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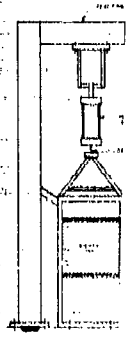

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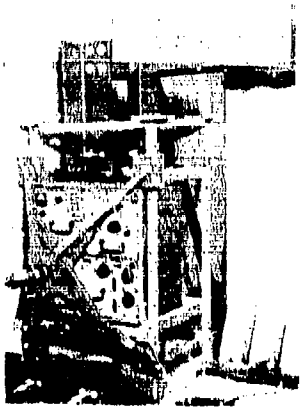

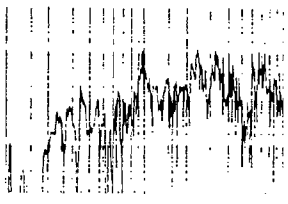

STRUCTURES LABORATORY

TECHNICAL REPORT SL-85 6

FORCE-PULSE TESTS OF TACTICAL COMMUNICATION EQUIPMENT

by

Roger D. Crowson

Structures Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-0631

and

Frederick Safford

Agbabian Associates
250 North Nash Street
El Segundo, California 90245

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September 1985
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A unique test device has been developed and has been shown to be an effective means of subjecting electronic equipment to biaxial acceleration levels that might be encountered in a battlefield condition. The pulse generator can develop simultaneously a 10,000-lb force vertically and horizontally. Test articles of up to 100 lb have been tested in a rack-mounted system to acceleration levels of 2000 g's. Several mechanical limitations have been identified (i.e., tool chatter) and research has been suggested to broaden the field of application of the pulser.

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PREFACE

This data report covers developmental work on the force-pulse generator and all pulse tests on the communication equipment through December 1980. Calibration test data have been previously reported. Overall program management for the sponsors was provided by Dr. William Schuman, U. S. Army Ballistic Research Laboratory, and Mr. Robert Freiberg, U. S. Army Electronics Research and Development Command. Project Engineers were Dr. Frederick Safford, Agbabian Associates, and Mr. Roger D. Crowson, Structural Mechanics Division (SMD), Structures Laboratory (SL), U. S. Army Engineer Waterways Experiment Station (WES). Instrumentation support was provided and data processing was performed by Messrs. James L. Pickens and Cary B. Cox, Instrumentation Services Division, WES.

Commanders and Directors of WES during the work and preparation of this report were COL Nelson P. Conover, CE, COL Tilford C. Creel, CE, and COL Robert C. Lee, CE; Mr. F. R. Brown was Technical Director, Mr. Bryant Mather was Chief, SL. At the time of publication of this report, COL Allen F. Grum, USA, was Director of WES and Dr. Robert W. Whalin 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 can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
acceleration of gravity (g's)	9.80665	metres per second squared
cubic feet	0.02831685	cubic metres
cubic inches	16.387064	cubic centimetres
feet	0.3048	metres
g's per pound (force)	2.20462243	metres per second squared per newton
gallons (U. S. liquid)	0.00378541	cubic metres
gallons (U. S. liquid) per minute	0.00006309	cubic metres per second
horsepower (electric)	746.0	watts
inches	2.54	centimetres
inches	0.0254	metres
inches per second	0.0254	metres per second
kips (1000 lb force)	4448.222	newtons
ounces (mass)	28.34952	grams
pounds (force) per square inch	6894.757	pascals
square inches	6.4516	square centimetres
tons (2000 lb mass)	907.18474	kilograms

FORCE-PULSE TESTS OF TACTICAL COMMUNICATION EQUIPMENT

PART I: INTRODUCTION

BACKGROUND

1. Mobile tactical communication systems used by the U. S. Army are housed in a shelter typically mounted on a 2-1/2-ton* truck. Airblast generated by high-explosive or nuclear weapons loads the shelter, thereby inducing transient vibrations to the communication equipment. Shelters containing the equipment have been tested in Events DICE THROW and MISERS BLUFF, and the shelters were scheduled to be part of the MILL RACE Event during 1981. Acceleration of various individual pieces of equipment as well as the equipment racks are typically measured in the field events.

2. The transient loadings and resulting motion of the equipment, as measured in the field events, are quite severe. However, due to the nature of the tests, it has not been possible to determine operational characteristics of the equipment before, during, and after the tests. A laboratory simulation device capable of generating specified force-time histories could be used to subject individual pieces of equipment to similar motions as measured in the actual field events. Such laboratory testing would be highly desirable in terms of cost-effectiveness and data obtainable and could be used to determine the vulnerability/survivability of the different classes of equipment. A program was initiated to develop such a simulation device and subject various components of the communication system to loadings as might be encountered in a battlefield environment. Program management is being provided by the U. S. Army Electronics Research and Development Command (ERADCOM) and the U. S. Army Ballistic Research Laboratory (BRL). The simulation system is being developed and implemented jointly by the U. S. Army Engineer Waterways Experiment Station (WES) and Agbabian Associates (AA).

* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

SCOPE

3. The simulation device, or force-pulse generator, is hydraulically driven. This report covers the design of the hydraulic power supply and discusses tests conducted on the communication equipment through December 1980. Design and operation of the pulse generator were previously described in the test plan (Reference 1), and calibration tests were reported in Reference 2.

PART II: HYDRAULIC POWER SUPPLY

4. The existing WES pulse-generator was powered by a hydraulic system using an air reservoir and air/hydraulic multiplier. This system is shown in Figure 1 and a schematic in Figure 2. The new system, consisting of two separate pulse generators and having a larger force capacity, would require a new power supply. Based on requirements of two pulsers each having a nominal 10,000-lbf capacity and a 13-in. stroke, a power system utilizing the air/hydraulic concept would have required: (a) a 14-in. to 3-in. air/hydraulic multiplier with a 20-in. stroke, (b) a 94-gal air reservoir, and (c) an input supply of 100 psi. Such a system would have been considerably larger than the existing system thereby greatly reducing the degree of portability. Due to size and operational characteristics, an alternative to the air/hydraulic multiplier concept was developed.

5. A power supply concept, utilizing a high-pressure pump and accumulator system, is shown schematically in Figure 3. Preliminary calculations, used for initial sizing of components, were made as follows:

Hydraulic cylinders:

10,000-lbf nominal design force

2500-psi operating pressure

$$\text{Net area required} = \frac{10{,}000 \text{ lb}}{2500 \text{ lb/in.}^2}$$

$$= 4.0 \text{ in.}^2$$

A 2-1/2-in. piston with 1-in. rod has a net effective area of 4.124 in.^2

Cylinder volume:

$(4.124 \text{ in.}^2)(13\text{-in. stroke}) = 53.6 \text{ in.}^3$

Piston velocity: 120 in./sec (nominal)

Flow rate:

Single cylinder = 128.5 gal/min

Two cylinders = 257 gal/min

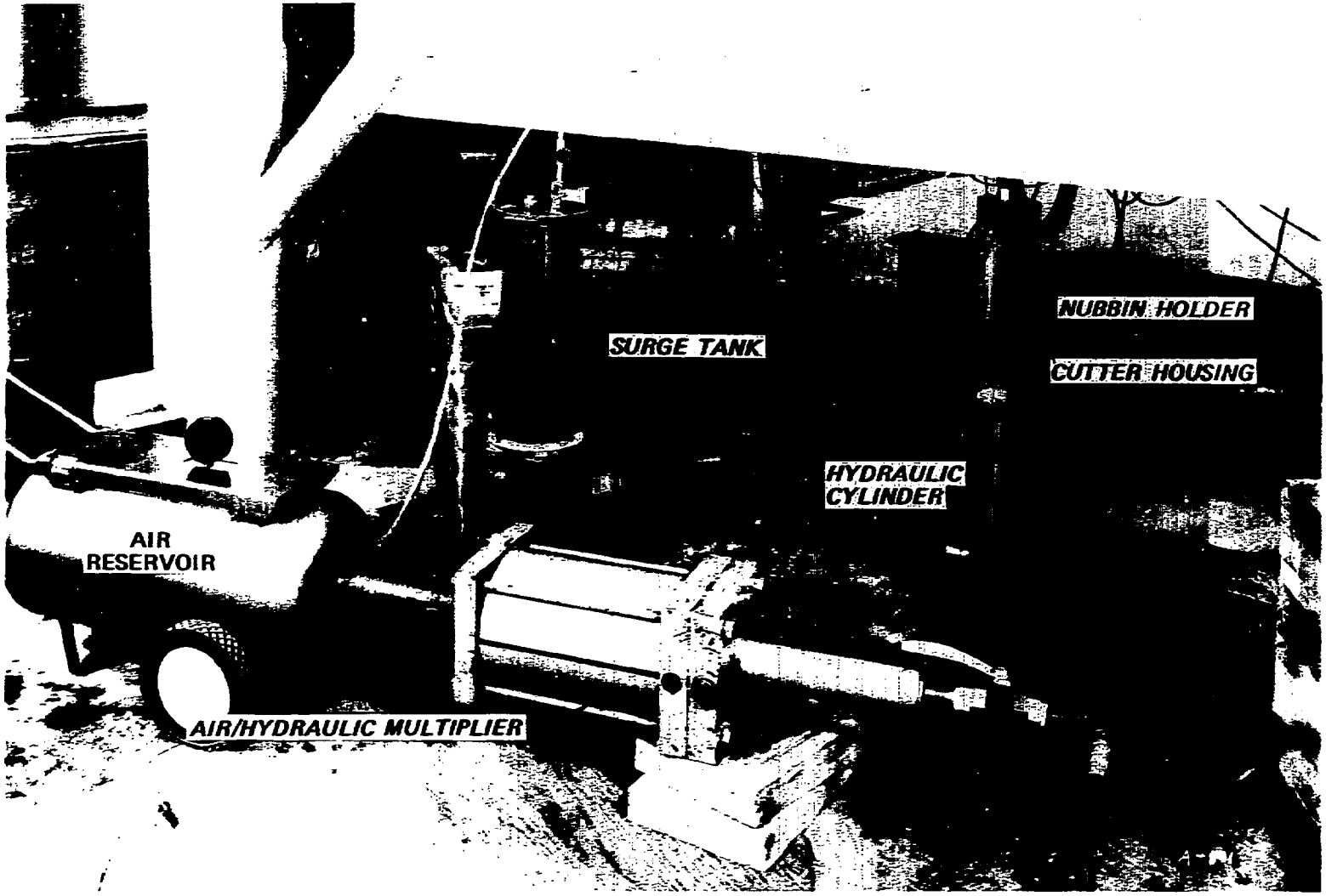


Figure 1. Initial WES pulser utilizing air/hydraulic multiplier in power supply.

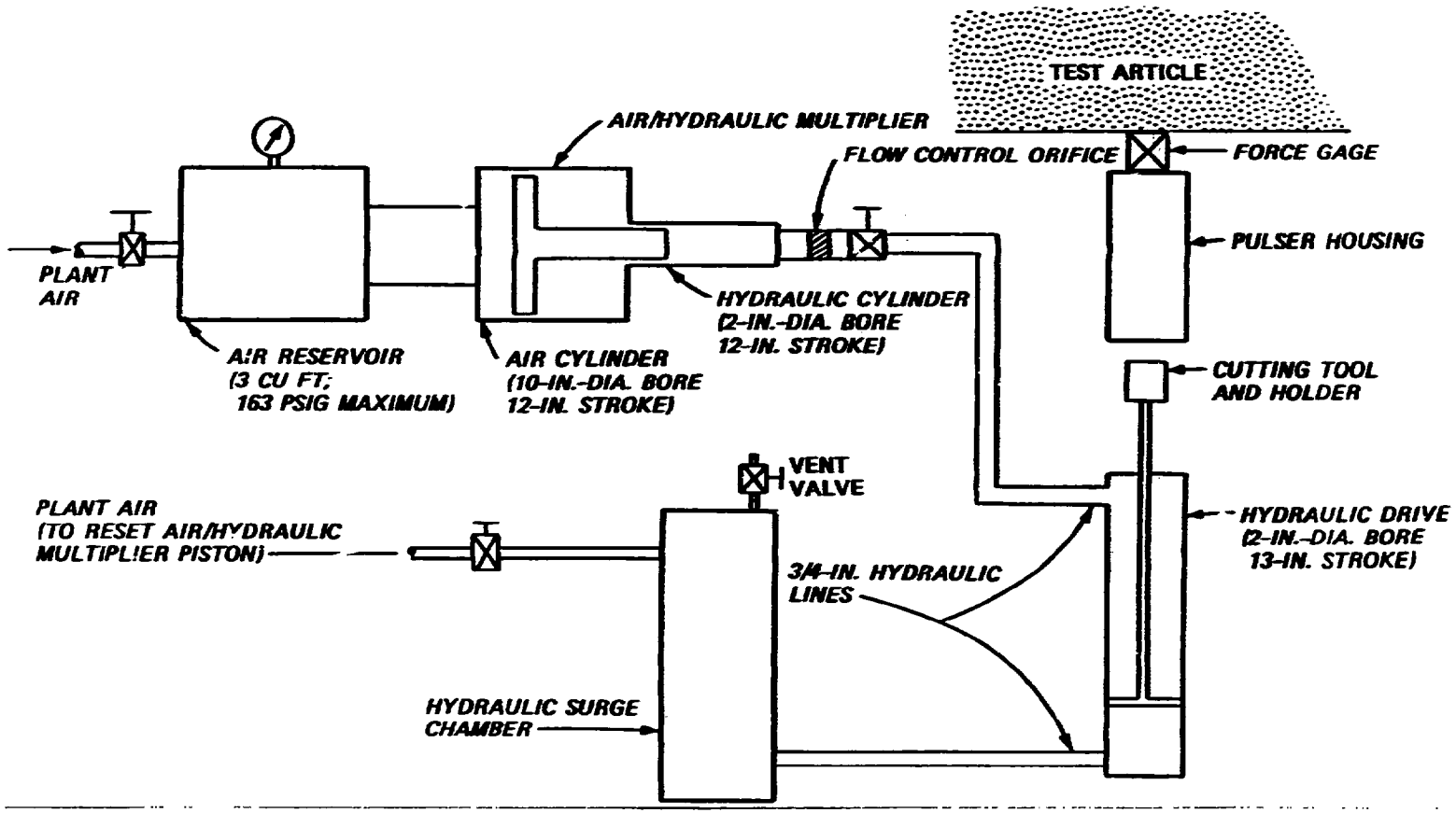


Figure 2. Schematic of initial WES pulser.

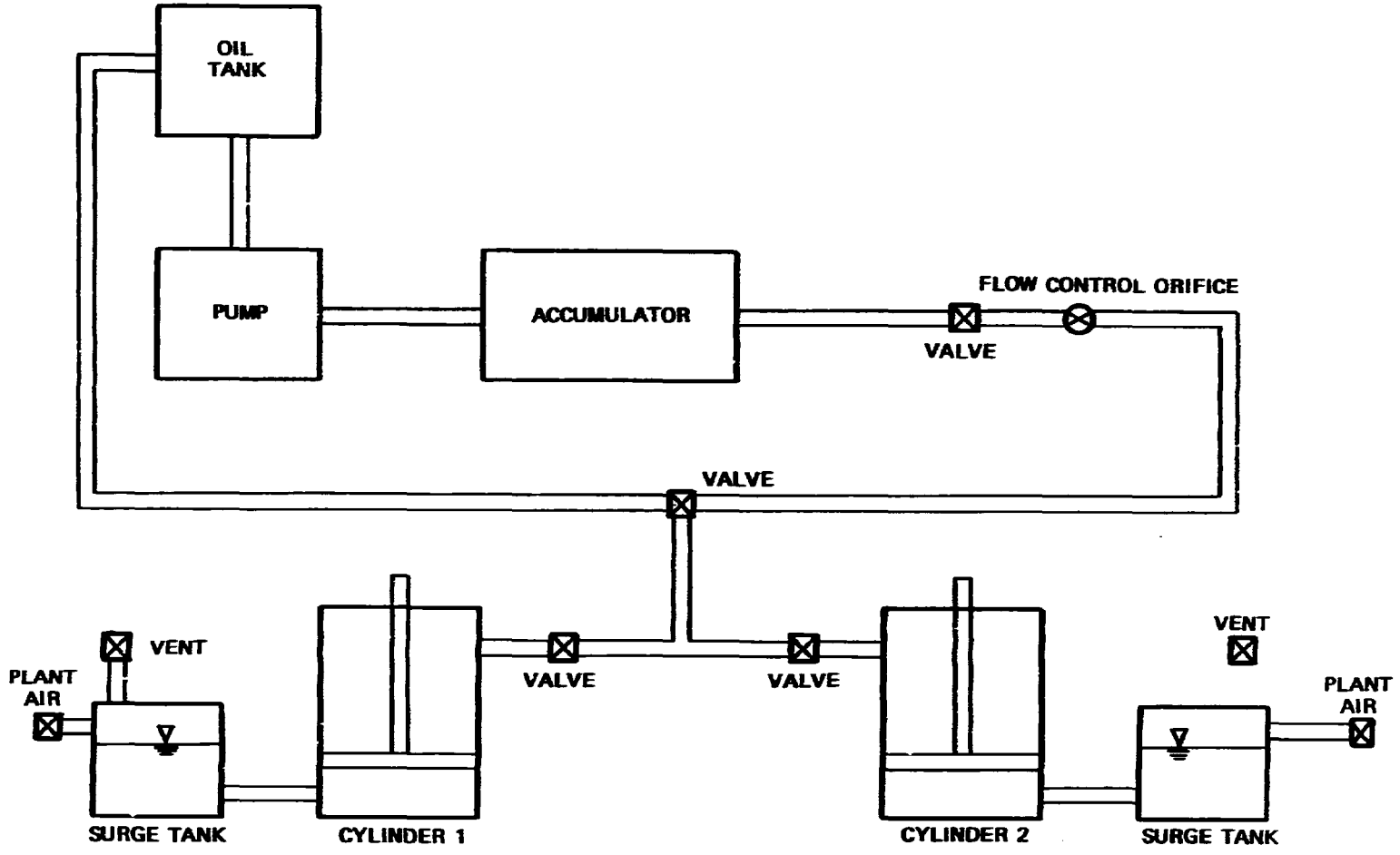


Figure 3. Hydraulic power supply schematic.

6. Gas-oil type accumulators operate on the principle of Boyle's Gas Law, $P_1V_1^n = P_2V_2^n$, where P_1 and P_2 are the initial and final gas pressures; V_1 and V_2 are the corresponding gas volumes; and n is the ratio between the specific heat of a gas at constant volume and its specific heat at constant pressure. For an isothermal condition (constant temperature) $n = 1.0$, and for an adiabatic condition (no heat transfer), $n = 1.4$. Generally, an adiabatic condition exists for rapid (less than 1 minute) expansion or compression of gas or when insulating materials are used in the accumulator. For sizing an accumulator as an auxiliary power source, the amount of fluid required from the accumulator to meet the system needs must be known. The following formula presents a simplified method of determining the capacity of the accumulator to be used (Reference 3, p. a-82):

$$V_1 = \frac{V_x\left(\frac{P_3}{P_1}\right)^{1/n}}{1 - \left(\frac{P_3}{P_2}\right)^{1/n}} \qquad (1)$$

where:

V_1 = size of accumulator necessary, $in.^3$ Maximum volume occupied by gas at precharge pressure

V_x = volume of fluid discharged from accumulator, $in.^3$ Additional volume of fluid demanded by the system

P_1 = gas precharge of accumulator, psi. Must be less than or equal to minimum system pressure, P_3

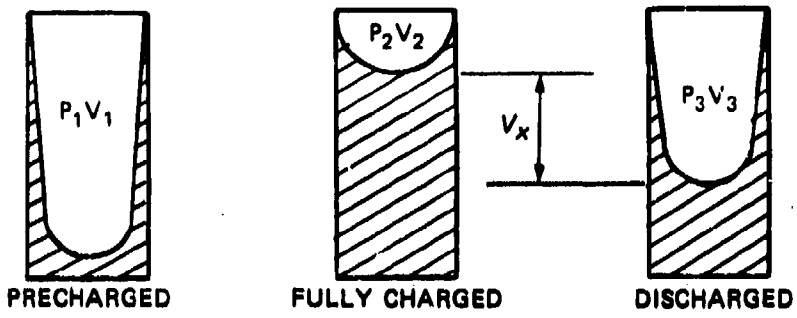
P_2 = maximum system design operating pressure, psi

V_2 = compressed volume of gas at maximum system pressure, $in.^3$

P_3 = minimum system pressure at which additional volume of fluid is needed, psi

V_3 = expended volume of gas at minimum system pressure, $in.^3$

$n = 1.4$



The maximum precharge pressure, P_1, was limited to that of a standard nitrogen bottle (2200 psi); considering the volume of two cylinders, V_x was taken to be 130 in.^{3}; the required pressure for 10,000 lbf, P_2, was taken to be

$$\frac{10{,}000 \text{ lbf}}{4.124 \text{ in.}^2} = 2424 \text{ psi}$$

and the minimum system pressure, P_3, was assumed to be 2100 psi. Using these parameters, Equation 1 resulted in a required accumulator volume of approximately 1400 in.^{3} A 10-gallon accumulator having a volume of 2080 in.^{3} was selected as optimum.

7. The final system design is shown schematically in Figure 4, and a list of components is given in Table 1. Final sizing and selection of components and fabrication of the complete power supply was performed by Activation Inc. under contract to WES. A photograph of the completed power supply is shown in Figure 5.

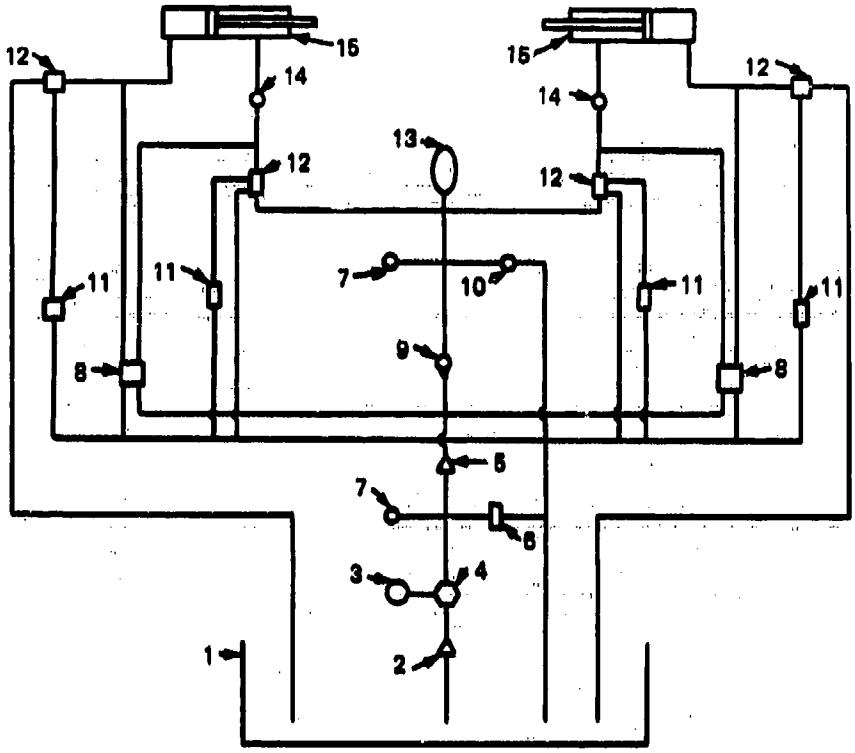


Figure 4. Hydraulic power supply circuit.

Table 1

Hydraulic Power Supply Component List

ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
1	1	Thirty-gallon reservoir with cover, sight gage, flush drain, and baffles, Activation No. T30L	9	1	Check valve, Gould No. DC 300
2	1	Suction strainer, MFP No. SR45	10	1	Ball valve, Clayton Mark No. 1/2 CSB-790
3	1	Electric motor, 3HP, Lincoln No. 182T	11	4	Directional control valve, 4-way, 2-position, solenoid-operated, Double A No. QJ-005-C-10B1
4	1	Pressure compensated pump, Hydura No. PVQ-06-LSAY-CNSN	12	4	Relief valve, Double A No. BT-12-12A2
5	1	High-pressure filter, 5 micron, MFP No. MF1-1-008	13	1	Ten-gallon accumulator, Greer No. 30A-10A
6	1	Relief valve, Sun No. RPGC-JAN-CEB	14	2	Flow control valve, Double A No. YB12-10A1
7	2	Pressure gage, 0-3000 psi, UCC No. UC-3907	15	2	Hydraulic cylinder, 2-1/2-in. bore. 1-in. rod diameter, 13-in. stroke, Sheffer Heavy Duty MH Series Model No. 2-1/2 MHRF13CRA
8	2	Directional control valve, 4-way, 3-position, solenoid-operated, Double A No. QF-01-C-10F1			

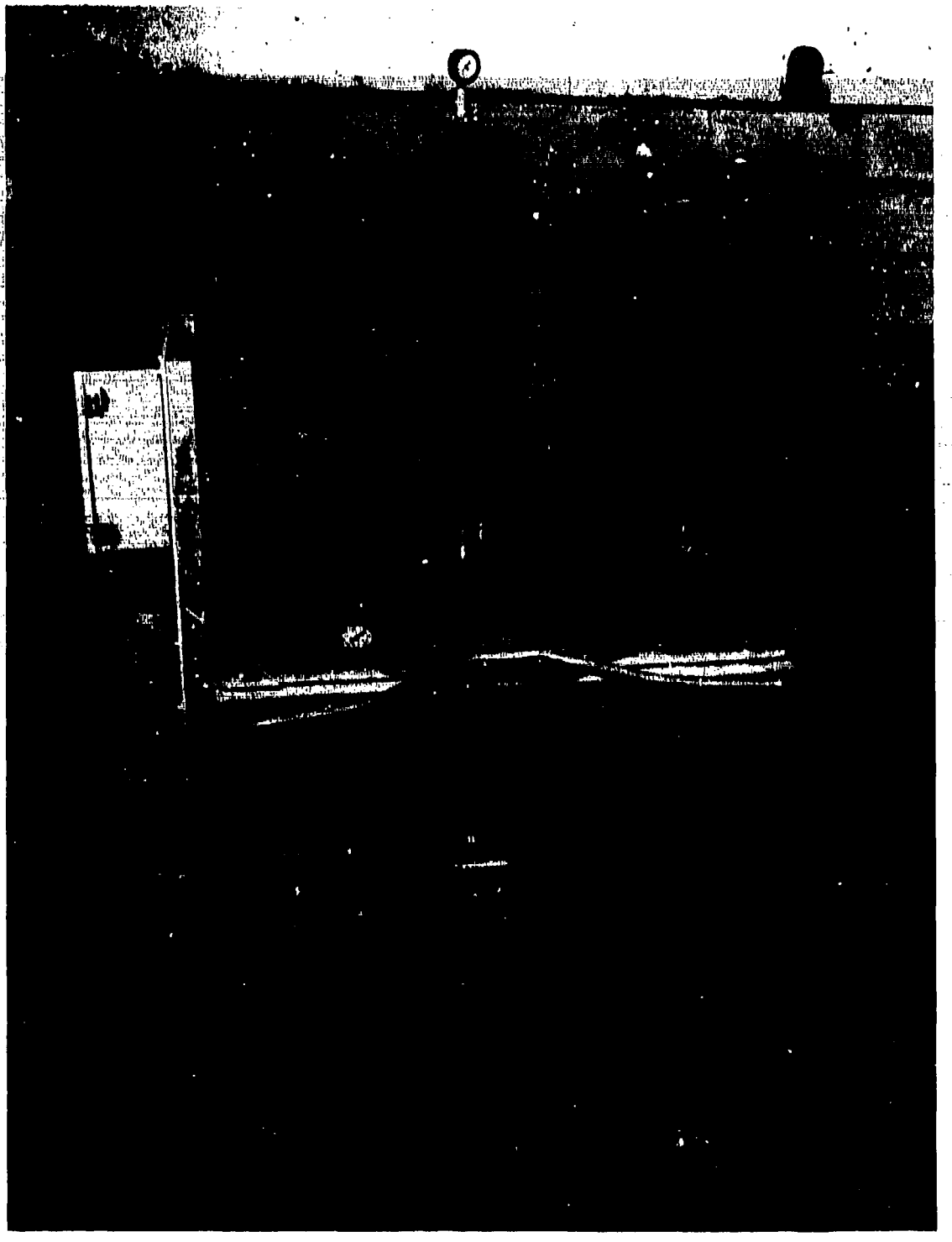


Figure 5. Hydraulic power supply.

PART III: TESTS CONDUCTED

CALIBRATION TESTS

8. An extensive series of calibration tests was conducted, and results are reported in Reference 2.

EQUIPMENT TEST SETUP

9. The equipment rack used in the mobile system and furnished to WES was modified for testing. The rack, constructed of 1-in. aluminum box tubing and 3/16-in. aluminum plate, was reduced in height to approximately 3 ft so that the total height of the system with vertical pulser attached would be less than 8 ft. To accommodate the largest pieces of radio equipment, maximum shelf spacing was not altered in the modified rack. Steel reaction structures to which the pulsers were attached were designed and fabricated. For attaching the pulsers to the equipment rack, a loading yoke ("quadrapod") arrangement was utilized. The loading yoke was fabricated from 3/4-in. steel box tubing and attached to the rack with three 3/8-in. bolts at four locations. The test setup is shown schematically in Figure 6 and as a photograph in Figure 7.

INSTRUMENTATION

10. Accelerations were measured with piezoresistive shock accelerometers (Endevco Model 2264A). These are small gages (0.05 oz weight) having a high resonance frequency (30,000 Hz) and essentially zero damping thereby allowing accurate response to fast-rise-time, short-duration shock motion. Complete specifications are given in Table 2. The accelerometers were attached directly to the equipment with cynoacrylate adhesive.

11. Force measurements were made with piezoelectric force links (Kistler Model 936A) having a crystalline quartz sensing element. These transducers have a high natural frequency (25,000 Hz), high resolution (0.0004 percent), and very high sensitivity. Complete specifications are given in Table 2.

12. All data were recorded on an FM magnetic tape recorder and played back through a tuneable analog filter on oscillograph traces. Some data were also digitized for additional analysis. The tape

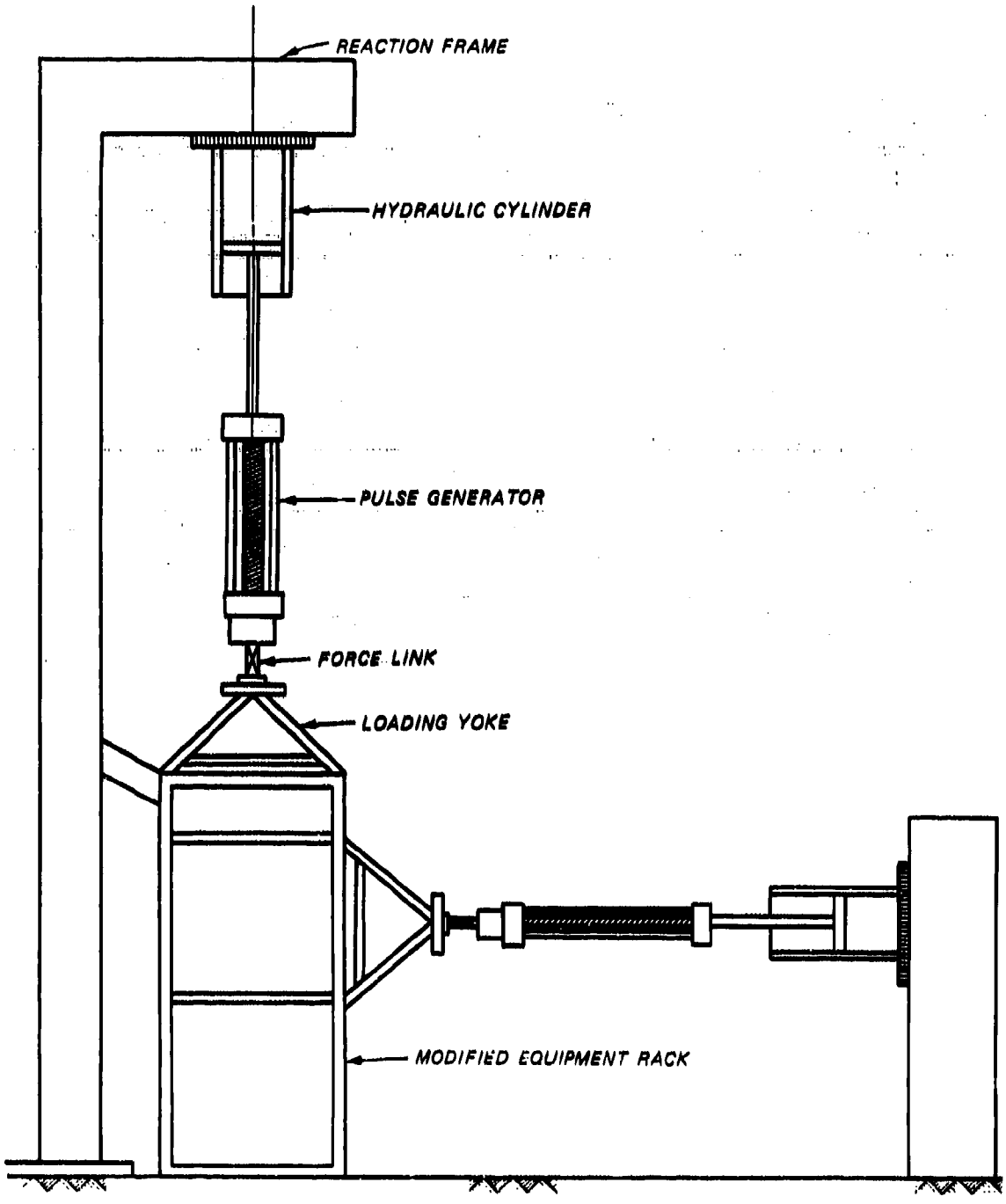


Figure 6. Schematic of biaxial test facility.

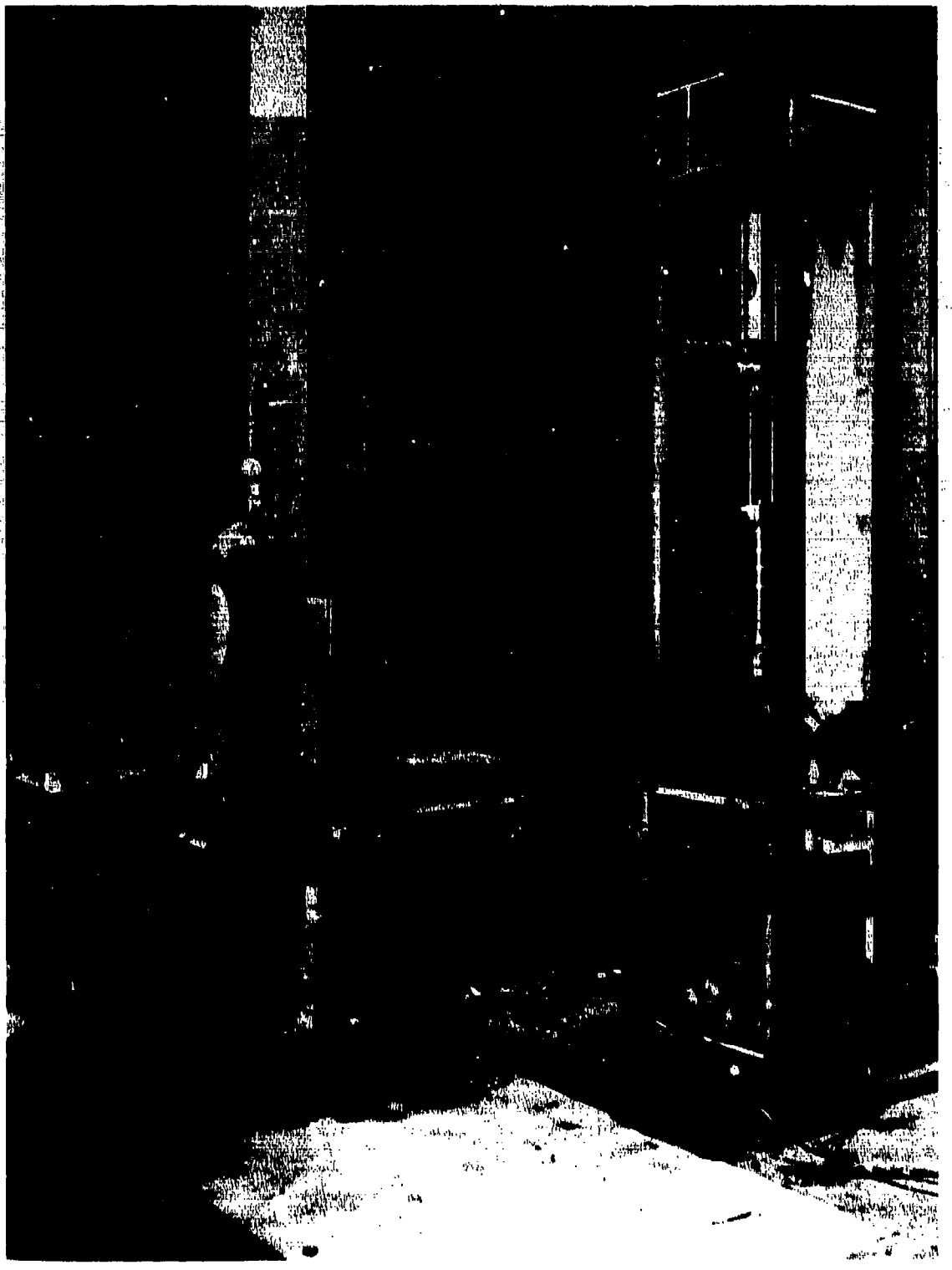


Figure 7. Setup for biaxial tests.

Table 2

Transducer Specifications

Endevco 2264A Accelerometer	
Range, g's pk	±2000
Sensitivity, mV/g at 10 Vdc, nom.	0.250
Mounted resonance frequency, Hz	30,000
Useful frequency response, Hz, dc to	5000
Environmental acceleration limit, g's pk	±5000
Damping factor, nom	0.002
Transverse sensitivity	5%, max
Weight, oz	0.05
Kistler 936A Quartz Force Link	
Range, lb, tension compression	15,000 25,000
Resolution, lb	0.1
Resonant frequency, Hz, unmounted	25,000
Weight, oz	50
Sensitivity	10 pC/lb
Overload capacity	10%
Linearity	1%
Useful frequency response, Hz, near dc to	5000
Environmental acceleration limit, g's pk	±5000
Rise time	20 μsec

machines were operated at 30 ips, wide band, thereby having a frequency response from DC to 20 kHz (half-power point response).

BIAXIAL TESTS

13. After completion of the calibration test phase, a series of tests was conducted utilizing the biaxial capability of the pulser. As shown in Figure 7, both horizontal and vertical axes were excited. However, in lieu of an actual piece of communications equipment, lead weights were placed in the rack for the initial biaxial tests. No specific pulse train was used for these tests; arbitrary excitation was sufficient to check out the system. For these biaxial tests, both vertical and horizontal accelerations of the equipment rack were measured.

14. The two circuits in the hydraulic power supply have different response times. Delays of up to 30 msec are within specifications of the solenoid-controlled valves in the power supply. Thus, if both pulsers are simultaneously fired with a common circuit, one will start moving 10 to 30 msec before the other. For simultaneous initiation of both pulses (i.e., each cutter striking its first nubbin at the same point in time), it is necessary to position one cutter closer to the first nubbin than the other. After several test firings of both pulsers, simultaneous initiation of the first pulse was achieved with the following parameters:

Precharge accumulator pressure	= 1250 psi
System operating pressure	= 2000 psi
Flow control valve (vertical unit)	= 4-1/2 turns
Flow control valve (horizontal unit)	= 6-1/2 turns
Horizontal cutter initial run-up	= 7.5 mm
Vertical cutter initial run-up	= 5.1 mm

However, after repeated firing with the same parameters, initiation of pulses between the two units could be controlled to within only 7 msec. Typical data records from biaxial tests, produced directly from the tape recorder with no additional filtering, are shown in Figures 8 and 9. As can be seen in Figure 9, significant accelerations were recorded on the rack (800 g's both vertical and horizontal directions) with relatively moderate input forces (approximately 2000 lb). No significant problems

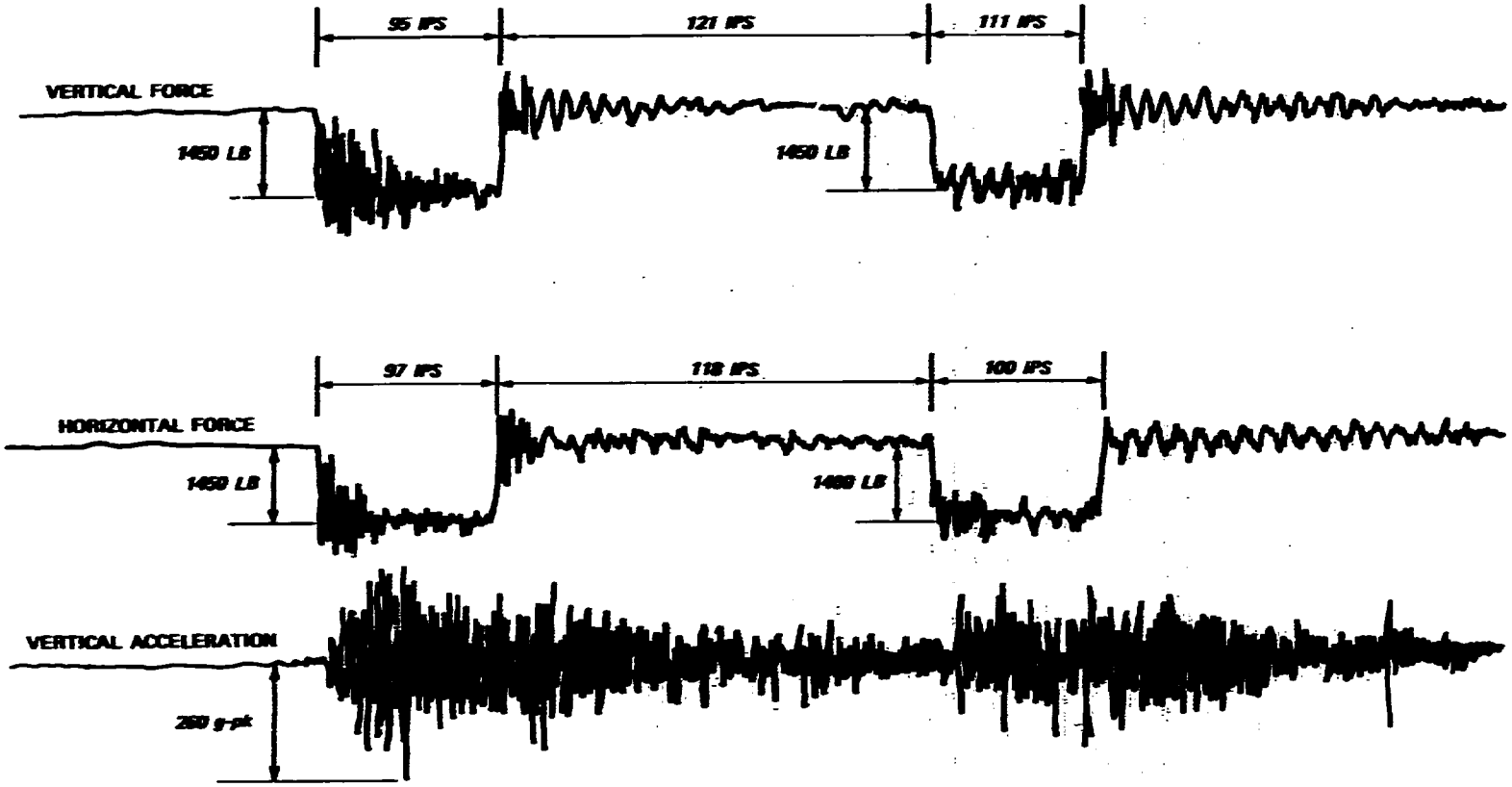


Figure 8. Biaxial pulse test data, simultaneous pulse initiation.

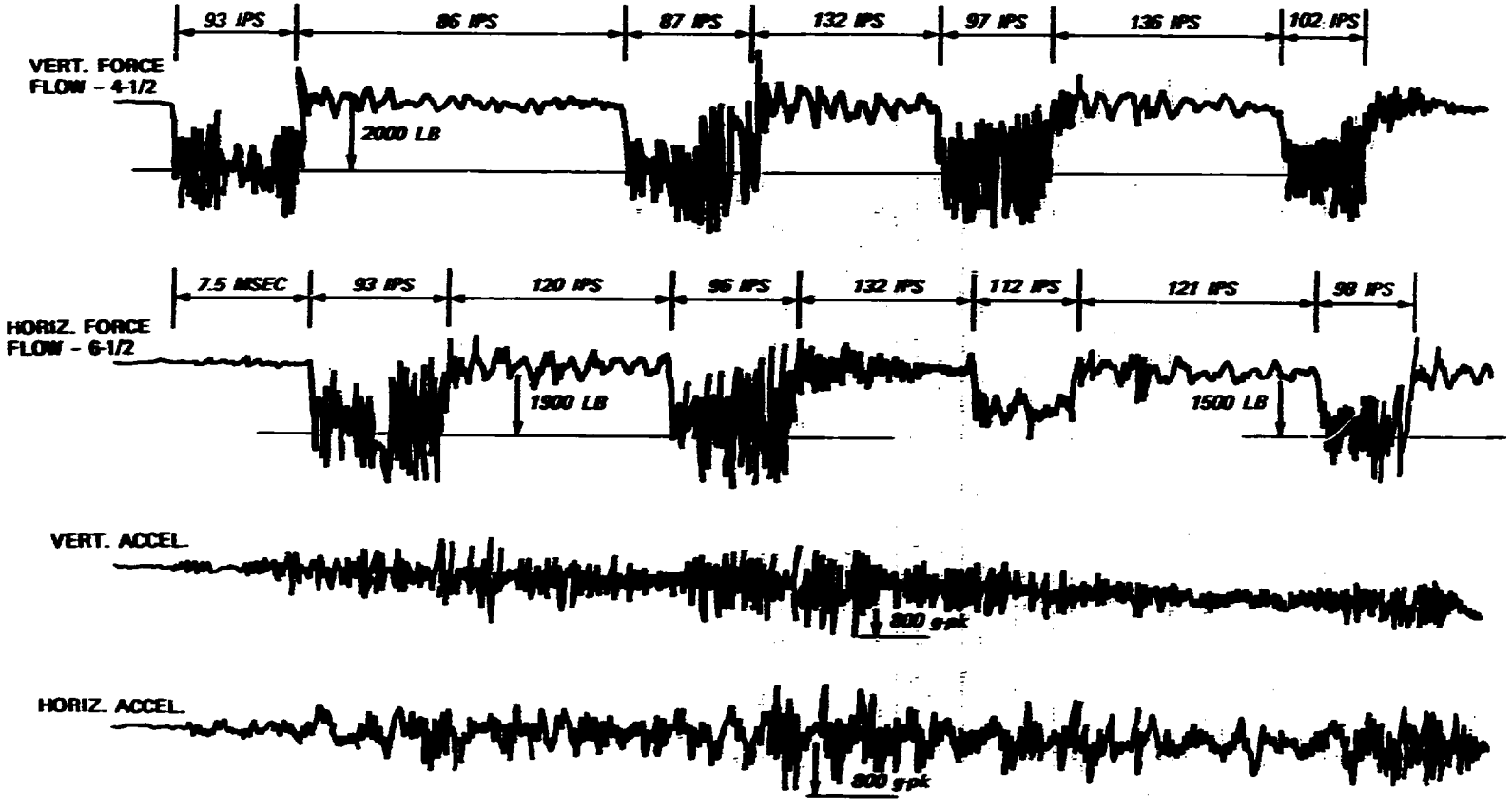


Figure 9. Biaxial pulse test data, delayed pulse initiation.

were encountered while operating the system in the biaxial mode, other than maintaining alignment, which is a critical inherent characteristic of the system.

IMPEDANCE TESTS

15. Two sets of impedance tests were run. The first set, as specified in the original test plan (Reference 1), was conducted using a hammer to produce a force impulse. Data from these tests were to be used in deriving a pulse train to simulate field test response records. The other set of impedance tests was conducted using vibration sine sweeps. Frequency response data of the radio equipment and rack were obtained from these vibration tests. All impedance tests were conducted with the rack hard-mounted to the floor and reaction structure.

16. Hammer tests. The system configurations shown in Figures 10 and 11 were utilized for the hammer impedance tests. Force impulses, induced by a calibrated hammer having a force link attached to its head, excited the system, and the resulting accelerations were measured in both horizontal and vertical directions. Figure 10 shows the arrangement for the vertical impedance test. Horizontal testing was also performed with the vertical pulser attached and the input being applied horizontally. Source impedance measurements were made, as shown in Figure 11, by exciting the pulse generators directly (pulse generators disconnected from equipment rack) and measuring the drive point acceleration. A nonoperational AN/GRC-103 radio system was mounted in the rack for all the impedance tests. The data were recorded on FM magnetic tape and later digitized. The digital records were forwarded to Agbabian Associates for analysis and use in the pulse optimization algorithms.

17. Vibration tests. Once the degree of acceleration attenuation from equipment rack to radio had been observed, vibration tests were conducted. Frequency response data of both the equipment rack and AN/GRC-103 radio were obtained from these tests. The pulsers were disconnected from the rack, and an electromagnetic vibrator was attached to the horizontal loading yoke (Figure 12). Frequency sweep tests from 100 to 10,000 Hz were conducted using a 2-lb sinusoidal input. Other

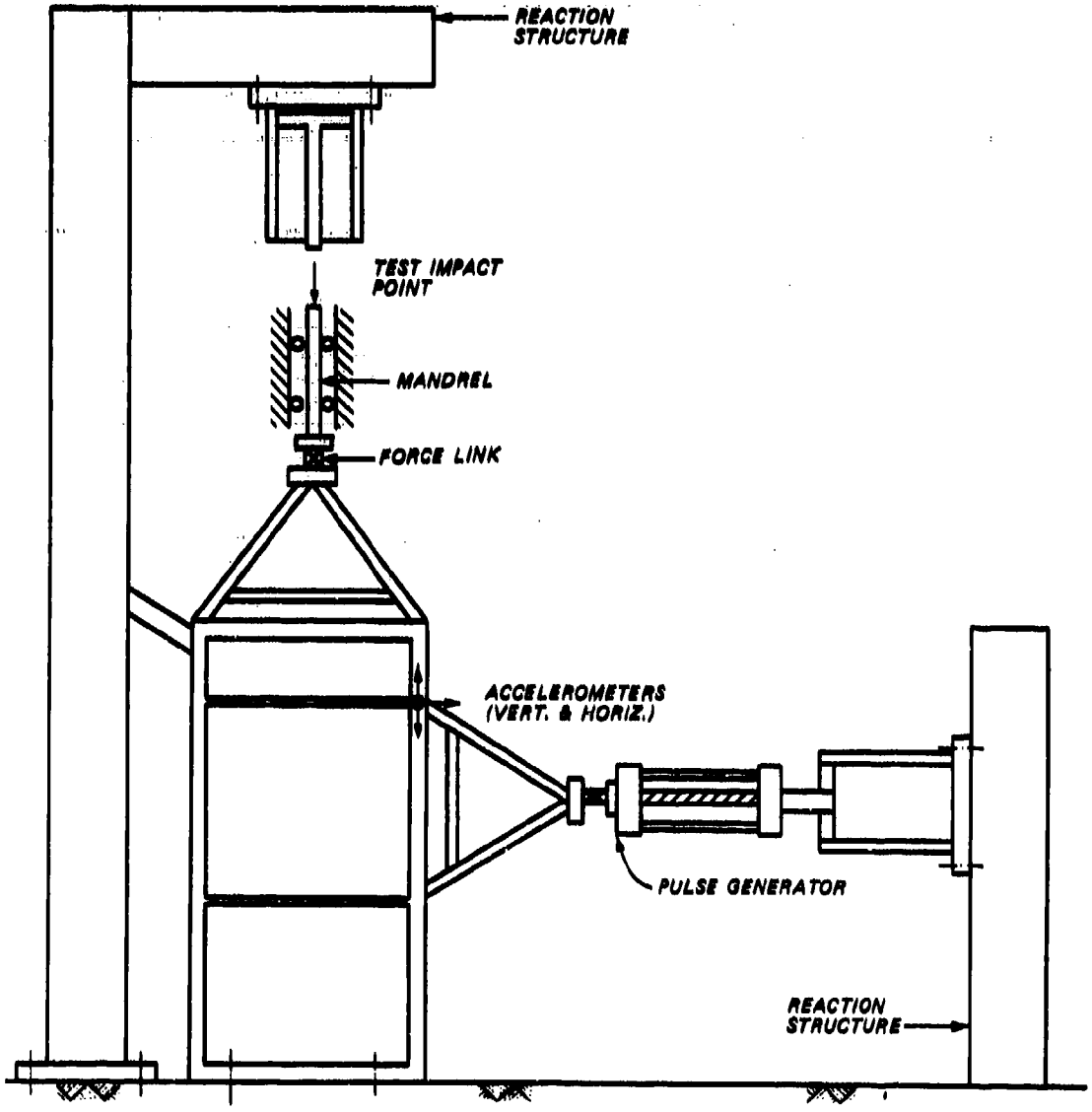


Figure 10. Vertical impedance test of biaxial test facility.

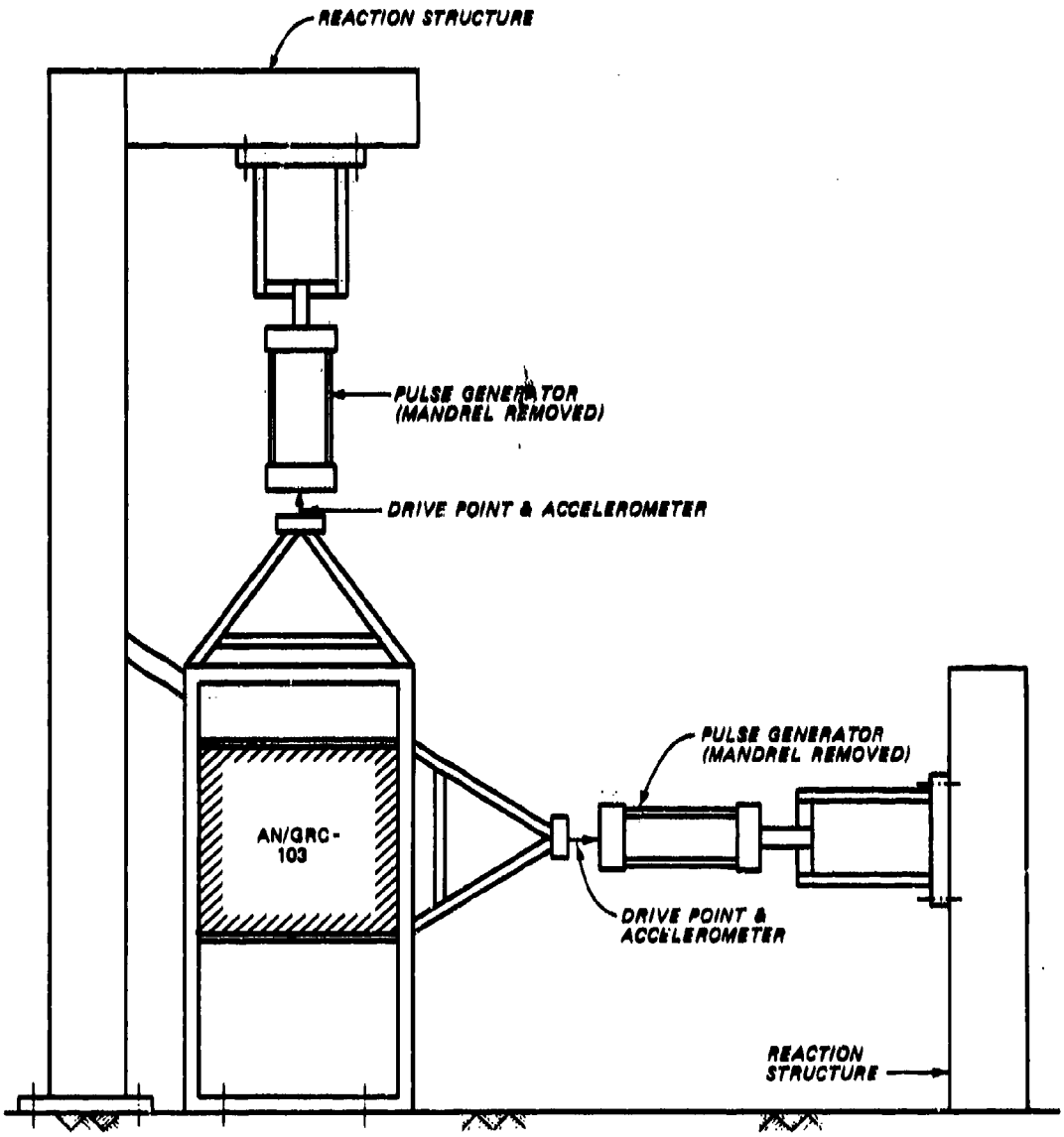


Figure 11. Source impedance measurement locations of biaxial test facility.

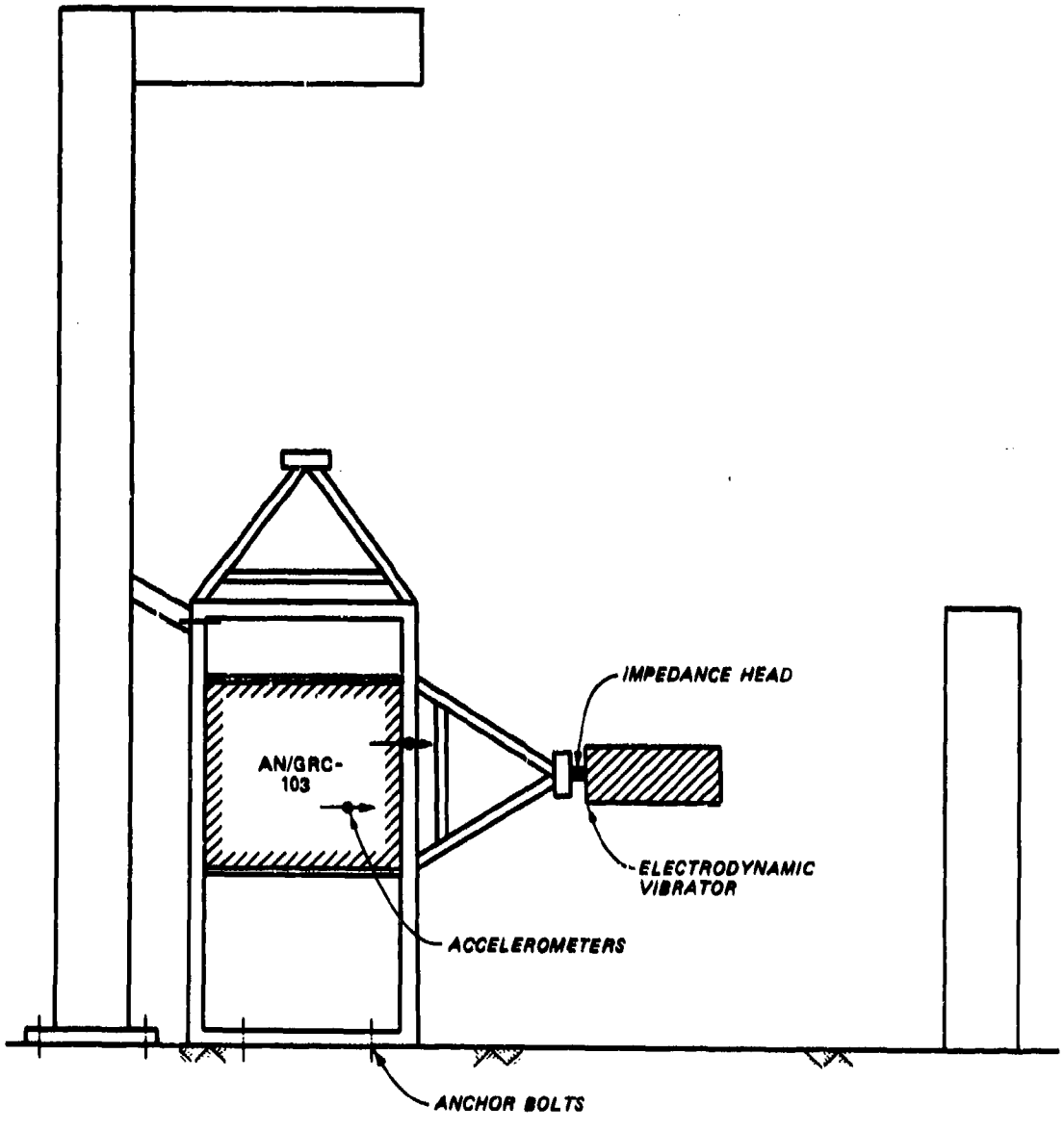


Figure 12. Vibration test setup.

tests were conducted using 1-, 5-, and 20-lb input forces. Accelerations were measured at the point of loading (drive point acceleration) on a vertical leg of the rack and on the face of the AN/GRC-103 transmitter (directly in front of a stiffening plate).

18. Data from the vibration tests are shown in Figures 13-16. Figures 13, 14, and 15 are inertance plots, $(\frac{\text{acceleration response}}{\text{driving force}})$ versus frequency. Figure 13 is the drive point inertance, i.e., $(\frac{\text{drive point acceleration}}{\text{input force}})$; Figure 14 is the inertance plot of the rack; and Figure 15 is the inertance plot of the radio as mounted in the rack. A comparison of Figures 14 and 15 reveals that general response characteristics of the rack and radio are quite similar. Several resonance peaks are observed in the 100- to 400-Hz range, with distinctive antiresonances particularly prevalent in the 400- to 700-Hz range. Numerous resonances occur at frequencies above 1000 Hz, the strongest being at approximately 2600 Hz. Above 4000 Hz, the radio response has more antiresonances than the rack. Figure 16 is a transmissibility plot, the ratio of radio and rack accelerations versus frequency. As can be seen, there are numerous, high Q (lightly damped) resonances and antiresonances throughout the frequency range. There are distinctive peaks in the curve at frequencies below 400 Hz, particularly in the 150- to 200-Hz range, representing amplifications of up to 10 of radio versus rack accelerations. However, the curve generally falls in the 0.1 to 1.0 amplitude range signifying reduced accelerations being transmitted from the rack to the radio. This energy is apparently lost in the radio/rack bolted connection.

TESTS OF OPERATIONAL EQUIPMENT

19. Two units of operational equipment were delivered to WES for testing: (a) AN/GRC-103 Transmitter and Receiver, and (b) TD660 Multiplexer. These units were brought to WES, installed in the rack, and operated on-line during testing by personnel from the U. S. Army Depot, Tobyhenna, Pa. Horizontal, uniaxial pulse tests were conducted on these units utilizing the same instrumentation as in the impedance tests; i.e.

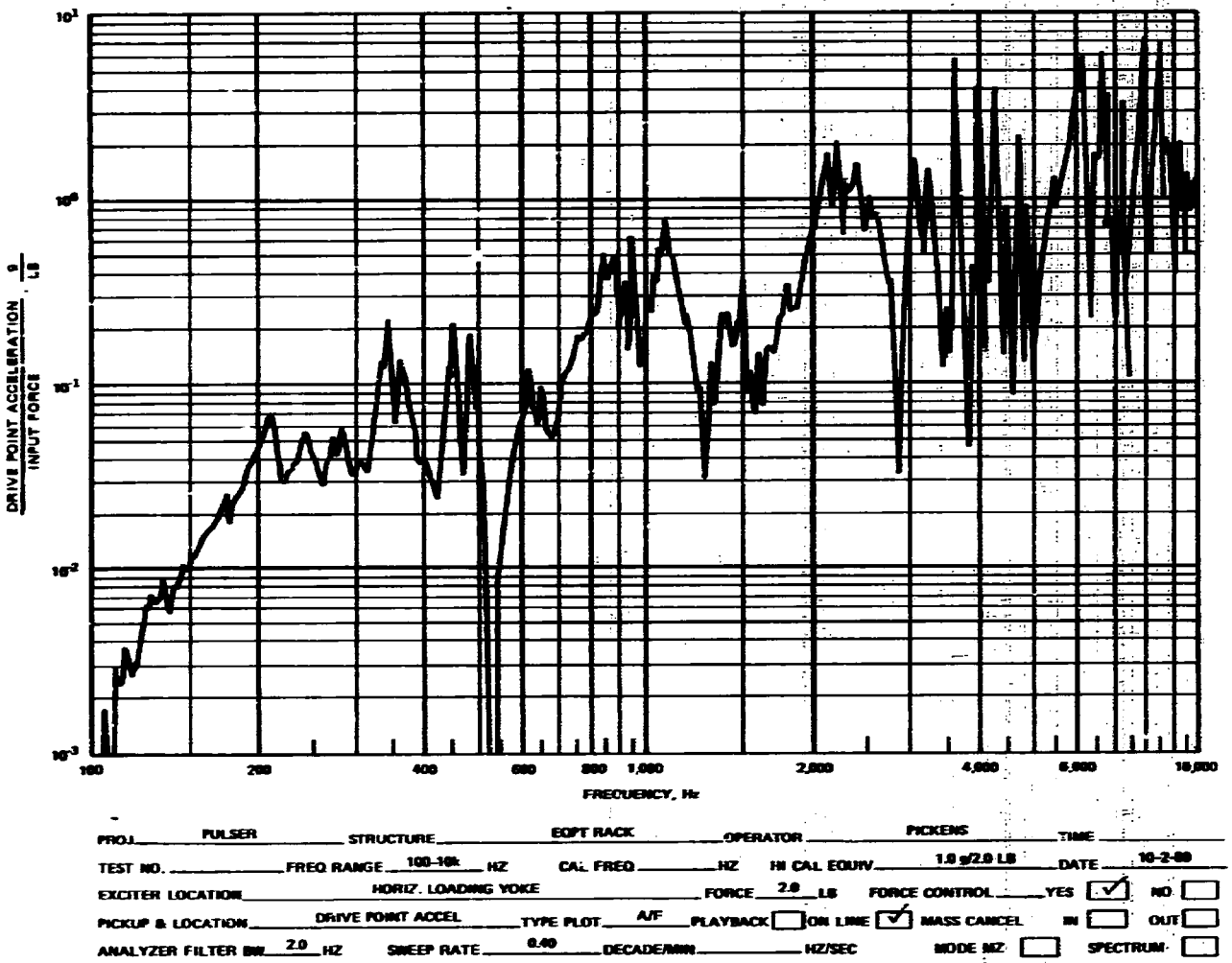


Figure 13. Vibration test data, drive point inertance.

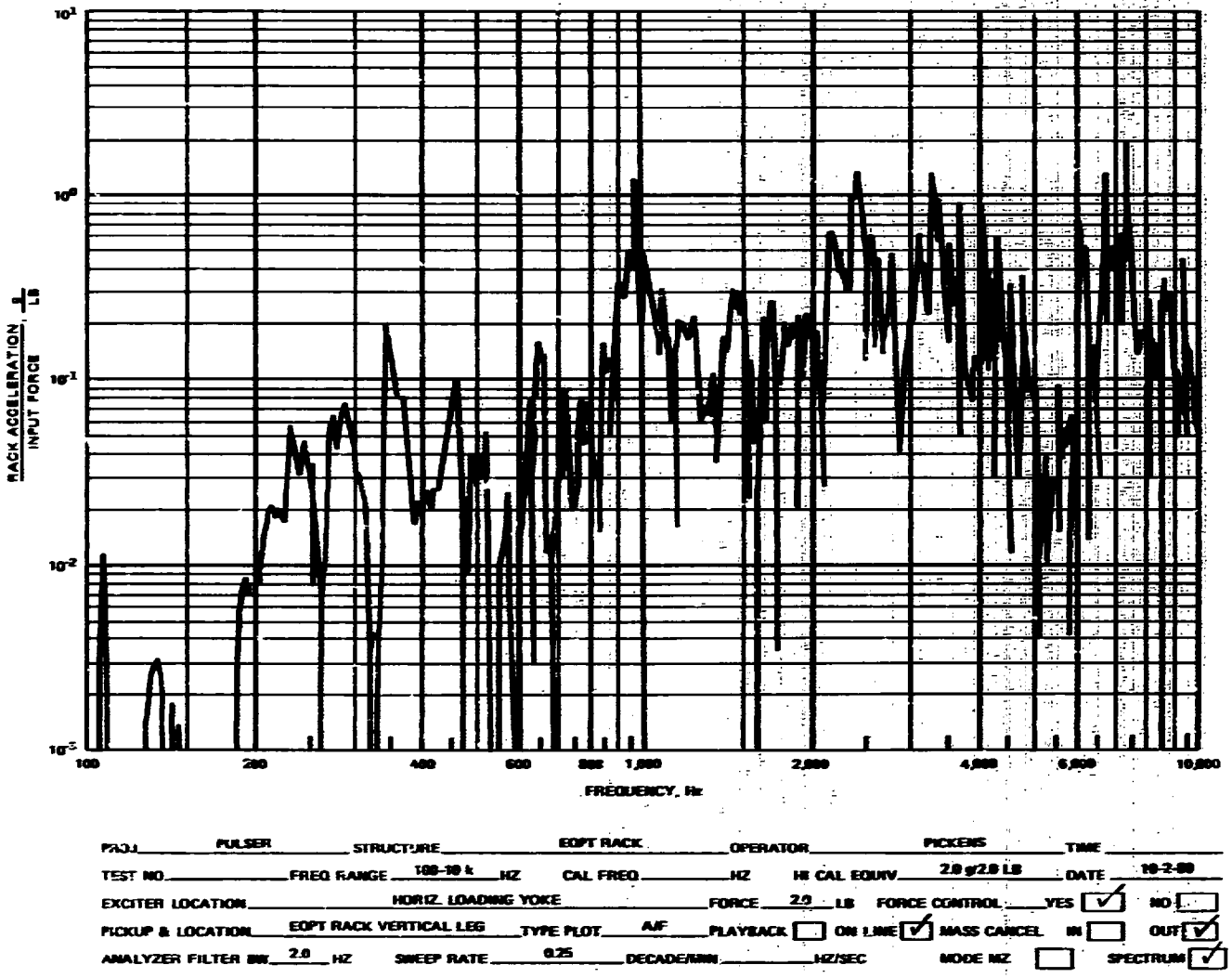


Figure 14. Vibration test data, equipment rack inertance.

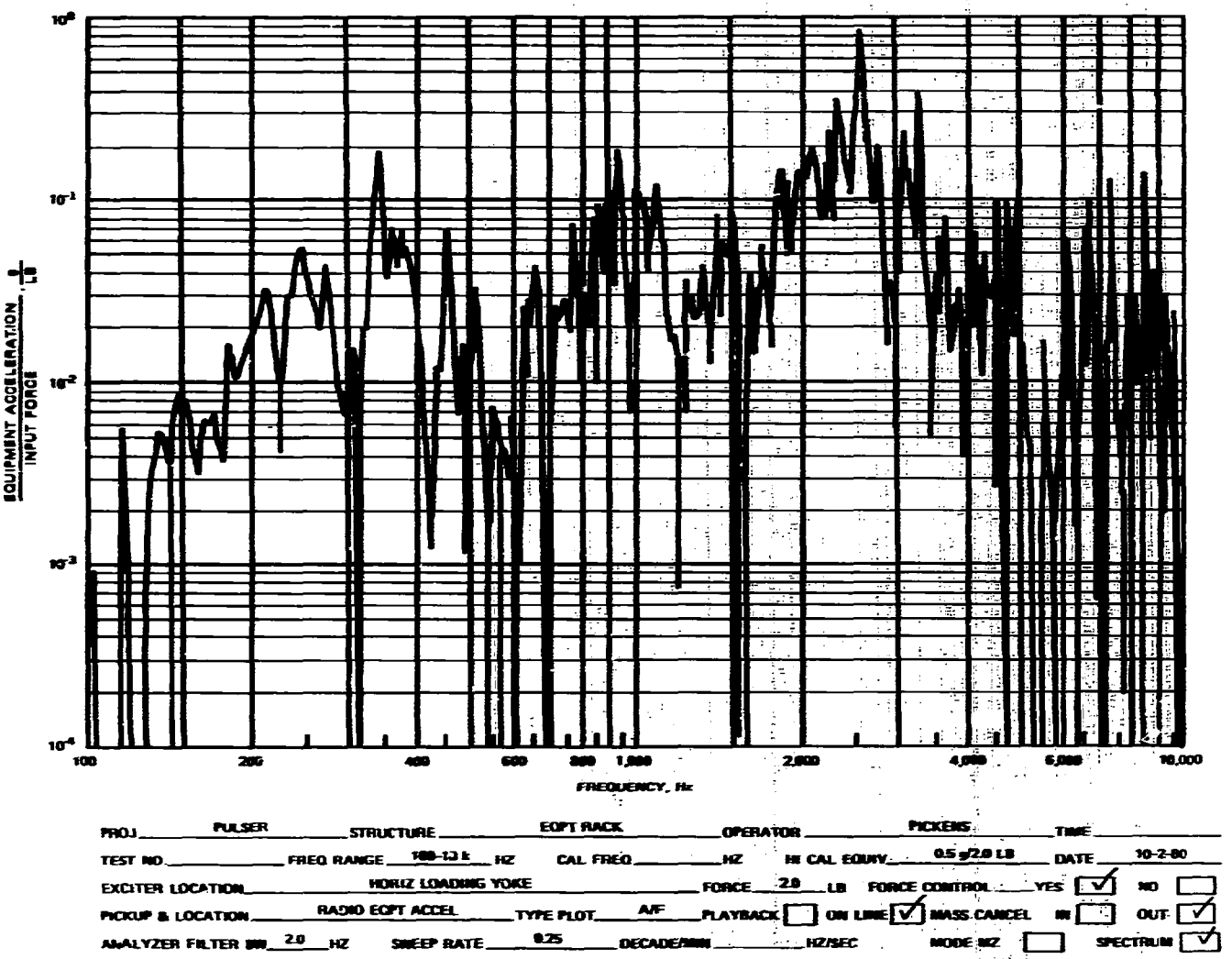


Figure 15. Vibration test data, equipment inertance.

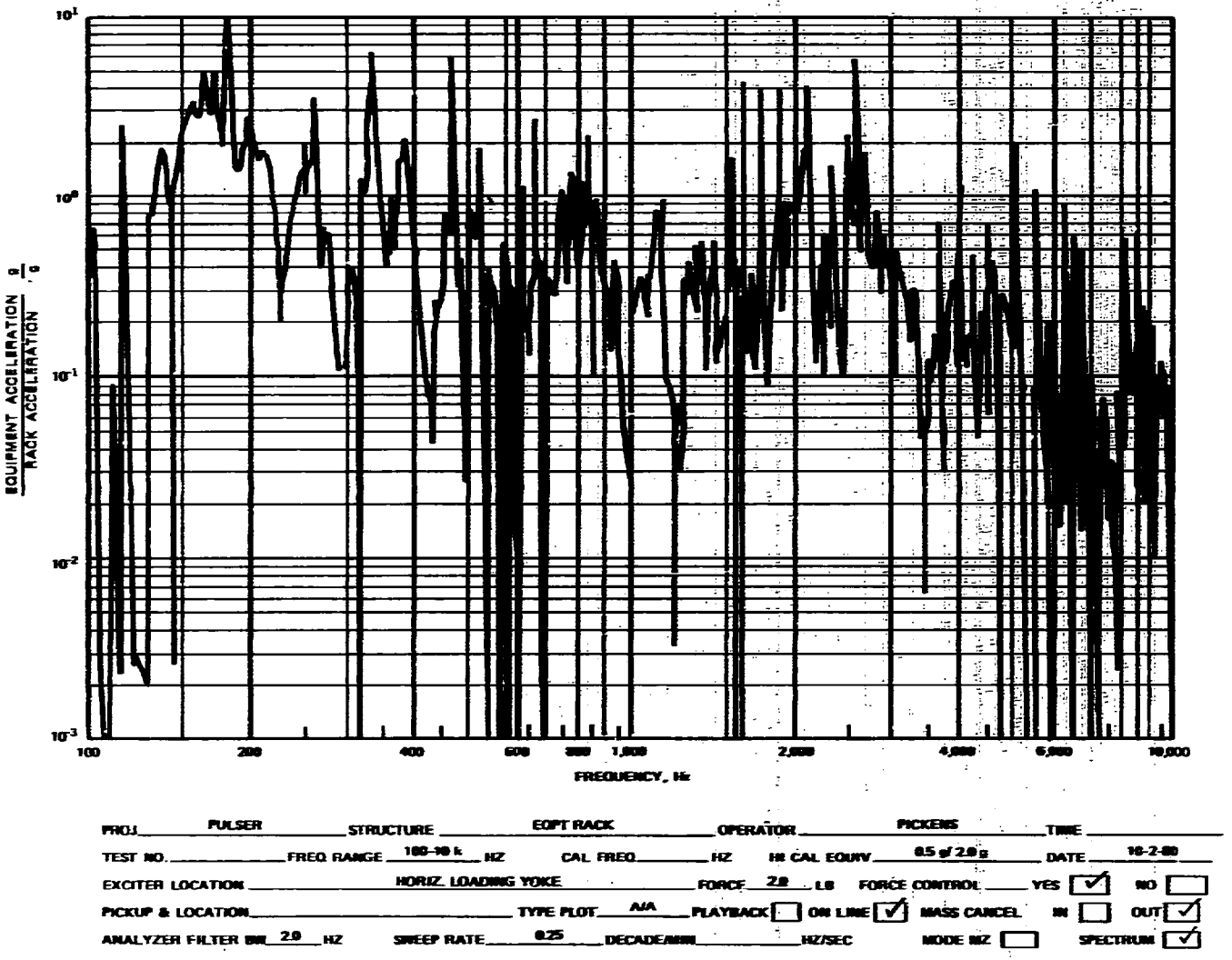


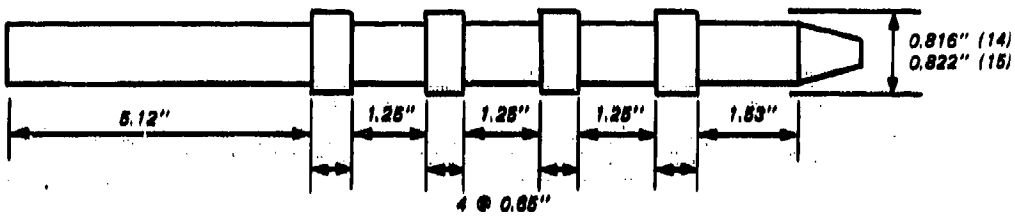
Figure 16. Vibration test data, transmissibility plot.

accelerometers on the rack vertical leg and on the face of the equipment along with the force link. Initial tests were run with the AN/GRC-103 installed, but not on-line, followed by on-line tests of both the AN/GRC-103 and TD660.

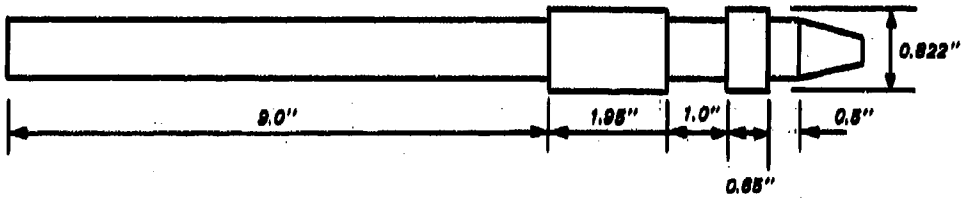
20. Both transmitter and receiver were mounted in the rack using standard mounting angles and screws. Six tests were conducted utilizing different pulse trains (Figure 17) in the horizontal axis. The tests are summarized in Table 3, and data for each test are presented in Appendices A-F. The data were digitized at rates of 20,000 and 10,000 samples per second, thereby limiting the useful frequency ranges to 10 kHz and 5 kHz, respectively (based on conventional digitizing procedures). Data for each test are in the form of time histories, fast Fourier transforms (FFT's), auto correlations, cross correlations, and cross spectral density records. For the data in the frequency domain (at the 10K digitizing rate), both fine and coarse plots were made; i.e., the curves were defined with either 1024 points or 512 points. The coarse data plots simply give gross approximations of the curves, often better for visualization of the data.

21. There was no apparent damage to any of the pieces of equipment during the tests. The off-line tests of equipment were conducted using nonoperational units followed by the tests of operational units. For the operational, on-line tests, the units were turned on several minutes before testing and allowed to operate several minutes after testing. Even though relatively high acceleration levels were measured on the rack (up to 200 g's peak), the equipment suffered no apparent damage. This result led to a closer look at what the measured accelerations actually indicate.

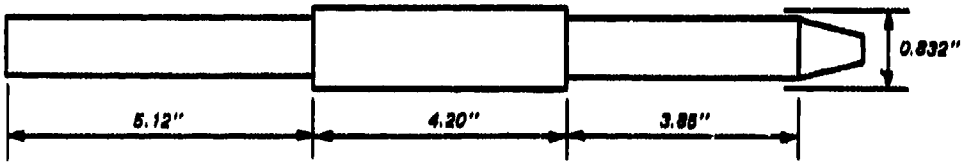
22. The motions measured on the rack and those transmitted to the equipment are highly dependent on the particular pulse train. Maximum utilization of the pulse generator, leading to maximum loading of the equipment, can only be accomplished using specifically designed pulse trains taking into account the dynamic characteristics of the total system being tested. The energy accepted by the equipment is frequency-sensitive, and the frequency content of a particular pulse train cannot



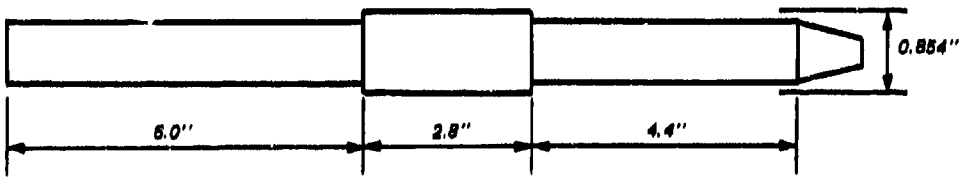
TESTS 14 AND 15



TEST 16



TEST 17



TESTS 18 AND 20

Figure 17. Pulse trains for tests 14-20, rack hard-mounted.

Table 3

Summary of Tests 14-20, Rack Hard-Mounted

Test No.	Average Force (lb)	Rack Acceleration (g) MAX	Rack Acceleration (g) RMS	Rack Acceleration (g) RMS/MAX	Equipment Acceleration (g) MAX	Equipment Acceleration (g) RMS	Equipment Acceleration (g) RMS/MAX	EQPT/RACK RMS	Low-Pass Filter (kHz)	Notes
14	1100	516	111	0.23	88	20	0.23	0.18	10	AN/GRC-103, off-line
	1000	116	38	0.24	69	18	0.26	0.47	5	
15	1400	428	68	0.16	165	26	0.16	0.38	10	
	1400	232	38	0.16	109	20	0.18	0.52	5	
16	1500	477	81	0.17	130	24	0.18	0.30	10	
	1400	175	28	0.16	86	15	0.17	0.54	5	
17	2400	968	176	0.18	208	48	0.23	0.27	10	
	2200	202	47	0.23	152	42	0.28	0.89	5	
18	4000	2029	257	0.13	167	32	0.19	0.12	10	AN/GRC-103, on-line
	4000	772	114	0.15	85	22	0.26	0.19	5	
20	4000	1750	302	0.17	148	3	0.20	0.10	10	TD660, on-line
	4000	800	194	0.24	88	22	0.25	0.12	5	

be predetermined without a detailed analysis. However, the general pulse trains used in these initial tests were quite useful in determining how the equipment responds to motions input to the rack.

23. The accelerations measured on both the rack and the equipment contain sharp, high-frequency peaks. The 10-kHz filtered data contain rack acceleration peaks of up to 4.8 times those of the 5-kHz limited digitized records (Test 17, Table 3). For Test 15, the 10-kHz rack peak accelerations were only 1.8 times those of the 5-kHz records. However, the pulse trains of Tests 15 and 17 are significantly different. Perhaps more important than peak response is the RMS value of measured acceleration. The 5-kHz RMS acceleration response of the equipment in Test 17 is nearly equivalent to that of the rack (42 g's versus 47 g's). For this pulse train, then, the transmissibility of energy from rack to equipment was quite high (89 percent). However, in Test 20, the RMS equipment response was only 22 g's compared to rack RMS response of 194 g's, giving a transmissibility of only 12 percent. The ratios of equipment RMS response to rack RMS response are shown in Table 3 for each test. It is of interest to note that although the pulse trains of Tests 20 and 17 are quite similar (except for depth of cut; i.e., nubbin diameter), these two tests represent the extremes of equipment-to-rack response ratios (0.89 for Test 17 and 0.12 for Test 20). Upon comparison of the FFT's for the force input for each test (plot No. 90, Appendix D, for Test 17 and plot No. 98, Appendix F, for Test 20), it is seen that the primary frequency content is 2880 Hz for Test 17 and 2620 Hz for Test 20. This relatively small difference in frequency content of input force can significantly change the transmissibility ratio of equipment-to-rack response. This is quite apparent when considering the transmissibility plot of Figure 16 from the vibration tests. Extremely large differences in the ratio, on the order of 1000 to 1, exist for only minute changes in frequency. This is simply the nature of the rack-equipment system. It is a high Q, lightly damped, ringing type of structure having numerous resonances. It must also be kept in mind that the vibration tests were conducted using a 2-lbf input and the resonances and anti-resonances for both rack and radio could change significantly for a

force input of several thousand pounds due to nonlinearity in the system.

24. Consider the force input FFT for Tests 14-20. With the exception of Tests 14 and 15, there is a predominant peak occurring in the 2500- to 3000-Hz region, indicating that most of the input force is at this frequency. This harmonic motion can also be seen on the auto correlation functions of the force inputs. This motion is due to chatter in the pulse generator as the cutter plows through a nubbin. The chatter is also apparent in the cut nubbin as the cut surface contains ripples rather than being smooth. The deeper and longer the cut, the greater the amount of chatter. During the calibration tests, a different cutter geometry was tried in an effort to reduce this chatter. However, the new cutter, which utilized a rake angle, did not reduce chatter; it actually increased it somewhat. The pulse train used in Tests 14 and 15 contained several short nubbins, as opposed to a single longer nubbin, and the chatter is not as severe. This fact is reflected in the FFT's of the input force for these tests, which do not exhibit the large spike in the 2500- to 3000-Hz region.

TESTS OF SOFT-MOUNTED EQUIPMENT

25. In an effort to introduce higher accelerations into the equipment at lower frequencies, the equipment rack mounting configuration was changed. For all previous tests, the rack was secured directly to the concrete floor with four anchor bolts and tied to the reaction structure with a steel angle and bolts. This type mounting arrangement was considered to be a "hard mount." The "soft-mount" arrangement, shown schematically in Figure 18 and in the photographs, Figures 19-21, consisted of using Firestone Airmount Isolators (air bags) for all horizontal support. The floor anchor bolts were removed as was the horizontal steel angle positioned at the top of the rack. The rack was attached to four air bags (two at the top and two at the bottom) as shown in Figures 18-21. The air bags used, Firestone Airmount No. 125, have a natural frequency of 160 Hz and will deflect approximately 3 in. before bottoming out. Tests were conducted with the bags pressurized at values ranging from 30 to 70 psi. Having an effective area of 11.5 in.^{2} each, or 46 in.^{2} total, the four bags could resist a load of up to 1380 lb with each bag

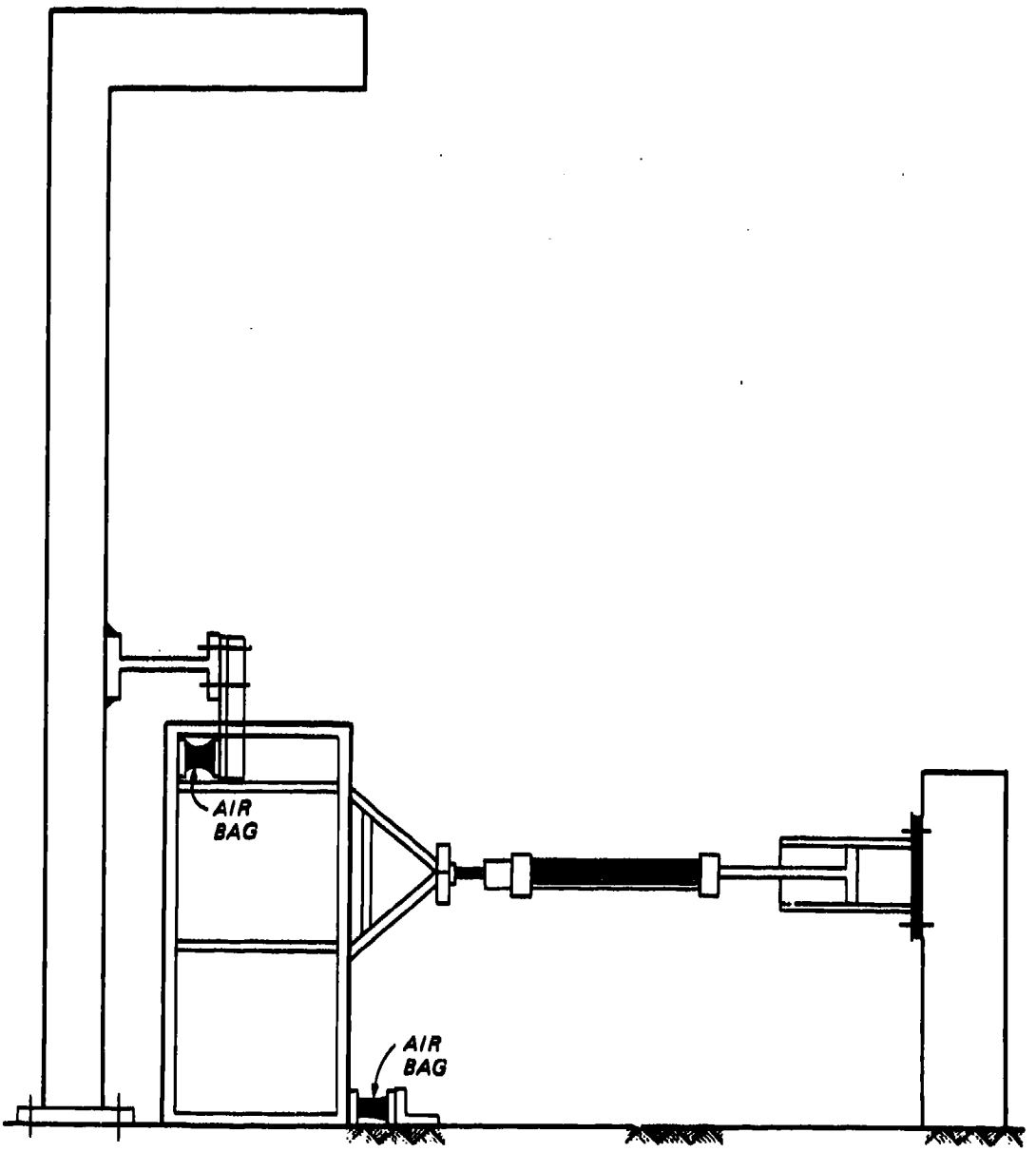


Figure 18. Schematic of soft-mount test setup.

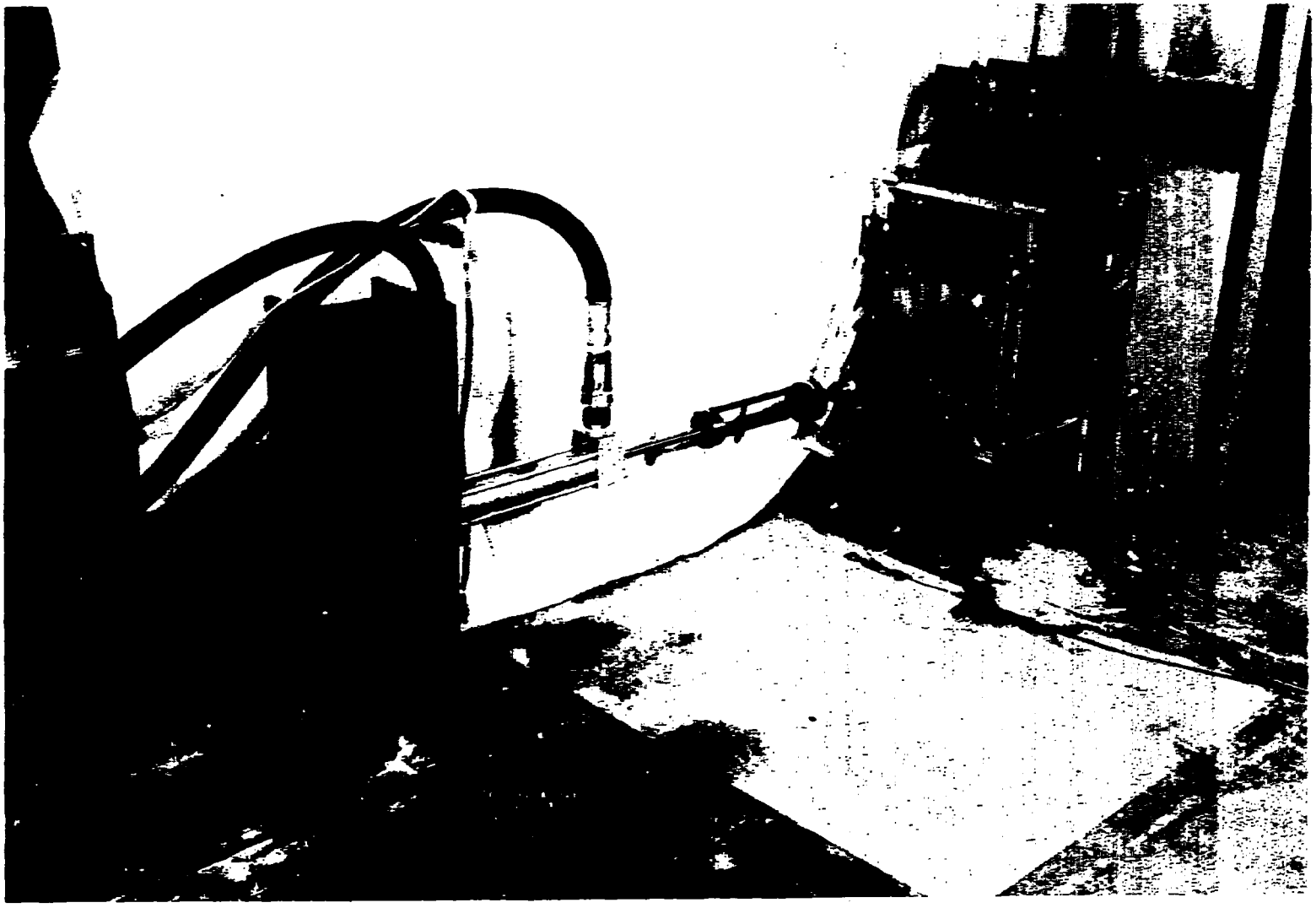


Figure 19. Test setup with rack soft-mounted (view A).

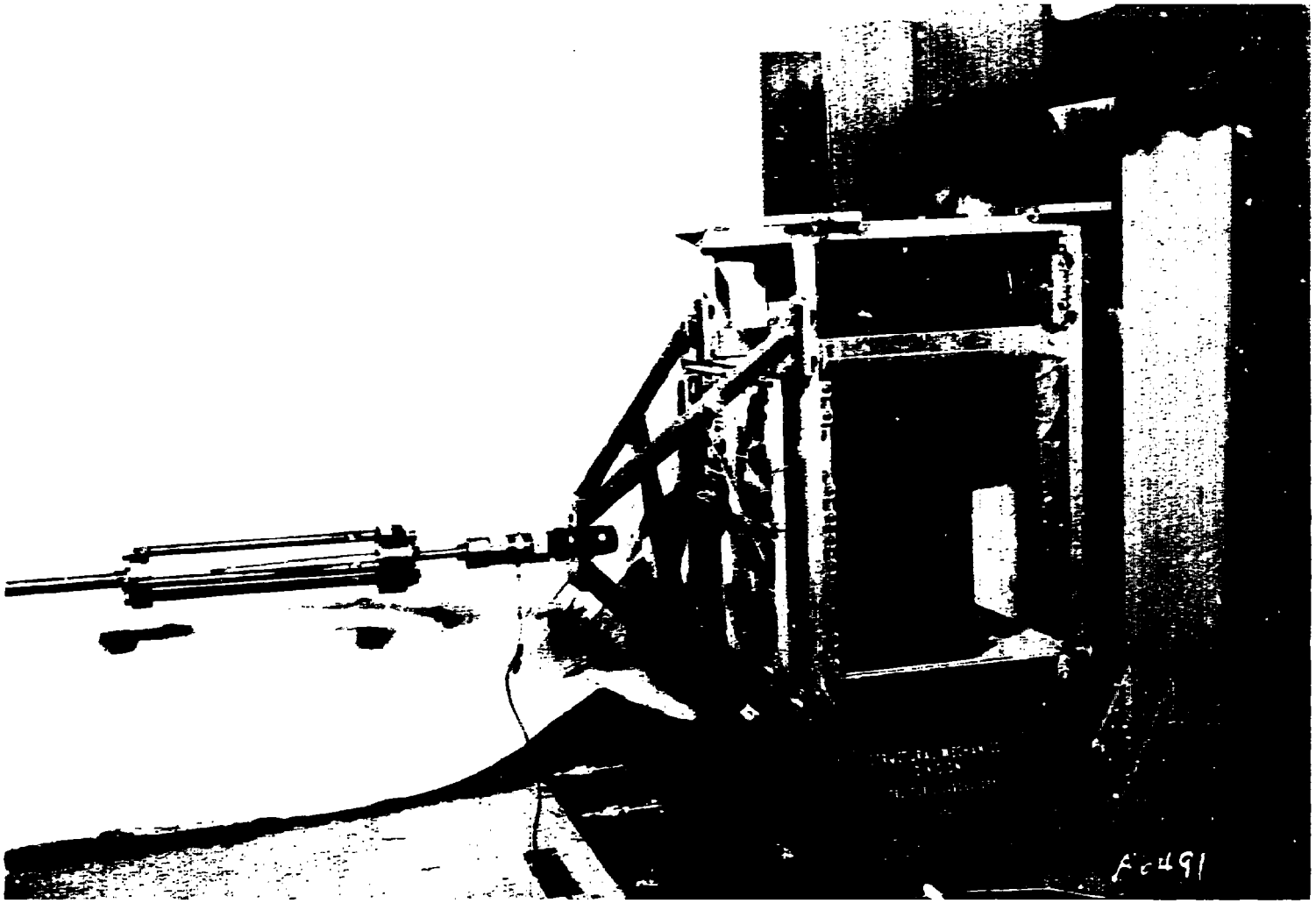


Figure 20. Test setup with rack soft-mounted (view B).

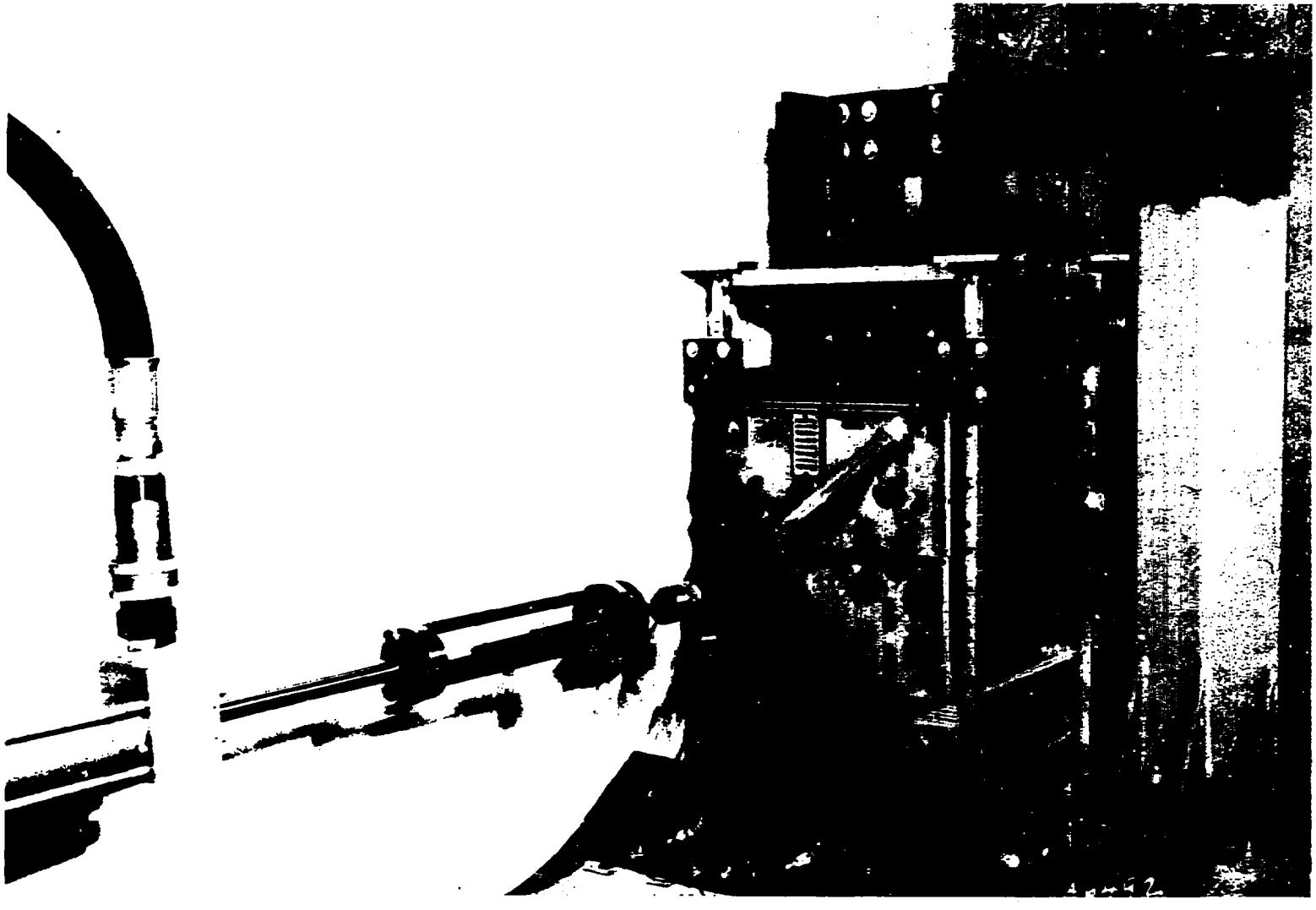
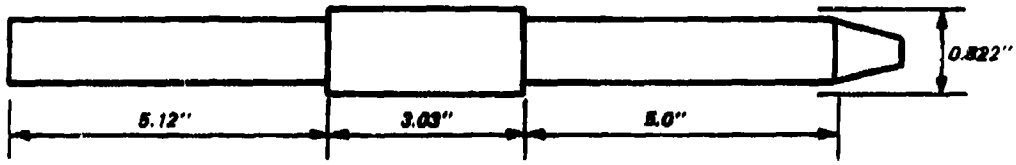


Figure 21. Test setup with rack soft-mounted (view C).

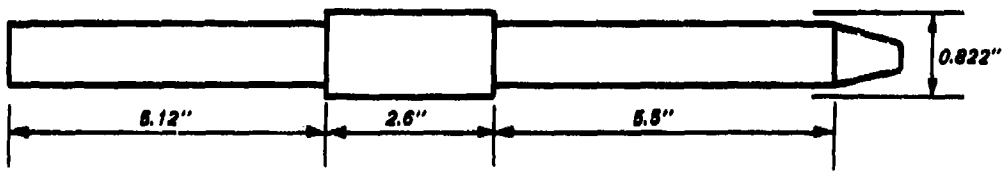
pressurized at 30 psi and up to 3220 lb at 70 psi (net area × pressure).

26. A nonoperational AN/GRC-103 transmitter and receiver was placed in the rack and the system was instrumented as in the previous tests; i.e. a force link, an accelerometer on the rack vertical leg, and an accelerometer on the equipment face plate. Five tests were run using the pulse trains shown in Figure 22. The data are summarized in Table 4 and presented in graphical form in Appendices G-K.

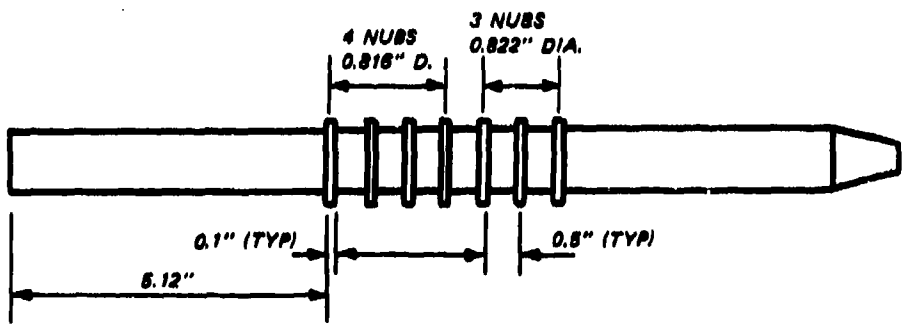
27. In general, the RMS value of the rack accelerations was 9 to 20 percent that of the peak acceleration, whereas, for the equipment, the RMS value ranged from 14 to 40 percent that of the peak. Playbacks of the time histories, FFT's, and cross spectral density records using low-pass filters of 10, 5, 3.5, 2.5, 1.5, and 0.5 kHz are given in the appendices. Such filtered plots offer a better picture of the frequency-dependent equipment motion. For the five tests conducted, the RMS value of the 500-Hz filtered equipment acceleration ranged from 25 percent to 50 percent that of the 10-kHz filtered RMS values. The ratio of equipment-to-rack RMS accelerations varied from 0.08 to 0.16 (considering only 5- and 10-kHz filtered data). For the hard-mounted tests, this same ratio ranged from 0.10 to 0.89. Thus, in general, more energy was transmitted from the rack to the equipment in the hard-mounted tests than in the soft-mounted tests. Displacements for the soft-mounted tests were substantially larger, however, as the rack was observed to move approximately 2 in. For the hard-mounted tests, displacements were on the order of 0.1 in.



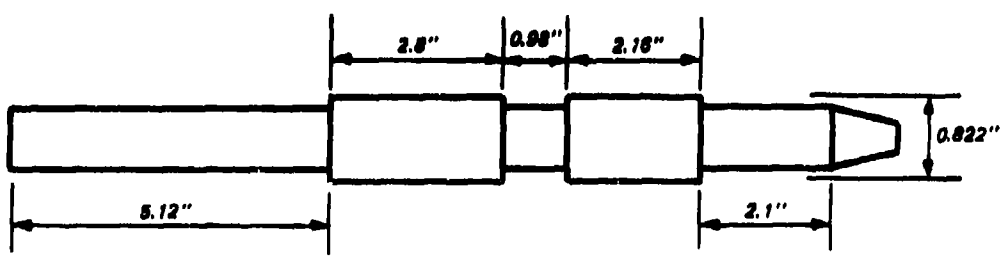
TESTS 21 AND 22



TEST 23



TEST 24



TEST 25

Figure 22. Pulse trains for Tests 21-25, rack soft-mounted.

Table 4

Summary of Tests 21-25, Rack Soft-Mounted on Air Bags

Test No.	Average Force (lb)	Rack Acceleration (g)			Equipment Acceleration, (g)			$\frac{\text{EQPT}}{\text{RACK}}$ RMS	Low-Pass Filter (kHz)
		MAX	RMS	$\frac{\text{RMS}}{\text{MAX}}$	MAX	RMS	$\frac{\text{RMS}}{\text{MAX}}$		
21	900	1244	233	0.19	84	19	0.23	0.08	10
		1145	252	0.22	70	19	0.27	0.08	5
		1400	227	0.16	70	18	0.26	0.08	3.5
		1150	203	0.18	55	15	0.27	0.07	2.5
		900	177	0.20	30	9	0.30	0.05	1.5
		680	138	0.20	25	8	0.32	0.06	0.5
22	1000	1302	203	0.16	63	16	0.25	0.08	10
		1160	210	0.18	50	16	0.32	0.08	5
		1300	192	0.15	70	15	0.21	0.08	3.5
		1100	169	0.15	30	11	0.37	0.06	2.5
		930	142	0.15	22	8	0.36	0.06	1.5
		600	102	0.18	20	8	0.40	0.08	0.5
23	1000	1252	134	0.11	98	19	0.19	0.14	10
		1100	142	0.13	90	19	0.21	0.13	5
		700	120	0.17	70	17	0.24	0.14	3.5
		650	93	0.14	38	12	0.32	0.13	2.5
		350	65	0.19	22	8	0.36	0.12	1.5
		130	31	0.24	21	8	0.38	0.26	0.5
24	1500	1221	155	0.13	99	14	0.14	0.12	10
		1200	163	0.14	80	14	0.18	0.09	5
		1500	132	0.09	70	12	0.17	0.09	3.5
		1226	107	0.09	40	8	0.20	0.07	2.5
		850	84	0.10	25	7	0.28	0.08	1.5
		320	54	0.17	15	5	0.33	0.09	0.5
25	1100	1238	184	0.15	152	29	0.19	0.16	10
		1174	191	0.16	130	28	0.22	0.15	5
		1150	160	0.14	130	27	0.21	0.17	3.5
		900	120	0.13	80	16	0.20	0.13	2.5
		700	93	0.13	22	8	0.36	0.08	1.5
		350	57	0.16	20	7	0.35	0.12	0.5

PART IV: CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

28. The effort to date has been successful. A unique test device has been developed and has been shown to be an effective means for subjecting communication equipment to acceleration levels that might be encountered in a battlefield condition. Based on results of tests thus far conducted, the following conclusions are drawn:

a. A biaxial force-pulse generating device (pulser) has been developed which has a force output capacity of approximately 10,000 lb.

b. The pulser can be controlled to initiate simultaneous force pulses in both horizontal and vertical axes.

c. Up to 2000-g-peak and 300-g-RMS acceleration levels have been induced in the equipment rack with up to 200 g's peak and 48 g's RMS being transmitted to the equipment in the rack.

d. The AN/GRC-103 and TD660 communication equipment sustained no damage while being operated on-line during force-pulse tests which produced 300 g's peak (32 g's RMS) in the equipment.

e. For the pulse trains thus far used in the test program, acceleration levels measured on the equipment were 10 to 89 percent (average of 34 percent) of those measured on the rack with the rack hard-mounted and 8 to 16 percent with the rack soft-mounted on air bags (considering 5-kHz low-pass filtered data).

f. The present cutter being used in the pulser produces a certain amount of tool chatter as the aluminum nubbins are cut. This chatter results in a high concentration of force in the 2500- to 3000-Hz region. For cuts without the chatter, the force input is more broadbanded without large concentrations of energy at particular frequencies.

