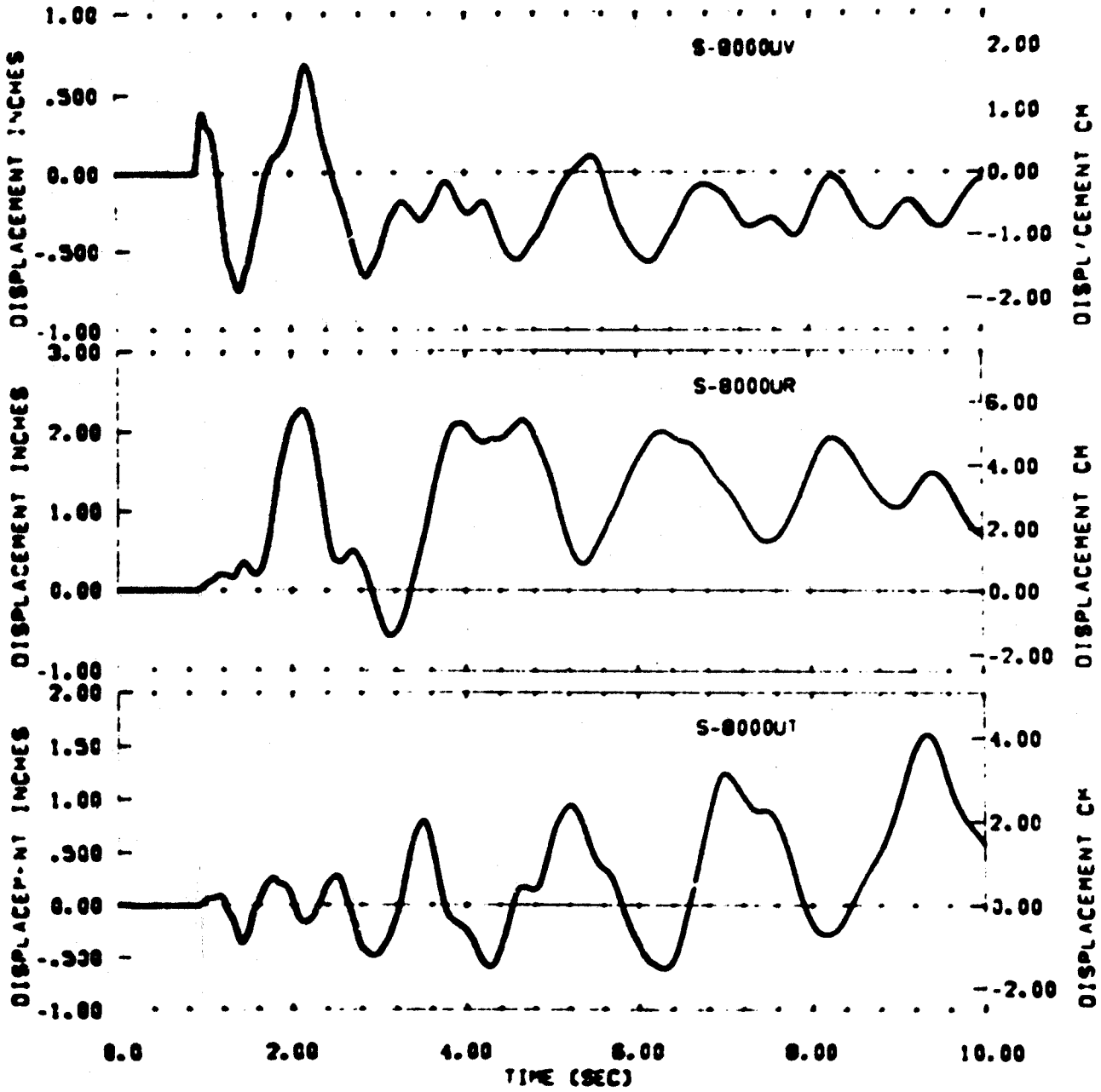

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