RECOMMENDATIONS

29. For a successful program of testing communication equipment with the force-pulse generator, the following recommendations are offered:

a. Specific pulse trains should be designed utilizing the dynamic characteristics of the equipment and equipment-rack system.

Furthermore, the dynamic characteristics should be obtained from high-level excitation such as an actual force-pulse test.

b. Additional development work should be done in an effort to reduce tool chatter. Areas to consider include cutter shape, depth of cut, and nubbin material. Perhaps a softer material, such as nylon, Teflon, Micarta, etc., using greater depths of cuts with the existing cutter would produce acceptable force levels with reduced chatter.

c. A realistic acceleration standard, to which the communication equipment could be subjected in a laboratory test environment, should be developed. Once this standard is known, a pulse train should be designed which will result in equipment response matching the standard.

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1. Agbabian Associates. 1979 (Dec). "Biaxial Transient Vibration Simulation for C^3 Equipment to Match Field Test Records-Tests Plan," Report R-8014-4994, El Segundo, Calif.

2. US Army Engineer Waterways Experiment Station and Agbabian Associates. 1980 (Oct). "Biaxial Transient Vibration Simulation for C^3 Equipment-Pulse Train Calibration," Report R-8014-5136, El Segundo, Calif.

3. Industrial Publishing Co. 1972/73. Fluid Power Handbook and Directory, Cleveland, Ohio.

APPENDIX A: TEST 14 DATA

TEST 14
Equipment Rack Hard-Mounted
AN/GRC-103 in Rack, Off-Line

Plot Heading Nomenclature (Tests 14-20)

CHAN 1 - Input force (data at 20,000 digitizing rate)

CHAN 2 - Rack acceleration (data at 20,000 rate)
- Input force (data at 10,000 rate)

CHAN 3 - Equipment acceleration (data at 20,000 rate)
- Rack acceleration (data at 10,000 rate)

CHAN 4 - Equipment acceleration (data at 10,000 rate)

RMS, AVG, MAX, XMAX, XMIN, MEAN - RMS, average, maximum, minimum and mean values of data plots

FREQ - Frequency at which maximum value occurs

FFT 0.0 - Fast Fourier transform of time history

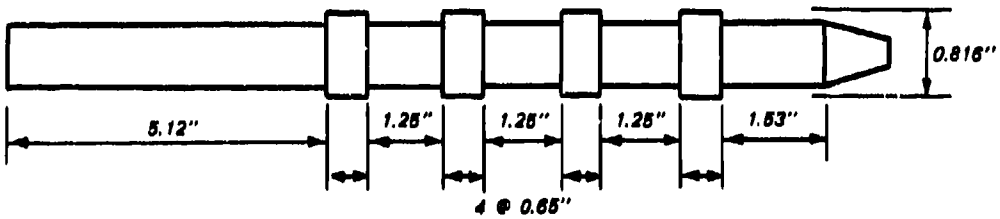
TIME 0.0 - Time history record

CSDF 0.0 - Cross spectral density function

CH/2 1.0
CH/2 2.0
CH/2 3.0
Channel number of the second channel for plots involving two-channel functions (CSDF)

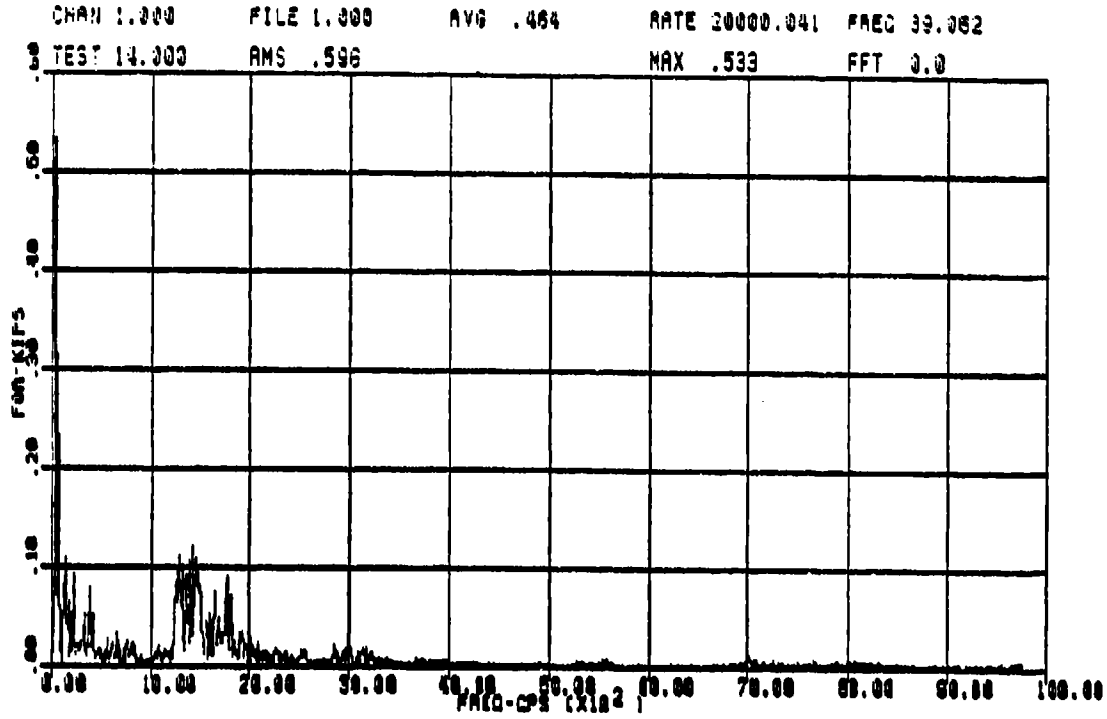
POINTS - Number of points used for plotting the record

RATE - Digitizing rate, samples per second



PULSE TRAIN - TEST 14

PRECHARGE PRESSURE - 1250 PSI
SYSTEM PRESSURE - 2000 PSI
FLOW CONTROL #6¼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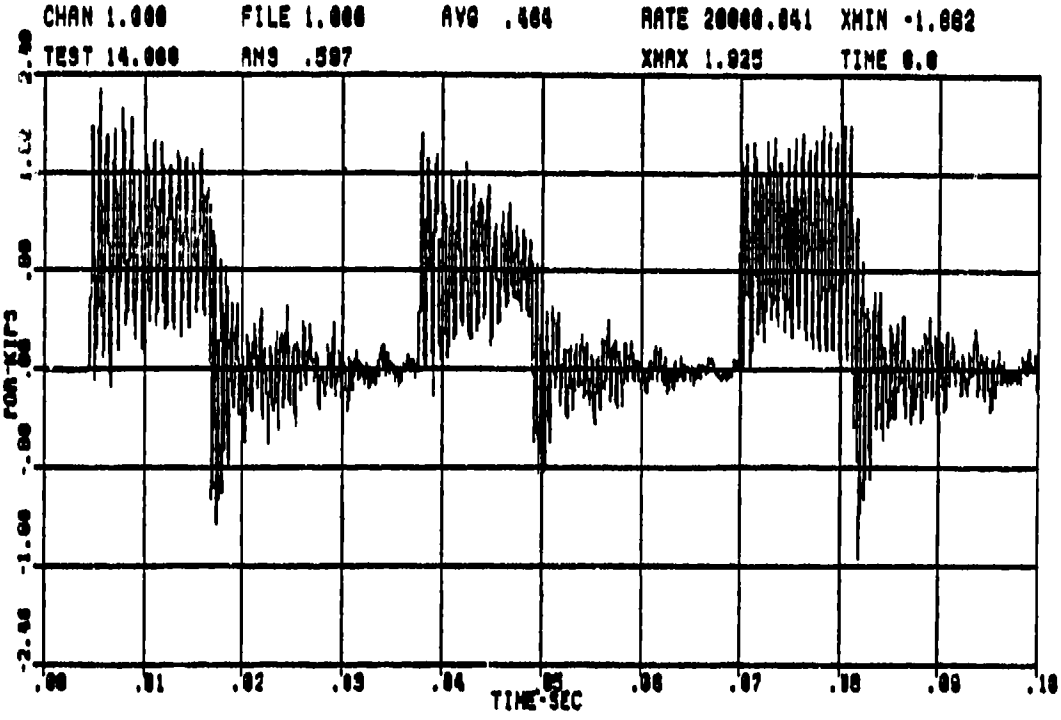
FILE 1.000
AVG .464
RATE 20000.041
FREQ 39.062
TEST 14.000
RMS .596
MAX .533
FFT 0.0
FOR-KIPS
0.00
10.00
20.00
30.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)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FILE 1.000
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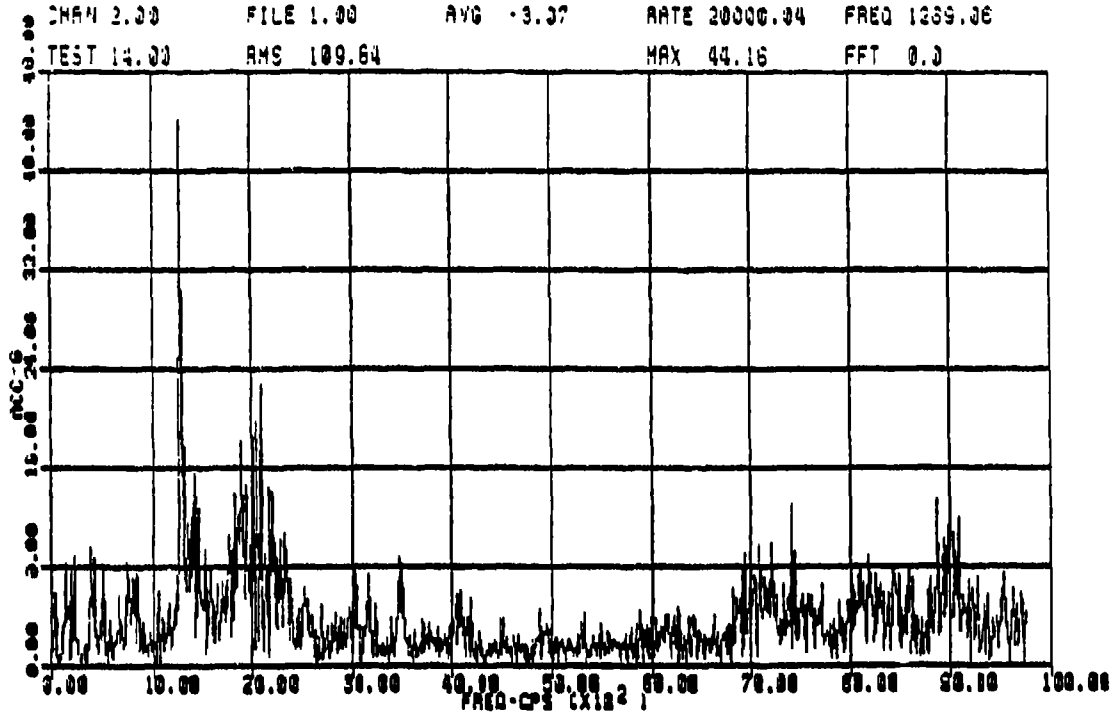
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC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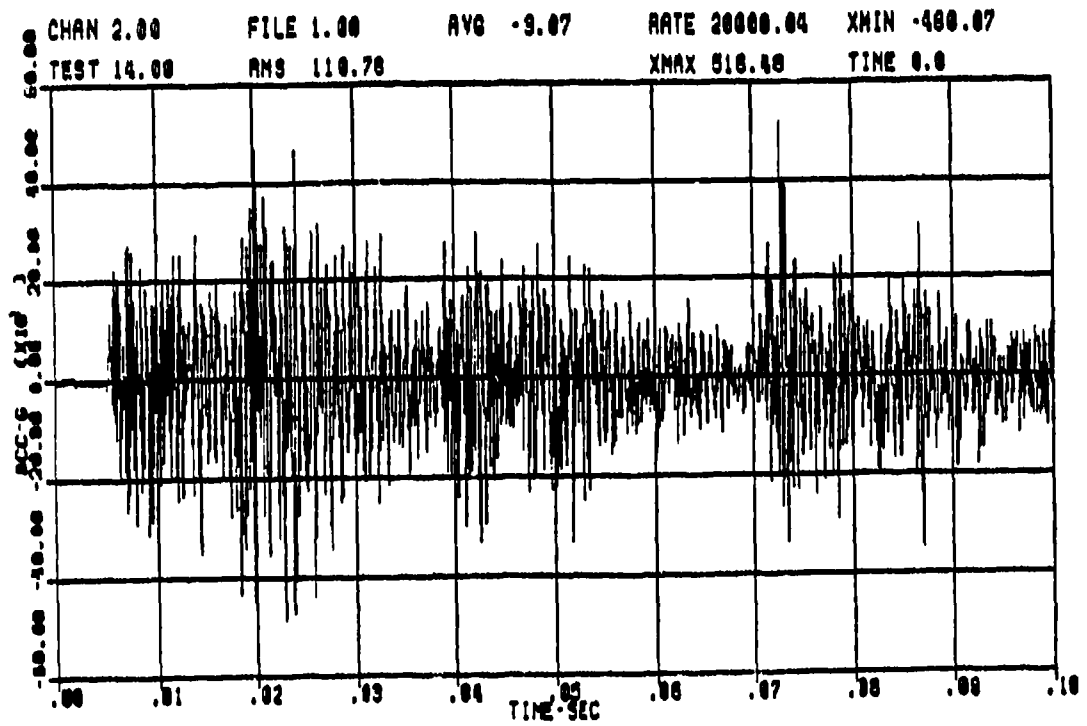
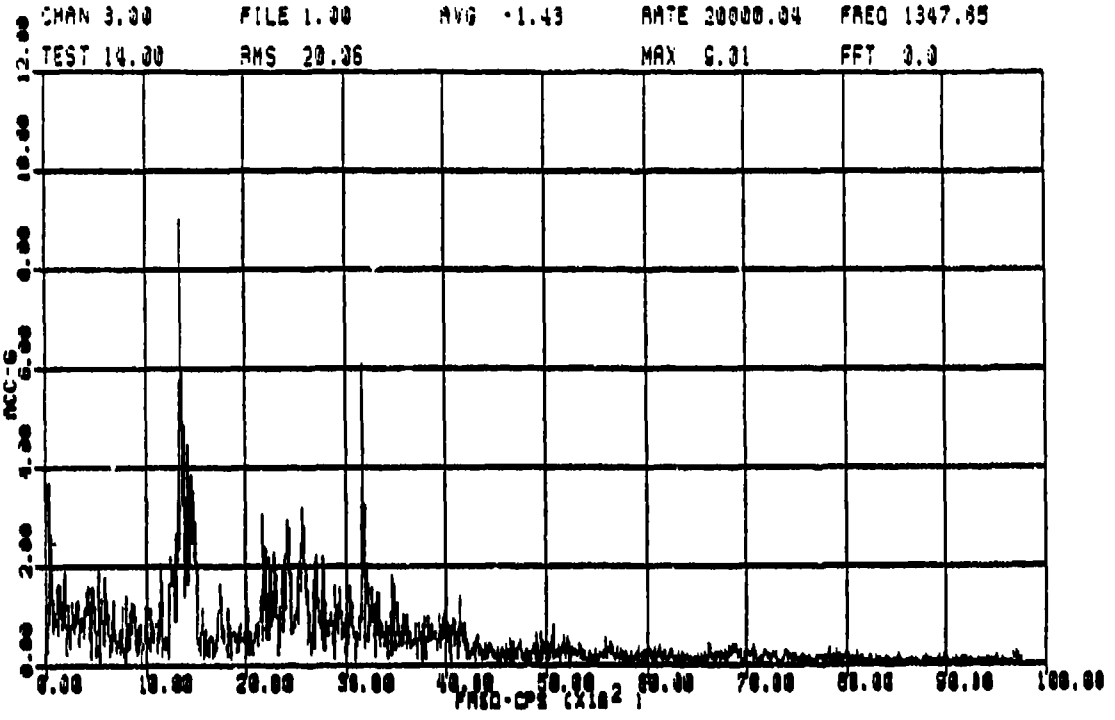
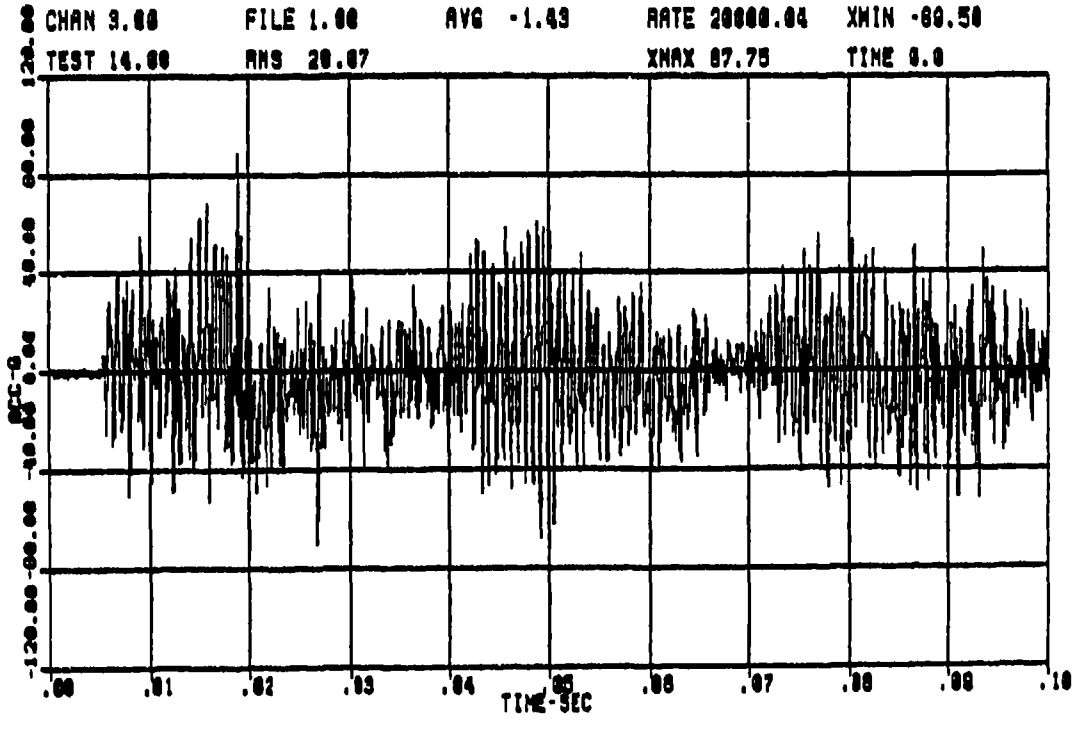
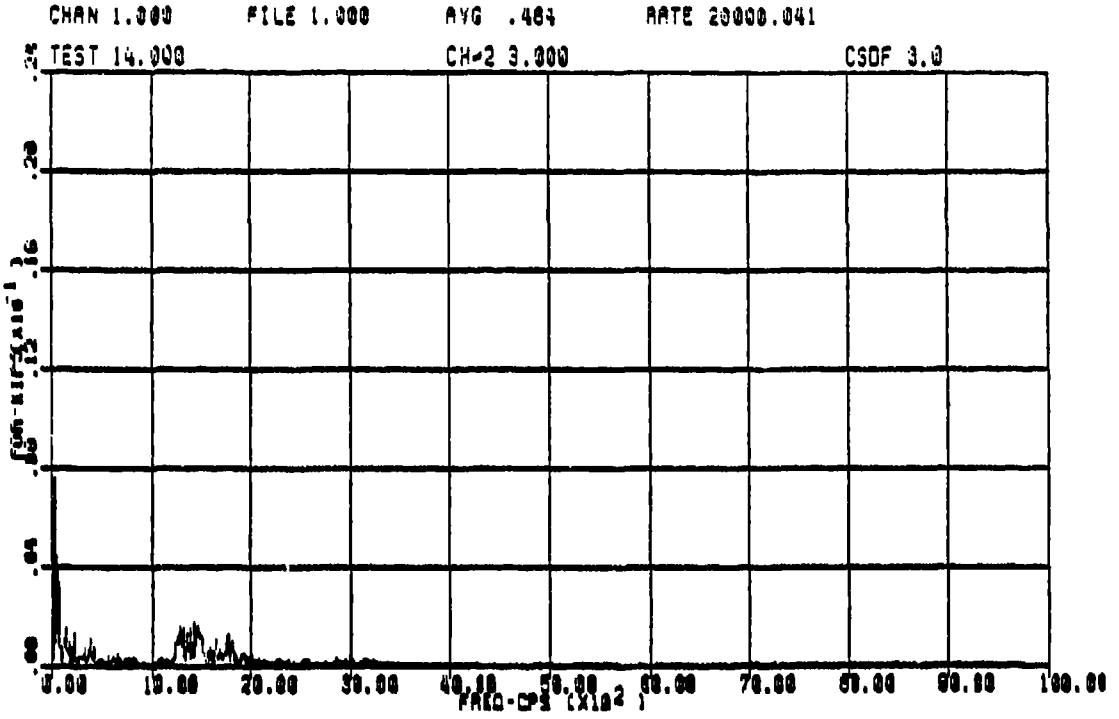
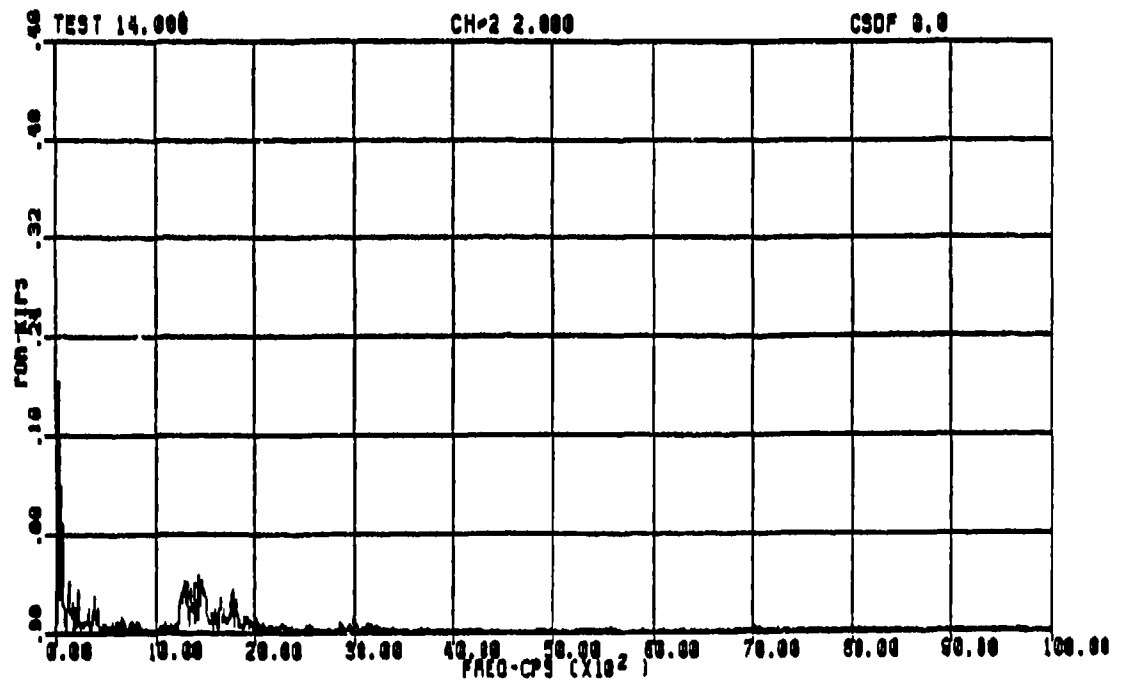
TEST 14.00
RMS 109.64
MAX 44.16
FFT 0.0
ACC-G
FREQ-CPS (X10^2)

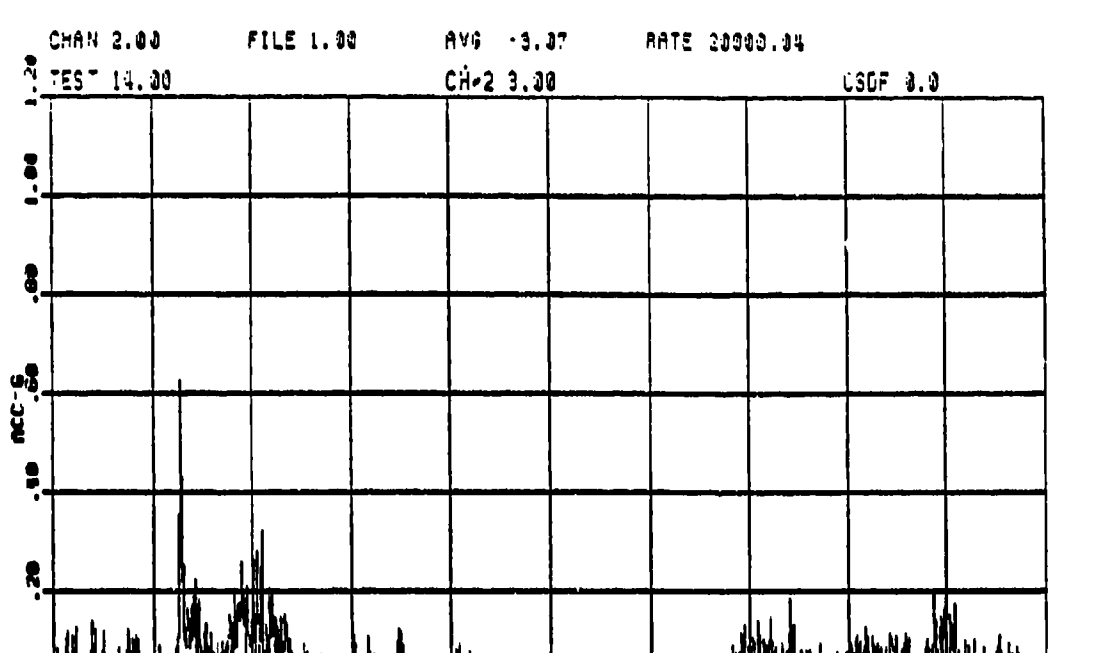

CHAN 2.00
FILE 1.00
AVG -9.07
RATE 20000.04
XMIN -400.07
TEST 14.00
RMS 110.78
XMAX 516.48
TIME 0.0
ACC-G
TIME-SEC

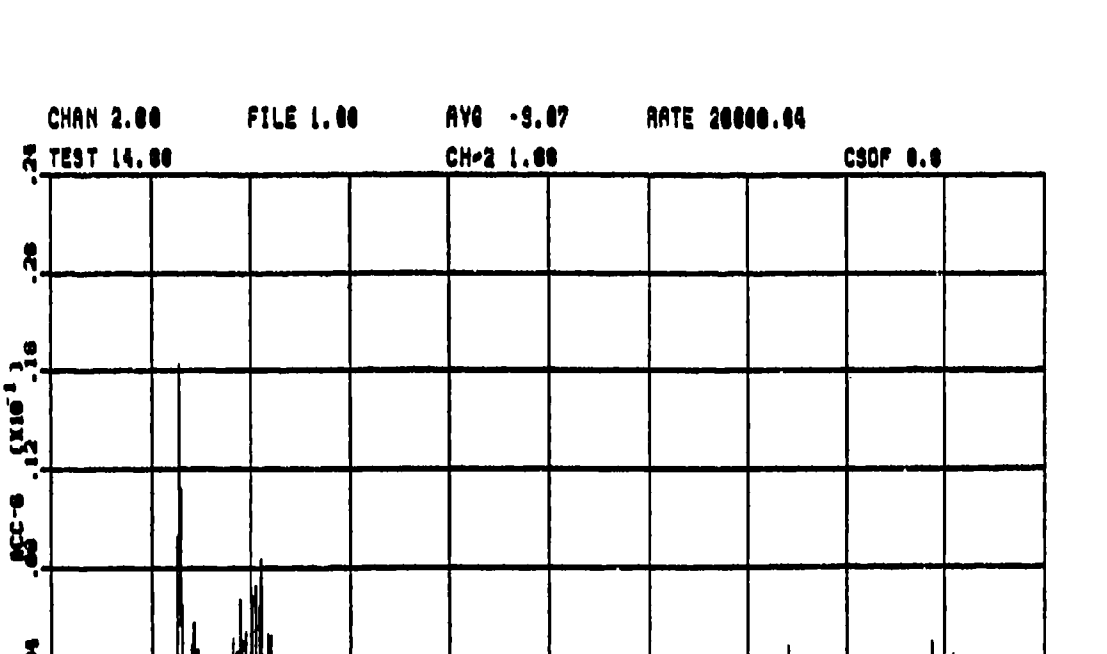

CHAN 3.00
FILE 1.00
AVG -1.43
RATE 20000.04
FREQ 1347.85
TEST 14.00
RMS 20.36
MAX 6.31
FFT 0.0
ACC-G
FREQ-CPS (X10^2)

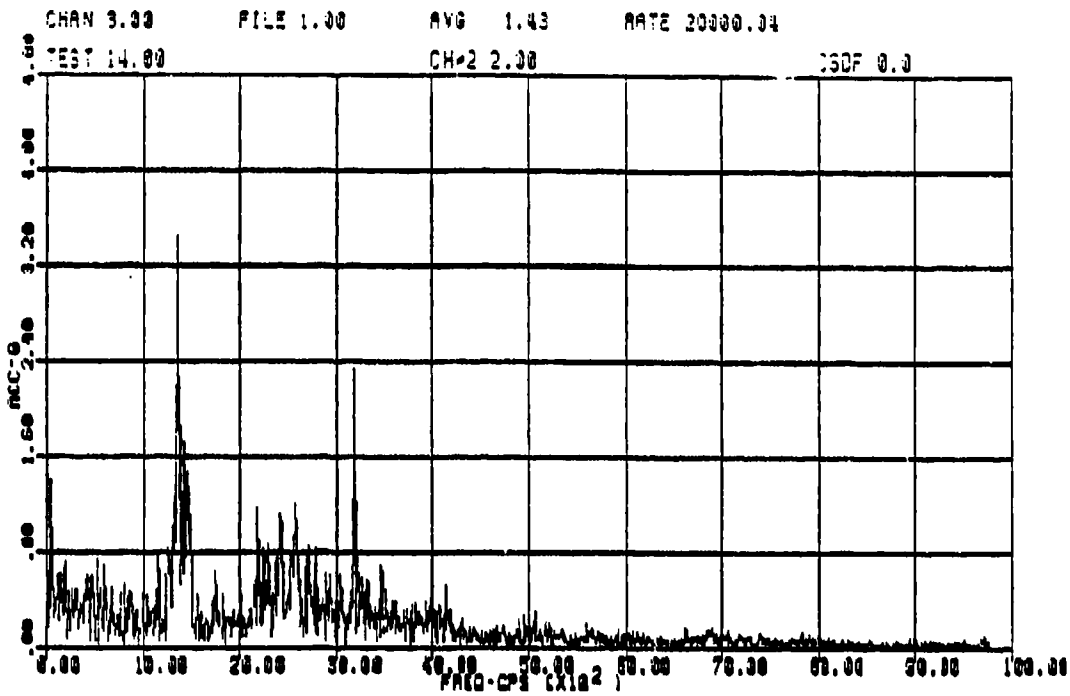

CHAN 3.00
FILE 1.00
AVG -1.43
RATE 20000.04
XMIN -60.50
TEST 14.00
RMS 20.07
XMAX 87.75
TIME 0.0
ACC-G
TIME-SEC

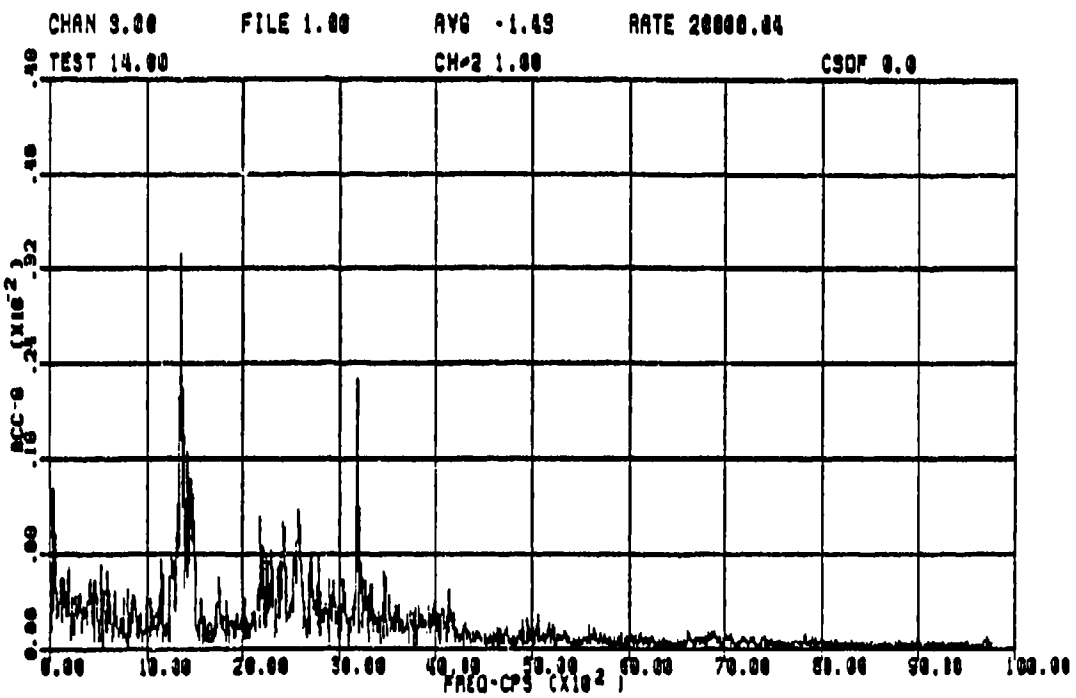

CHAN 1.000
FILE 1.000
AVG .484
RATE 20000.041
TEST 14.000
CH-2 3.000
CSDF 3.0
FREQ-CPS (X10^2)

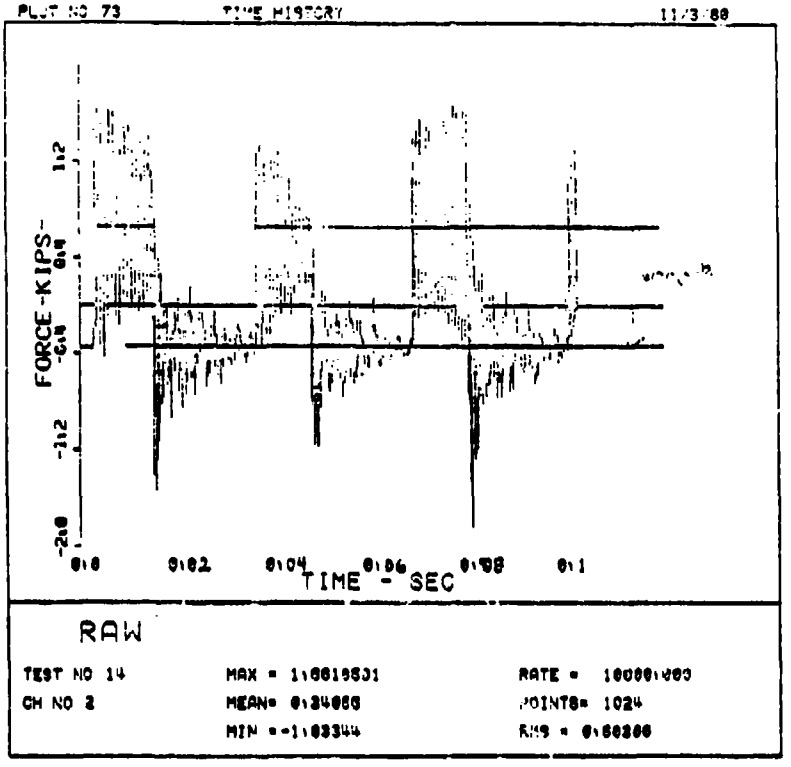

CHAN 1.000
FILE 1.000
AVG .484
RATE 20000.041
TEST 14.000
CH-2 2.000
CSDF 0.0
FREQ-CPS (X10^2)

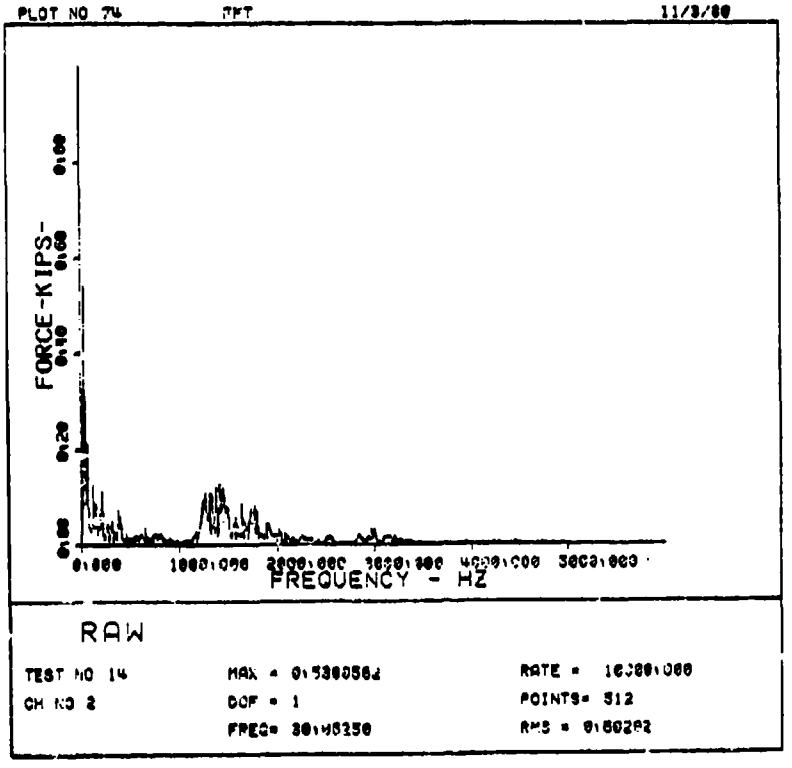

CHAN 2.00
FILE 1.00
AVG -3.07
RATE 20000.04
TEST 14.00
CH-2 3.00
CSOF 0.0
ACC-G
FREQ-CPS (X10^2)

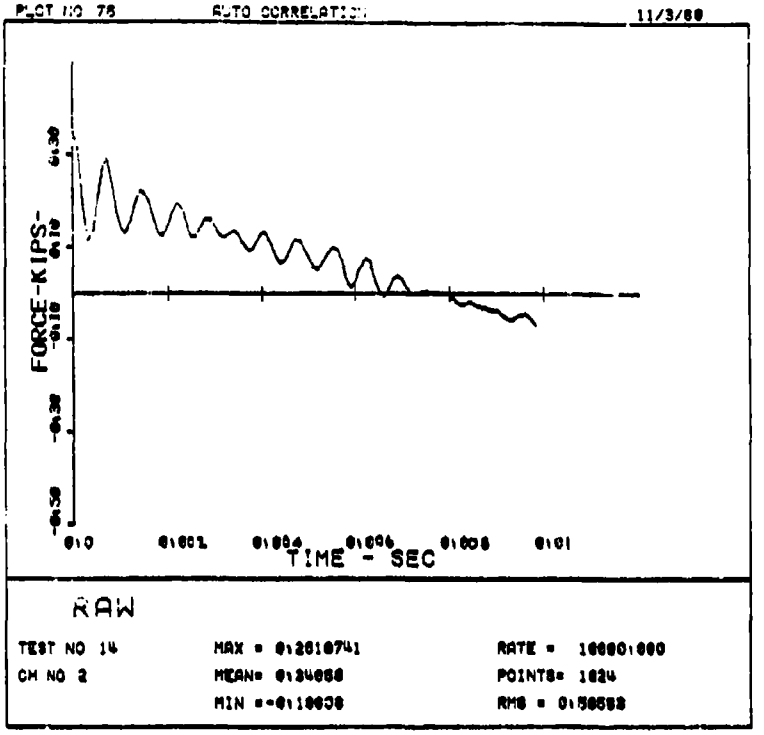

CHAN 2.00
FILE 1.00
AVG -3.07
RATE 20000.04
TEST 14.00
CH-2 1.00
CSOF 0.0
ACC-G (X10^-1)
FREQ-CPS (X10^2)

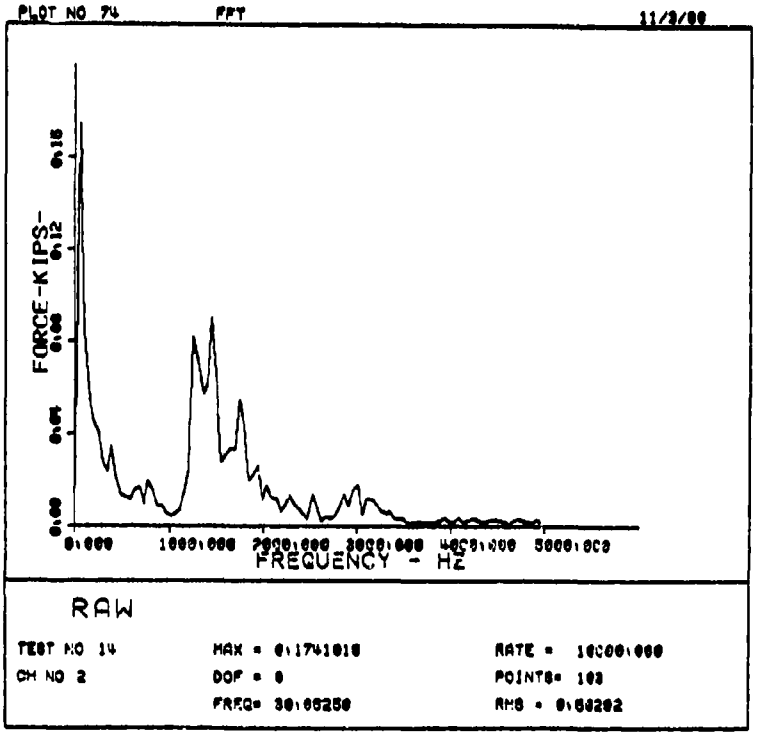

CHAN 3.00
FILE 1.00
AVG 1.43
RATE 20000.04
TEST 14.00
CH#2 2.00
CSOF 0.0
ACC-G
FREQ-CPS (X10^2)

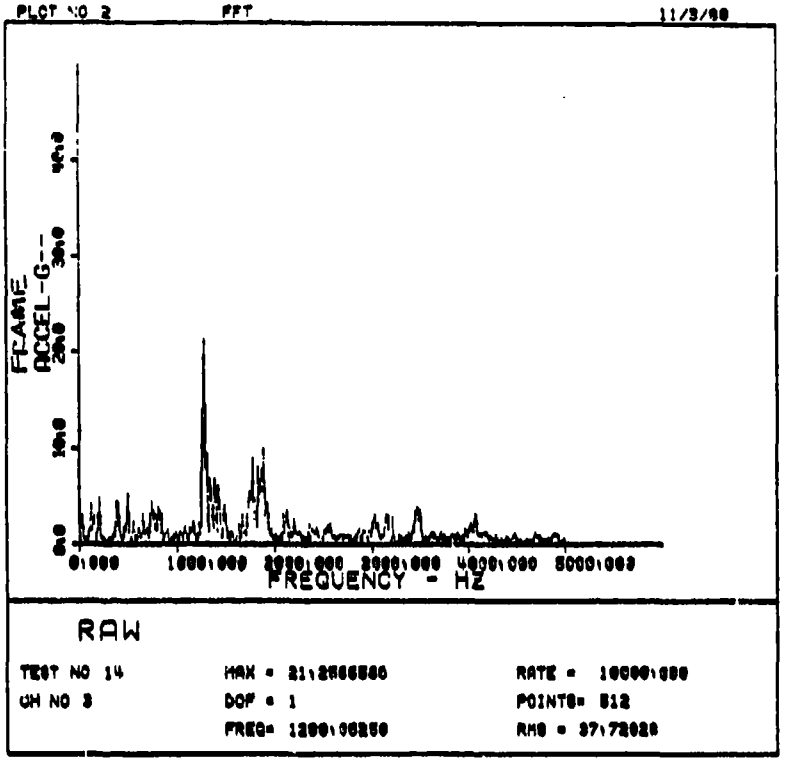

CHAN 3.00
FILE 1.00
AVG 1.43
RATE 20000.04
TEST 14.00
CH#2 1.00
CSOF 0.0
ACC-G (X10^-2)
FREQ-CPS (X10^2)

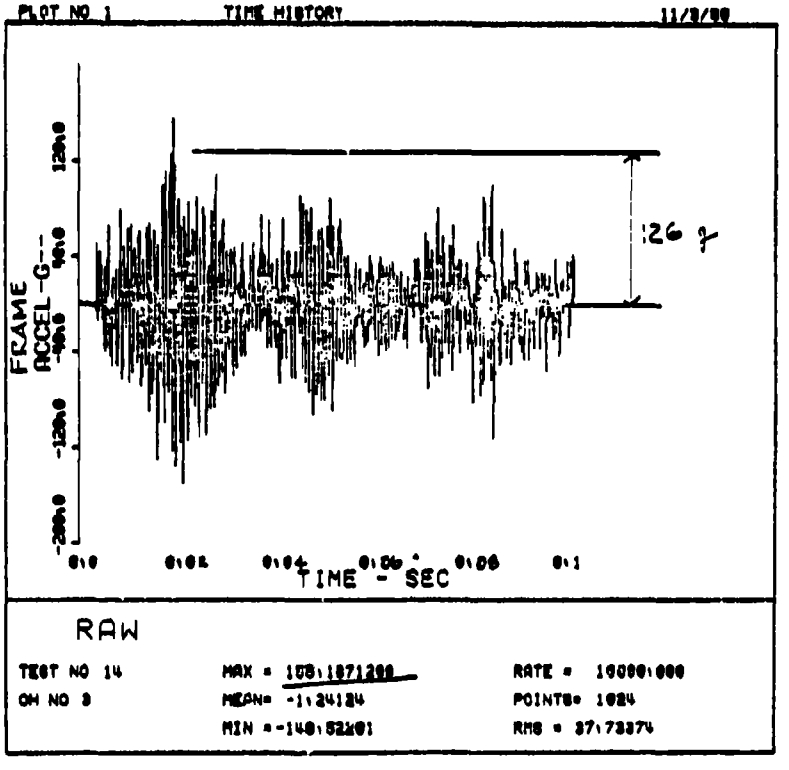

PLOT NO 73
TIME HISTORY
11/3/80
FORCE-KIPS-
TIME - SEC
RAW
TEST NO 14
CH NO 2
MAX = 1.6619531
MEAN= 0.34066
MIN =-1.03344
RATE = 10000.000
POINTS= 1024
RMS = 0.60300

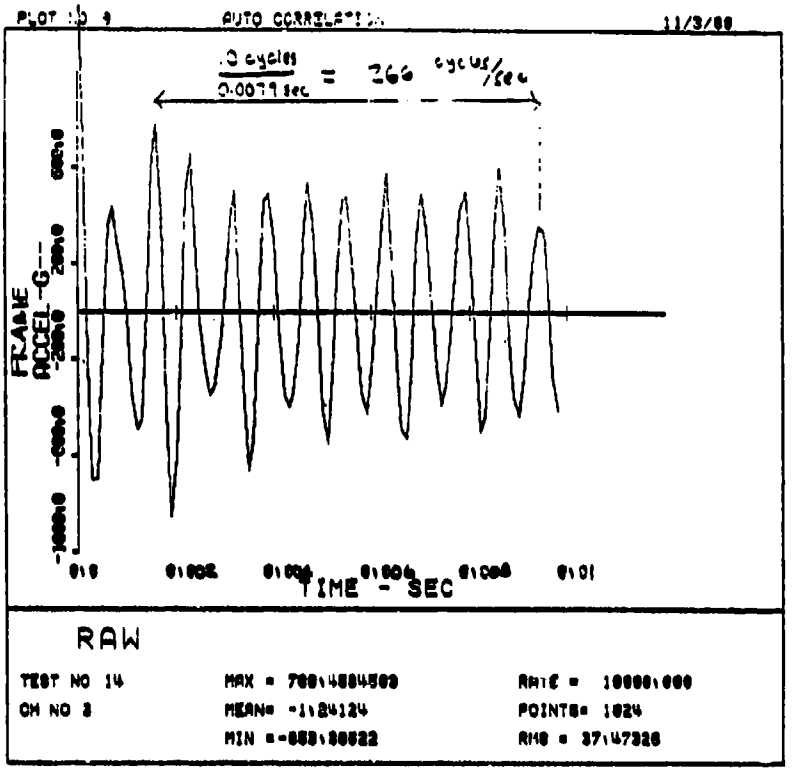

PLOT NO 74
FFT
11/3/80
FORCE-KIPS-
FREQUENCY - HZ
RAW
TEST NO 14
CH NO 2
MAX = 0.5380562
DOF = 1
FREQ= 30.05250
RATE = 10000.000
POINTS= 512
RMS = 0.60282

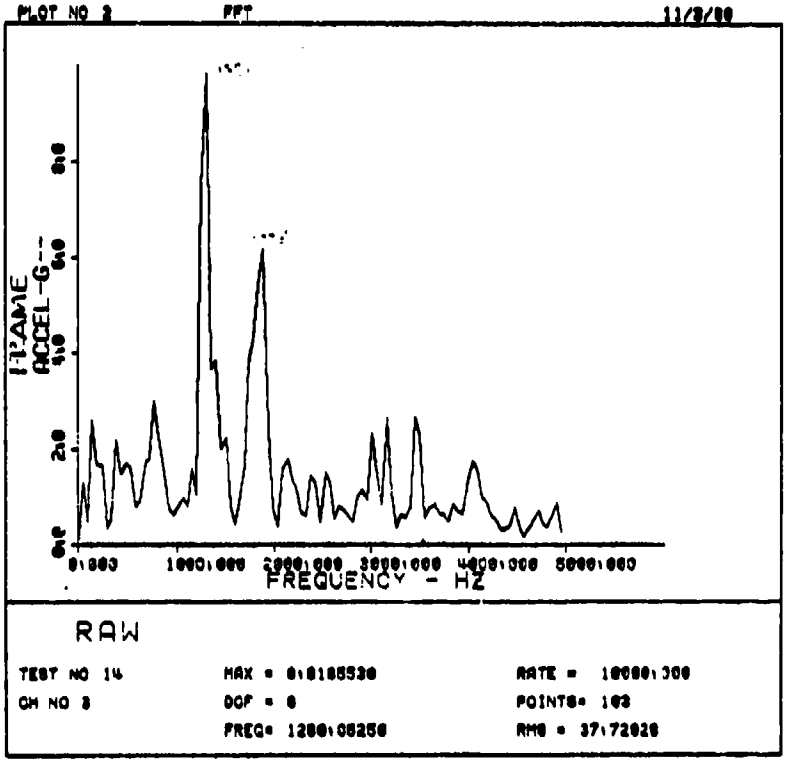

PLOT NO 75
AUTO CORRELATION
11/3/80
FORCE-KIPS-
TIME - SEC
RAW
TEST NO 14
CH NO 2
MAX = 0.2610741
MEAN= 0.34058
MIN =-0.18038
RATE = 10000.000
POINTS= 1024
RMS = 0.50593

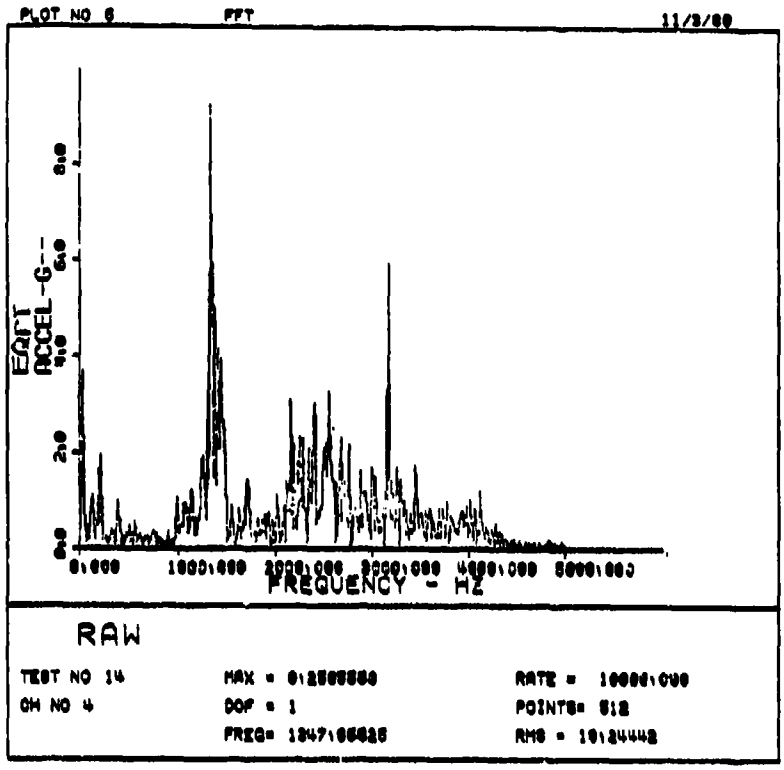

PLOT NO 74
FFT
11/3/80
FORCE-KIPS-
FREQUENCY - HZ
RAW
TEST NO 14
CH NO 2
MAX = 0.1741018
DOF = 0
FREQ= 30.05250
RATE = 10000.000
POINTS= 103
RMS = 0.50292

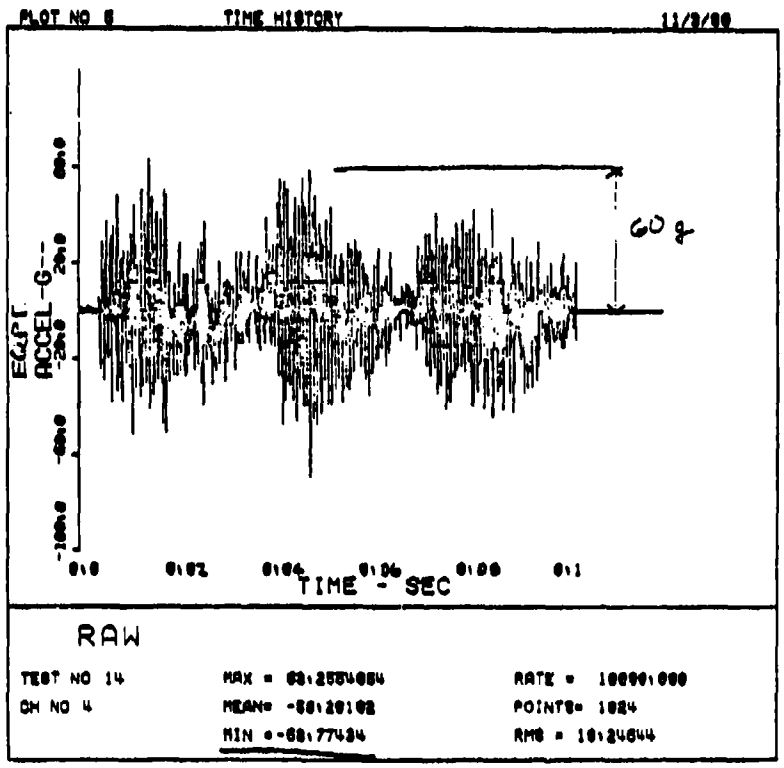

PLOT NO 2
FFT
11/3/88
FRAME ACCEL-G--
FREQUENCY - HZ
RAW
TEST NO 14
CH NO 3
MAX = 21.2666588
DOF = 1
FREQ= 1200.00250
RATE = 10000.000
POINTS= 512
RMS = 37.72028

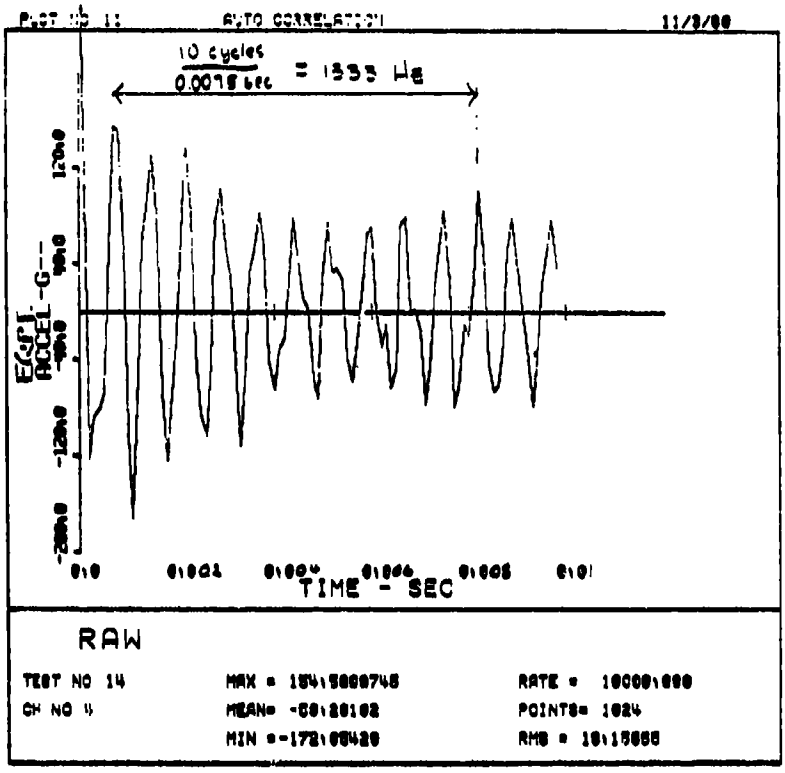

PLOT NO 1
TIME HISTORY
11/3/88
FRAME ACCEL-G--
TIME - SEC
126 g
RAW
TEST NO 14
CH NO 3
MAX = 158.1871298
MEAN= -1.24124
MIN = -148.52401
RATE = 10000.000
POINTS= 1024
RMS = 37.73374

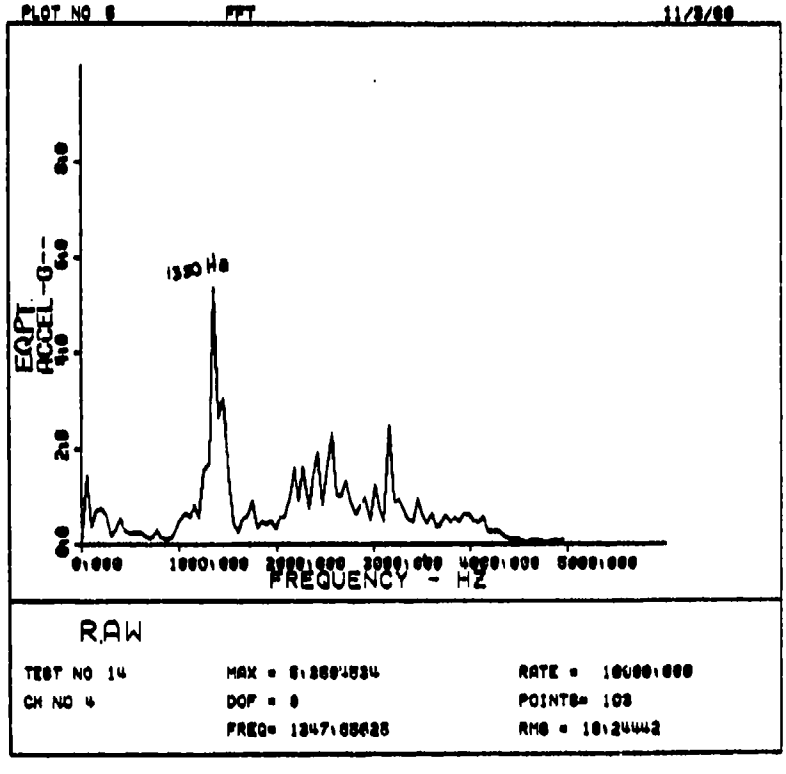

PLOT NO 9
AUTO CORRELATION
11/3/80
.0 cycles / 0.0079 sec = 266 cycles/sec
FRAME ACCEL-G--
TIME - SEC
RAW
TEST NO 14
CH NO 3
MAX = 700.4884503
MEAN= -1.24124
MIN =-853.38522
RATE = 10000.000
POINTS= 1024
RMS = 37.47326

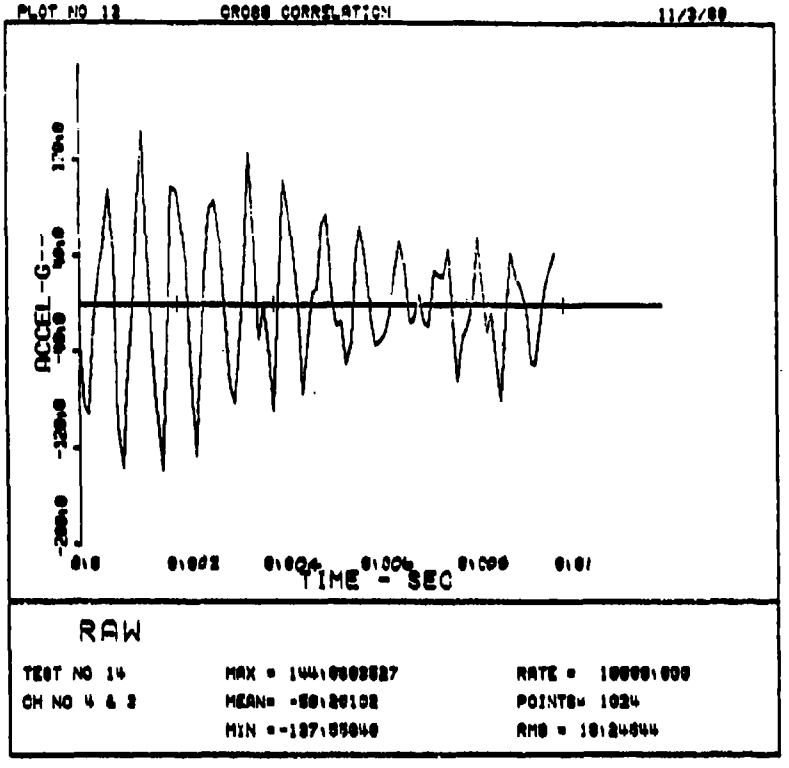

PLOT NO 2
FFT
11/3/80
FRAME ACCEL-G--
FREQUENCY - HZ
RAW
TEST NO 14
CH NO 3
MAX = 0.0185530
DOF = 0
FREQ= 1200.05250
RATE = 10000.000
POINTS= 103
RMS = 37.72020

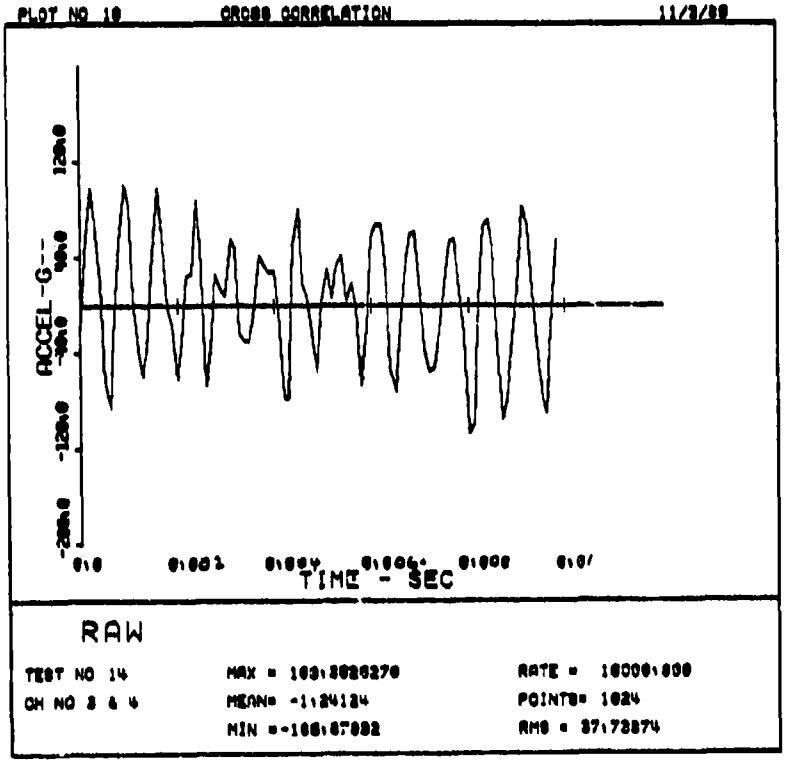

PLOT NO 6
FFT
11/3/89
EAST ACCEL -G--
FREQUENCY - HZ
RAW
TEST NO 14
CH NO 4
MAX = 0:2500000
DOF = 1
FREQ= 1347:66626
RATE = 10000:000
POINTS= 512
RMS = 10:24442

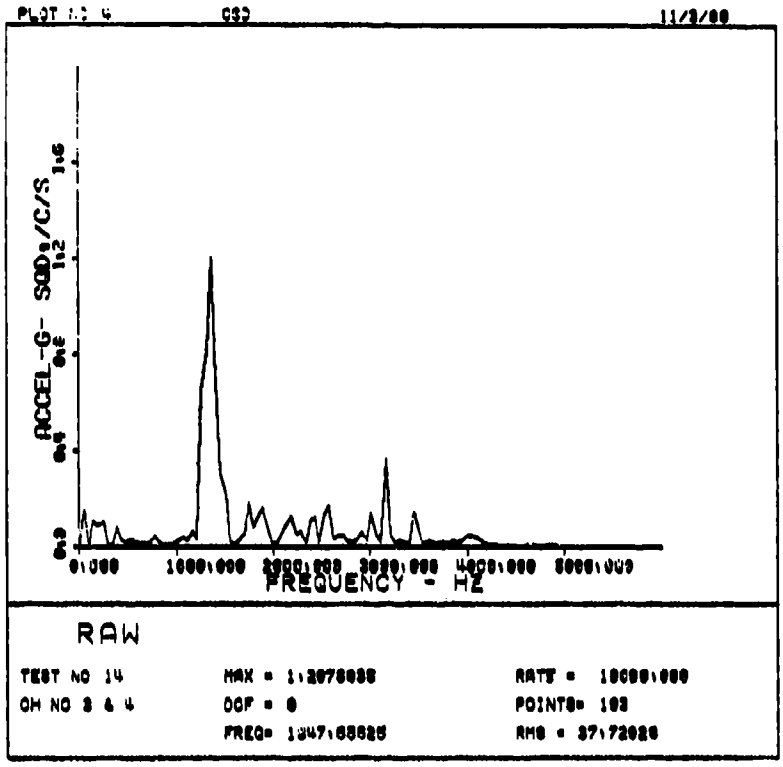

PLOT NO 6
TIME HISTORY
11/3/89
EAST ACCEL -G--
60 g
TIME - SEC
RAW
TEST NO 14
CH NO 4
MAX = 63:2554654
MEAN= -56:20102
MIN = -68:77434
RATE = 10000:000
POINTS= 1024
RMS = 10:24644

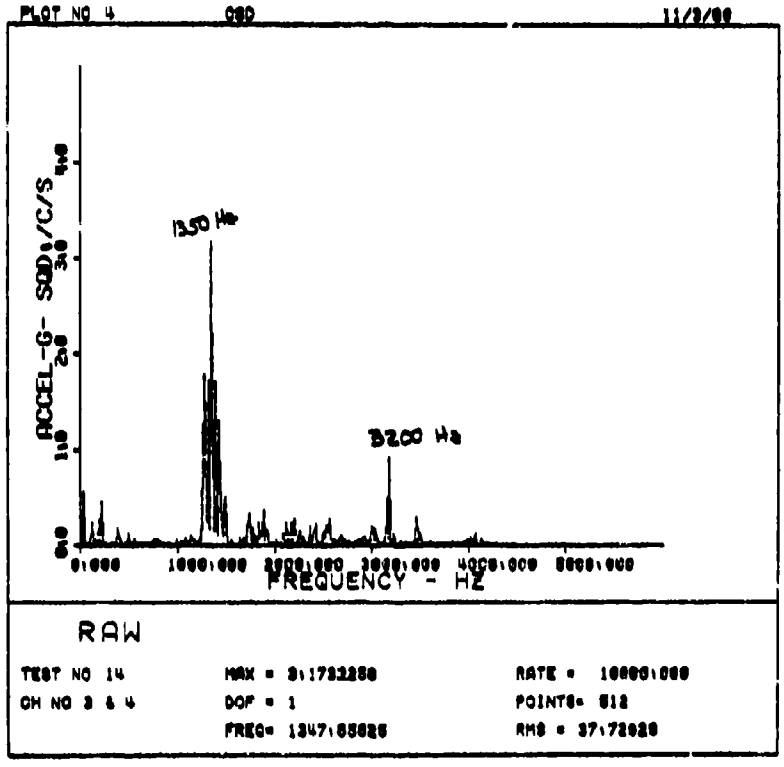

AUTO CORRELATION
11/3/80
10 cycles / 0.0075 sec = 1333 Hz
EQPT. ACCEL -G--
TIME - SEC
RAW
TEST NO 14
CH NO 4
MAX = 154.5000745
MEAN= -50.20102
MIN =-172.05420
RATE = 10000.000
POINTS= 1024
RMS = 18.15655


PLOT NO 6
FFT
11/3/80
1330 Hz
EQPT. ACCEL -G--
FREQUENCY - HZ
RAW
TEST NO 14
CH NO 4
MAX = 5.2604534
DOF = 0
FREQ= 1347.05625
RATE = 10000.000
POINTS= 103
RMS = 18.24442


PLOT NO 13
CROSS CORRELATION
11/3/89
ACCEL -G--
TIME - SEC
RAW
TEST NO 14
CH NO 4 & 3
MAX = 144.0803527
MEAN= -50.20102
MIN =-137.55040
RATE = 10000.000
POINTS= 1024
RMS = 18.24644

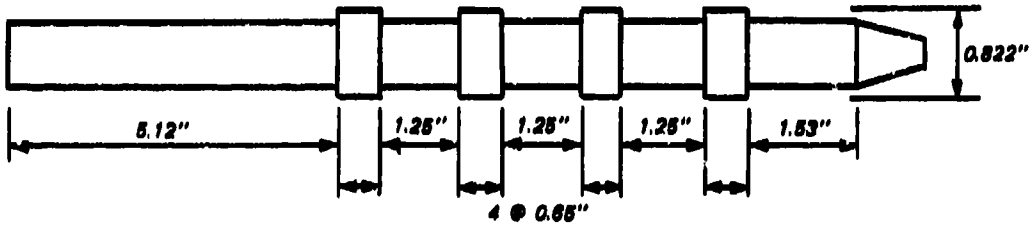

PLOT NO 10
CROSS CORRELATION
11/3/89
ACCEL -G--
TIME - SEC
RAW
TEST NO 14
CH NO 3 & 4
MAX = 103.3026270
MEAN= -1.24124
MIN =-166.67032
RATE = 10000.000
POINTS= 1024
RMS = 37.73874


PLOT NO 4
CSD
11/3/88
ACCEL-G- SQD's/C/S
FREQUENCY - HZ
RAW
TEST NO 14
CH NO 3 & 4
MAX = 1.2078038
DOF = 0
FREQ= 1347.65625
RATE = 10000.000
POINTS= 193
RMS = 37.72028


PLOT NO 4
CSD
11/3/88
ACCEL-G- SQD's/C/S
13.50 Hz
32.00 Hz
FREQUENCY - HZ
RAW
TEST NO 14
CH NO 3 & 4
MAX = 3.1732258
DOF = 1
FREQ= 1347.65625
RATE = 10000.000
POINTS= 512
RMS = 37.72028

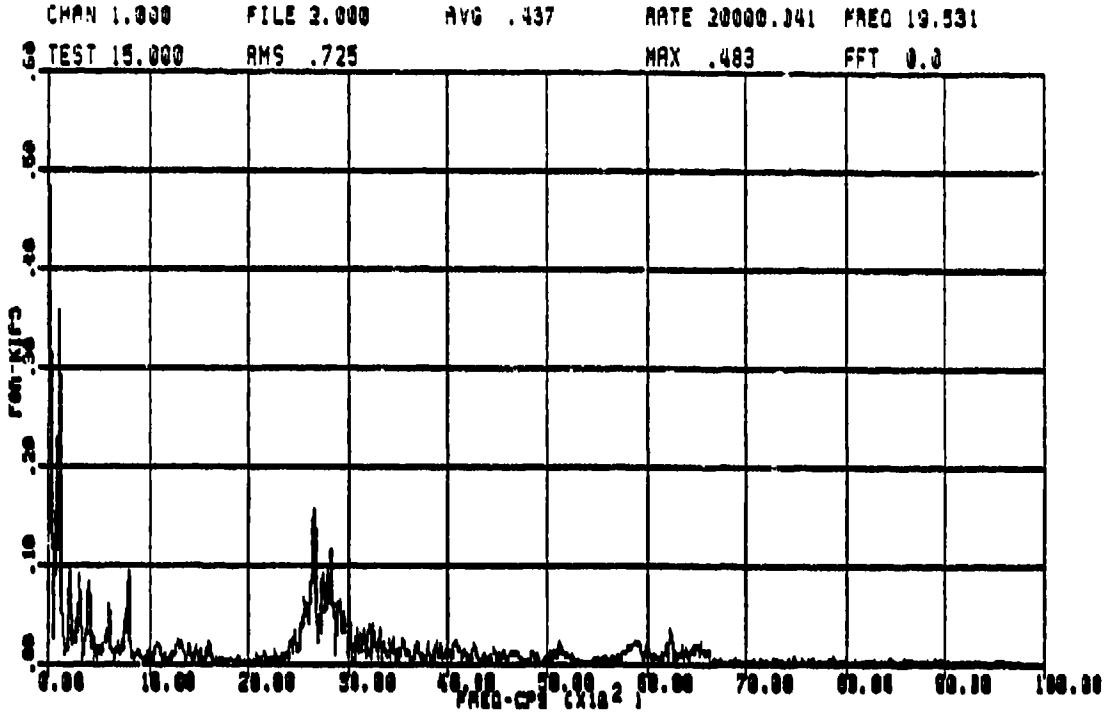
APPENDIX B: TEST 15 DATA

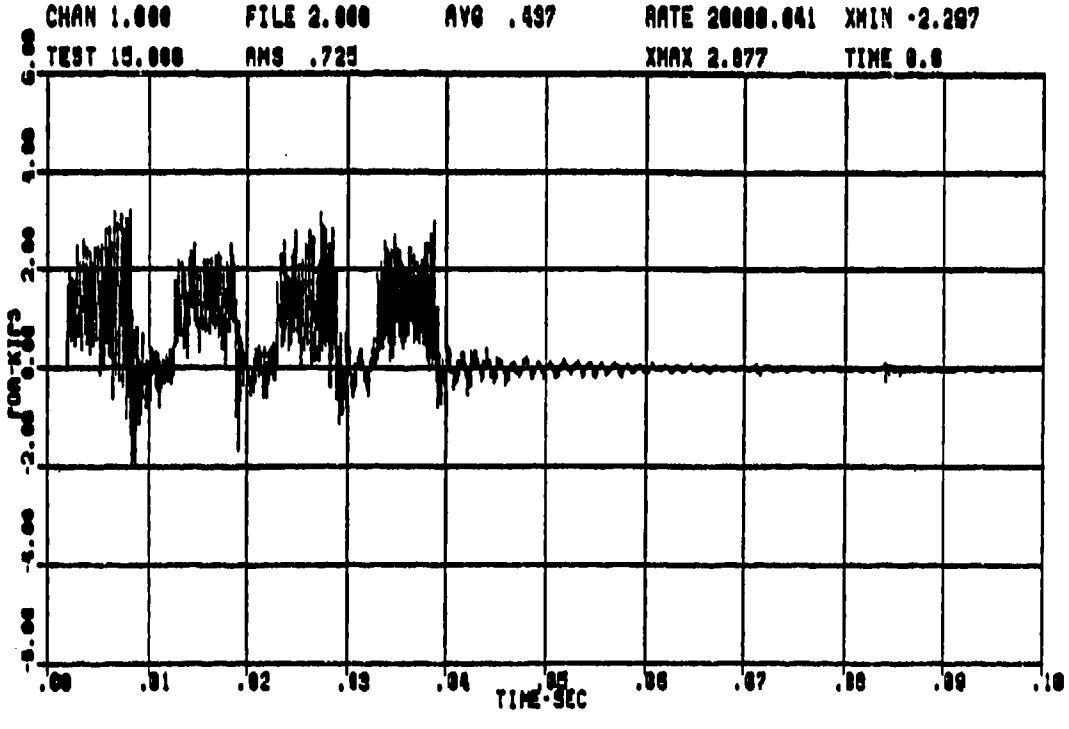
Test 15
Equipment Rack Hard-Mounted
AN/GRC-103 in Rack, Off-Line

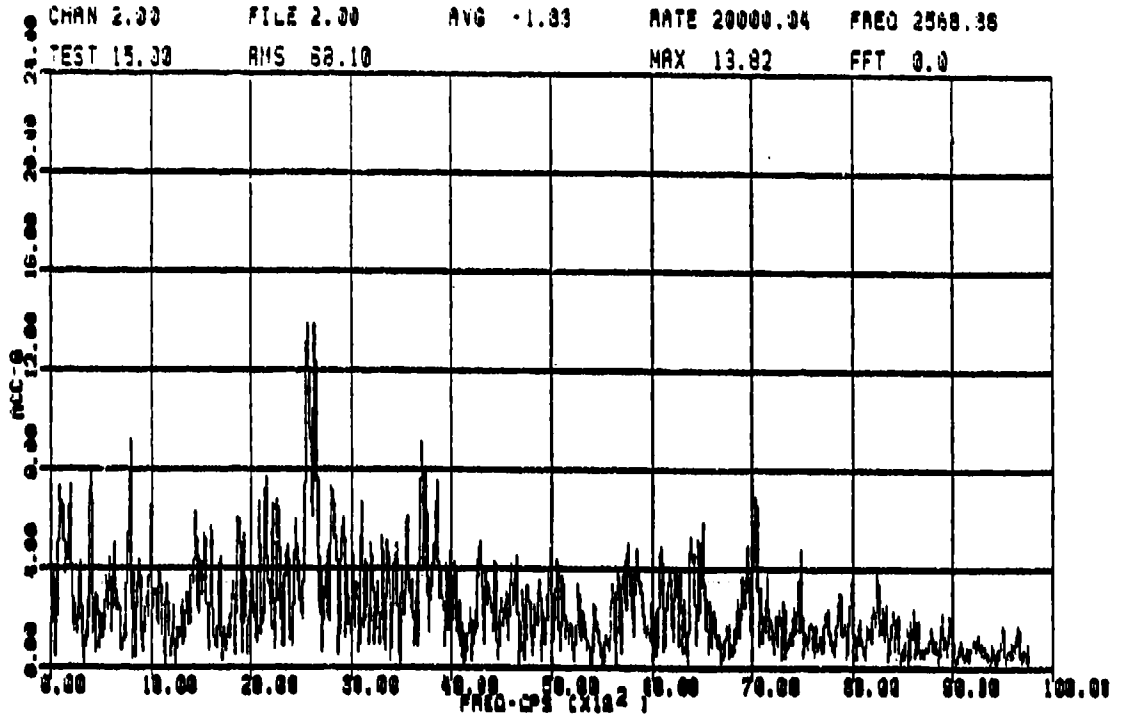


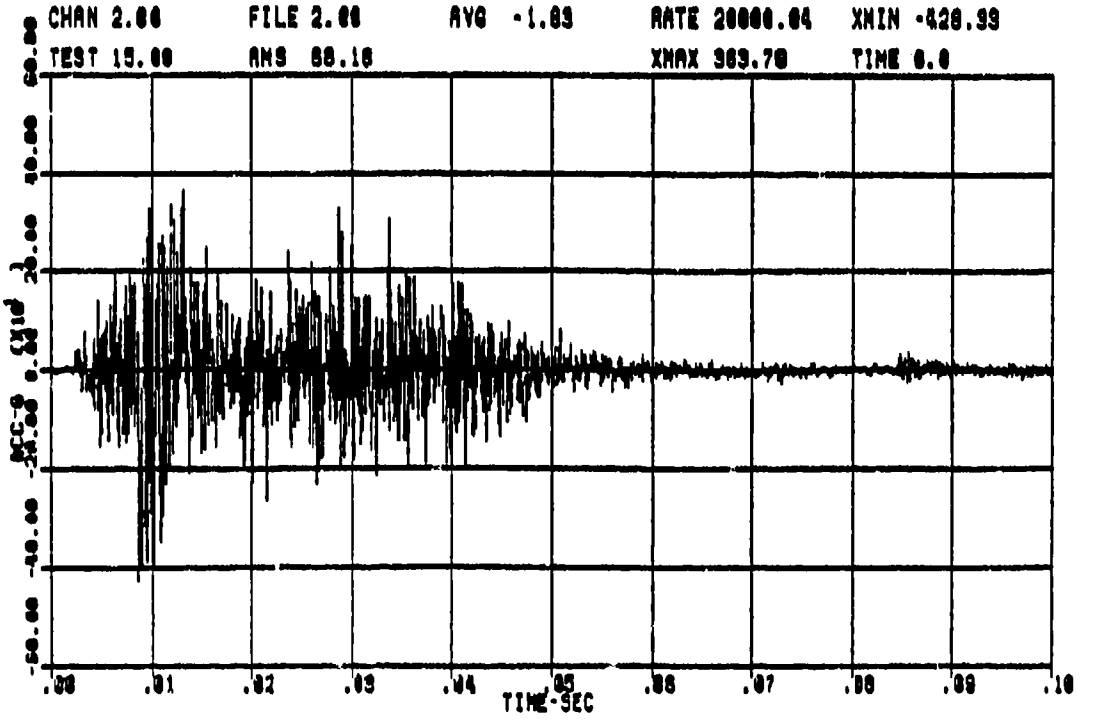
PULSE TRAIN - TEST 15

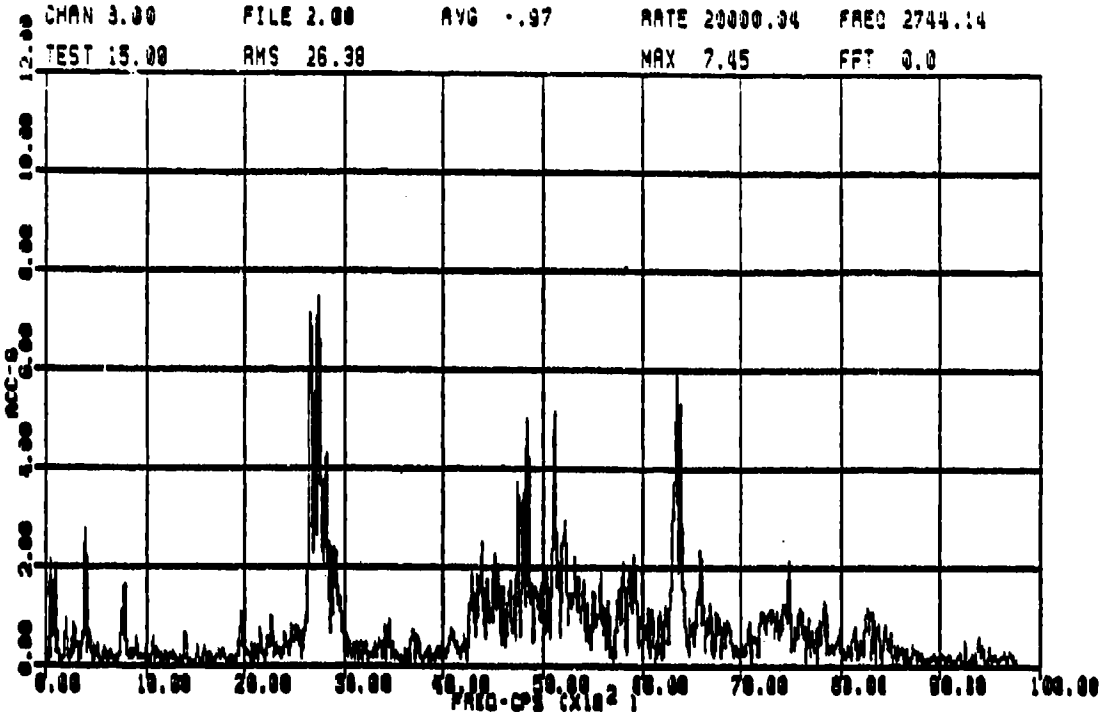
PRECHARGE PRESSURE = 1250 PSI
SYSTEM PRESSURE = 2000 PSI
FLOW CONTROL #6½

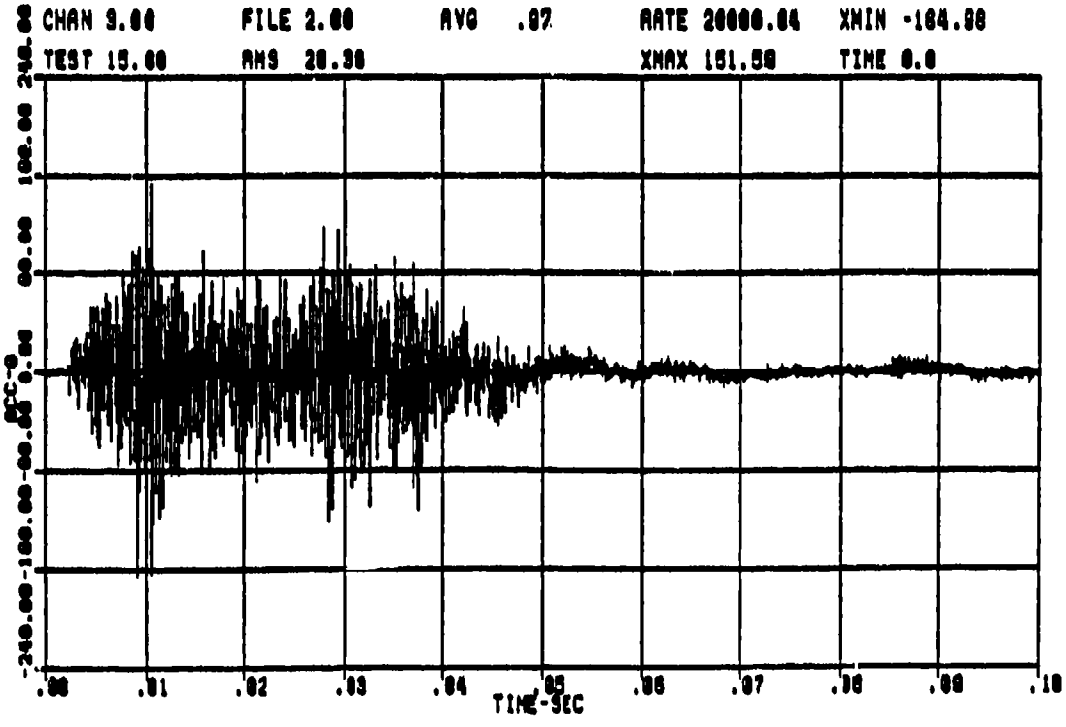

CHAN 1.000
FILE 2.000
AVG .437
RATE 20000.041
FREQ 19.531
TEST 15.000
RMS .725
MAX .483
FFT 0.0
FREQ-CPS (X10^2)

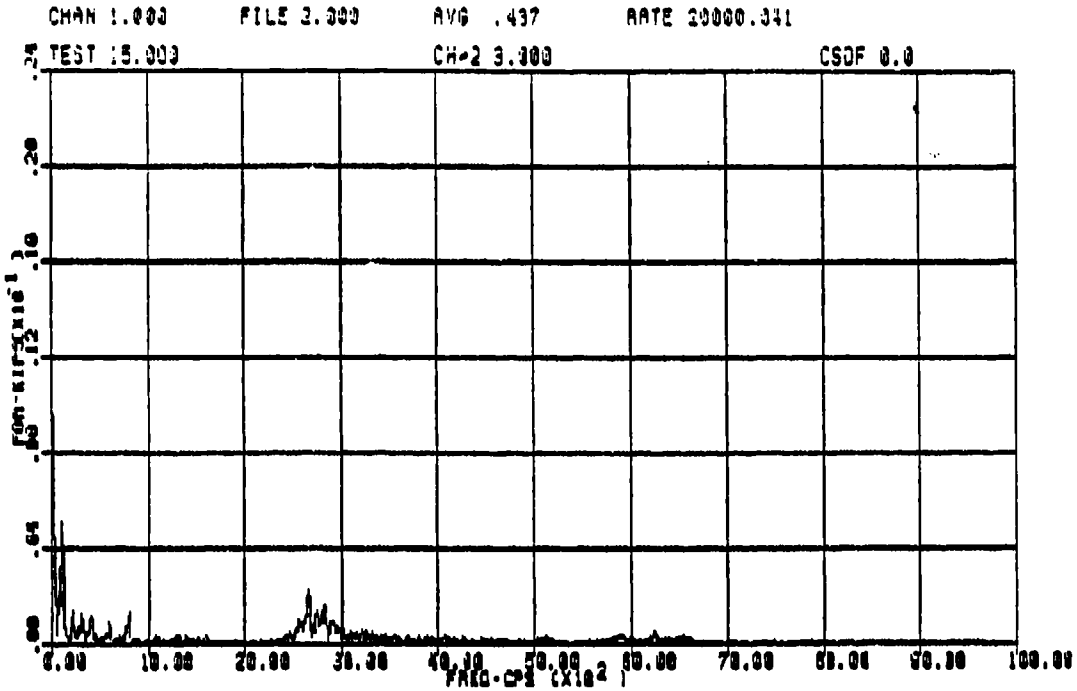

CHAN 1.000
FILE 2.000
AVG .437
RATE 20000.041
XMIN -2.297
TEST 15.000
RMS .725
XMAX 2.077
TIME 0.0
TIME-SEC

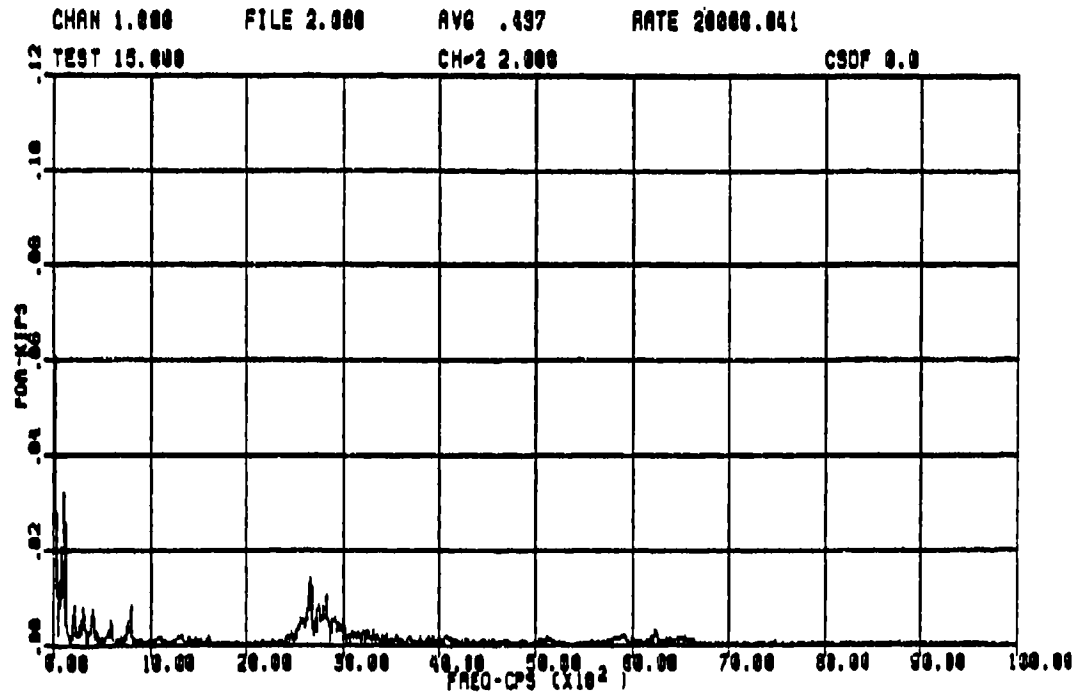

CHAN 2.00
FILE 2.00
AVG -1.83
RATE 20000.04
FREQ 2568.38
TEST 15.30
RMS 68.10
MAX 13.82
FFT 0.0
ACC-G
FREQ-CPS (X10^2)

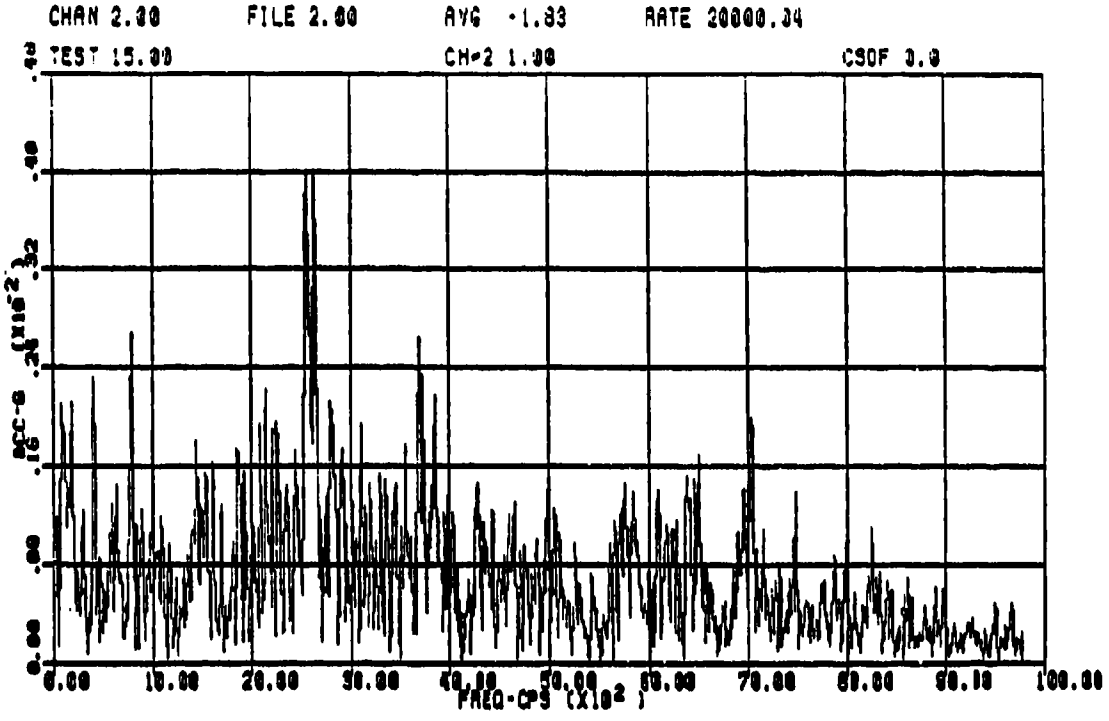

CHAN 2.00
FILE 2.00
AVG -1.83
RATE 20000.04
XMIN -428.33
TEST 15.00
RMS 68.16
XMAX 383.70
TIME 0.0
ACC-G (X10^1)
TIME-SEC

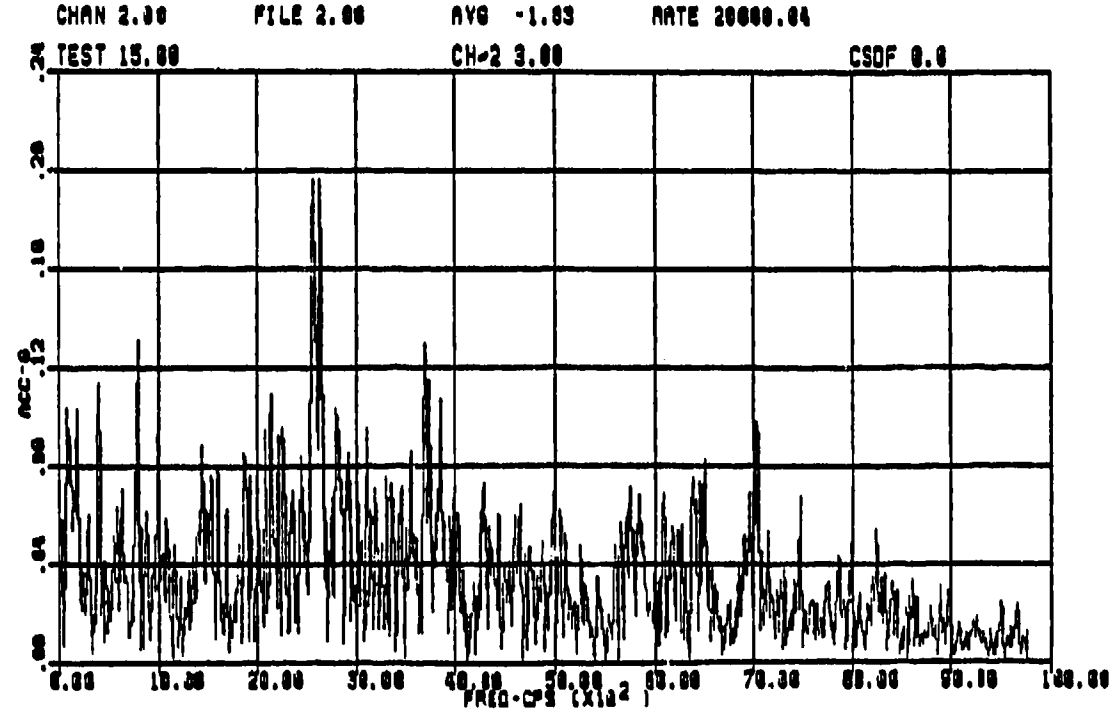

CHAN 3.00
FILE 2.00
AVG .97
RATE 20000.04
FREQ 2744.14
TEST 15.00
RMS 26.38
MAX 7.45
FFT 0.0
ACC-G
FREQ-CPS (X10^2)

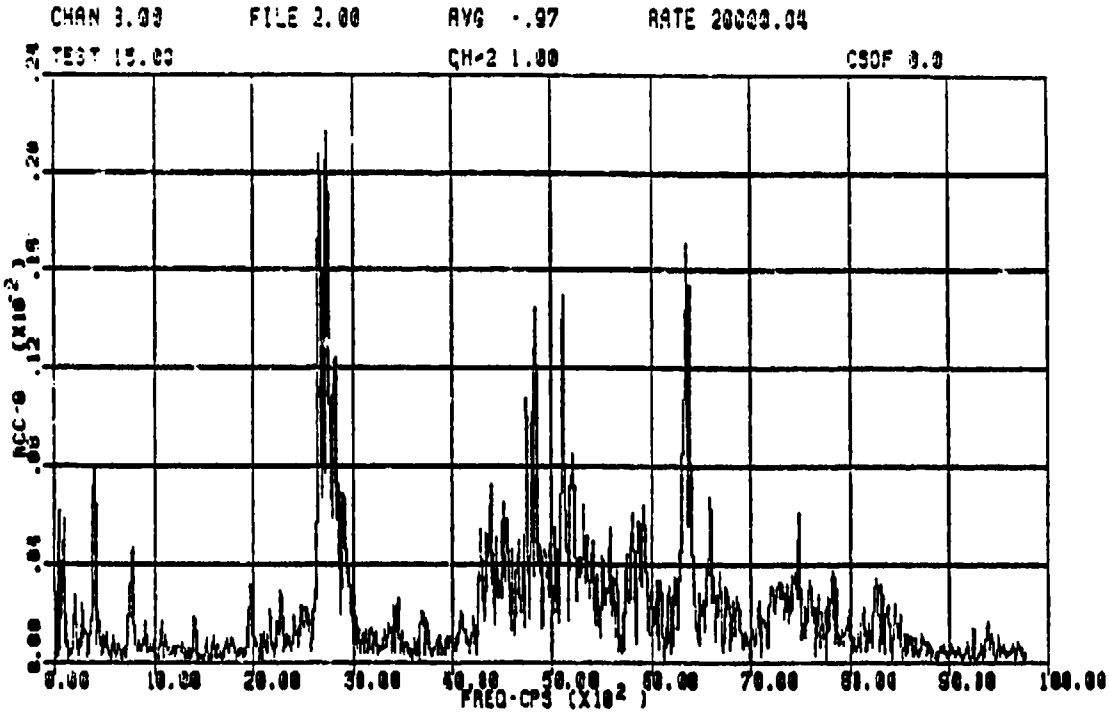

CHAN 9.00
FILE 2.00
AVG .07
RATE 20000.04
XMIN -104.38
TEST 15.00
RMS 28.38
XMAX 151.50
TIME 0.0
ACC-G
TIME-SEC

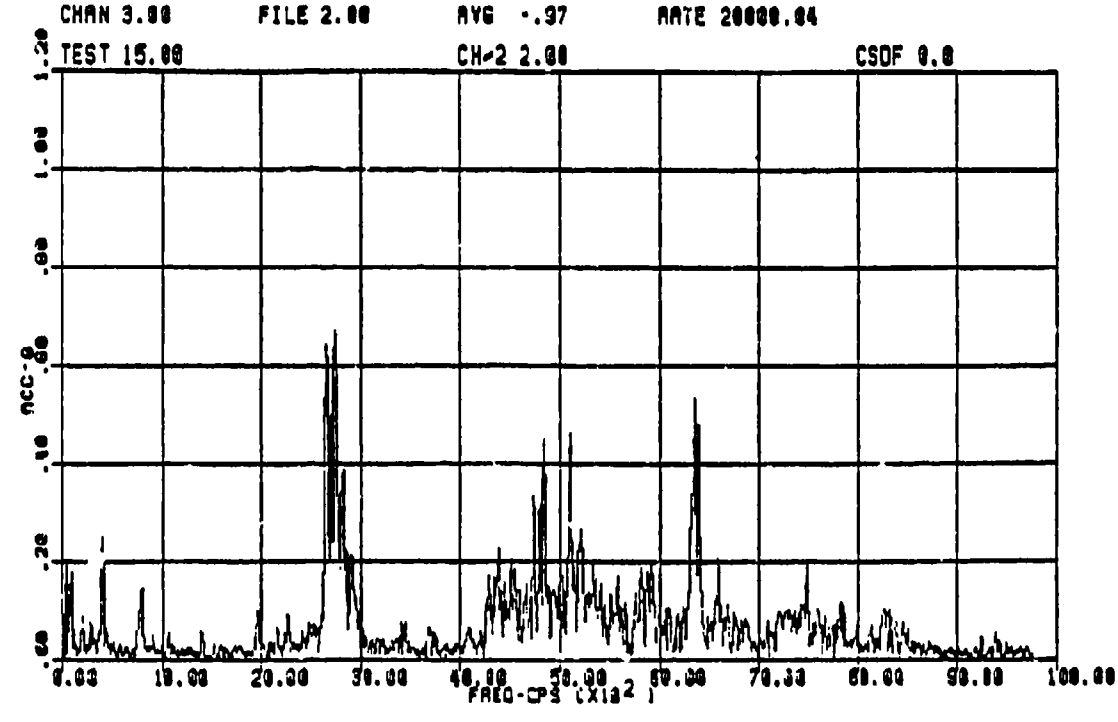

CHAN 1.000 FILE 3.000 AVG .437 RATE 20000.341
TEST 15.000 CH-2 3.000 CSDF 0.0
.24
.20
.16
.12
.08
.04
.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

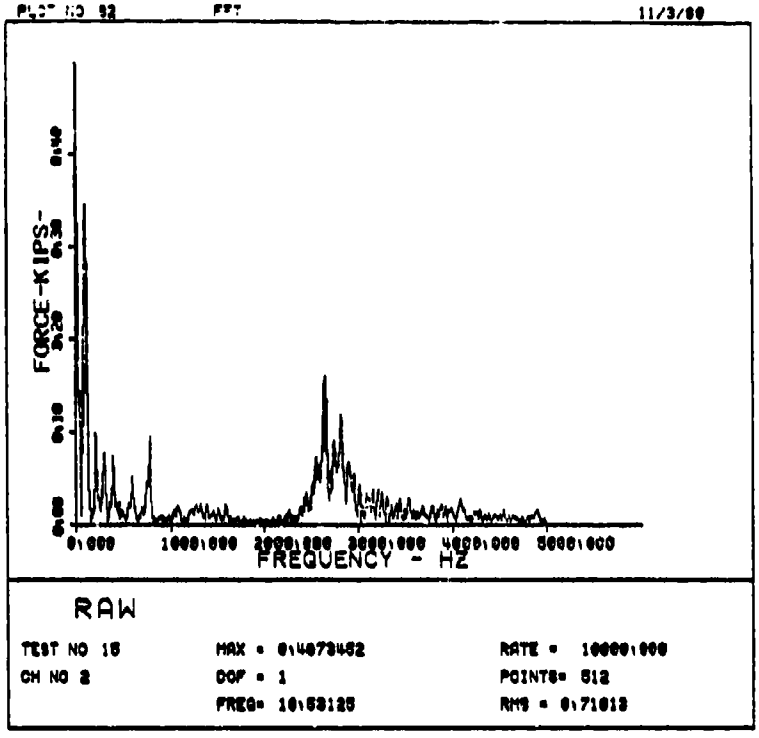

CHAN 1.000 FILE 2.000 AVG .437 RATE 20000.041
TEST 15.000 CH-2 2.000 CSDF 0.0
.12
.10
.08
.06
.04
.02
.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

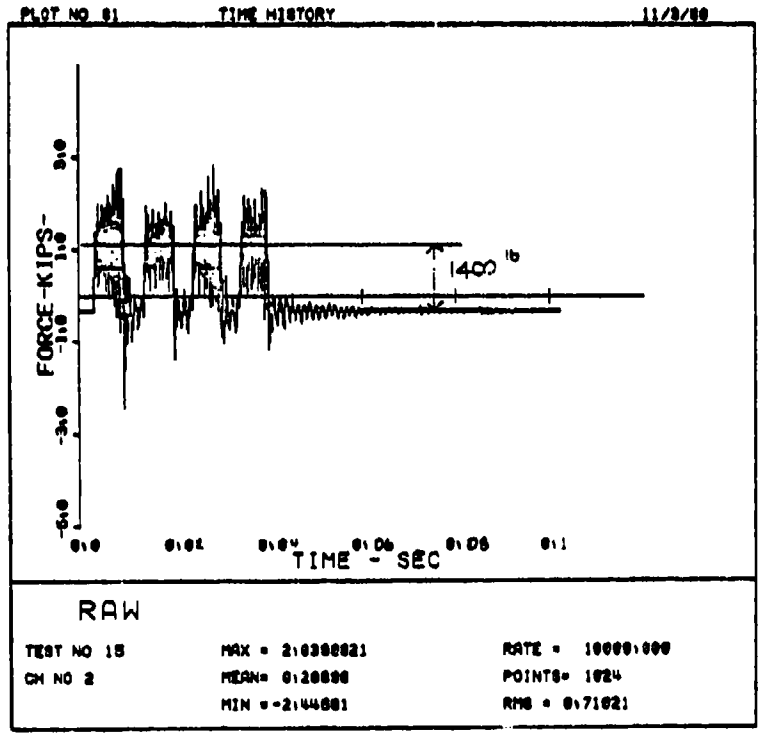

CHAN 2.00
FILE 2.00
AVG -1.83
RATE 20000.04
TEST 15.00
CH-2 1.00
CSOF 0.0
ACC-G (X10^2)
FREQ-CPS (X10^2)

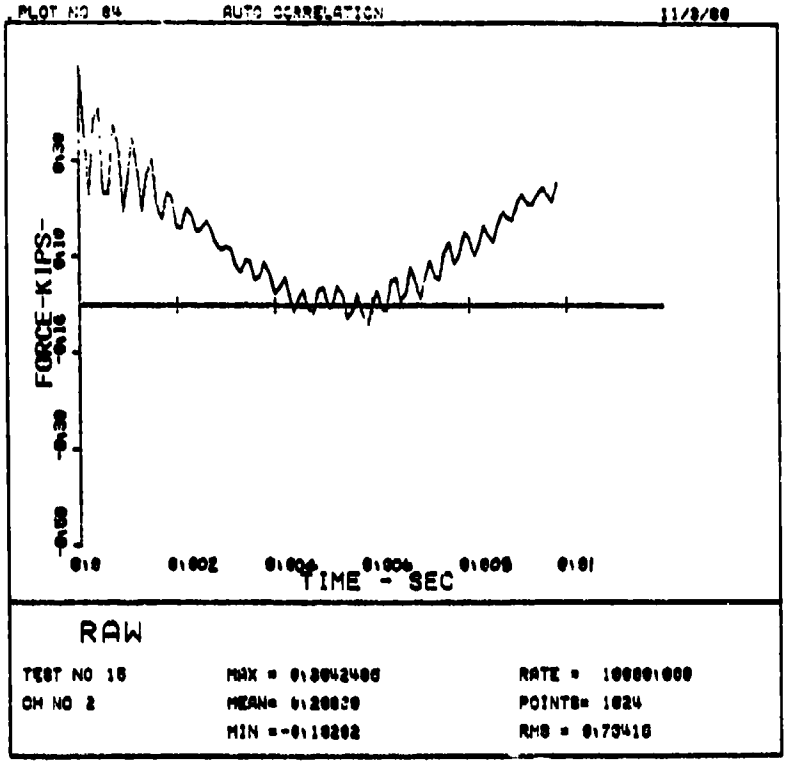

CHAN 2.00
FILE 2.00
AVG -1.83
RATE 20000.04
TEST 15.00
CH-2 3.00
CSOF 0.0
ACC-G
FREQ-CPS (X10^2)

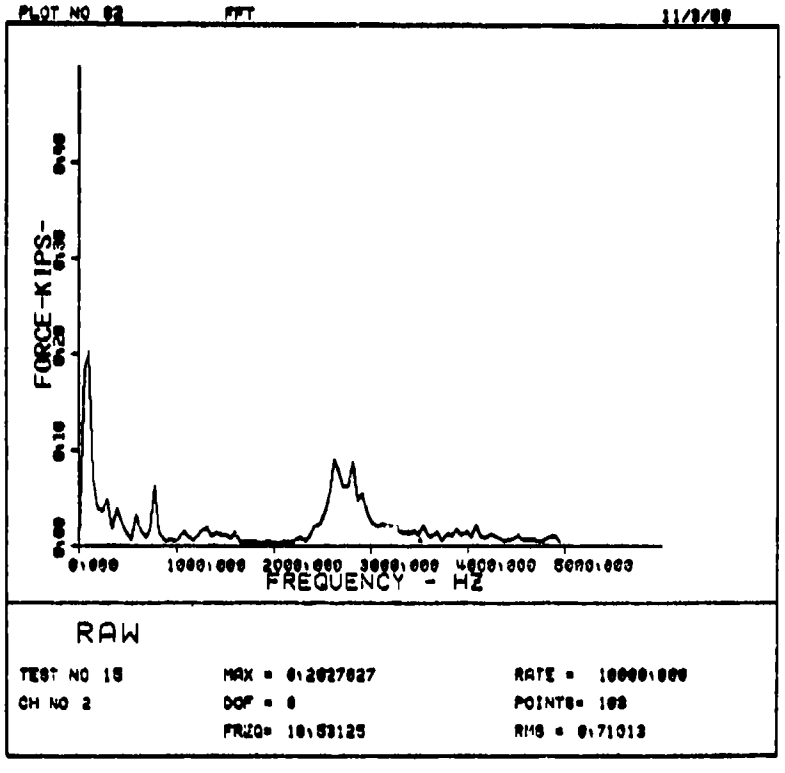

CHAN 3.00 FILE 2.00 AVG .97 RATE 20000.04
TEST 15.00 CH-2 1.00 CSOF 0.0
ACC-G**2 (X10**2)
FREQ-CPS (X10**2)

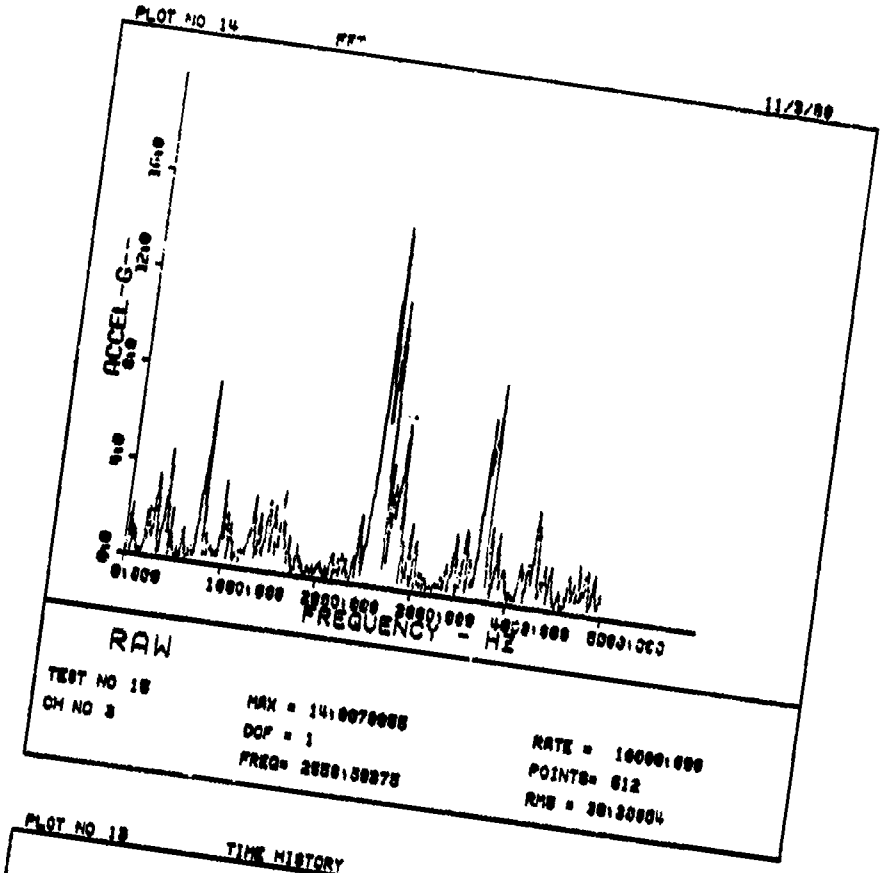

CHAN 3.00 FILE 2.00 AVG .97 RATE 20000.04
TEST 15.00 CH-2 2.00 CSOF 0.0
ACC-G
FREQ-CPS (X10**2)

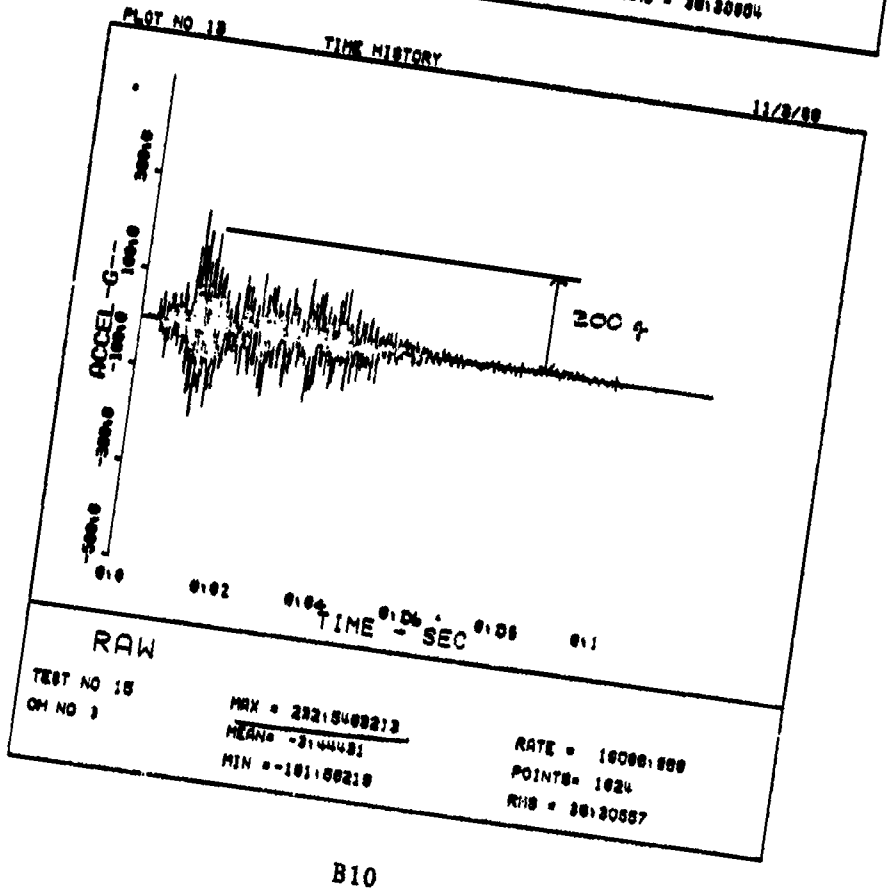

PLOT NO 92
FFT
11/3/80
FORCE-KIPS-
FREQUENCY - HZ
RAW
TEST NO 15
CH NO 2
MAX = 0.4873452
DOF = 1
FREQ= 10.53125
RATE = 10000.000
POINTS= 512
RMS = 0.71013

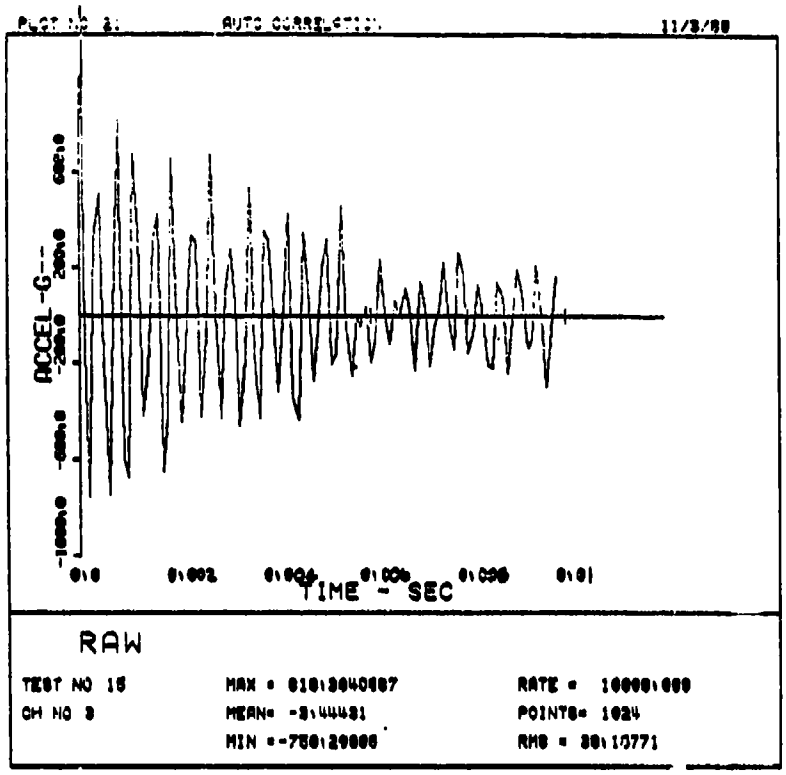

PLOT NO 81
TIME HISTORY
11/3/80
FORCE-KIPS-
1400 lb
TIME - SEC
RAW
TEST NO 15
CH NO 2
MAX = 2.0380821
MEAN= 0.28896
MIN = -2.44681
RATE = 10000.000
POINTS= 1024
RMS = 0.71021

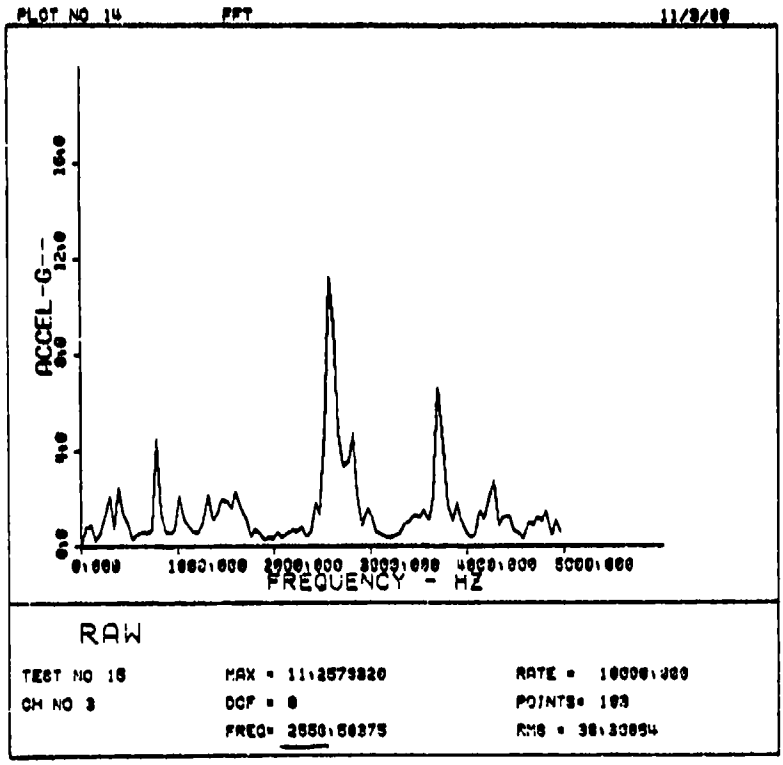

PLOT NO 84
AUTO CORRELATION
11/3/80
FORCE-KIPS-
TIME - SEC
RAW
TEST NO 16
CH NO 2
MAX = 0.3042486
MEAN= 0.20839
MIN =-0.10282
RATE = 10000.000
POINTS= 1024
RMS = 0.73416

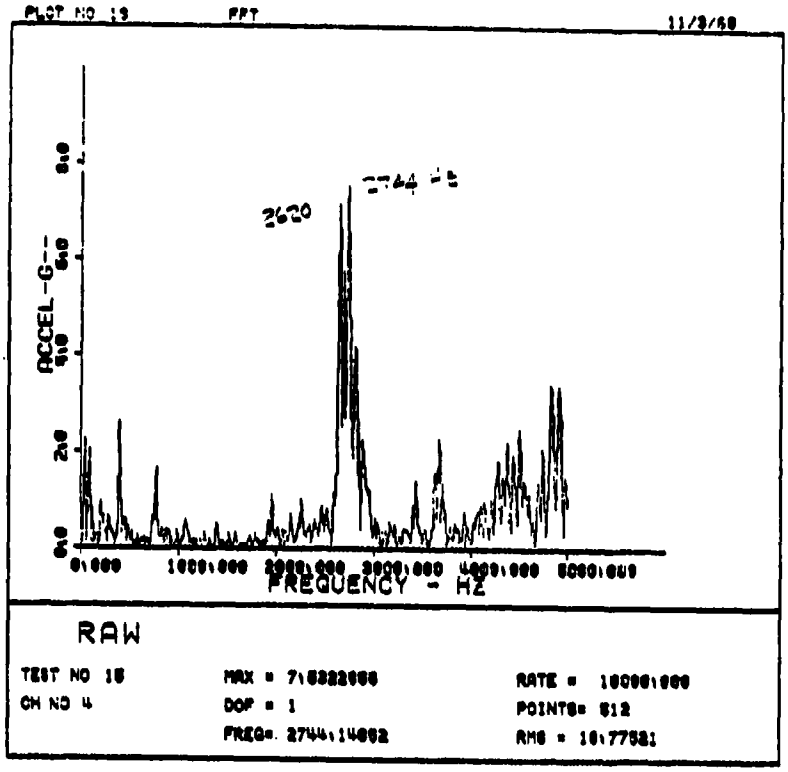

PLOT NO 83
FFT
11/3/80
FORCE-KIPS-
FREQUENCY - HZ
RAW
TEST NO 16
CH NO 2
MAX = 0.2027027
DOF = 8
FREQ= 10.53125
RATE = 10000.000
POINTS= 103
RMS = 0.71013

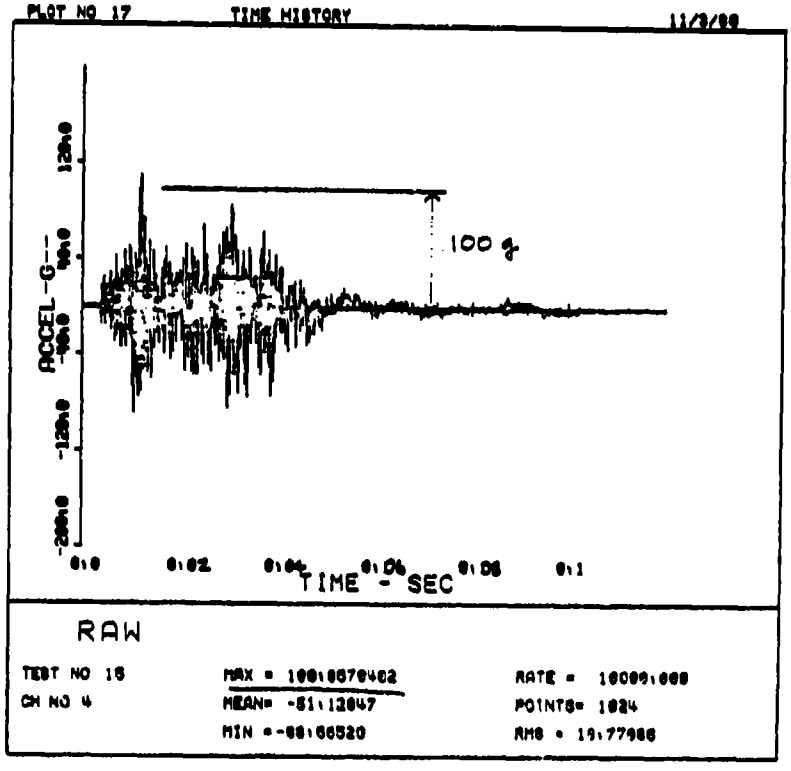

PLOT NO 14
11/3/89
ACCEL -G--
FREQUENCY - HZ
RAW
TEST NO 15
CH NO 3
DOF = 1
RATE =
POINTS= 612

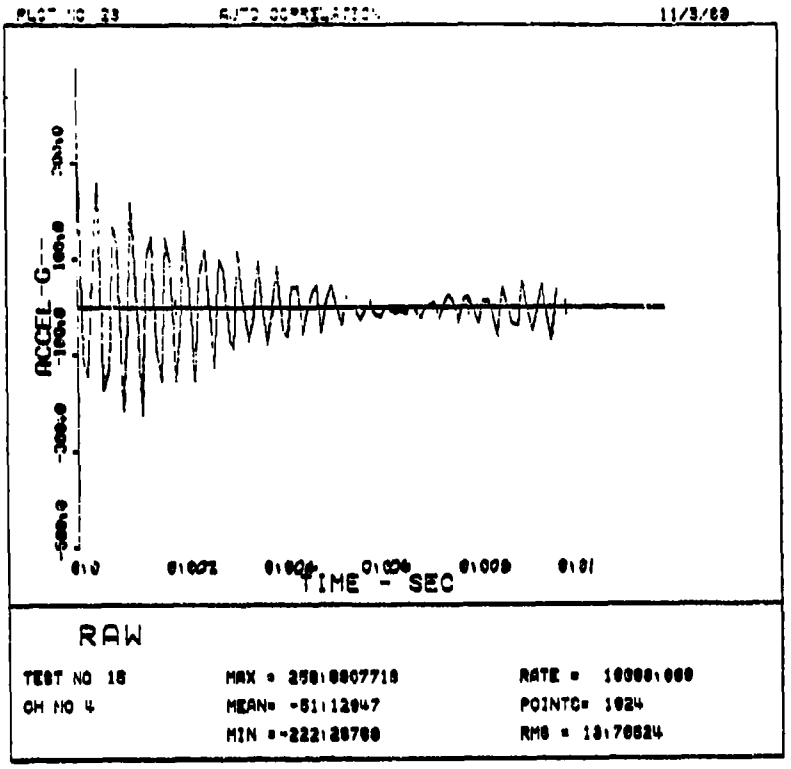

PLOT NO 13
TIME HISTORY
11/3/89
ACCEL -G--
200 g
TIME - SEC
RAW
TEST NO 15
CH NO 3
MAX =
MEAN= -3:44431
MIN =-101:56219
RATE =
POINTS= 1024
RMS = 36:30557

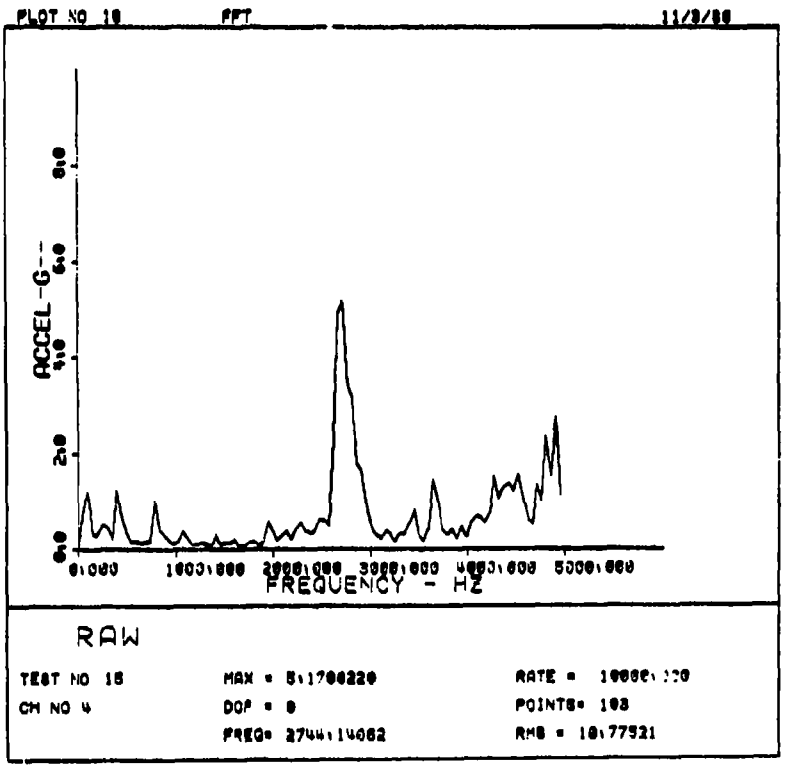

PLOT NO 2
AUTO CORRELATION
11/3/88
ACCEL -G--
TIME - SEC
RAW
TEST NO 15
CH NO 3
MAX = 818.3040887
MEAN= -3.44431
MIN =-750.29886
RATE = 10000.000
POINTS= 1024
RMS = 38.10771

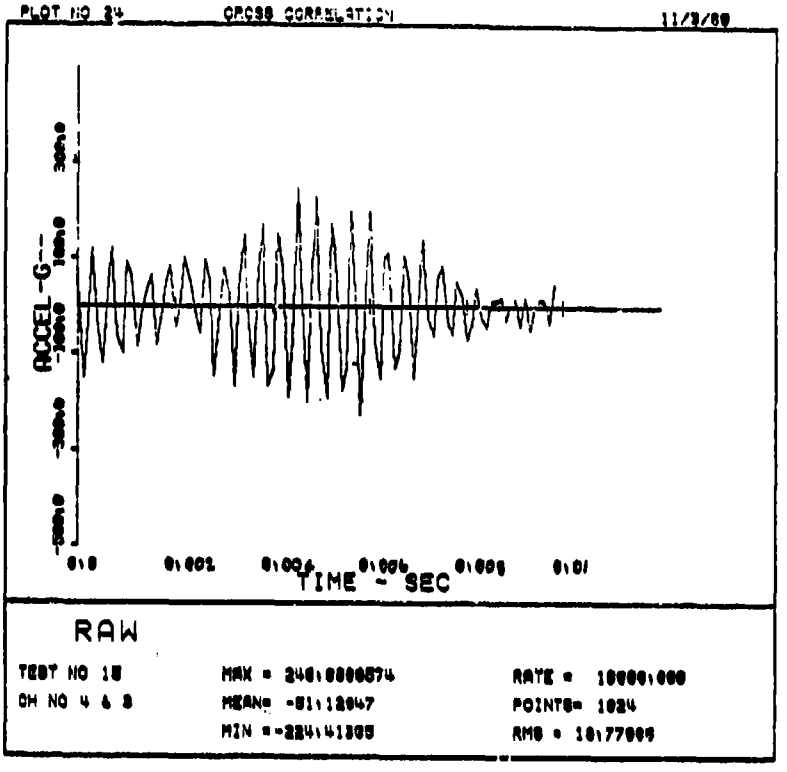

PLOT NO 14
FFT
11/3/88
ACCEL -G--
FREQUENCY - HZ
RAW
TEST NO 15
CH NO 3
MAX = 11.2579320
DCF = 0
FREQ= 2550.50375
RATE = 10000.000
POINTS= 103
RMS = 38.30854

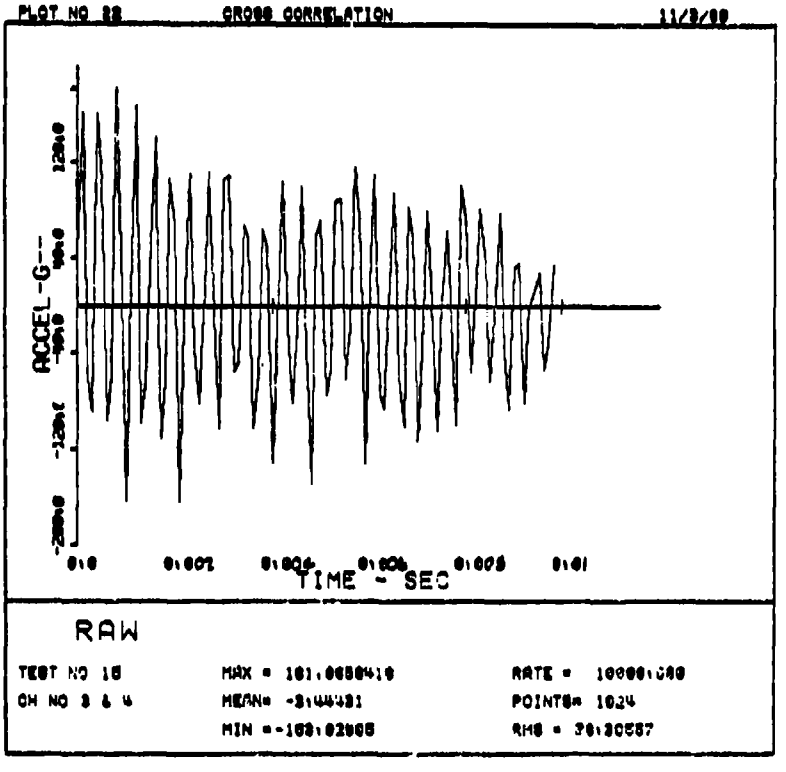

PLOT NO 19
FFT
11/3/88
2620
2744 Hz
ACCEL-G--
FREQUENCY - HZ
RAW
TEST NO 15
CH NO 4
MAX = 7.5322666
DOF = 1
FREQ= 2744.14062
RATE = 10000.000
POINTS= 512
RMS = 10.77521

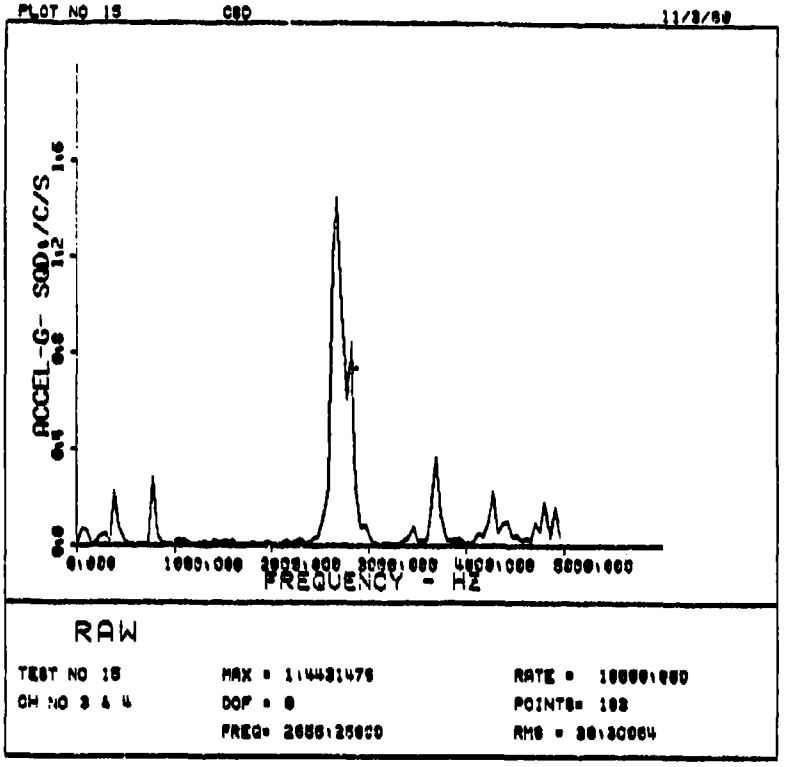

PLOT NO 17
TIME HISTORY
11/3/88
100 g
ACCEL-G--
TIME - SEC
RAW
TEST NO 15
CH NO 4
MAX = 100.0570402
MEAN= -51.12047
MIN = -88.66520
RATE = 10000.000
POINTS= 1024
RMS = 19.77986

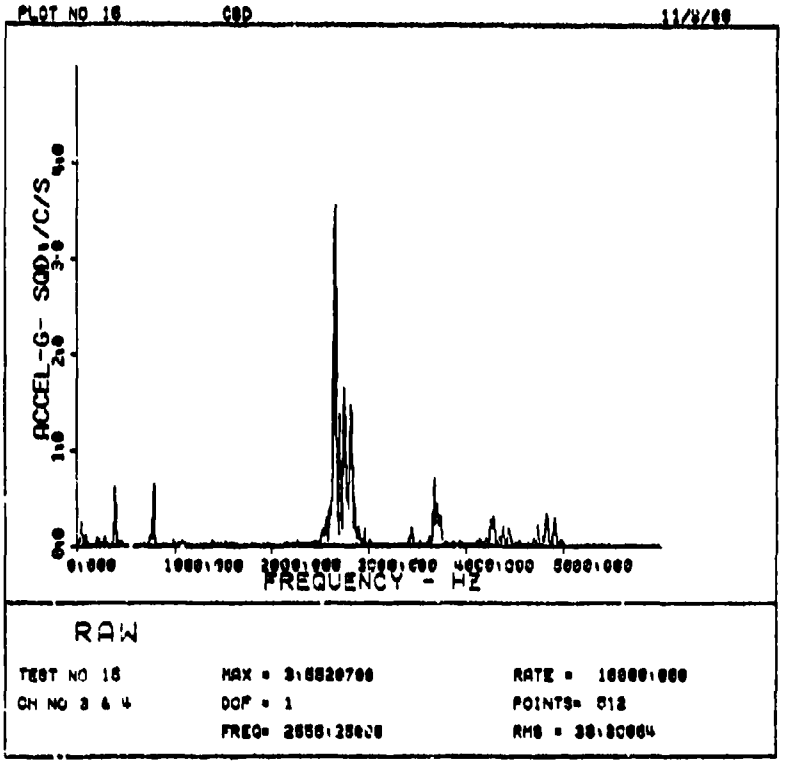

11/3/89
ACCEL -G--
TIME - SEC
RAW
TEST NO 18
CH NO 4
MAX = 258.8807718
MEAN= -51.12847
MIN =-222.28788
RATE = 10000.000
POINTS= 1024
RMS = 18.78824


PLOT NO 19
FFT
11/3/89
ACCEL -G--
FREQUENCY - HZ
RAW
TEST NO 18
CH NO 4
MAX = 5.1788228
DOF = 8
FREQ= 2744.14062
RMS = 18.77521


PLOT NO 24
CROSS CORRELATION
11/3/80
ACCEL-G--
TIME - SEC
RAW
TEST NO 15
CH NO 4 & 3
MAX = 246.0000574
MEAN= -51.12947
MIN =-224.41305
RATE = 10000.000
POINTS= 1024
RMS = 18.77005

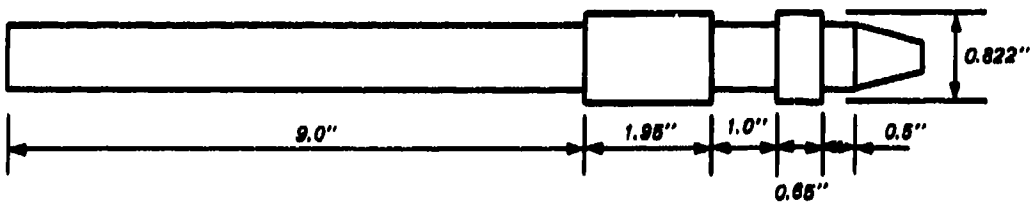

PLOT NO 22
CROSS CORRELATION
11/3/80
ACCEL-G--
TIME - SEC
RAW
TEST NO 15
CH NO 3 & 4
MAX = 161.0050419
MEAN= -3.44431
MIN =-153.02905
RATE = 10000.000
POINTS= 1024
RMS = 36.30557


PLOT NO 15
CSD
11/3/89
ACCEL-G- SQD$/C/S
FREQUENCY - HZ
RAW
TEST NO 15
CH NO 3 & 4
MAX = 1.14431479
DOF = 8
FREQ= 2656.25000
RATE = 10000.000
POINTS= 102
RMS = 38.30064


PLOT NO 15
CSD
11/3/89
ACCEL-G- SQD$/C/S
FREQUENCY - HZ
RAW
TEST NO 15
CH NO 3 & 4
MAX = 3.65529788
DOF = 1
FREQ= 2656.25000
RATE = 10000.000
POINTS= 512
RMS = 38.30064

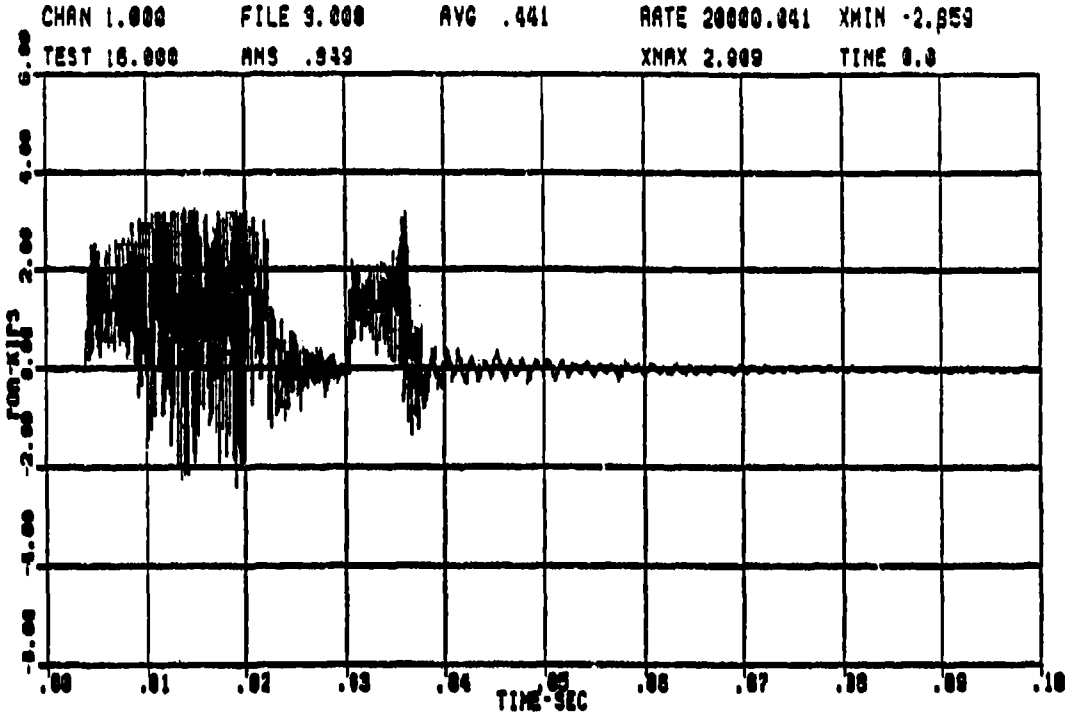
APPENDIX C: TEST 16 DATA

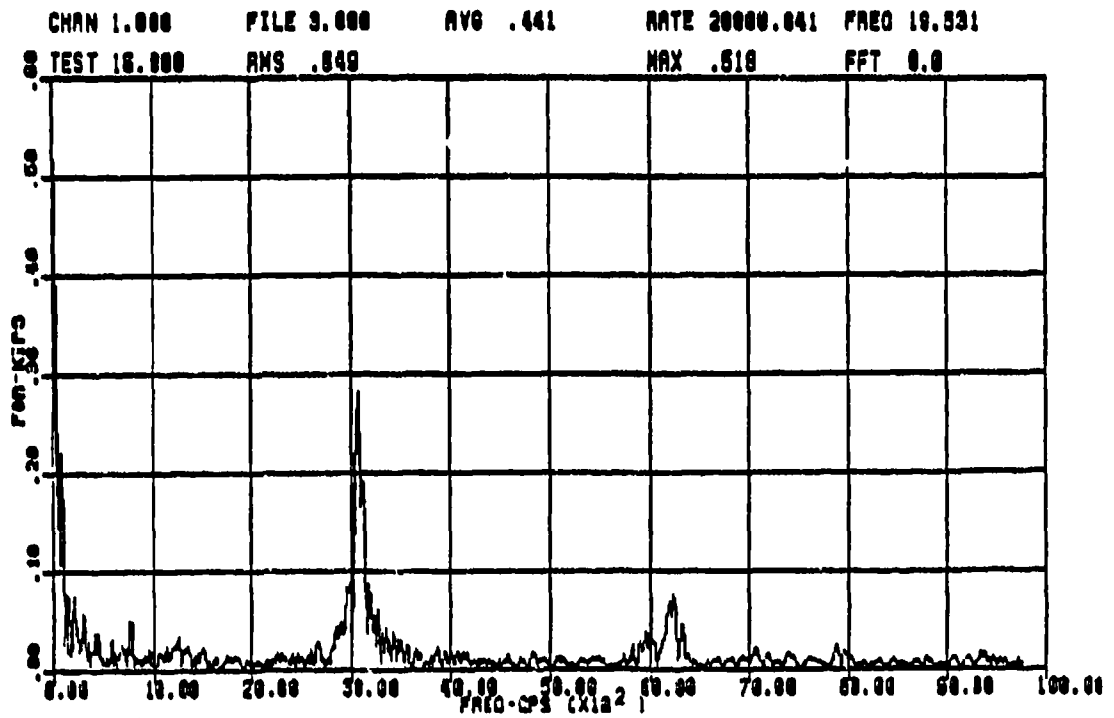
Test 16
Equipment Rack Hard-Mounted
AN/GRC-103 in Rack, Off-Line

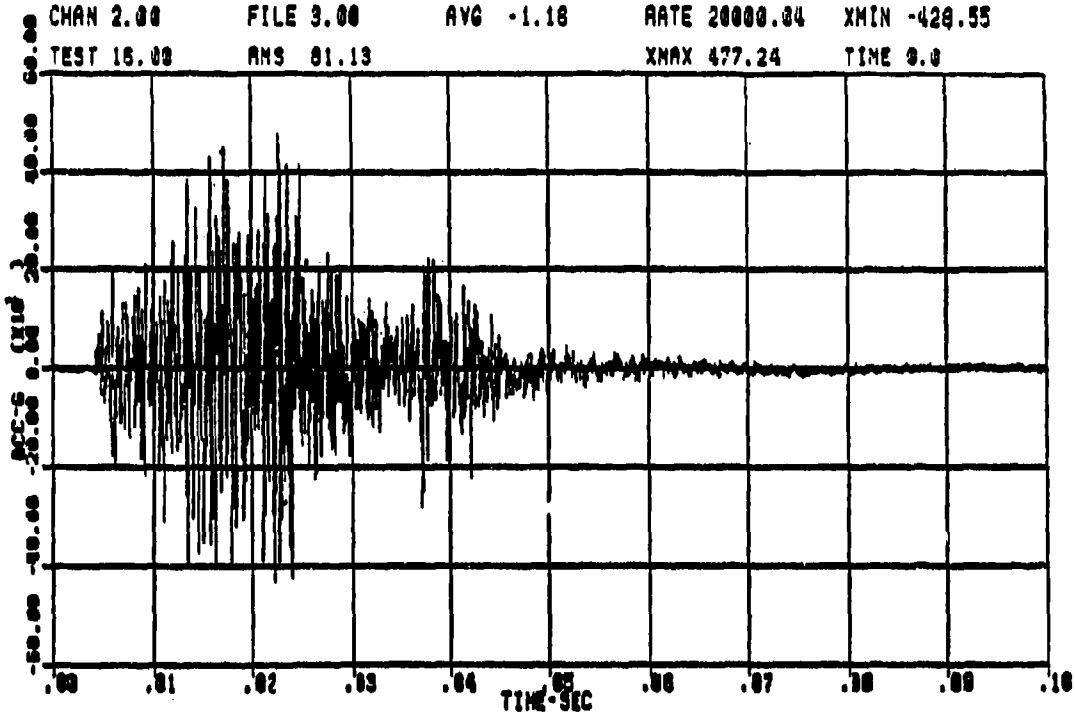


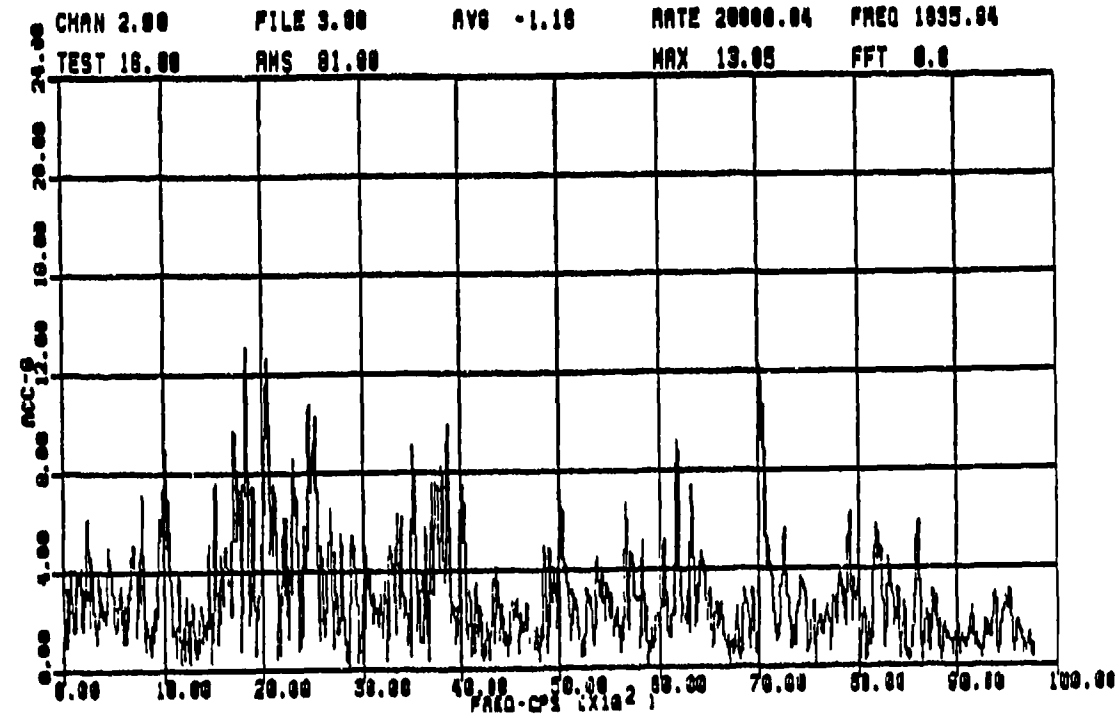
PULSE TRAIN - TEST 16

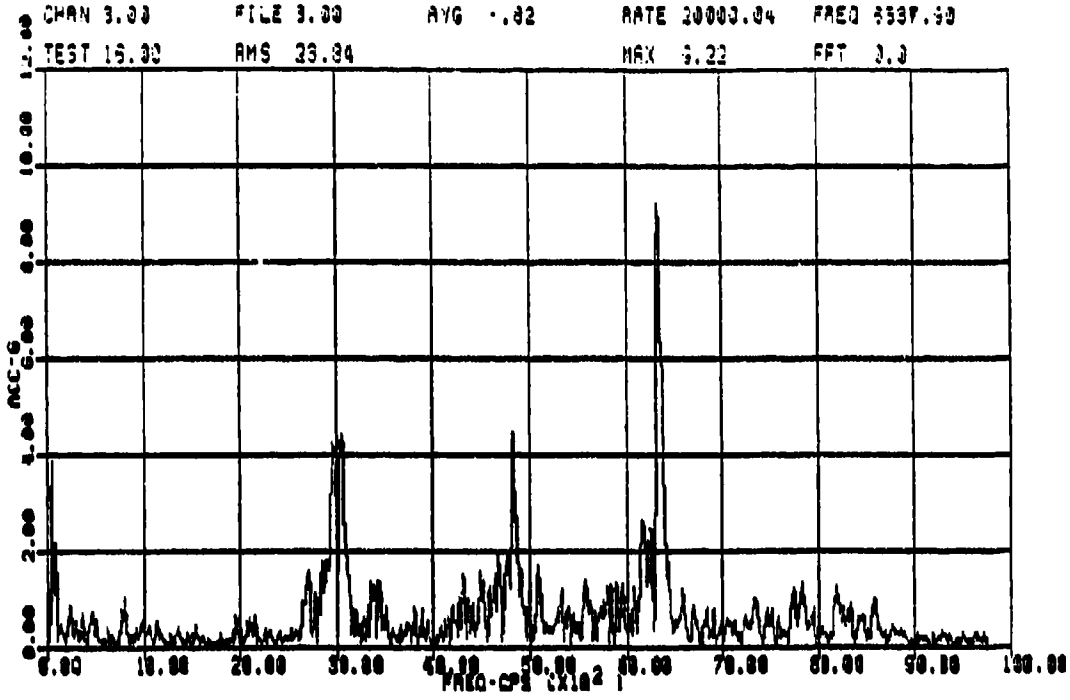
PRECHARGE PRESSURE = 1250 PSI
SYSTEM PRESSURE ≈ 2000 PSI
FLOW CONTROL #6½

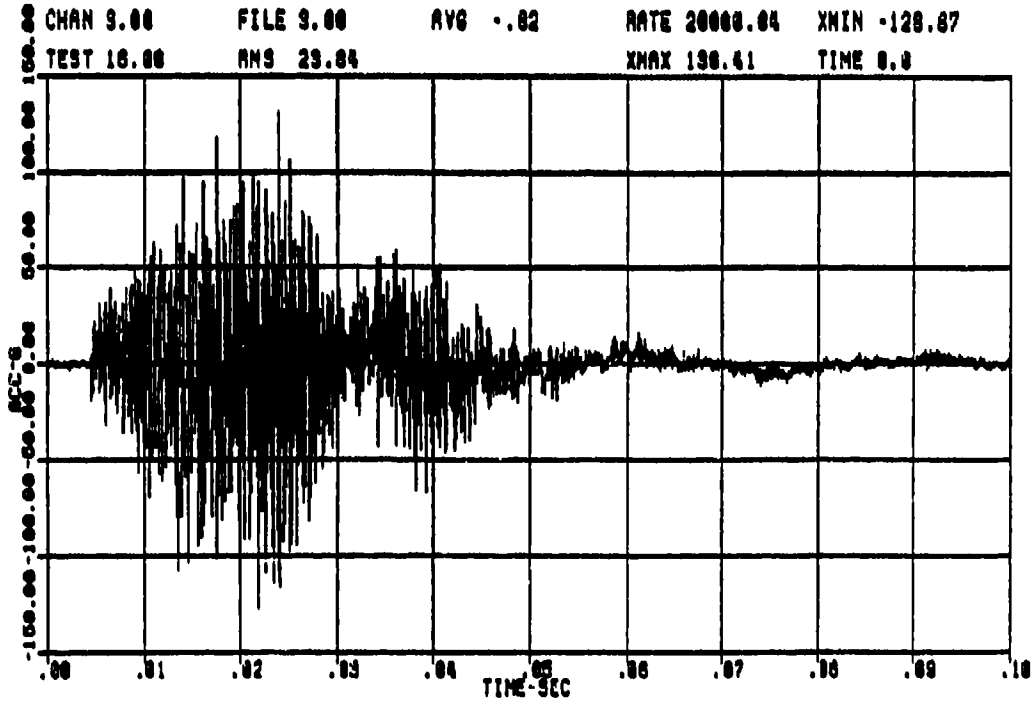

CHAN 1.000
FILE 3.000
AVG .441
RATE 20000.041
XMIN -2.859
TEST 16.000
RMS .939
XMAX 2.000
TIME 0.0
TIME-SEC

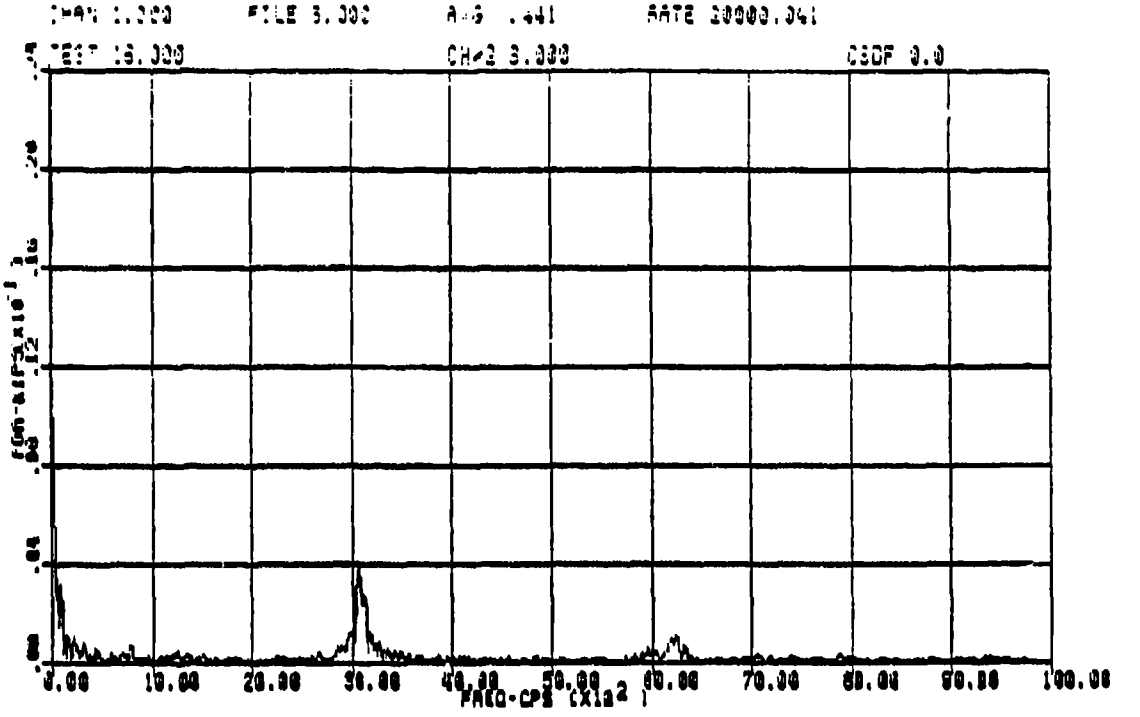

CHAN 1.000
FILE 3.000
AVG .441
RATE 20000.041
FREQ 10.531
TEST 16.000
RMS .849
MAX .518
FFT 0.0

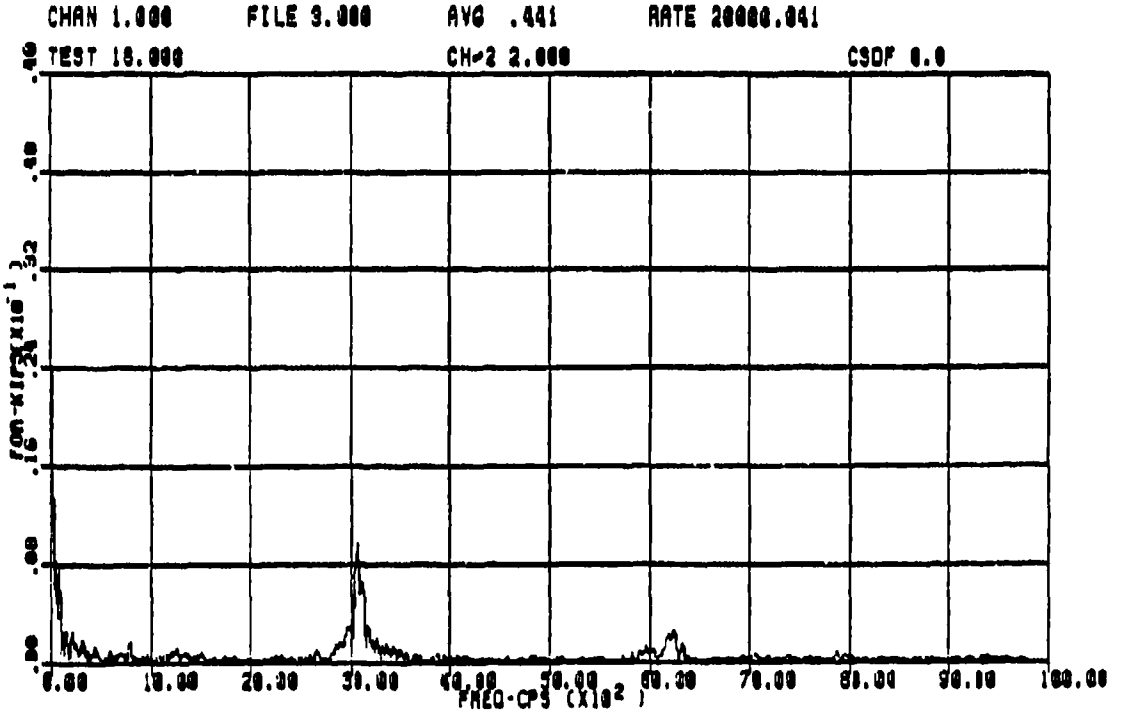

CHAN 2.00
FILE 3.00
AVG -1.16
RATE 20000.04
XMIN -420.55
TEST 16.00
RMS 81.13
XMAX 477.24
TIME 0.0
TIME-SEC

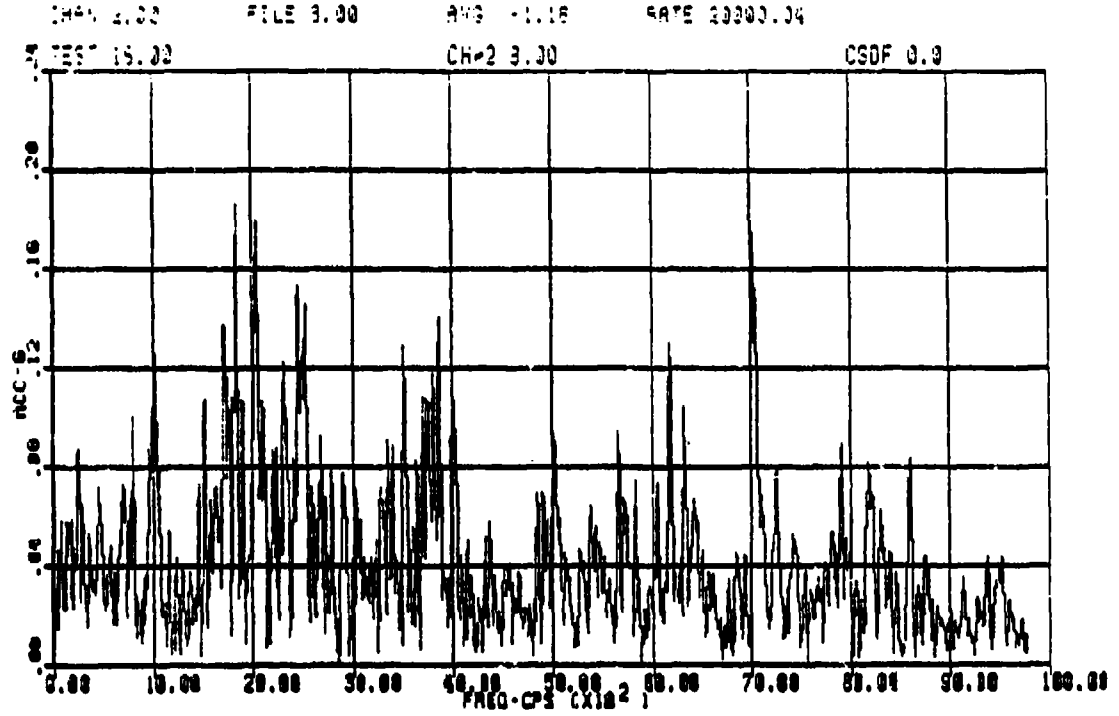

CHAN 2.00
FILE 3.00
AVG -1.16
RATE 20000.04
FREQ 1035.94
TEST 16.00
RMS 81.00
MAX 13.05
FFT 0.0

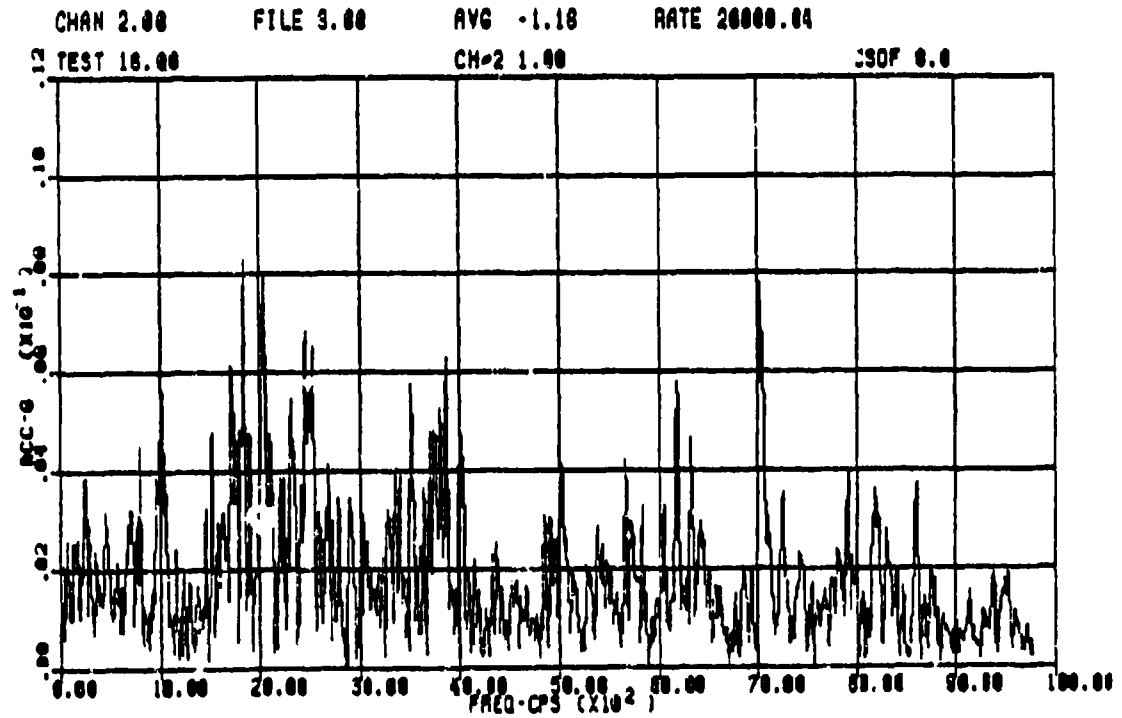

CHAN 3.00
FILE 3.00
AVG .82
RATE 20000.04
FREQ 6537.50
TEST 16.00
RMS 23.84
MAX 3.22
FFT 3.0
ACC-G
FREQ-CPS (X10^2)

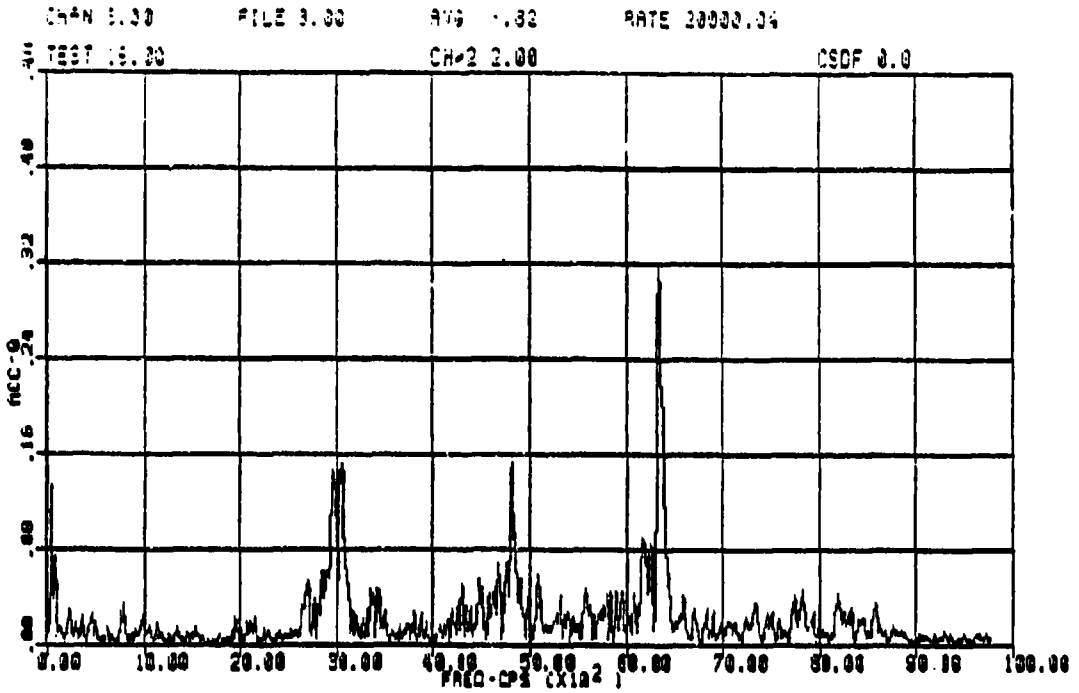

CHAN 3.00
FILE 3.00
AVG .82
RATE 20000.04
XMIN -128.87
TEST 16.00
RMS 29.84
XMAX 136.41
TIME 0.0
ACC-G
TIME-SEC

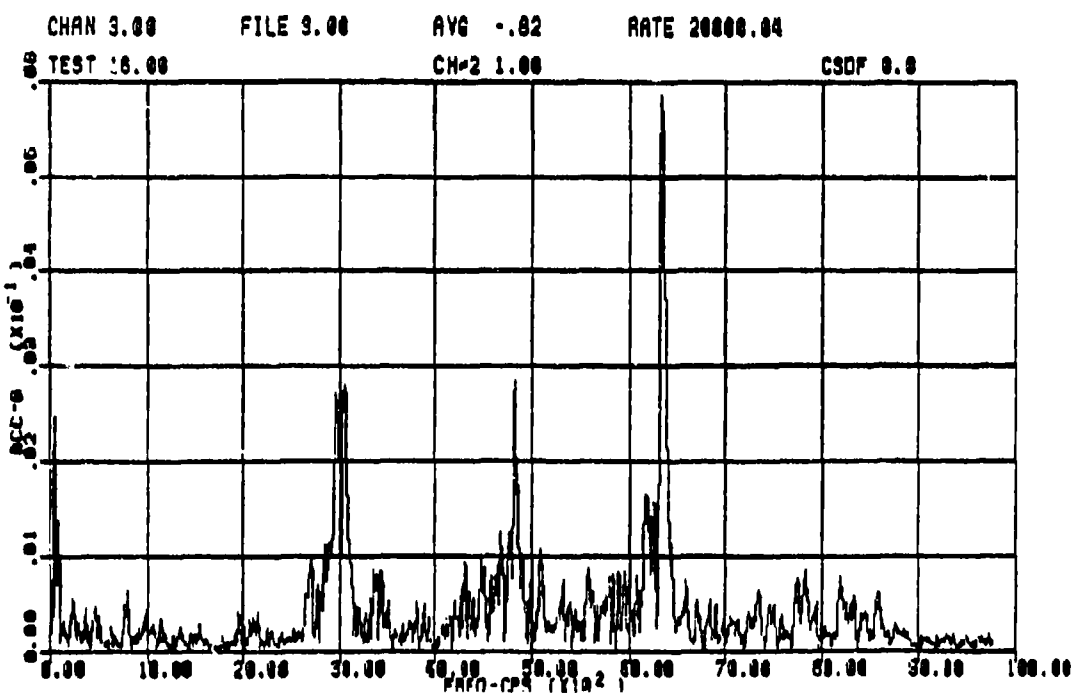

CHAN 1.000 FILE 3.000 AVG .441 RATE 20000.041
TEST 18.000 CH#2 3.000 CSDF 0.0
FREQ-CPS (X10^2)

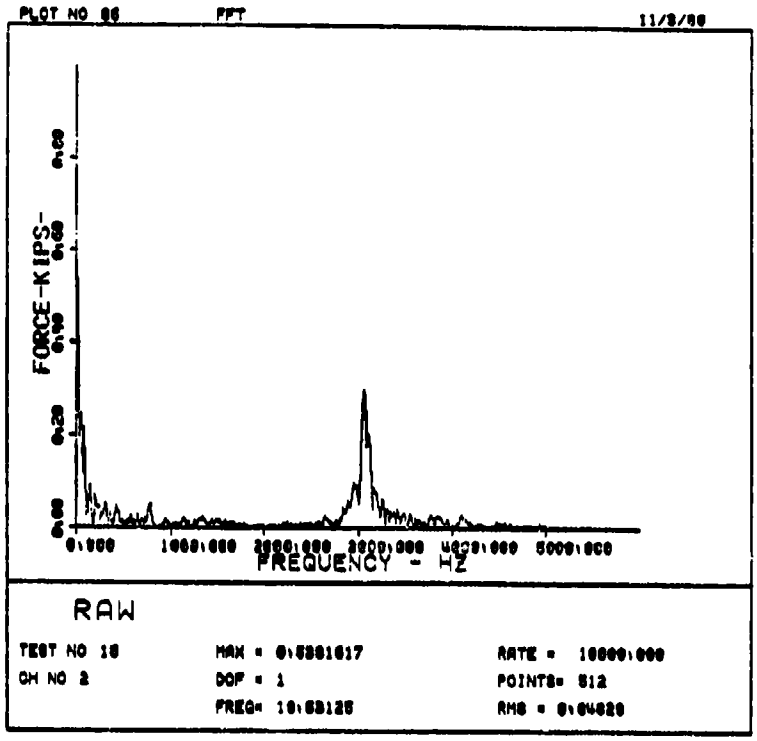

CHAN 1.000 FILE 3.000 AVG .441 RATE 20000.041
TEST 18.000 CH#2 2.000 CSDF 0.0
0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00
FREQ-CPS (X10^2)

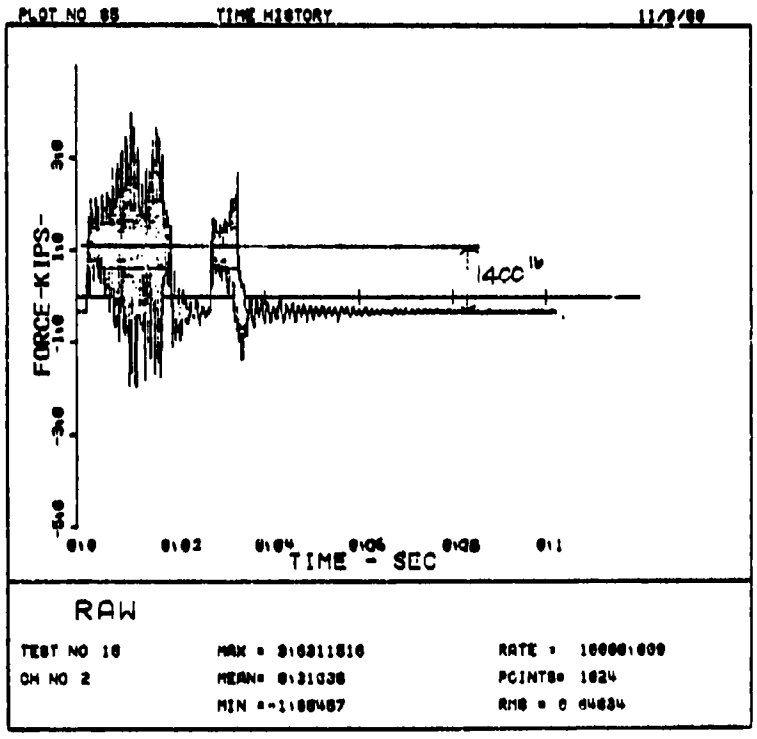

CHAN 2.00 FILE 3.00 AVG -1.18 RATE 20000.04
TEST 16.00 CH#2 3.00 CSDF 0.0
.24
.20
.16
.12
.08
.04
.00
NCC-6
0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00
FREQ-CPS (X10^2)

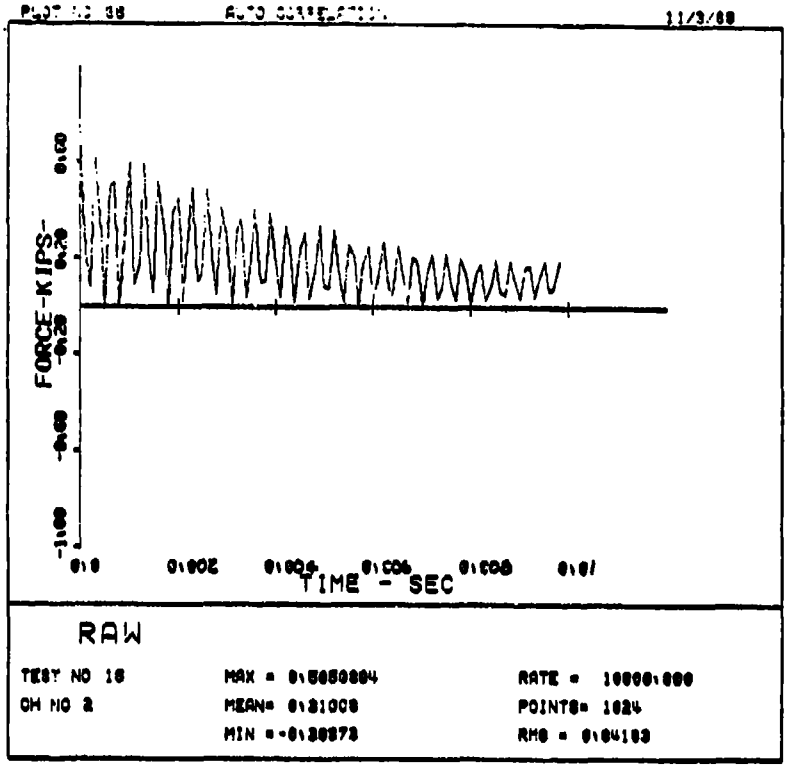

CHAN 2.00 FILE 3.00 AVG -1.18 RATE 20000.04
TEST 16.00 CH#2 1.00 CSDF 0.0
.12
.10
.08
.06
.04
.02
.00
NCC-6 (X10^-1)
0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00
FREQ-CPS (X10^2)

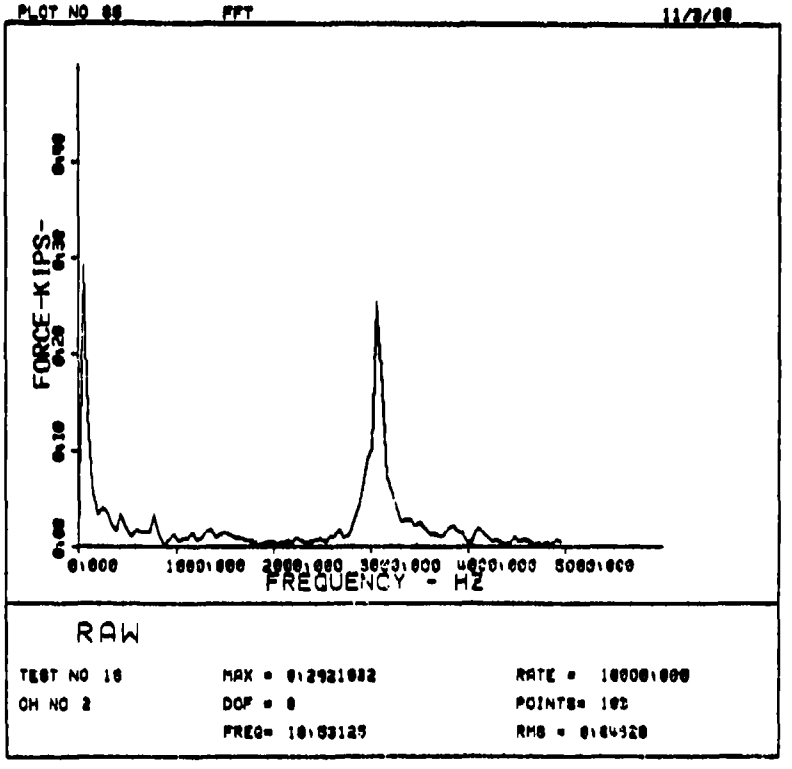

CHAN 3.00 FILE 3.00 AVG -.02 RATE 20000.04
TEST 16.00 CH#2 2.00 CSDF 0.0
.48
.32
.16
.00
0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00

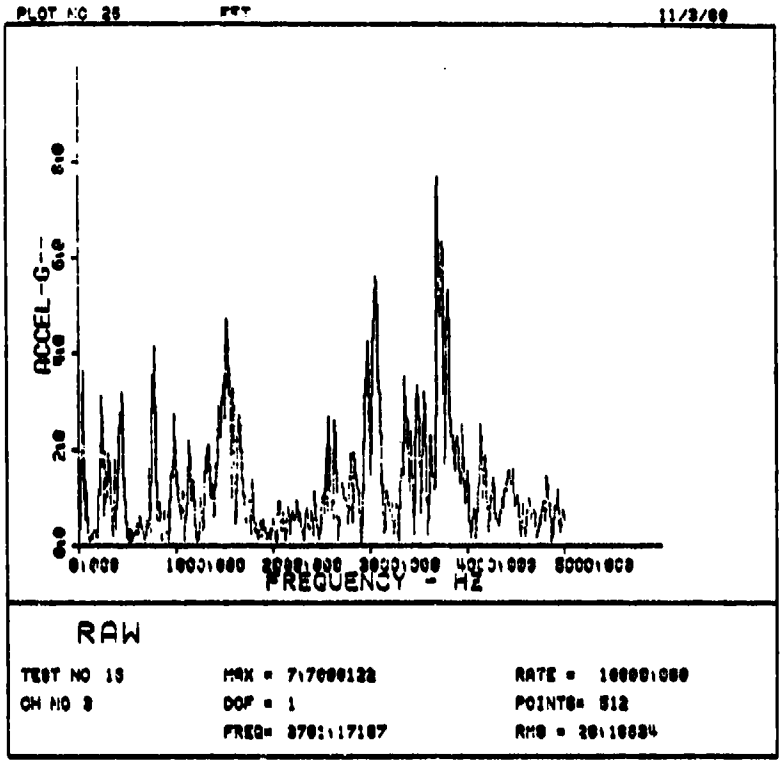

CHAN 3.00 FILE 3.00 AVG -.02 RATE 20000.04
TEST 16.00 CH#2 1.00 CSDF 0.0
.08
.06
.04
.02
.00
0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00

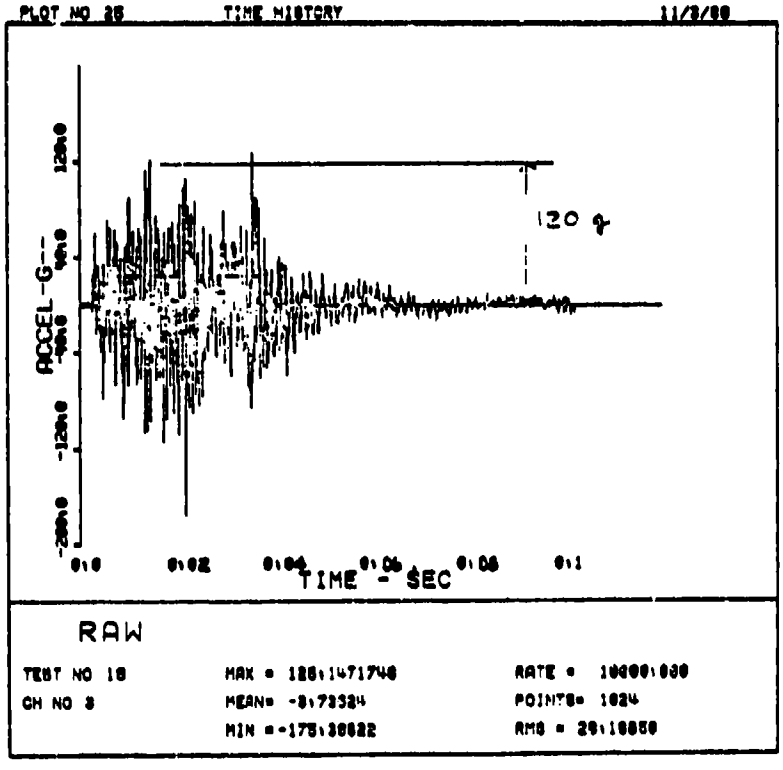

PLOT NO 86
FFT
11/3/89
FORCE-KIPS-
FREQUENCY - HZ
RAW
TEST NO 16
CH NO 2
MAX = 0.5881617
DOF = 1
FREQ= 10.68125
RATE = 10000.000
POINTS= 512
RMS = 0.104828

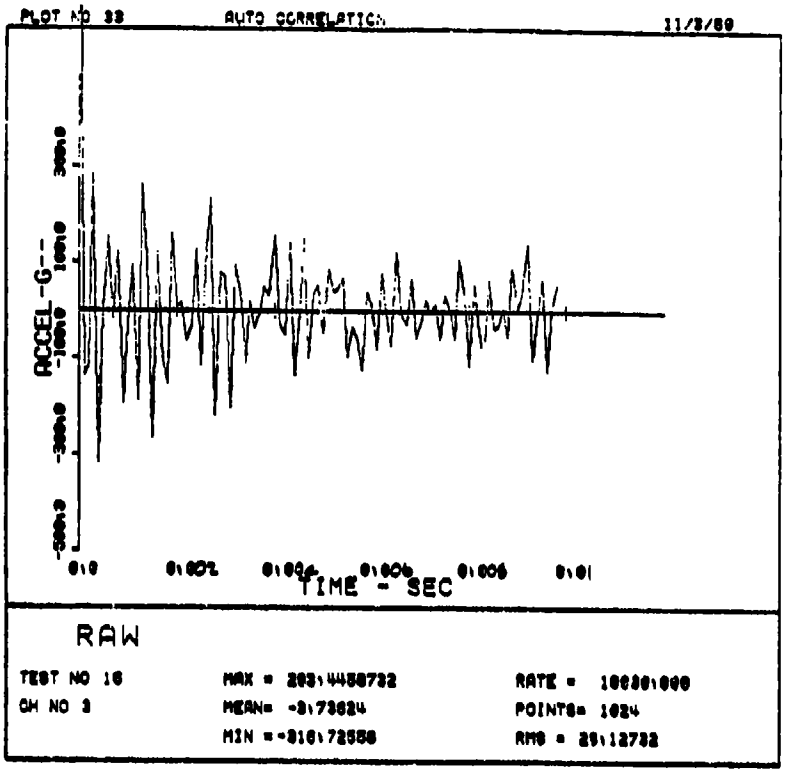

PLOT NO 85
TIME HISTORY
11/3/89
FORCE-KIPS-
TIME - SEC
RAW
TEST NO 16
CH NO 2
MAX = 3.6311516
MEAN= 0.31038
MIN =-1.186487
RATE = 10000.000
POINTS= 1024
RMS = 0.64634

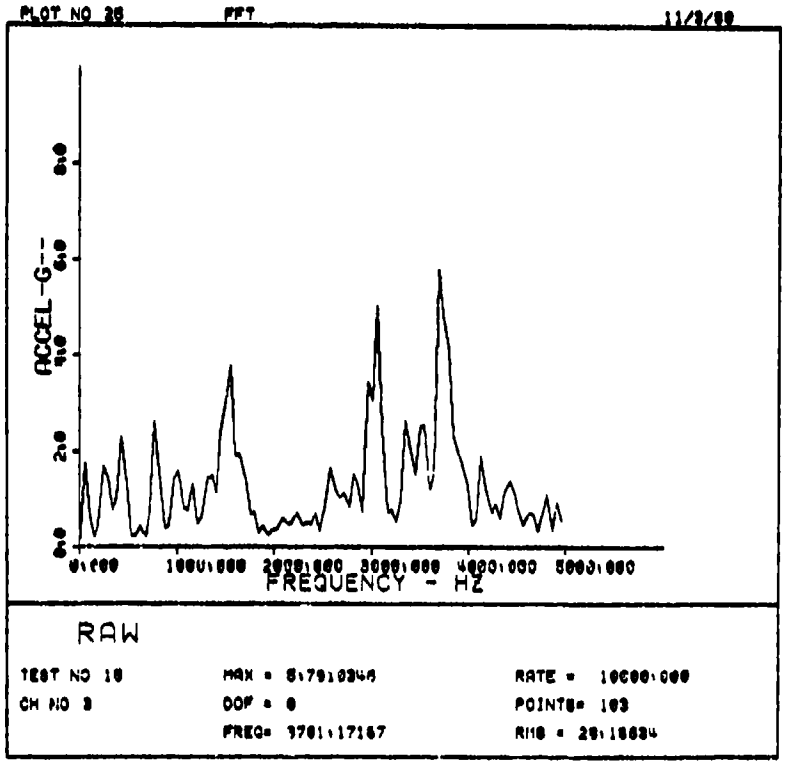

FORCE-KIPS-
TIME - SEC
RAW
TEST NO 16
CH NO 2
MAX =
MEAN=
MIN =
RATE =
POINTS=
RMS =


PLOT NO 86
FFT
FORCE-KIPS-
FREQUENCY - HZ
RAW
TEST NO 16
CH NO 2
MAX =
DOF =
FREQ=
RATE =
POINTS=
RMS =

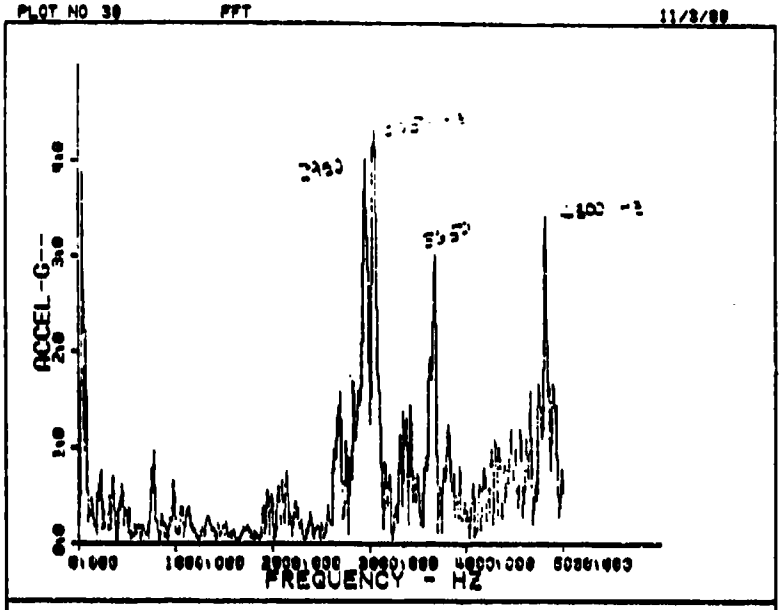

PLOT NO 25
FFT
11/3/89
ACCEL-G--
FREQUENCY - HZ
RAW
TEST NO 19
CH NO 3
MAX = 7.7690122
DOF = 1
FREQ= 370.17187
RATE = 10000.000
POINTS= 512
RMS = 20.10834


PLOT NO 26
TIME HISTORY
11/3/89
ACCEL-G--
120 g
TIME - SEC
RAW
TEST NO 19
CH NO 3
MAX = 126.1471748
MEAN= -8.73324
MIN =-175.38622
RATE = 10000.000
POINTS= 1024
RMS = 29.10859


PLOT NO 33
AUTO CORRELATION
11/3/89
ACCEL -G--
TIME - SEC
RAW
TEST NO 16
CH NO 3
MAX = 293.4458732
MEAN= -3.73624
MIN = -316.72558
RATE = 10000.000
POINTS= 1024
RMS = 29.12732


PLOT NO 26
FFT
11/3/89
ACCEL -G--
FREQUENCY - HZ
RAW
TEST NO 16
CH NO 3
MAX = 5.7910346
DOF = 0
FREQ= 3701.17167
RATE = 10000.000
POINTS= 103
RMS = 29.18634

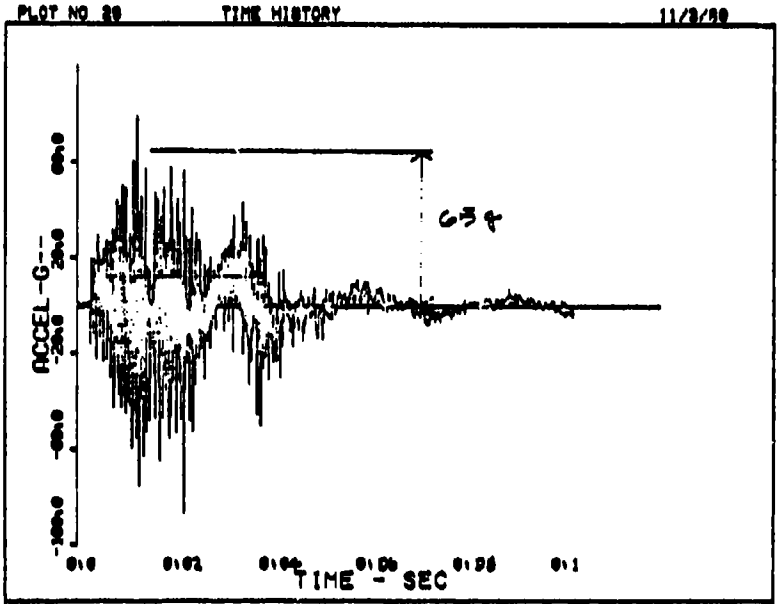
PLOT NO 30 FFT 11/3/80



RAW

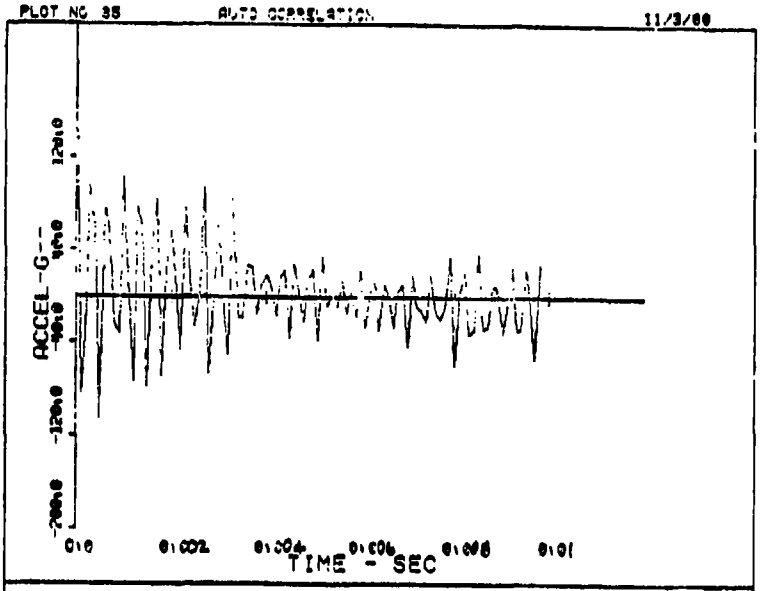
TEST NO 15 MAX = 4.3158540 RATE = 10000.000
CH NO 4 DOF = 1 POINTS= 512
FREQ= 3056.64052 RMS = 15.36031

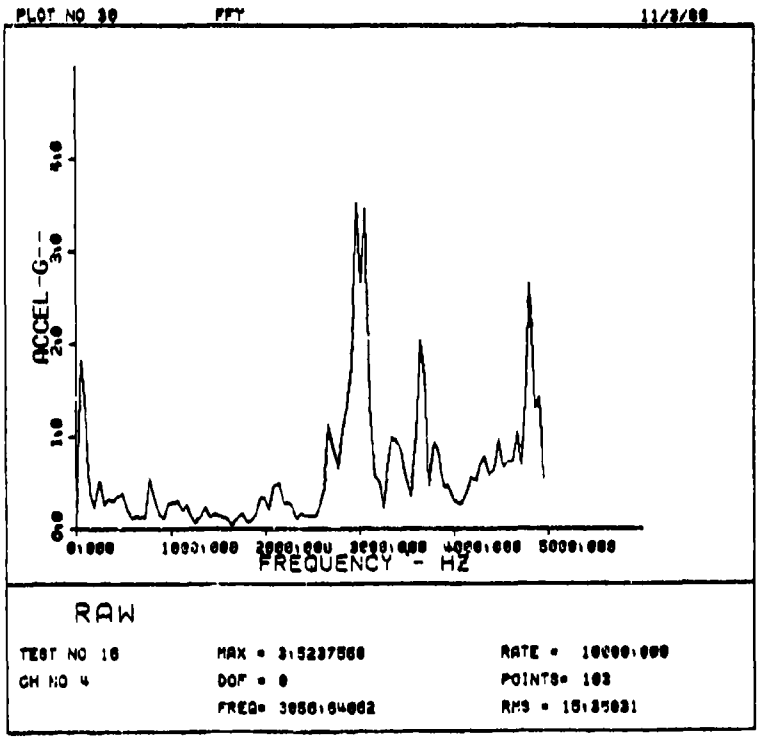
PLOT NO 20 TIME HISTORY 11/3/80



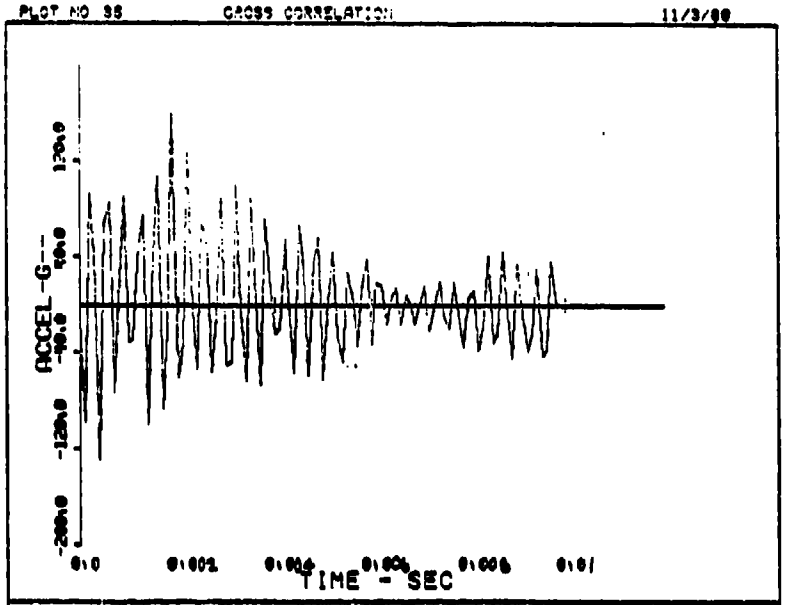
RAW

TEST NO 15 MAX = 78.6158512 RATE = 10000.000
CH NO 4 MEAN= -51.17632 POINTS= 1024
MIN = -88.60541 RMS = 15.37050


PLOT NO 38
AUTO CORRELATION
11/3/88
ACCEL -G--
TIME - SEC
RAW
TEST NO 16
CH NO 4
MAX = 102.1457185
MEAN= -51.17632
MIN =-103.88174
RATE = 10000.000
POINTS= 1024
RMS = 15.34203


PLOT NO 39
FFT
11/3/88
ACCEL -G--
FREQUENCY - HZ
RAW
TEST NO 16
CH NO 4
MAX = 3.5237568
DOF = 0
FREQ= 3956.64062
RATE = 10000.000
POINTS= 103
RMS = 15.35031

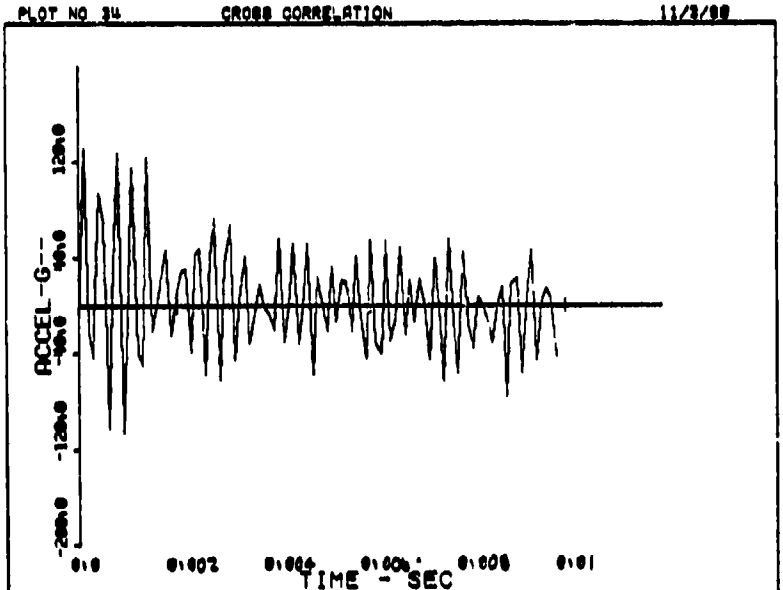
PLOT NO 35 CROSS CORRELATION 11/3/80



RAW

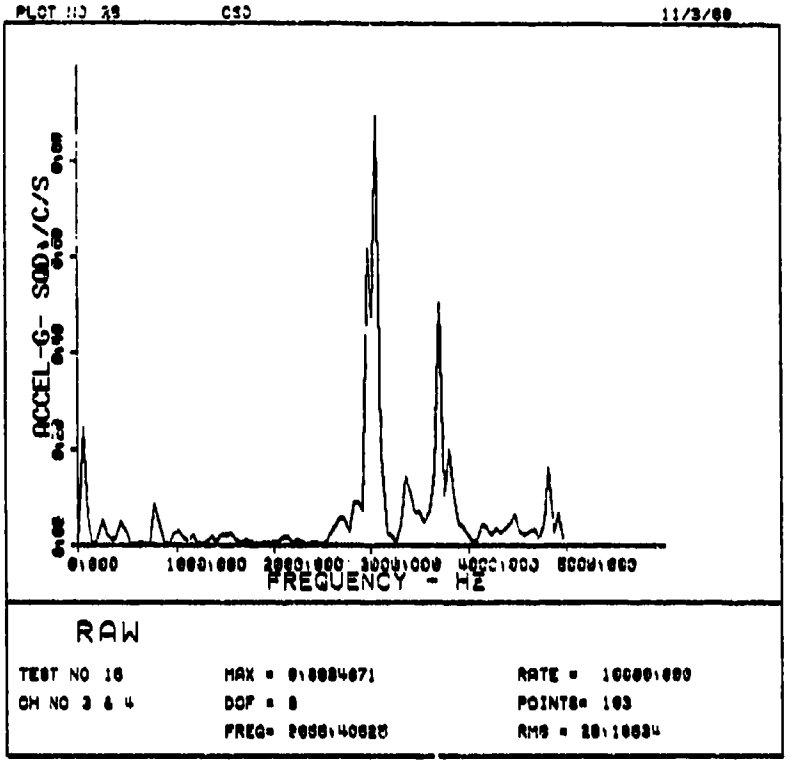
TEST NO 15 MAX = 150.3557493 RATE = 10000.000
CH NO 4 & 3 MEAN= -51.17832 POINTS= 1024
MIN =-128.79552 RMS = 15.37050

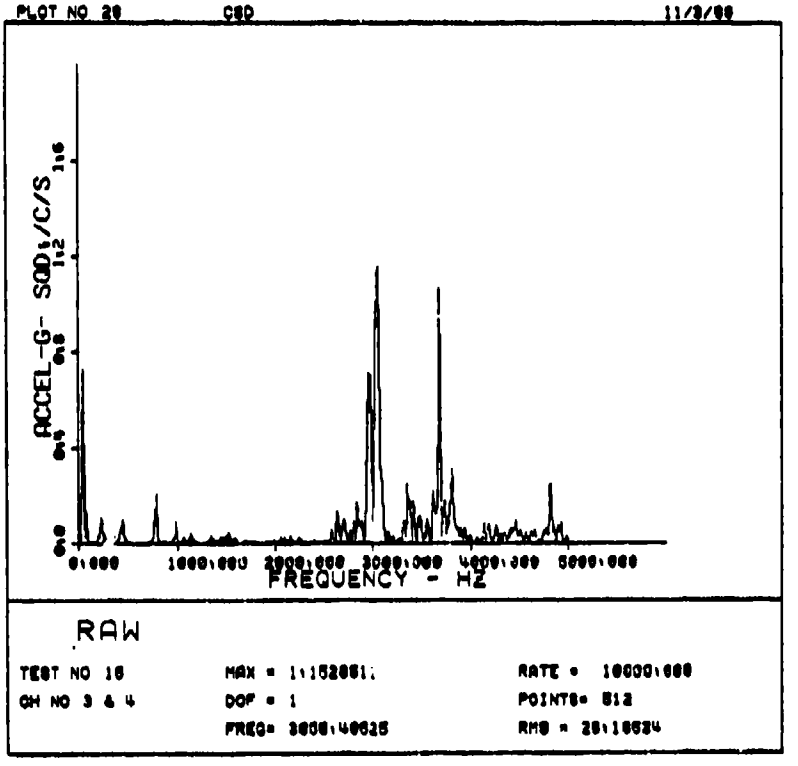
PLOT NO 34 CROSS CORRELATION 11/3/80



RAW

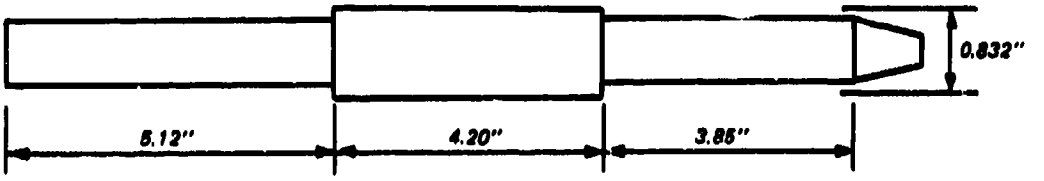
TEST NO 16 MAX = 132.2032020 RATE = 10000.000
CH NO 3 & 4 MEAN= -3.73524 POINTS= 1024
MIN =-105.85750 RMS = 20.18050


PLOT NO 28
CSD
11/3/80
ACCEL-G- SQD$_i$/C/S
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
FREQUENCY - HZ
RAW
TEST NO 16
CH NO 3 & 4
MAX = 0.0084671
DOF = 8
FREQ= 2656.40625
RATE = 10000.000
POINTS= 103
RMS = 28.18634


PLOT NO 28
CSD
11/3/80
ACCEL-G- SQD$_i$/C/S
0.0
0.4
0.8
1.2
1.6
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
FREQUENCY - HZ
RAW
TEST NO 16
CH NO 3 & 4
MAX = 1.1528611
DOF = 1
FREQ= 3656.40625
RATE = 10000.000
POINTS= 512
RMS = 28.18634

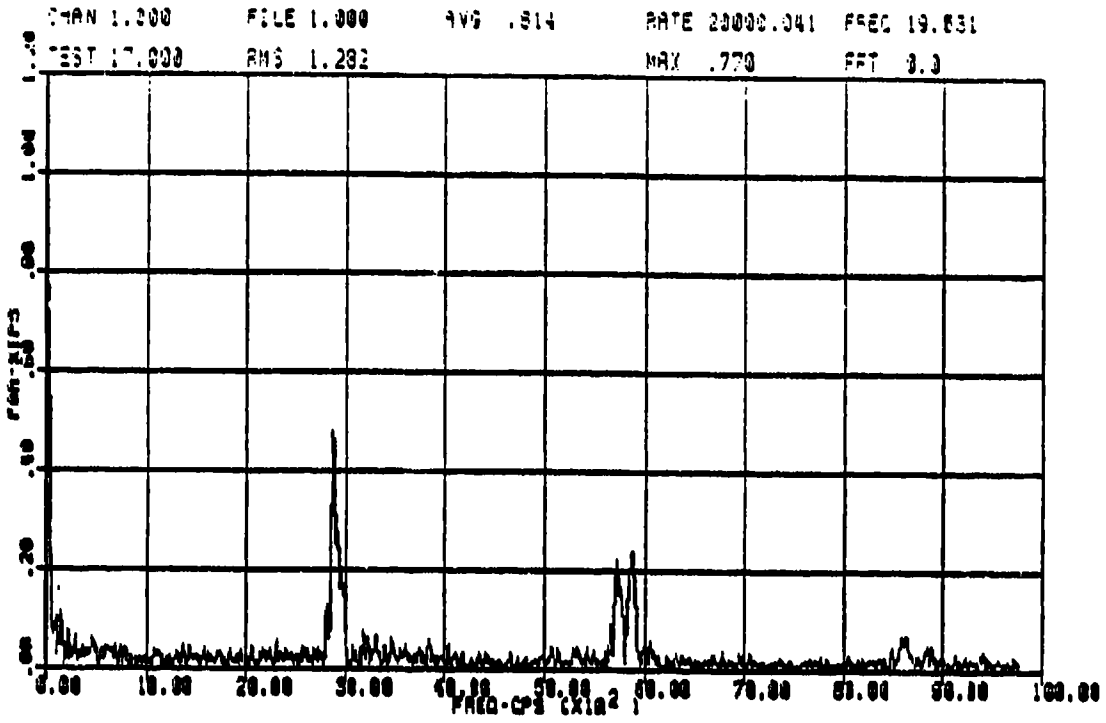
APPENDIX D: TEST 17 DATA

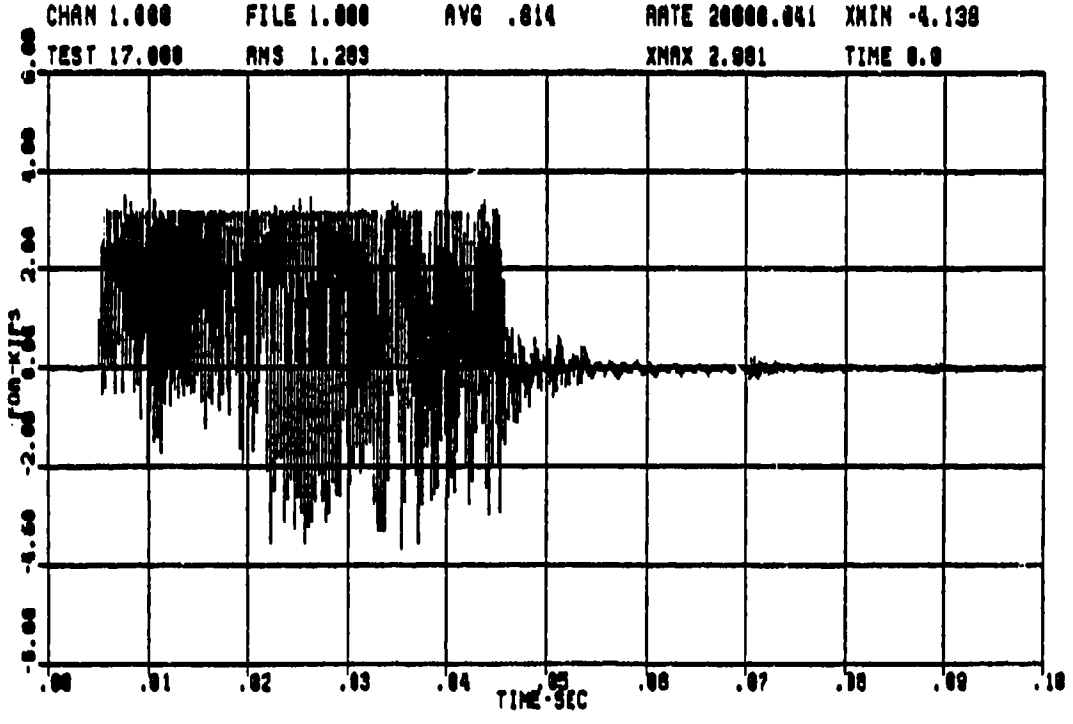
Test 17
Equipment Rack Hard-Mounted
AN/GRC-103 in Rack, Off-Line

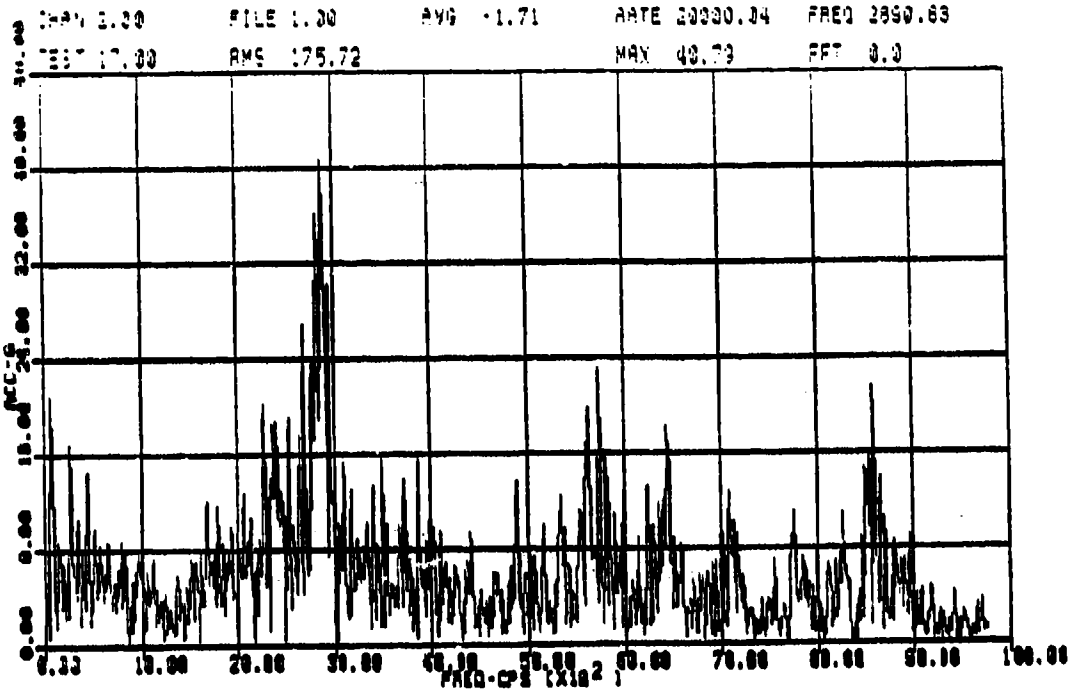


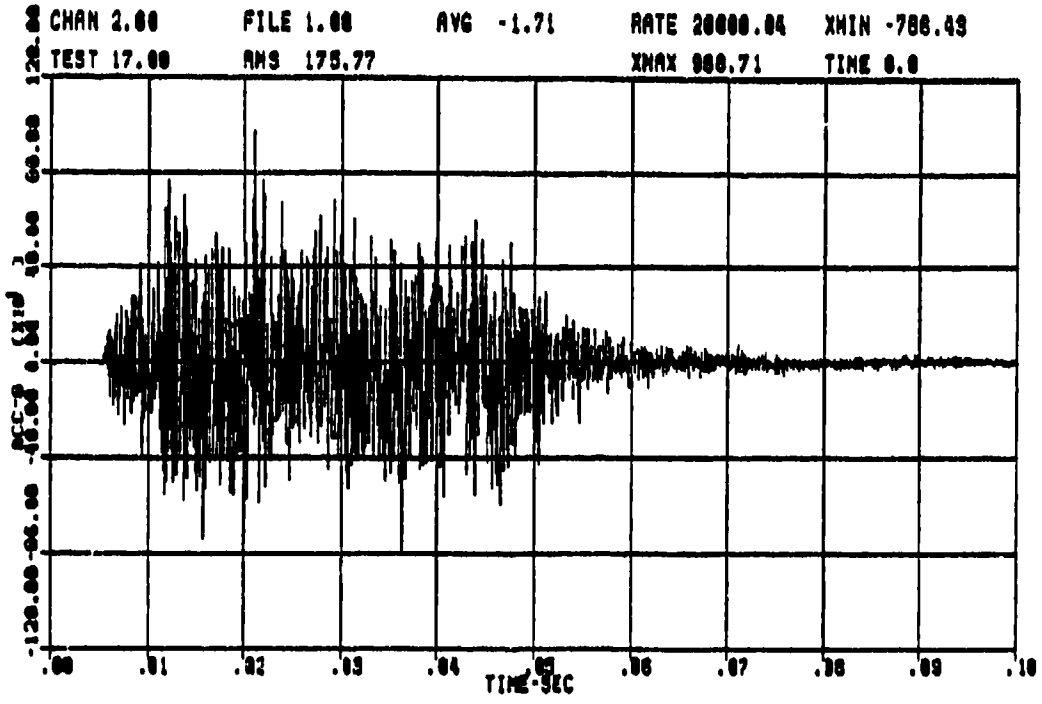
PULSE TRAIN - TEST 17

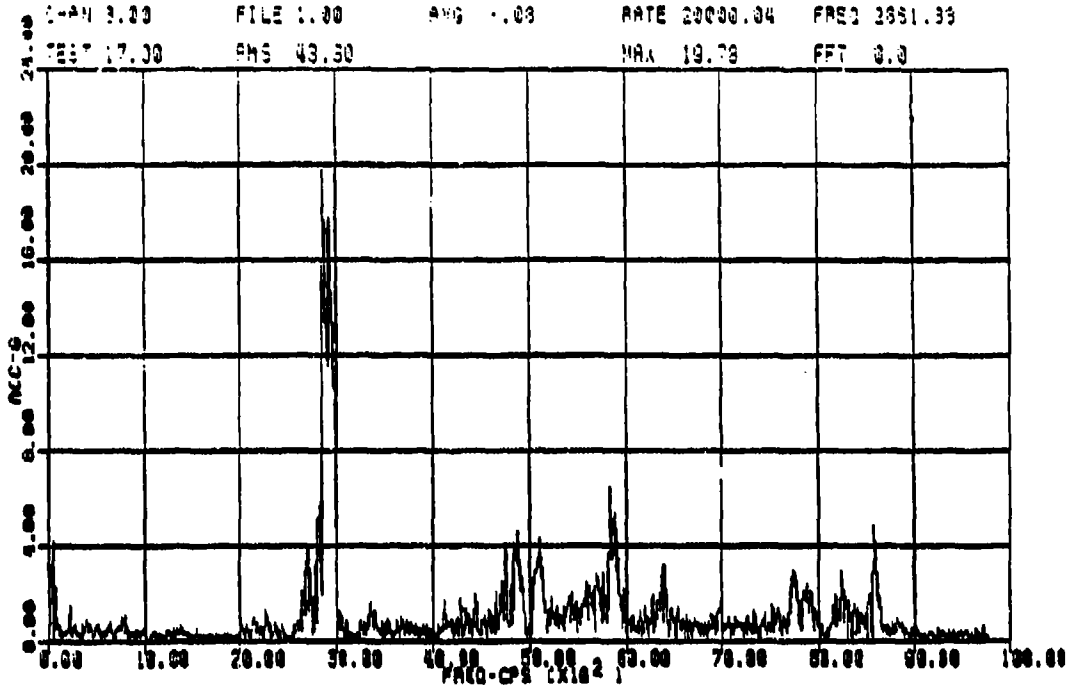
PRECHARGE PRESSURE = 1250 PSI
SYSTEM PRESSURE = 2000 PSI
FLOW CONTROL #6½

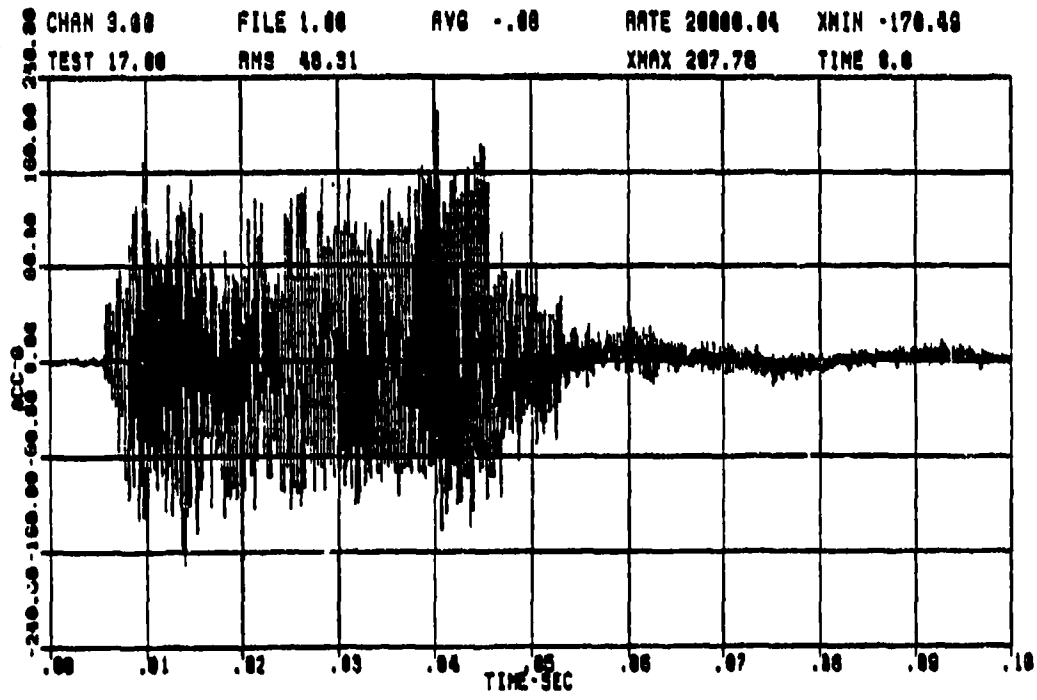

CHAN 1.000
FILE 1.000
AVG .814
RATE 20000.041
FREQ 19.831
TEST 17.000
RMS 1.282
MAX .770
FFT 0.0
FREQ-CPS (X10^2)

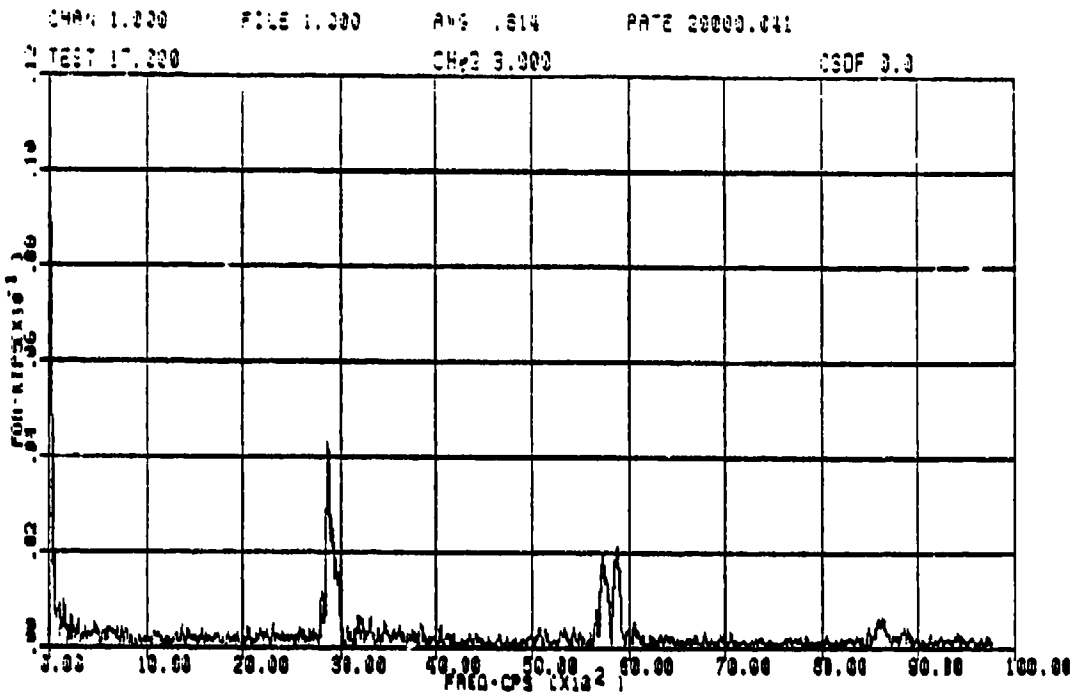

CHAN 1.000
FILE 1.000
AVG .814
RATE 20000.041
XMIN -4.139
TEST 17.000
RMS 1.283
XMAX 2.981
TIME 0.0
TIME-SEC

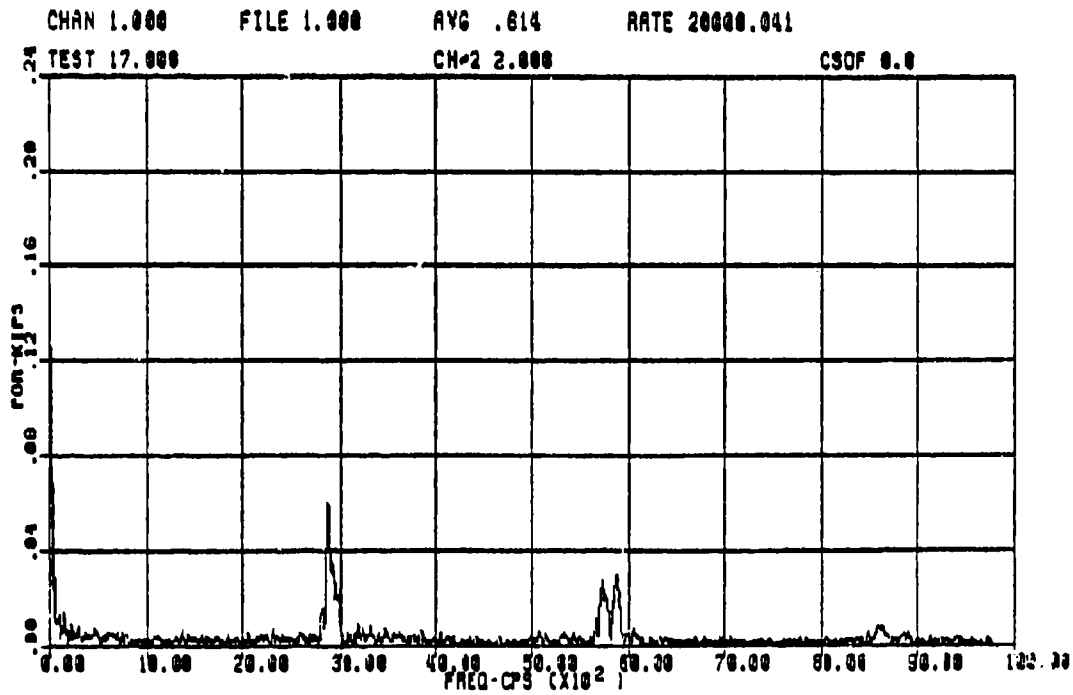

FILE 1.00
AVG -1.71
RMS 175.72
MAX 40.79
FREQ-CPS (X10^2)

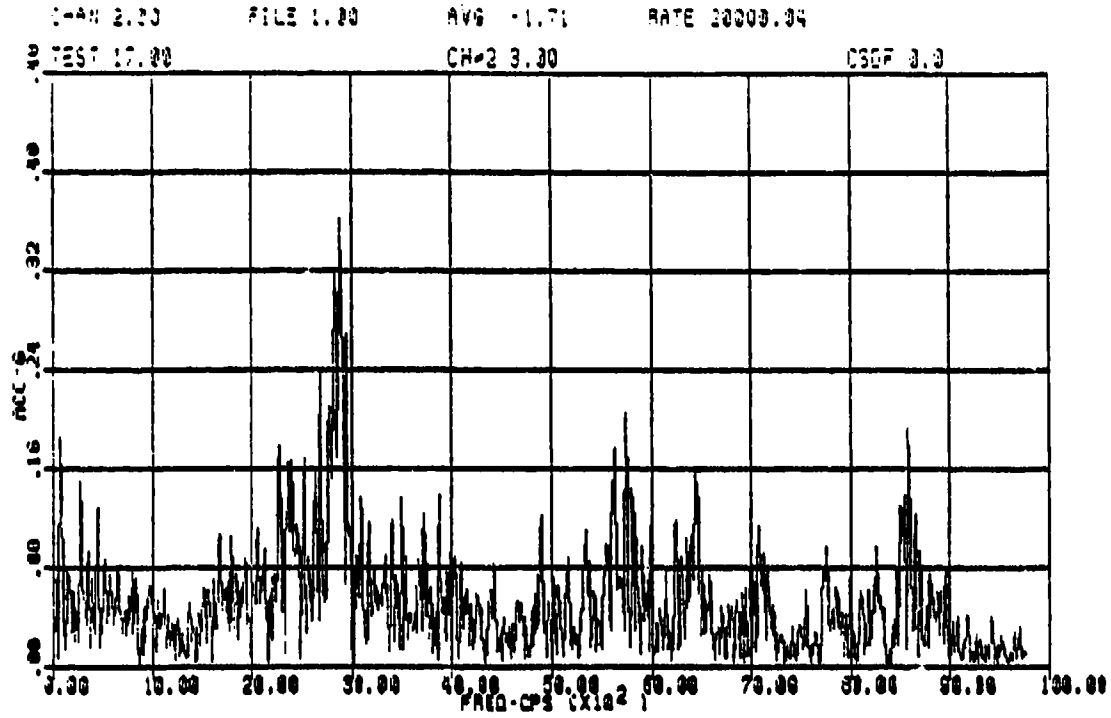

CHAN 2.00
FILE 1.00
AVG -1.71
RATE 20000.04
XMIN -788.49
TEST 17.00
RMS 175.77
XMAX 988.71
TIME 0.0
TIME-SEC

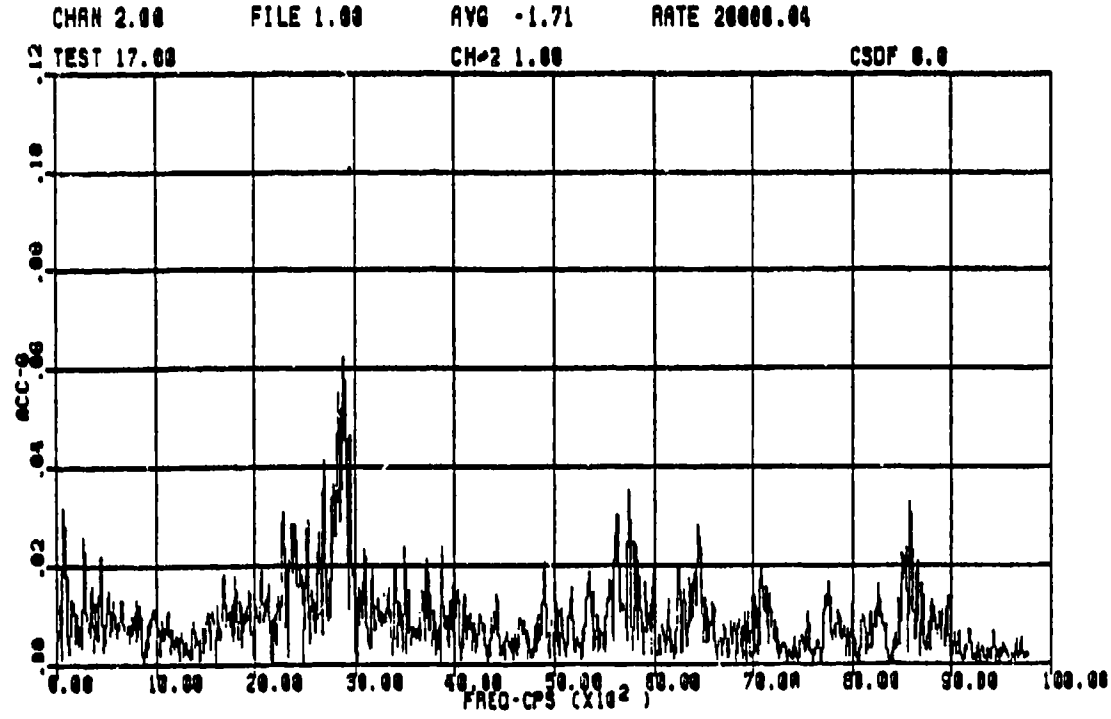

FILE 1.00
AVG -.03
RATE 20000.04
FREQ 3851.33
RMS 43.30
MAX 19.78
FFT 0.0
ACC-G
FREQ-CPS (X10^2)

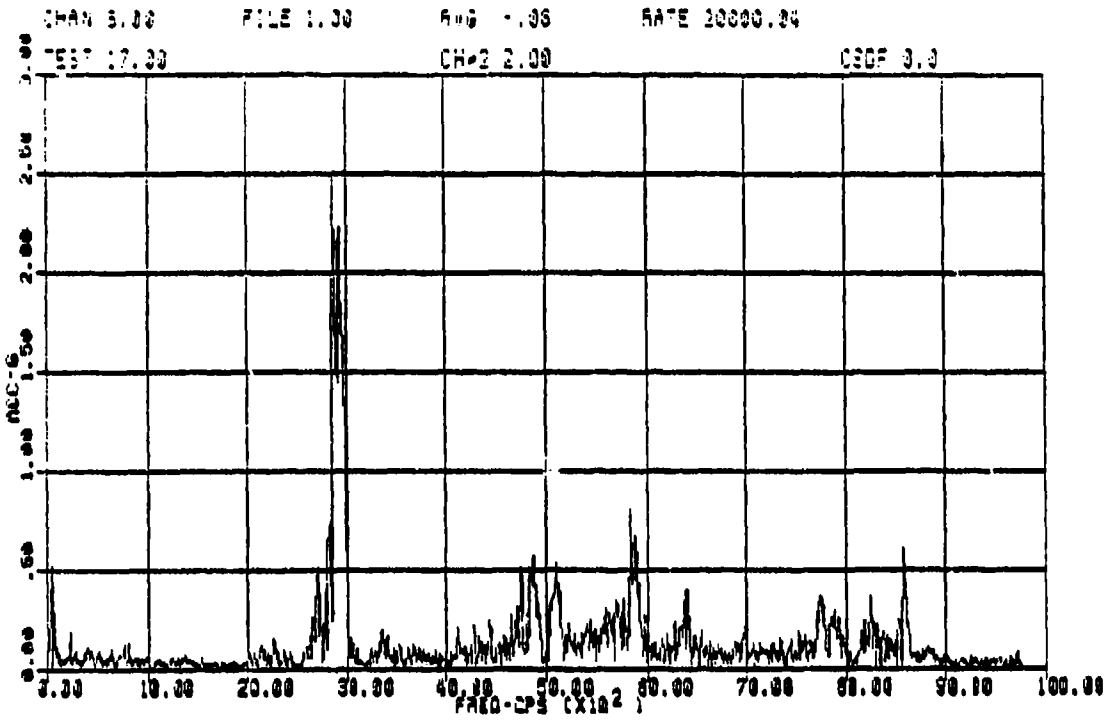

CHAN 9.00
FILE 1.00
AVG -.00
RATE 20000.04
XMIN -170.48
TEST 17.00
RMS 48.31
XMAX 207.76
TIME 0.0
ACC-G
TIME-SEC

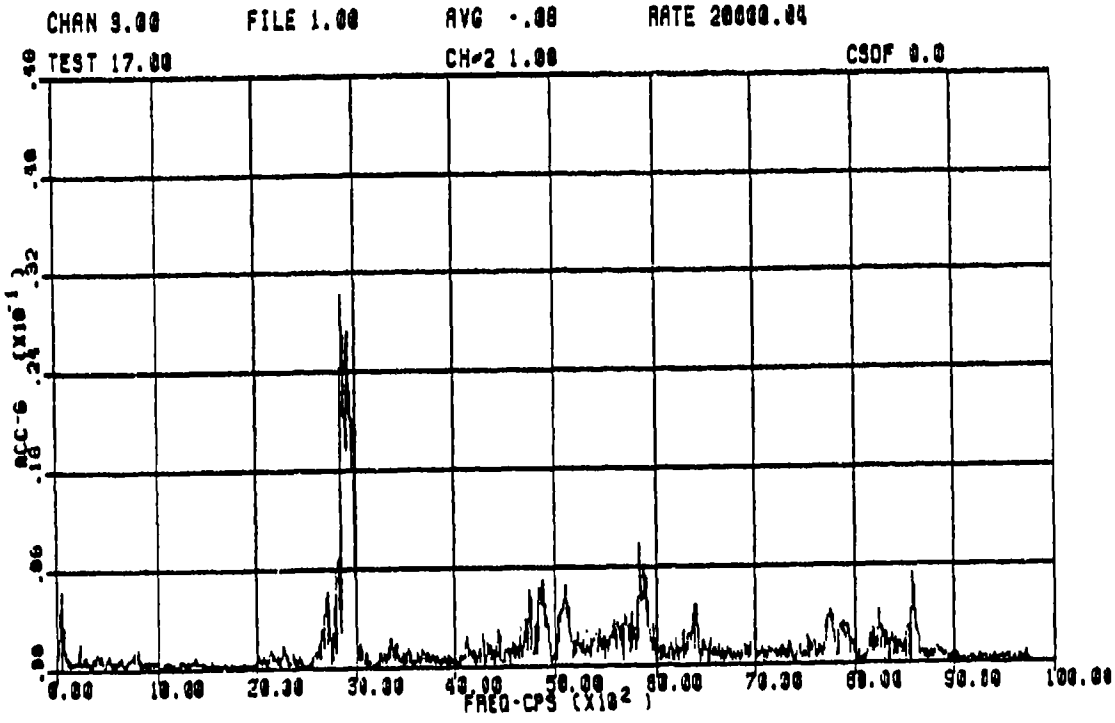

CHAN 1.000
FILE 1.000
AVG .614
RATE 20000.041
TEST 17.000
CH#2 3.000
CSOF 0.0
FREQ-CPS (X10^2)

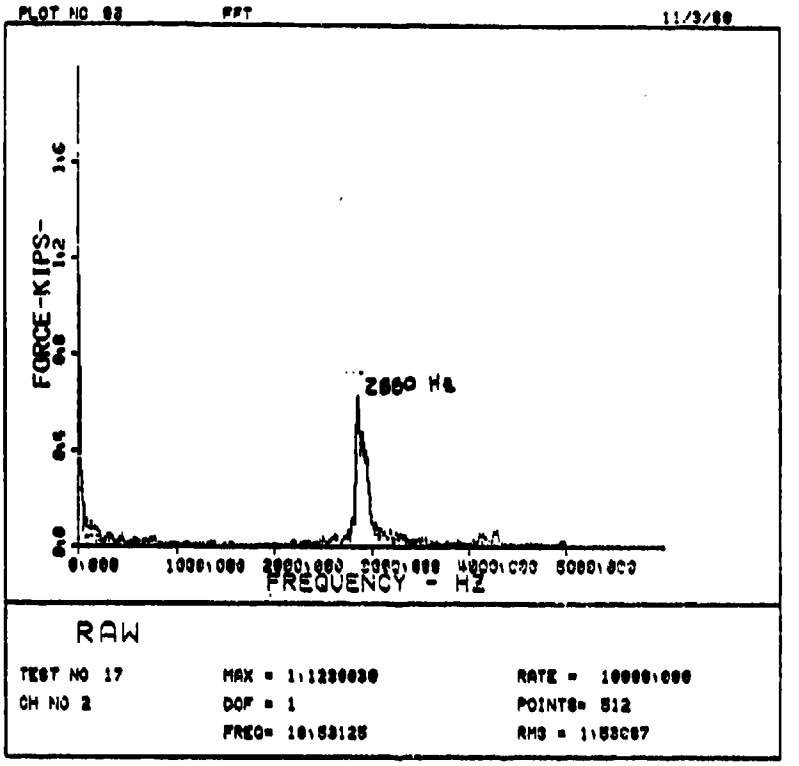

CHAN 1.000
FILE 1.000
AVG .614
RATE 20000.041
TEST 17.000
CH#2 2.000
CSOF 0.0
FREQ-CPS (X10^2)

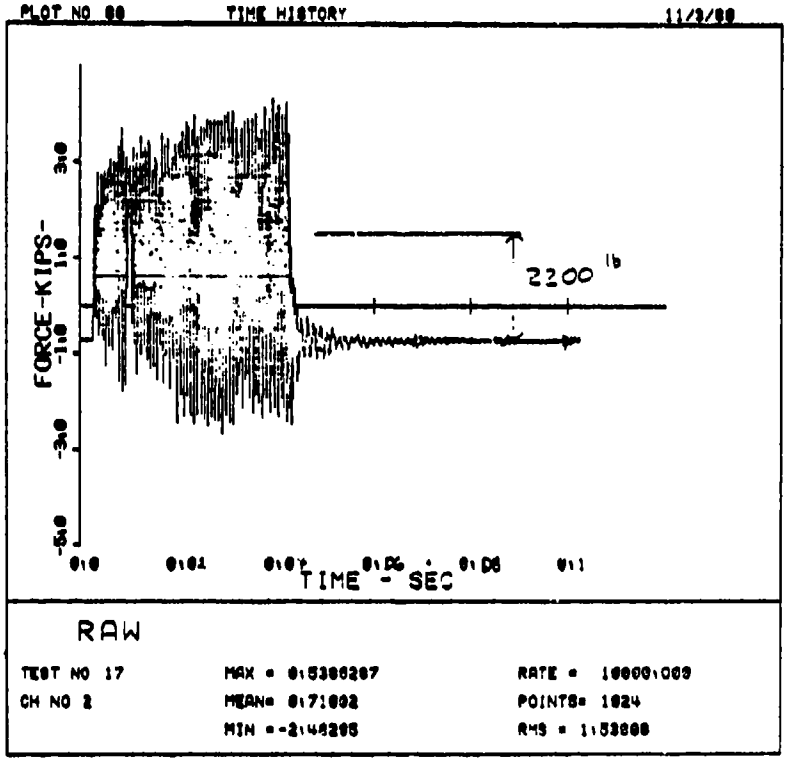

CHAN 2.00 FILE 1.00 AVG -1.71 RATE 20000.04
TEST 17.00 CH#2 3.00 CSDF 0.0
.40
.32
.24
.16
.08
.00
ACC-G
0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00
FREQ-CPS (X10^2)

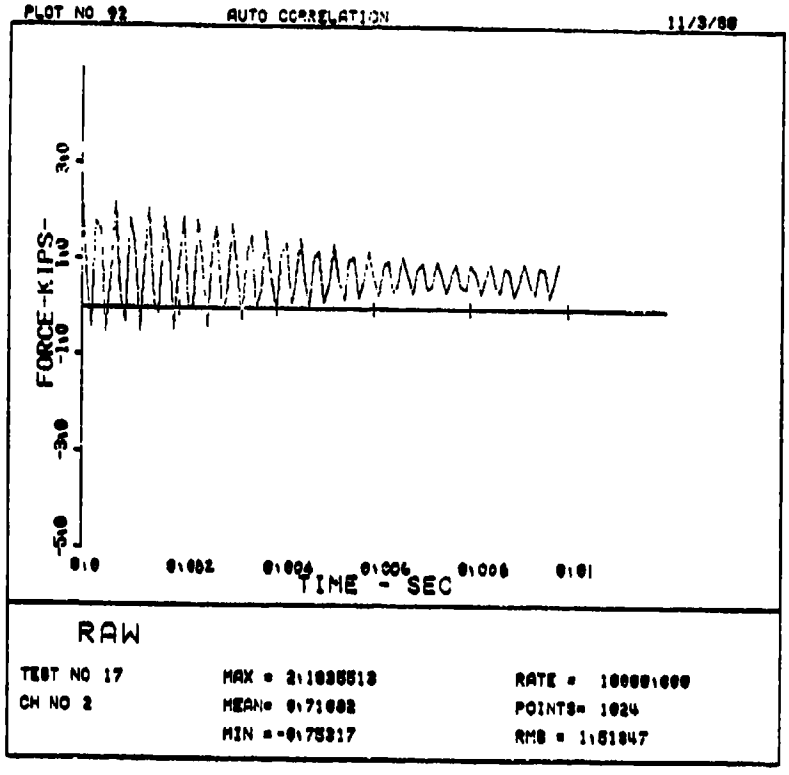

CHAN 2.00 FILE 1.00 AVG -1.71 RATE 20000.04
TEST 17.00 CH#2 1.00 CSDF 0.0
.12
.10
.08
.06
.04
.02
.00
ACC-G
0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00 90.00 100.00
FREQ-CPS (X10^2)

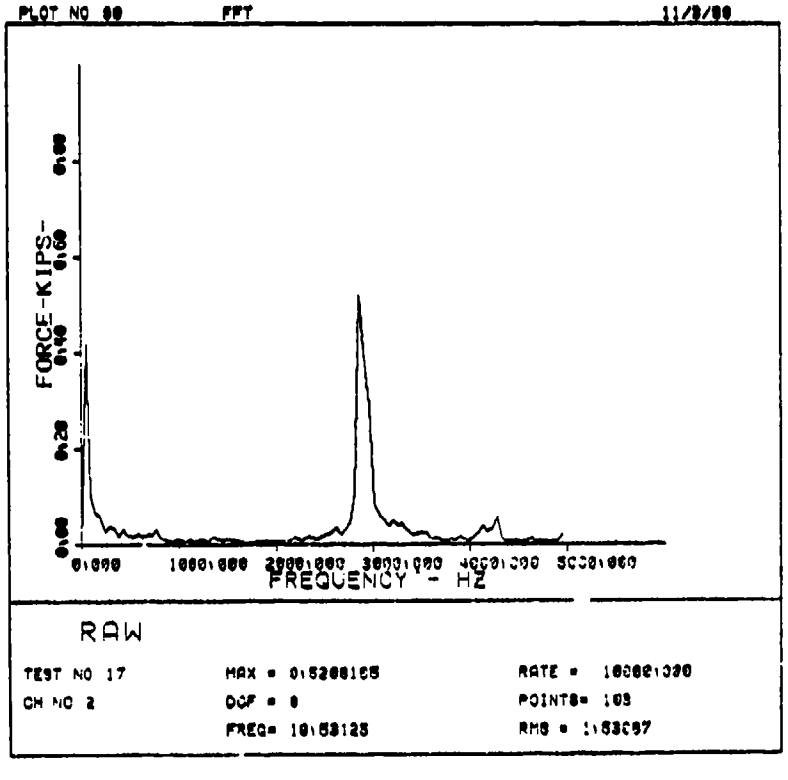

CHAN 9.00
FILE 1.00
AVG -.00
RATE 20000.00
TEST 17.00
CH#2 2.00
CSOF 0.0
ACC-G
FREQ-CPS (X10^2)

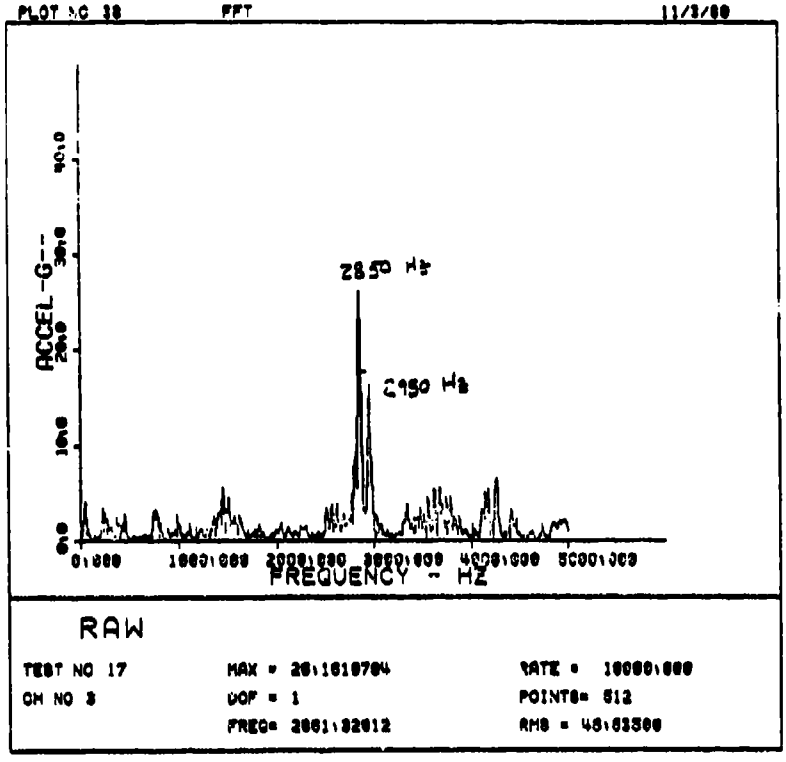

CHAN 9.00
FILE 1.00
AVG -.00
RATE 20000.00
TEST 17.00
CH#2 1.00
CSOF 0.0
ACC-G (X10^-1)
FREQ-CPS (X10^2)

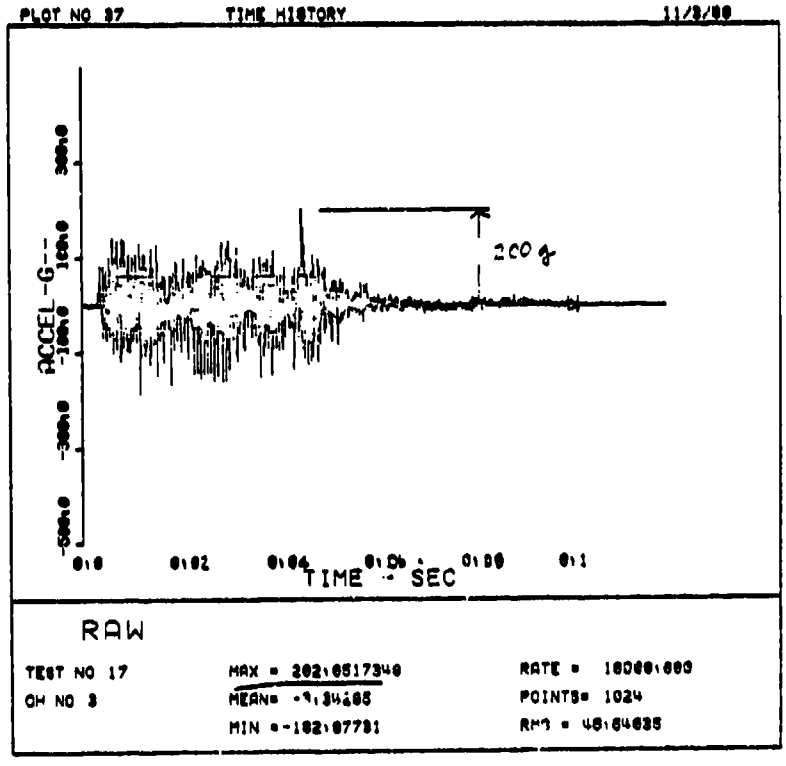

PLOT NO 88
FFT
11/3/88
FORCE-KIPS-
2800 Hz
FREQUENCY - HZ
RAW
TEST NO 17
CH NO 2
MAX = 1.1230030
DOF = 1
FREQ= 10.53125
RATE = 10000.000
POINTS= 512
RMS = 1.53C07


PLOT NO 89
TIME HISTORY
11/3/89
FORCE-KIPS-
2200 lb
TIME - SEC
RAW
TEST NO 17
CH NO 2
MAX = 0.5386287
MEAN= 0.71092
MIN = -2.146295
RATE = 10000.000
POINTS= 1024
RMS = 1.53888

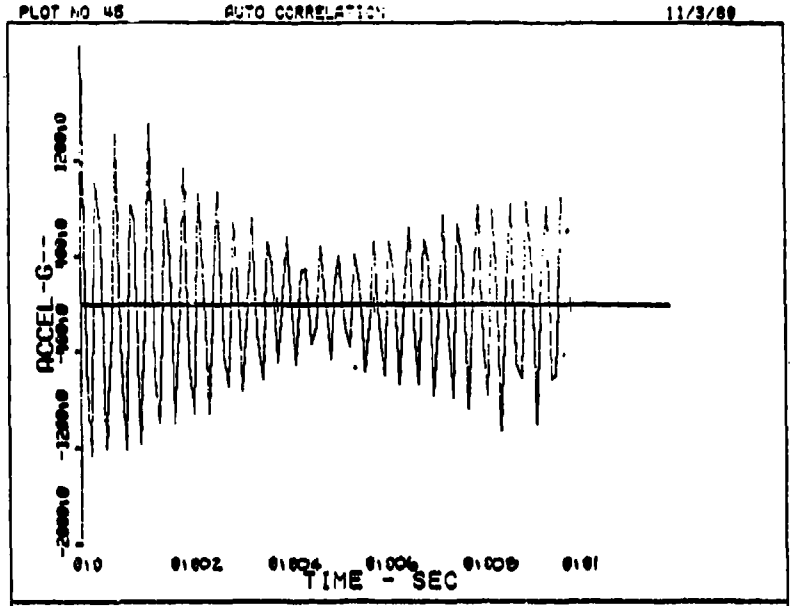

PLOT NO 92
AUTO CORRELATION
11/3/88
FORCE-KIPS-
TIME - SEC
RAW
TEST NO 17
CH NO 2
MAX = 2.1036513
MEAN= 0.71002
MIN = -0.75317
RATE = 1000.000
POINTS= 1024
RMS = 1.61847


PLOT NO 90
FFT
11/3/88
FORCE-KIPS-
FREQUENCY - HZ
RAW
TEST NO 17
CH NO 2
MAX = 0.5208105
DOF = 0
FREQ= 10.53125
RATE = 1000.000
POINTS= 103
RMS = 1.53097


PLOT NO 38
FFT
11/3/80
ACCEL -G--
2850 Hz
2950 Hz
FREQUENCY - HZ
RAW
TEST NO 17
CH NO 3
MAX = 20.1610704
DOF = 1
FREQ= 2861.32012
RATE = 10000.000
POINTS= 512
RMS = 46.63500


PLOT NO 37
TIME HISTORY
11/3/80
ACCEL -G--
200 g
TIME - SEC
RAW
TEST NO 17
CH NO 3
MAX = 202.6517340
MEAN= -9.34285
MIN =-182.87731
RATE = 10000.000
POINTS= 1024
RMS = 46.64635

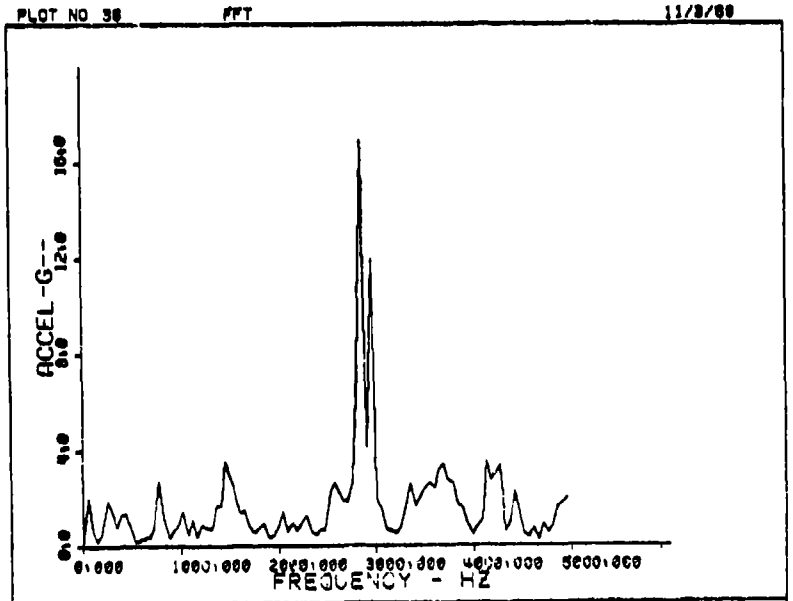
PLOT NO 45 AUTO CORRELATION 11/3/80



RAW

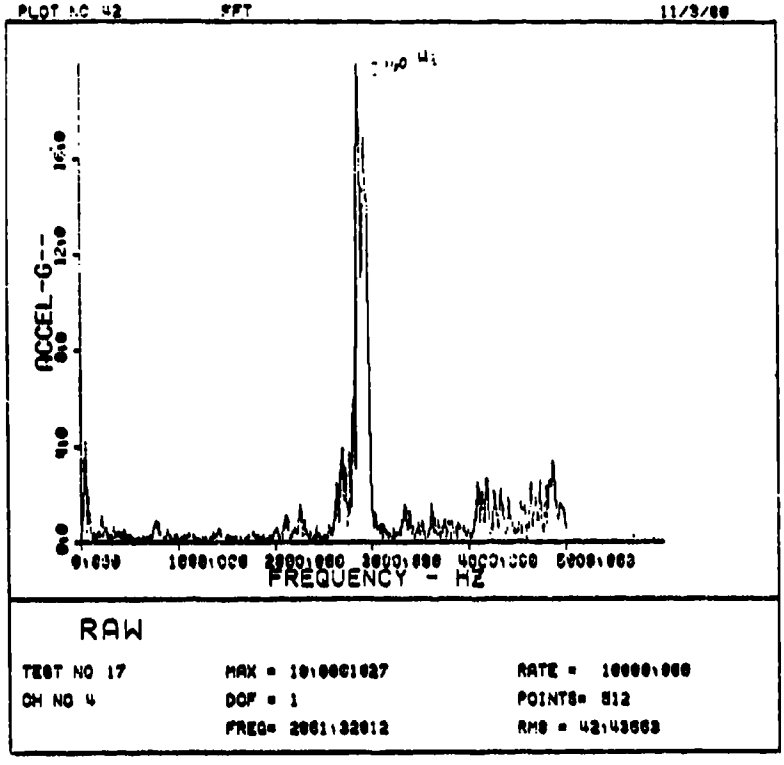
TEST NO 17	MAX = 1515.4858542	RATE = 10000.000
CH NO 3	MEAN= -3.34295	POINTS= 1024
	MIN =-1260.52071	RMS = 45.37092

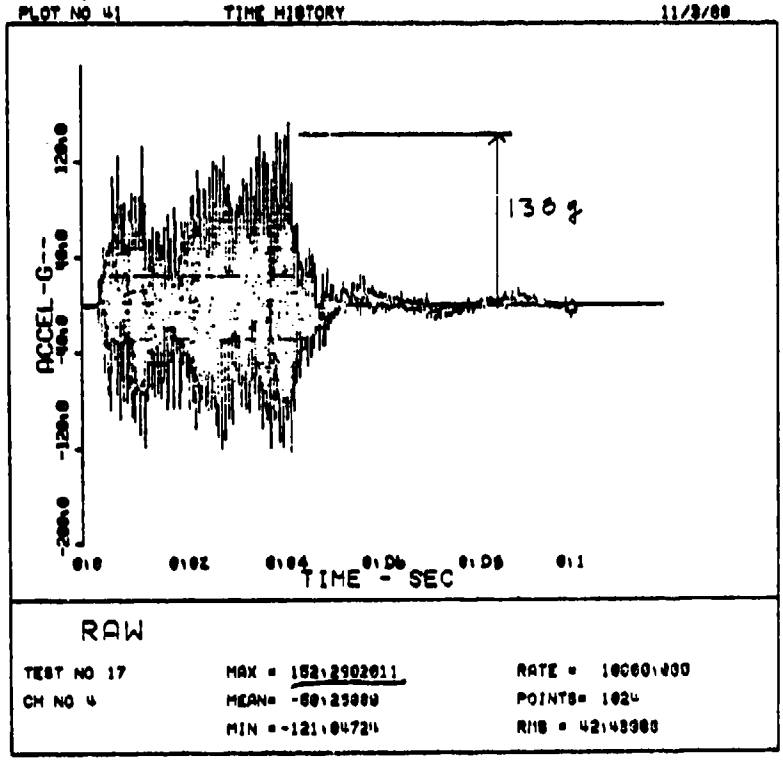
PLOT NO 38 FFT 11/3/80



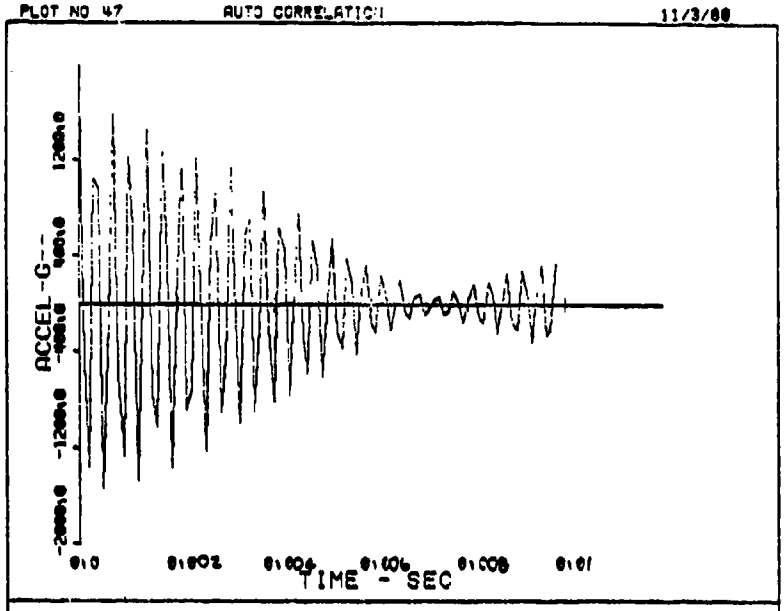
RAW

TEST NO 17	MAX = 16.8932170	RATE = 10000.000
CH NO 3	DCF = 0	POINTS= 103
	FREQ= 2651.32612	RMS = 45.63500


PLOT NO 42
FFT
11/3/88
ACCEL-G--
FREQUENCY - HZ
RAW
TEST NO 17
CH NO 4
MAX = 19.0061827
DOF = 1
FREQ= 2061.32812
RATE = 10000.000
POINTS= 512
RMS = 42.43663


PLOT NO 41
TIME HISTORY
11/3/88
ACCEL-G--
130 g
TIME - SEC
RAW
TEST NO 17
CH NO 4
MAX = 152.2902611
MEAN= -60.25989
MIN = -121.0472
RATE = 10000.000
POINTS= 1024
RMS = 42.43663

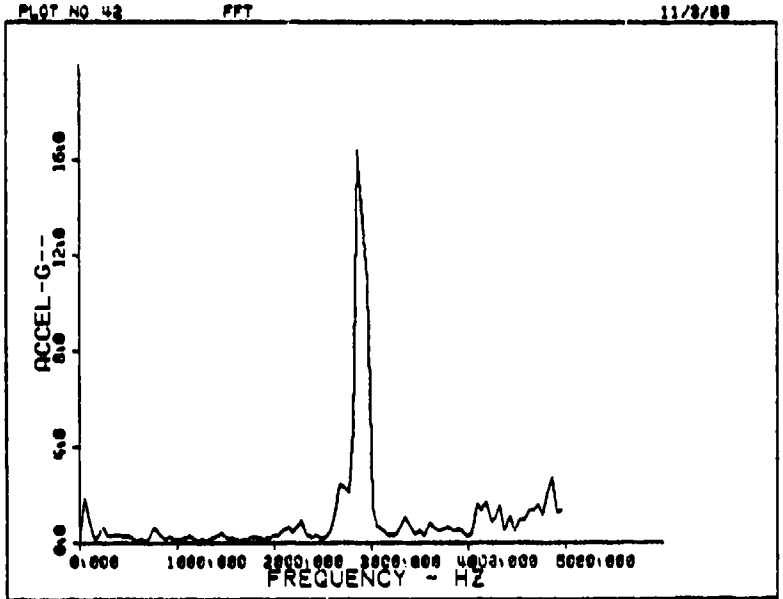
PLOT NO 47 AUTO CORRELATION 11/3/80



RAW

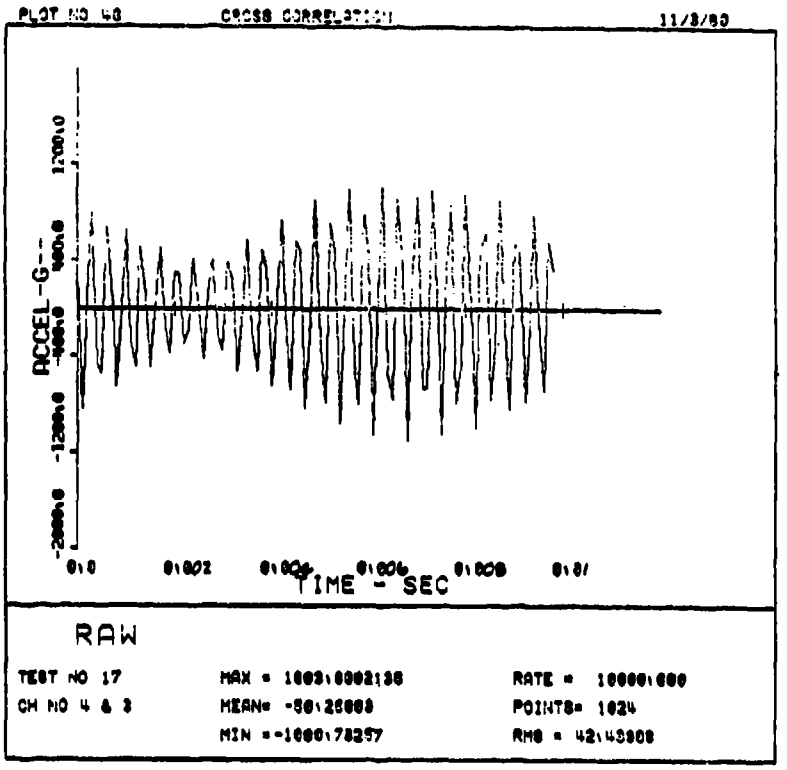
TEST NO 17	MAX = 1581.8320678	RATE = 10000.000
CH NO 4	MEAN= -50.25000	POINTS= 1024
	MIN =-1530.84087	RMS = 42.24612

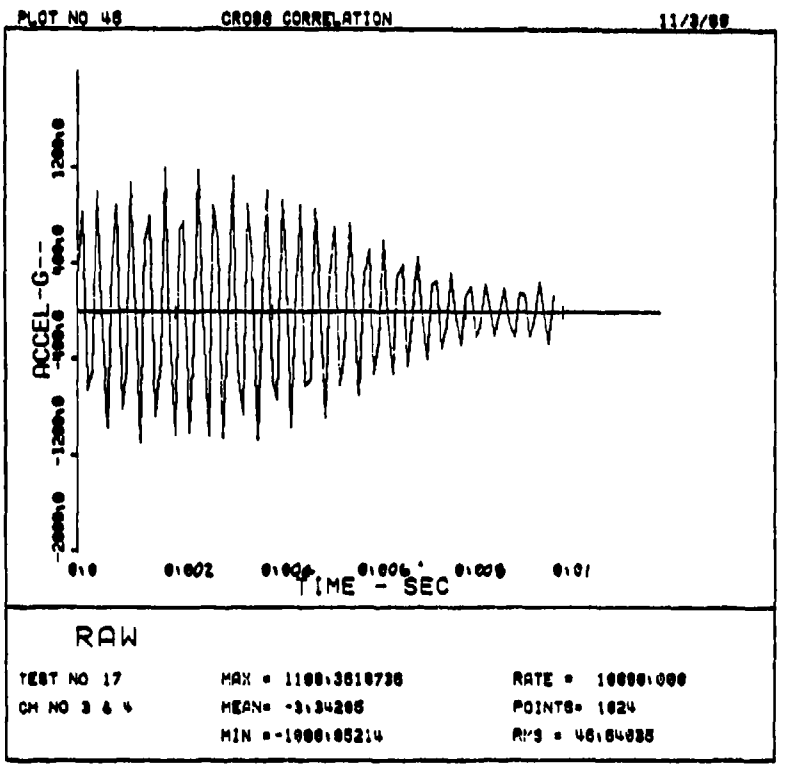
PLOT NO 42 FFT 11/3/80

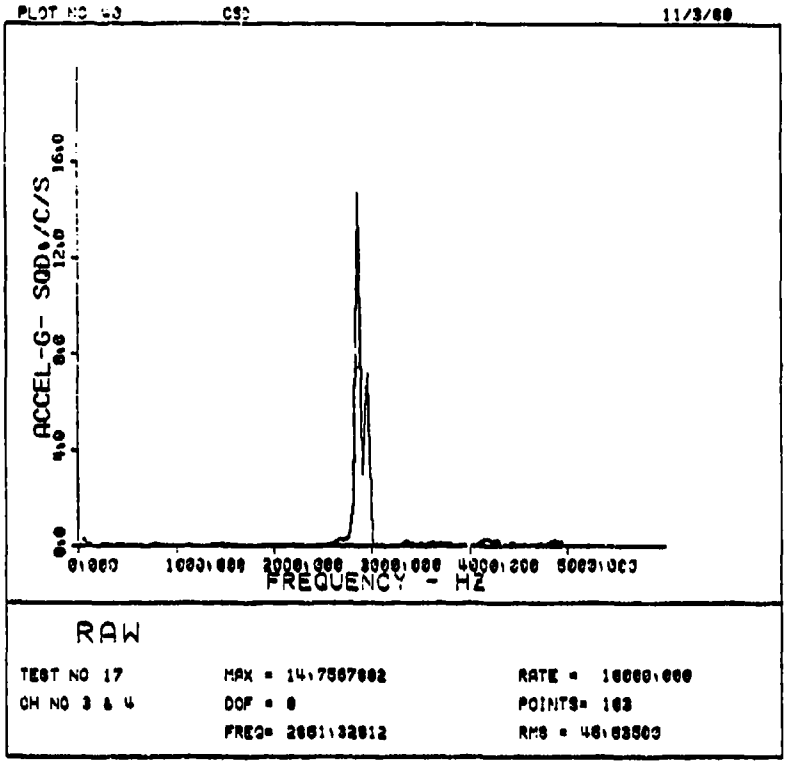


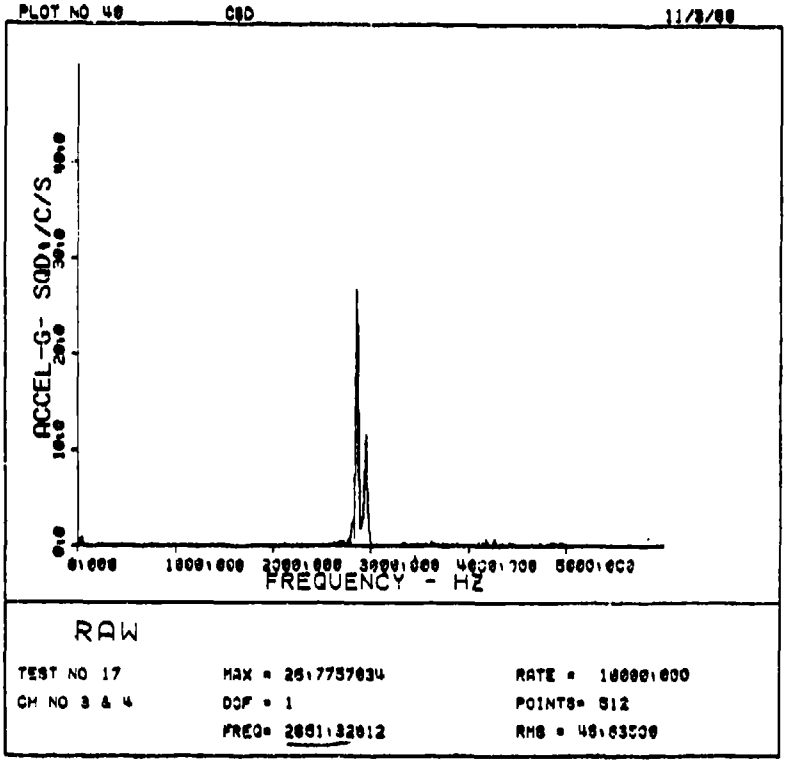
RAW

TEST NO 17	MAX = 16.3060266	RATE = 10000.000
CH NO 4	DOF = 0	POINTS= 103
	FREQ= 2861.32912	RMS = 42.43653


PLOT NO 46
CROSS CORRELATION
11/3/89
ACCEL-G--
TIME - SEC
RAW
TEST NO 17
CH NO 4 & 3
MAX = 1003.0002136
MEAN= -58.25008
MIN =-1000.78257
RATE = 10000.000
POINTS= 1024
RMS = 42.43808

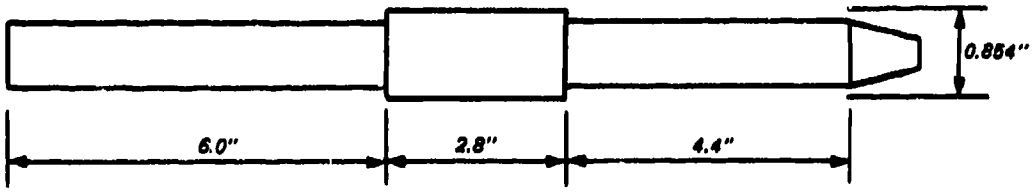

PLOT NO 46
CROSS CORRELATION
11/3/89
ACCEL-G--
TIME - SEC
RAW
TEST NO 17
CH NO 3 & 4
MAX = 1100.3618738
MEAN= -3.34265
MIN =-1000.85214
RATE = 10000.000
POINTS= 1024
RMS = 46.64035


PLOT NO 43
CSD
11/3/88
ACCEL-G- SQDs/C/S
16.0
12.0
8.0
4.0
0.0
0.000
1000.000
2000.000
3000.000
4000.200
5000.000
FREQUENCY - HZ
RAW
TEST NO 17
CH NO 3 & 4
MAX = 14.7567882
DOF = 0
FREQ= 2661.32812
RATE = 10000.000
POINTS= 103
RMS = 46.63503


PLOT NO 48
CSD
11/3/88
ACCEL-G- SQDs/C/S
30.0
20.0
10.0
0.0
0.000
1000.000
2000.000
3000.000
4000.700
5000.000
FREQUENCY - HZ
RAW
TEST NO 17
CH NO 3 & 4
MAX = 26.7757034
DOF = 1
FREQ= 2661.32812
RATE = 10000.000
POINTS= 512
RMS = 46.63500

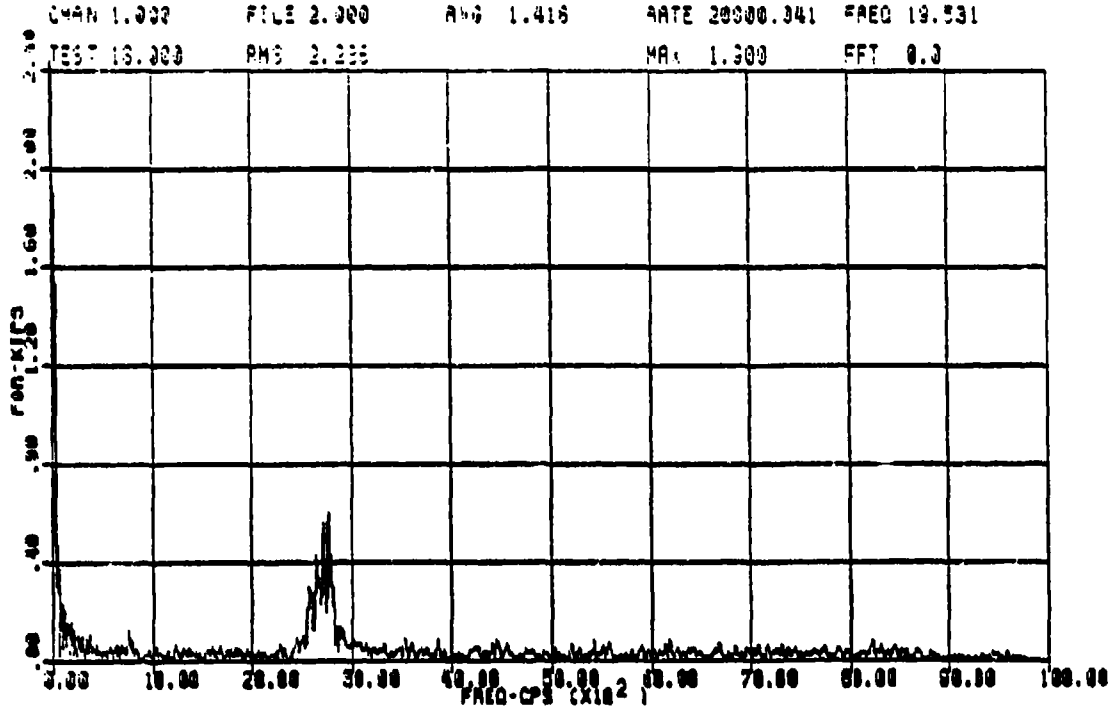
APPENDIX E: TEST 18 RESULTS

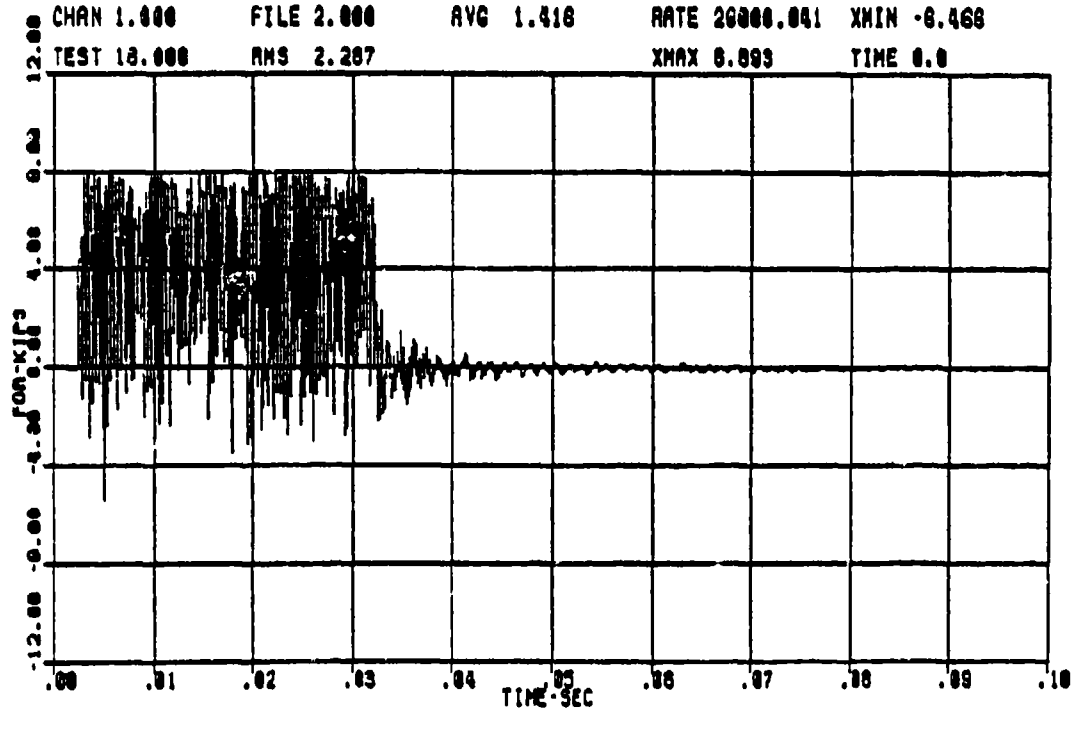
Test 18
Equipment Rack Hard-Mounted
AN/GRC-103 in Rack, On-Line

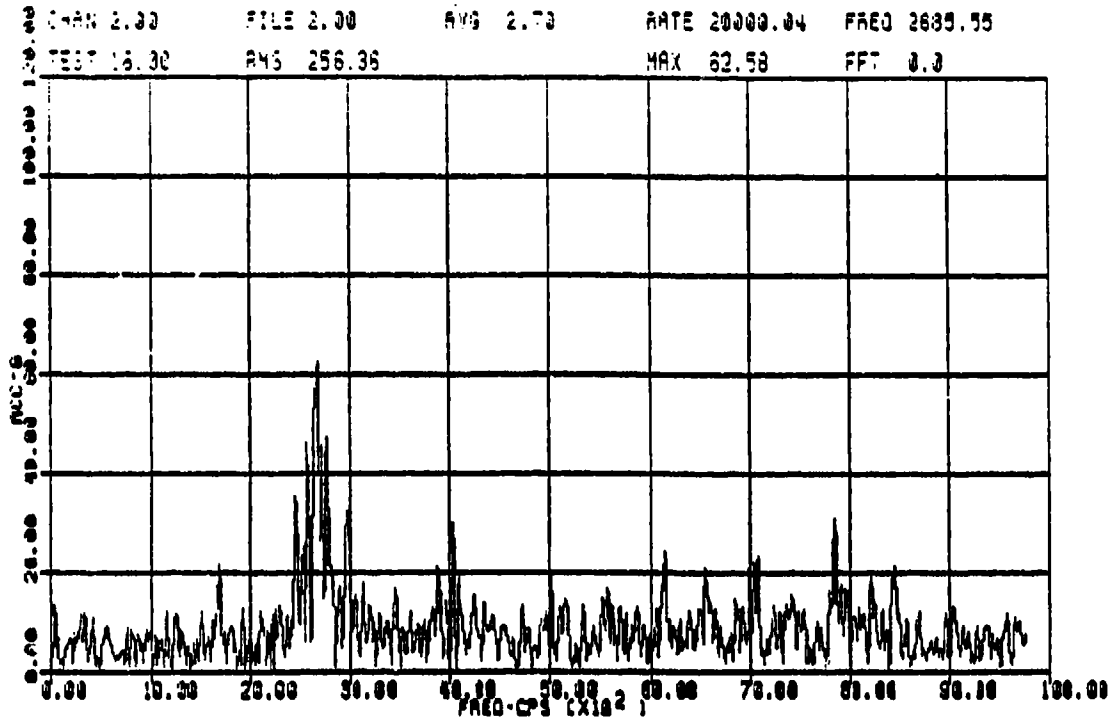


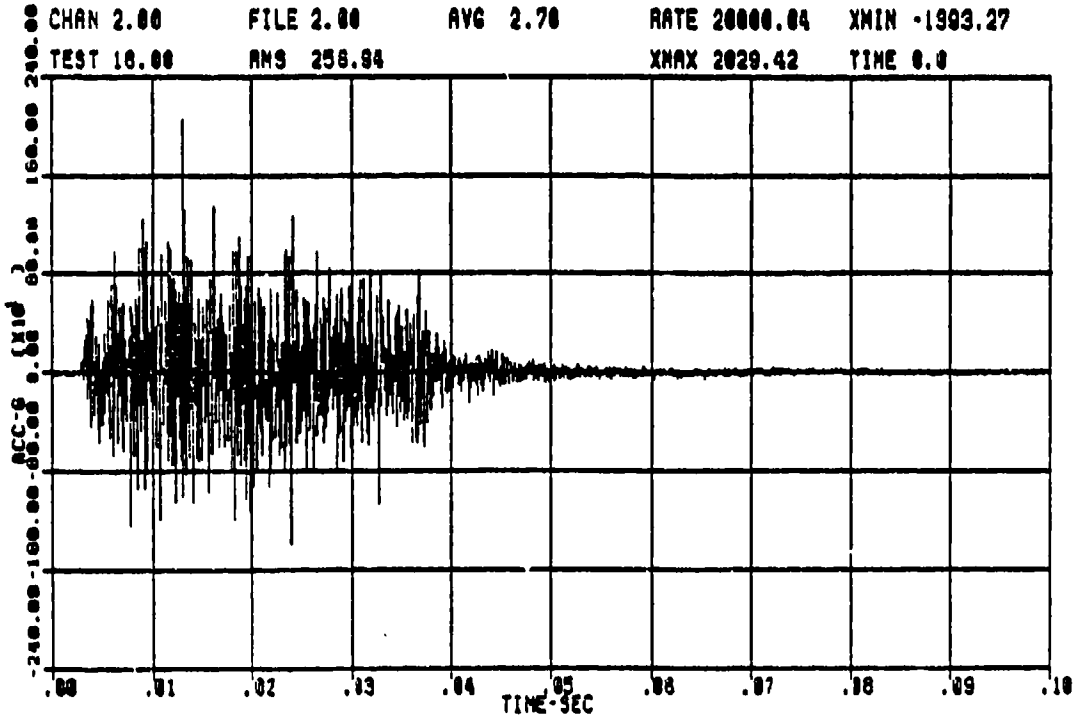
PULSE TRAIN - TEST 18

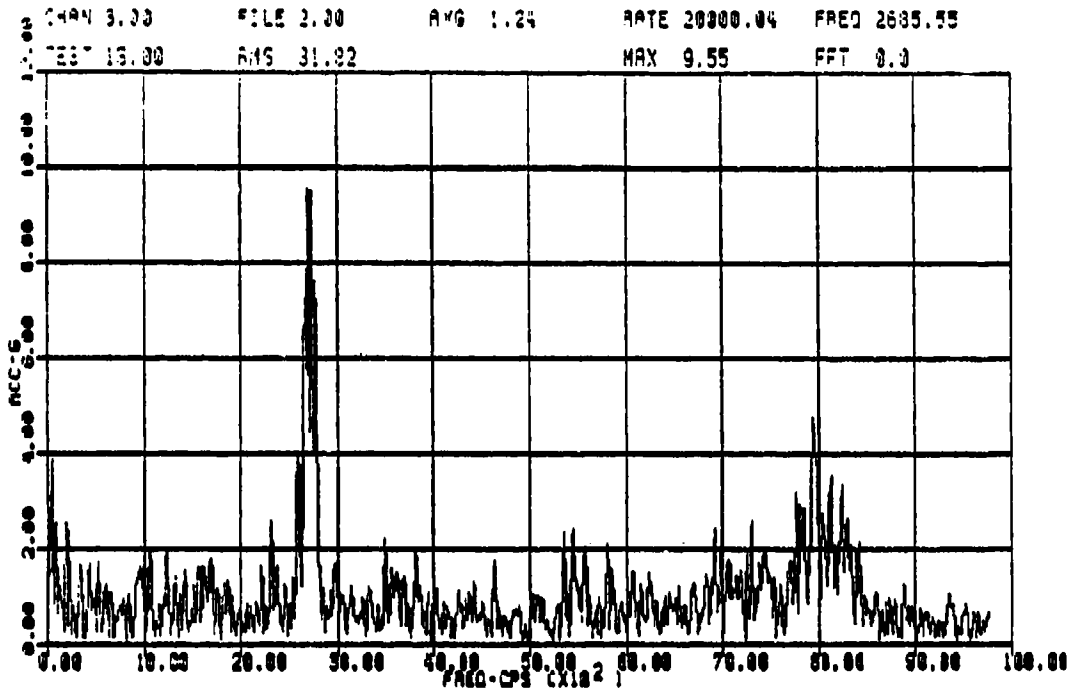
PRECHARGE PRESSURE = 1250 PSI
SYSTEM PRESSURE = 2000 PSI
FLOW CONTROL #6½

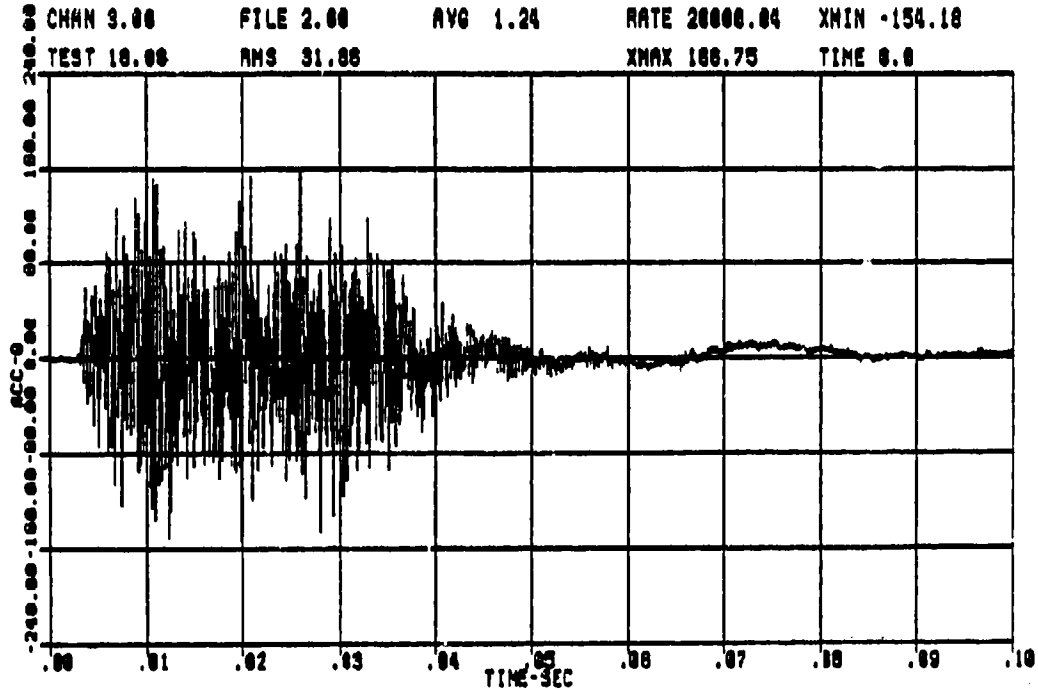

CHAN 1.000
FILE 2.000
AVG 1.416
RATE 20000.041
FREQ 19.531
TEST 18.000
RMS 2.235
MAX 1.300
FFT 0.0
FREQ-CPS (X10^2)

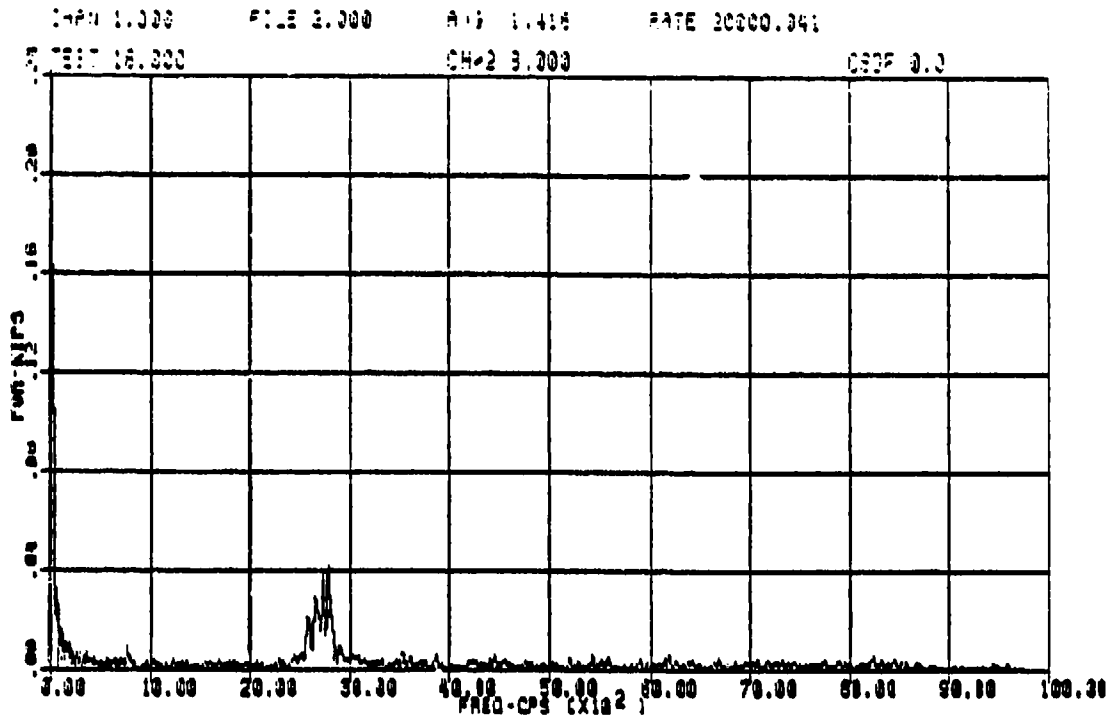

CHAN 1.000
FILE 2.000
AVG 1.416
RATE 20000.041
XMIN -0.468
TEST 18.000
RMS 2.287
XMAX 0.893
TIME 0.0
TIME-SEC

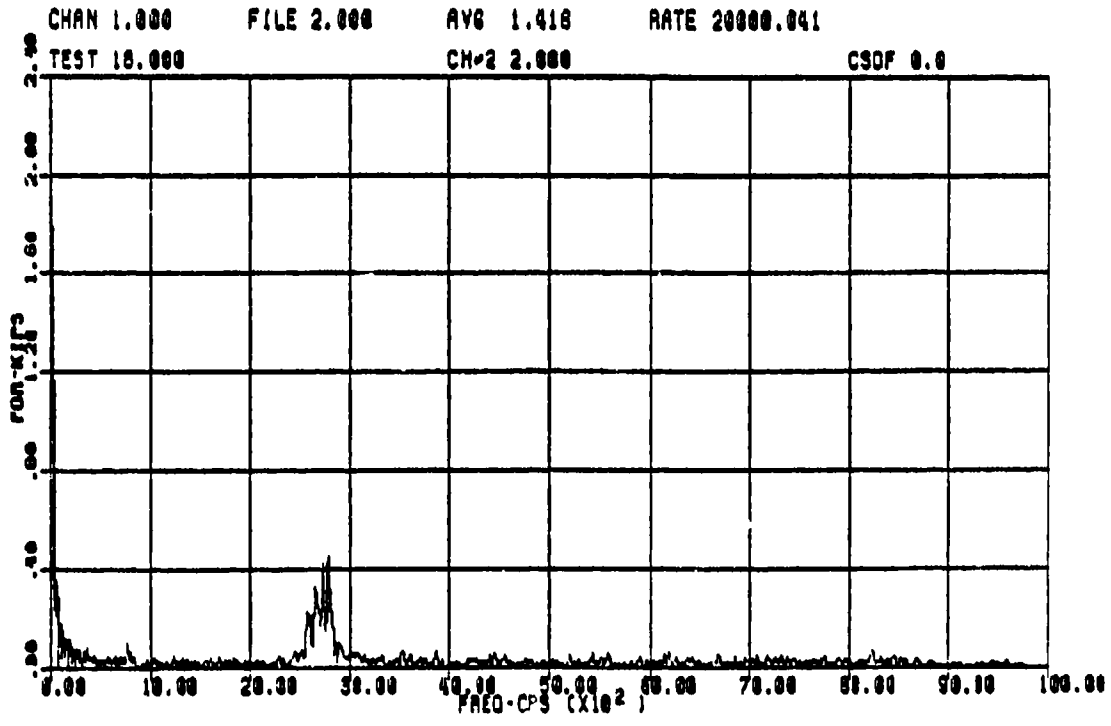

CHAN 2.00
FILE 2.00
AVG 2.73
RATE 20000.04
FREQ 2635.55
TEST 16.30
RMS 256.36
MAX 62.58
FFT 0.0
ACC-G
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

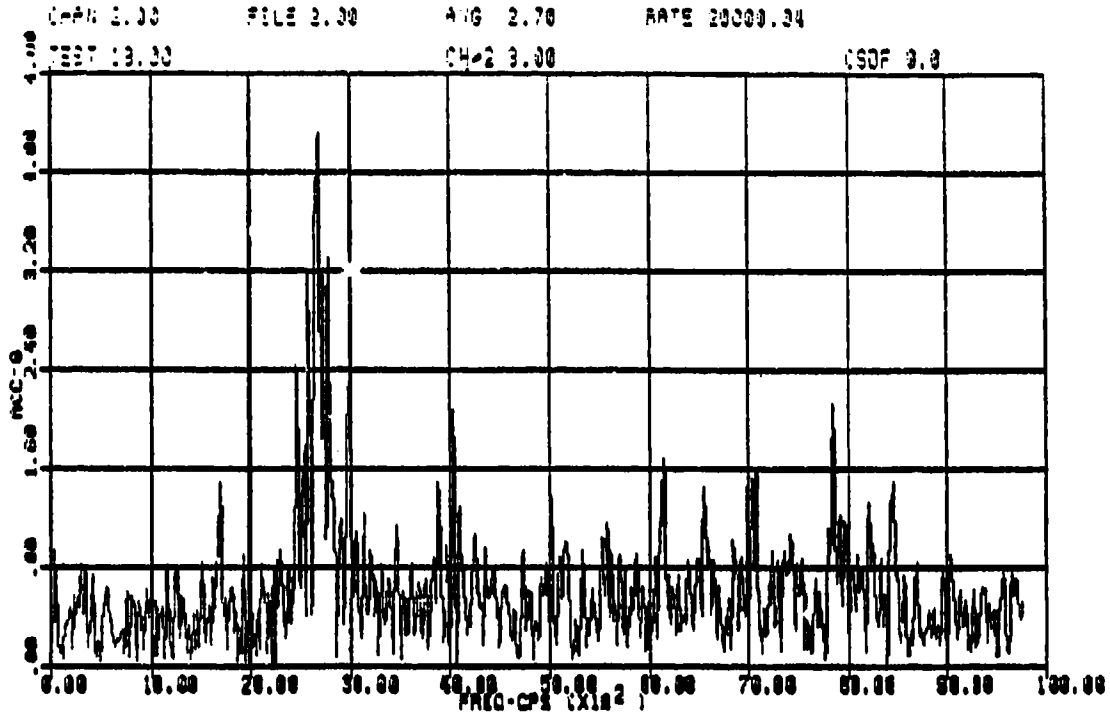

CHAN 2.00
FILE 2.00
AVG 2.70
RATE 20000.04
XMIN -1993.27
TEST 16.00
RMS 256.94
XMAX 2029.42
TIME 0.0
ACC-G (X10^2)
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

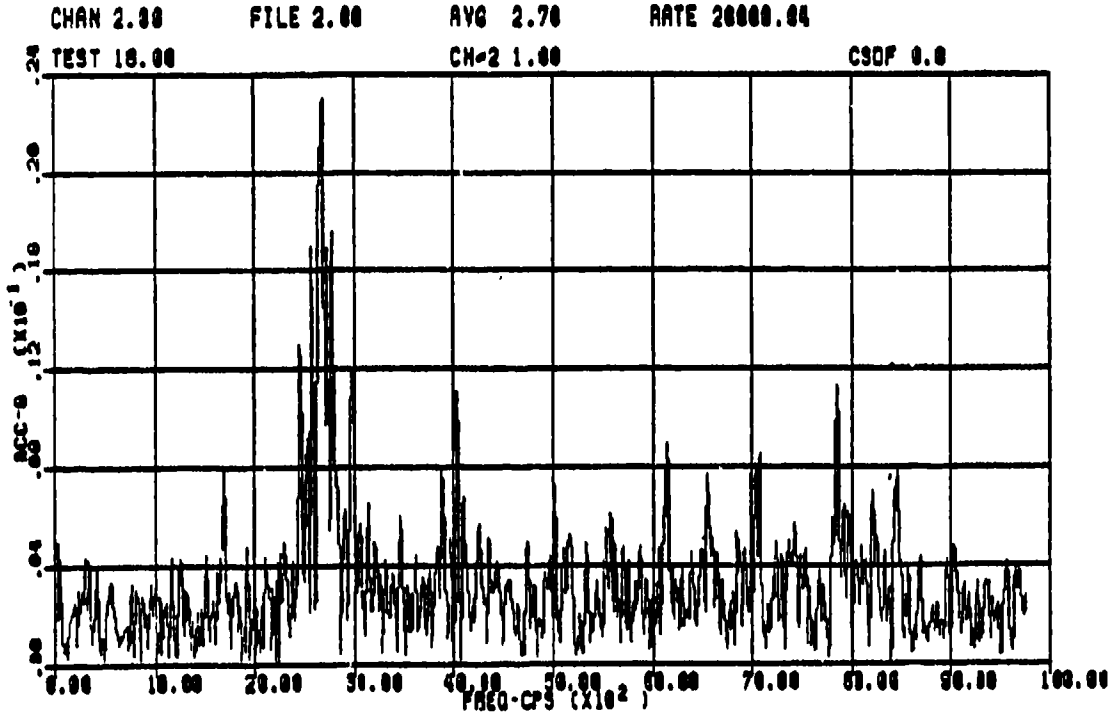

CHAN 3.00
FILE 2.00
AVG 1.24
RATE 20000.04
FREQ 2685.55
TEST 10.00
RMS 31.82
MAX 9.55
FFT 0.0
ACC-G
FREQ-CPS (X10^2)

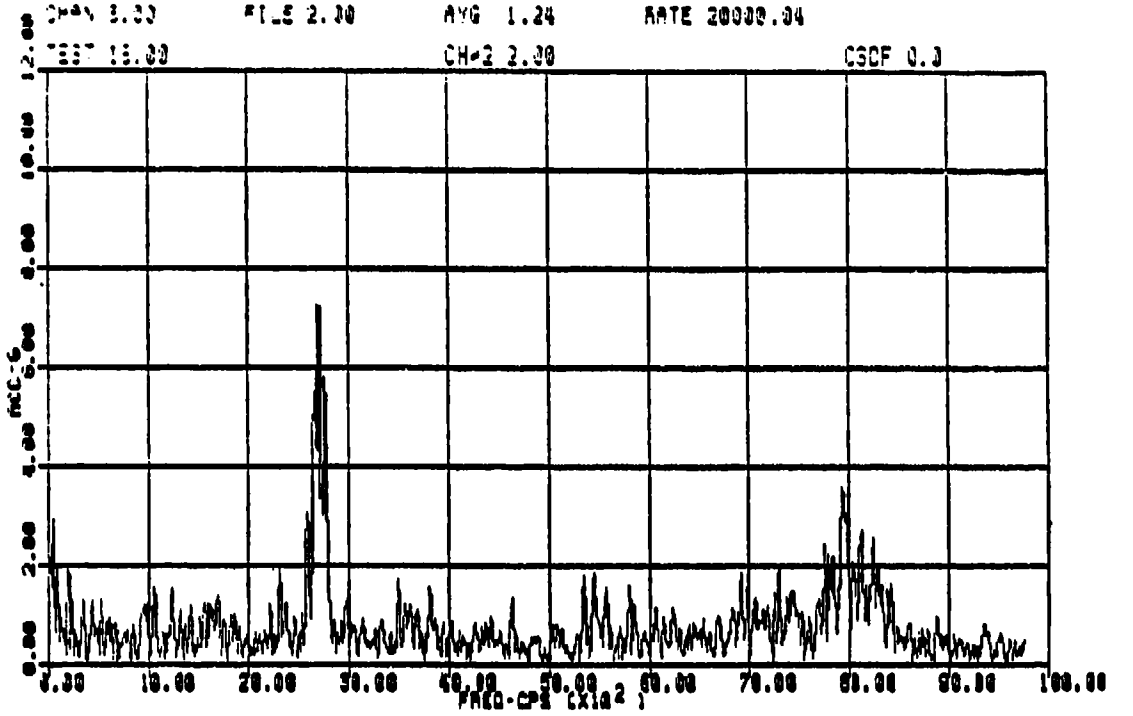

CHAN 3.00
FILE 2.00
AVG 1.24
RATE 20000.04
XMIN -154.18
TEST 10.00
RMS 31.86
XMAX 166.75
TIME 0.0
ACC-G
TIME-SEC

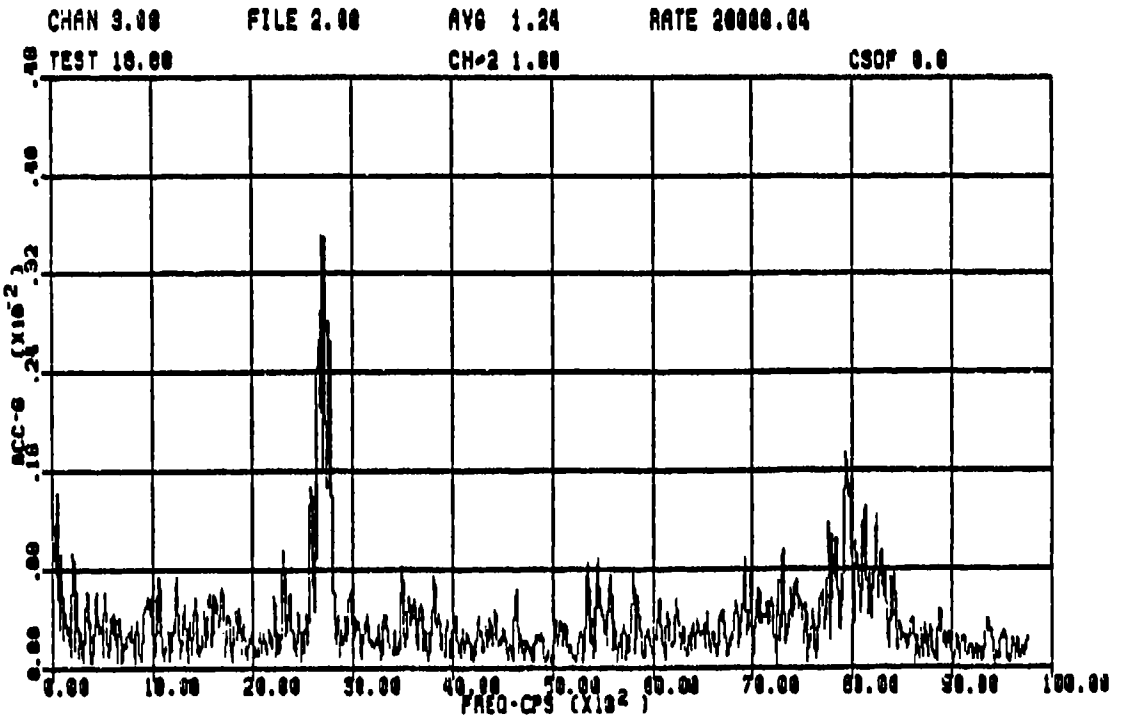

CHAN 1.000
FILE 2.000
AVG 1.416
RATE 20000.041
TEST 16.000
CH#2 3.000
CSDF 0.0
FOR-KIPS
FREQ-CPS (X10^2)

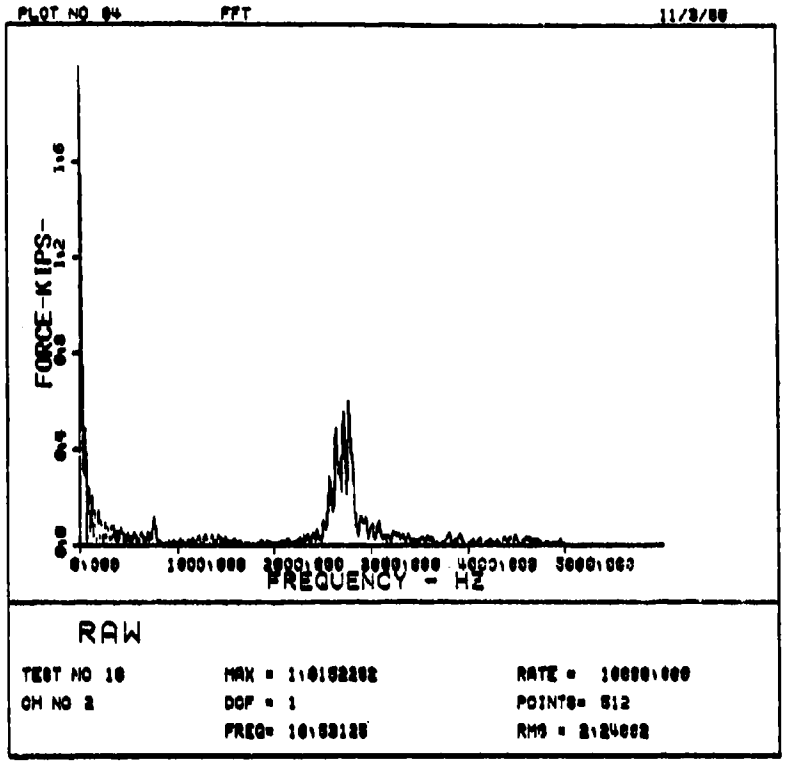

CHAN 1.000
FILE 2.000
AVG 1.416
RATE 20000.041
TEST 16.000
CH#2 2.000
CSDF 0.0
FOR-KIPS
FREQ-CPS (X10^2)

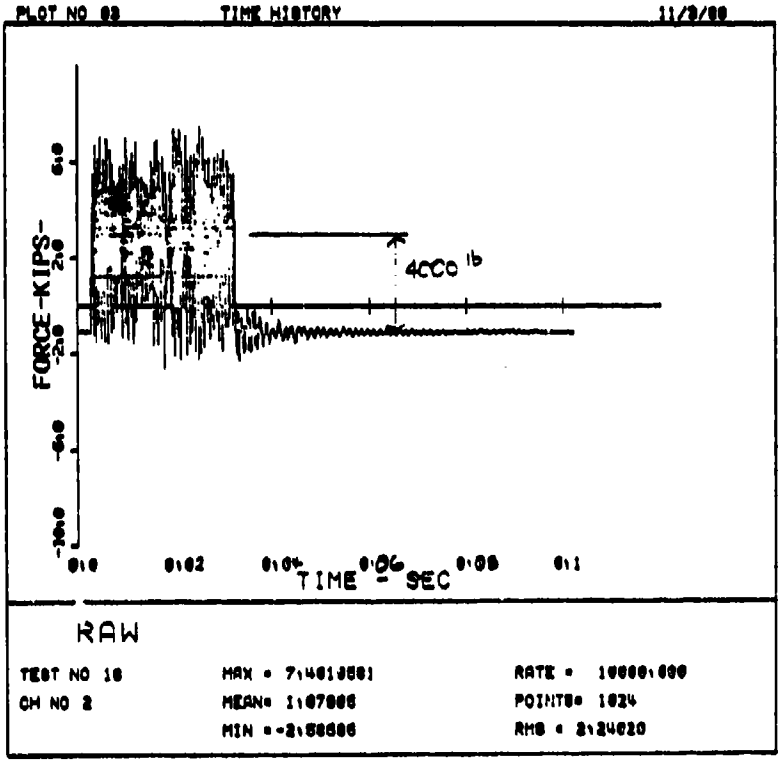

CHAN 2.00
FILE 2.00
AVG 2.70
RATE 20000.04
TEST 18.00
CH-2 3.00
CSOF 0.0
ACC-G
FREQ-CPS (X10^2)

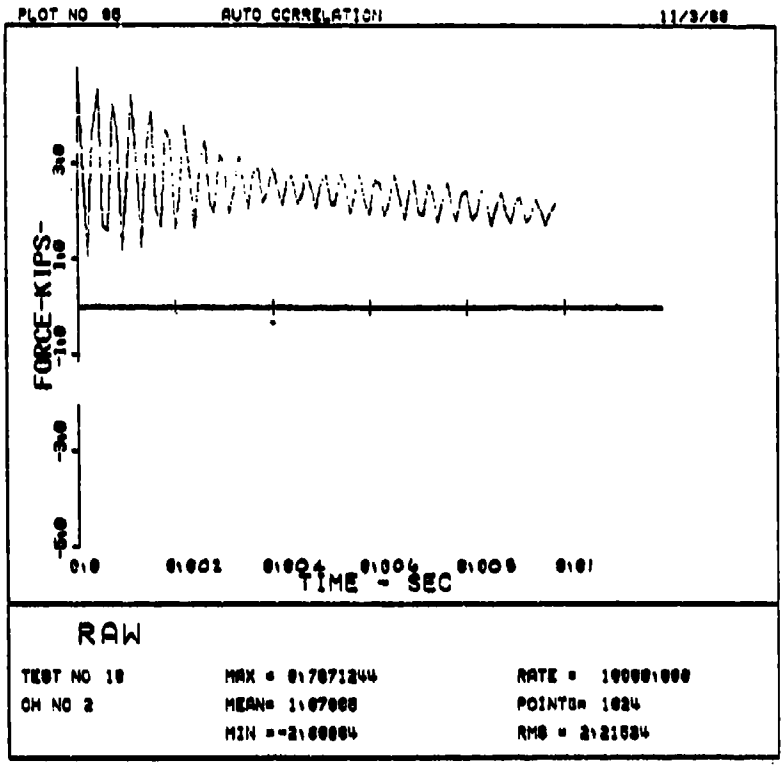

CHAN 2.00
FILE 2.00
AVG 2.70
RATE 20000.04
TEST 18.00
CH-2 1.00
CSOF 0.0
ACC-G (X10^-1)
FREQ-CPS (X10^2)

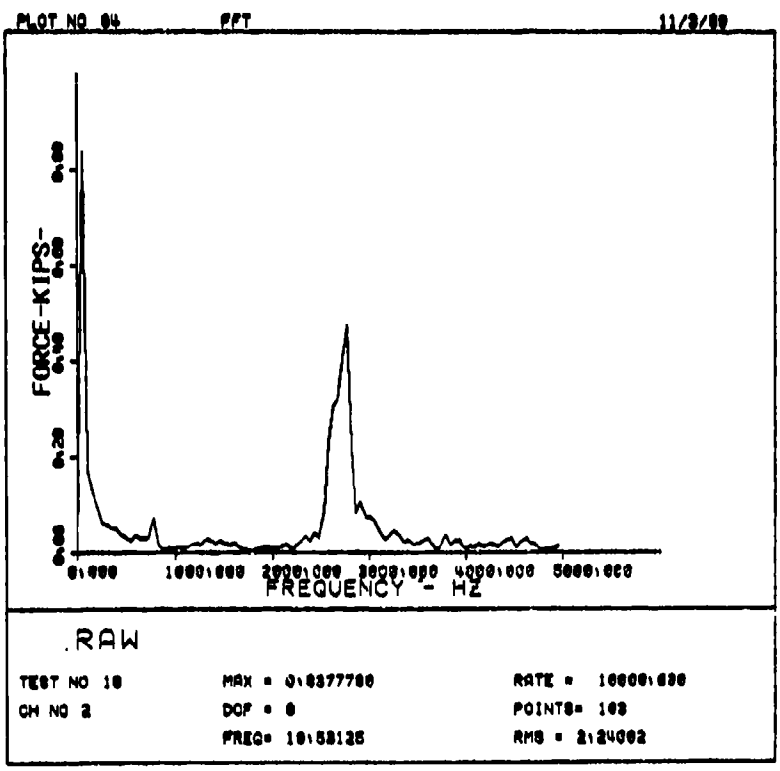

CHAN 3.00
FILE 2.00
AVG 1.24
RATE 20000.04
TEST 10.00
CH-2 2.00
CSOF 0.0
PSD-G
FREQ-CPS (X10^2)

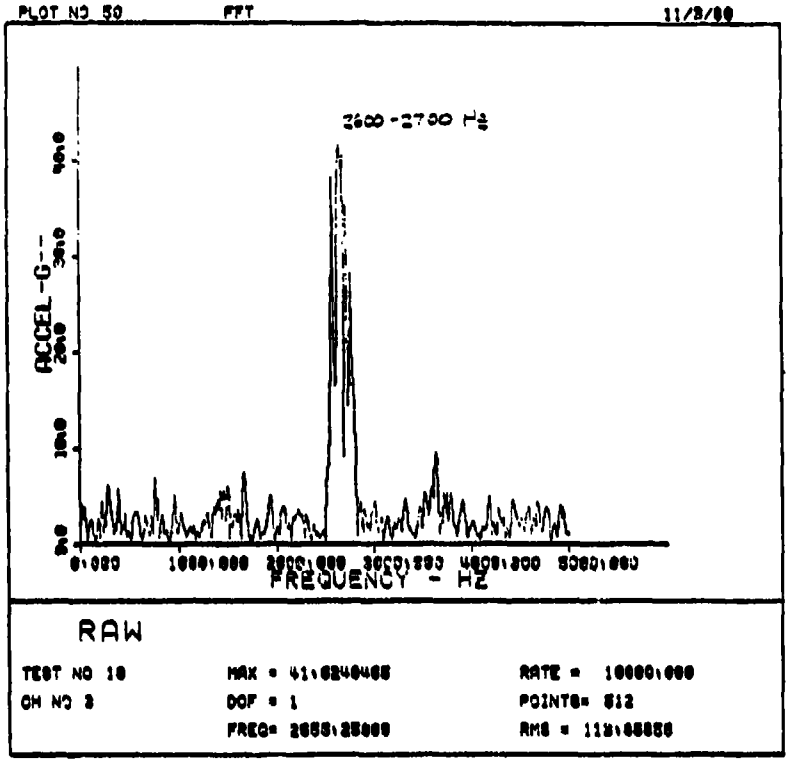

CHAN 3.00
FILE 2.00
AVG 1.24
RATE 20000.04
TEST 10.00
CH-2 1.00
CSOF 0.0
PSD-G (X10^2)
FREQ-CPS (X10^2)

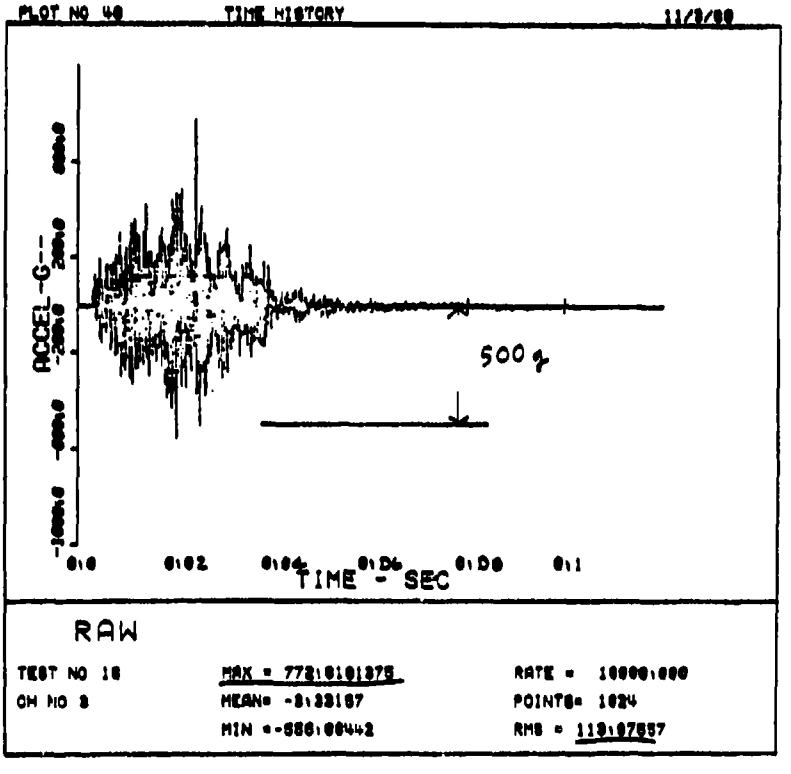

PLOT NO 04
FFT
11/3/80
FORCE-KIPS-
FREQUENCY - HZ
RAW
TEST NO 10
CH NO 2
MAX = 1.0152282
DOF = 1
FREQ= 10.53125
RATE = 10000.000
POINTS= 512
RMS = 2.24002


PLOT NO 03
TIME HISTORY
11/3/80
FORCE-KIPS-
4000 lb
TIME - SEC
RAW
TEST NO 10
CH NO 2
MAX = 7.4013581
MEAN= 1.07986
MIN = -2.58686
RATE = 10000.000
POINTS= 1024
RMS = 2.24020

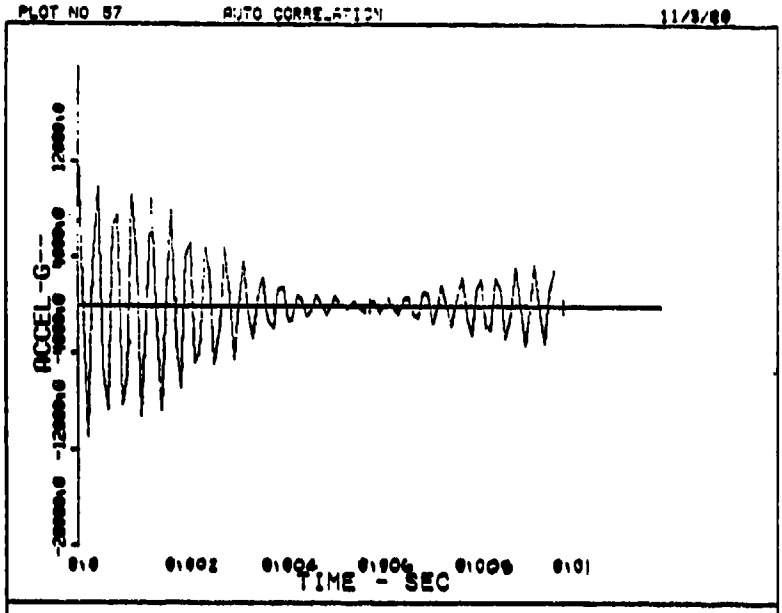

PLOT NO 95
AUTO CORRELATION
11/3/88
FORCE-KIPS-
TIME - SEC
RAW
TEST NO 10
CH NO 2
MAX = 0.7871244
MEAN= 1.07000
MIN =-2.60004
RATE = 10000.000
POINTS= 1024
RMS = 2.21534


PLOT NO 94
FFT
11/3/88
FORCE-KIPS-
FREQUENCY - HZ
RAW
TEST NO 10
CH NO 2
MAX = 0.8377780
DOF = 0
FREQ= 10.53125
RATE = 10000.000
POINTS= 103
RMS = 2.24002


PLOT NO 50
FFT
11/3/80
2600-2700 Hz
ACCEL -G--
FREQUENCY - HZ
RAW
TEST NO 10
CH NO 3
MAX = 41.6240465
DOF = 1
FREQ= 2655.25000
RATE = 10000.000
POINTS= 512
RMS = 113.65856


PLOT NO 40
TIME HISTORY
11/3/80
ACCEL -G--
500 g
TIME - SEC
RAW
TEST NO 10
CH NO 3
MAX = 772.0101375
MEAN= -3.33157
MIN =-556.00442
RATE = 10000.000
POINTS= 1024
RMS = 113.97557

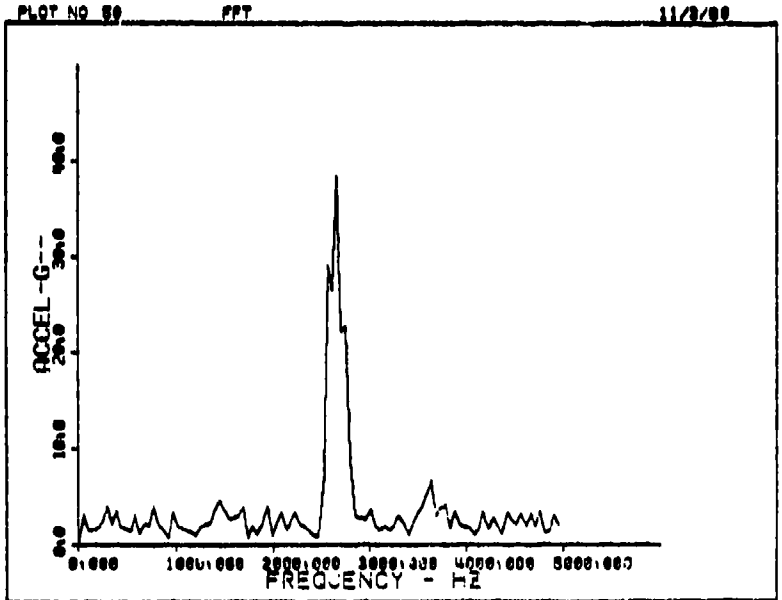
PLOT NO 57 AUTO CORRELATION 11/3/80



RAW

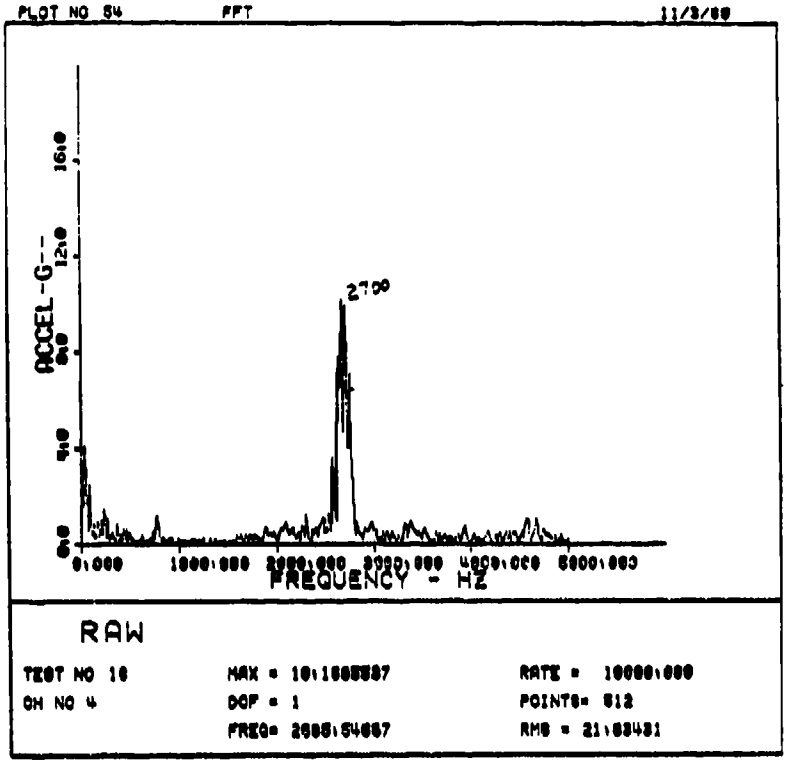
TEST NO 16 MAX = 8808.5722100 RATE = 10000.000
CH NO 3 MEAN= -3.33167 POINTS= 1024
MIN =-10862.12535 RMS = 113.63858

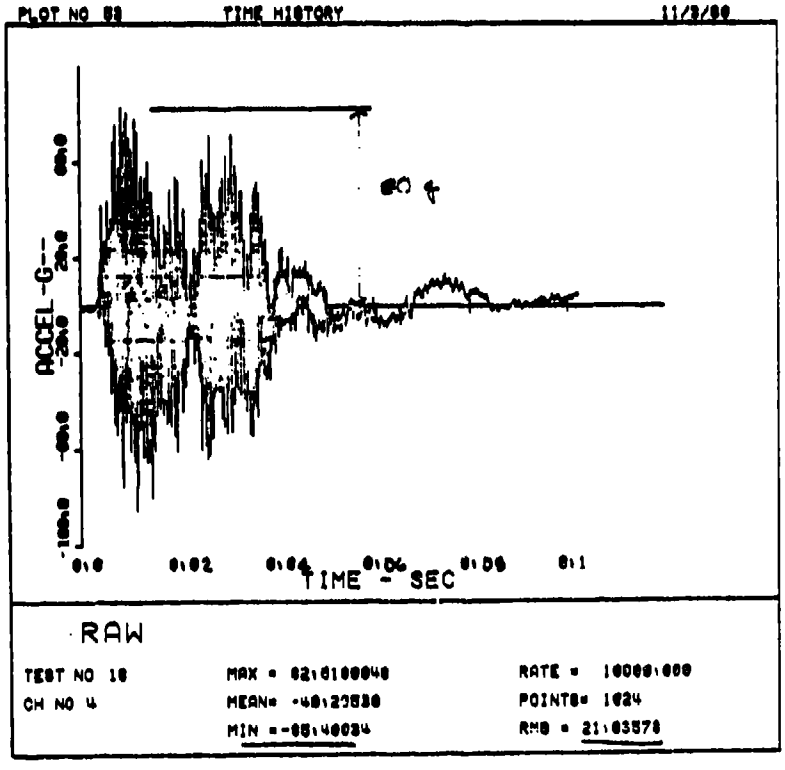
PLOT NO 58 FFT 11/3/80

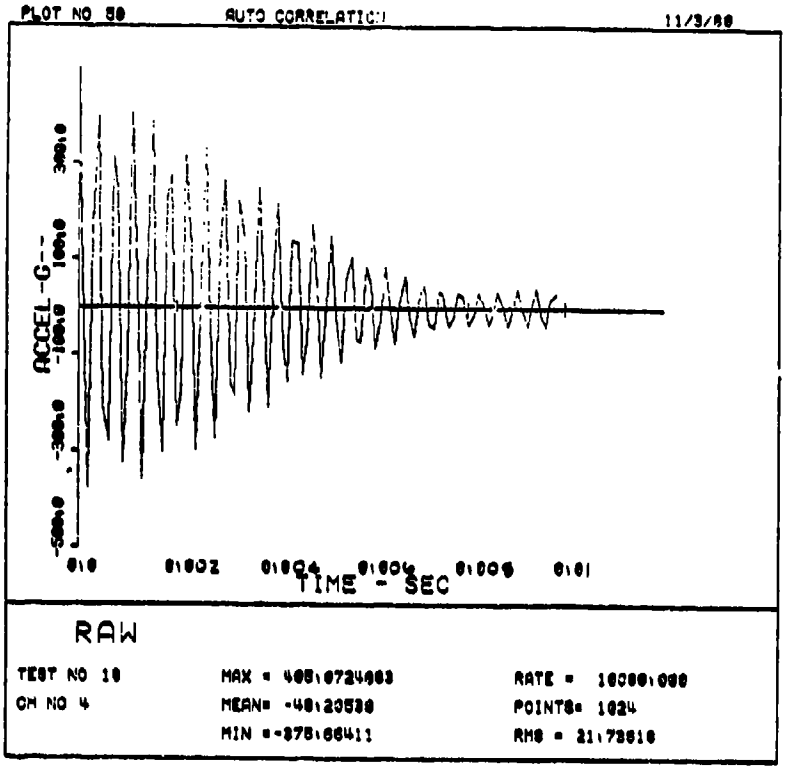


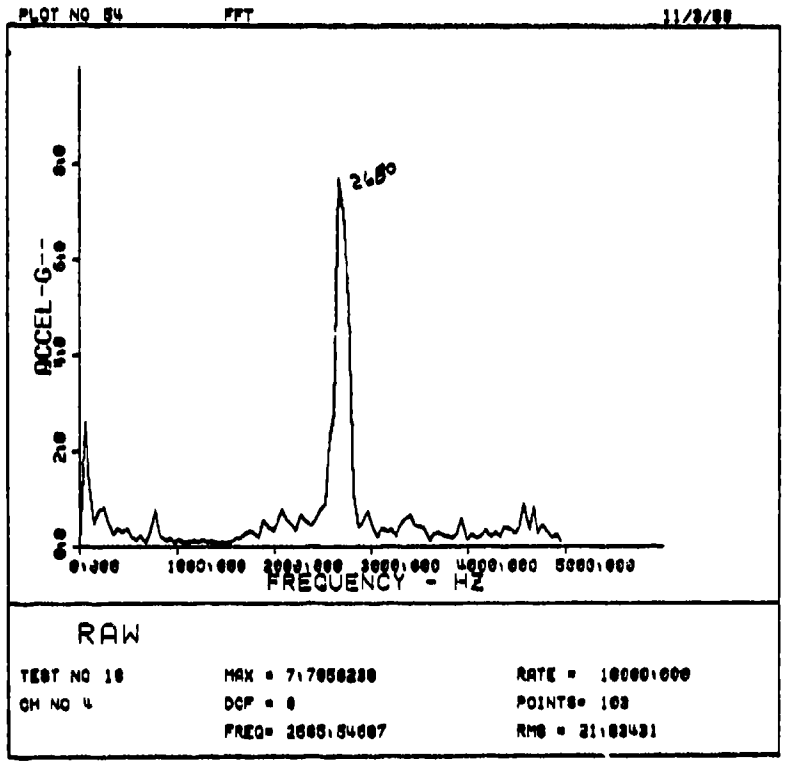
RAW

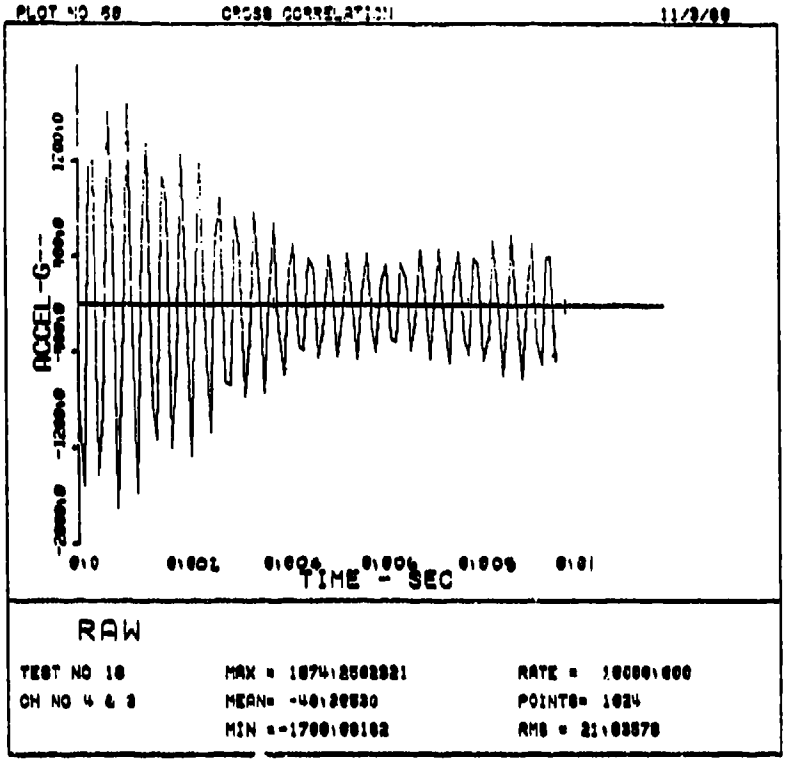
TEST NO 19 MAX = 38.4013503 RATE = 10000.000
CH NO 3 DOF = 0 POINTS= 103
FREQ= 2658.25000 RMS = 113.06858

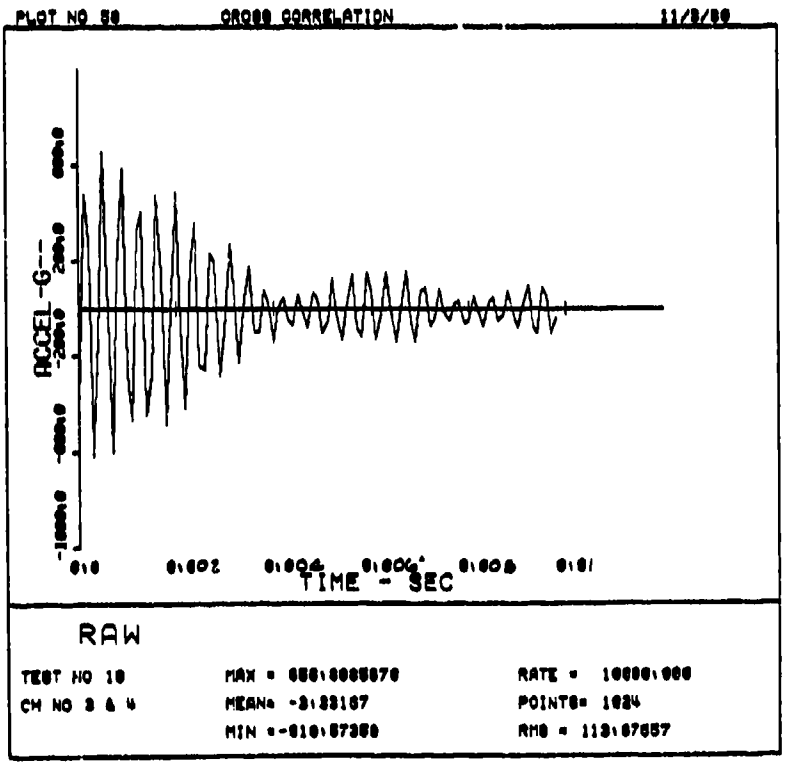

PLOT NO 54
FFT
11/3/80
ACCEL -G--
16.0
12.0
8.0
4.0
0.0
2700
0.000
1000.000
2000.000
3000.000
4000.000
5000.000
FREQUENCY - HZ
RAW
TEST NO 10
CH NO 4
MAX = 10.1665587
DOF = 1
FREQ= 2685.54667
RATE = 10000.000
POINTS= 512
RMS = 21.83431

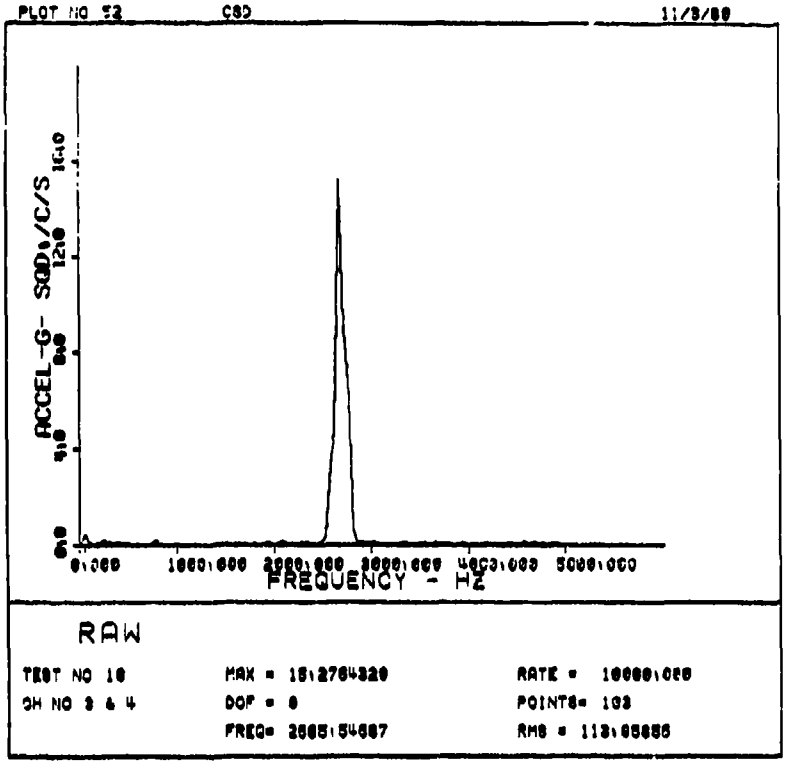

PLOT NO 53
TIME HISTORY
11/3/80
ACCEL -G--
60.0
20.0
-20.0
-60.0
-100.0
0.0
0.02
0.04
0.06
0.08
0.1
TIME - SEC
RAW
TEST NO 10
CH NO 4
MAX = 82.6100048
MEAN= -40.23530
MIN =-85.40034
RATE = 10000.000
POINTS= 1024
RMS = 21.83578

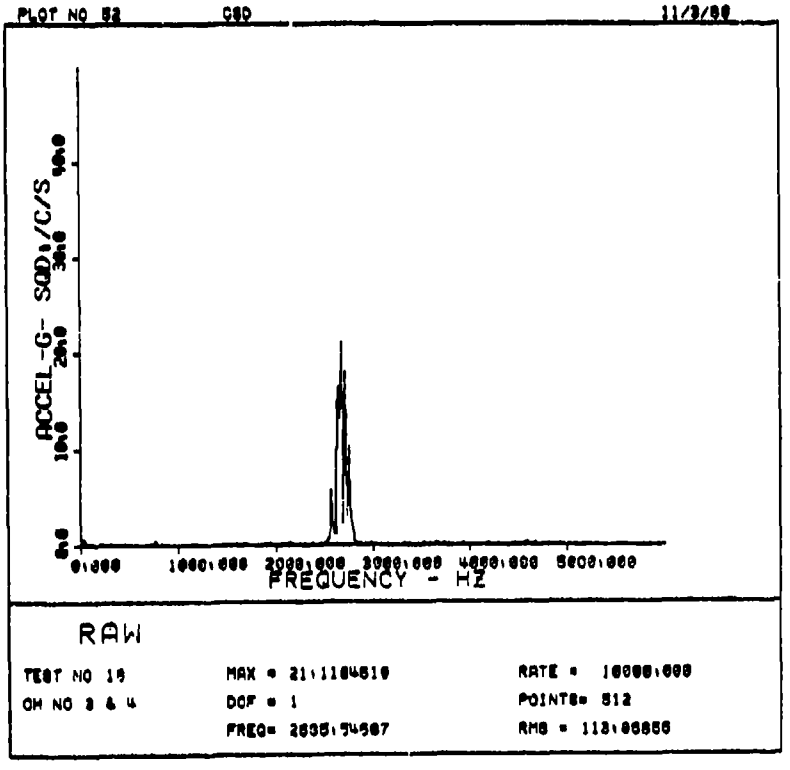

PLOT NO 50
AUTO CORRELATION
11/3/88
ACCEL-G--
TIME - SEC
RAW
TEST NO 10
CH NO 4
MAX = 405.0724463
MEAN= -48.23538
MIN = -875.66411
RATE = 10000.000
POINTS= 1024
RMS = 21.73516


PLOT NO 54
FFT
11/3/88
2480
ACCEL-G--
FREQUENCY - HZ
RAW
TEST NO 10
CH NO 4
MAX = 7.7858238
DCP = 0
FREQ= 2585.54687
RATE = 10000.000
POINTS= 103
RMS = 21.83431


PLOT NO 58
CROSS CORRELATION
11/3/80
ACCEL -G--
TIME - SEC
RAW
TEST NO 18
CH NO 4 & 3
MAX = 1874.2502921
MEAN= -40.20530
MIN =-1700.00182
RATE = 10000.000
POINTS= 1024
RMS = 21.03578

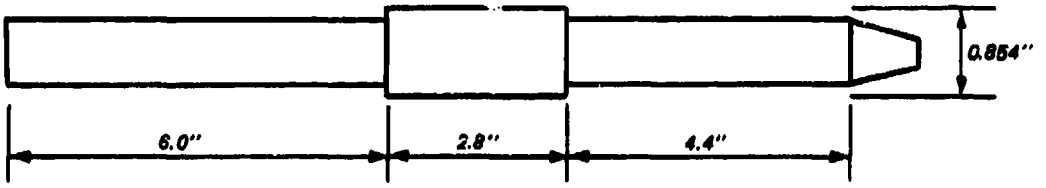

PLOT NO 58
CROSS CORRELATION
11/3/80
ACCEL -G--
TIME - SEC
RAW
TEST NO 18
CH NO 3 & 4
MAX = 656.0005070
MEAN= -3.33167
MIN =-610.57350
RATE = 10000.000
POINTS= 1024
RMS = 113.07657


PLOT NO 52
CSD
11/3/88
ACCEL -G- SQD's/C/S
FREQUENCY - HZ
RAW
TEST NO 18
CH NO 3 & 4
MAX = 15.2764320
DOF = 8
FREQ= 2665.54687
RATE = 10000.000
POINTS= 103
RMS = 113.66666


PLOT NO 52
CSD
11/3/88
ACCEL -G- SQD's/C/S
FREQUENCY - HZ
RAW
TEST NO 19
CH NO 3 & 4
MAX = 21.1184619
DOF = 1
FREQ= 2635.54687
RATE = 10000.000
POINTS= 512
RMS = 113.66666

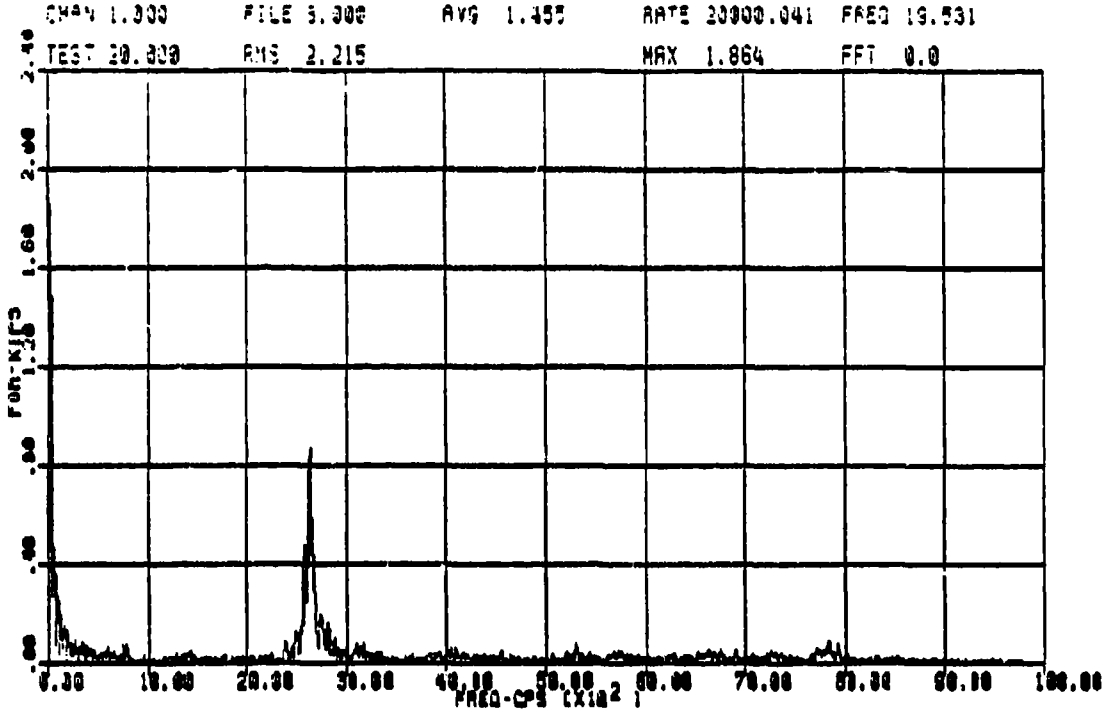
APPENDIX F: TEST 20 RESULTS

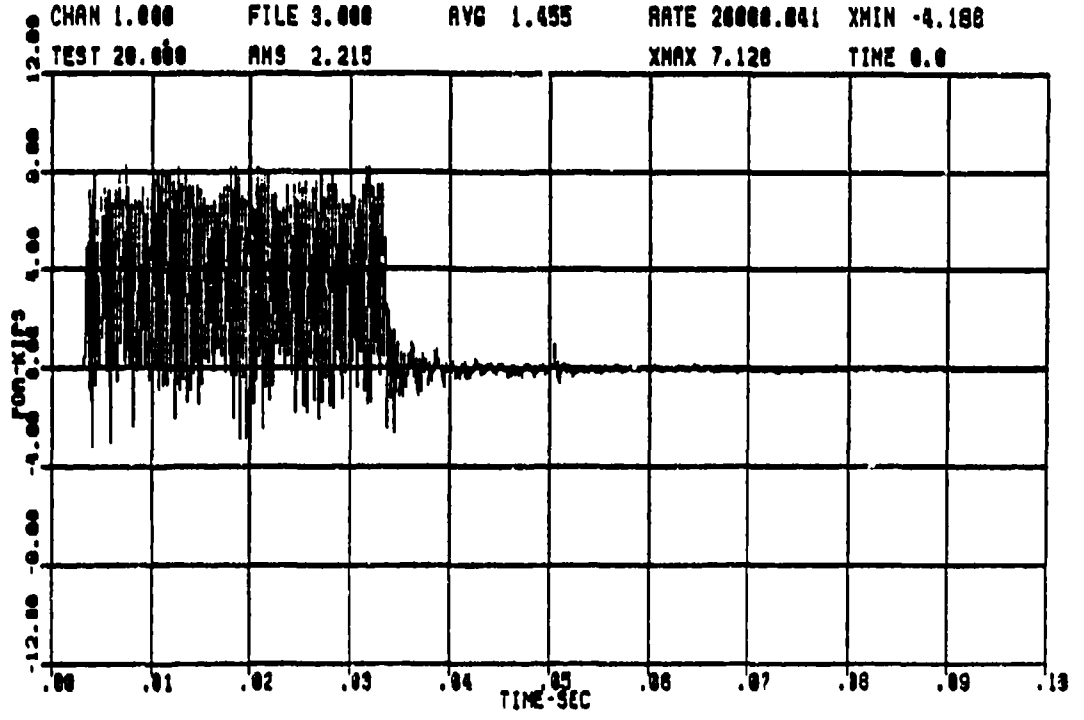
Test 20
Equipment Rack Hard-Mounted
TD660 in Rack, On-Line

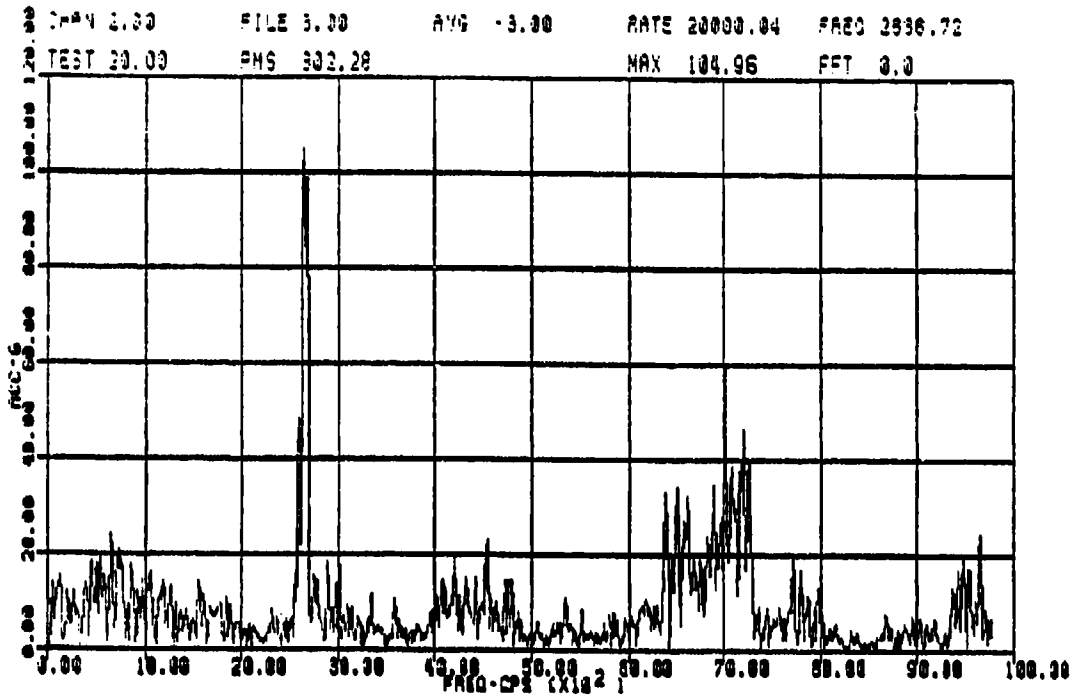


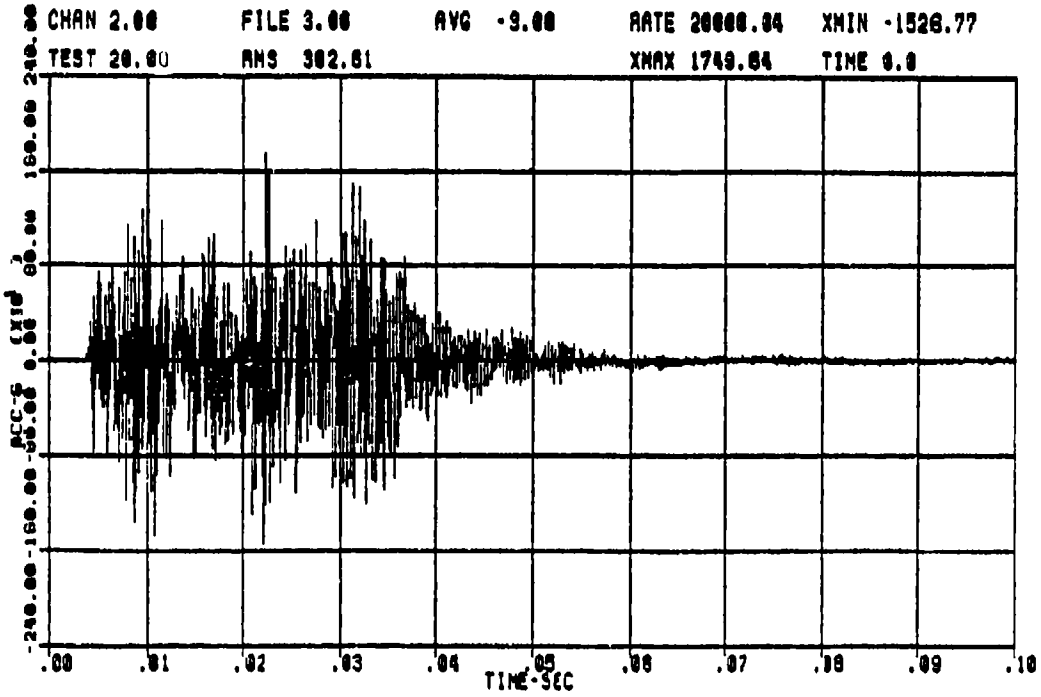
PULSE TRAIN - TEST 20

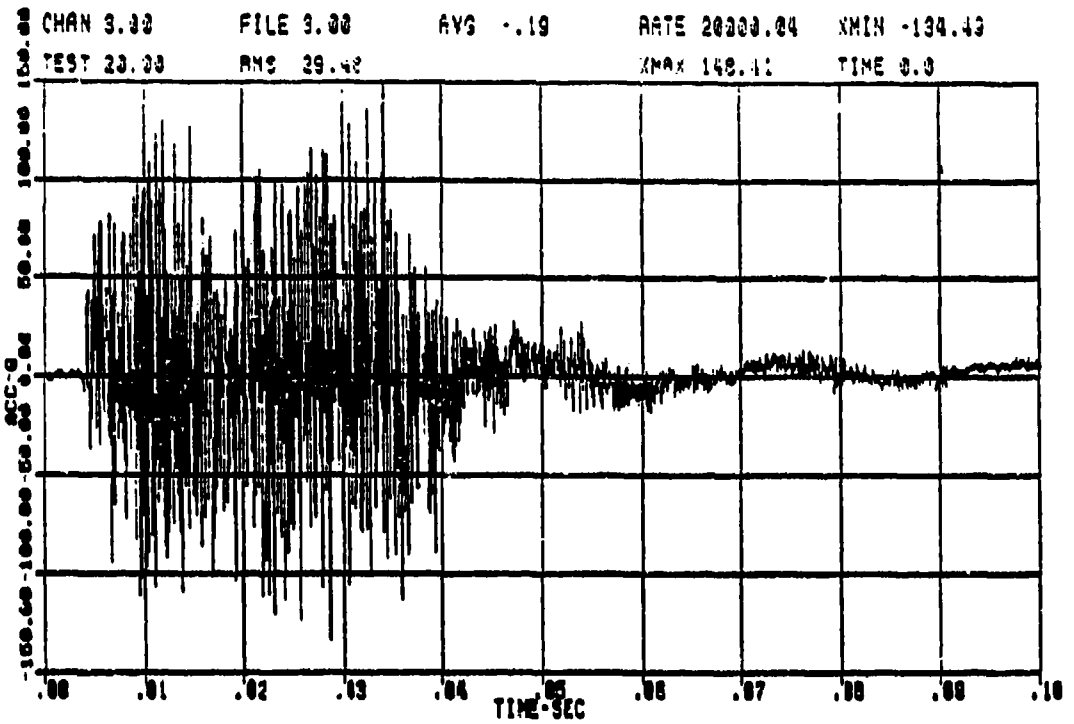
PRECHARGE PRESSURE = 1250 PSI
SYSTEM PRESSURE = 2000 PSI
FLOW CONTROL #6½

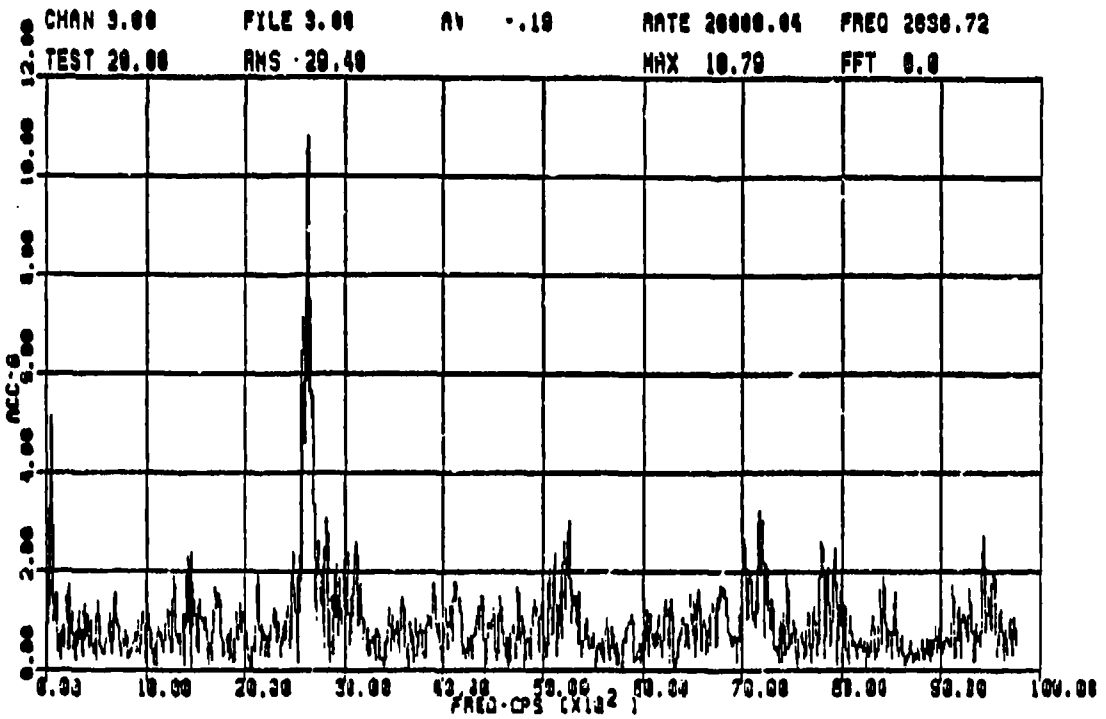

CHAN 1.000
FILE 3.000
AVG 1.455
RATE 20000.041
FREQ 19.531
TEST 20.000
RMS 2.215
MAX 1.864
FFT 0.0
FOR-KIPS
FREQ-CPS (X10^2)

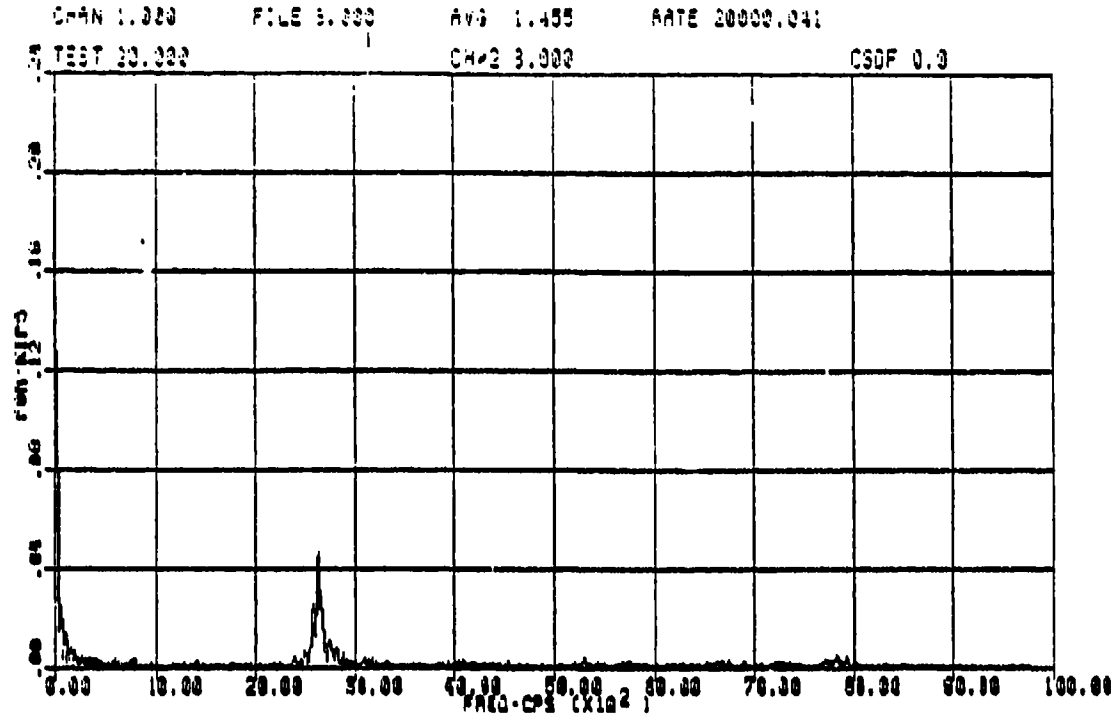

CHAN 1.000
FILE 3.000
AVG 1.455
RATE 20000.041
XMIN -4.188
TEST 20.000
RMS 2.215
XMAX 7.128
TIME 0.0
FOR-KIPS
TIME-SEC

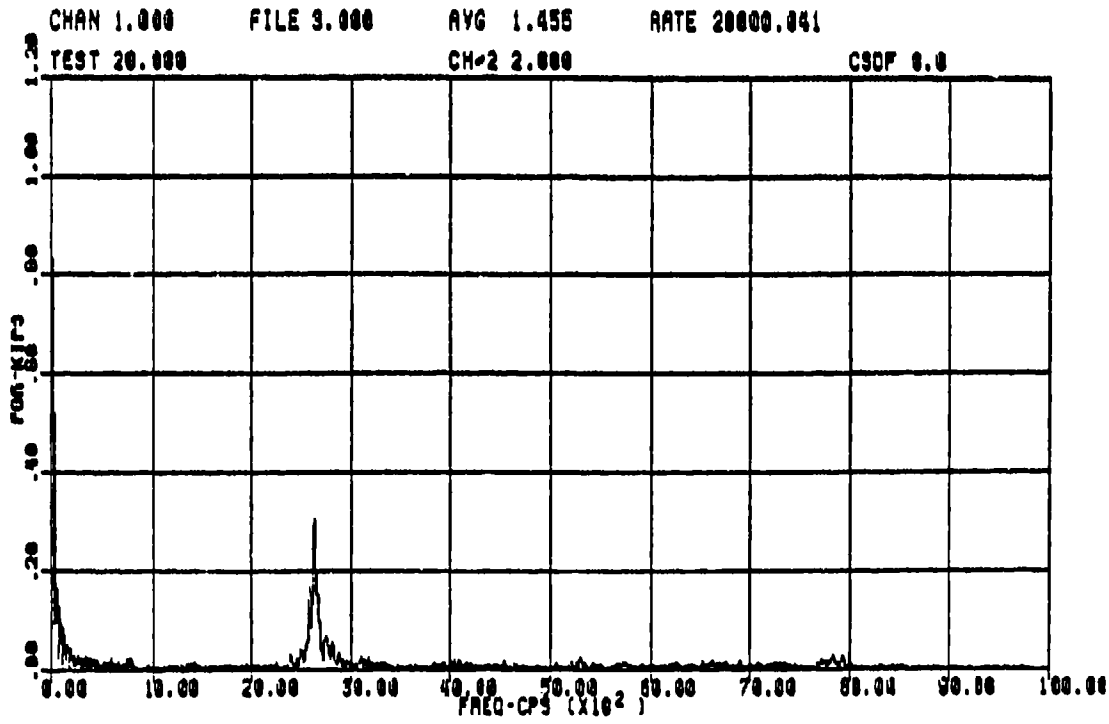

CHAN 2.00
FILE 3.00
AVG -3.00
RATE 20000.04
FREQ 2536.72
TEST 20.00
RMS 302.28
MAX 104.96
FFT 0.0
ACC-G
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

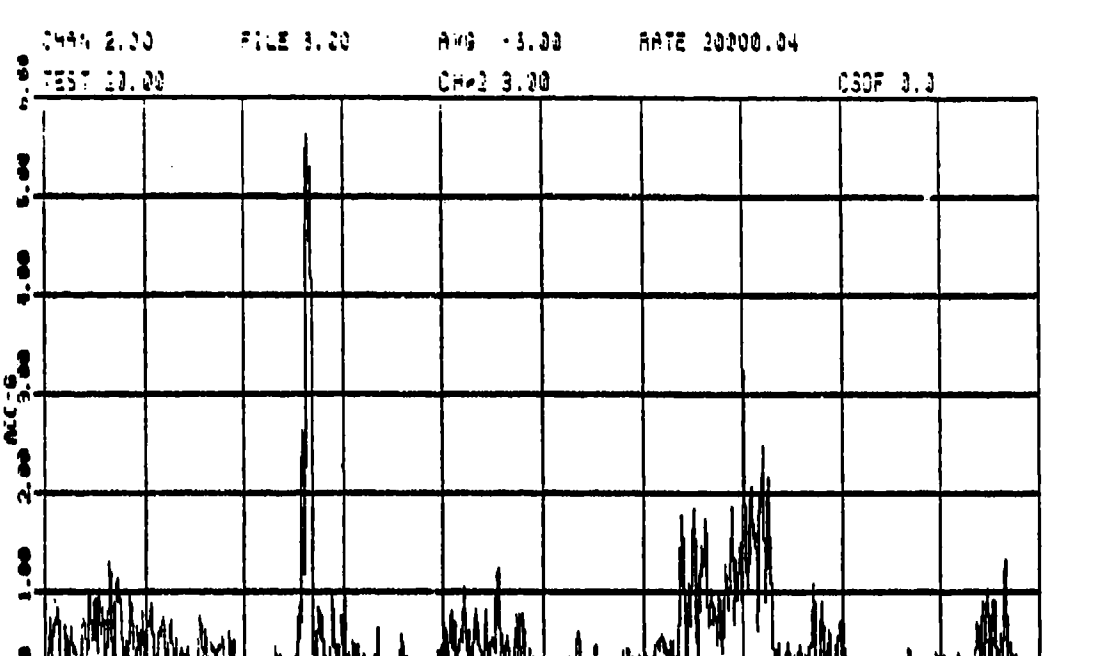

CHAN 2.00
FILE 3.00
AVG -3.00
RATE 20000.04
XMIN -1526.77
TEST 20.00
RMS 302.61
XMAX 1749.64
TIME 0.0
ACC-G (X10^1)
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

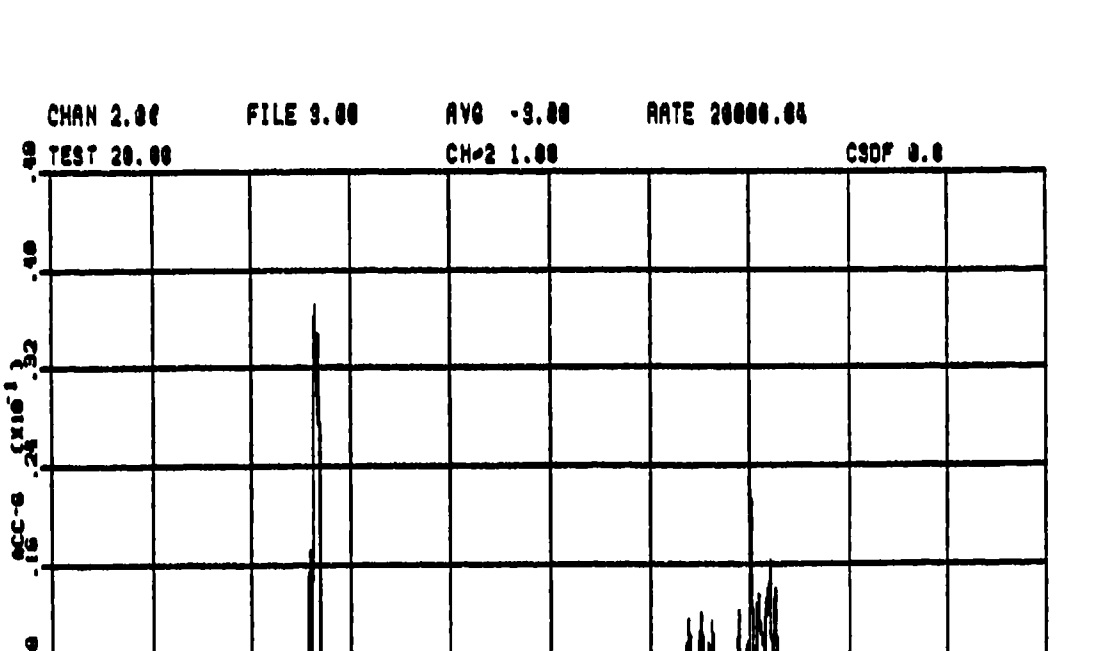

CHAN 3.00
FILE 3.00
AVG -.19
RATE 20000.04
XMIN -134.43
TEST 20.00
RMS 29.42
XMAX 140.11
TIME 0.0
ACC-G
TIME-SEC

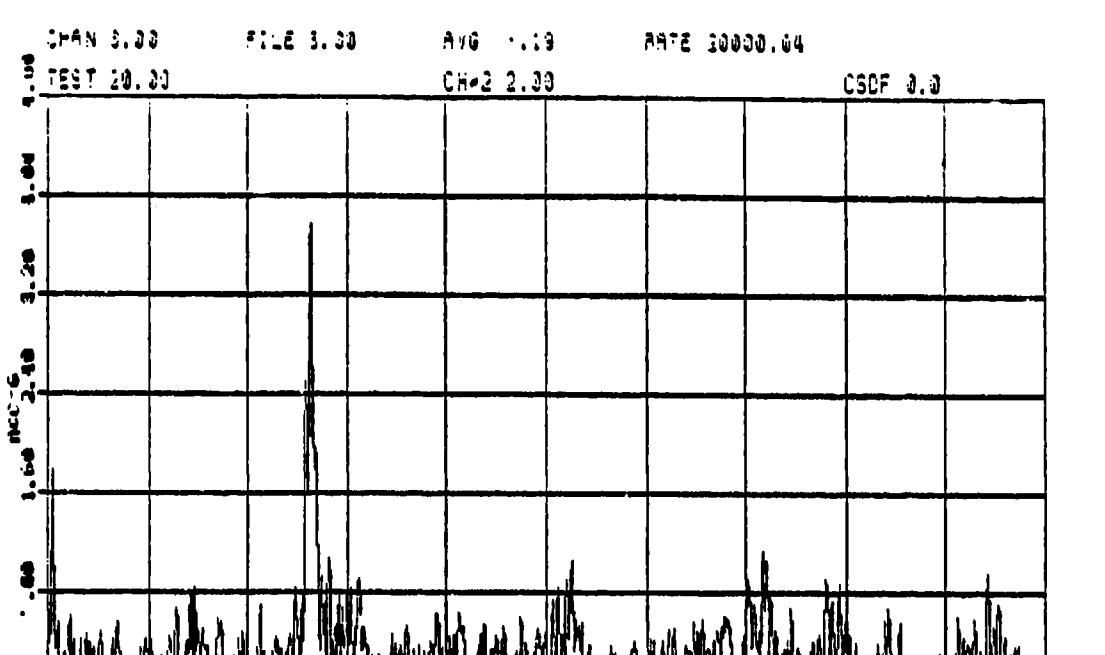

CHAN 9.00
FILE 3.00
AV -.19
RATE 20000.04
FREQ 2030.72
TEST 20.00
RMS 29.40
MAX 10.79
FFT 0.0
ACC-G
FREQ-CPS (X10^2)

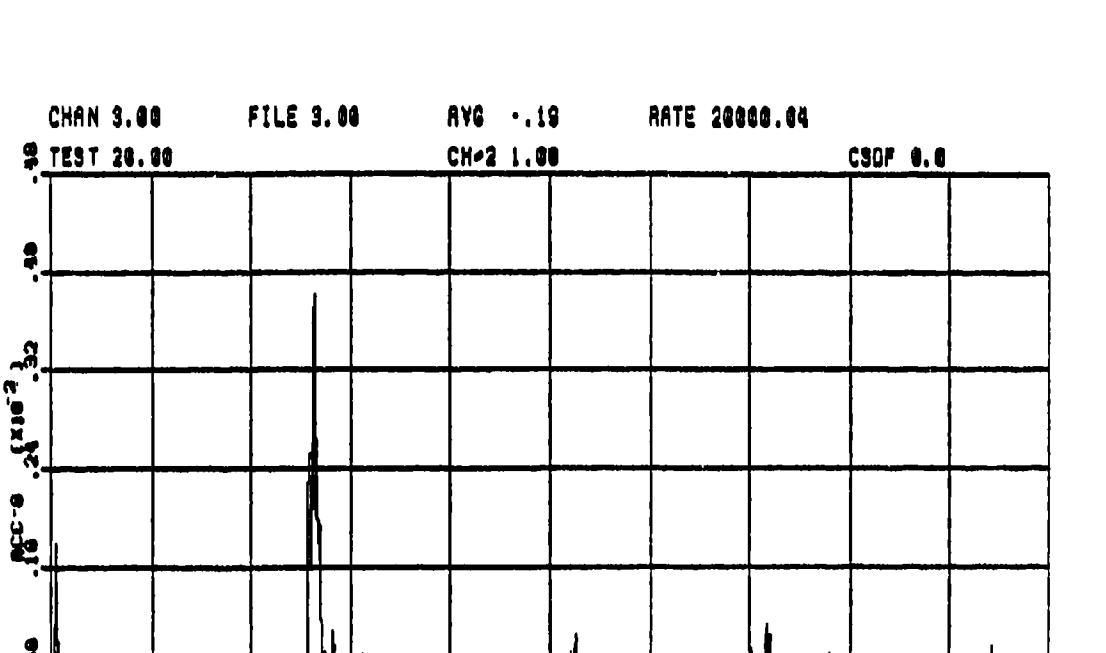

CHAN 1.000 FILE 3.000 AVG 1.455 RATE 20000.041
TEST 20.000 CH#2 3.000 CSDF 0.0
FREQ-CPS (X10^2)

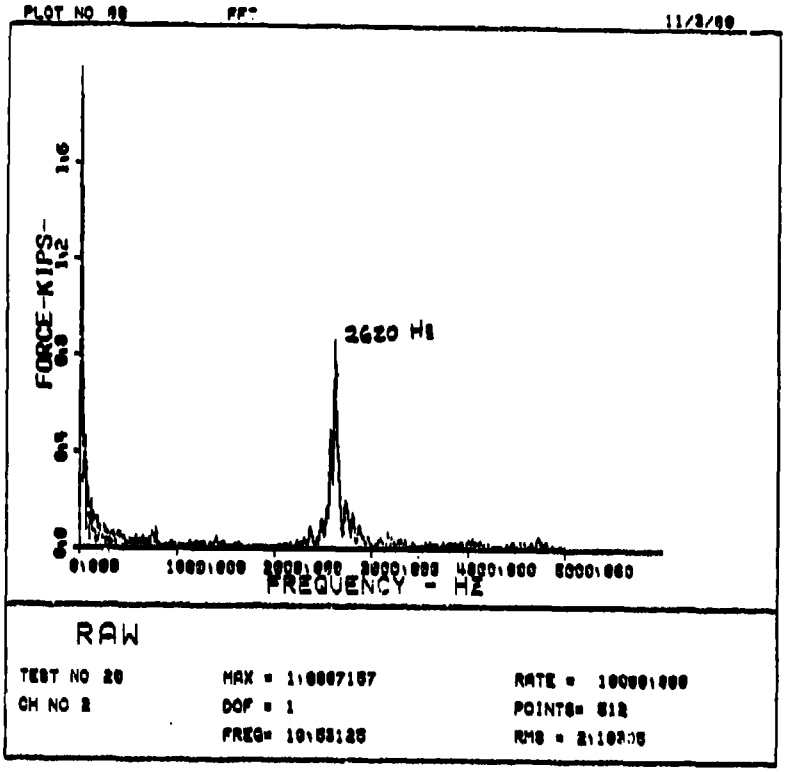

CHAN 1.000 FILE 3.000 AVG 1.455 RATE 20000.041
TEST 20.000 CH#2 2.000 CSDF 0.0
FREQ-CPS (X10^2)

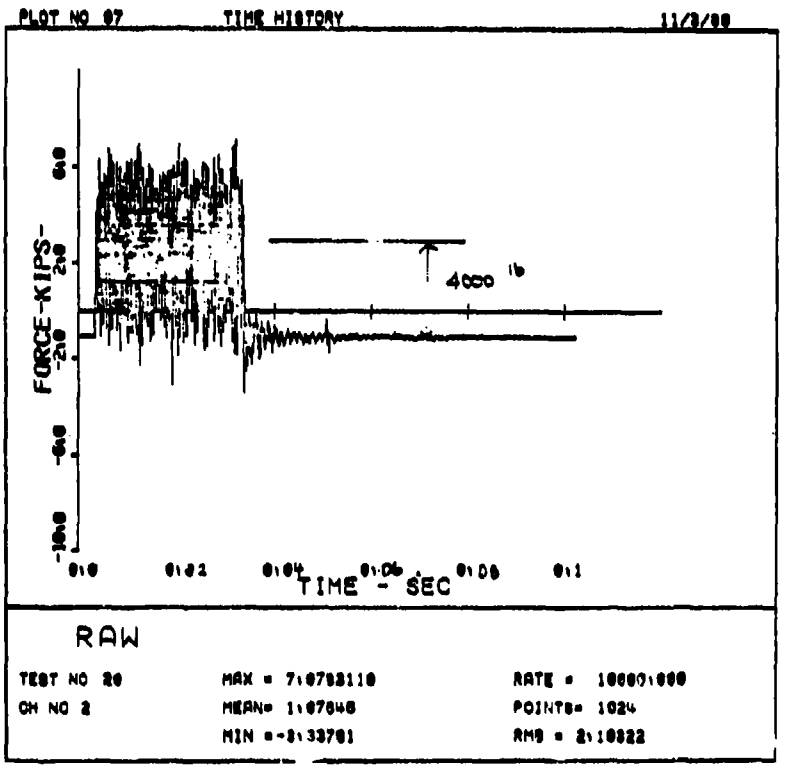

CHAN 2.00 FILE 3.00 AVG -3.00 RATE 20000.04
TEST 20.00 CH#2 3.00 CSDF 3.3
ACC-G
FREQ-CPS (X10^2)

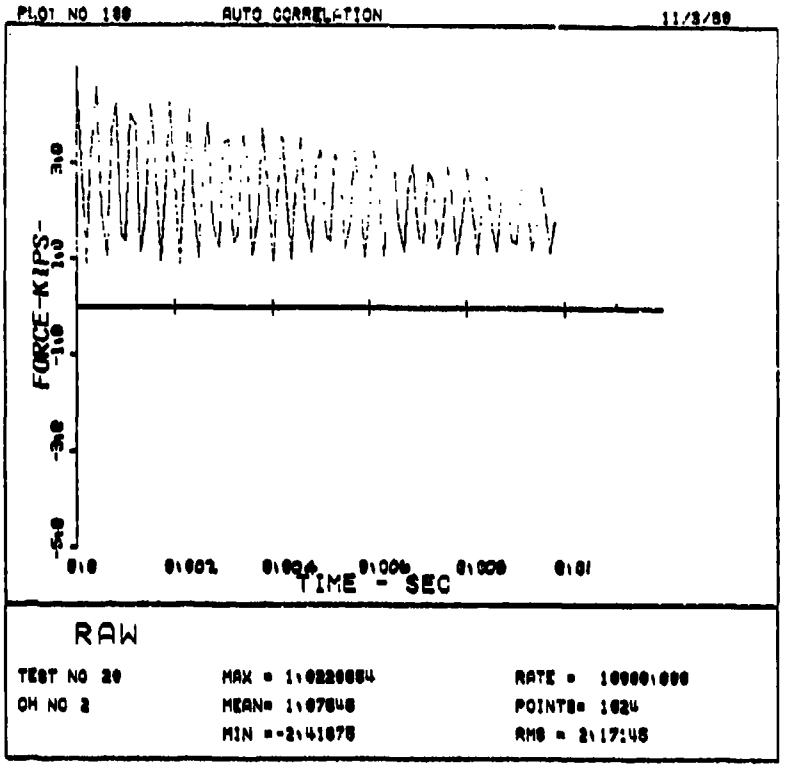

CHAN 2.00 FILE 3.00 AVG -3.00 RATE 20000.04
TEST 20.00 CH#2 1.00 CSDF 0.0
ACC-G (X10^-1)
FREQ-CPS (X10^2)

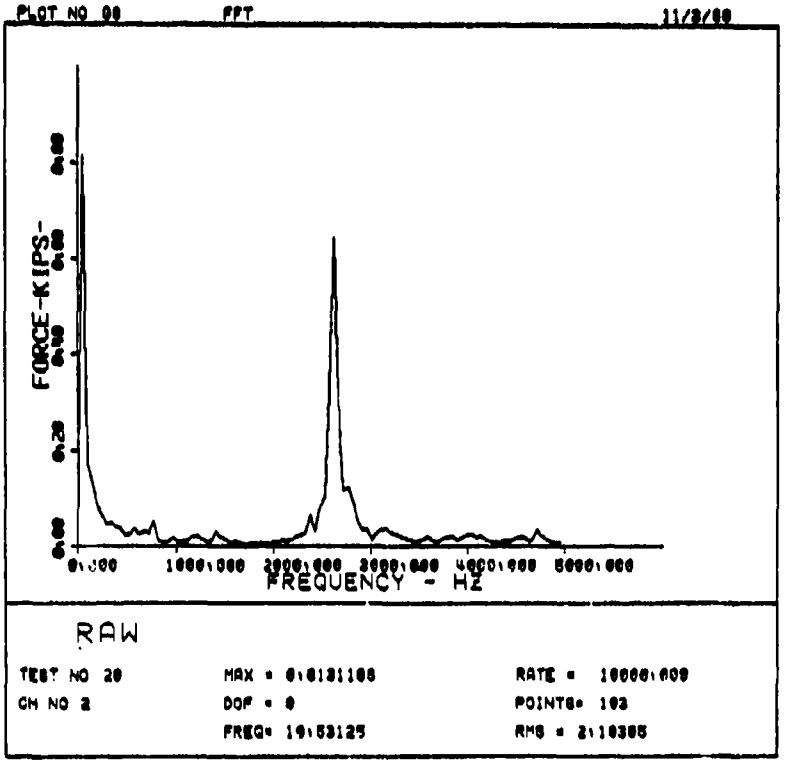

CHAN 3.00
FILE 3.00
AVG .19
RATE 20000.04
TEST 20.00
CH-2 2.00
CSDF 0.0
FREQ-CPS (X10^2)

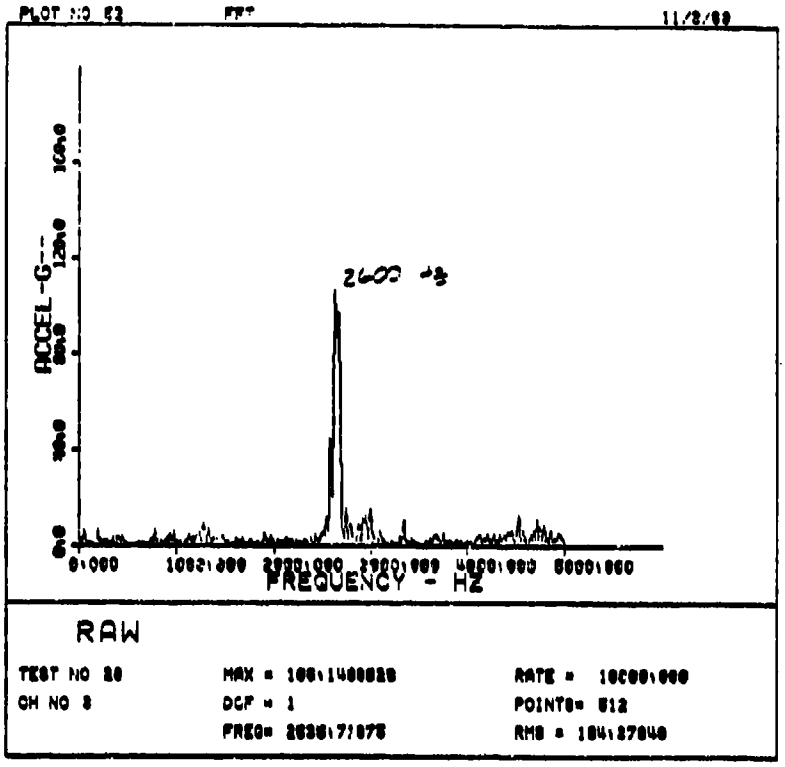

CHAN 3.00
FILE 3.00
AVG .19
RATE 20000.04
TEST 20.00
CH-2 1.00
CSDF 0.0
FREQ-CPS (X10^2)

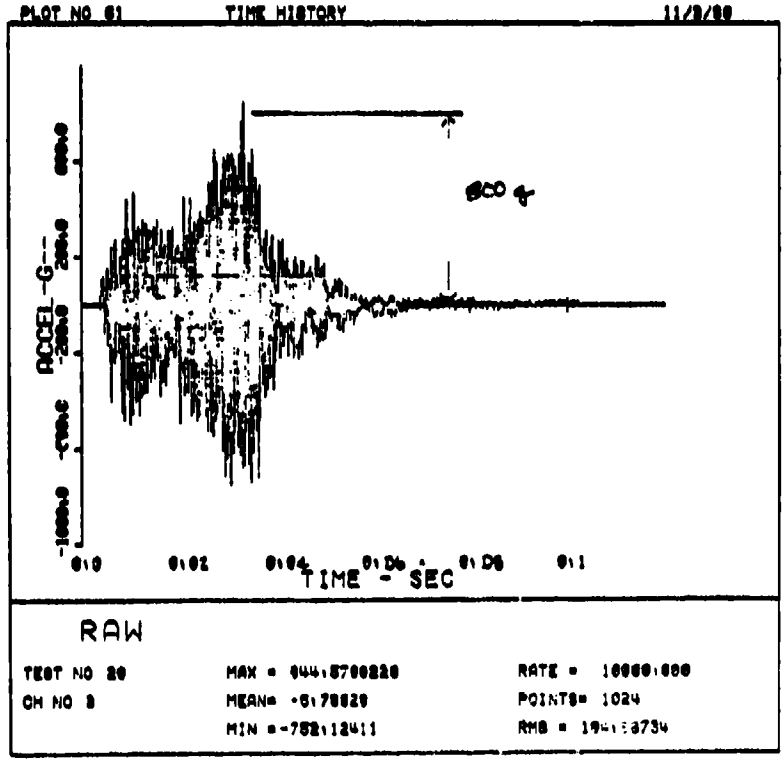

PLOT NO 08
FFT
11/3/80
FORCE-KIPS-
2620 Hz
FREQUENCY - HZ
RAW
TEST NO 20
CH NO 2
MAX = 1.0007157
DOF = 1
FREQ= 10.53125
RATE = 10000.000
POINTS= 512
RMS = 2.10305

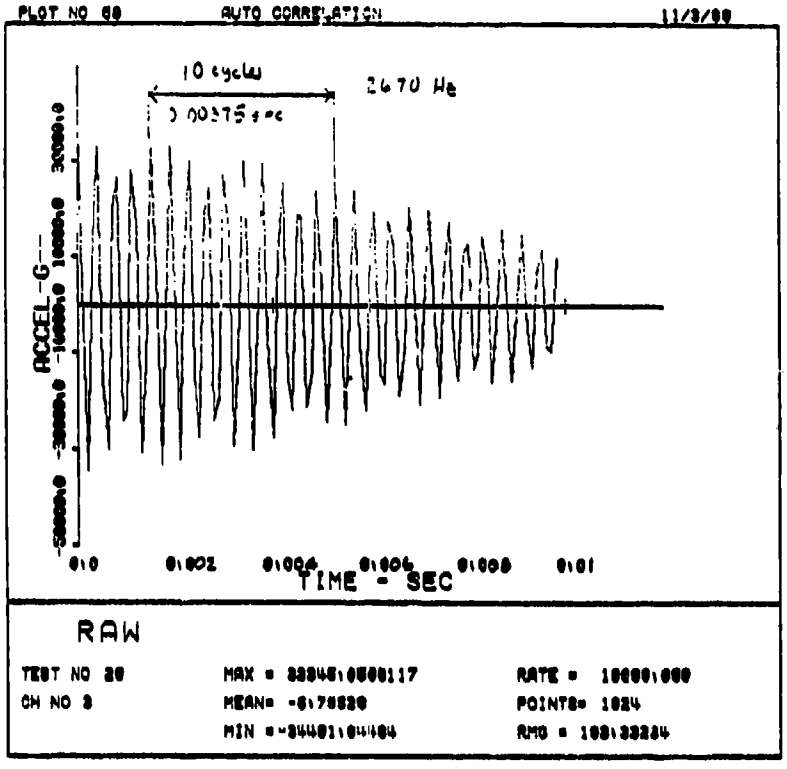

PLOT NO 07
TIME HISTORY
11/3/80
FORCE-KIPS-
4000 lb
TIME - SEC
RAW
TEST NO 20
CH NO 2
MAX = 7.0793110
MEAN= 1.07646
MIN =-3.33701
RATE = 10000.000
POINTS= 1024
RMS = 2.10322

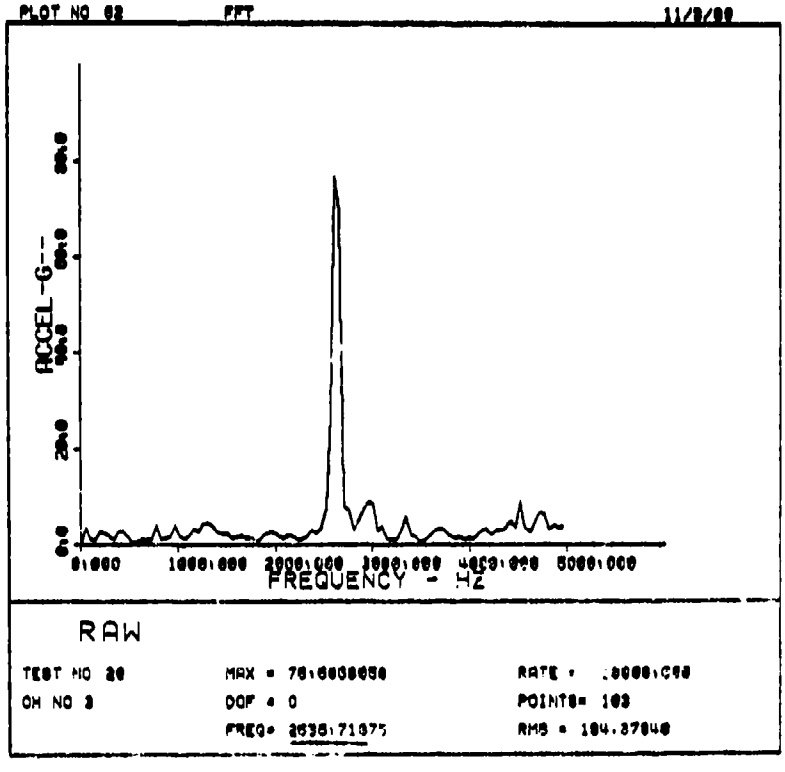

PLOT NO 100
AUTO CORRELATION
11/3/89
FORCE-KIPS-
TIME - SEC
RAW
TEST NO 20
CH NO 2
MAX = 1.0220664
MEAN= 1.078648
MIN =-2.141875
RATE = 10000.000
POINTS= 1024
RMS = 2.17148

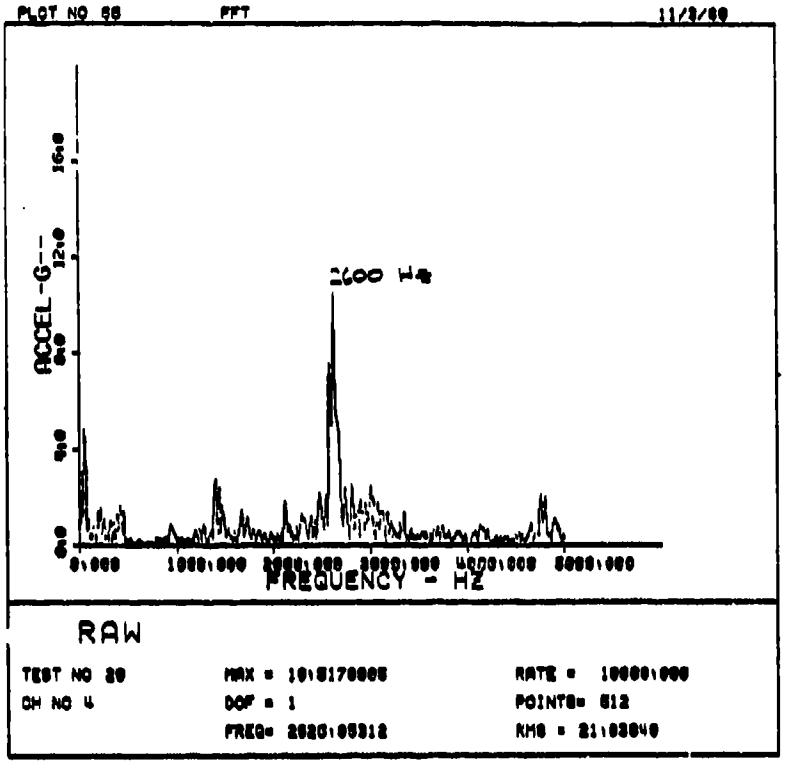

PLOT NO 99
FFT
11/3/89
FORCE-KIPS-
FREQUENCY - HZ
RAW
TEST NO 20
CH NO 2
MAX = 0.8131186
DOF = 0
FREQ= 19.53125
RATE = 10000.000
POINTS= 103
RMS = 2.10365

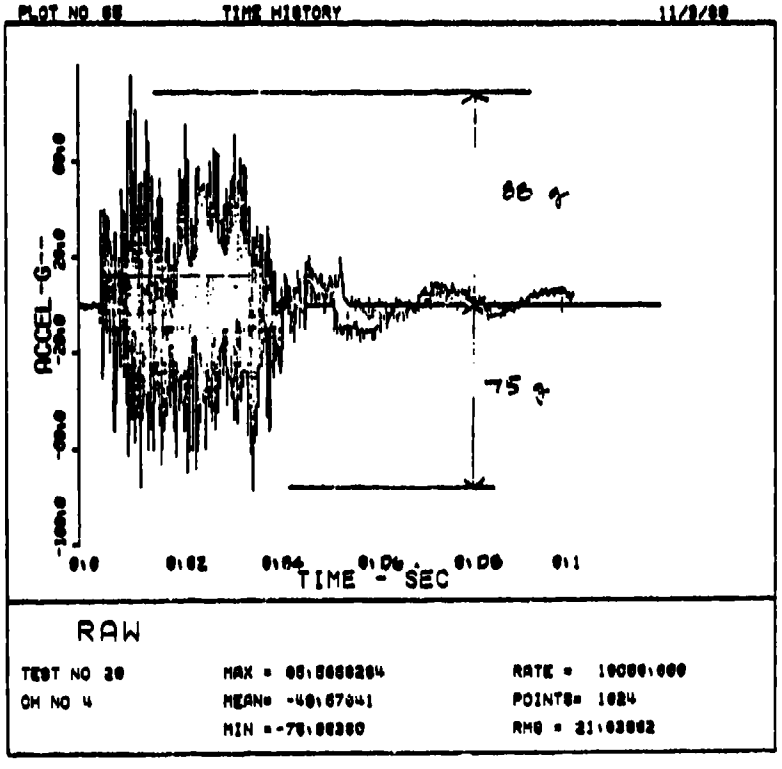

PLOT NO 52
FFT
11/3/89
ACCEL -G--
2600 Hz
FREQUENCY - HZ
RAW
TEST NO 20
CH NO 3
MAX = 106.1400828
DCF = 1
FREQ= 2636.71875
RATE = 10000.000
POINTS= 512
RMS = 184.27840

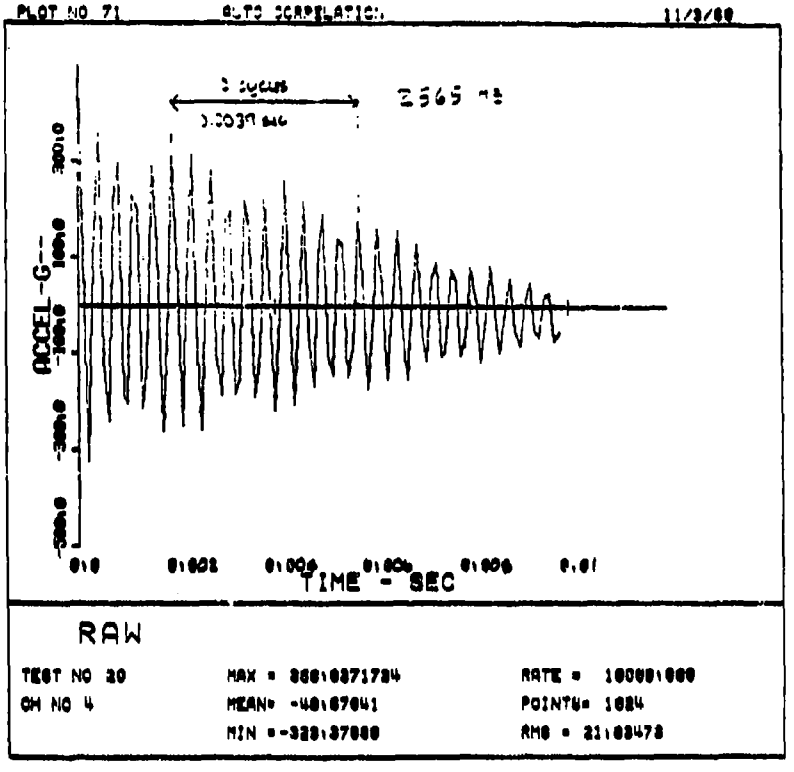

PLOT NO 61
TIME HISTORY
11/3/89
ACCEL -G--
800 g
TIME - SEC
RAW
TEST NO 20
CH NO 3
MAX = 944.5700220
MEAN= -5.78829
MIN =-752.12411
RATE = 10000.000
POINTS= 1024
RMS = 194.58734

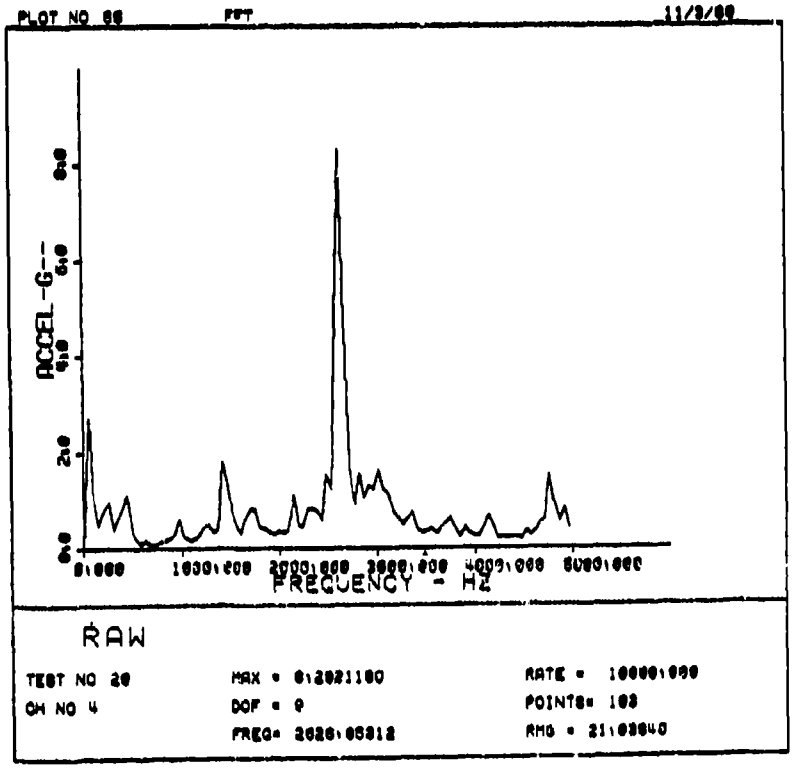

PLOT NO 60
AUTO CORRELATION
11/3/90
10 cycles
2670 Hz
ACCEL-G--
TIME - SEC
RAW
TEST NO 20
CH NO 3
MAX =
MEAN=
MIN =
RATE =
POINTS= 1024
RMS =

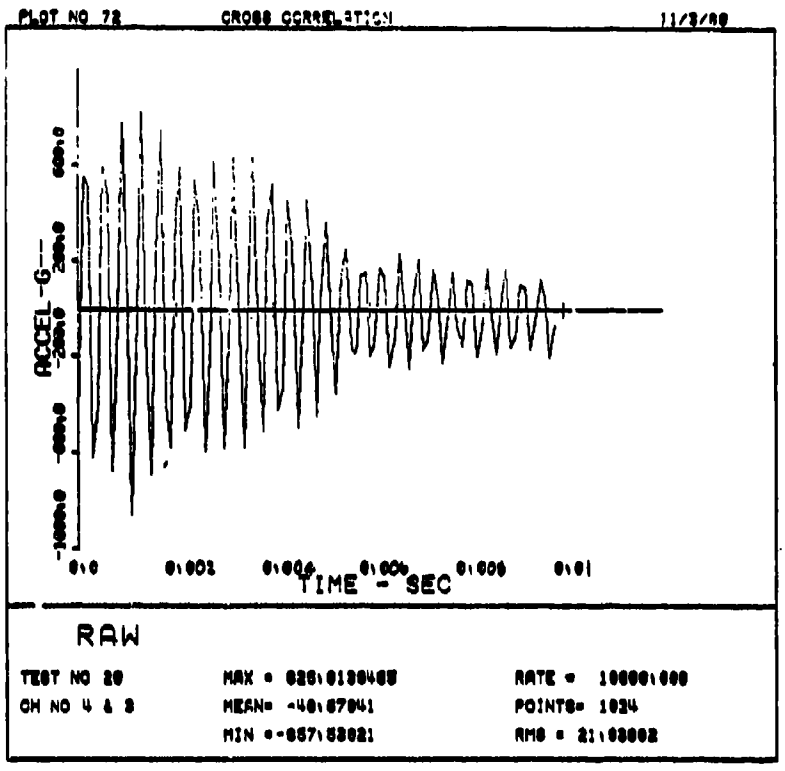

PLOT NO 62
FFT
11/3/90
ACCEL-G--
FREQUENCY - HZ
RAW
TEST NO 20
CH NO 3
MAX =
DOF = 0
FREQ=
RATE =
POINTS= 103
RMS =

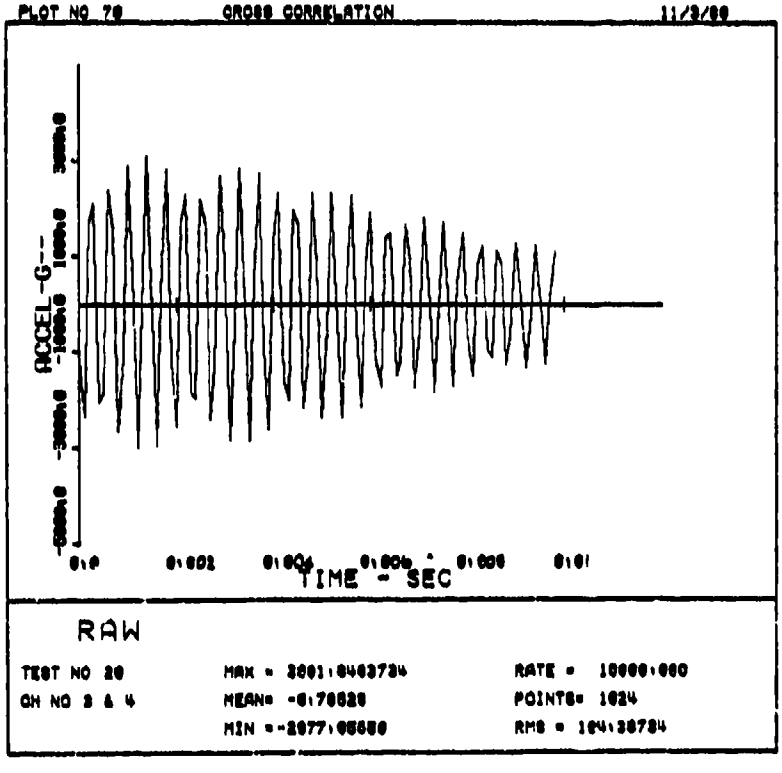

PLOT NO 65
FFT
11/3/89
ACCEL -G--
2600 Hz
FREQUENCY - HZ
RAW
TEST NO 20
CH NO 4
MAX = 10.5170005
DOF = 1
FREQ= 2620.05312
RATE = 10000.000
POINTS= 512
RMS = 21.03840

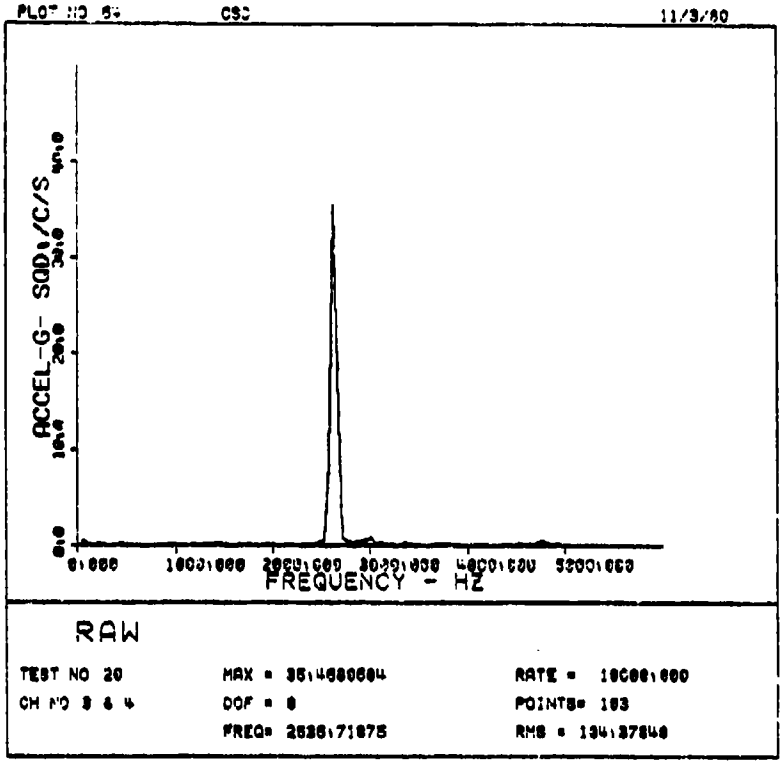

PLOT NO 65
TIME HISTORY
11/3/89
ACCEL -G--
88 g
75 g
TIME - SEC
RAW
TEST NO 20
CH NO 4
MAX = 85.5660204
MEAN= -40.67041
MIN = -75.00380
RATE = 10000.000
POINTS= 1024
RMS = 21.03862

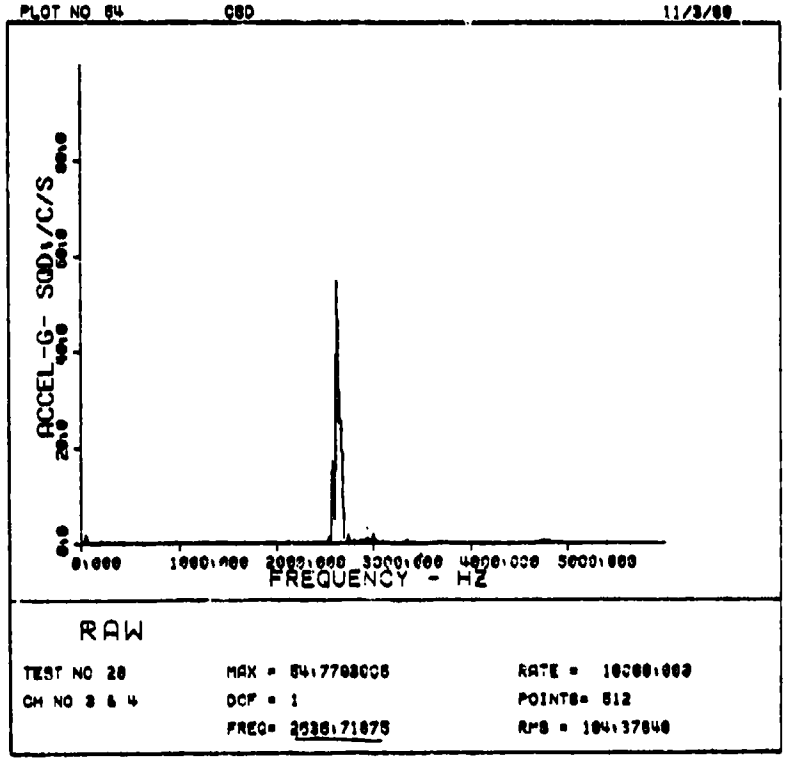

PLOT NO 71
AUTO CORRELATION
11/3/80
2565 Hz
ACCEL-G--
TIME - SEC
RAW
TEST NO 20
CH NO 4
MAX = 366.0371724
MEAN= -48.67041
MIN =-323.37880
RATE = 10000.000
POINTS= 1024
RMS = 21.03473


PLOT NO 66
FFT
11/3/80
ACCEL-G--
FREQUENCY - HZ
RAW
TEST NO 20
CH NO 4
MAX = 6.2021180
DOF = 9
FREQ= 2626.05312
RATE = 10000.000
POINTS= 103
RMS = 21.03840


PLOT NO 72
CROSS CORRELATION
11/3/80
ACCEL -G--
TIME - SEC
RAW
TEST NO 20
CH NO 4 & 3
MAX = 626.0138465
MEAN= -40.67041
MIN =-657.53021
RATE = 10000.000
POINTS= 1024
RMS = 21.03002


PLOT NO 70
CROSS CORRELATION
11/3/80
ACCEL -G--
TIME - SEC
RAW
TEST NO 20
CH NO 3 & 4
MAX = 3001.0403734
MEAN= -6.70528
MIN =-2077.05650
RATE = 10000.000
POINTS= 1024
RMS = 104.38734


PLOT NO 64
CSD
11/3/80
ACCEL-G- SQD1/C/S
FREQUENCY - HZ
RAW
TEST NO 20
CH NO 3 & 4
MAX = 35.4680664
DOF = 0
FREQ= 2536.71875
RATE = 10000.000
POINTS= 103
RMS = 134.37848


PLOT NO 64
CSD
11/3/80
ACCEL-G- SQD1/C/S
FREQUENCY - HZ
RAW
TEST NO 20
CH NO 3 & 4
MAX = 54.7705078
DOF = 1
FREQ= 2536.71875
RATE = 10000.000
POINTS= 512
RMS = 134.37848

APPENDIX G: TEST 21 RESULTS

Test 21
Equipment Rack Soft-Mounted
AN/GRC-103 in Rack, Off-Line

Plot Heading Nomenclature (Tests 21-25)

CHAN 1 - Input force

CHAN 2 - Rack acceleration

CHAN 3 - Equipment acceleration

RMS, AVG, MAX, XMAX, XMIN - RMS, average, maximum, and minimum values of data plots

FREQ - Frequency at which maximum value occurs

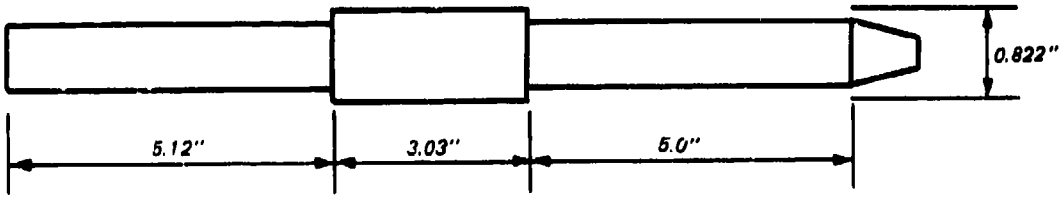
FFT 0.0 - Fast Fourier transform of time history

TIME 0.0 - Time history record

CSDF 0.0 - Cross spectral density function

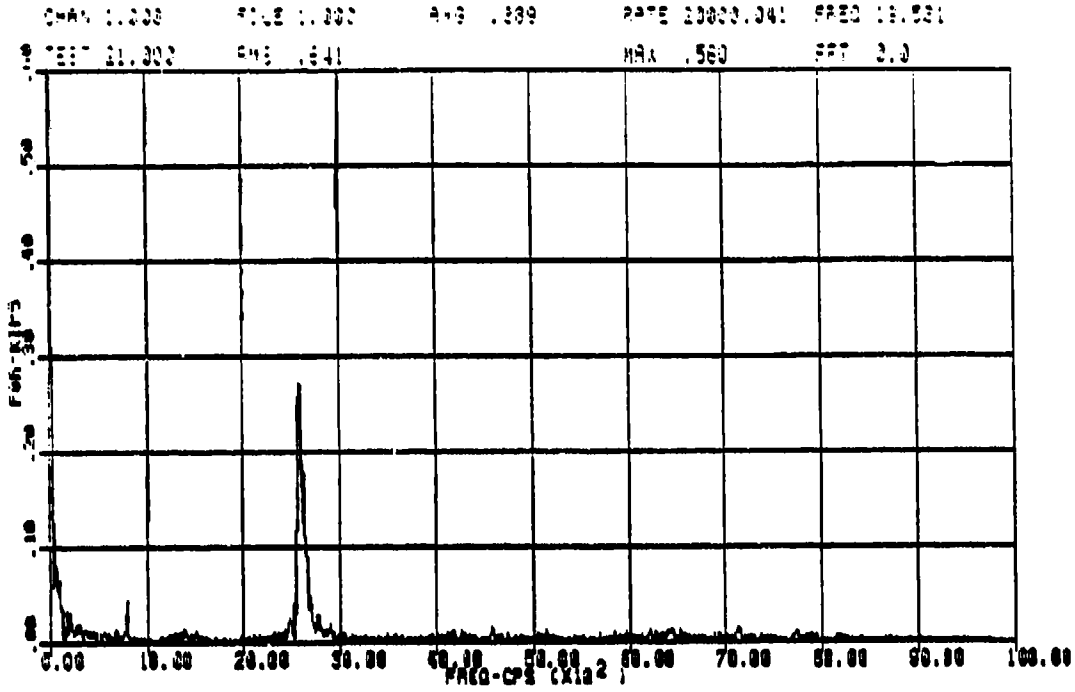
CH/2 1.0
CH/2 2.0
CH/2 3.0 — Channel number of the second channel for plots involving two-channel functions (CSDF)

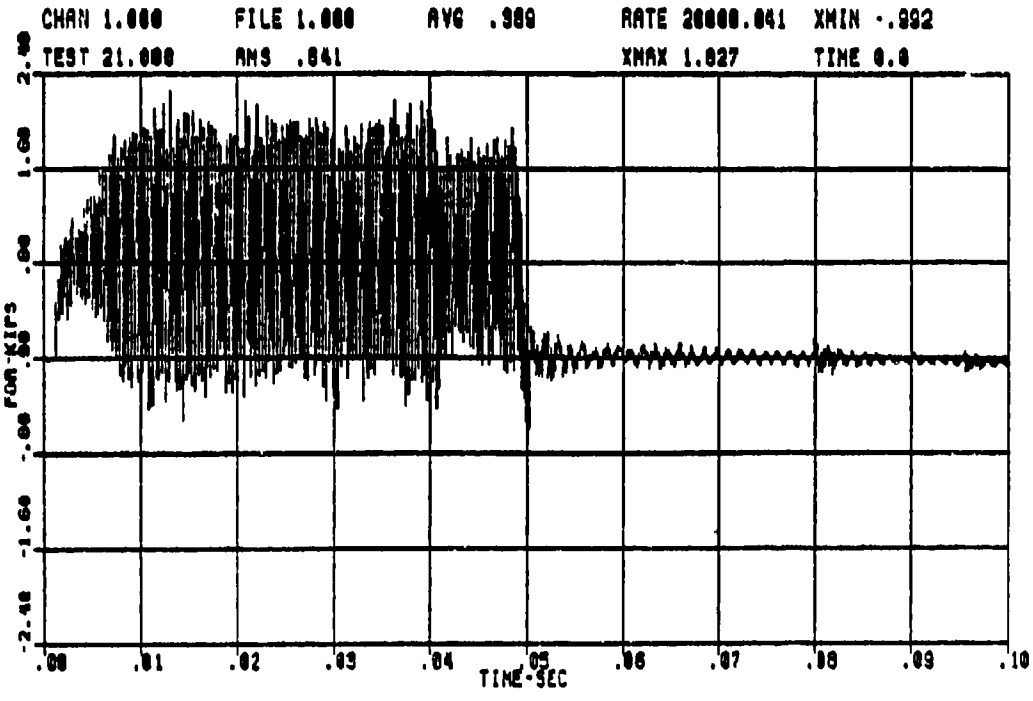
RATE - Digitizing rate, samples per second

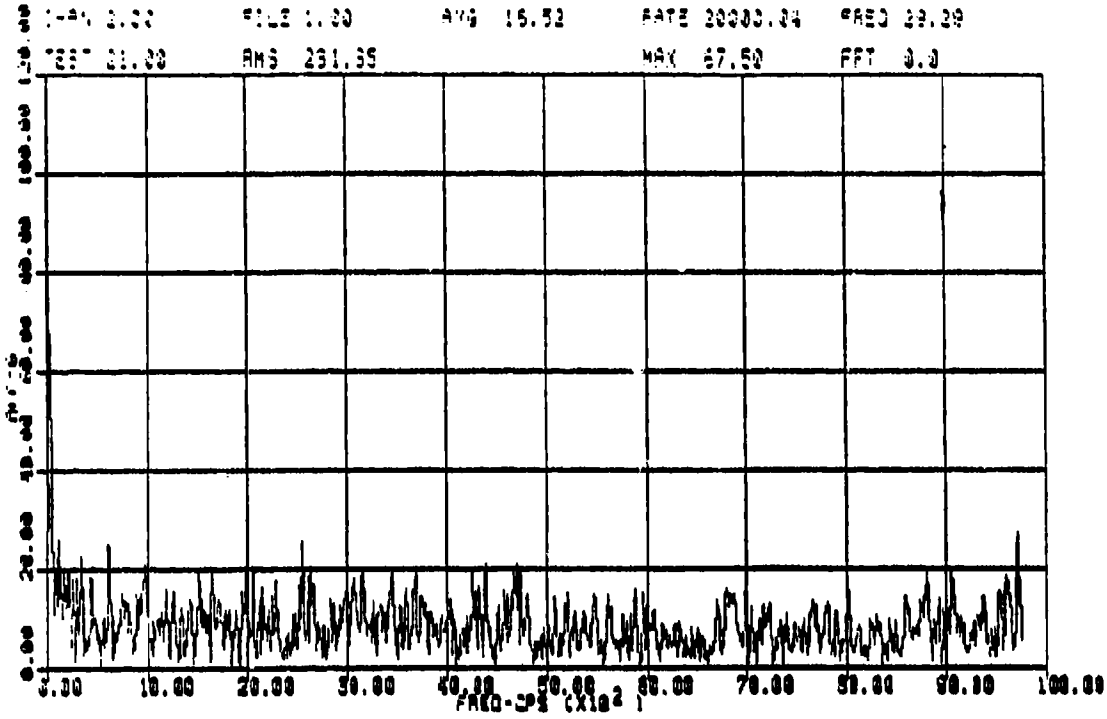


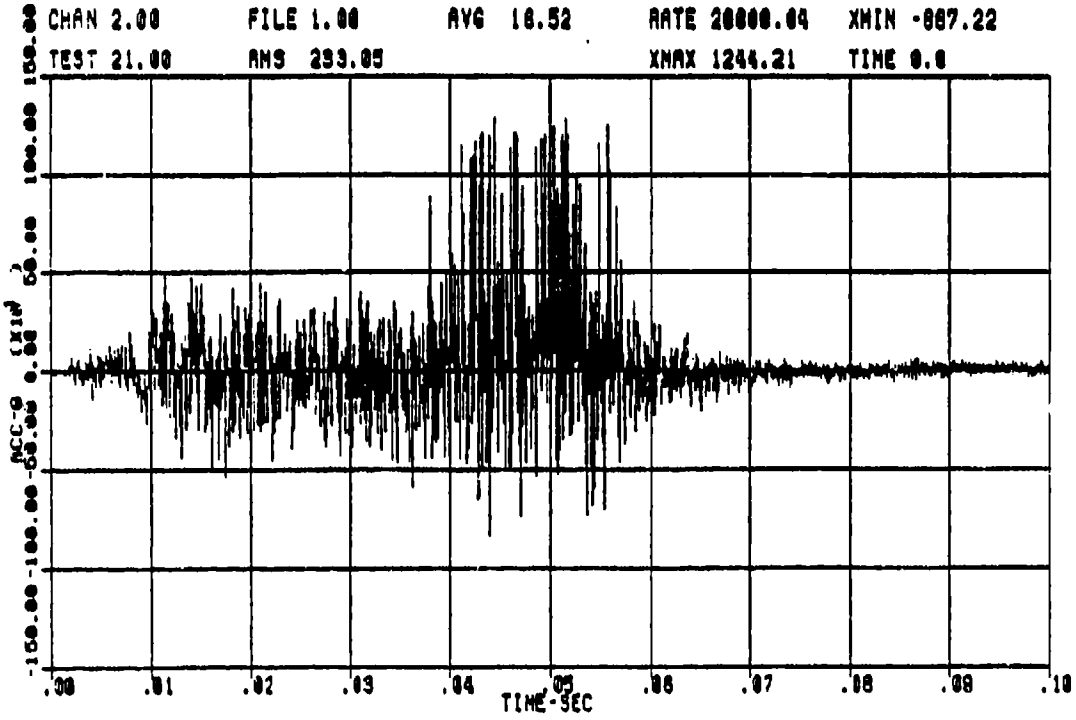
PULSE TRAIN - TEST 21

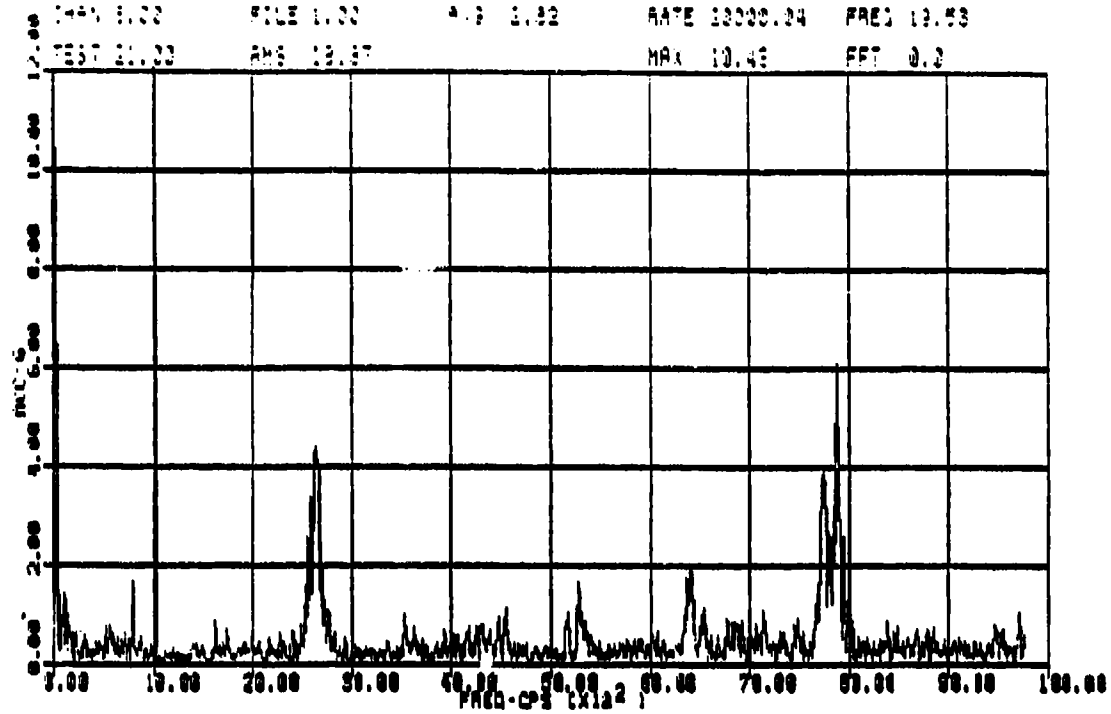
PRECHARGE PRESSURE = 1250 PSI
SYSTEM PRESSURE = 2000 PSI
FLOW CONTROL #6½
AIR BAG PRESSURE = 50 PSI

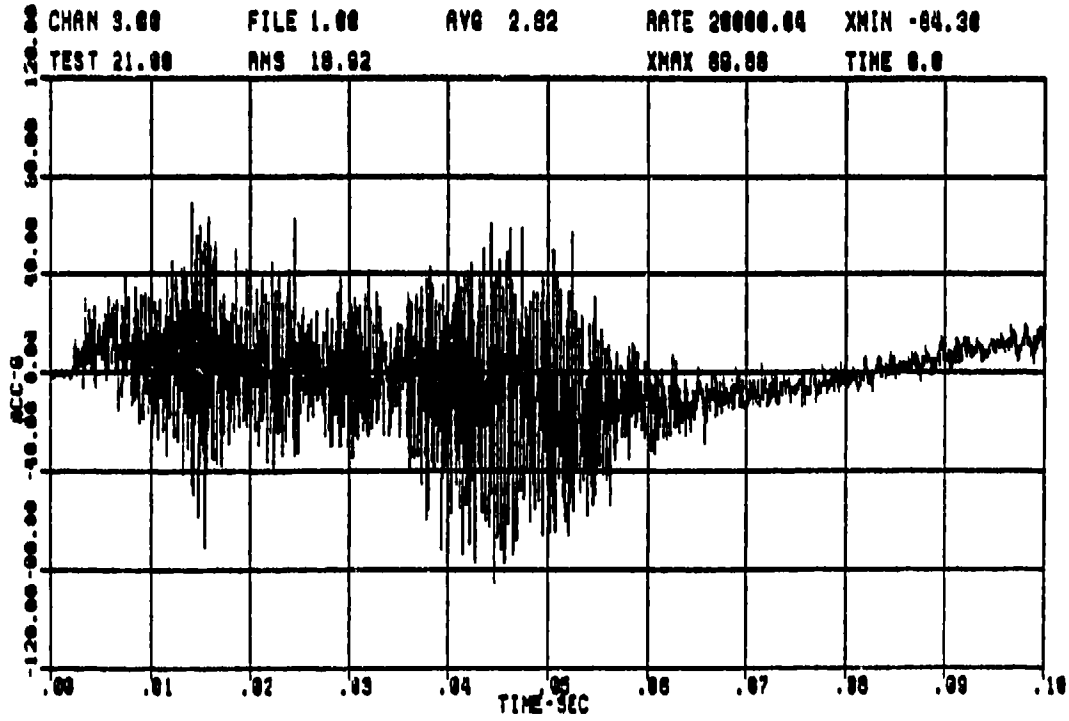

FREQ-CPS (X1e2)

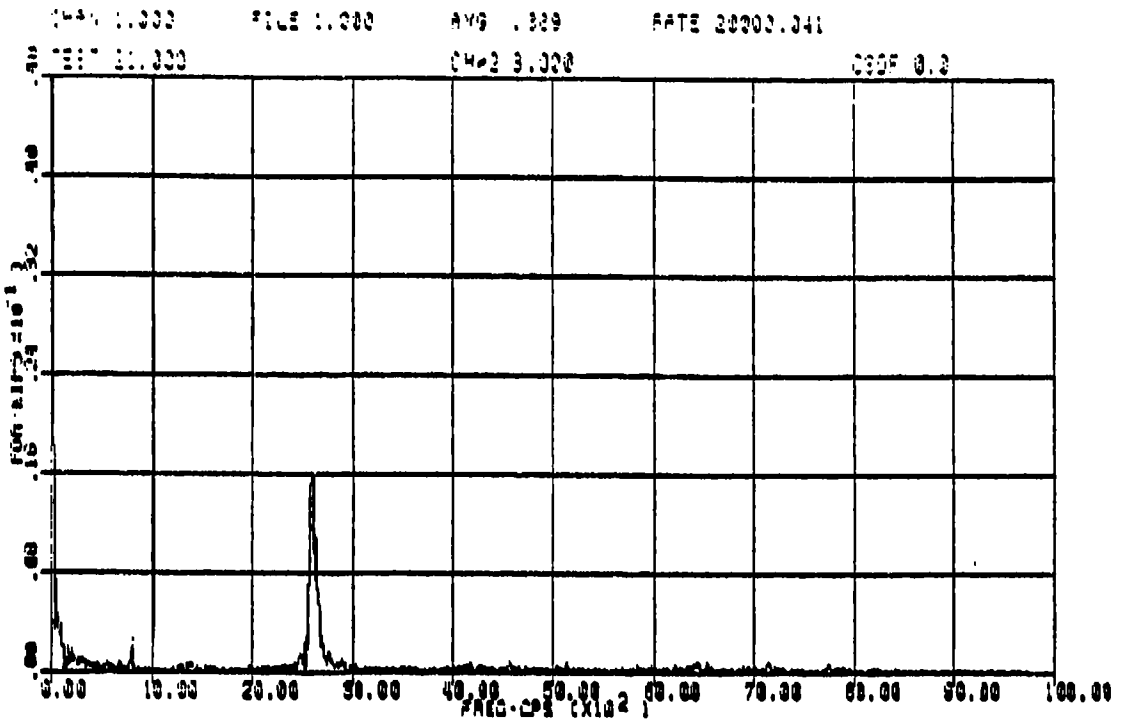

CHAN 1.000
FILE 1.000
AVG .999
RATE 20000.041
XMIN -.992
TEST 21.000
RMS .841
XMAX 1.027
TIME 0.0
TIME-SEC

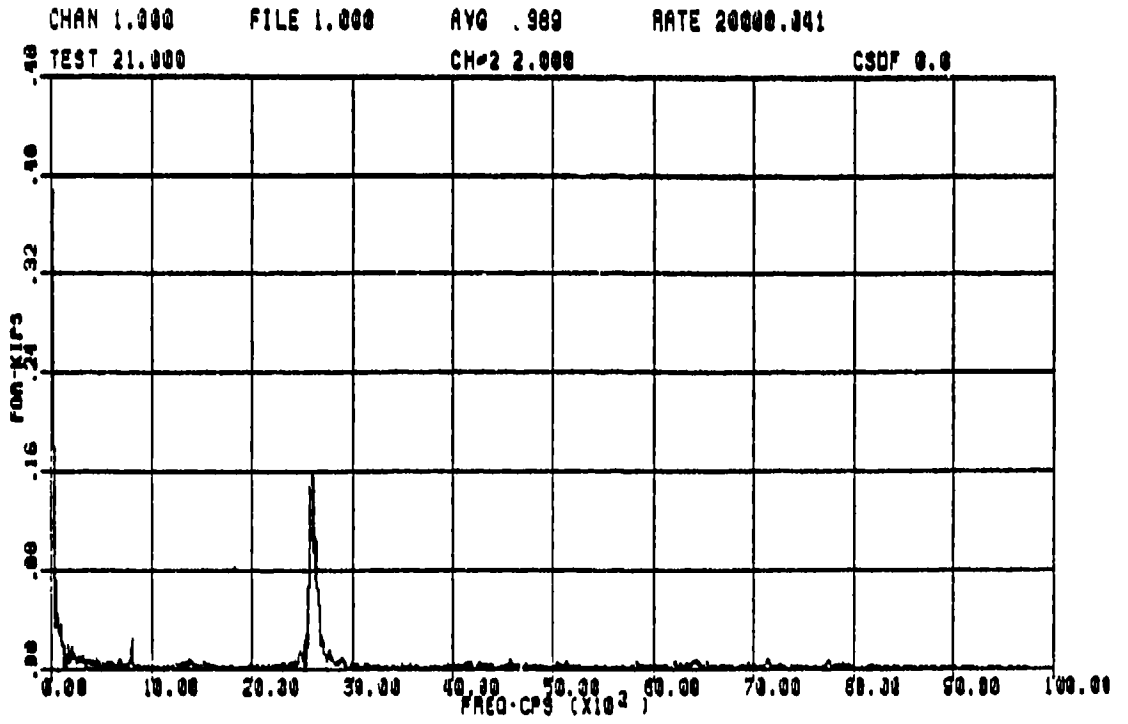

CHAN 2.00
FILE 1.00
AVG 16.52
RATE 20000.04
FREQ 39.29
TEST 21.00
RMS 291.35
MAX 67.50
FFT 0.0
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

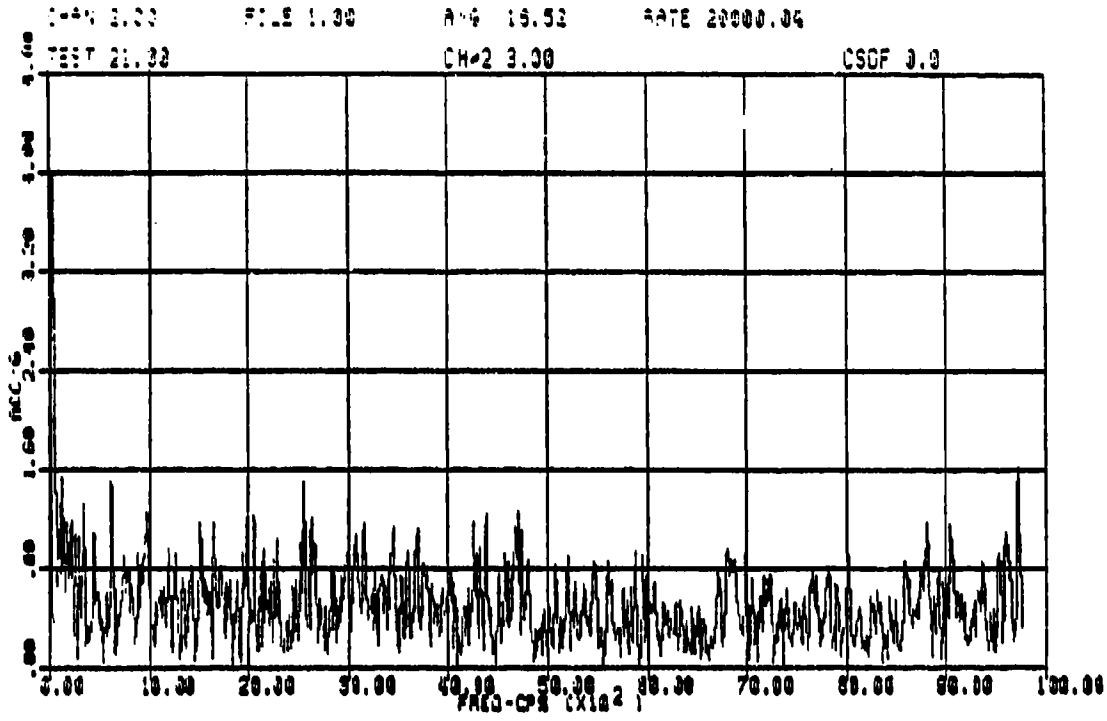

CHAN 2.00
FILE 1.00
AVG 16.52
RATE 20000.04
XMIN -887.22
TEST 21.00
RMS 293.05
XMAX 1244.21
TIME 0.0
ACC-G (X10^3)
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

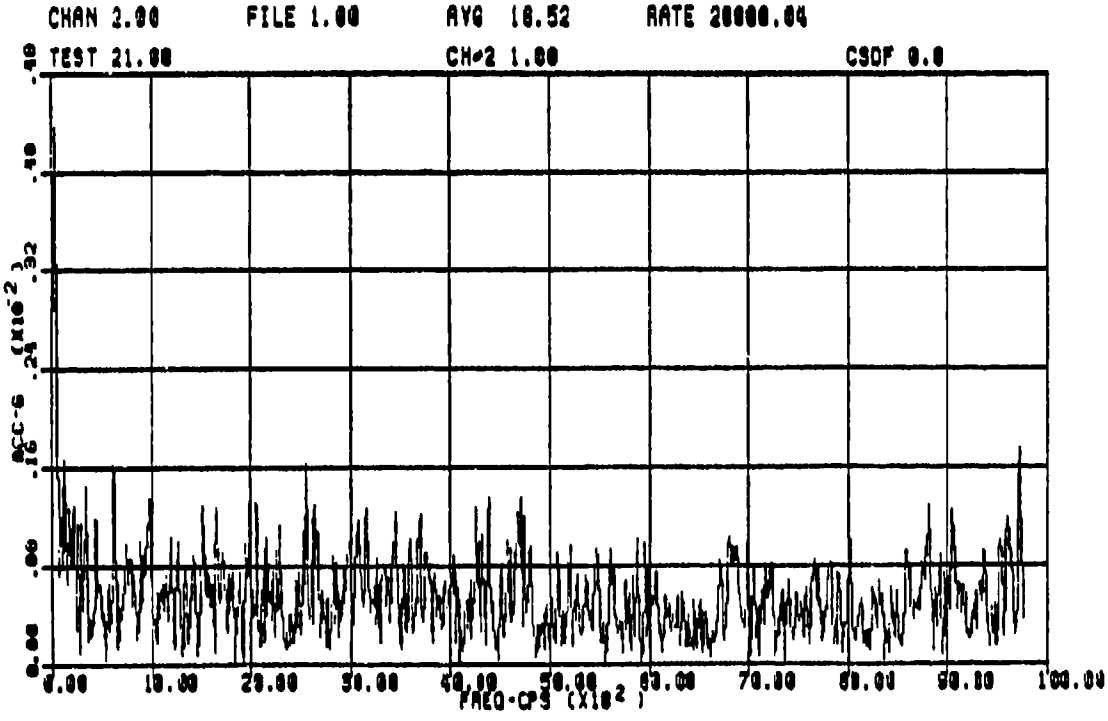

FREQ-CPS (X10^2)

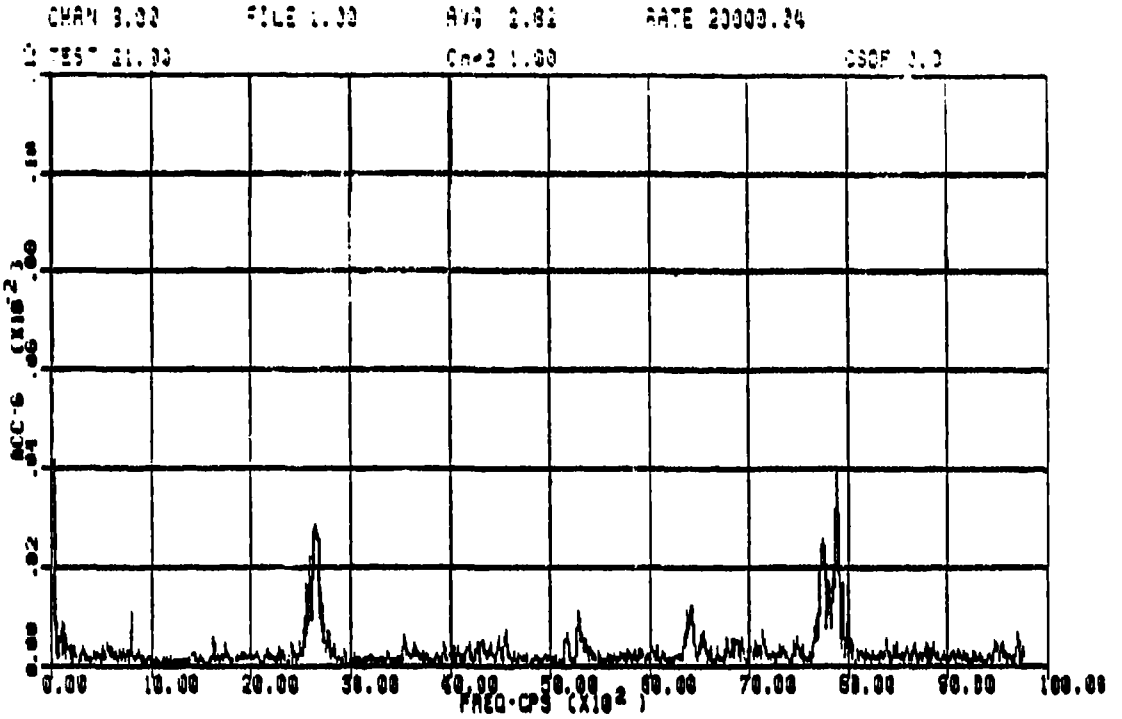

CHAN 3.00
FILE 1.00
AVG 2.82
RATE 20000.04
XMIN -84.30
TEST 21.00
RMS 18.92
XMAX 89.88
TIME 0.0
ACC-G
TIME-SEC

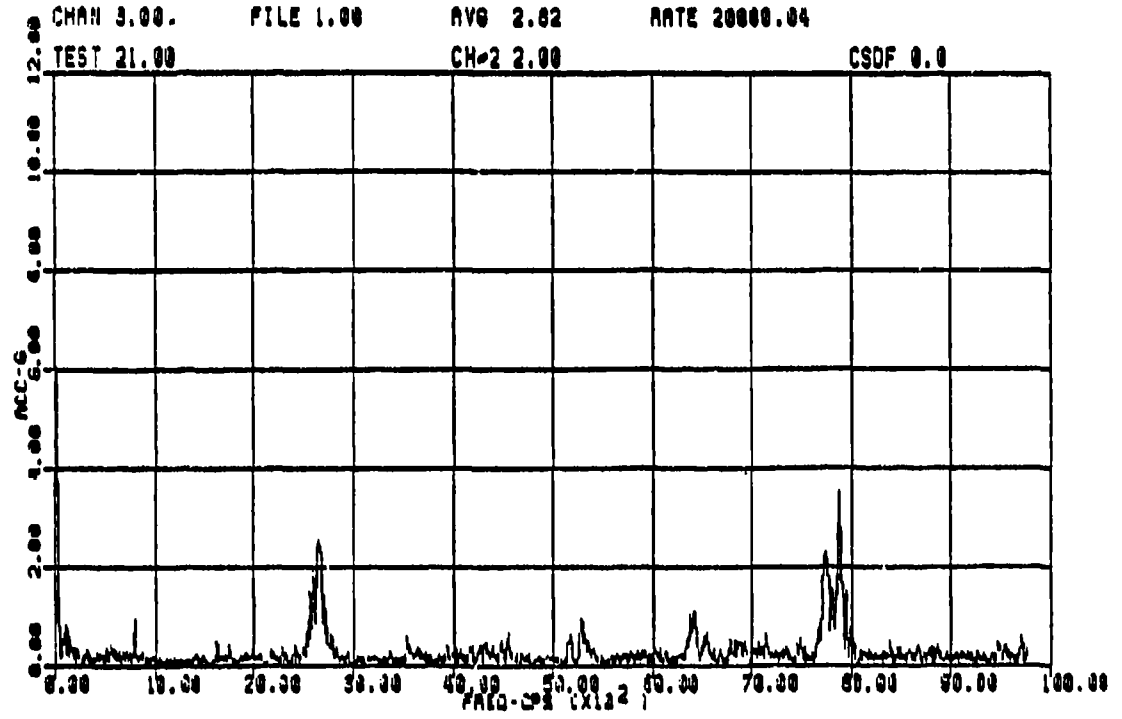

FILE 1.000
AVG .989
RATE 20000.041
CH=2 3.000
CSDF 0.0
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

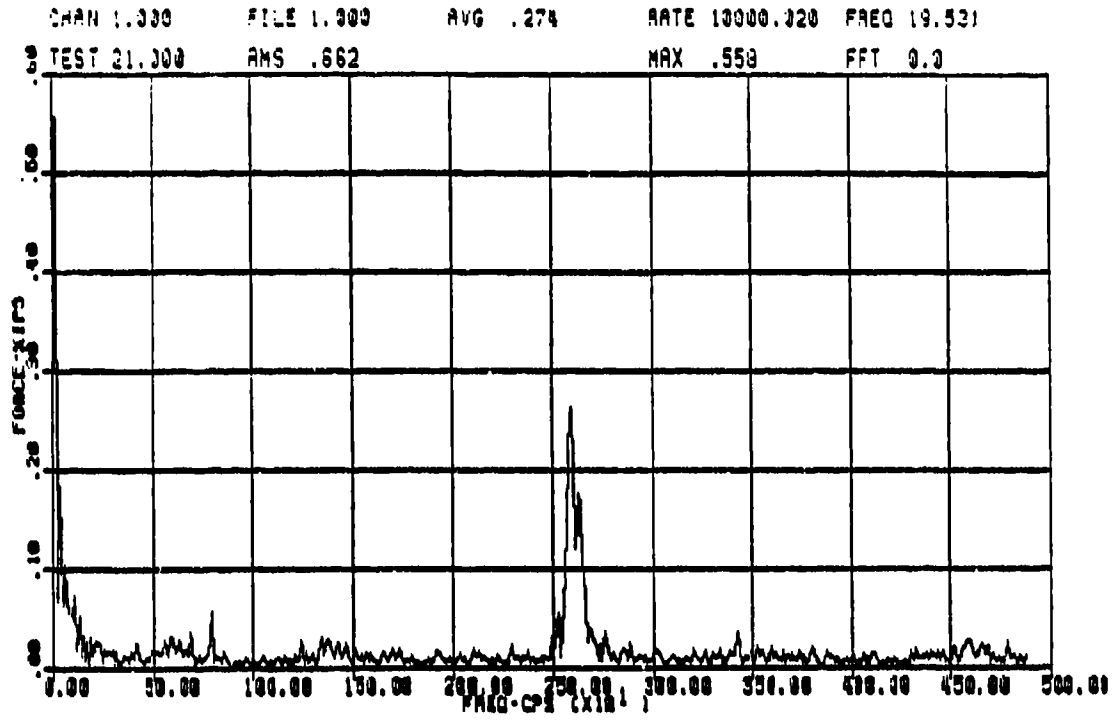

CHAN 1.000
FILE 1.000
AVG .989
RATE 20000.041
TEST 21.000
CH=2 2.000
CSDF 0.0
.48
.40
.32
.24
.16
.08
.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

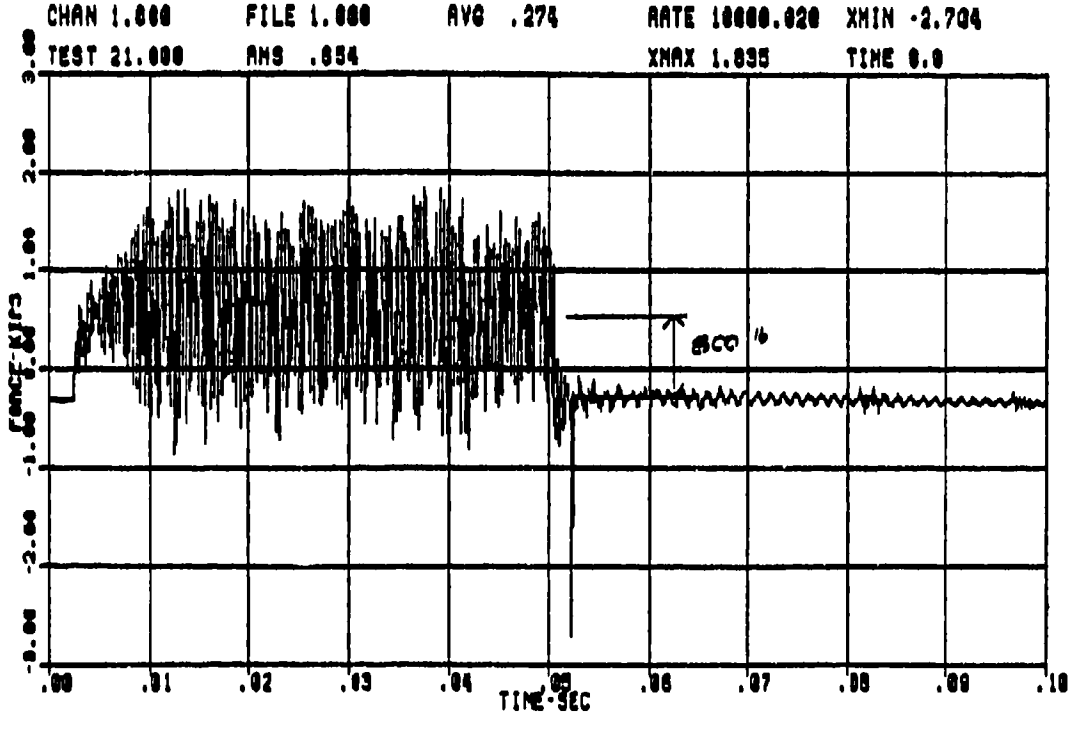

TEST 21.00
CH#2 3.00
CSDF 0.0
FREQ-CPS (X10^2)

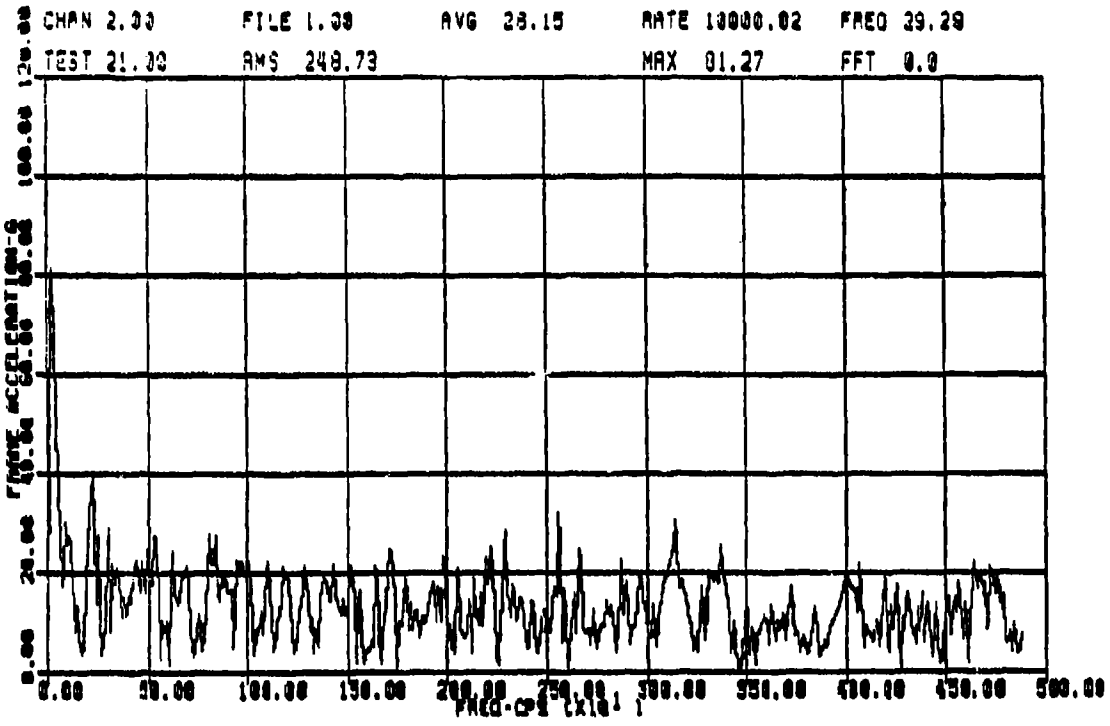

CHAN 2.00
FILE 1.00
AVG 10.52
RATE 20000.00
TEST 21.00
CH#2 1.00
CSDF 0.0
FREQ-CPS (X10^2)

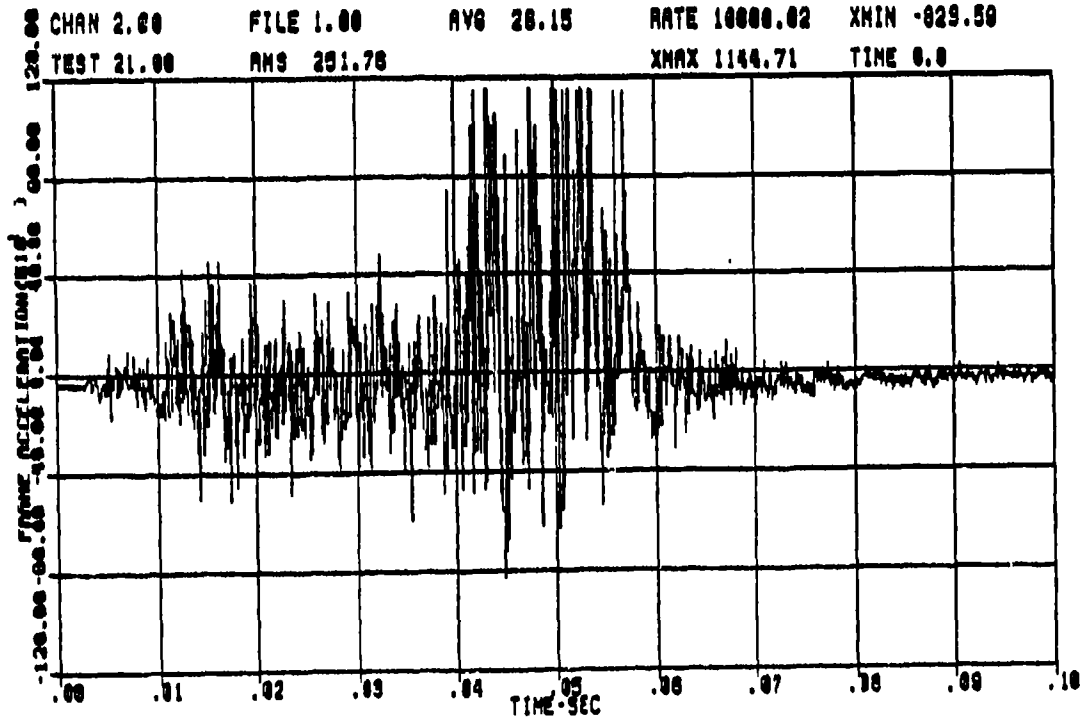

CHAN 3.00
FILE 1.00
AVG 2.82
RATE 20000.04
TEST 21.00
CH#2 1.00
CSDF 0.0
ACC-G (X10^-2)
FREQ-CPS (X10^2)

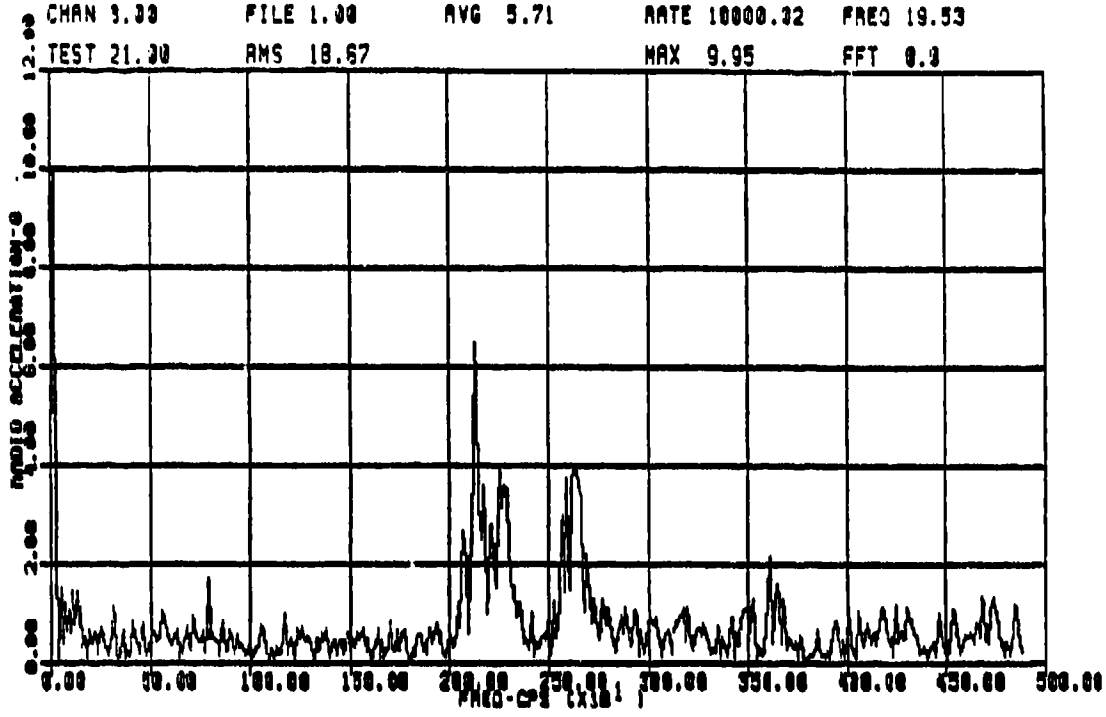

CHAN 3.00.
FILE 1.00
AVG 2.82
RATE 20000.04
TEST 21.00
CH#2 2.00
CSDF 0.0
ACC-G
FREQ-CPS (X10^2)

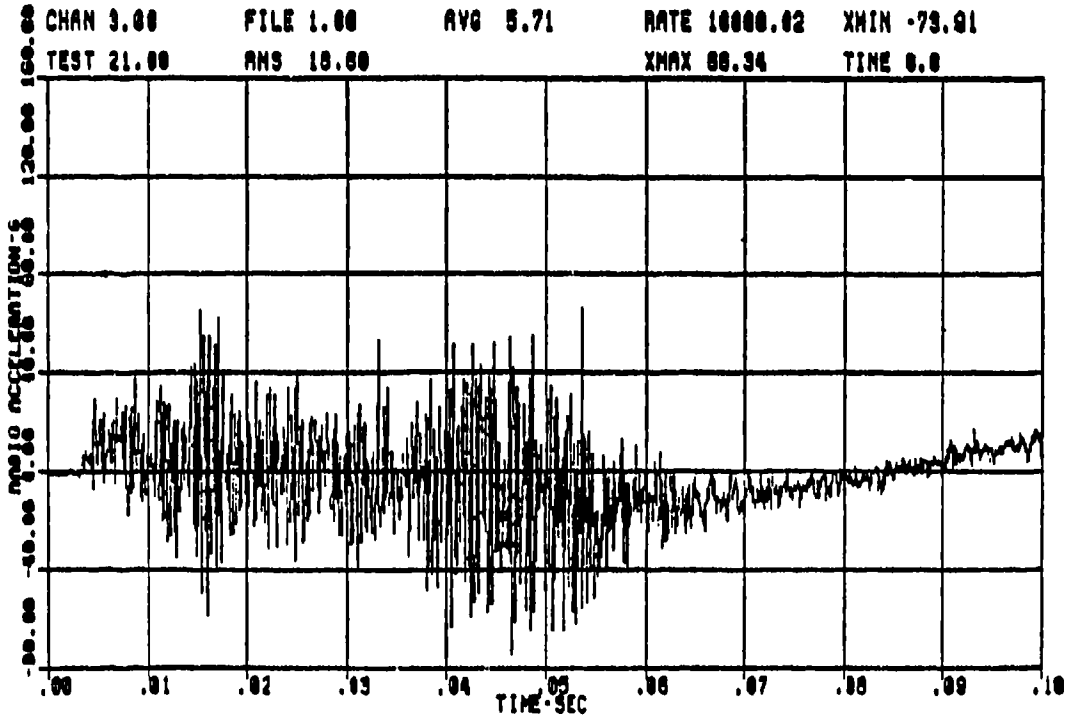

CHAN 1.000
FILE 1.000
AVG .274
RATE 10000.020
FREQ 19.531
TEST 21.000
RMS .662
MAX .559
FFT 0.0
FORCE-KIPS
FREQ-CPS (X10^1)

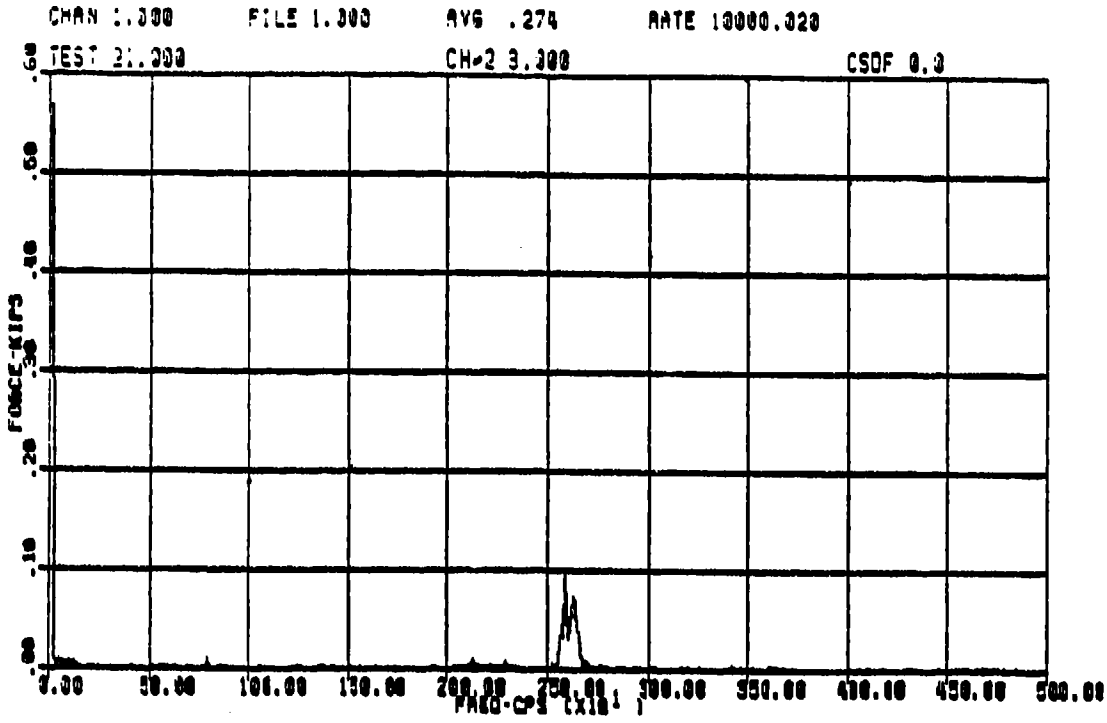

CHAN 1.000
FILE 1.000
AVG .274
RATE 10000.020
XMIN -2.704
TEST 21.000
RMS .654
XMAX 1.895
TIME 0.0
FORCE-KIPS
TIME-SEC

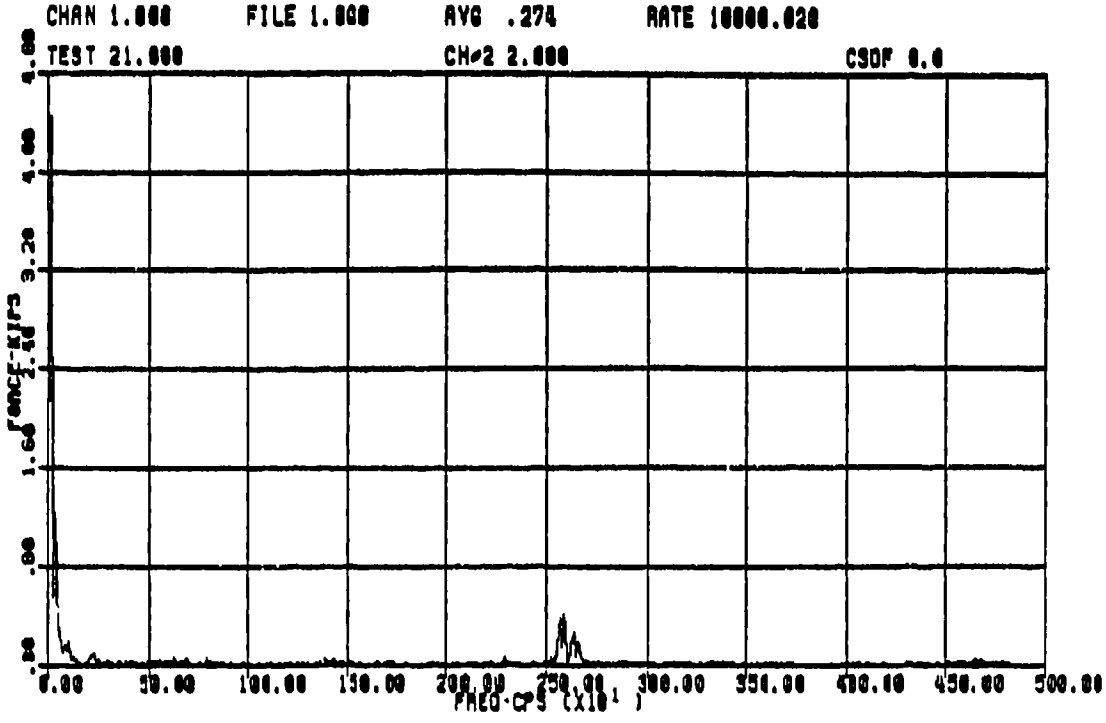

CHAN 2.00
FILE 1.00
AVG 28.15
RATE 10000.02
FREQ 29.29
TEST 21.00
RMS 248.73
MAX 81.27
FFT 0.0
FREQ-CPS (x10^1)

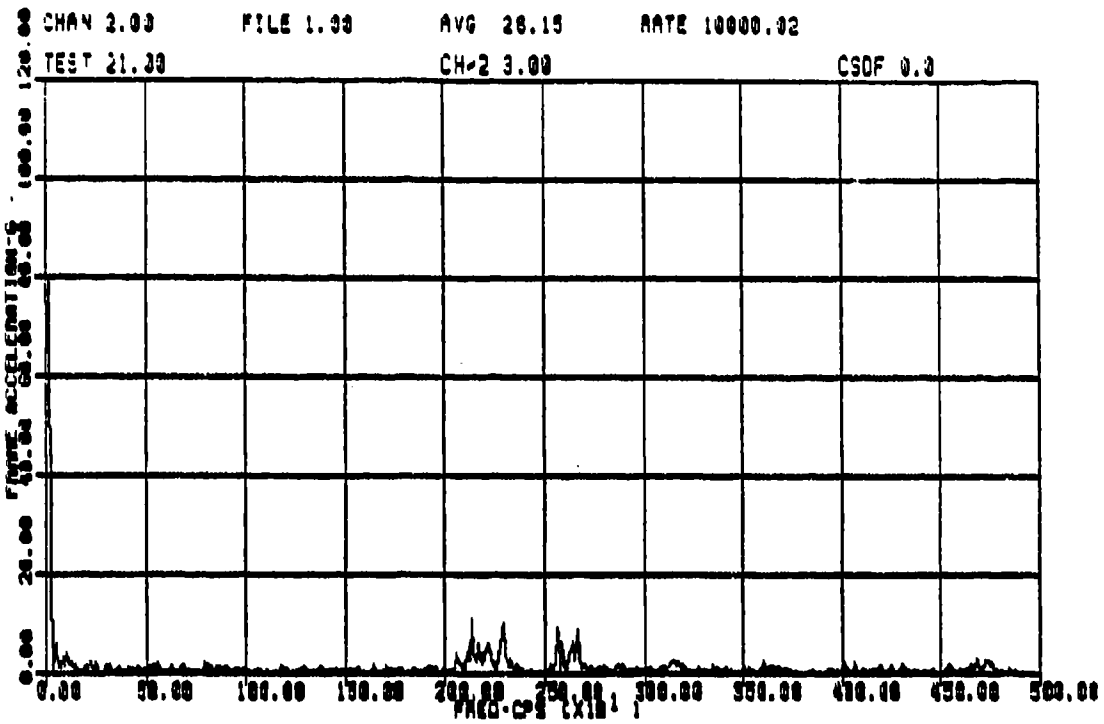

CHAN 2.00
FILE 1.00
AVG 28.15
RATE 10000.02
XMIN -829.50
TEST 21.00
RMS 251.76
XMAX 1144.71
TIME 0.0
TIME-SEC

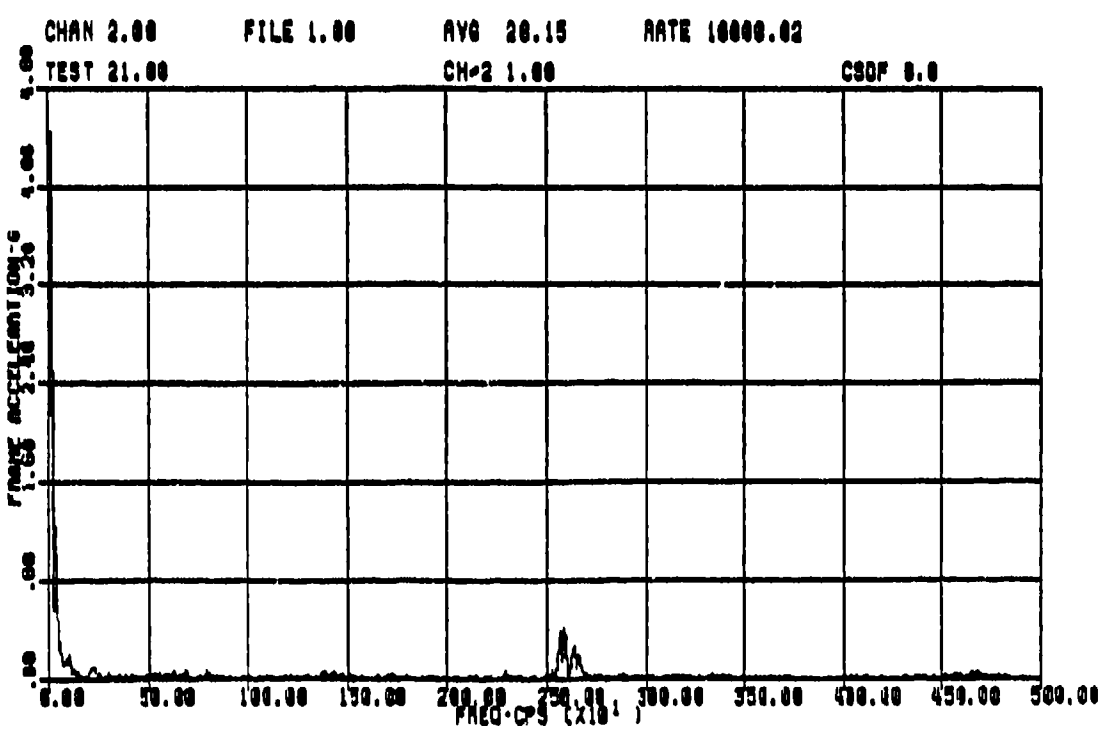

CHAN 3.00
FILE 1.00
AVG 5.71
RATE 10000.02
FREQ 19.53
TEST 21.00
RMS 18.67
MAX 9.95
FFT 0.0
FREQ-CPS (X10)

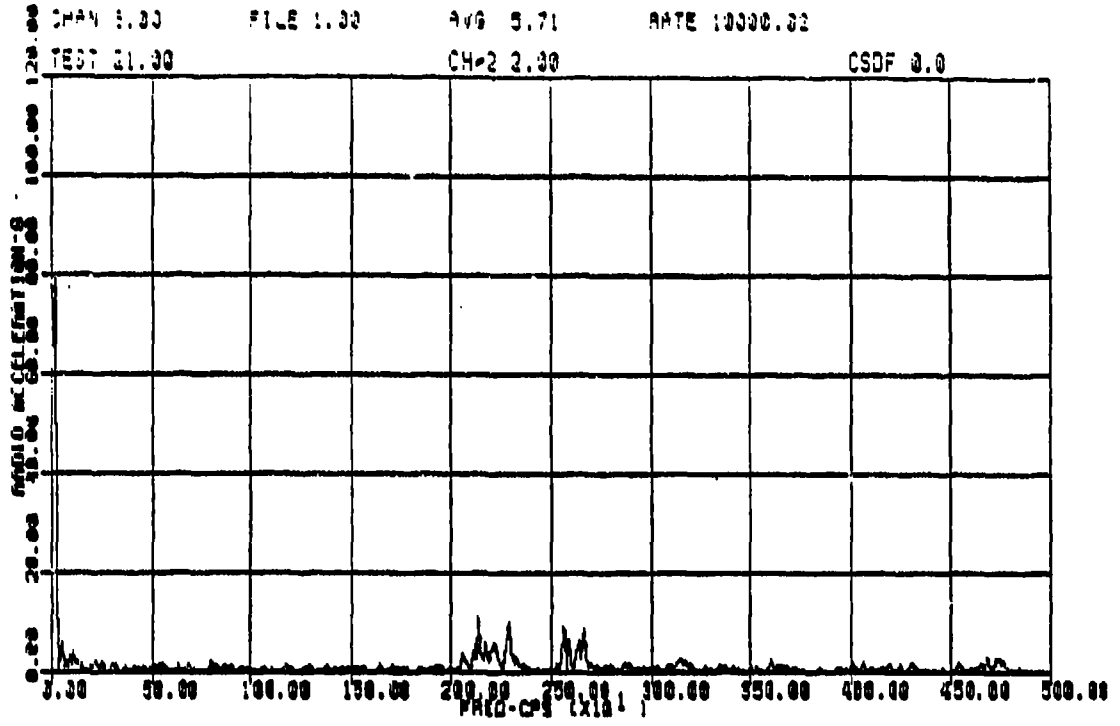

CHAN 3.00
FILE 1.00
AVG 5.71
RATE 10000.02
XMIN -79.91
TEST 21.00
RMS 18.60
XMAX 80.34
TIME 0.0
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

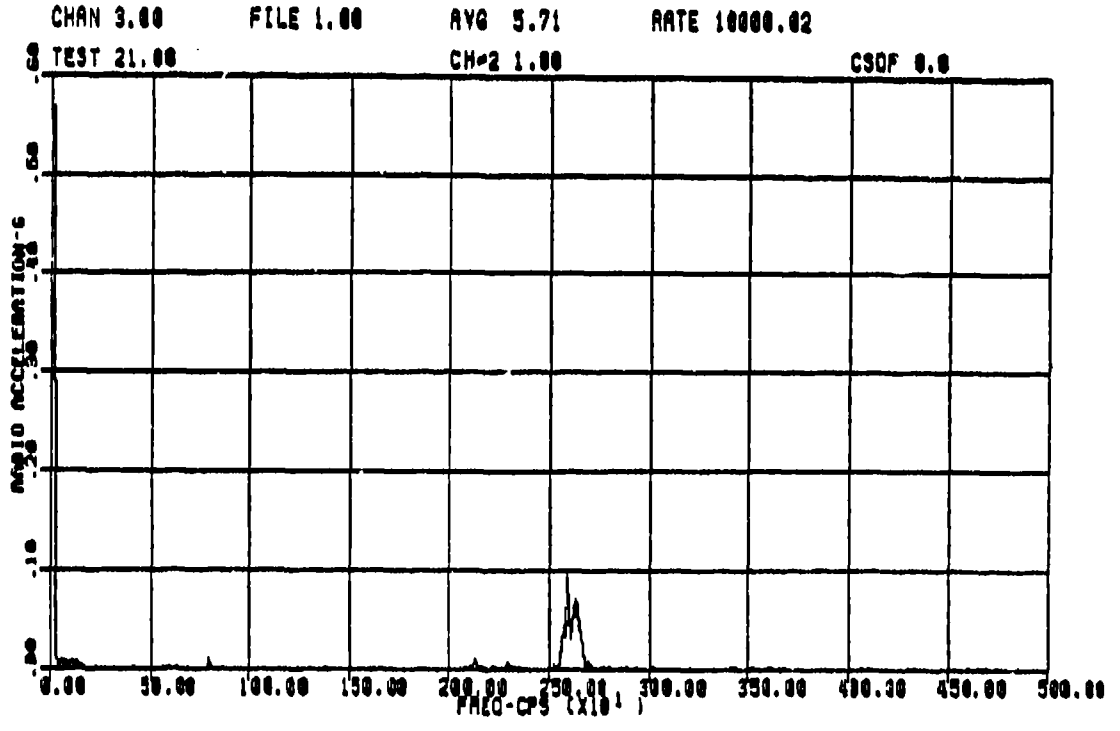

CHAN 1.000
FILE 1.000
AVG .274
RATE 10000.020
TEST 21.000
CH#2 3.000
CSOF 0.0
FORCE-KIPS
.60
.50
.40
.30
.20
.10
.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00
FREQ-CPS (x10)

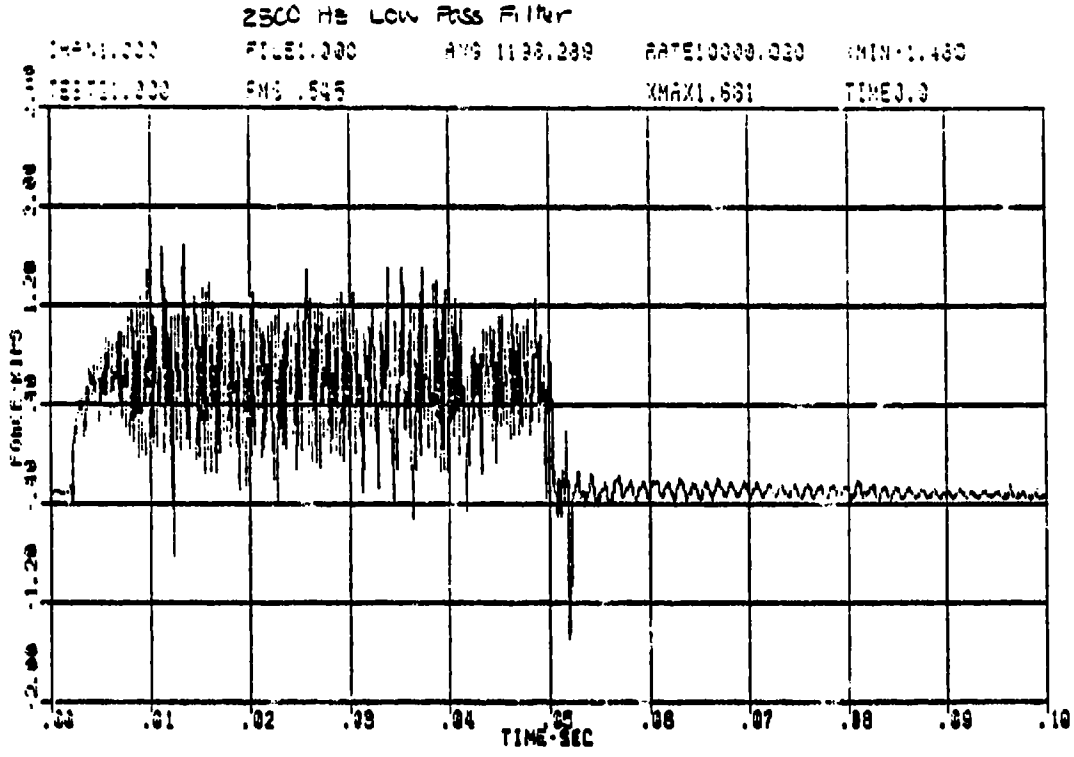

CHAN 1.000
FILE 1.000
AVG .274
RATE 10000.020
TEST 21.000
CH#2 2.000
CSOF 0.0
FORCE-KIPS
4.00
3.20
2.40
1.60
.80
.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00
FREQ-CPS (x10)

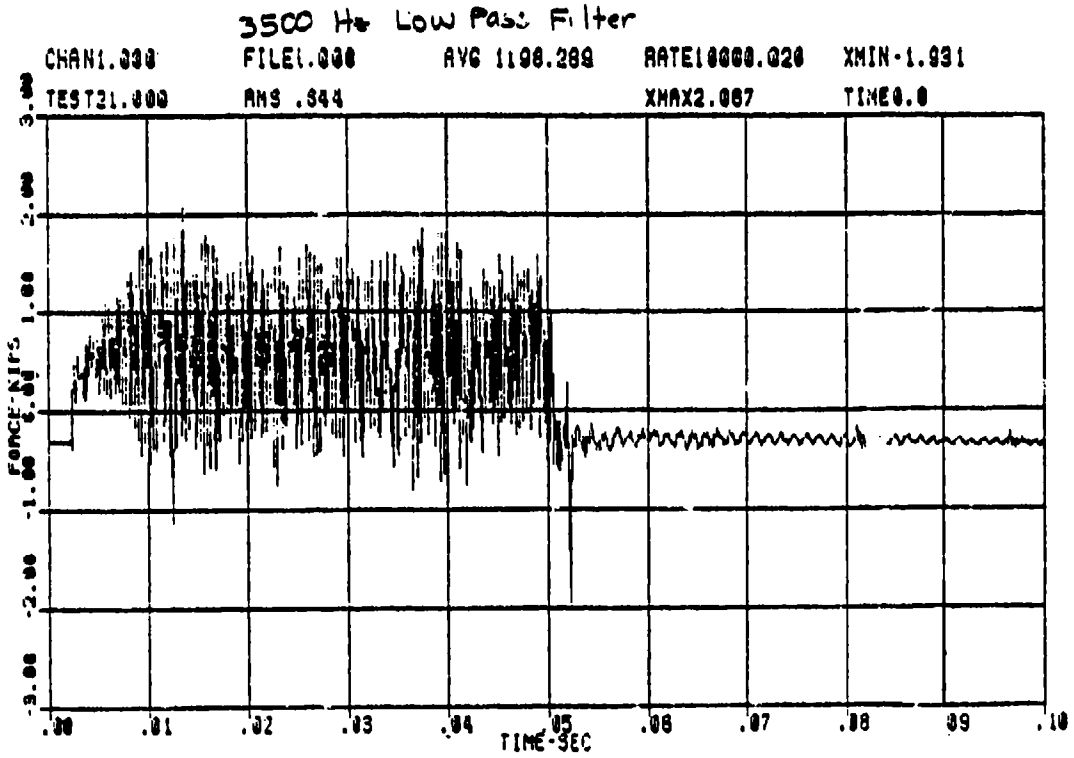

CHAN 2.00
FILE 1.00
AVG 20.15
RATE 10000.02
TEST 21.00
CH-2 3.00
CSOF 0.0
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00

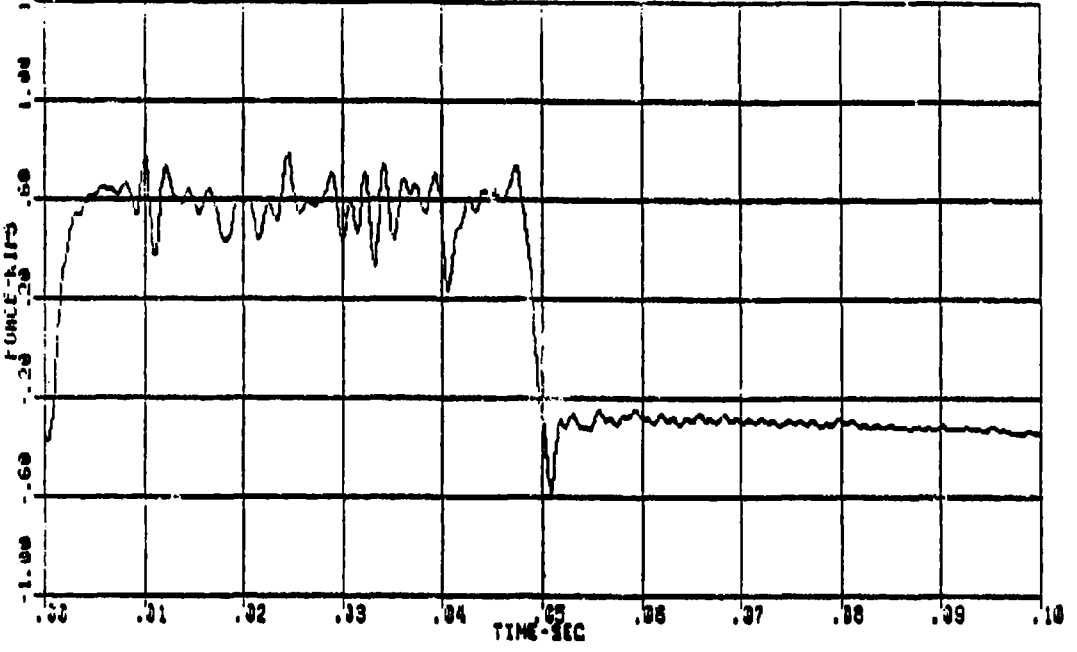

CHAN 2.00
FILE 1.00
AVG 20.15
RATE 10000.02
TEST 21.00
CH-2 1.00
CSOF 0.0
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00

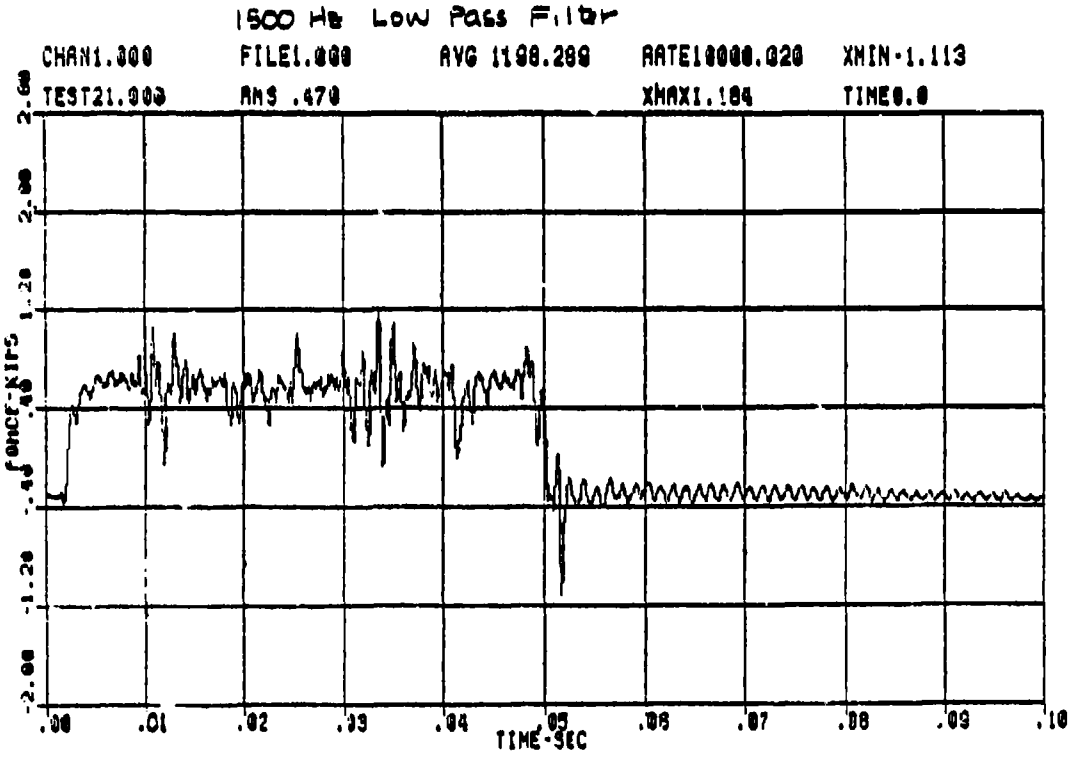

CHAN 3.00 FILE 1.00 AVG 5.71 RATE 10000.02
TEST 21.00 CH=2 2.00 CSDF 0.0
FREQ-CPS (x10¹)


CHAN 3.00 FILE 1.00 AVG 5.71 RATE 10000.02
TEST 21.00 CH=2 1.00 CSDF 0.0
FREQ-CPS (x10¹)

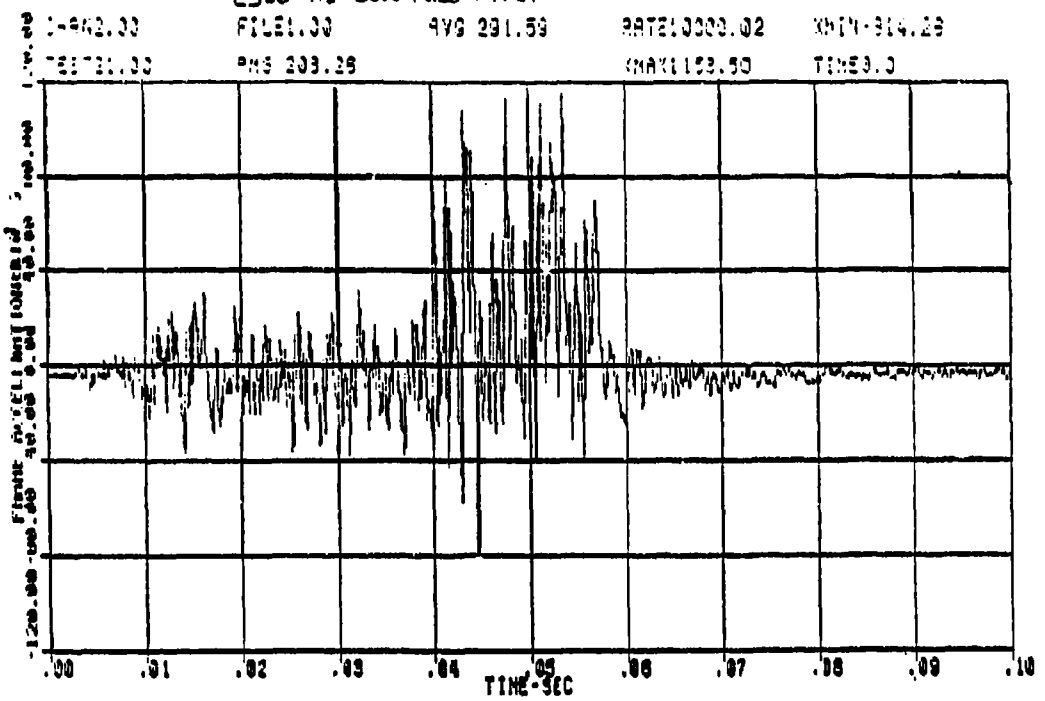

2500 Hz Low Pass Filter
CHAN1.000
FILE1.000
AVG 1198.289
RATE10000.020
XMIN-1.480
TEST31.000
RMS .545
XMAX1.661
TIME0.0
FORCE-KIPS
TIME-SEC


3500 Hz Low Pass Filter
CHAN1.000
FILE1.000
AVG 1198.289
RATE10000.020
XMIN-1.931
TEST31.000
RMS .544
XMAX2.067
TIME0.0
FORCE-KIPS
TIME-SEC

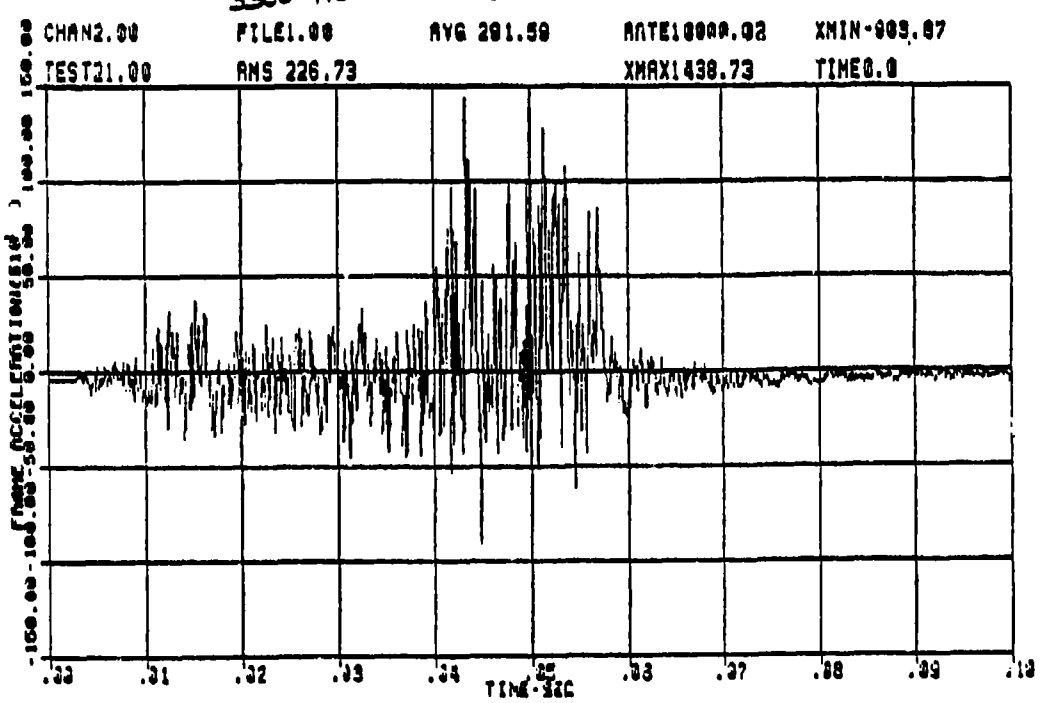

500 Hz Low Pass Filter
CHAN1.000
FILE1.000
AVG 1132.289
RATE10000.020
XMIN-.581
TEST21.000
RMS .458
XMAX.791
TIME0.0
FORCE-KIPS
TIME-SEC

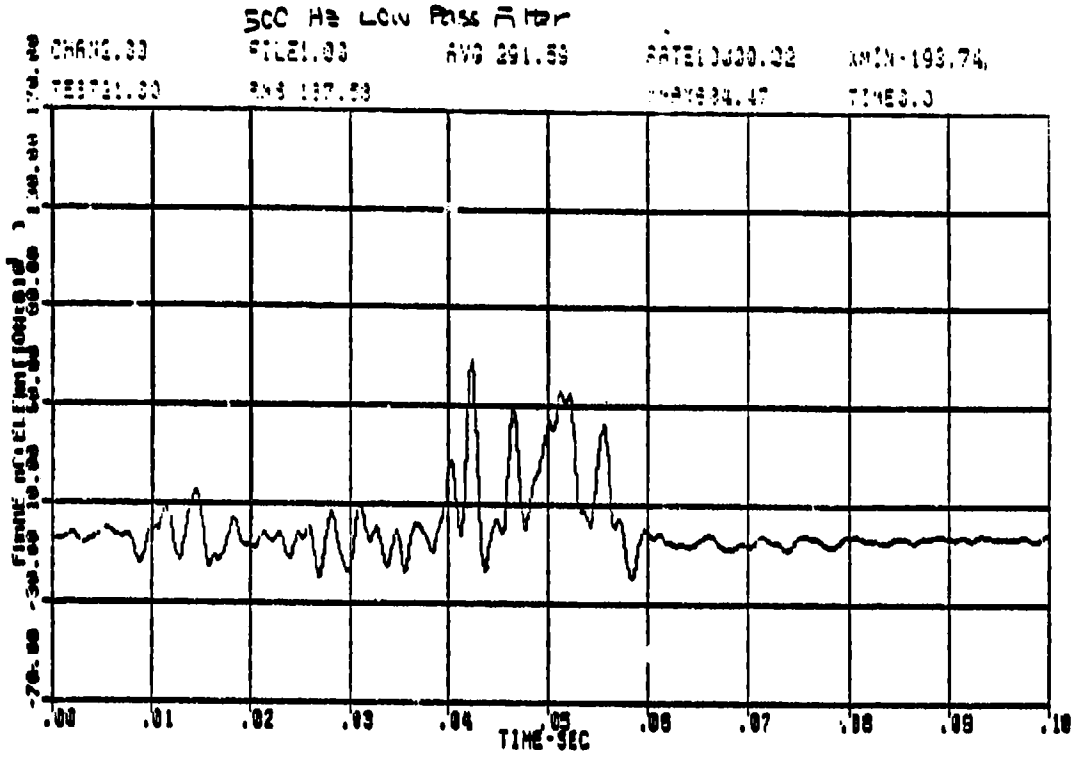

1500 Hz Low Pass Filter
CHAN1.000
FILE1.000
AVG 1198.299
RATE10000.020
XMIN-1.113
TEST21.000
RMS .470
XMAXI.184
TIME0.0
FORCE-KIPS
TIME-SEC

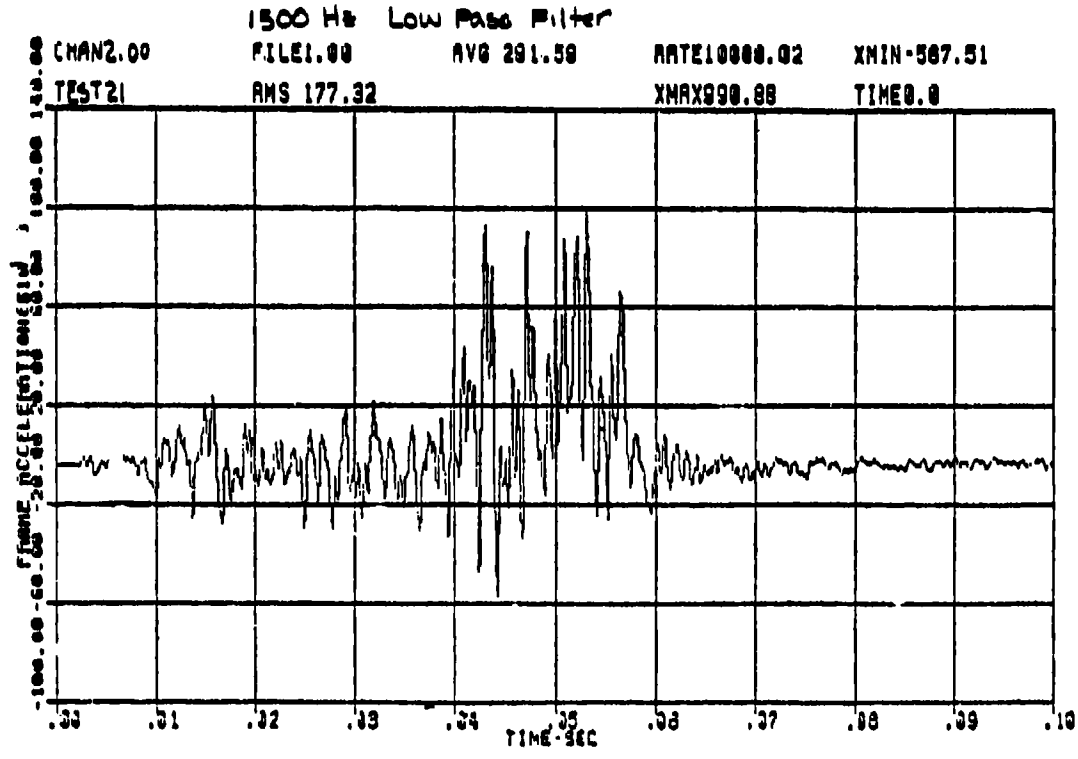
2500 Hz Low Pass Filter

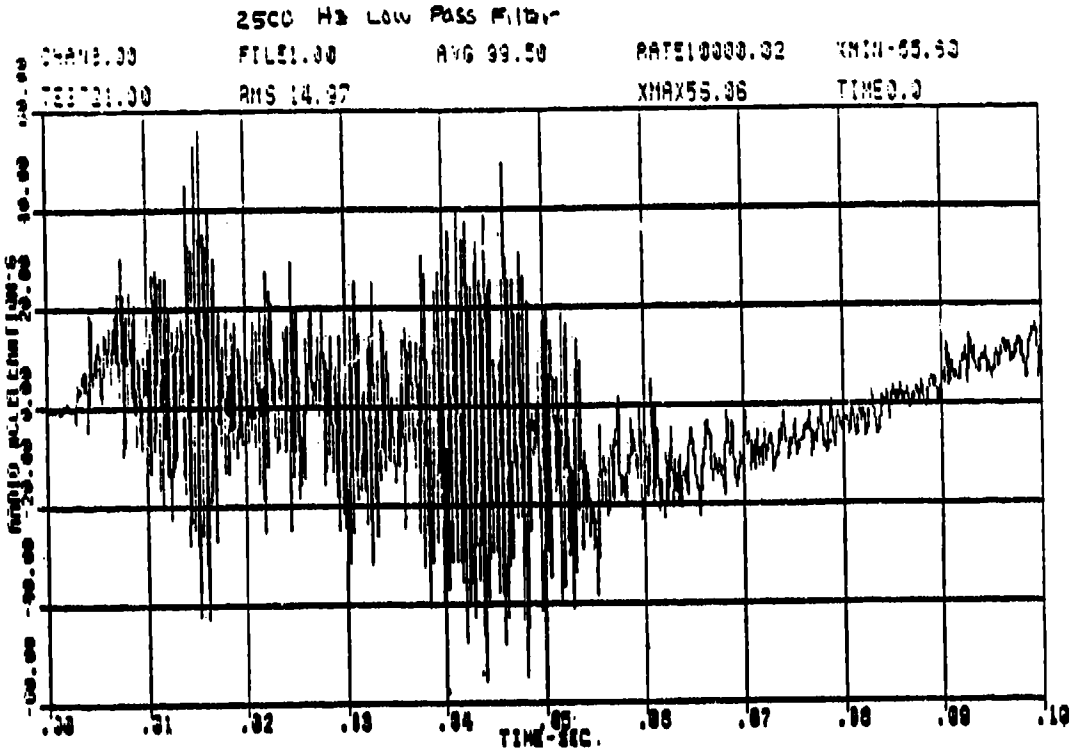


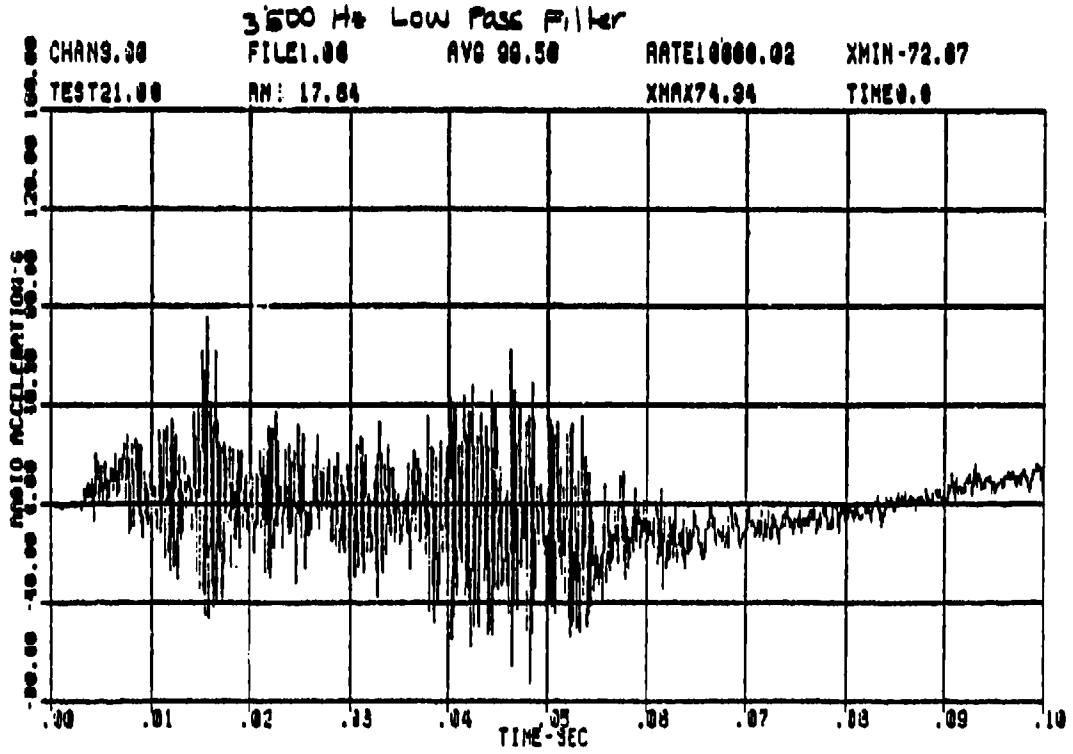
3500 Hz Low Pass Filter

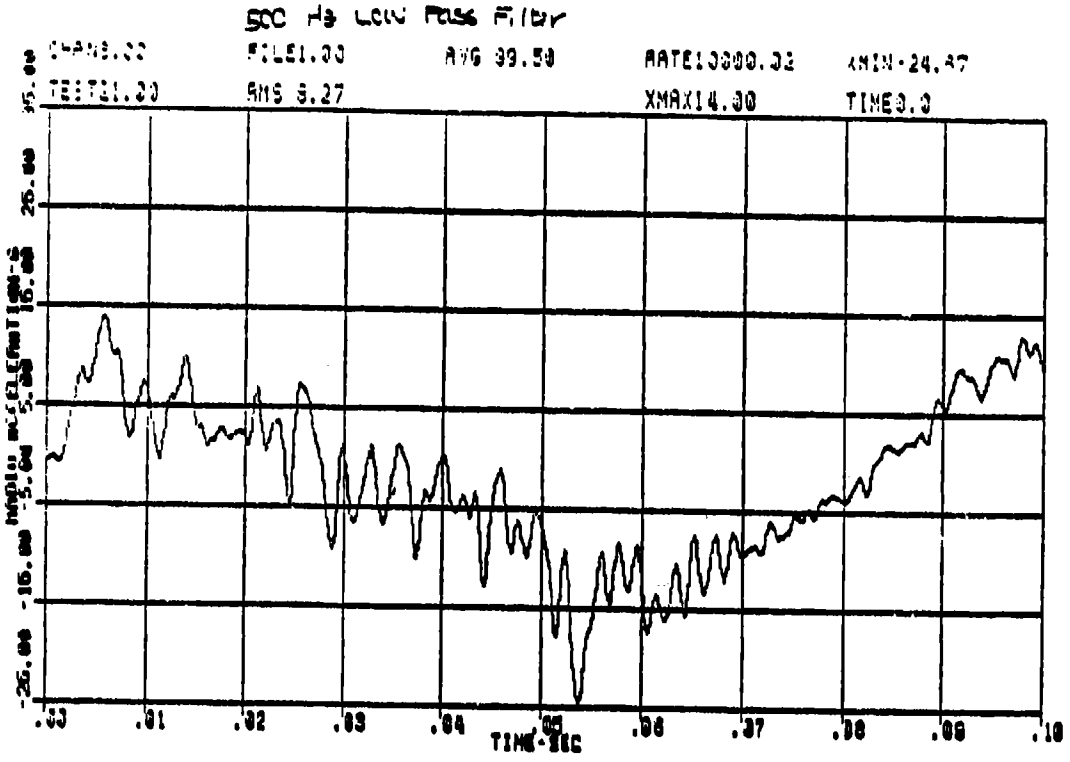


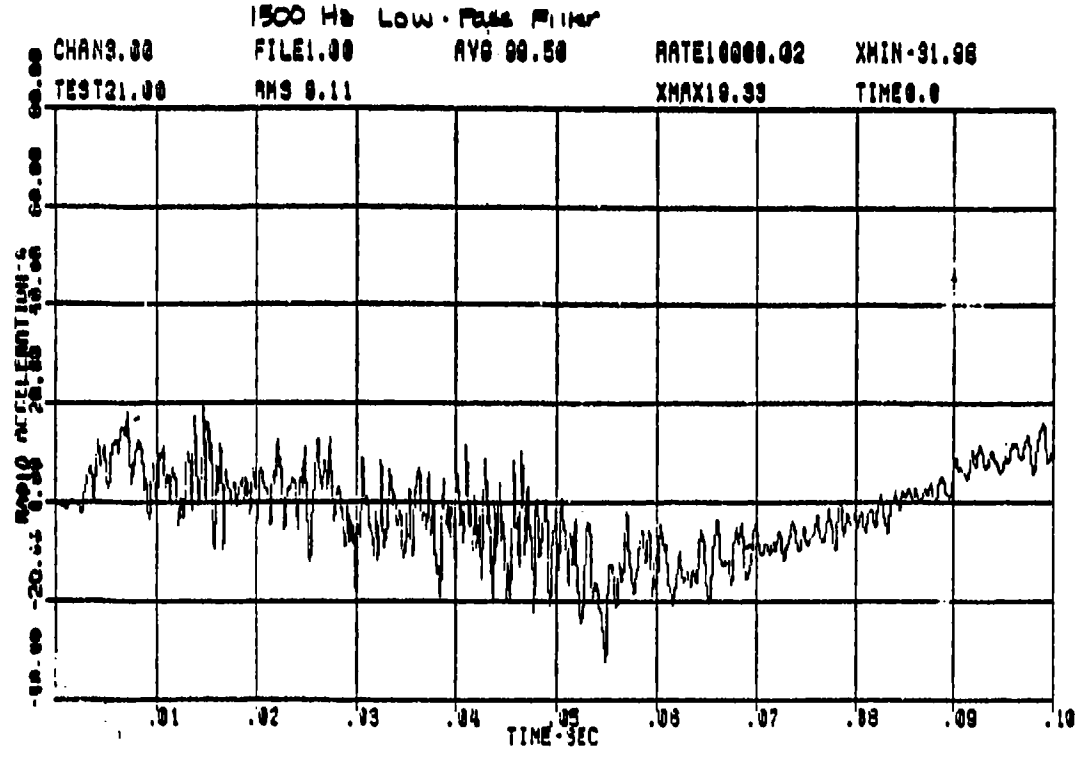

500 Hz Low Pass Filter
CHAN2.00
FILE1.00
AVG 291.59
RATE10000.02
XMIN-193.74
TEST21
RMS 177.32
XMAX994.47
TIME0.0
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC


1500 Hz Low Pass Filter
CHAN2.00
FILE1.00
AVG 291.59
RATE10000.02
XMIN-567.51
TEST21
RMS 177.32
XMAX998.88
TIME0.0
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC


2500 Hz Low Pass Filter
CHAN9.00
FILE1.00
AVG 99.50
RATE10000.02
XMIN-55.63
TEST21.00
RMS 14.97
XMAX55.36
TIME0.0
TIME-SEC.

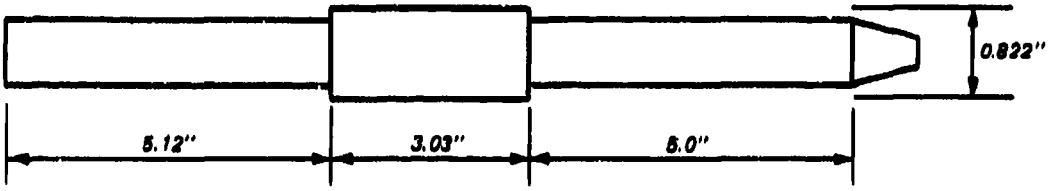

3500 Hz Low Pass Filter
CHAN9.00
FILE1.00
AVG 99.50
RATE10000.02
XMIN-72.87
TEST21.00
RMS 17.84
XMAX74.94
TIME0.0
TIME-SEC


500 Hz Low Pass Filter
CHAN3.00
FILE1.00
AVG 99.50
RATE13000.02
XMIN-24.47
TEST21.00
RMS 5.27
XMAX14.30
TIME0.0
TIME-SEC


1500 Hz Low-Pass Filter
CHAN3.00
FILE1.00
AVG 99.50
RATE10000.02
XMIN-31.96
TEST21.00
RMS 8.11
XMAX19.33
TIME0.0
TIME-SEC

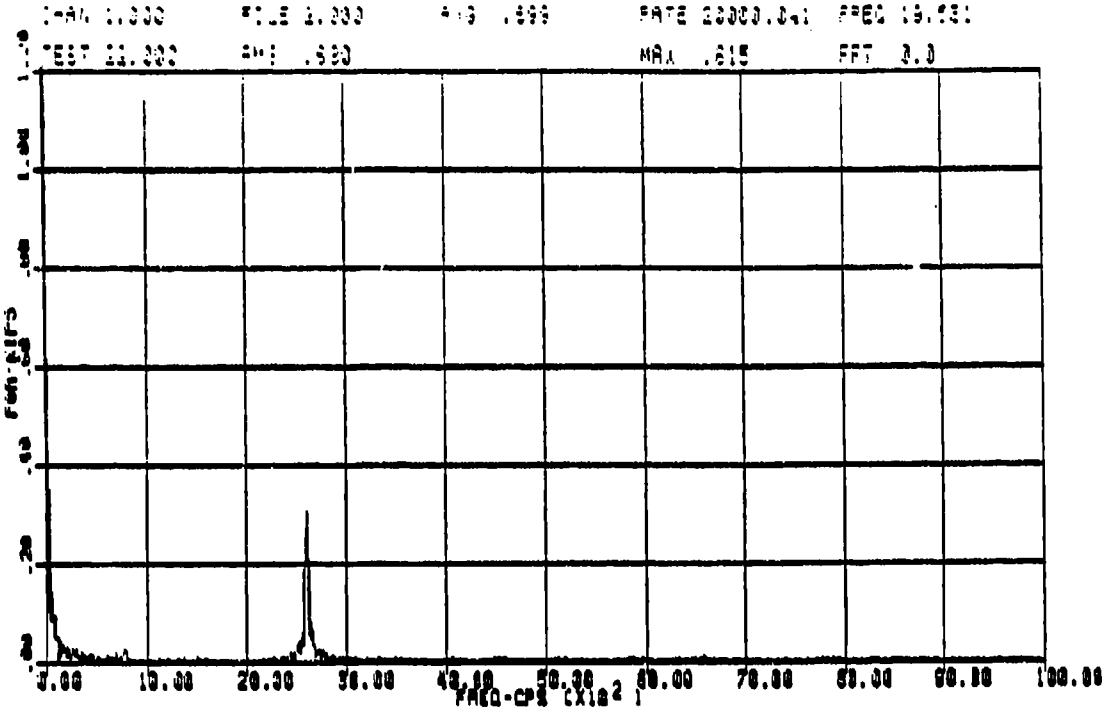
APPENDIX H: TEST 22 RESULTS

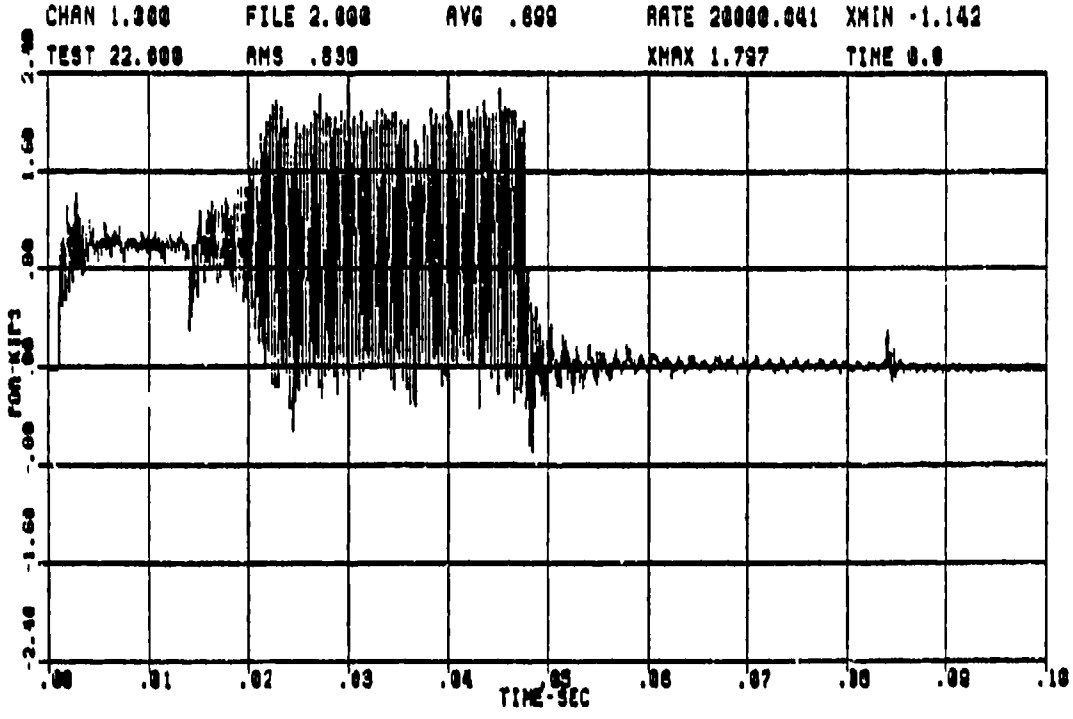
Test 22
Equipment Rack Soft-Mounted
AN/GRC-103 in Rack, Off-Line

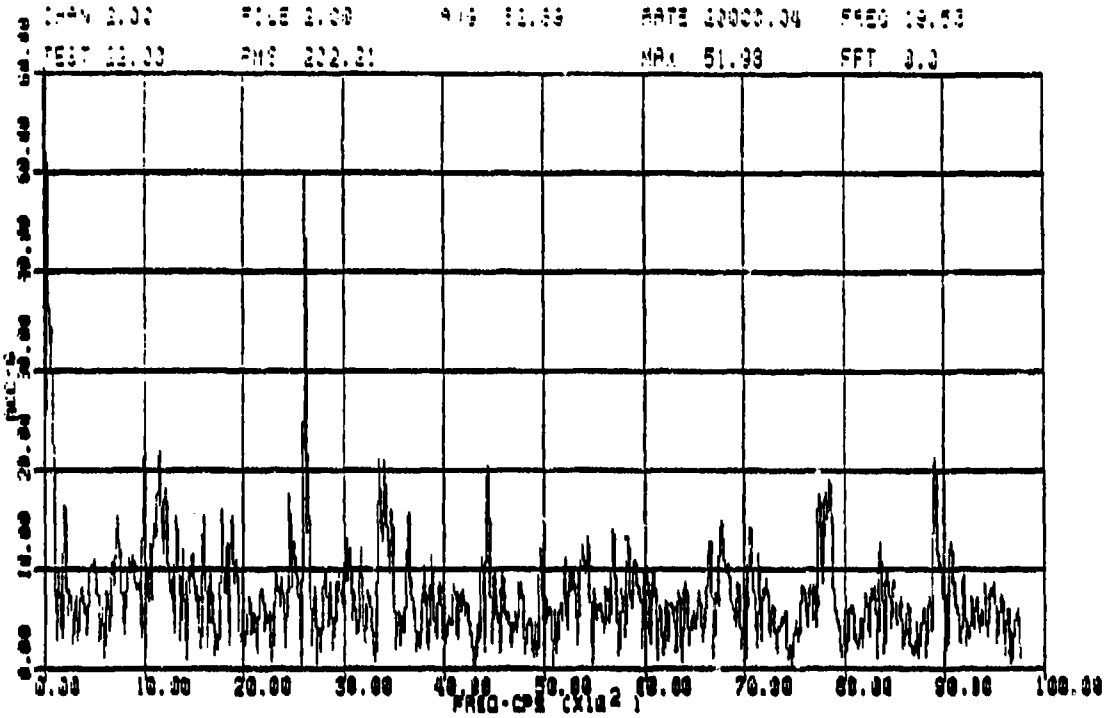


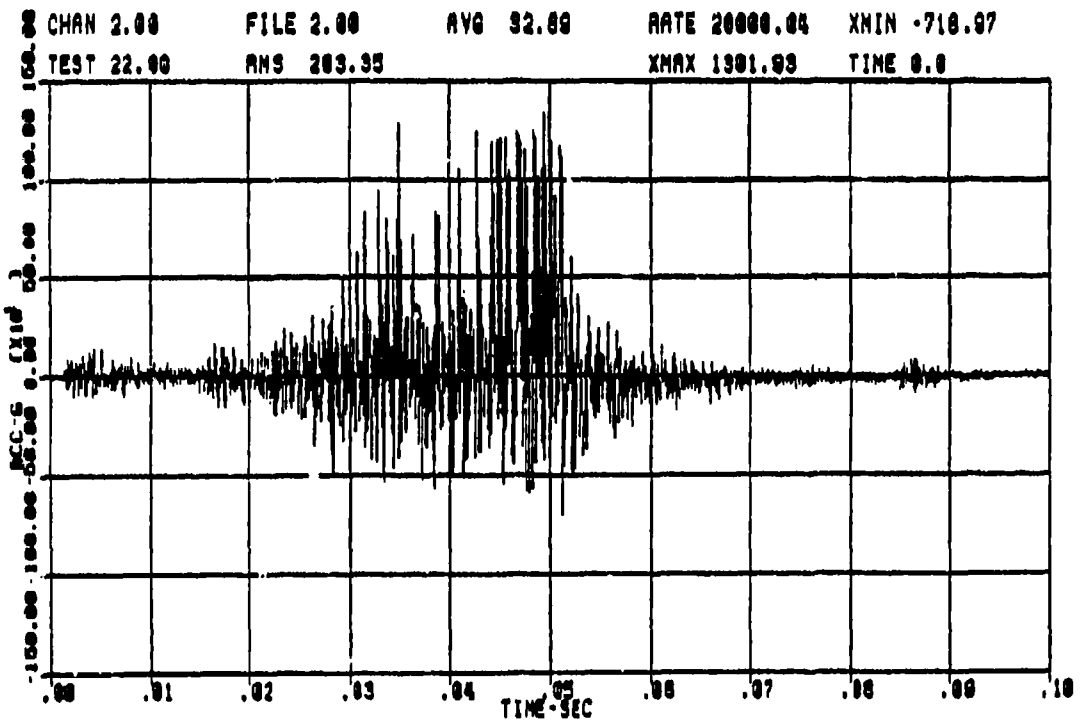
PULSE TRAIN - TEST 22

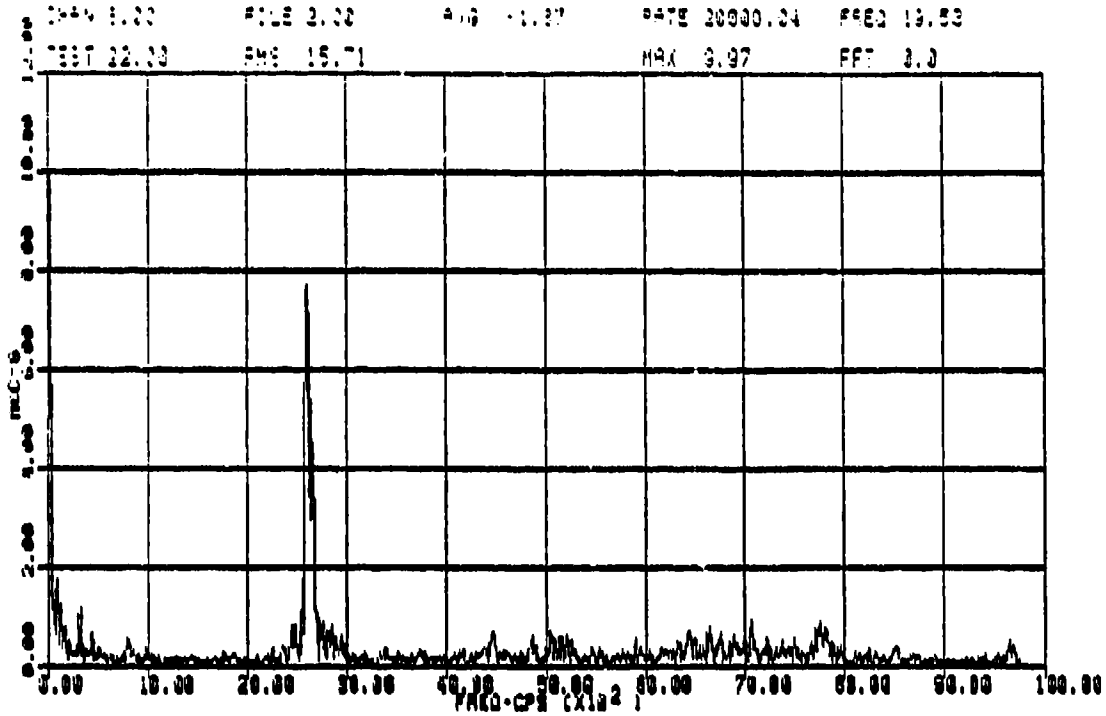
PRECHARGE PRESSURE = 1250 PSI
SYSTEM PRESSURE = 2000 PSI
FLOW CONTROL #6½
AIR BAG PRESSURE = 30 PSI

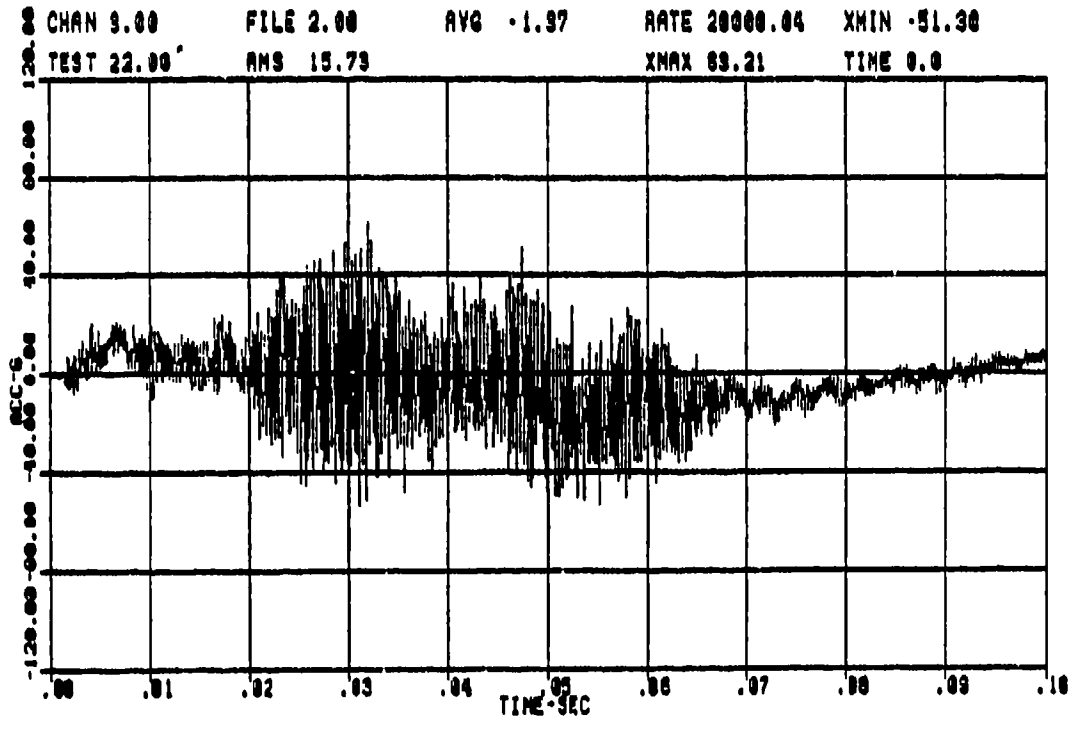

FREQ-CPS (X10^2)

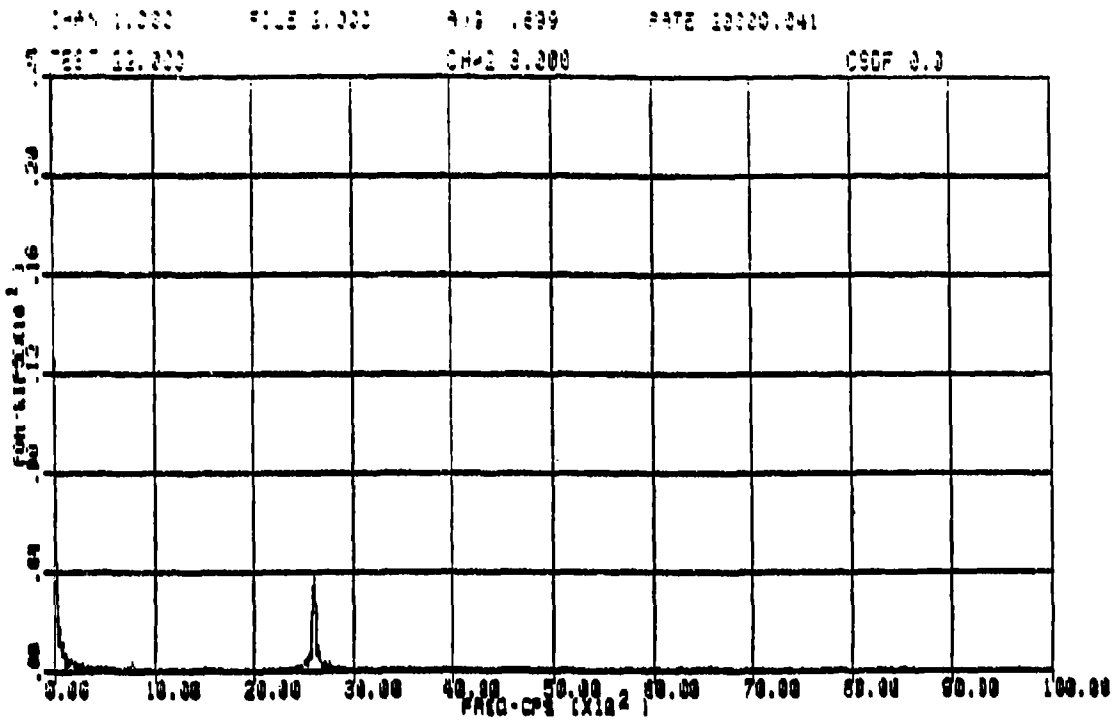

CHAN 1.000
FILE 2.000
AVG .000
RATE 20000.041
XMIN -1.142
TEST 22.000
RMS .830
XMAX 1.797
TIME 0.0
TIME-SEC

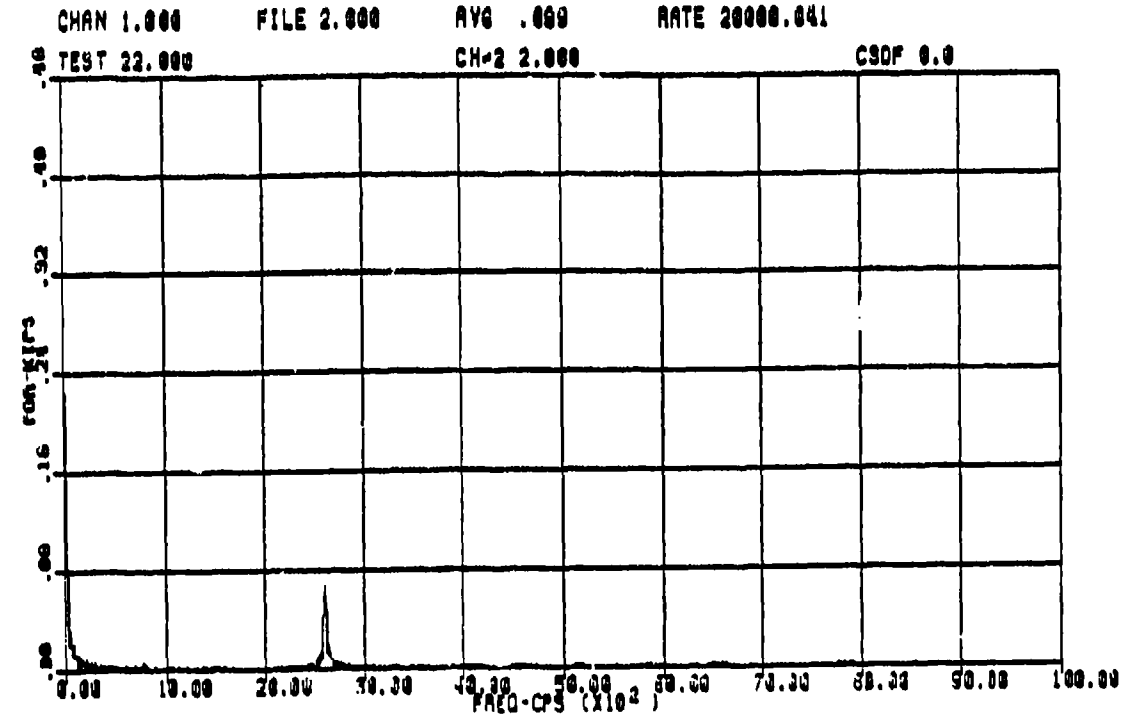

MAX 51.98
FREQ-CPS (X10^2)

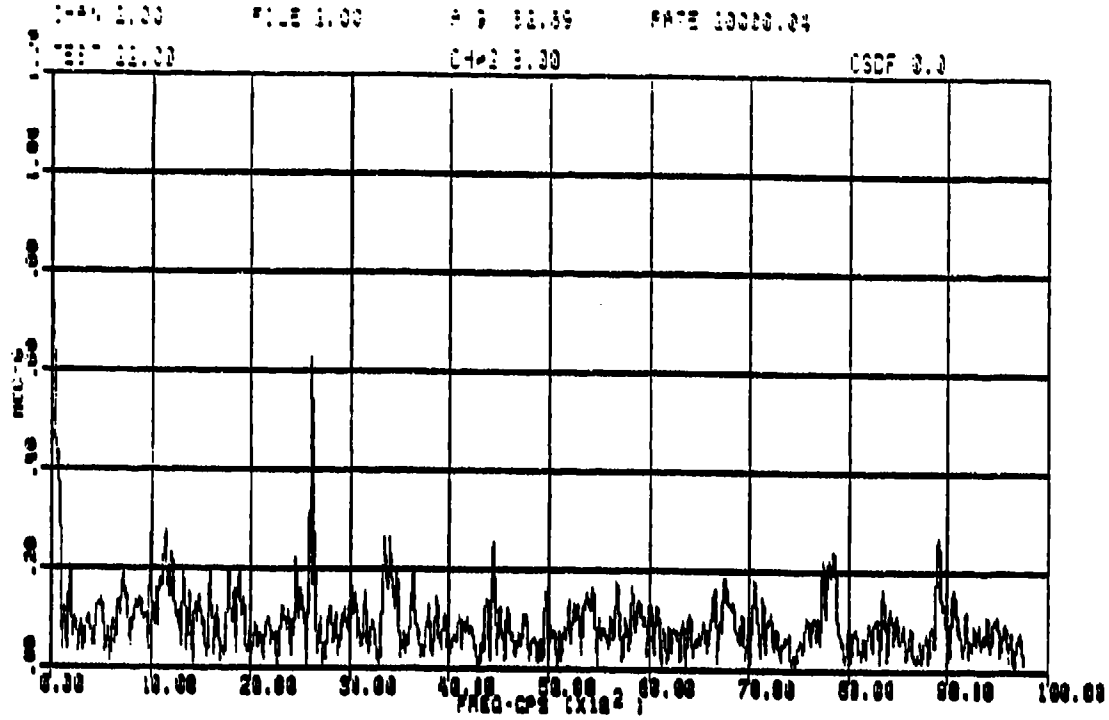

CHAN 2.00
FILE 2.00
AVG 32.89
RATE 20000.04
XMIN -718.97
TEST 22.00
RMS 203.35
XMAX 1301.93
TIME 0.0
TIME-SEC

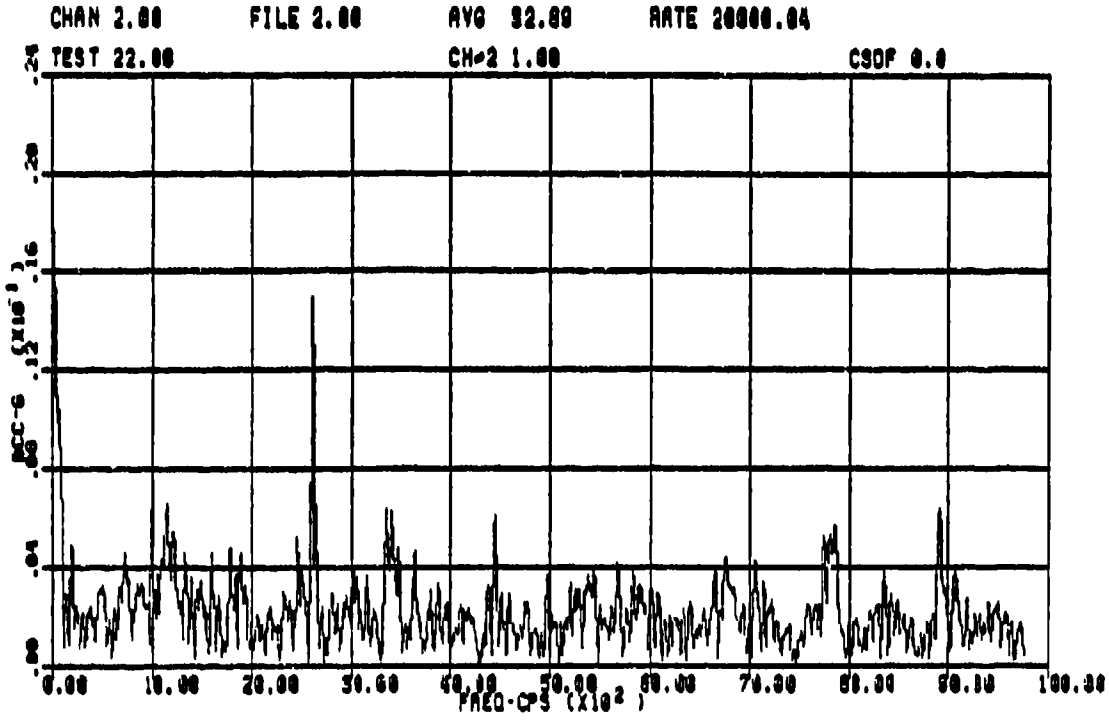

FILE 2.00
RMS 15.71
MAX 9.97
FFT 8.0
FREQ-CPS (X10^2)

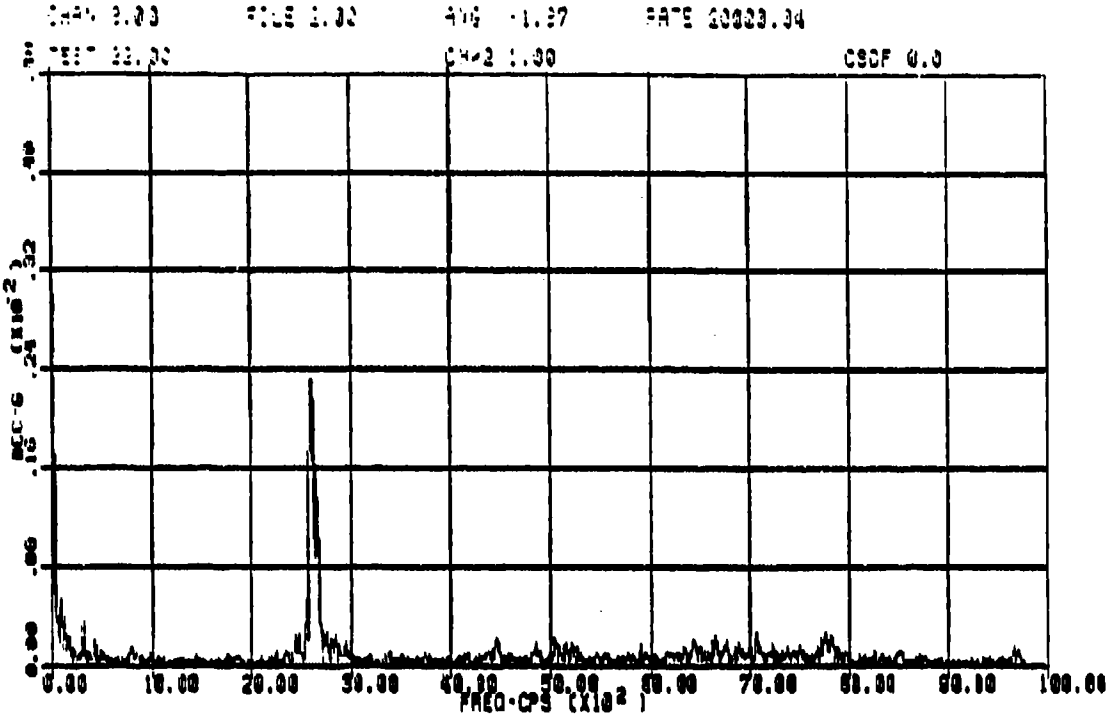

CHAN 9.00
FILE 2.00
AVG -1.97
RATE 20000.04
XMIN -51.30
TEST 22.00
RMS 15.79
XMAX 69.21
TIME 0.0
TIME-SEC

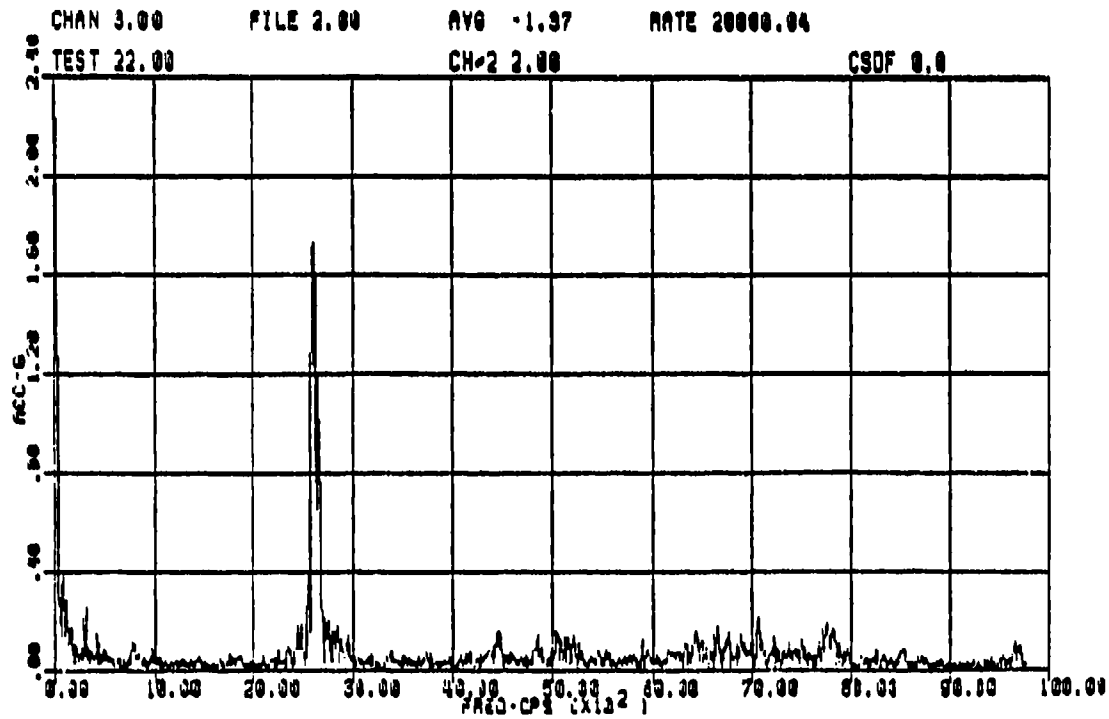

CH#2 3.000
CSDF 0.0
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

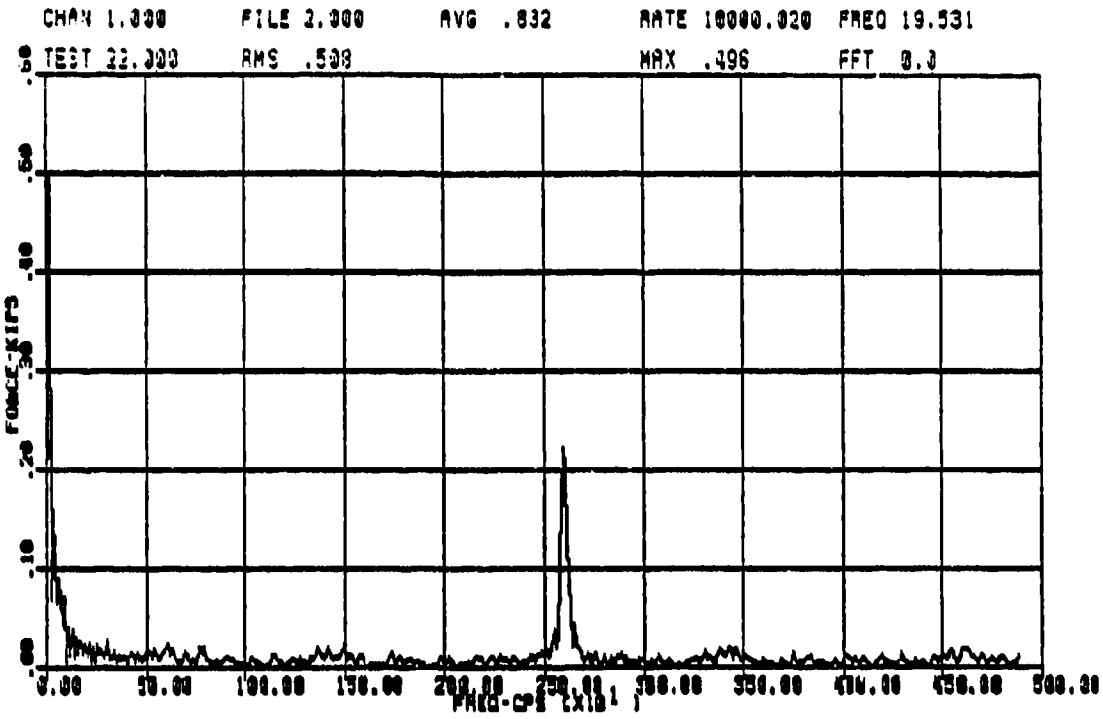

CHAN 1.000
FILE 2.000
AVG .099
RATE 20000.041
TEST 22.000
CH#2 2.000
CSDF 0.0
FOR-KIPS
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

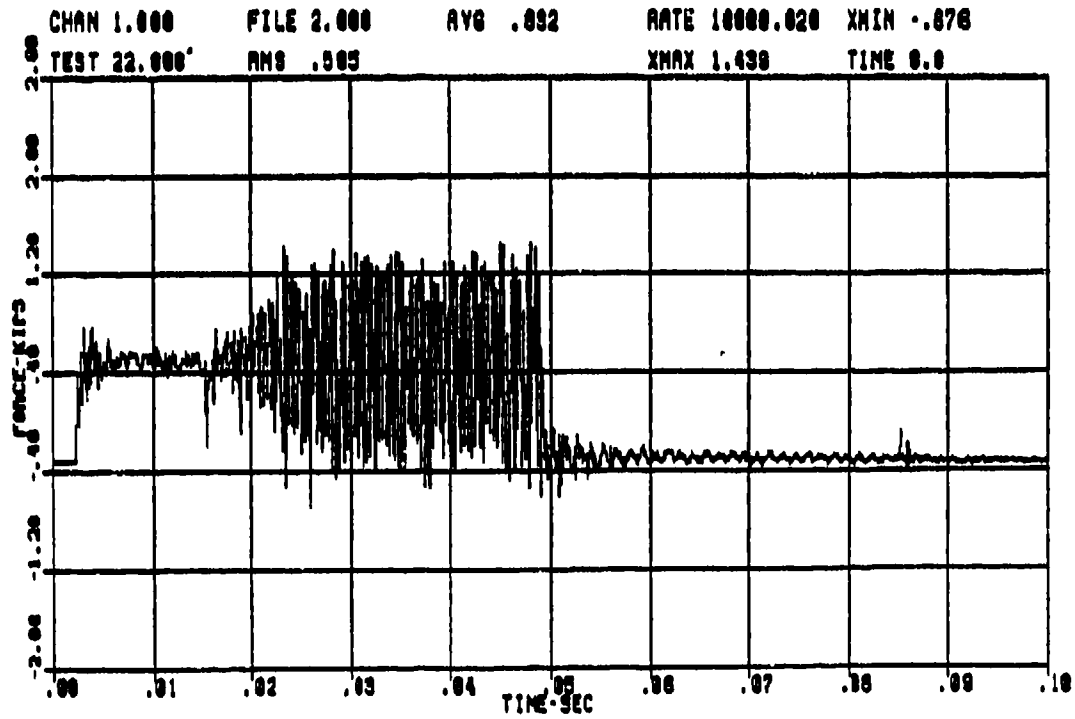

CHAN 1.00
FILE 1.00
AVG 32.00
RATE 20000.04
TEST 22.00
CH#2 1.00
CSDF 0.0
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

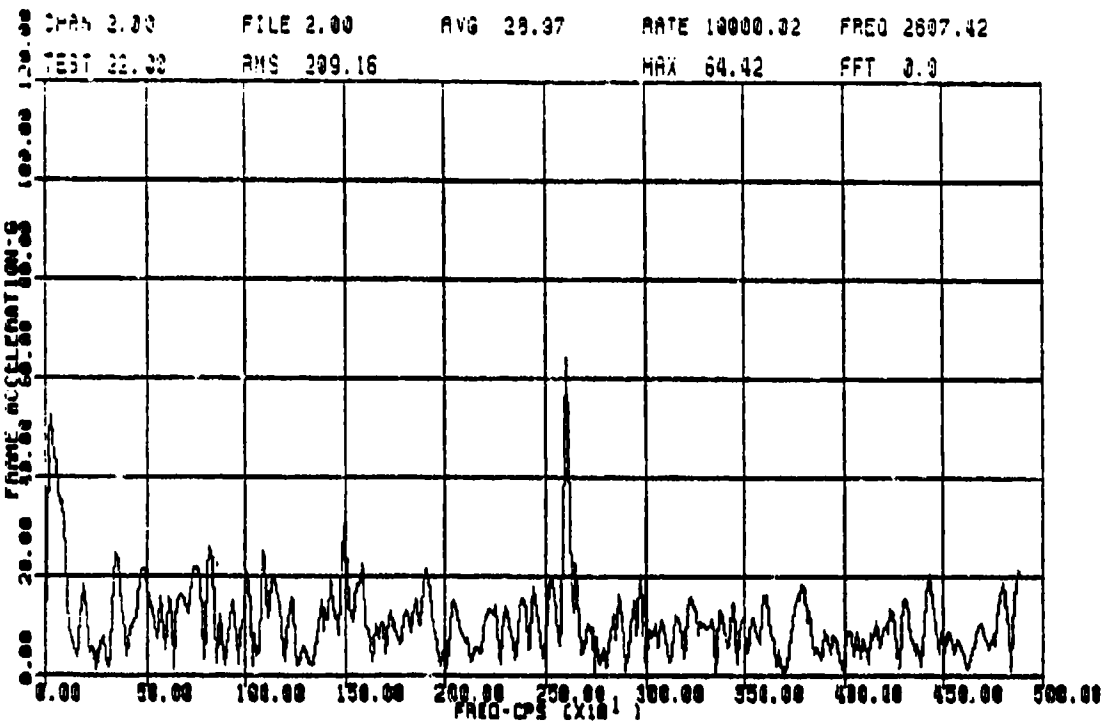

CHAN 2.00
FILE 2.00
AVG 32.00
RATE 20000.04
TEST 22.00
CH#2 1.00
CSDF 0.0
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

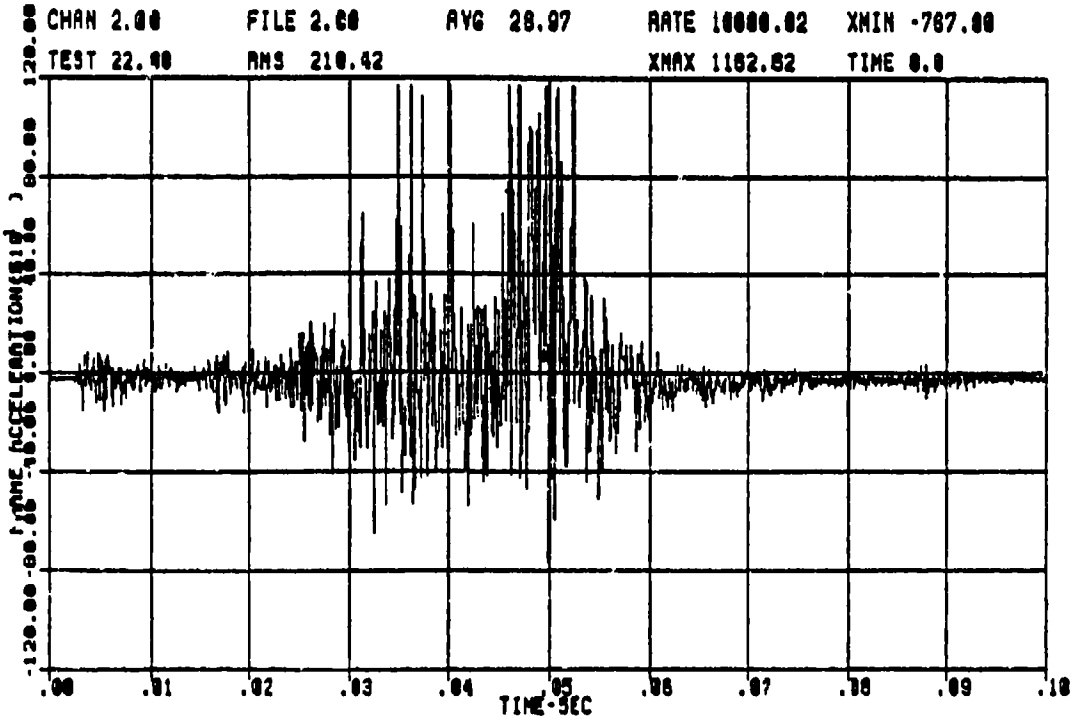

CHAN 3.00
FILE 2.00
AVG -1.97
RATE 20000.04
TEST 22.00
CH#2 2.00
CSDF 0.0
ACC-G (X10^2)
FREQ-CPS (X10^2)

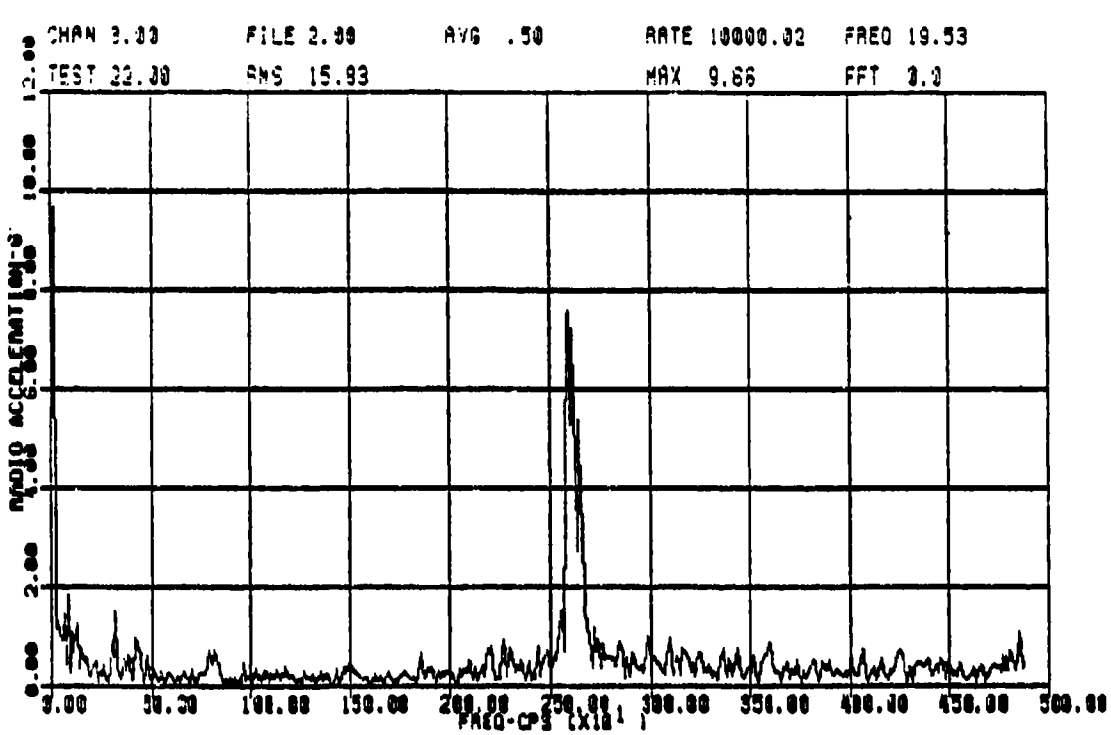

CHAN 3.00
FILE 2.00
AVG -1.97
RATE 20000.04
TEST 22.00
CH#2 2.00
CSDF 0.0
ACC-G
FREQ-CPS (X10^2)

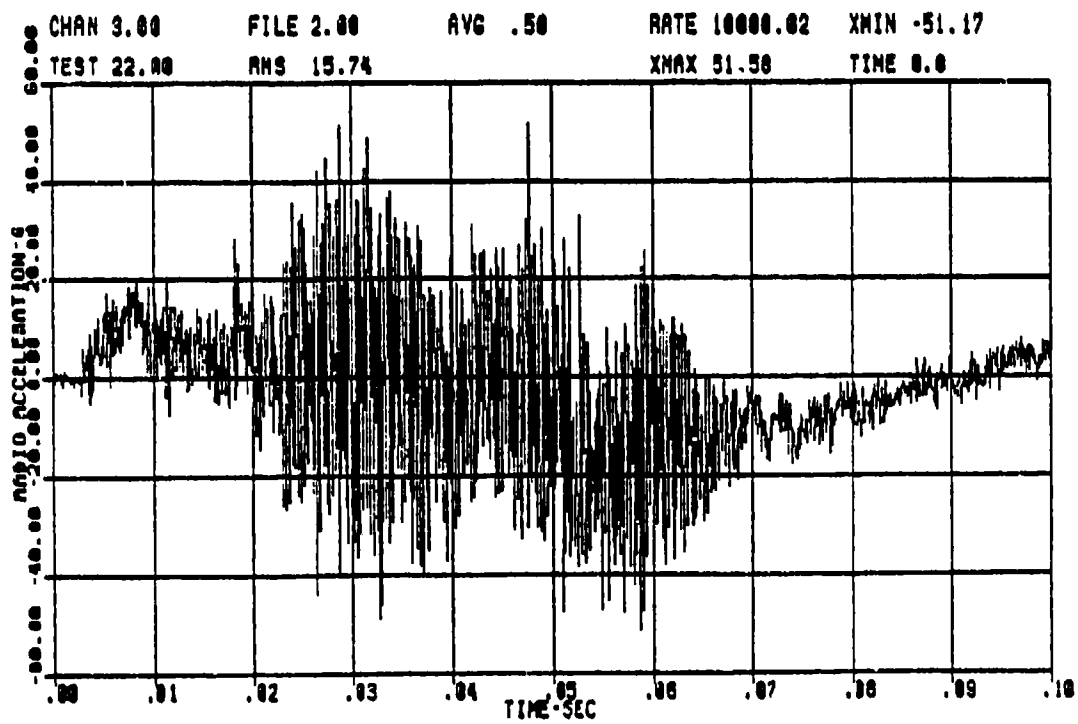

CHAN 1.000
FILE 2.000
AVG .832
RATE 10000.020
FREQ 19.531
TEST 22.000
RMS .508
MAX .496
FFT 0.0
FORCE-KIPS
.50
.40
.30
.20
.10
.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00
FREQ-CPS (X10)

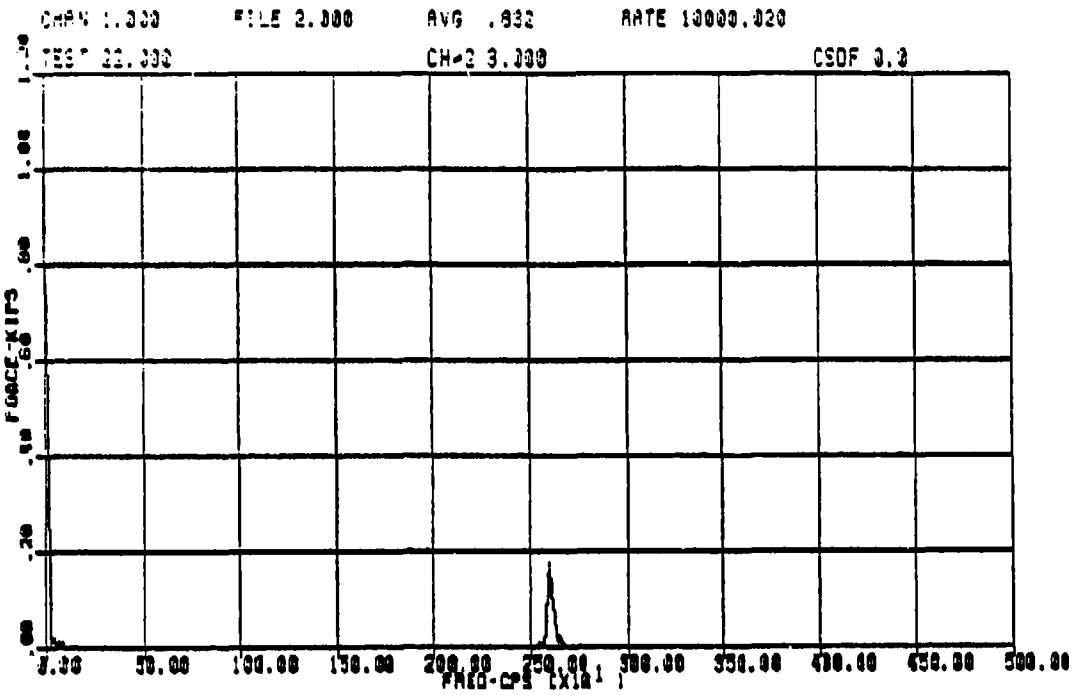

CHAN 1.000
FILE 2.000
AVG .892
RATE 10000.020
XMIN -.076
TEST 22.000
RMS .505
XMAX 1.438
TIME 0.0
FORCE-KIPS
2.00
1.60
1.20
.80
.40
.00
-.40
-.80
-1.20
-1.60
-2.00
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

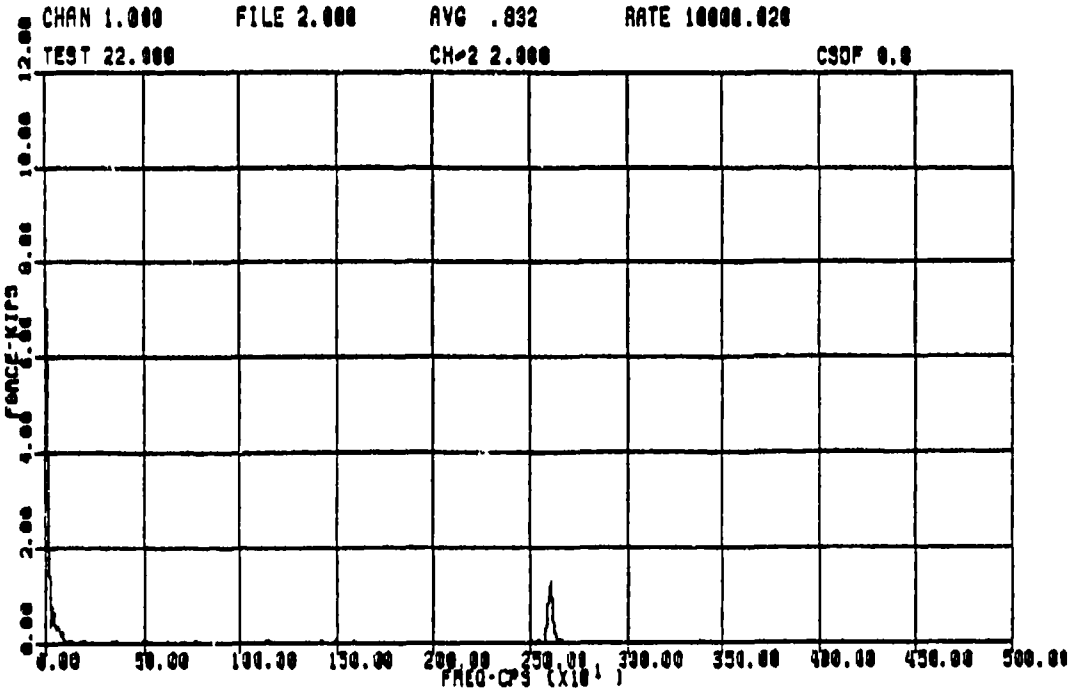

CHAN 2.00
FILE 2.00
AVG 28.37
RATE 10000.02
FREQ 2607.42
TEST 22.00
RMS 209.16
MAX 64.42
FFT 0.0
FREQ-CPS (X10)

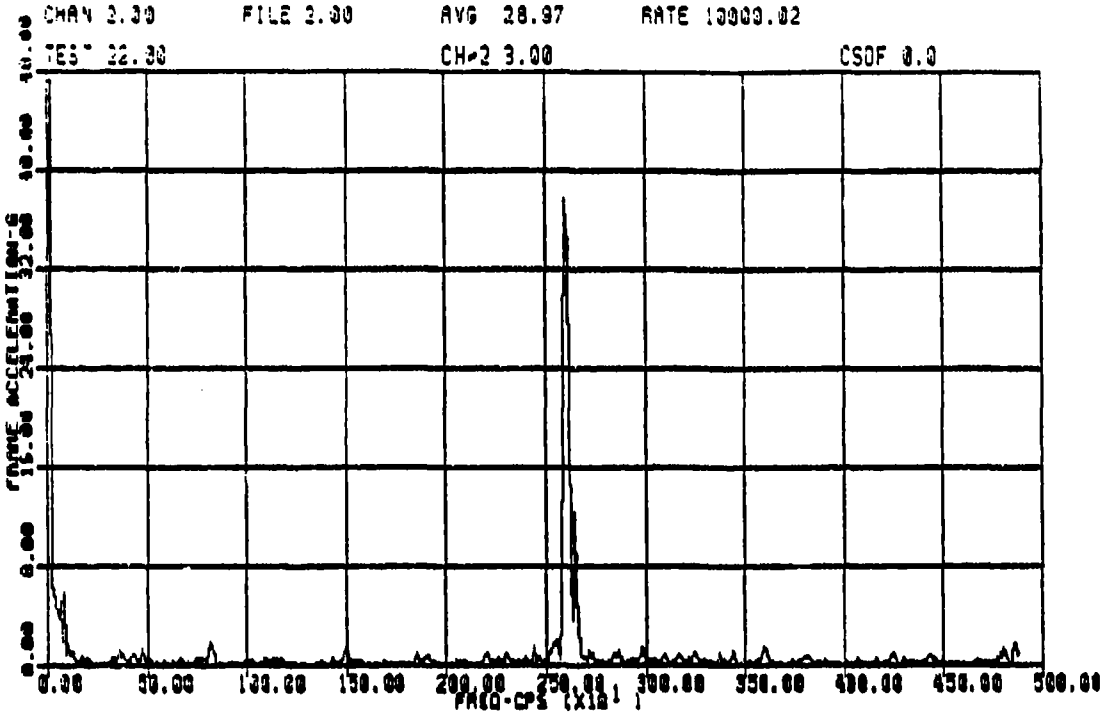

CHAN 2.00
FILE 2.00
AVG 28.97
RATE 10000.02
XMIN -787.00
TEST 22.00
RMS 210.42
XMAX 1162.02
TIME 0.0
TIME-SEC

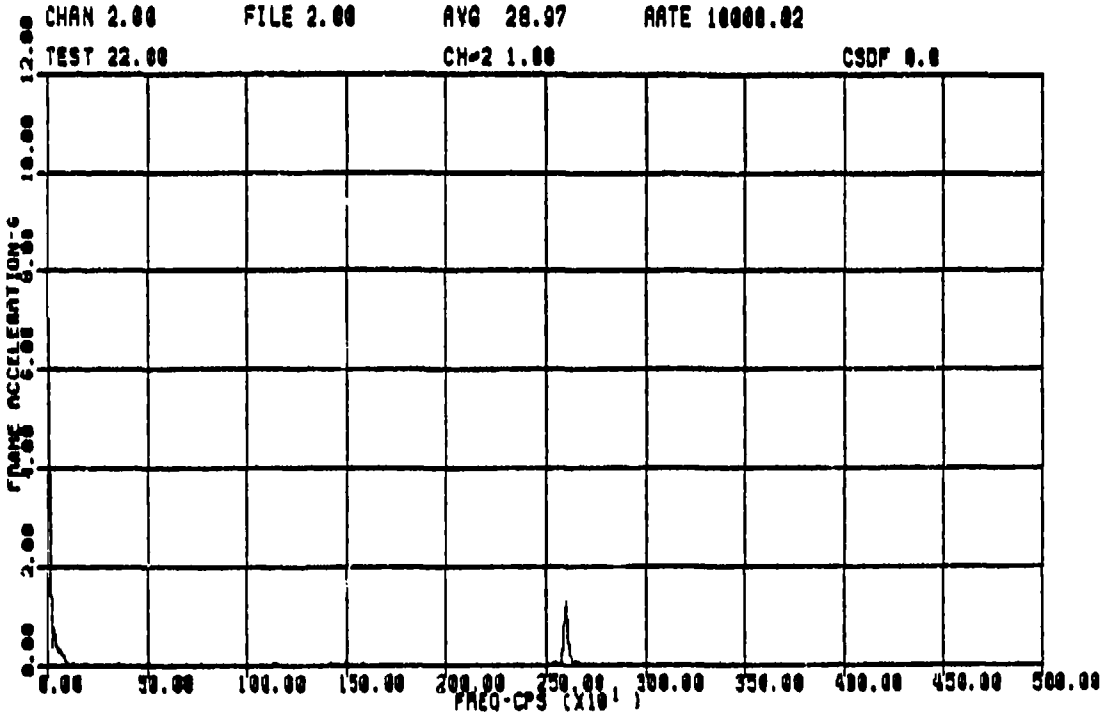

CHAN 3.00
FILE 2.00
AVG .50
RATE 10000.02
FREQ 19.53
TEST 22.00
RMS 15.93
MAX 9.66
FFT 3.0
RADIO ACCELERATION-G
FREQ-CPS (X10^1)

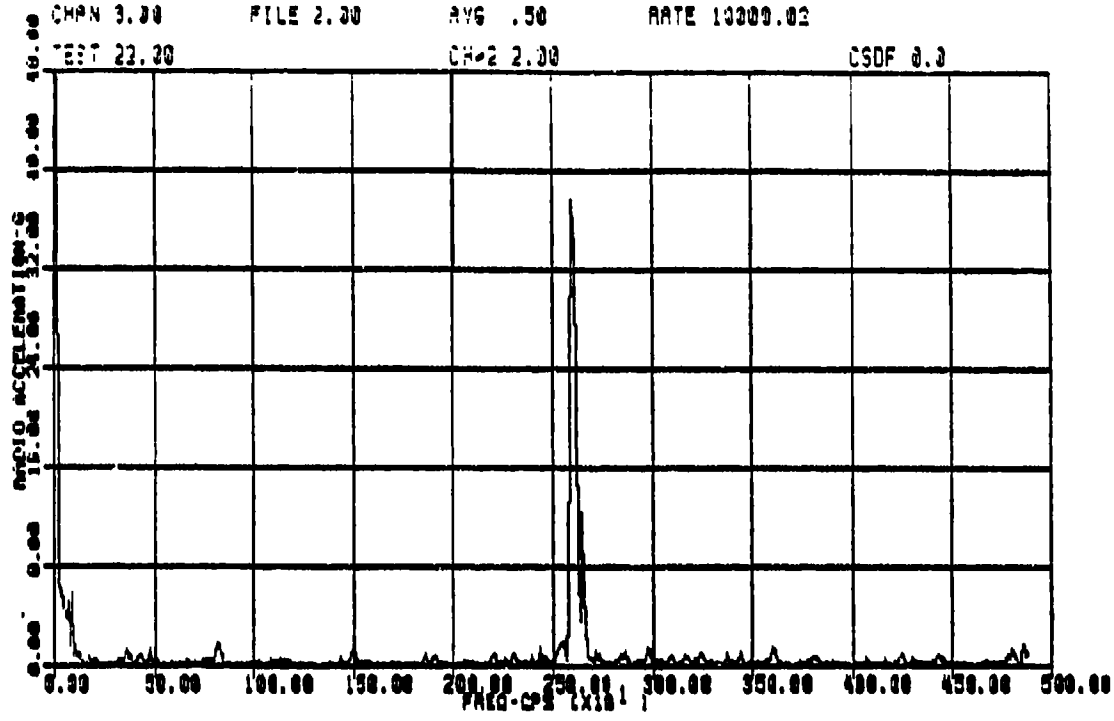

CHAN 3.00
FILE 2.00
AVG .50
RATE 10000.02
XMIN -51.17
TEST 22.00
RMS 15.74
XMAX 51.58
TIME 0.0
RADIO ACCELERATION-G
TIME-SEC

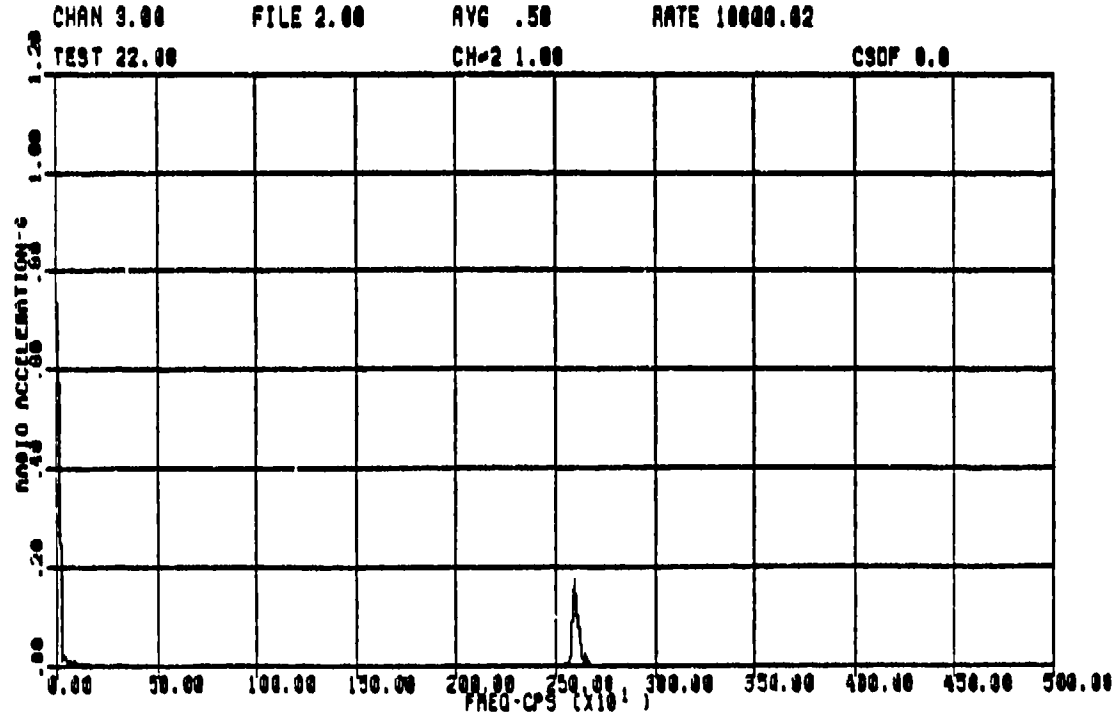

CHAN 1.000 FILE 2.000 AVG .832 RATE 10000.020
TEST 22.000 CH-2 3.000 CSOF 0.0
FORCE-KIPS
FREQ-CPS (X10)

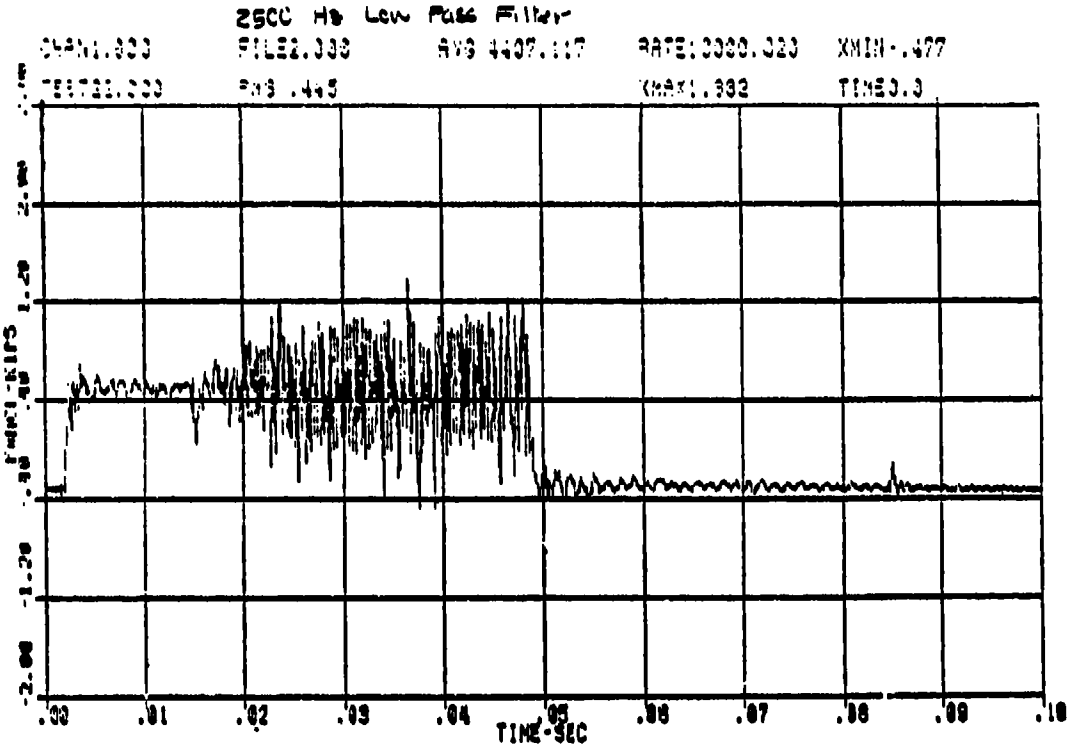

CHAN 1.000 FILE 2.000 AVG .832 RATE 10000.020
TEST 22.000 CH-2 2.000 CSOF 0.0
FORCE-KIPS
FREQ-CPS (X10)

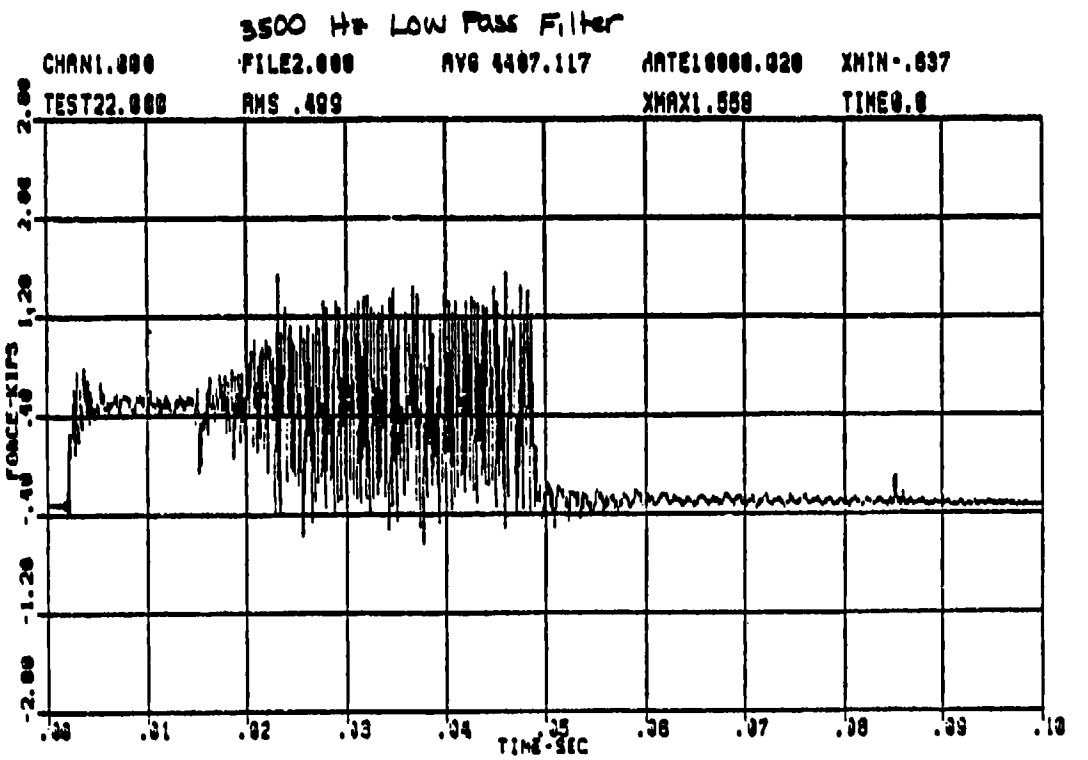

CHAN 3.00
FILE 3.00
AVG 28.97
RATE 10000.02
TEST 22.00
CH=2 3.00
CSOF 0.0
FRAME ACCELERATION-G
FREQ-CPS (X10¹)

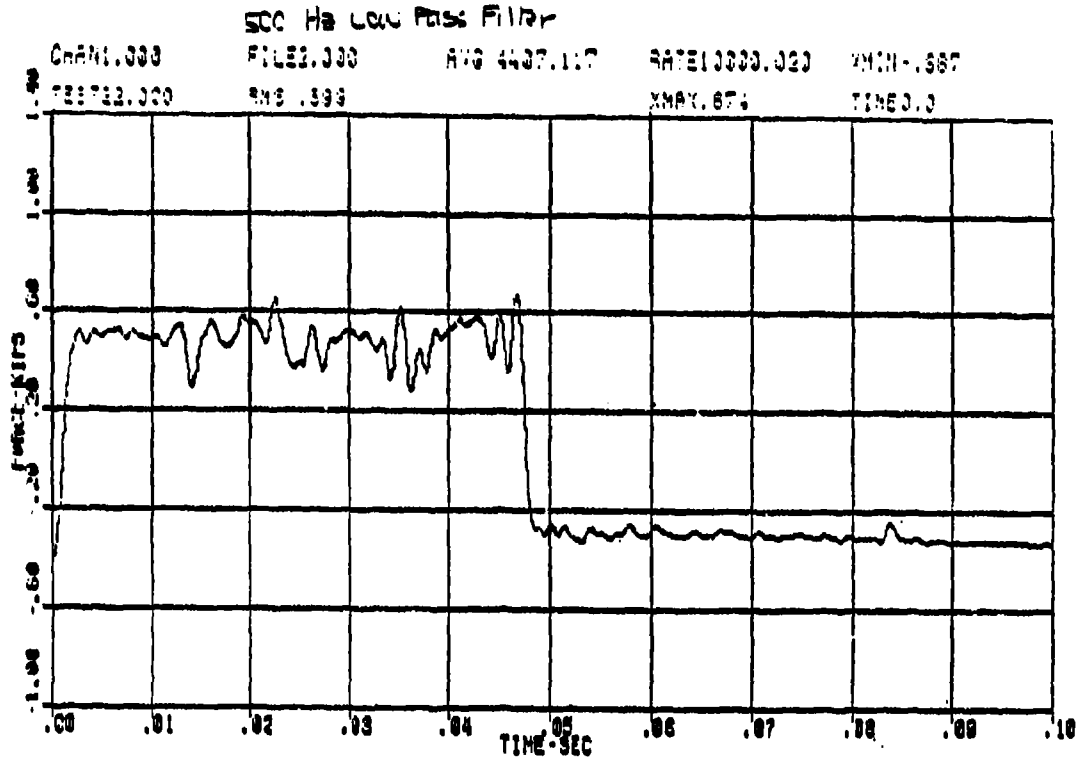

CHAN 2.00
FILE 2.00
AVG 28.97
RATE 10000.02
TEST 22.00
CH=2 1.00
CSOF 0.0
FRAME ACCELERATION-G
FREQ-CPS (X10¹)

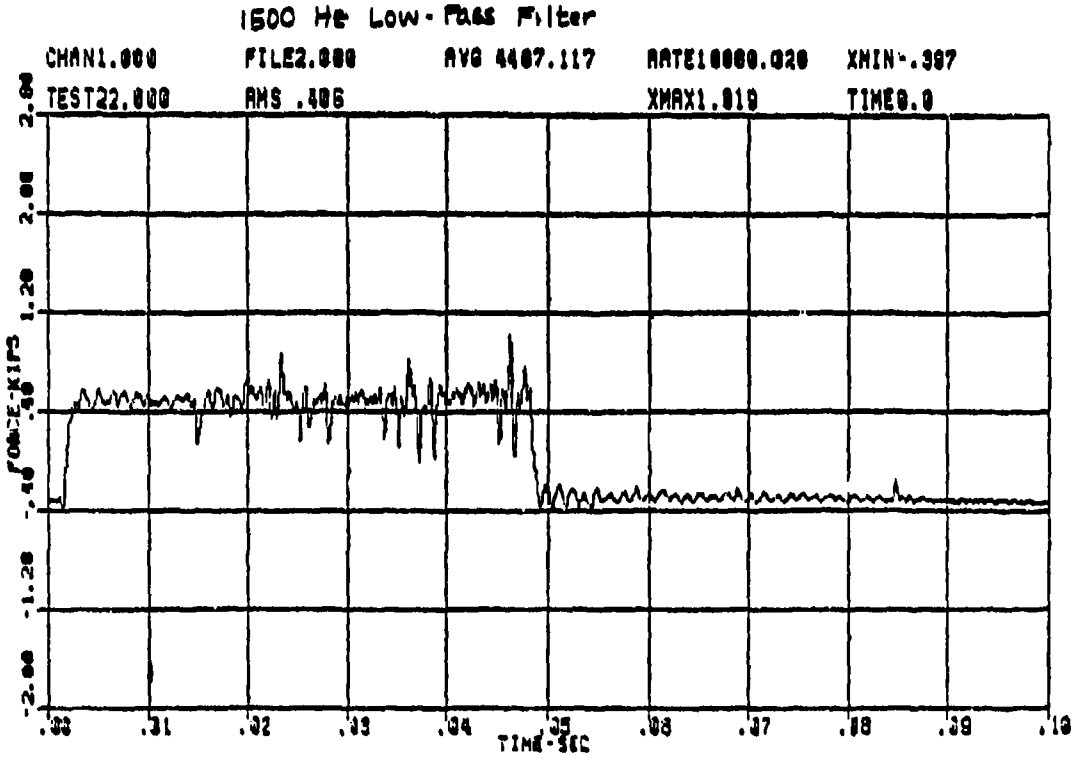

CHAN 3.00
FILE 2.00
AVG .50
RATE 10000.02
TEST 22.00
CH-2 2.00
CSDF 0.0
RADIO ACCELERATION-G
FREQ-CPS (X10¹)

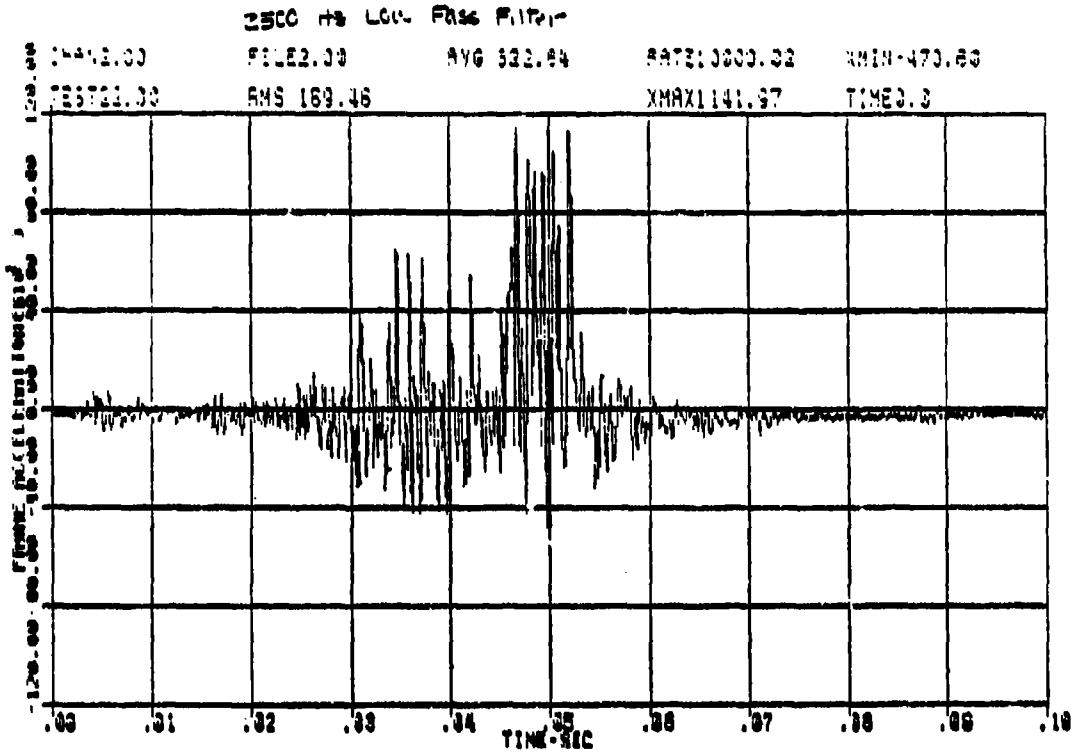

CHAN 3.00
FILE 2.00
AVG .50
RATE 10000.02
TEST 22.00
CH-2 1.00
CSDF 0.0
RADIO ACCELERATION-G
FREQ-CPS (X10¹)

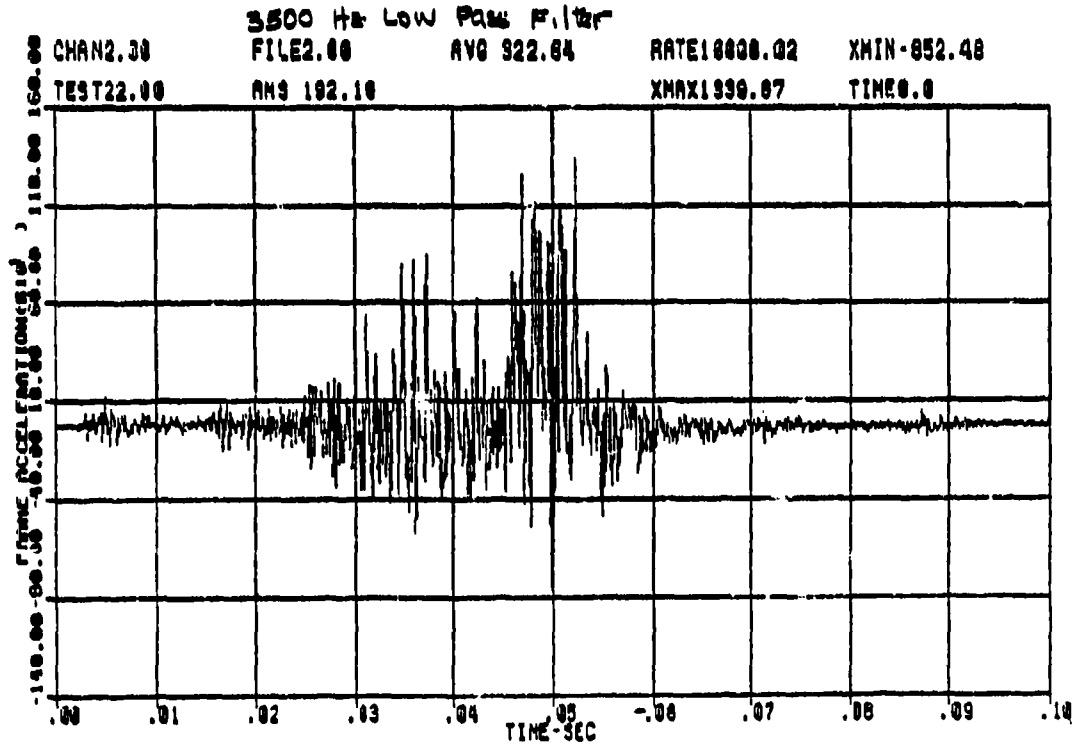

2500 Hz Low Pass Filter
CHAN1.000
FILE2.000
AVG 4407.117
RATE:3000.000
XMIN-.477
TEST22.000
RMS .445
XMAX1.332
TIME0.0
FORCE-KIPS
TIME-SEC

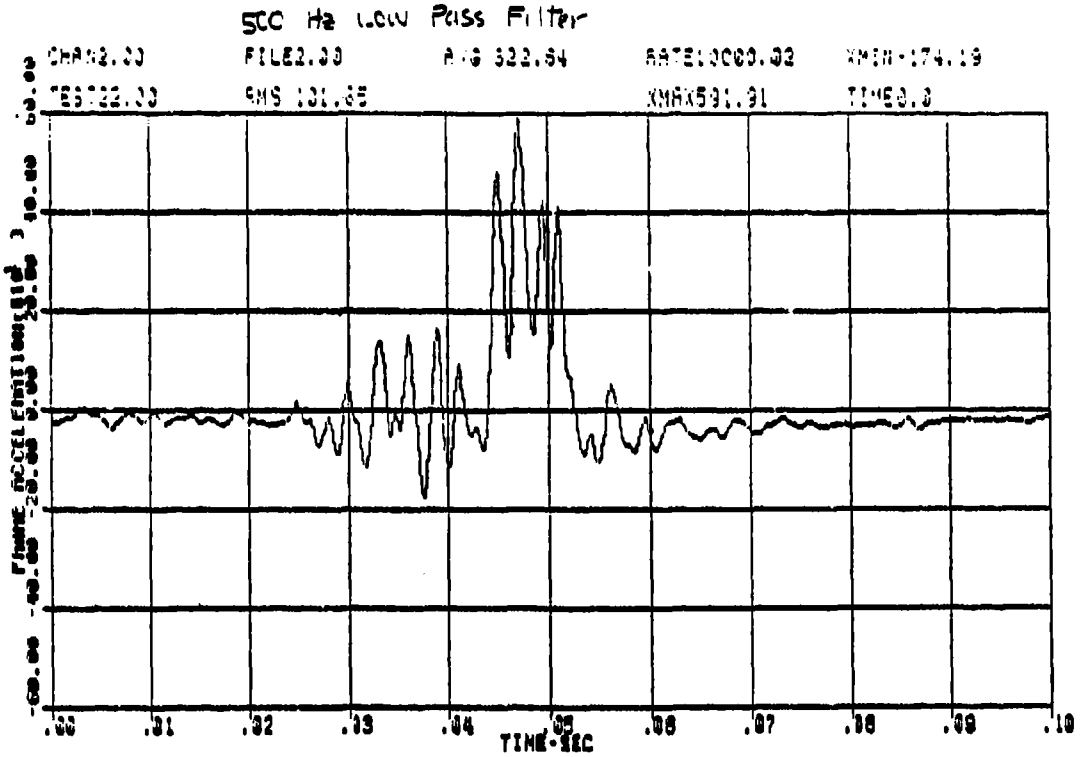

3500 Hz Low Pass Filter
CHAN1.000
FILE2.000
AVG 4407.117
RATE13000.000
XMIN-.037
TEST22.000
RMS .489
XMAX1.558
TIME0.0
FORCE-KIPS
TIME-SEC

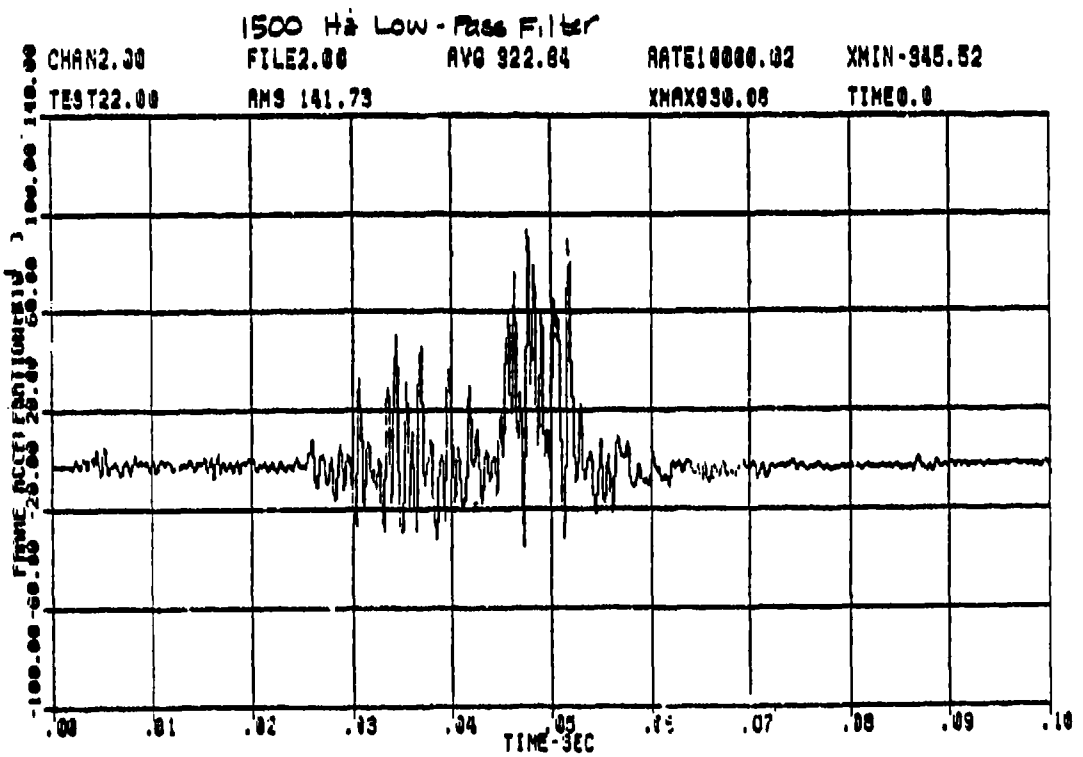

500 Hz Low Pass Filter
CHAN1.000
FILE2.000
AVG 4407.117
RATE10000.020
XMIN-.997
TEST22.000
RMS .596
XMAX.874
TIME0.0
FORCE-KIPS
TIME-SEC


1500 Hz Low-Pass Filter
CHAN1.000
FILE2.000
AVG 4407.117
RATE10000.020
XMIN-.997
TEST22.000
RMS .406
XMAX1.019
TIME0.0
FORCE-KIPS
TIME-SEC

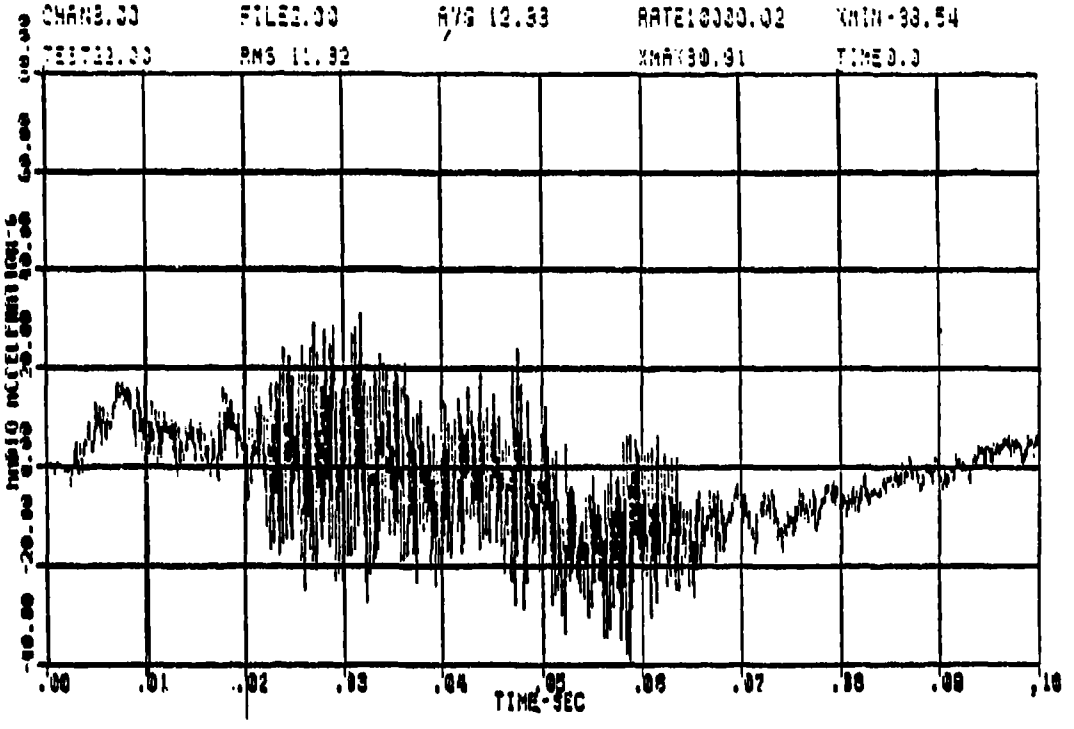

2500 Hz Low Pass Filter
FILE2.00
AVG 922.64
RMS 169.46
XMAX1141.97
TIME0.0
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC


3500 Hz Low Pass Filter
CHAN2.00
FILE2.00
AVG 922.64
RATE10000.02
XMIN-852.48
TEST22.00
RMS 192.10
XMAX1939.87
TIME0.0
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

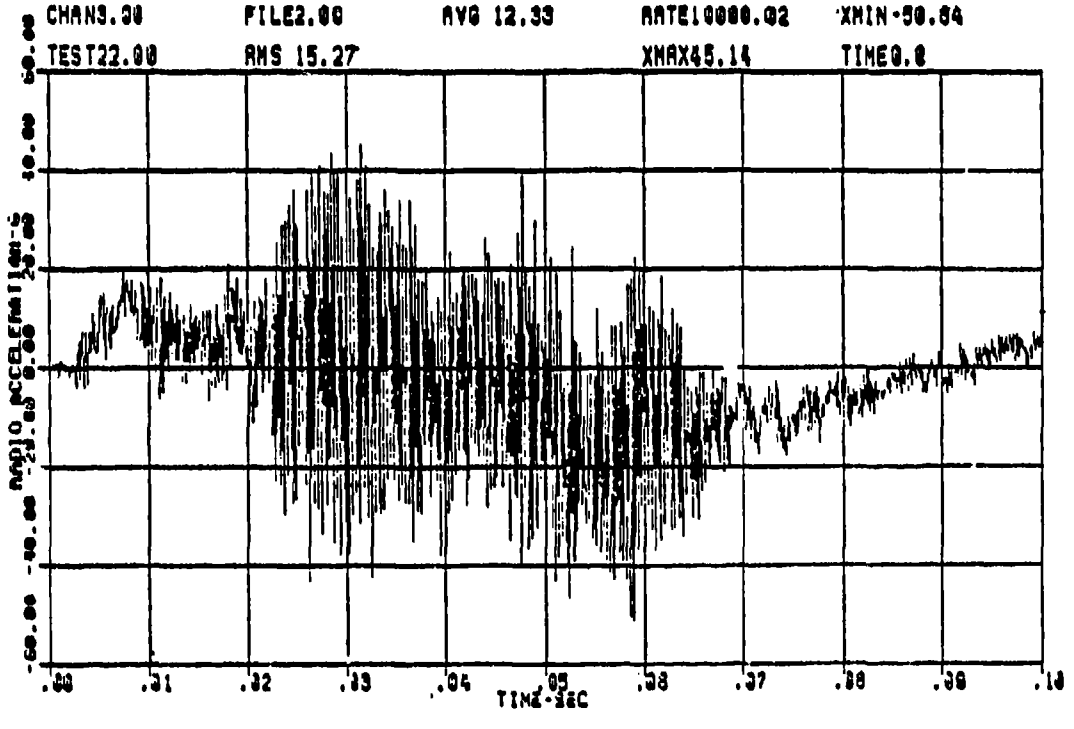

500 Hz Low Pass Filter
CHAN2.00
FILE2.00
AVG 322.84
RATE10000.02
XMIN-174.19
TEST22.00
RMS 131.65
XMAX591.91
TIME0.0
TIME-SEC

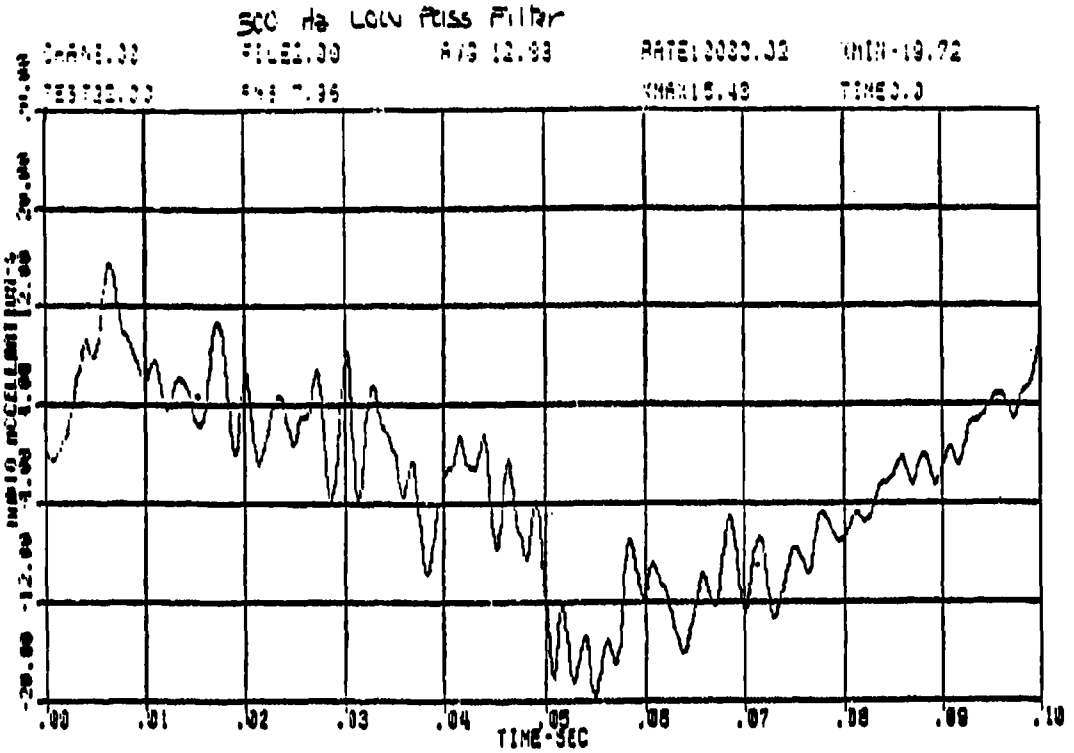

1500 Hz Low-Pass Filter
CHAN2.00
FILE2.00
AVG 322.84
RATE10000.02
XMIN-945.52
TEST22.00
RMS 141.73
XMAX930.06
TIME0.0
TIME-SEC

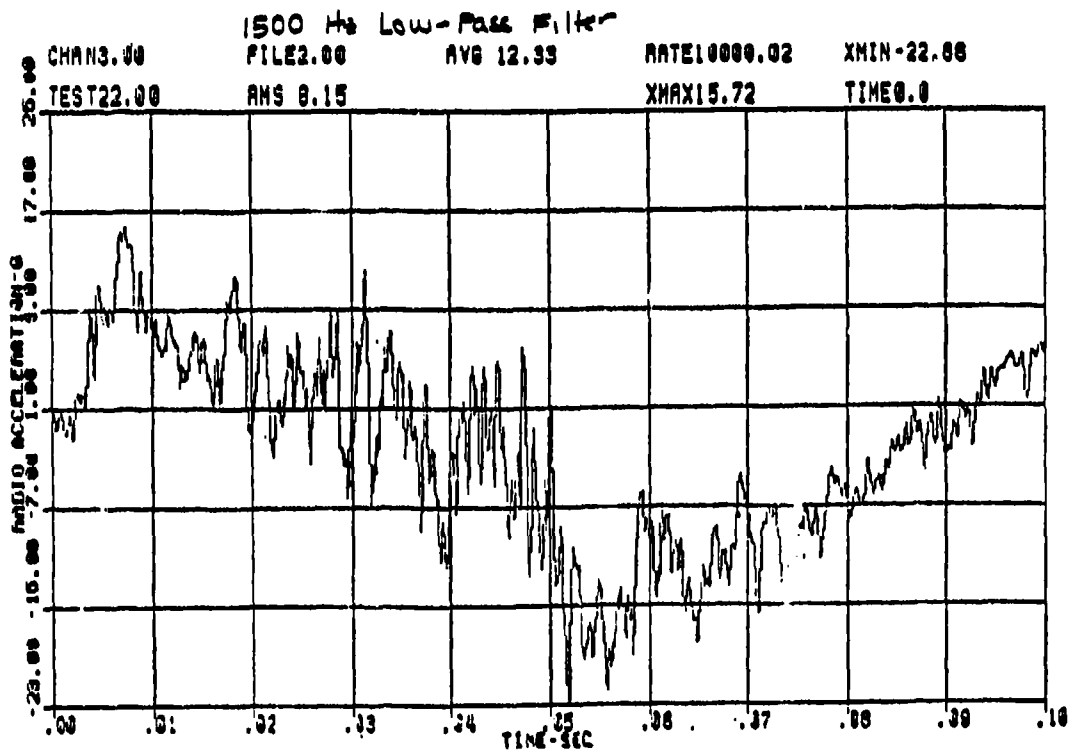
2500 Hz Low Pass Filter



3500 Hz Low Pass Filter

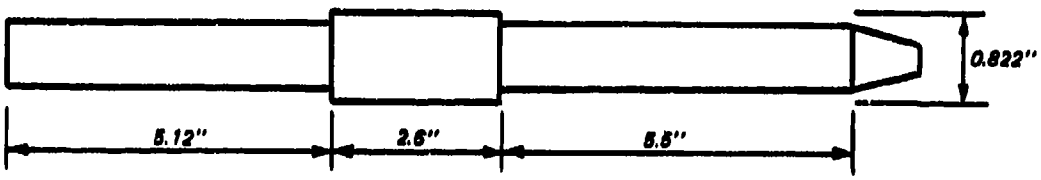



500 Hz Low Pass Filter
CHAN1.00
FILE1.00
AVG 12.93
RATE10000.02
XMIN-19.72
TEST22.00
RMS 7.36
XMAX15.43
TIME0.0
TIME-SEC


1500 Hz Low-Pass Filter
CHAN3.00
FILE2.00
AVG 12.93
RATE10000.02
XMIN-22.66
TEST22.00
RMS 8.15
XMAX15.72
TIME0.0
TIME-SEC

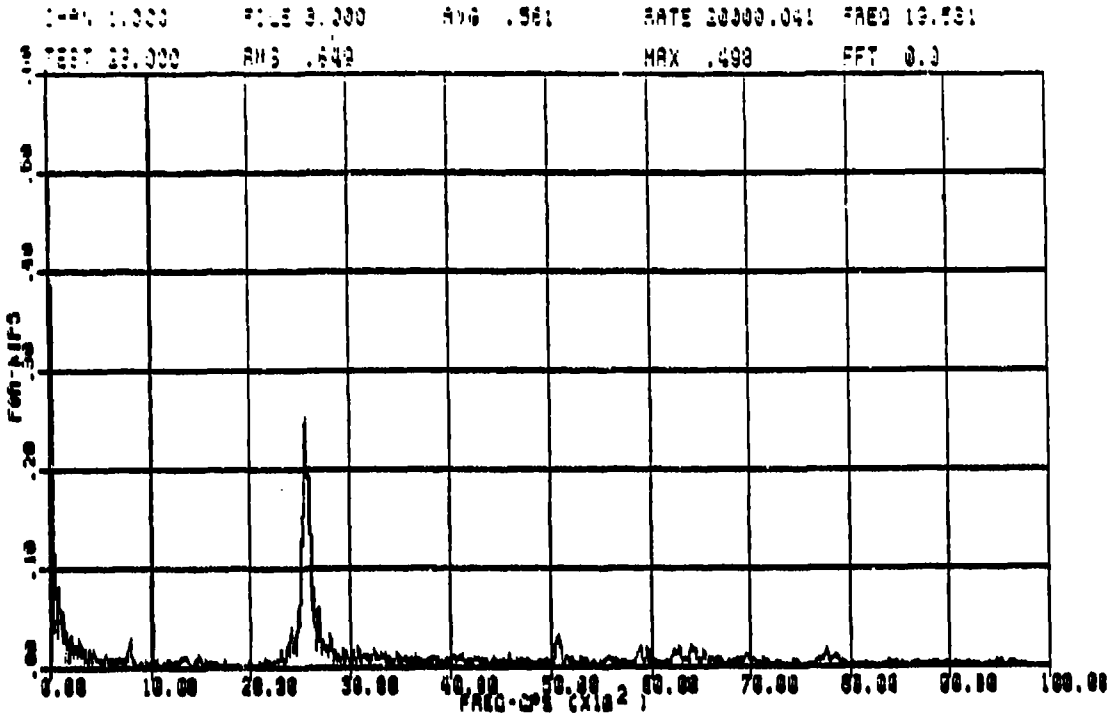
APPENDIX I: TEST 23 RESULTS

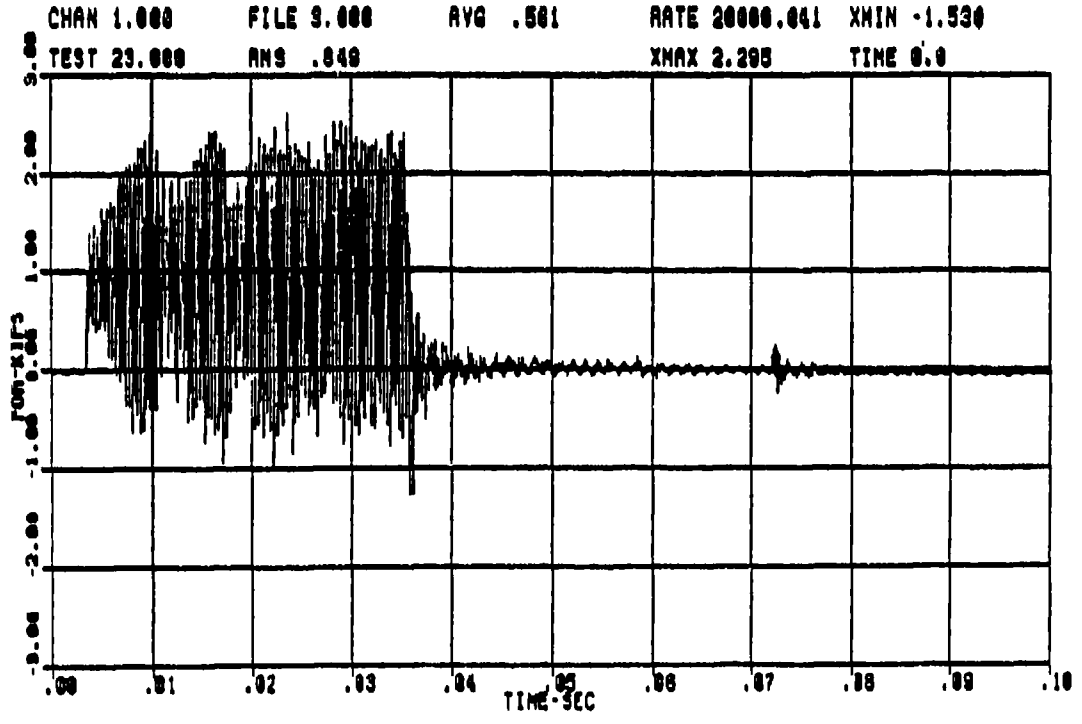
Test 23
Equipment Rack Soft-Mounted
AN/GRC-103 in Rack, Off-Line

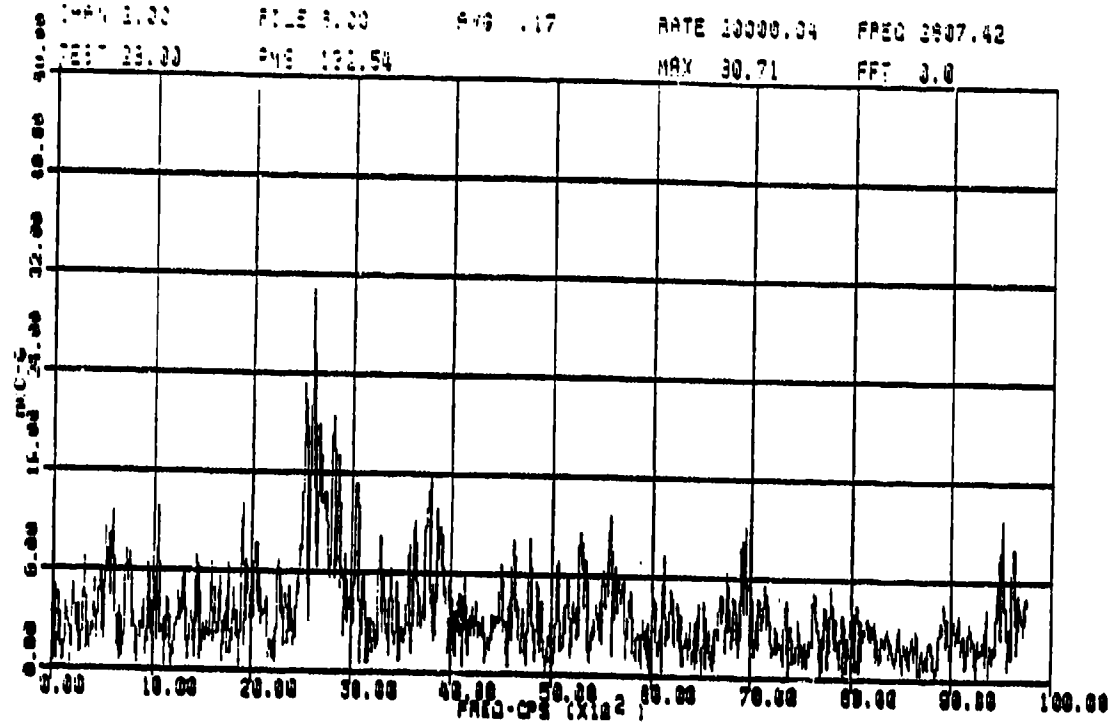


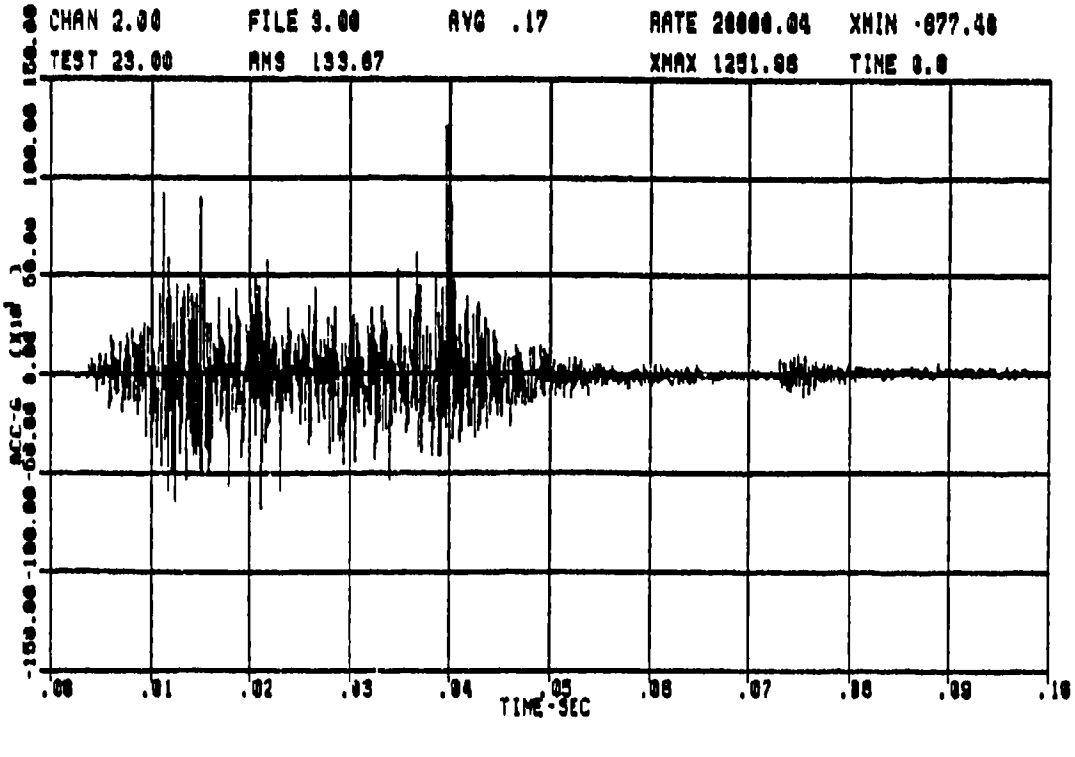
PULSE TRAIN - TEST 23

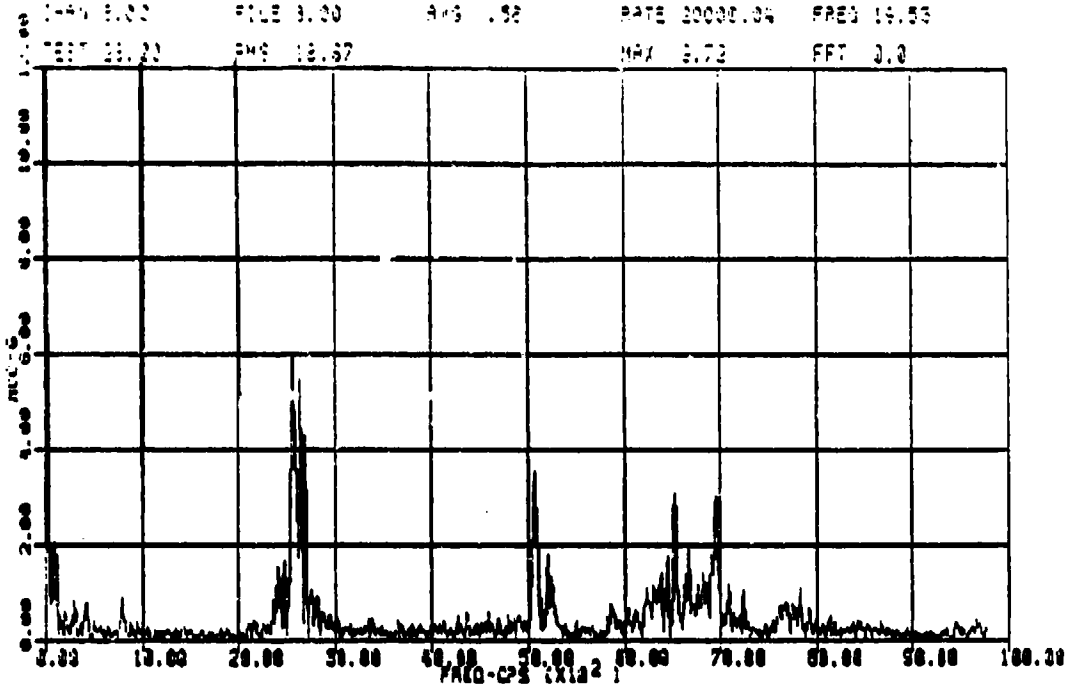
PRECHARGE PRESSURE	= 1250 PSI
SYSTEM PRESSURE	= 2000 PSI
FLOW CONTROL #6½	
AIR BAG PRESSURE	= 70 PSI

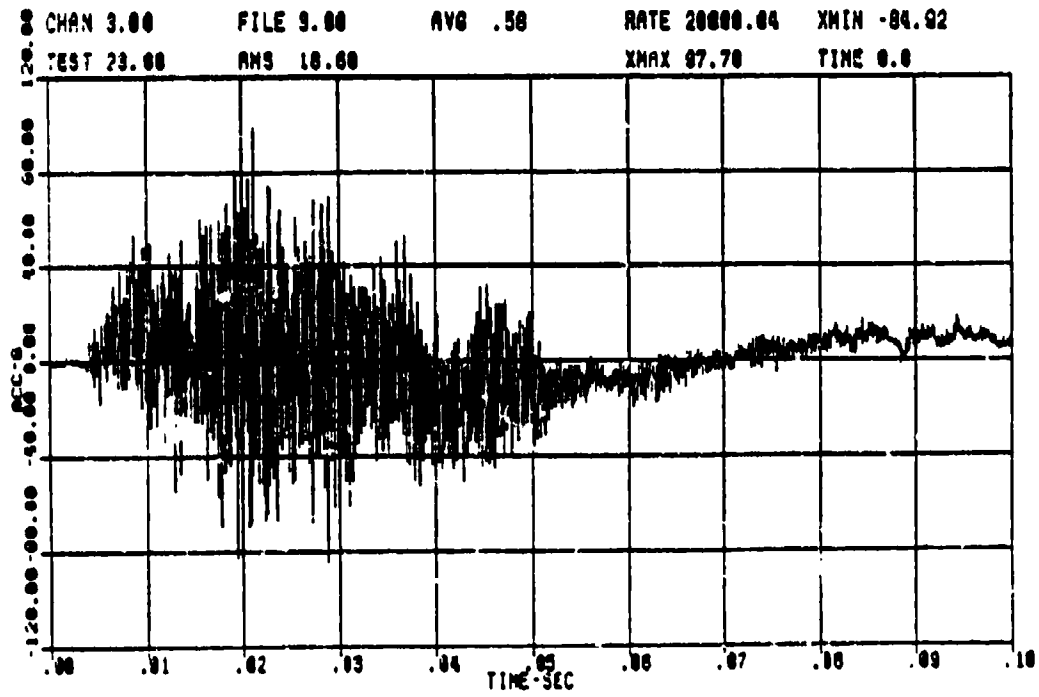

FILE 3.000
AVG .561
RATE 20000.041
MAX .498
FFT 0.0
FREQ-CPS (X10^2)

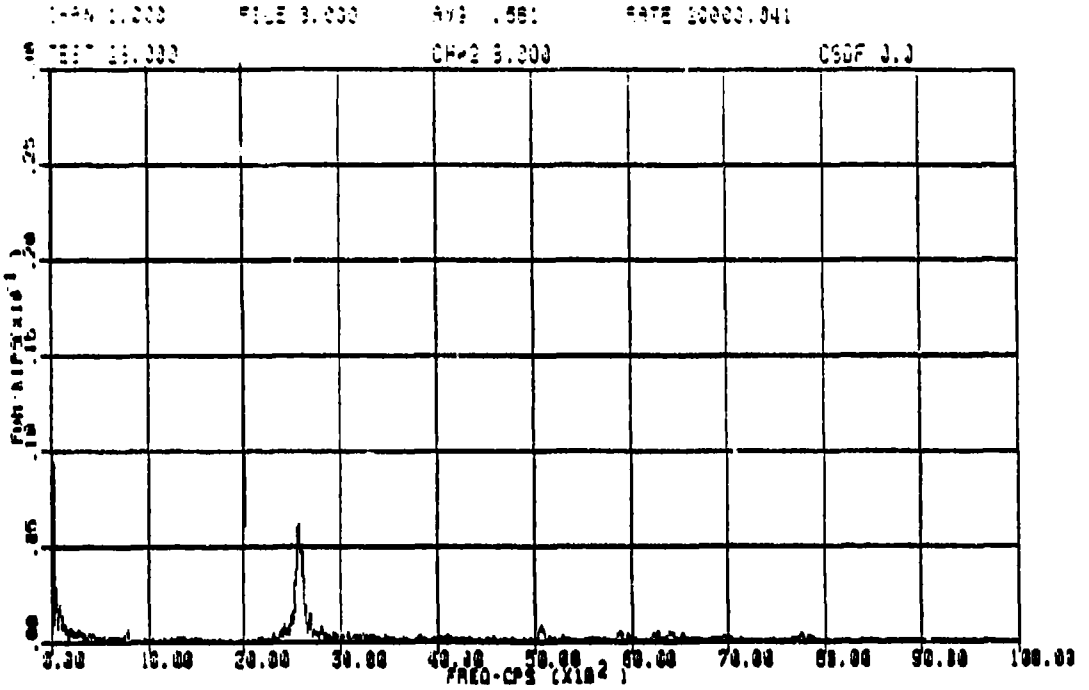

CHAN 1.000
FILE 3.000
AVG .561
RATE 20000.041
XMIN -1.530
TEST 23.000
RMS .849
XMAX 2.295
TIME 0.0
TIME-SEC

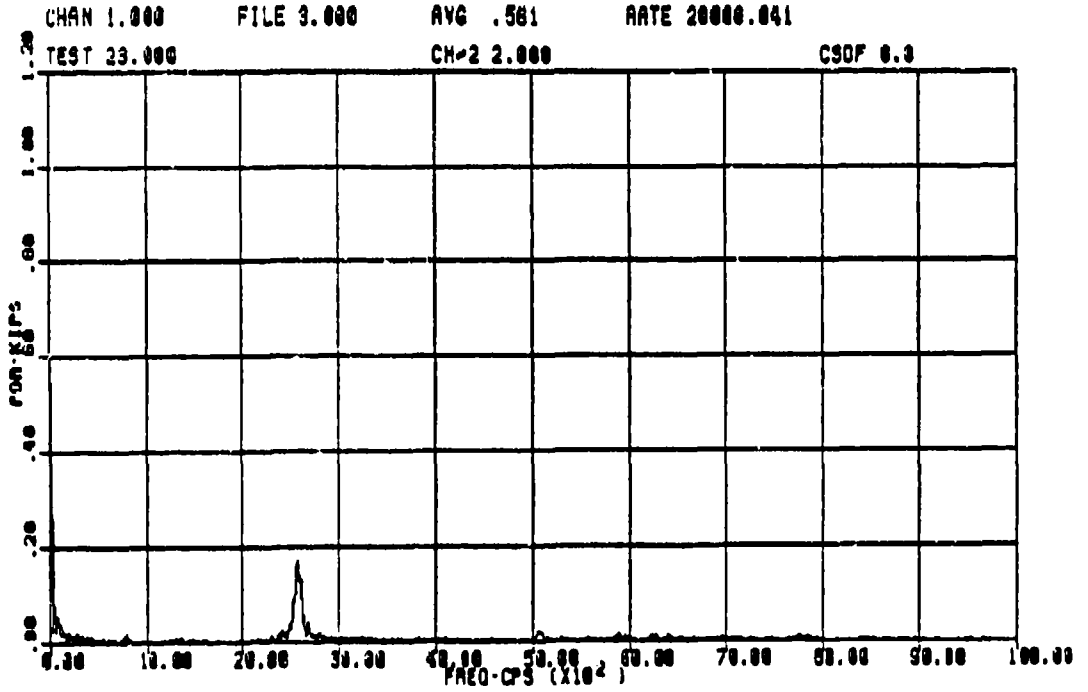

RATE 10000.04
FREQ 3907.42
MAX 30.71
FFT 3.0
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00

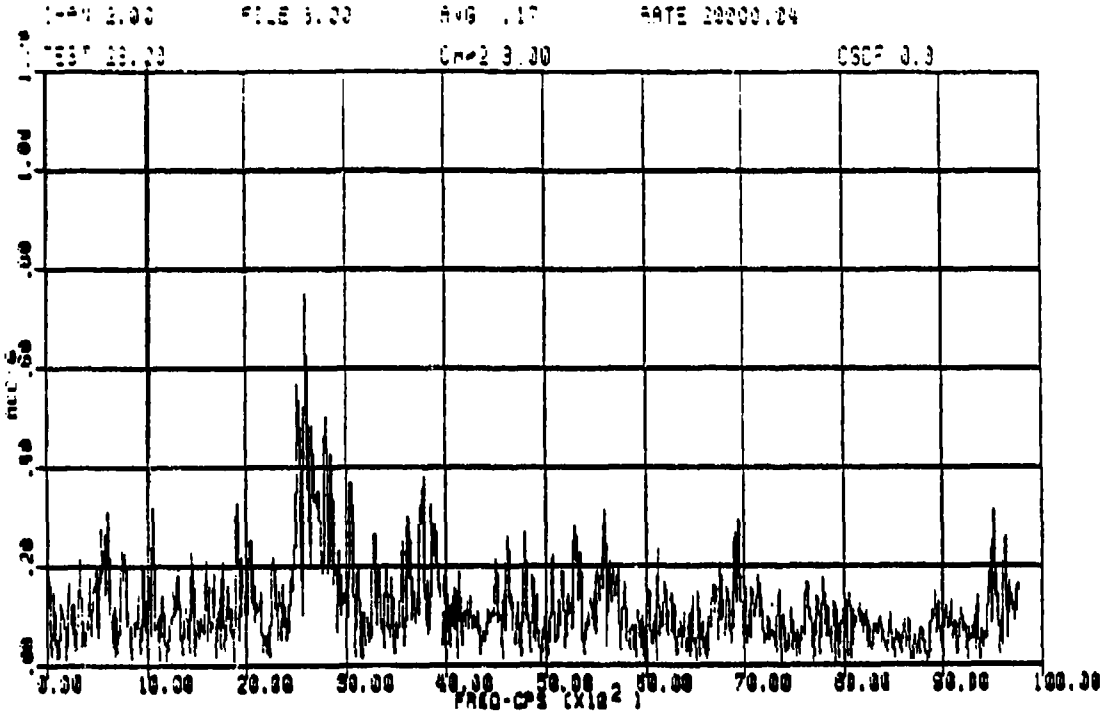

CHAN 2.00
FILE 3.00
AVG .17
RATE 20000.04
XMIN -877.48
TEST 23.00
RMS 133.87
XMAX 1251.96
TIME 0.0
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

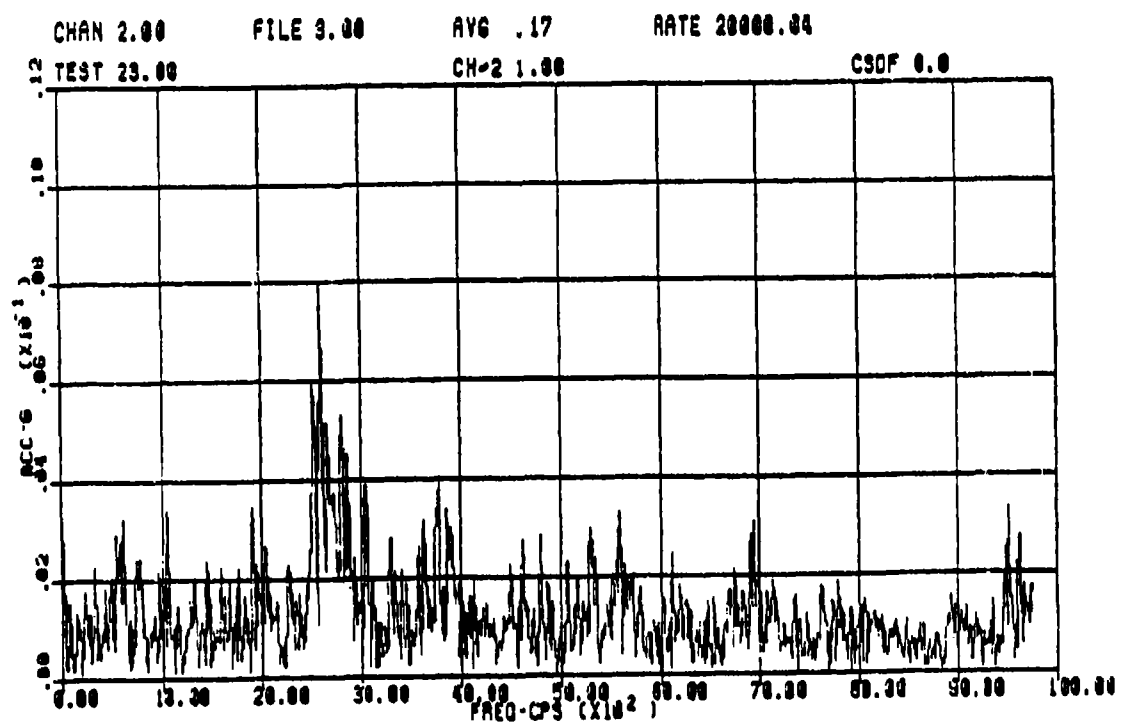

FILE 3.00
AVG .58
RATE 20000.04
FREQ 19.53
FFT 0.0
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

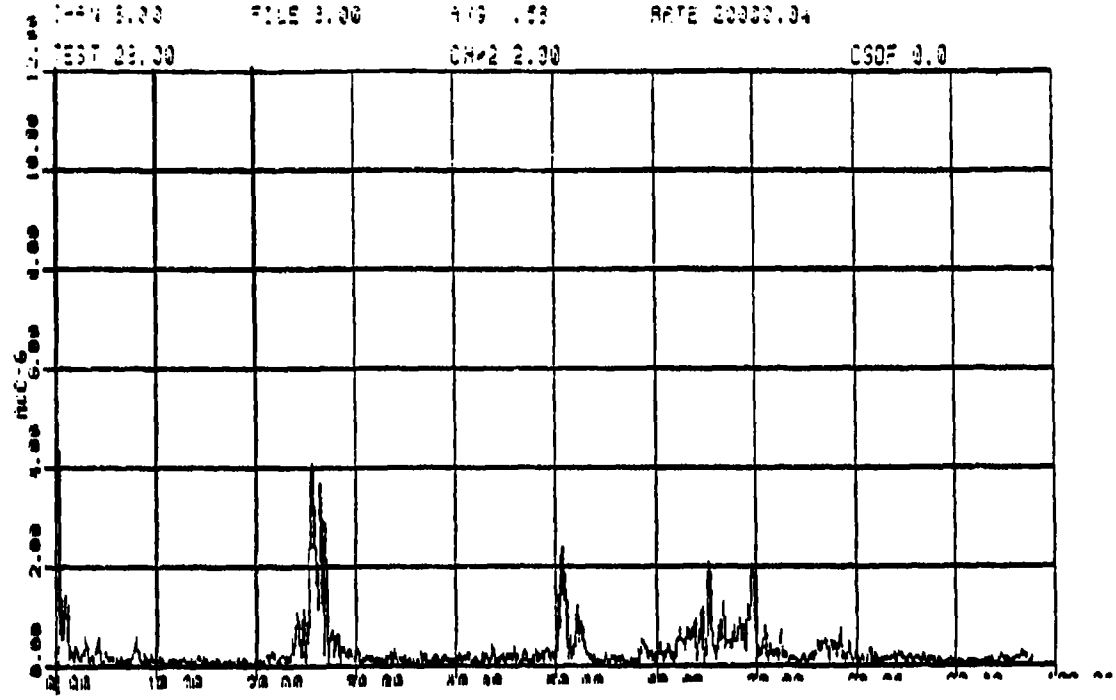

CHAN 3.00
FILE 3.00
AVG .58
RATE 20000.04
XMIN -84.92
TEST 23.00
RMS 18.60
XMAX 97.70
TIME 0.0
120.00
80.00
40.00
0.00
-40.00
-80.00
-120.00
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

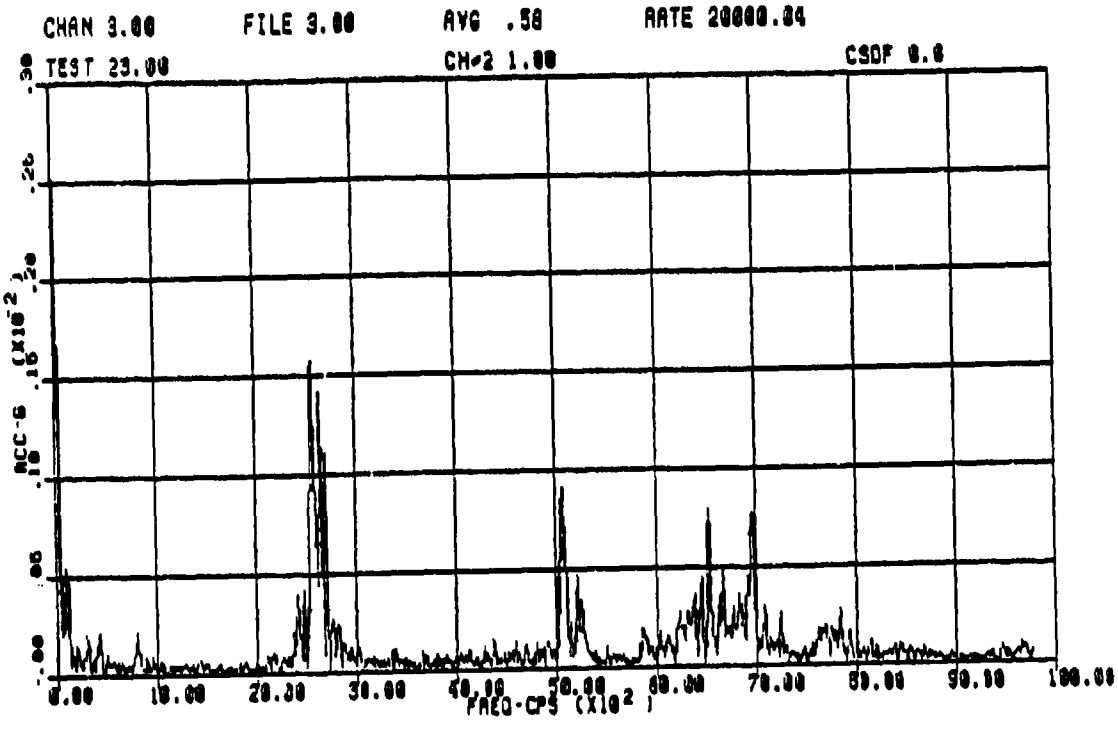

FILE 3.000
AVG .581
RATE 20000.041
CH#2 3.000
CSDF 0.0
FOR-KIPS (x10^-1)
FREQ-CPS (X10^2)

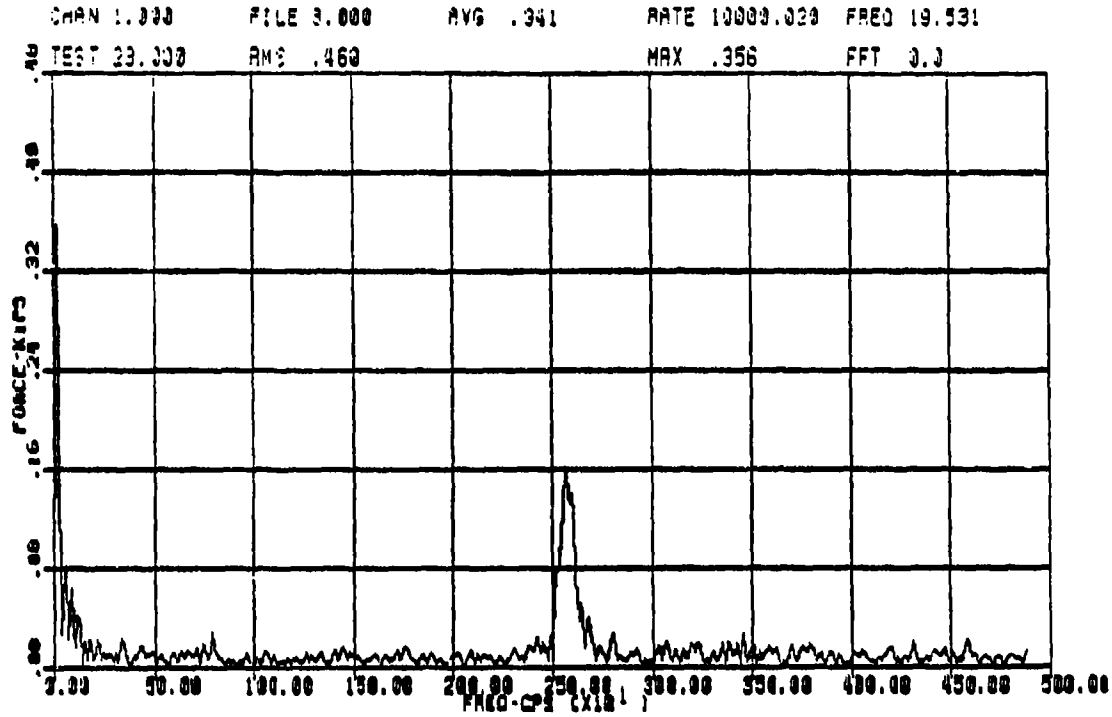

CHAN 1.000
FILE 3.000
AVG .581
RATE 20000.041
TEST 23.000
CH#2 2.000
CSDF 0.0
FOR-KIPS
FREQ-CPS (X10^2)

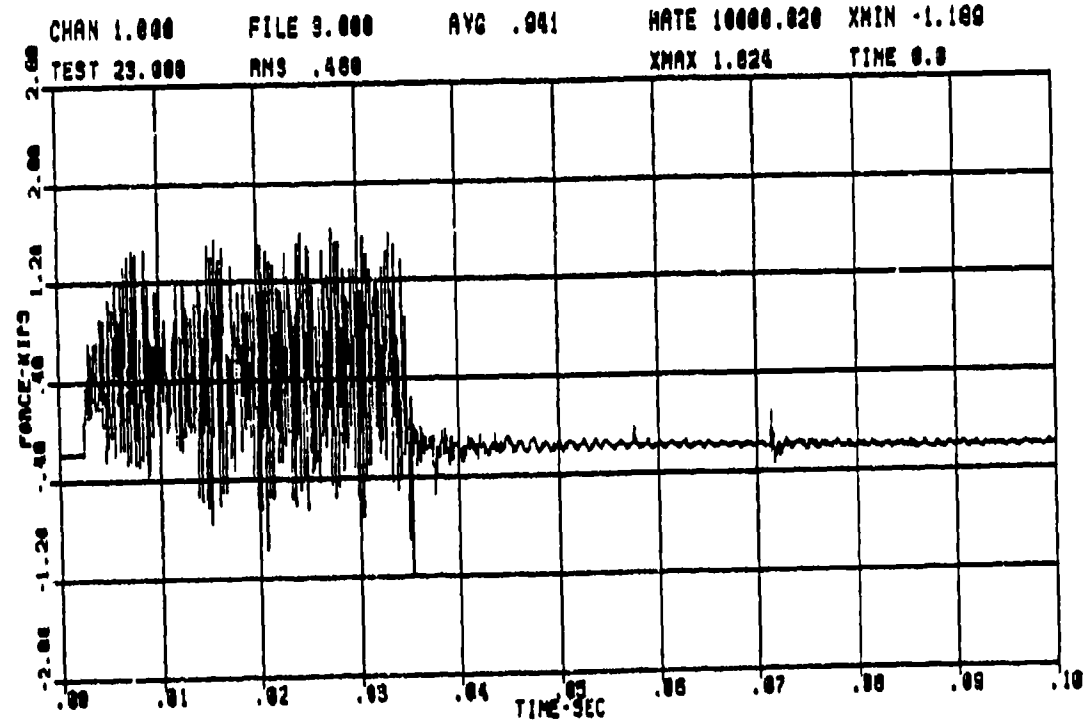

CHAN 2.00
FILE 3.00
AVG .17
RATE 20000.04
TEST 23.00
CH-2 3.00
CSOF 0.0
ACC-G
FREQ-CPS (X10^2)

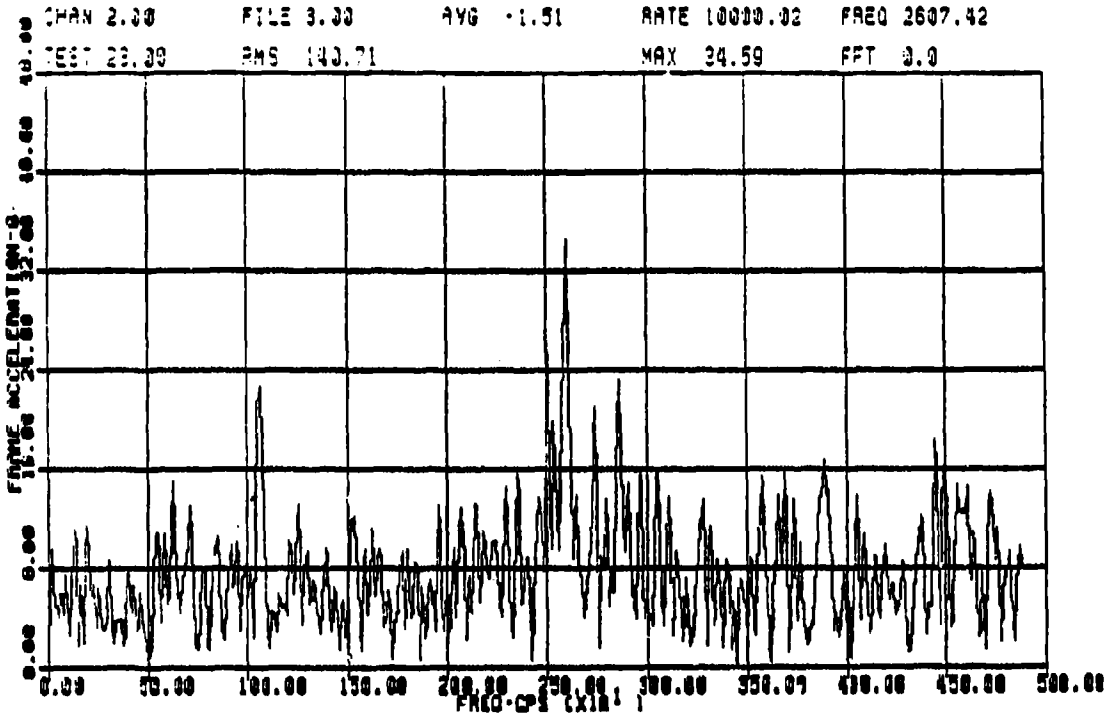

CHAN 2.00
FILE 3.00
AVG .17
RATE 20000.04
TEST 23.00
CH-2 1.00
CSOF 0.0
ACC-G (X10^1)
FREQ-CPS (X10^2)

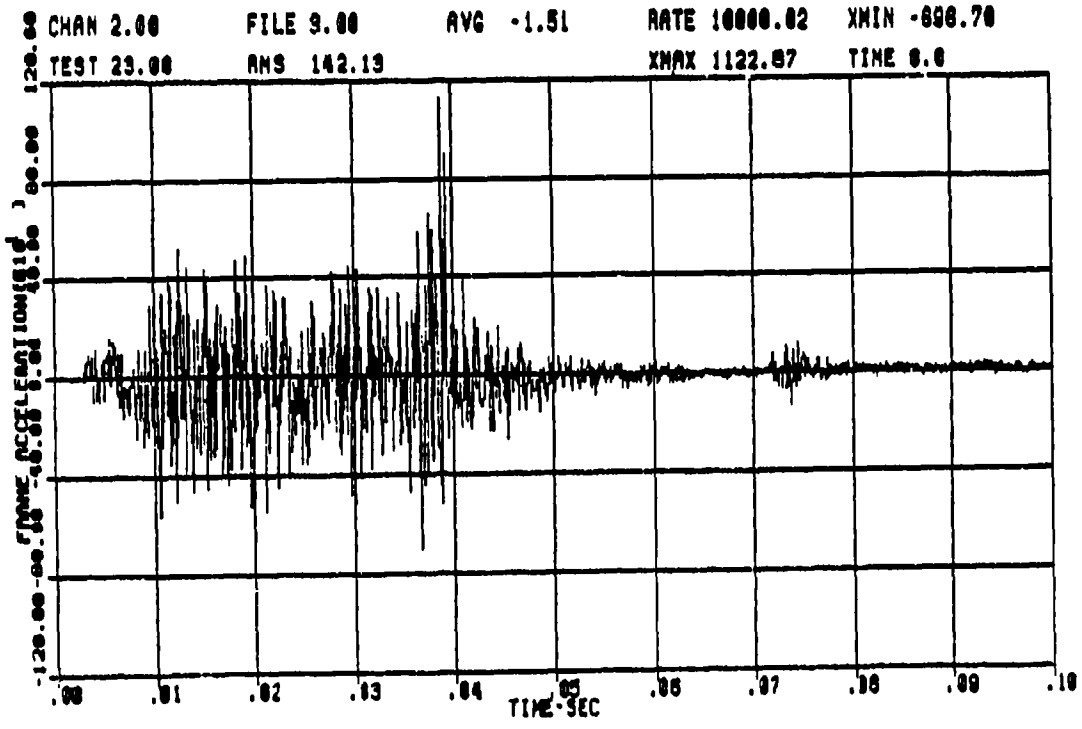


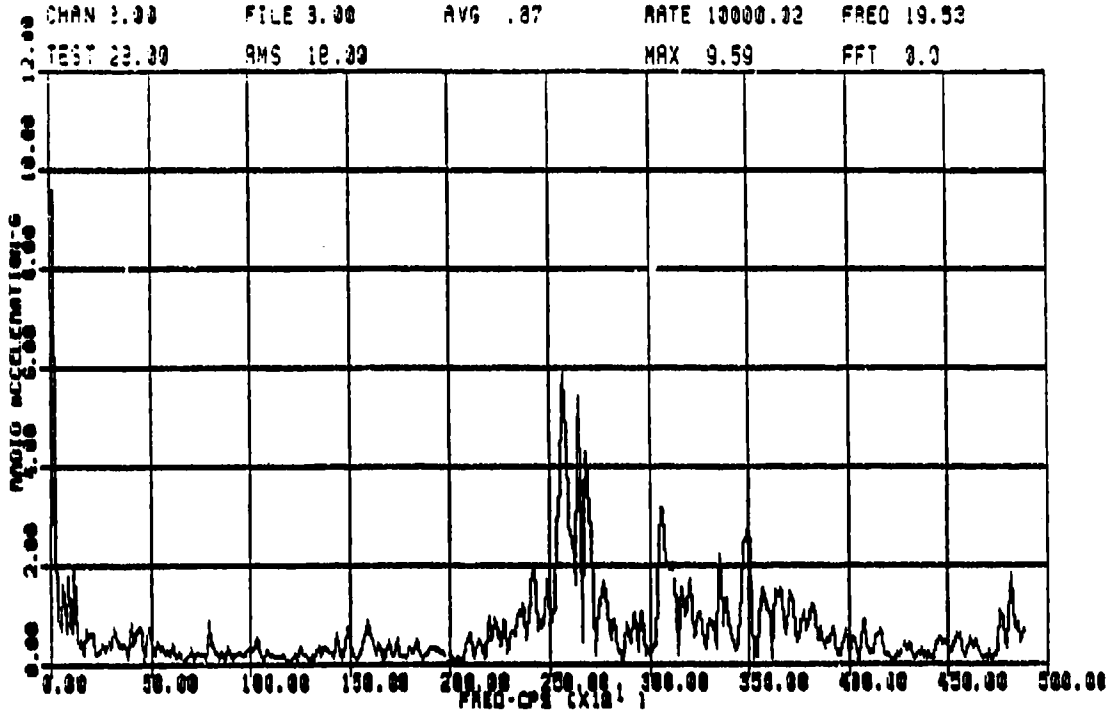

CHAN 3.00
FILE 3.00
AVG .50
RATE 20000.04
TEST 23.00
CH#2 1.00
CSOF 0.0
ACC-G (X10^2)
FREQ-CPS (X10^2)

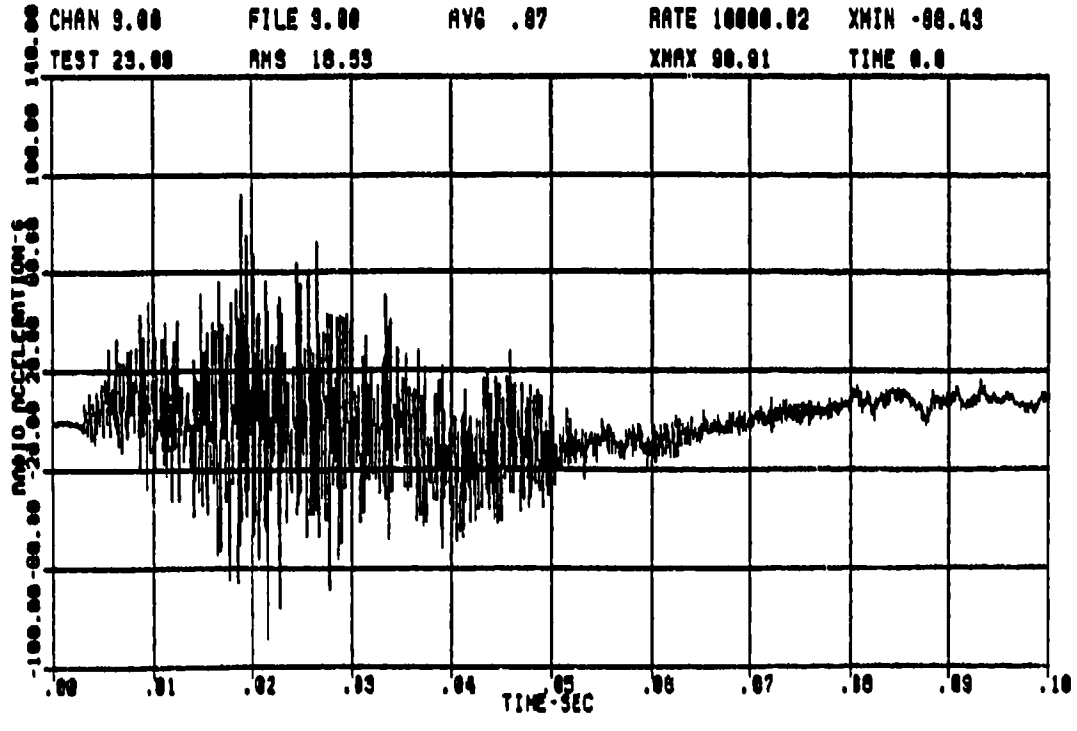

CHAN 1.000
FILE 3.000
AVG .341
RATE 10000.020
FREQ 19.531
TEST 23.000
RMS .460
MAX .356
FFT 0.0
FORCE-KIPS
.40
.32
.24
.16
.08
.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00
FREQ-CPS (X10)

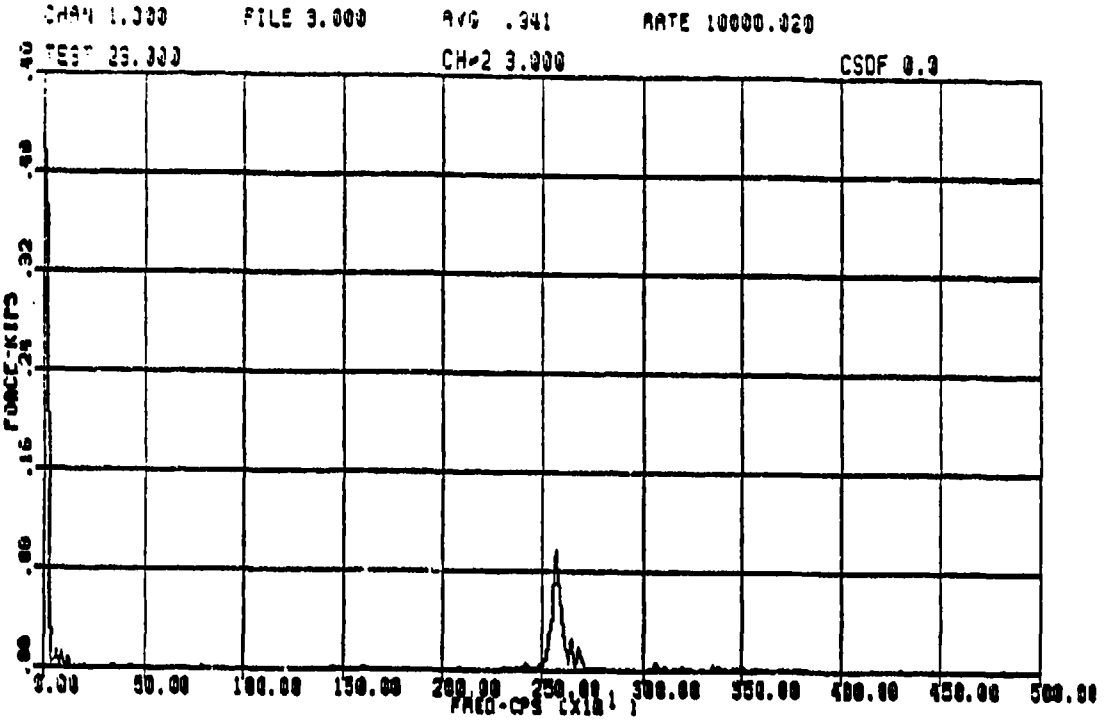

CHAN 1.000
FILE 3.000
AVG .341
RATE 10000.020
XMIN -1.100
TEST 23.000
RMS .460
XMAX 1.024
TIME 0.0
FORCE-KIPS
2.00
1.20
.40
-.40
-1.20
-2.00
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

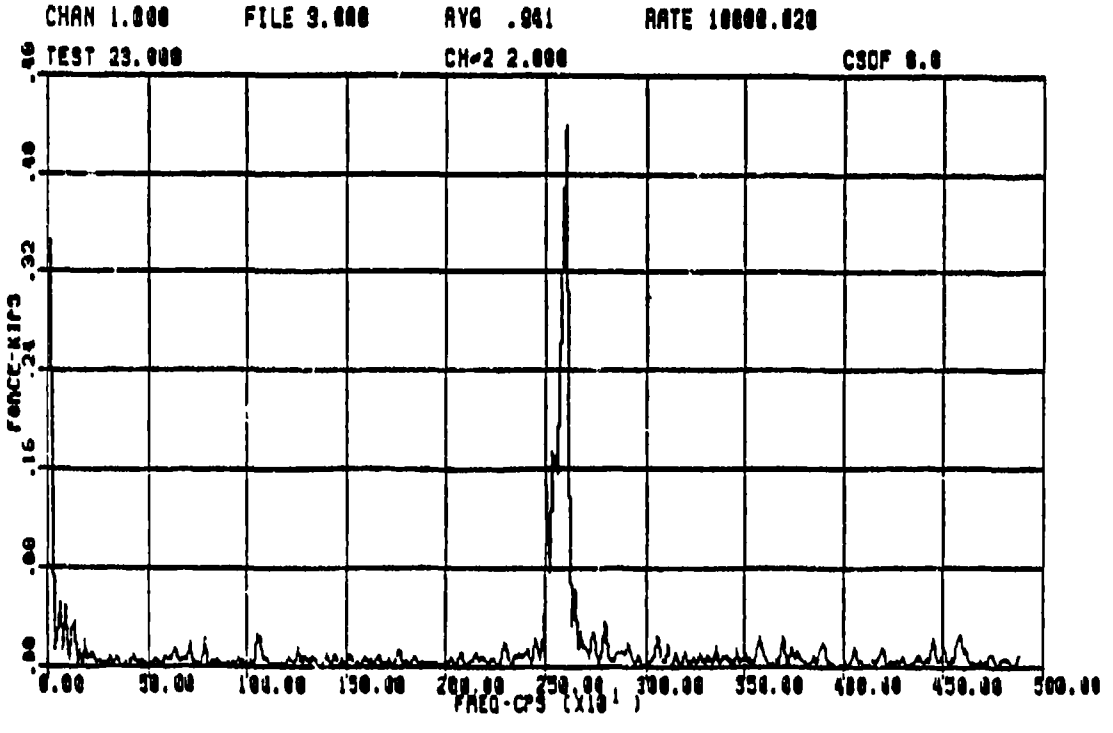

CHAN 2.00
FILE 3.00
AVG -1.51
RATE 10000.02
FREQ 2607.42
TEST 23.00
RMS 140.71
MAX 34.59
FFT 0.0
FRAME ACCELERATION-G
FREQ-CPS (X10+1)

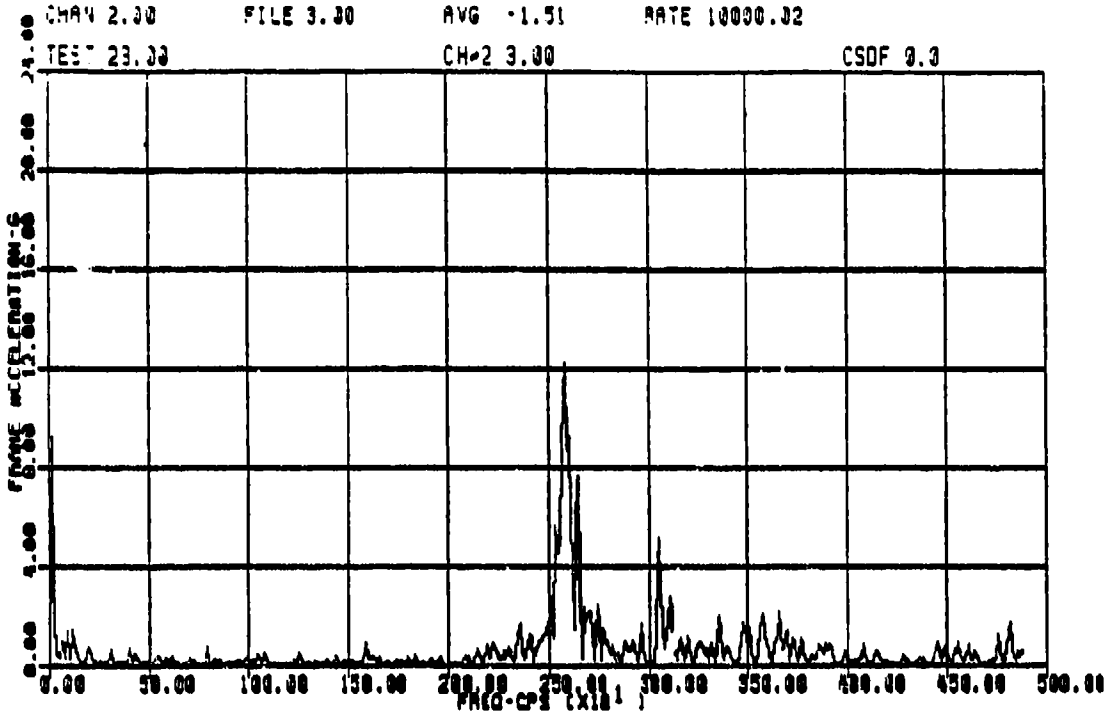

CHAN 2.00
FILE 9.00
AVG -1.51
RATE 10000.02
XMIN -600.70
TEST 23.00
RMS 142.13
XMAX 1122.87
TIME 0.0
FRAME ACCELERATION(G)
TIME-SEC

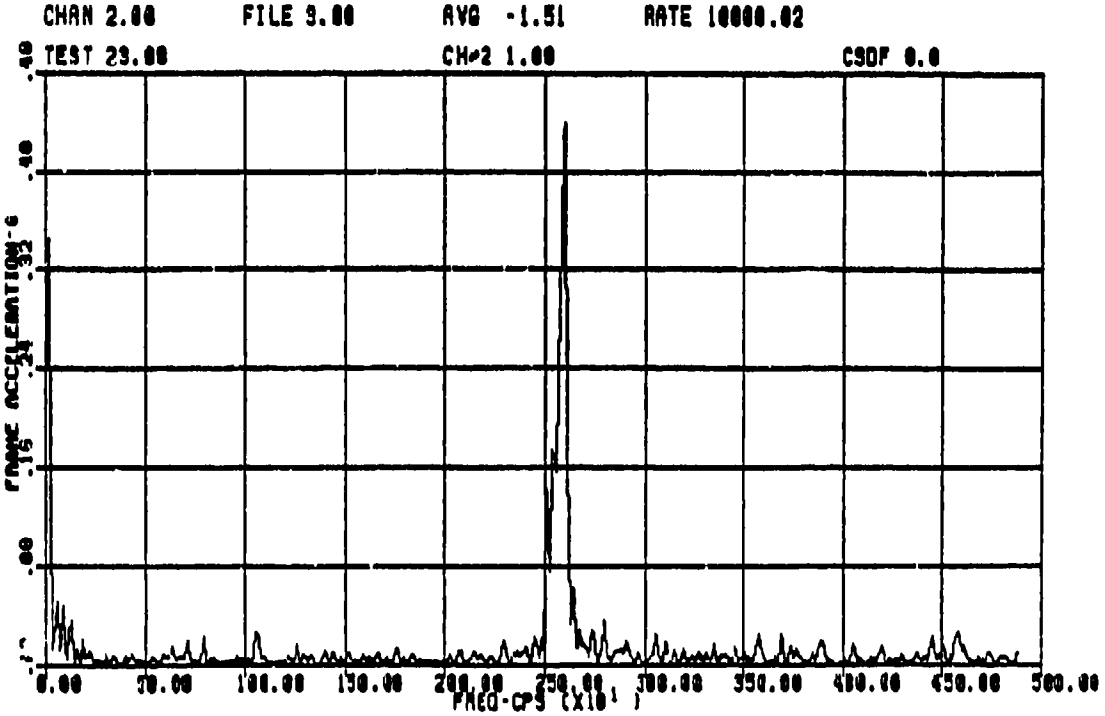

CHAN 3.00
FILE 3.00
AVG .87
RATE 10000.02
FREQ 19.53
TEST 23.00
RMS 10.00
MAX 9.59
FFT 0.0
FREQ-CPS (X10)

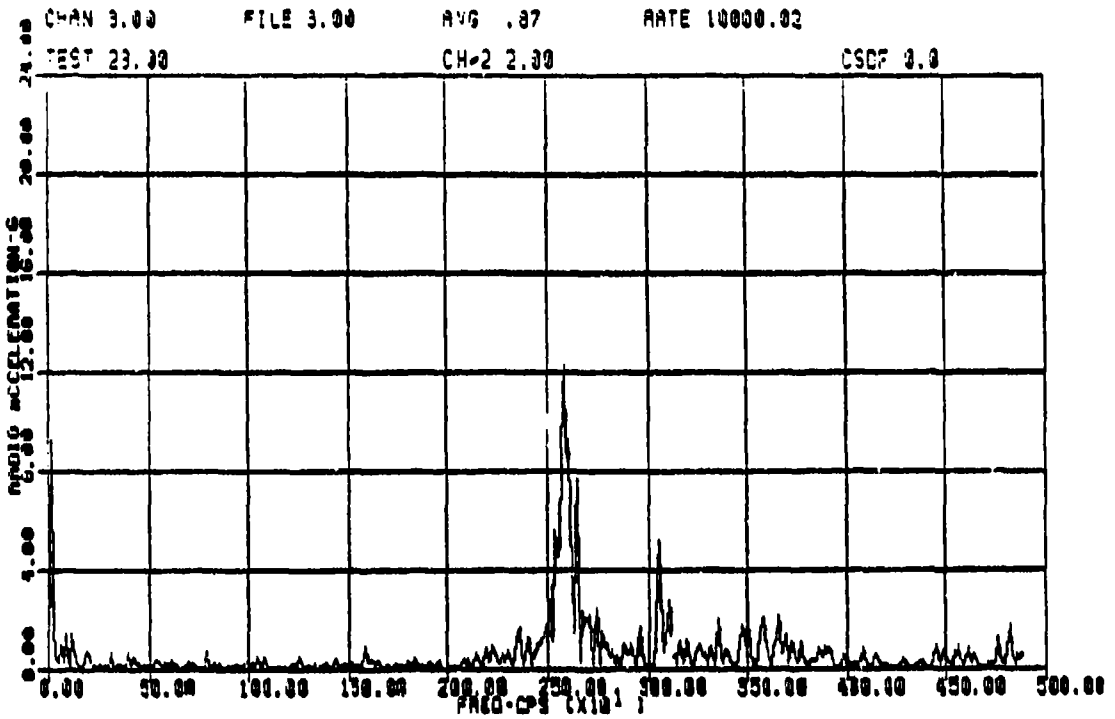

CHAN 9.00
FILE 9.00
AVG .87
RATE 10000.02
XMIN -00.43
TEST 23.00
RMS 10.53
XMAX 00.01
TIME 0.0
TIME-SEC

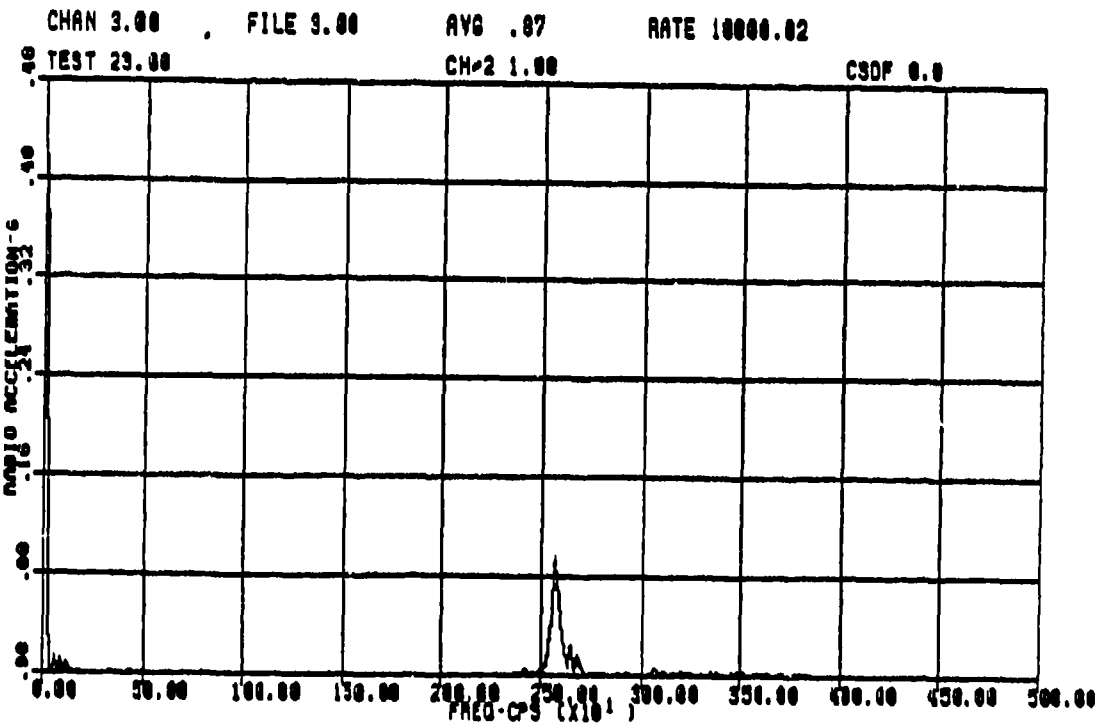

CHAN 1.000 FILE 3.000 AVG .341 RATE 10000.020
TEST 23.000 CH#2 3.000 CSDF 0.0
FORCE-KIPS
FREQ-CPS (X10¹)

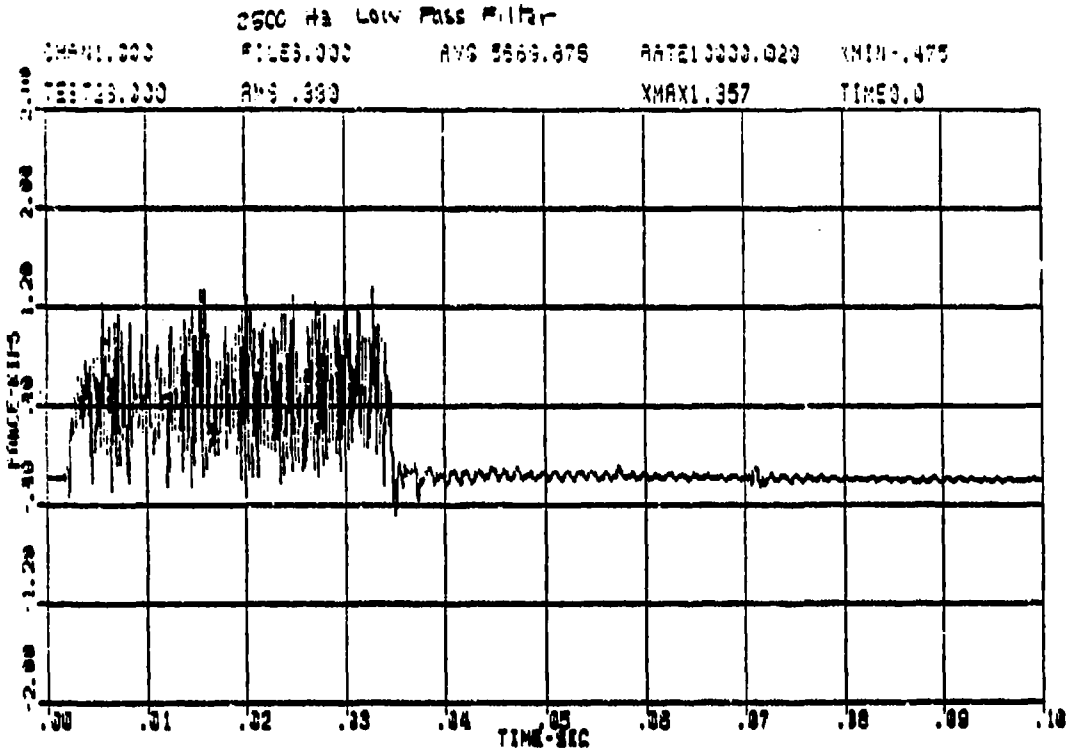

CHAN 1.000 FILE 3.000 AVG .341 RATE 10000.020
TEST 23.000 CH#2 2.000 CSDF 0.0
FORCE-KIPS
FREQ-CPS (X10¹)

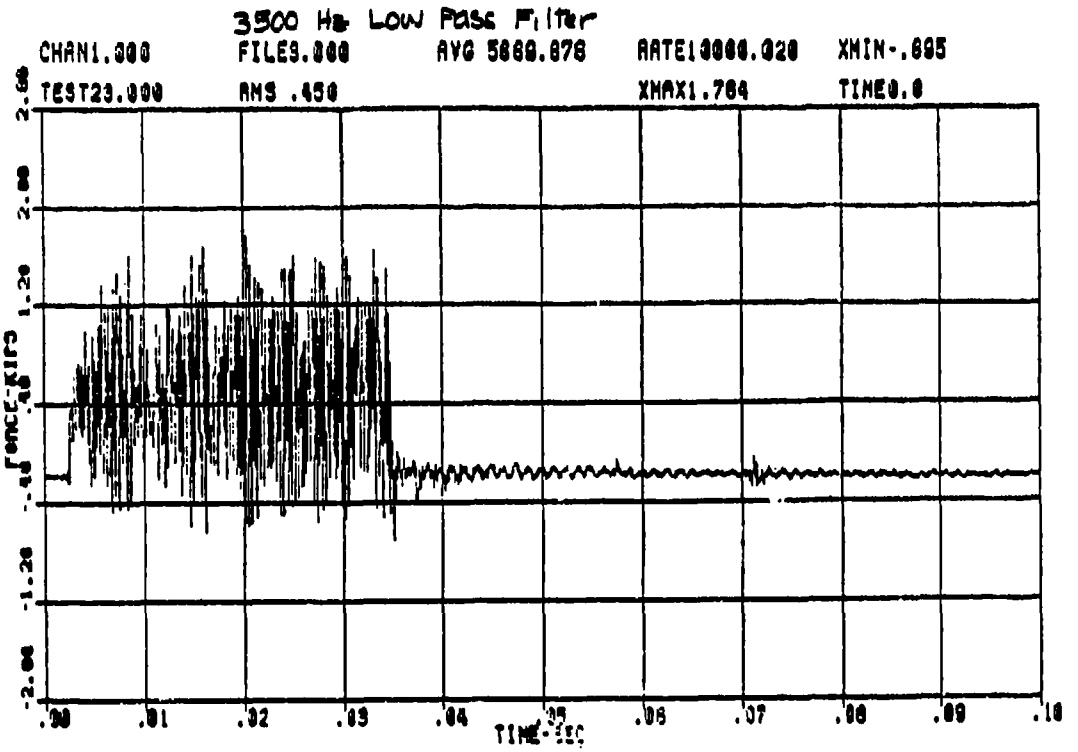

CHAN 2.00
FILE 3.00
AVG -1.51
RATE 10000.02
TEST 23.00
CH#2 3.00
CSDF 0.3
FREQ-CPS (X10)

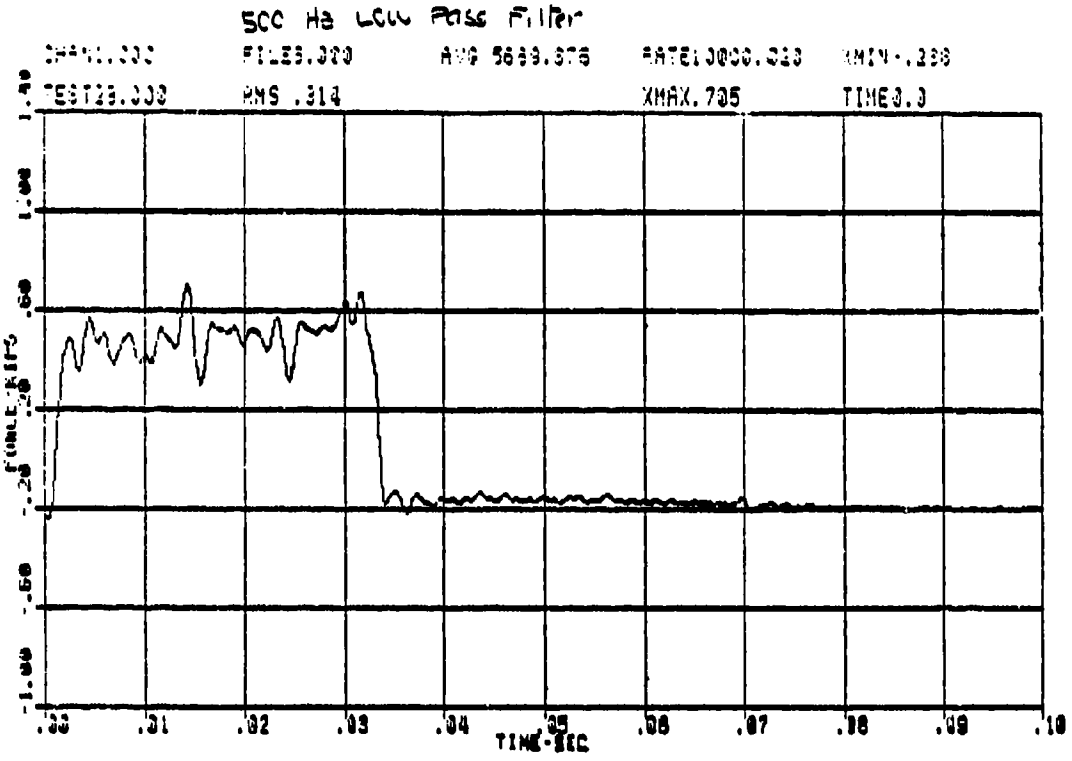

CHAN 2.00
FILE 9.00
AVG -1.51
RATE 10000.02
TEST 23.00
CH#2 1.00
CSDF 0.0
FREQ-CPS (X10)

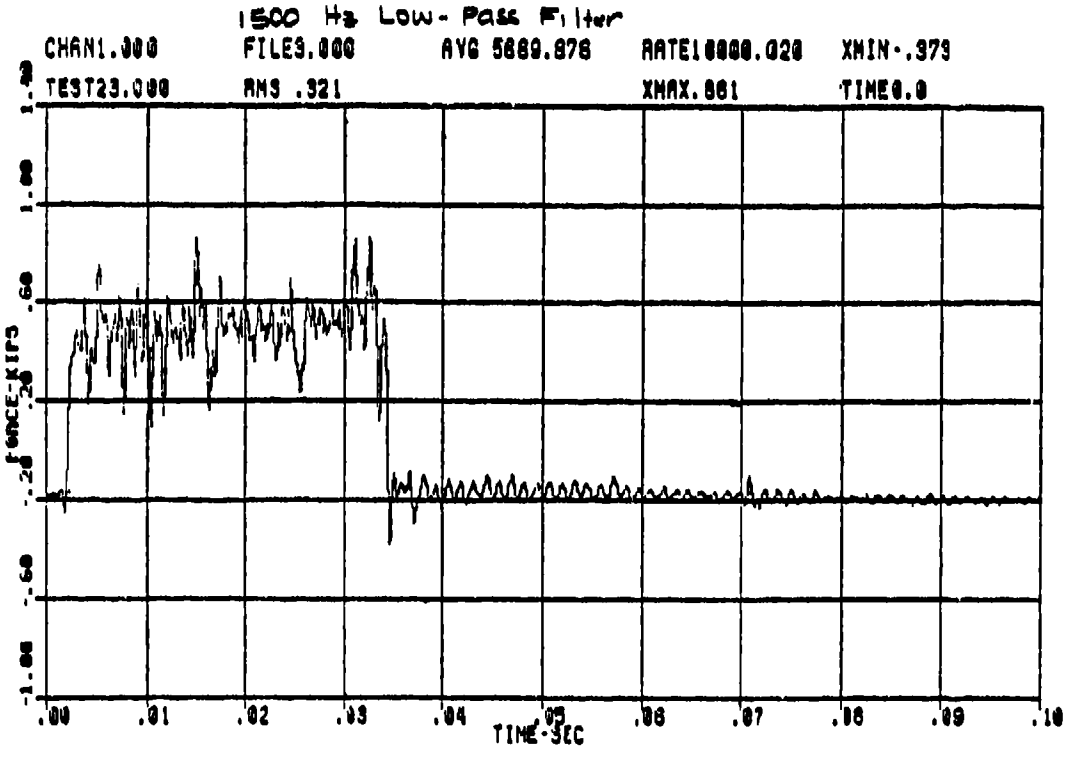

CHAN 3.00
FILE 3.00
AVG .87
RATE 10000.02
TEST 23.00
CH-2 2.00
CSDF 0.0
RADIO ACCELERATION-G
FREQ-CPS (X10¹)

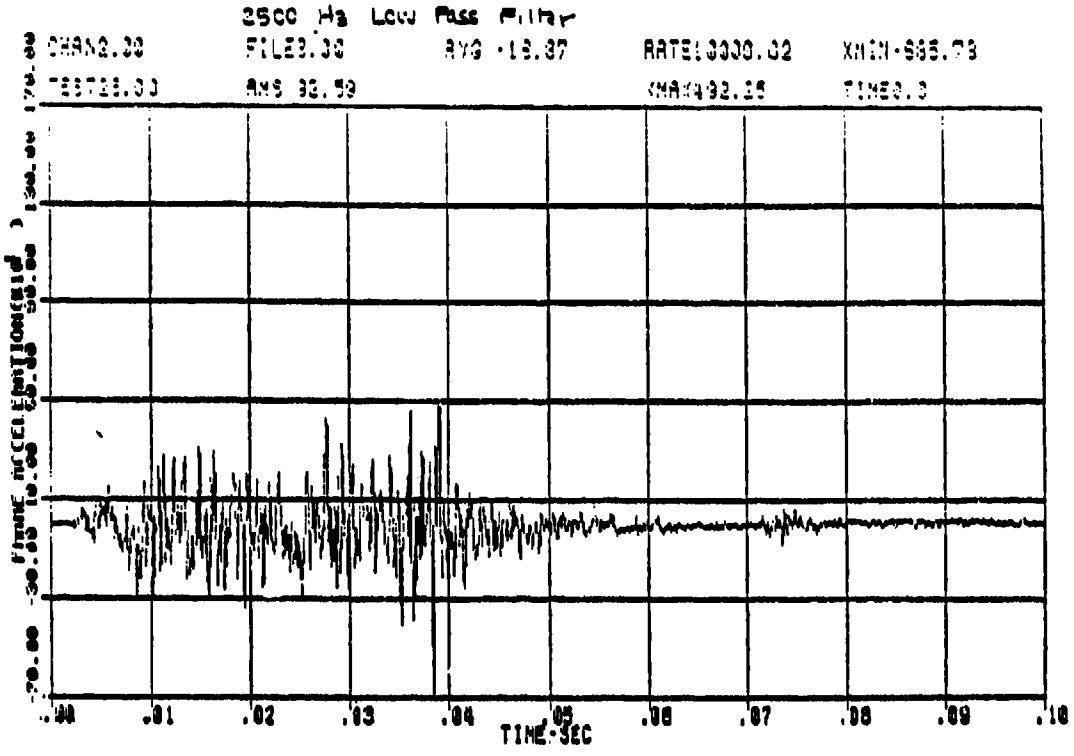

CHAN 3.00
FILE 3.00
AVG .87
RATE 10000.02
TEST 23.00
CH-2 1.00
CSDF 0.0
RADIO ACCELERATION-G
FREQ-CPS (X10¹)

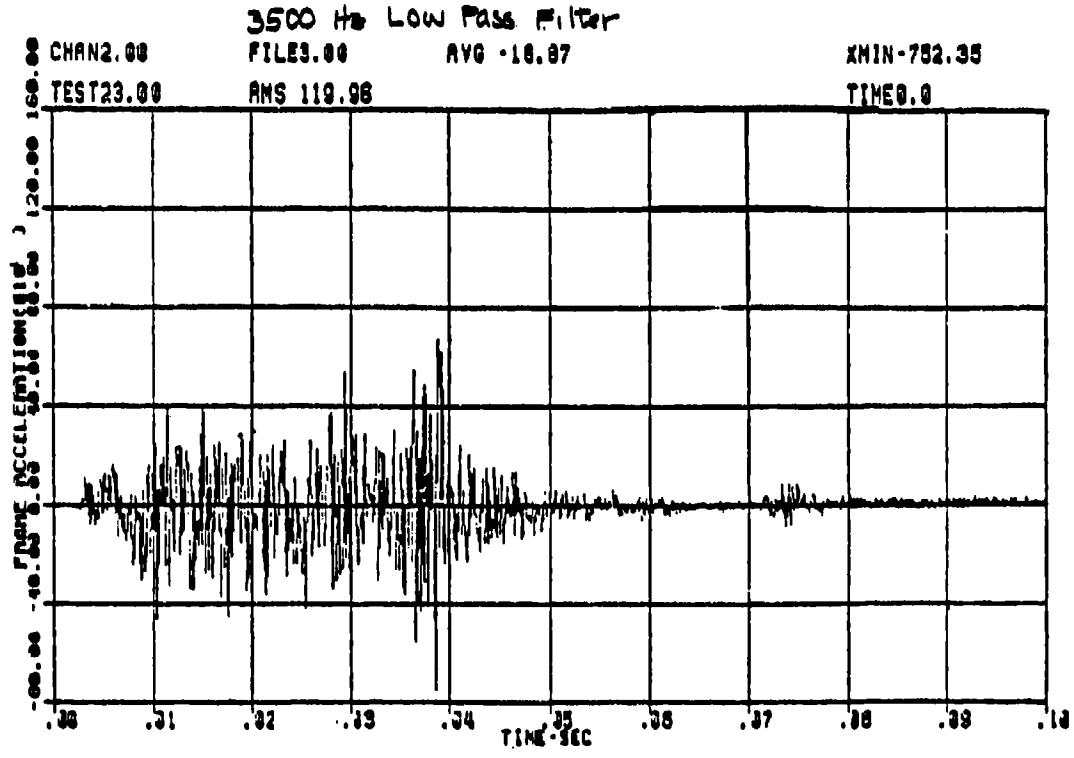

2500 Hz Low Pass Filter
CHAN1.000
FILES.000
AVG 5869.878
RATE13333.020
XMIN-.475
TEST23.000
RMS .380
XMAX1.357
TIME0.0
FORCE-KIPS
TIME-SEC

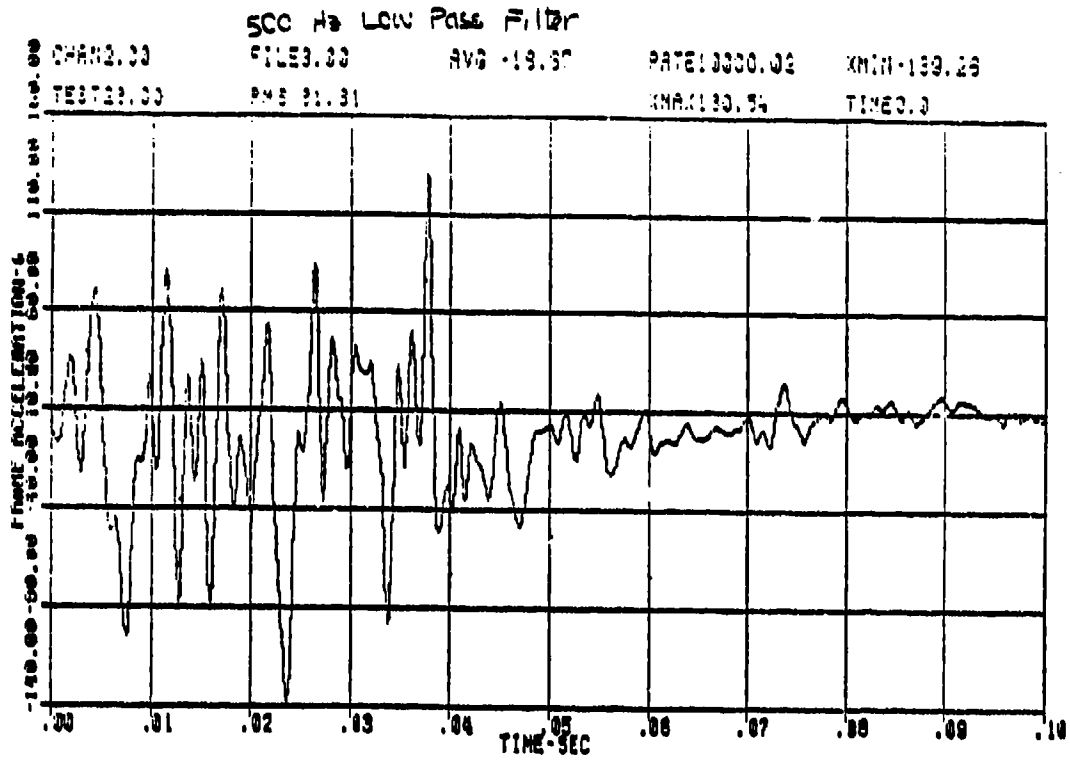

3500 Hz Low Pass Filter
CHAN1.000
FILES.000
AVG 5869.878
RATE13000.020
XMIN-.695
TEST23.000
RMS .450
XMAX1.784
TIME0.0
FORCE-KIPS
TIME-SEC

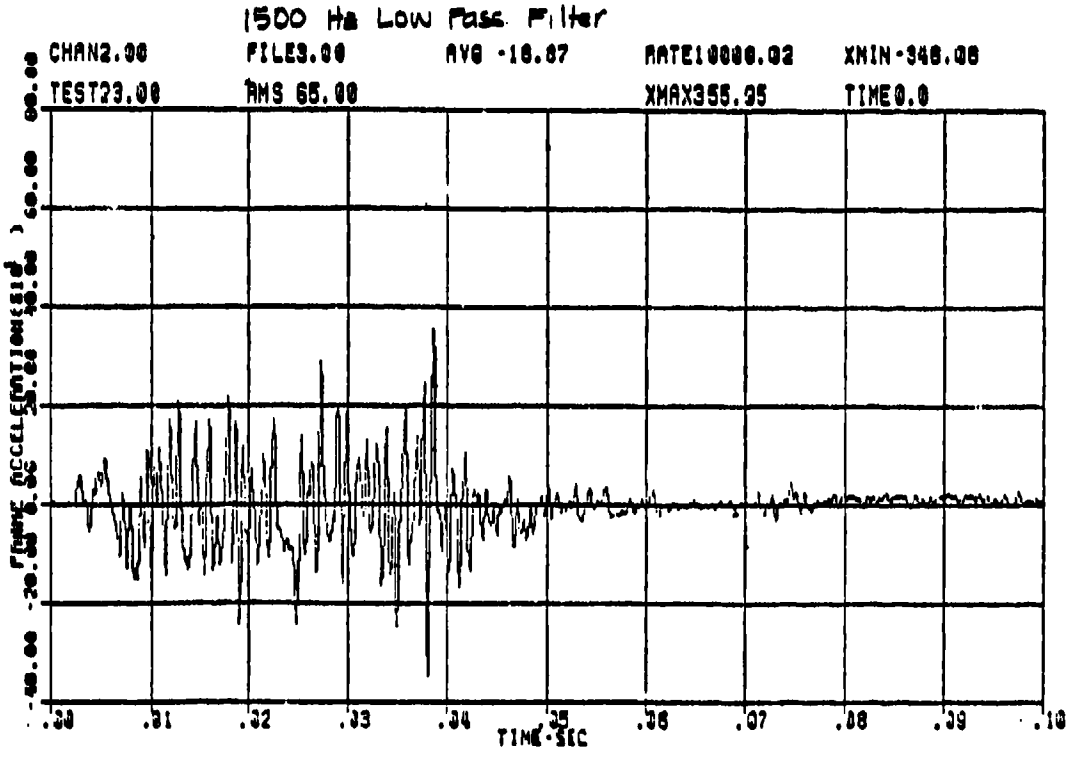

500 Hz Low Pass Filter
CHAN1.000
FILES.000
AVG 5689.878
RATE10000.020
XMIN-.238
TEST23.000
RMS .314
XMAX.705
TIME0.0
FORCE-KIPS
TIME-SEC

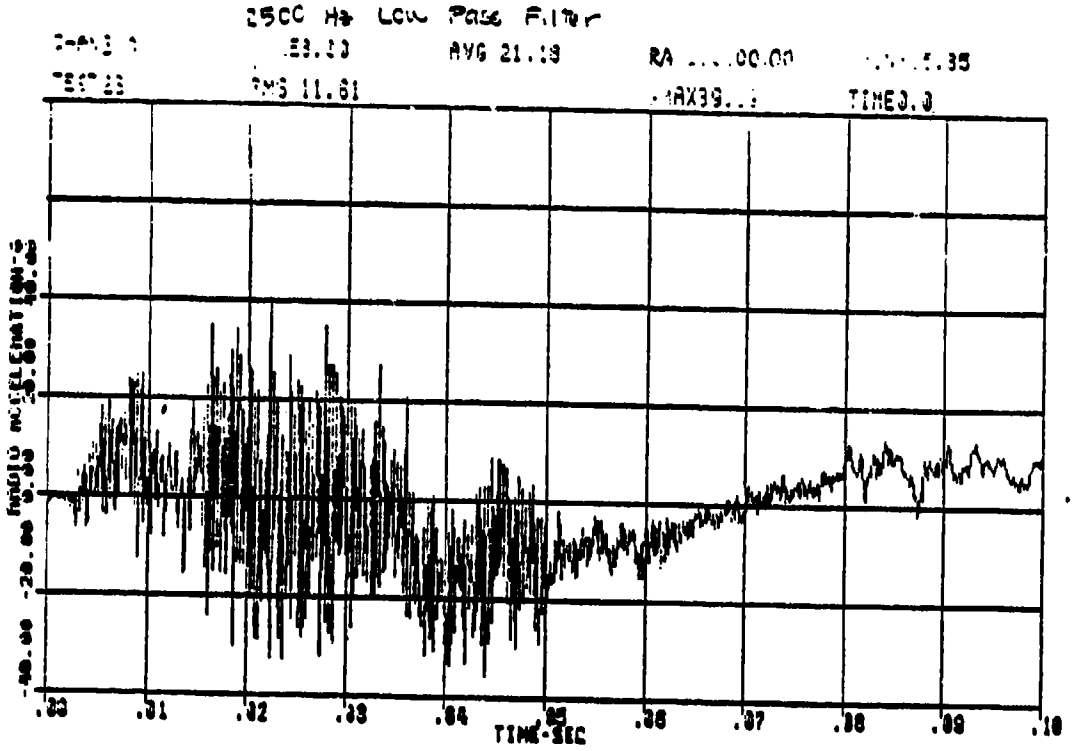

1500 Hz Low-Pass Filter
CHAN1.000
FILES.000
AVG 5689.878
RATE10000.020
XMIN-.379
TEST23.000
RMS .321
XMAX.861
TIME0.0
FORCE-KIPS
TIME-SEC

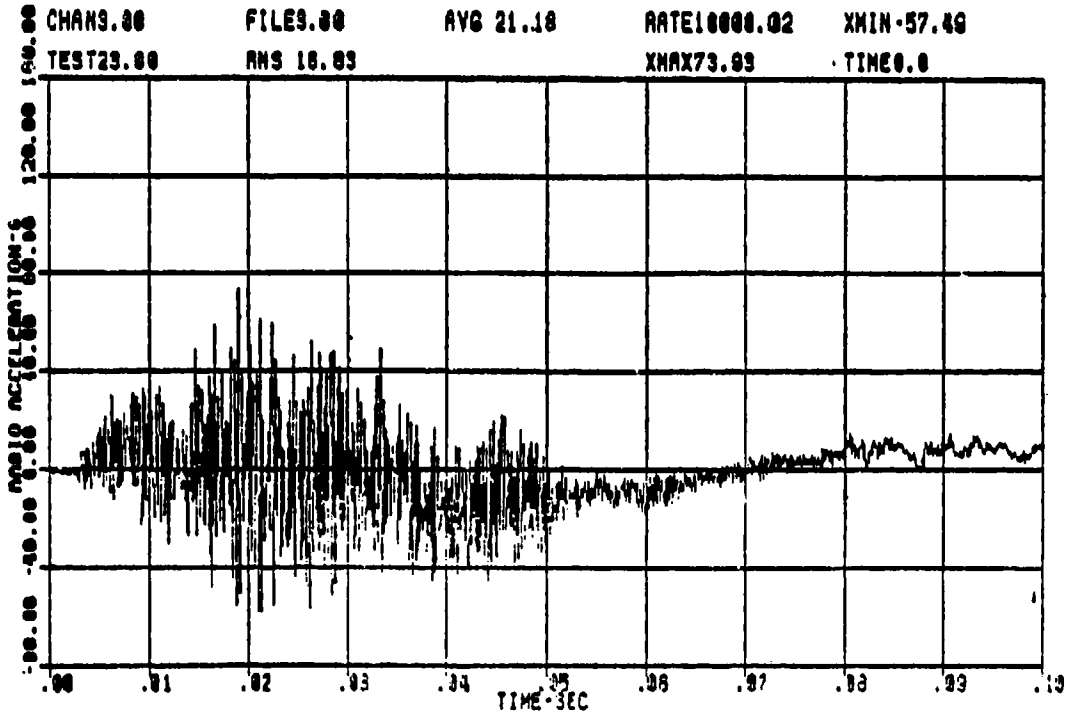

2500 Hz Low Pass Filter
CHAN2.00
FILE3.00
AVG -18.87
RATE10000.02
XMIN-685.73
TEST23.00
AMS 92.59
XMAX492.25
TIME0.0
FRAME ACCELERATION(X10^3)
TIME-SEC


3500 Hz Low Pass Filter
CHAN2.00
FILE3.00
AVG -18.87
XMIN-752.35
TEST23.00
AMS 119.96
TIME0.0
FRAME ACCELERATION(X10^3)
TIME-SEC

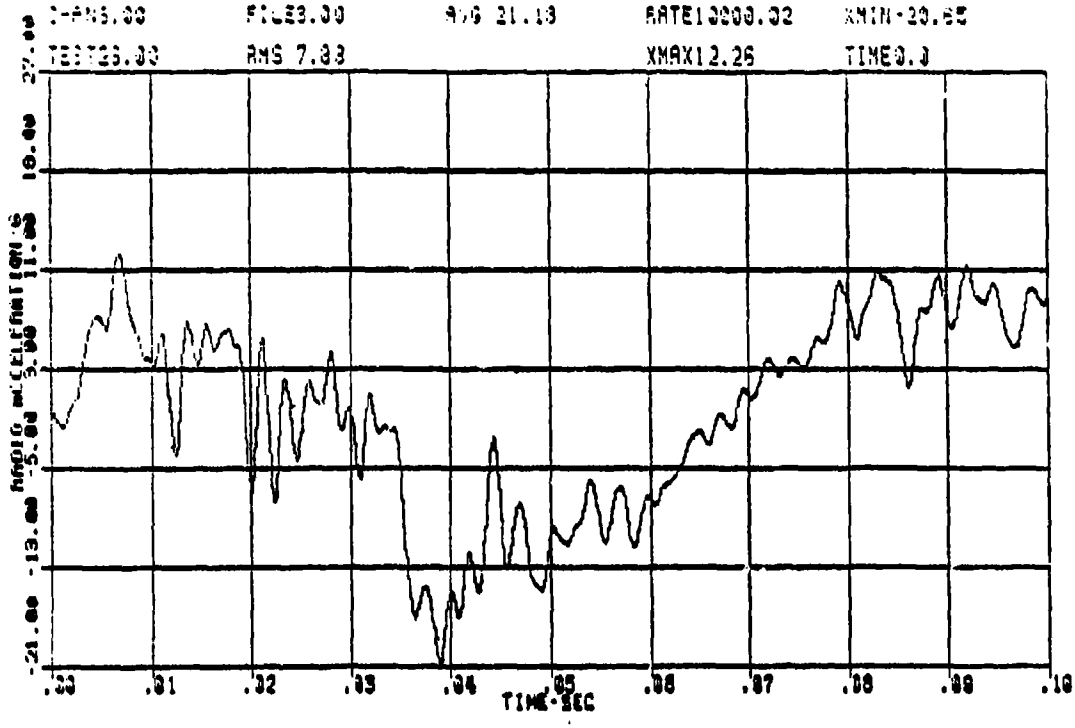

500 Hz Low Pass Filter
CHAN2.00
FILE3.00
AVG -18.87
RATE10000.02
XMIN-139.26
TEST23.00
RMS 91.31
XMAX139.95
TIME0.0
TIME-SEC


1500 Hz Low Pass Filter
CHAN2.00
FILE3.00
AVG -18.87
RATE10000.02
XMIN-348.08
TEST23.00
RMS 65.00
XMAX355.95
TIME0.0
TIME-SEC

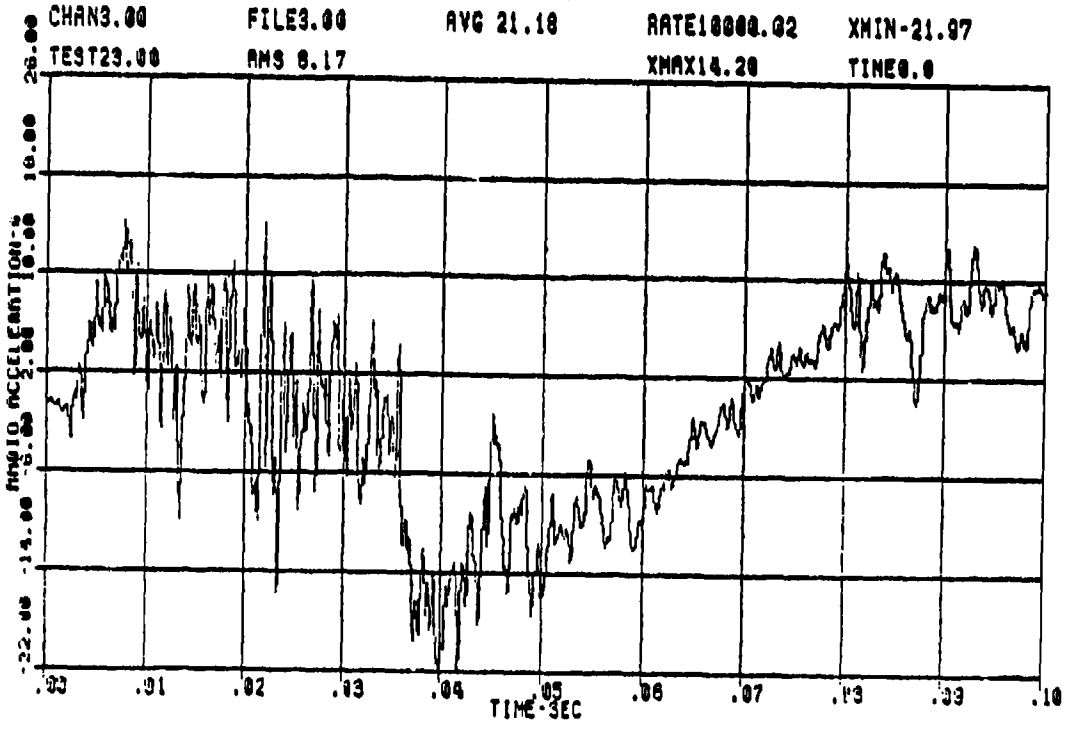

2500 Hz Low Pass Filter
AVG 21.18
RMS 11.61
TIME0.0
TIME-SEC


CHAN3.00
FILE3.00
AVG 21.18
RATE10000.02
XMIN-57.49
TEST23.00
RMS 16.03
XMAX73.99
TIME0.0
TIME-SEC

500 Hz Low Pass Filter

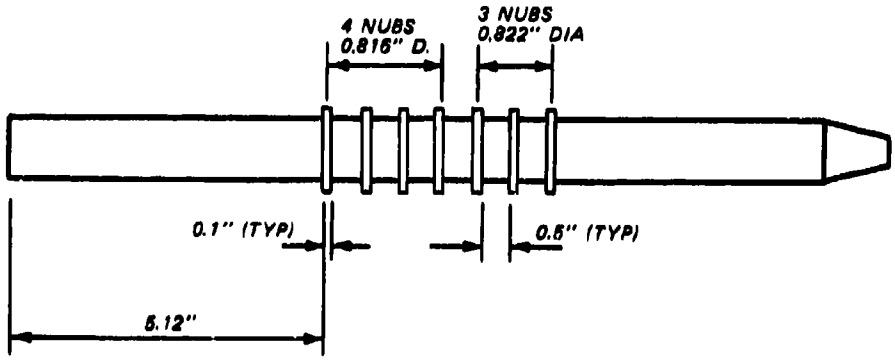


1500 Hz Low Pass Filter



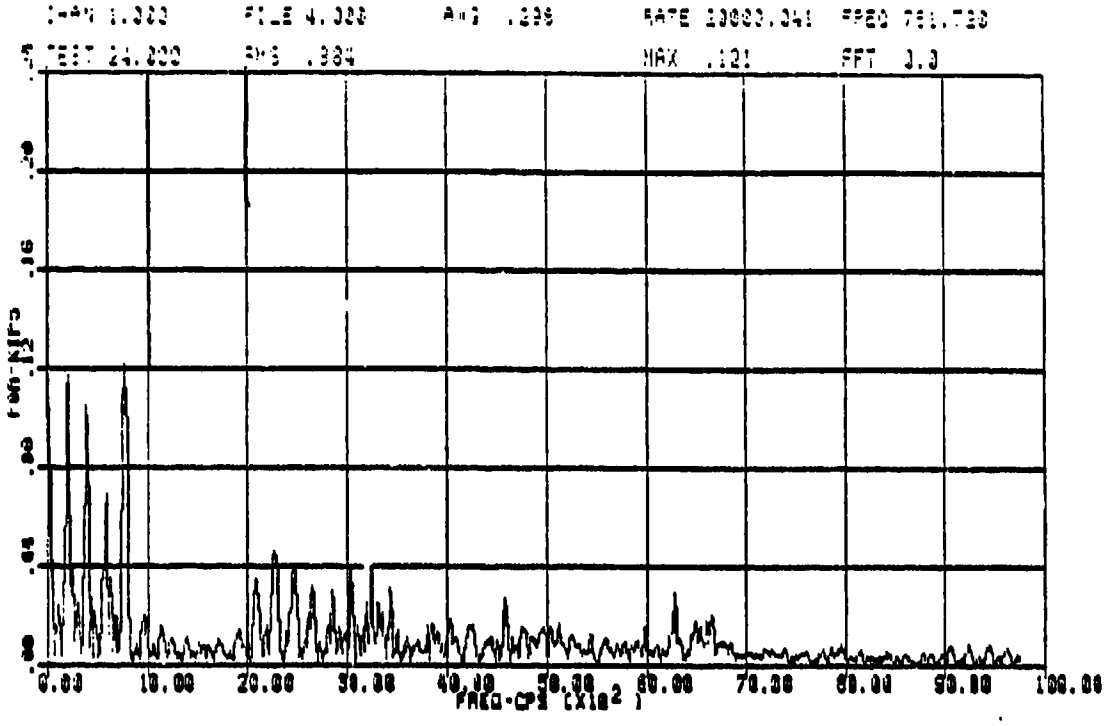
APPENDIX J: TEST 24 RESULTS

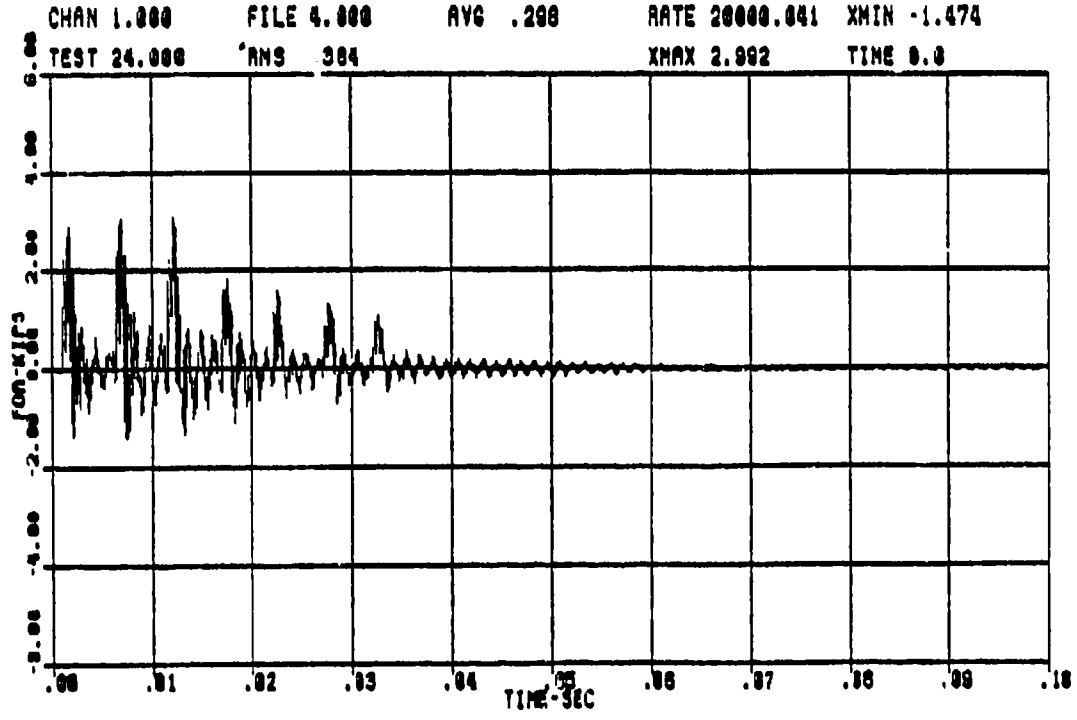
Test 24
Equipment Rack Soft-Mounted
AN/GRC-103 in Rack, Off-Line

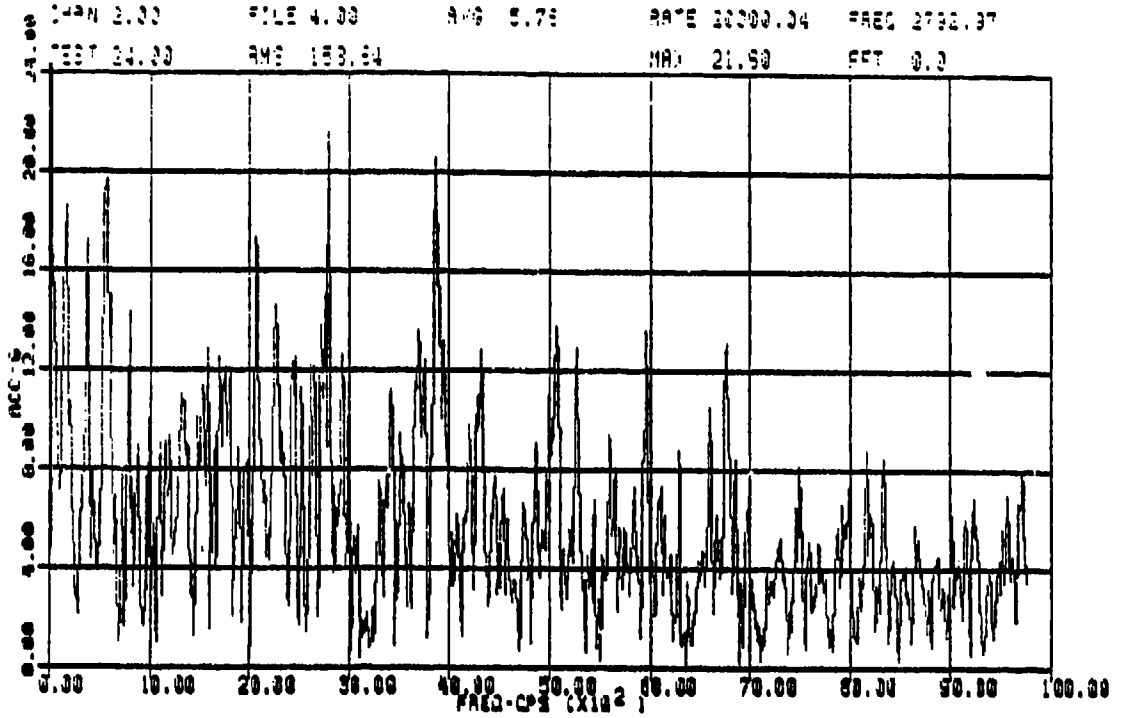


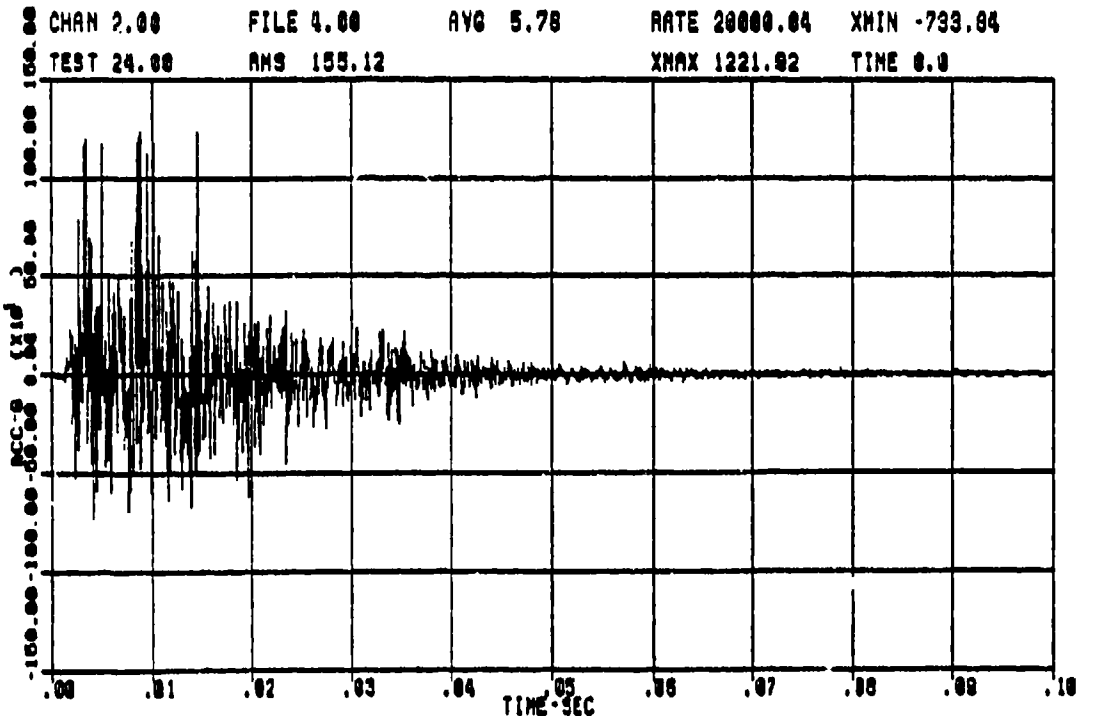
PULSE TRAIN - TEST 24

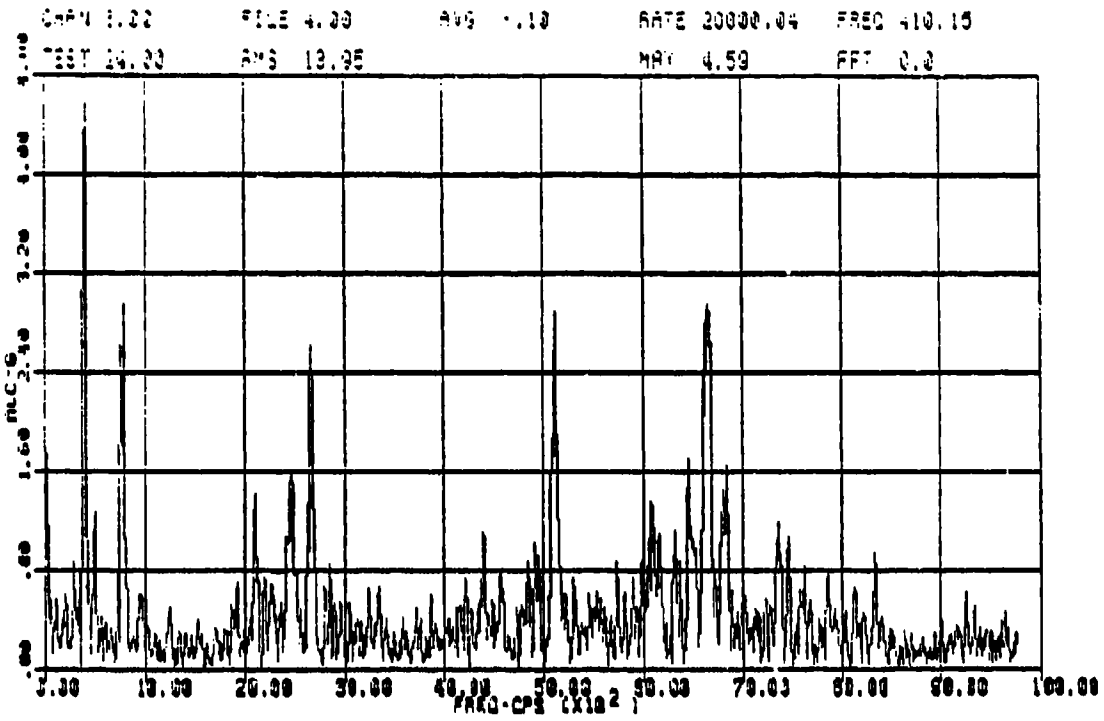
PRECHARGE PRESSURE = 1250 PSI
SYSTEM PRESSURE = 2000 PSI
FLOW CONTROL #6½
AIR BAG PRESSURE = 70 PSI

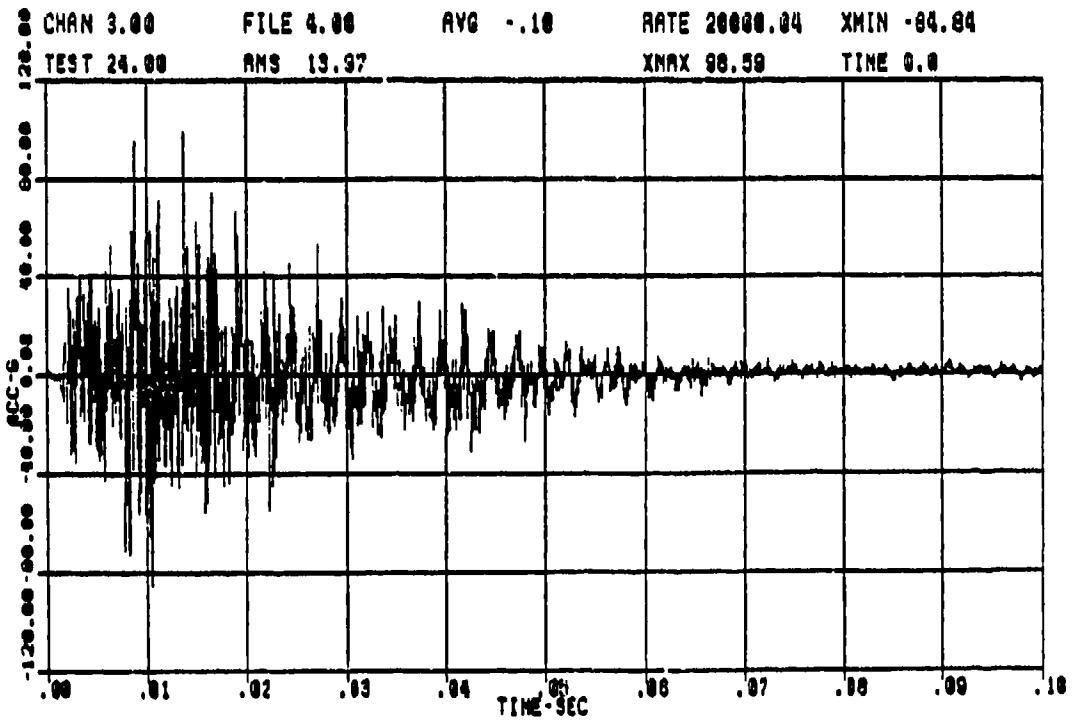

TEST 24.000
RMS .384
MAX .121
FFT 3.3
FREQ-CPI (X10^2)

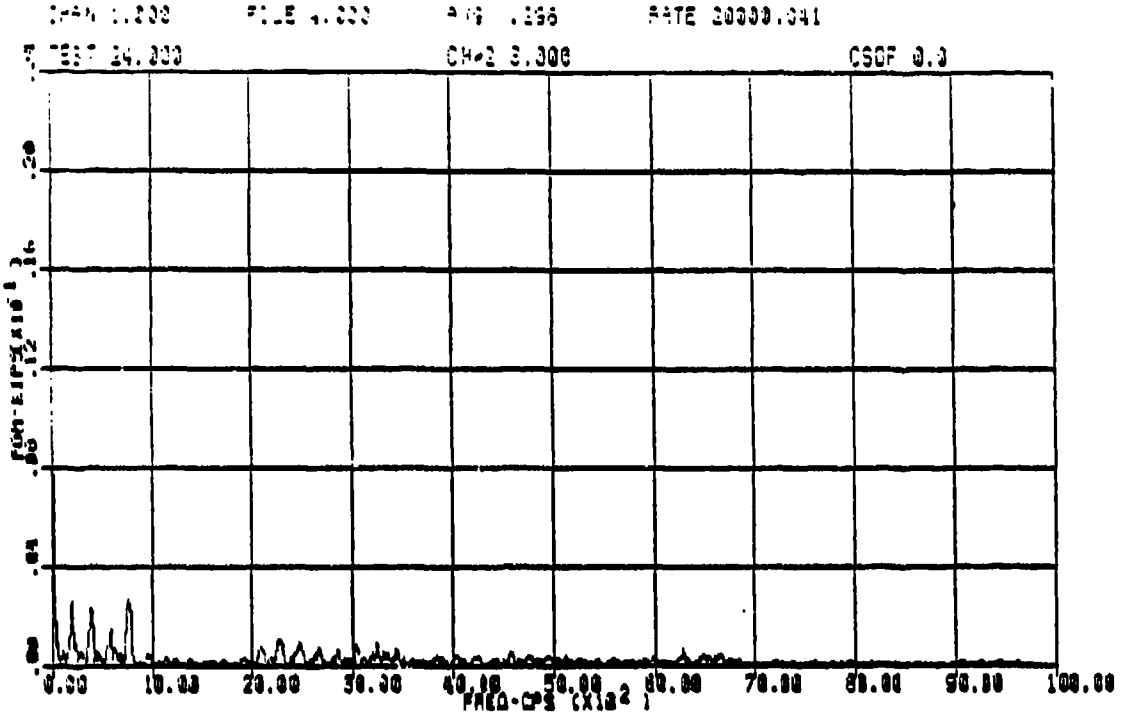

CHAN 1.000
FILE 4.000
AVG .200
RATE 20000.041
XMIN -1.474
TEST 24.000
RMS 384
XMAX 2.992
TIME 0.0
TIME-SEC

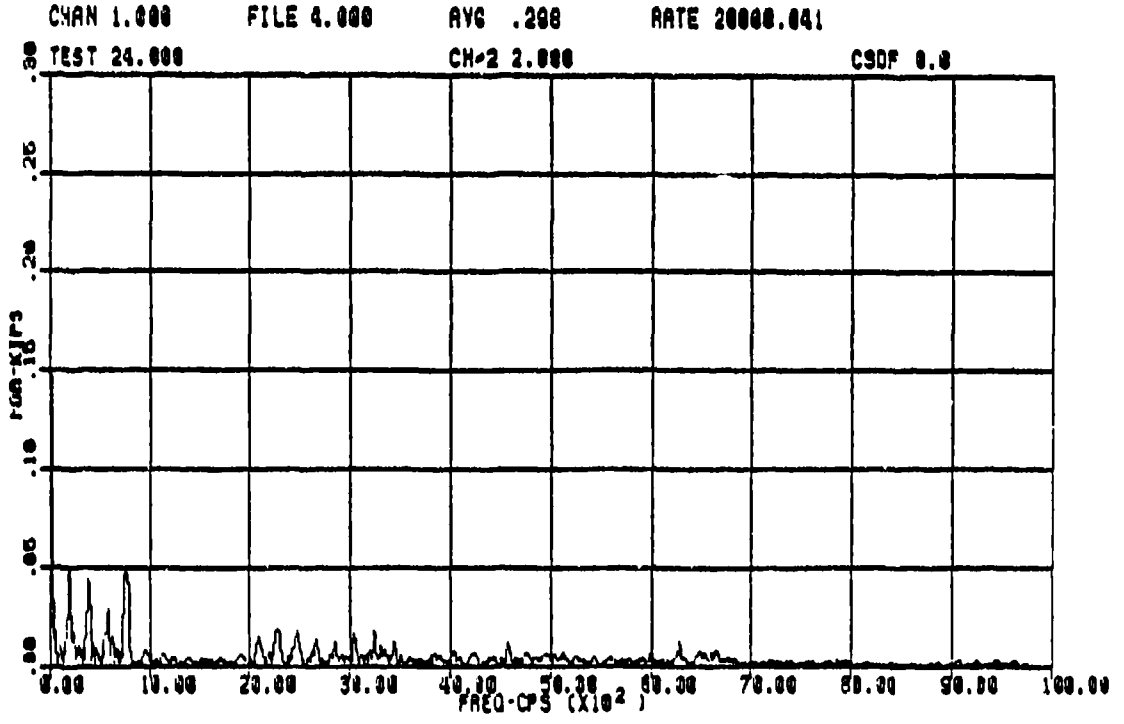

CHAN 2.00
FILE 4.00
AVG 5.78
RATE 20000.04
FREQ 2732.37
TEST 24.00
RMS 153.84
MAX 21.50
FFT 0.0
ACC-G
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
FREQ-CPS (X10^2)

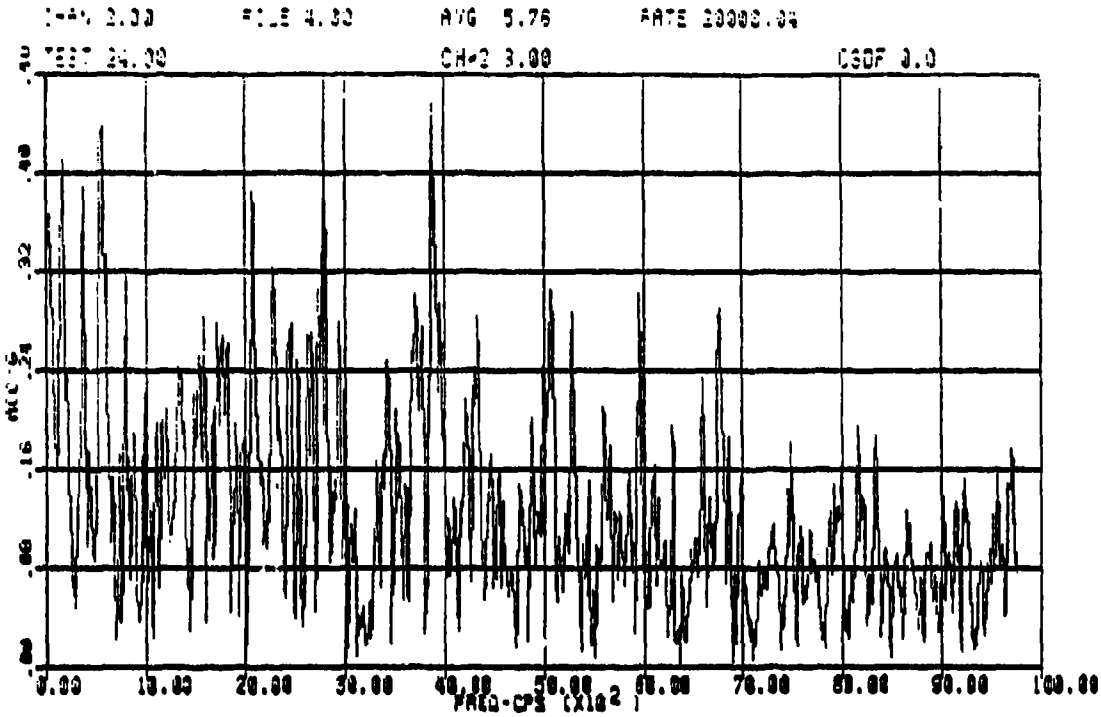

CHAN 2.00
FILE 4.00
AVG 5.78
RATE 20000.04
XMIN -733.84
TEST 24.00
RMS 155.12
XMAX 1221.92
TIME 0.0
ACC-G (X10^2)
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

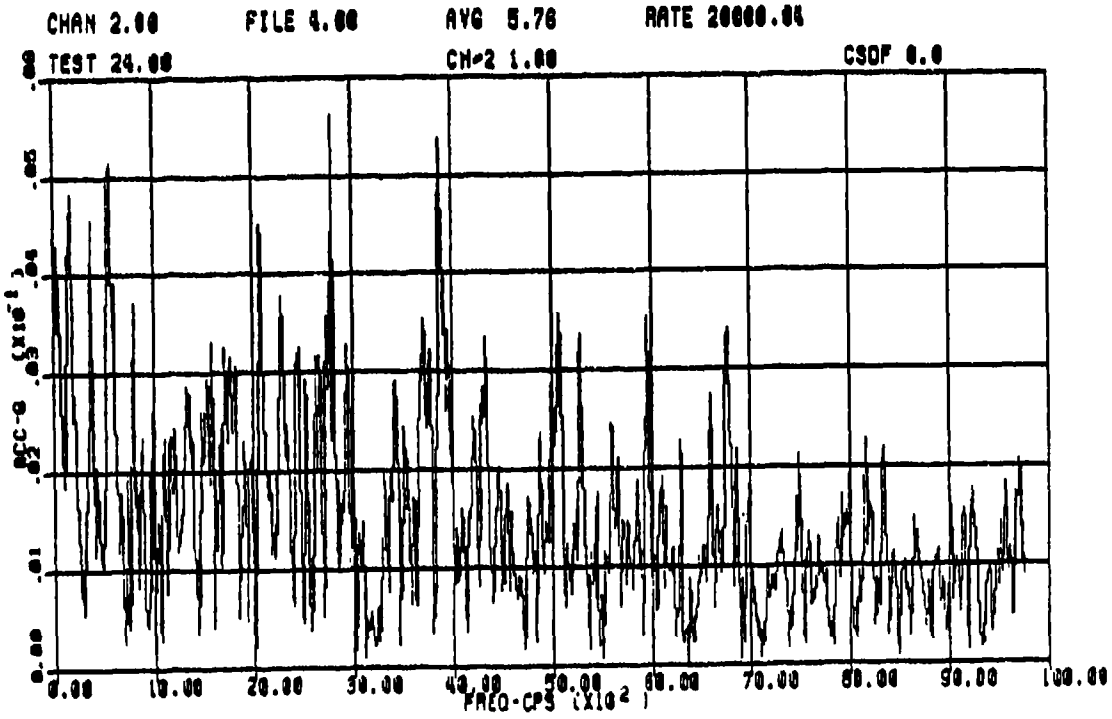

FILE 4.00
AVG -.10
RATE 20000.04
FREQ 410.15
RMS 13.95
MAX 4.59
FFT 0.0
ACC-G
FREQ-CPS (X10^2)

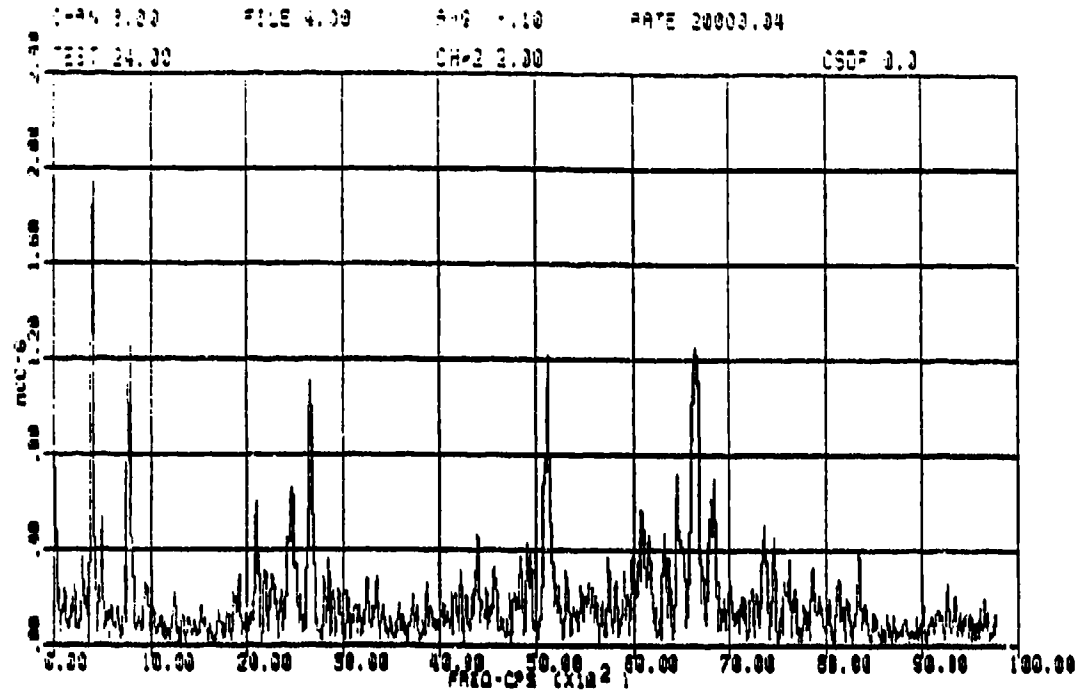

CHAN 3.00
FILE 4.00
AVG -.10
RATE 20000.04
XMIN -84.84
TEST 24.00
RMS 13.97
XMAX 98.59
TIME 0.0
ACC-G
TIME-SEC

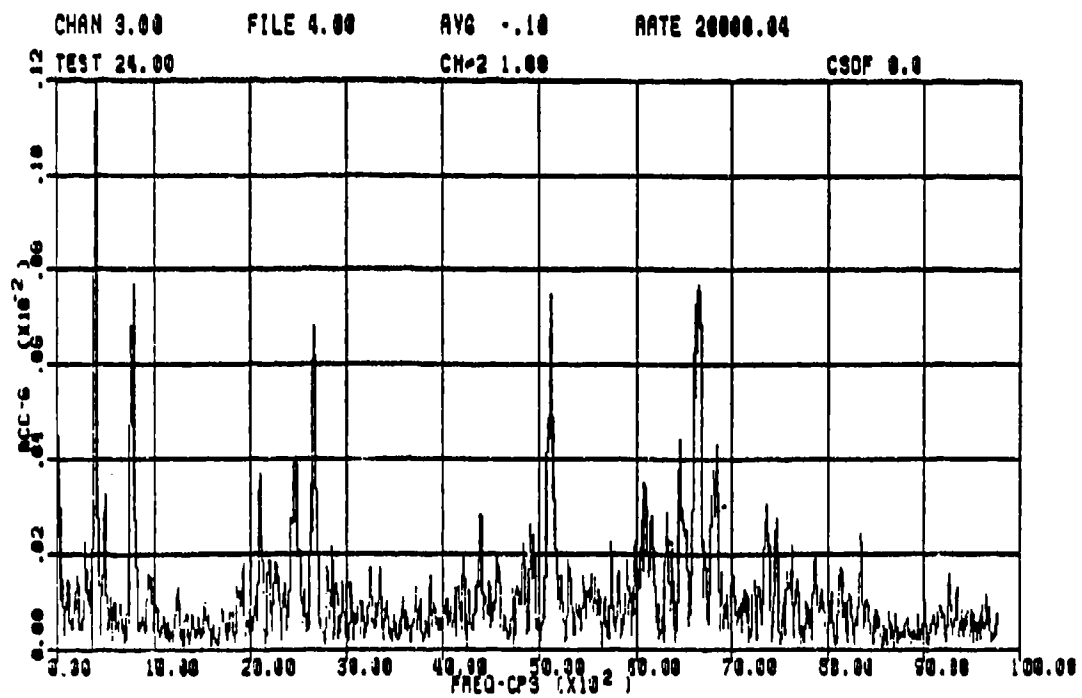

CSDF 0.0
FREQ-CPS (X10^2)

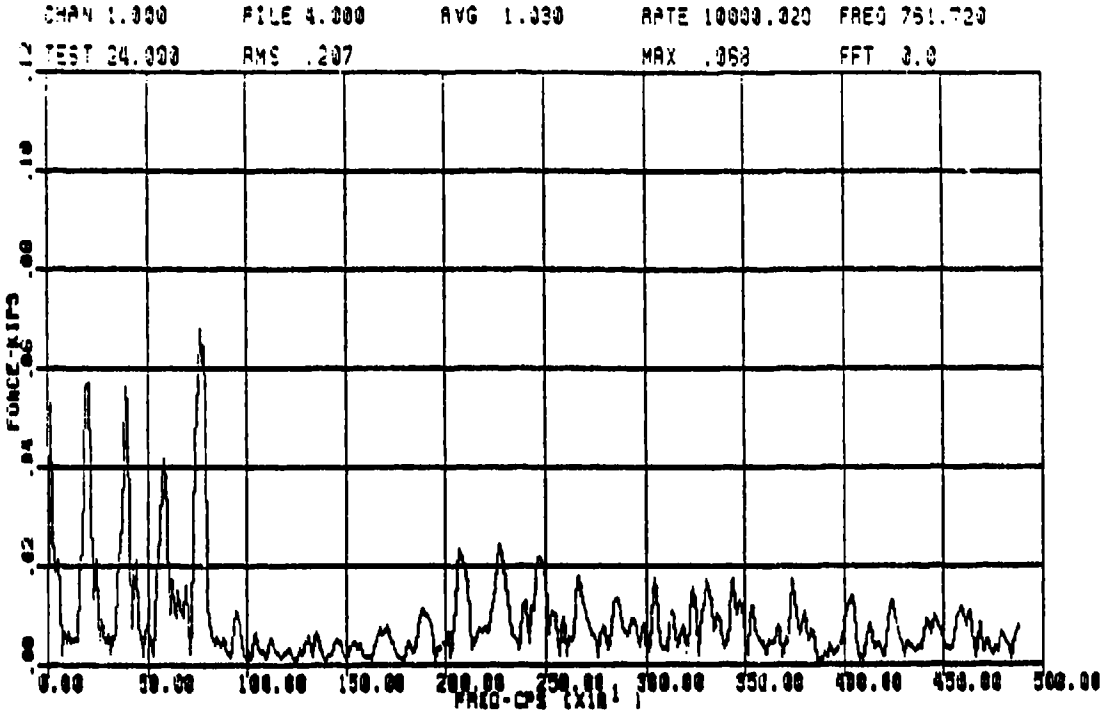

CHAN 1.000
FILE 4.000
AVG .298
RATE 20000.041
TEST 24.000
CH-2 2.000
CSDF 0.0
FREQ-CPS (X10^2)

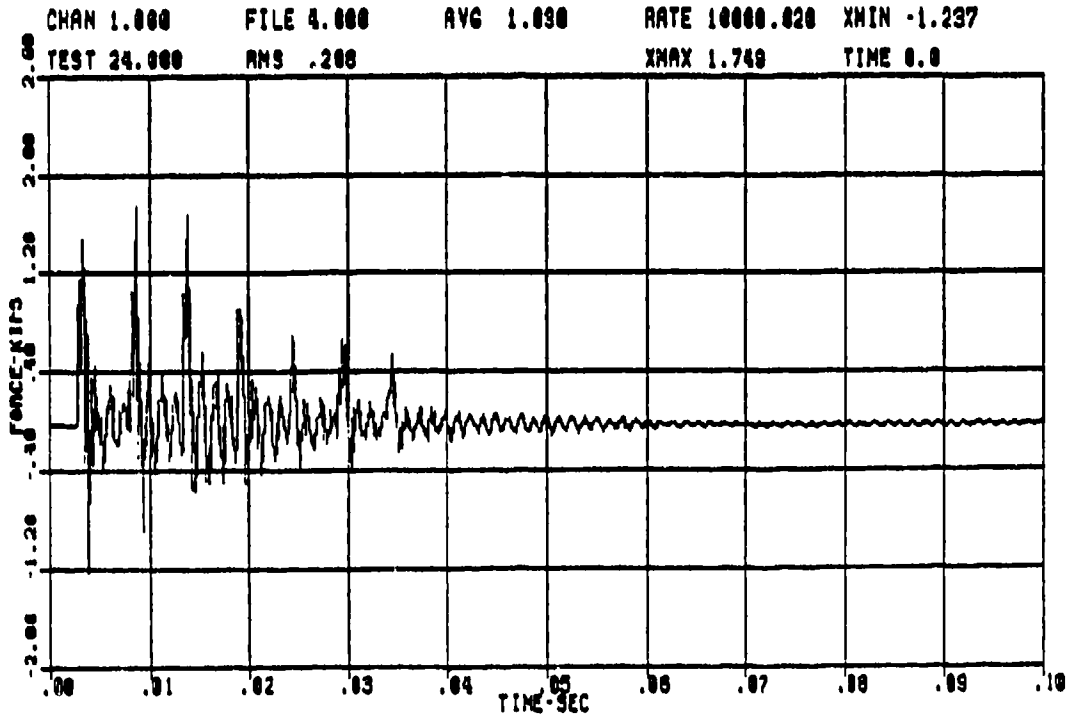

AVG 5.76
TEST 24.00
CH=2 3.00
FREQ-CPS (X10^2)

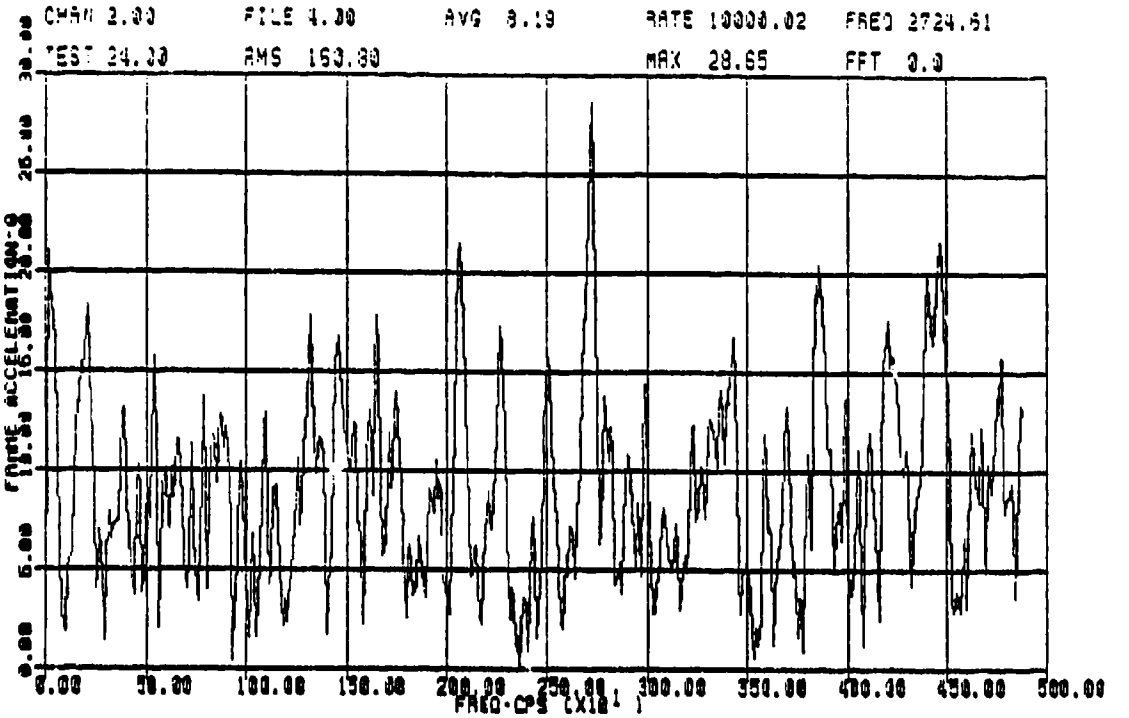

CHAN 2.00
FILE 4.00
AVG 5.76
RATE 20000.00
TEST 24.00
CH=2 1.00
CSOF 0.0
FREQ-CPS (X10^2)

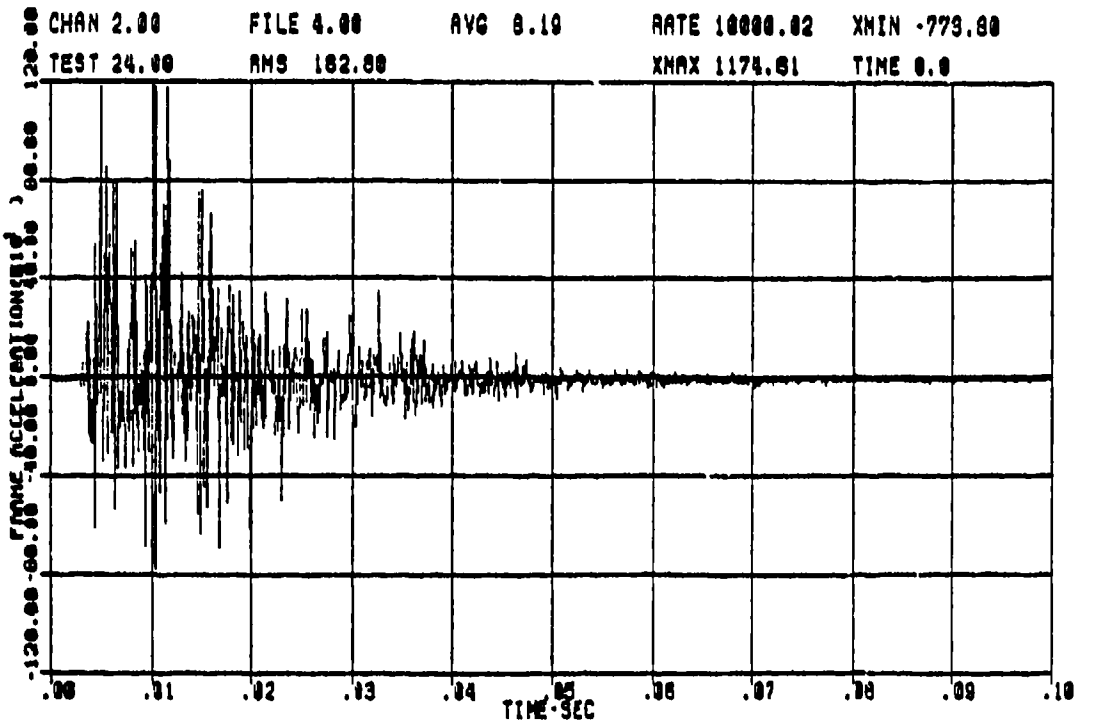

FILE 4.00
RATE 20000.04
TEST 24.00
CH=2 2.00
CSOF 0.0
FREQ-CPS (X10^2)

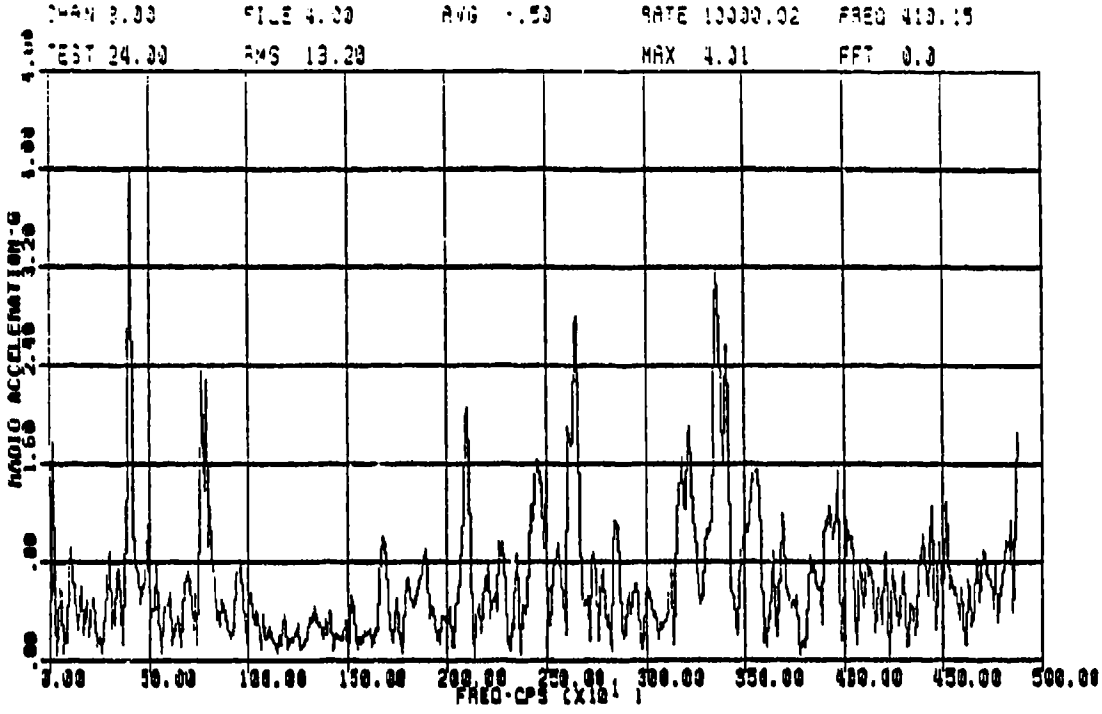

CHAN 3.00
FILE 4.00
AVG -.10
RATE 20000.04
TEST 24.00
CH=2 1.00
CSOF 0.0
FREQ-CPS (X10^2)

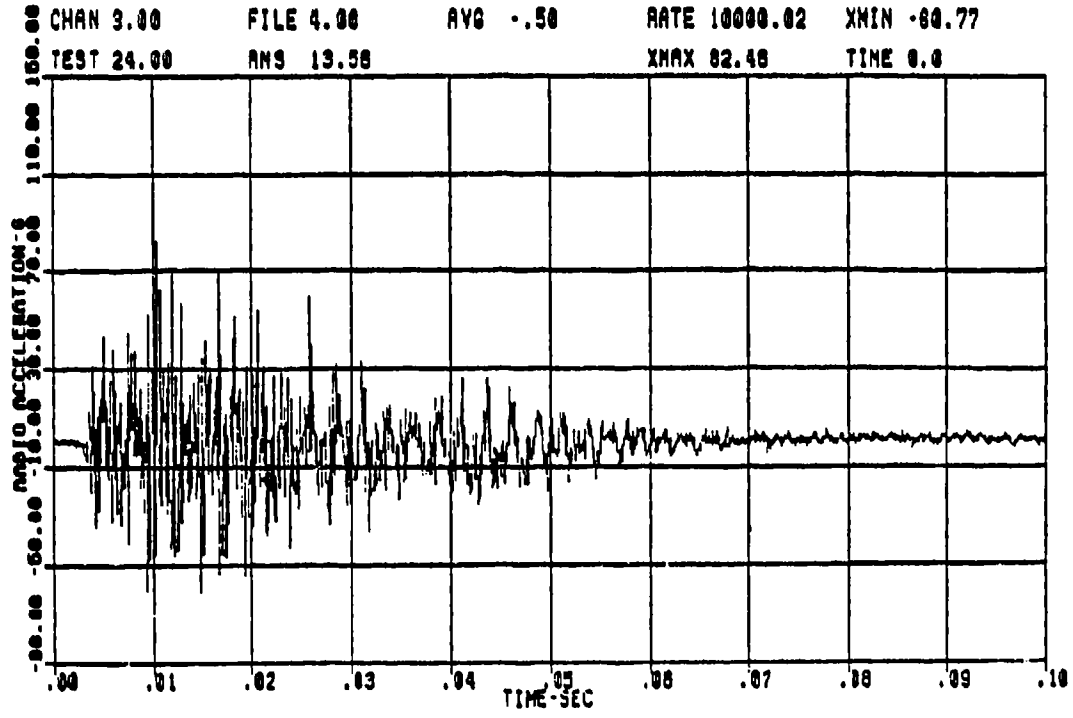

CHAN 1.000
FILE 4.000
AVG 1.000
RATE 10000.020
FREQ 751.720
TEST 24.000
RMS .207
MAX .868
FFT 3.0
FORCE-KIPS
.00
.02
.04
.06
.08
.10
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00
FREQ-CPS (X10)

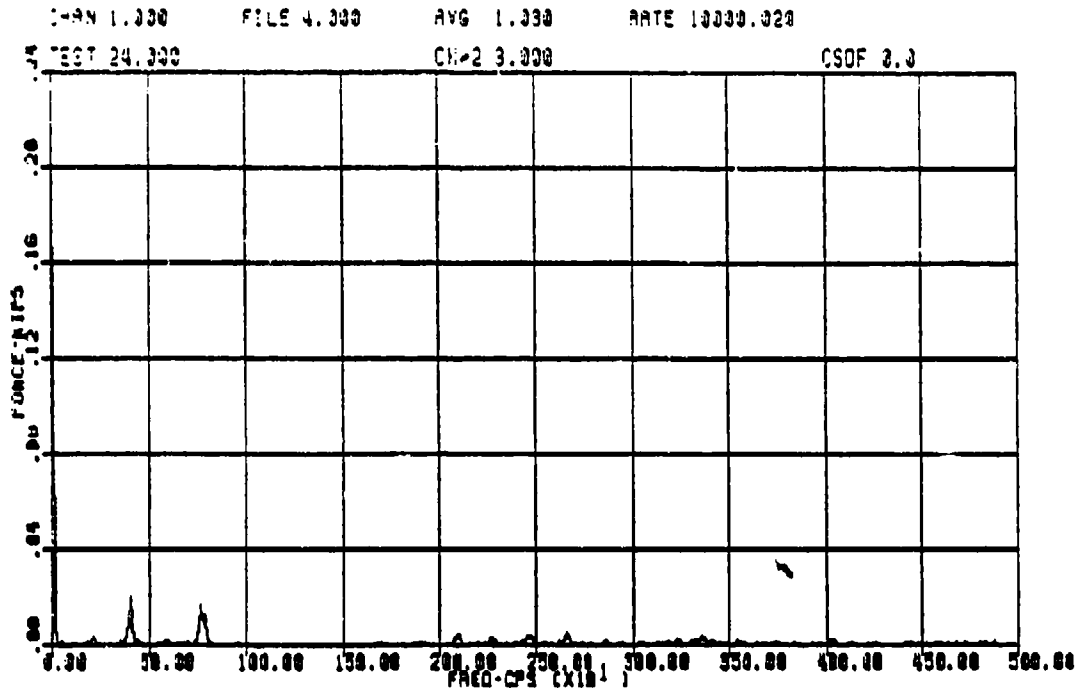

CHAN 1.000
FILE 4.000
AVG 1.000
RATE 10000.020
XMIN -1.237
TEST 24.000
RMS .208
XMAX 1.749
TIME 0.0
FORCE-KIPS
2.00
1.20
-.40
-1.20
-2.00
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

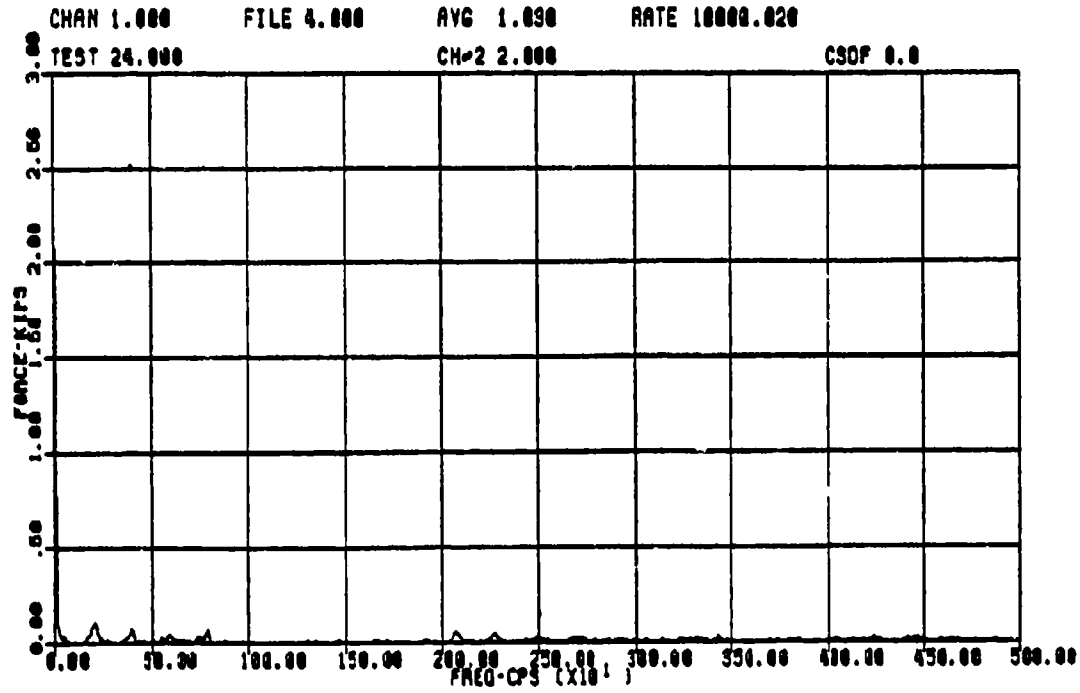

CHAN 2.00
FILE 4.00
AVG 8.19
RATE 10000.02
FREQ 2724.61
TEST 24.00
RMS 163.80
MAX 28.65
FFT 0.0
FREQ-CPS (X10)

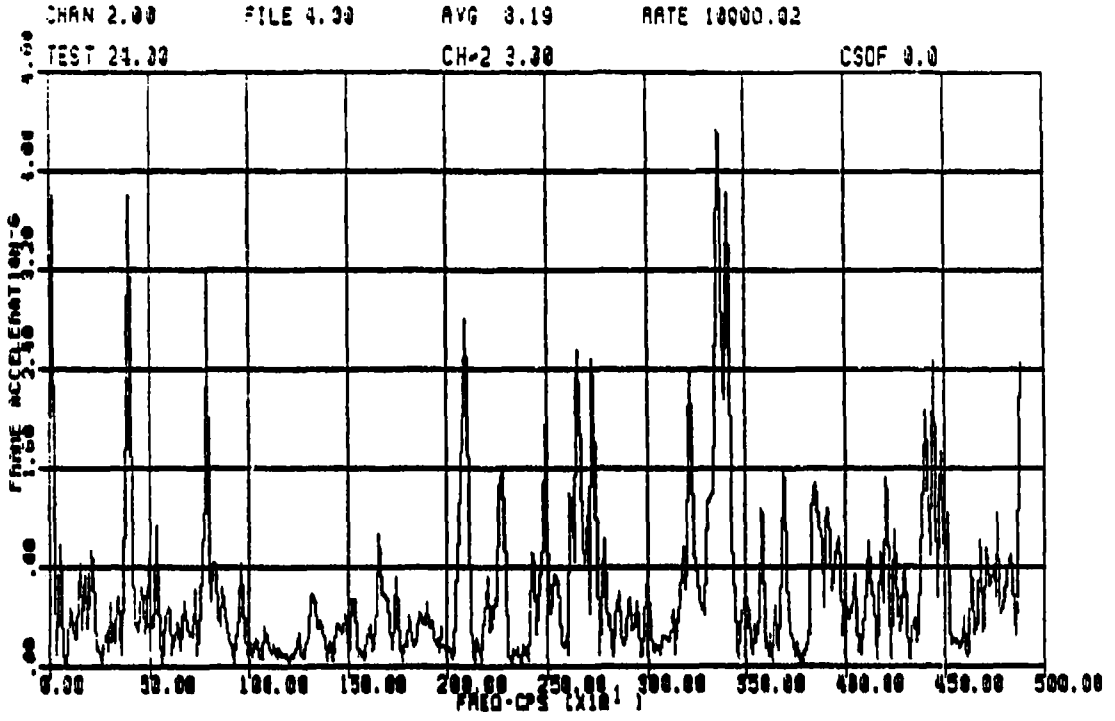

CHAN 2.00
FILE 4.00
AVG 8.19
RATE 10000.02
XMIN -779.00
TEST 24.00
RMS 162.80
XMAX 1174.61
TIME 0.0
TIME-SEC

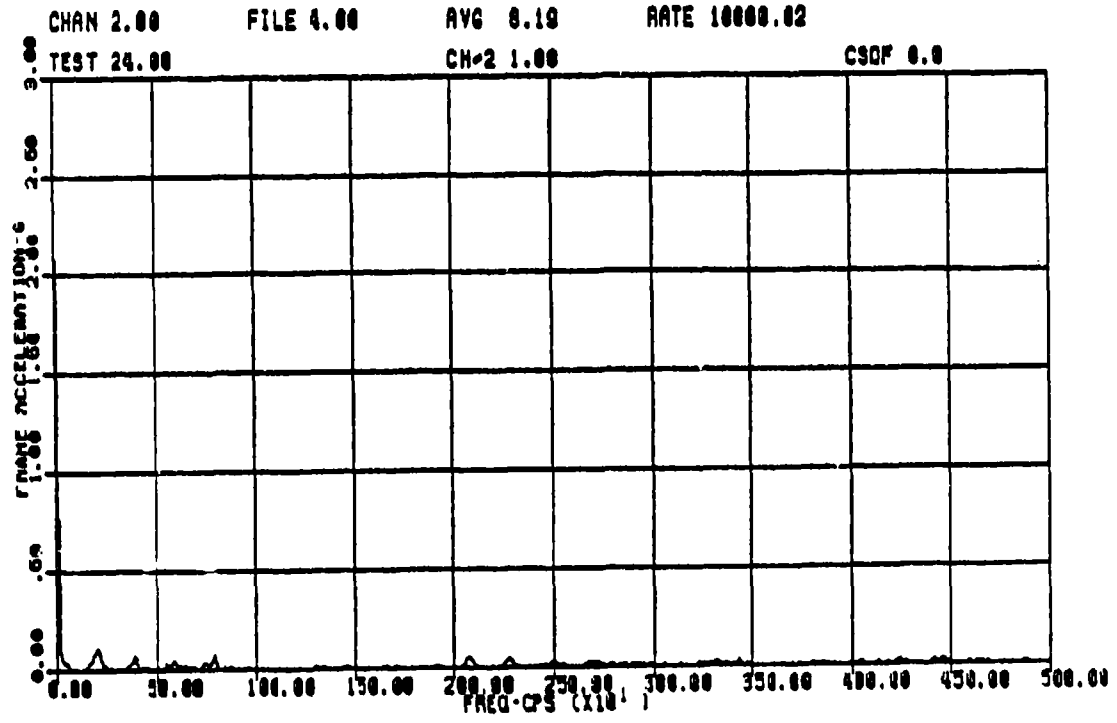

CHAN 3.00
FILE 4.00
AVG .50
RATE 10000.02
FREQ 413.15
TEST 24.00
RMS 13.20
MAX 4.31
FFT 0.0
RADIO ACCELERATION-G
FREQ-CPS (X10^1)

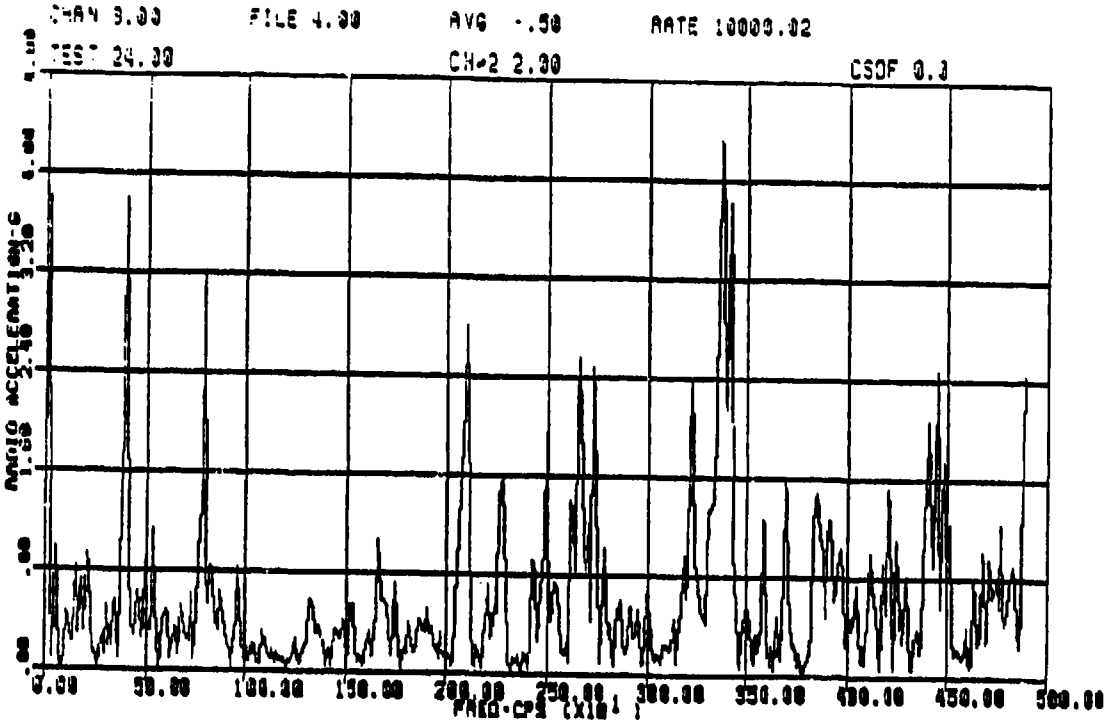

CHAN 3.00
FILE 4.00
AVG .50
RATE 10000.02
XMIN -60.77
TEST 24.00
RMS 13.58
XMAX 82.48
TIME 0.0
RADIO ACCELERATION-G
TIME-SEC

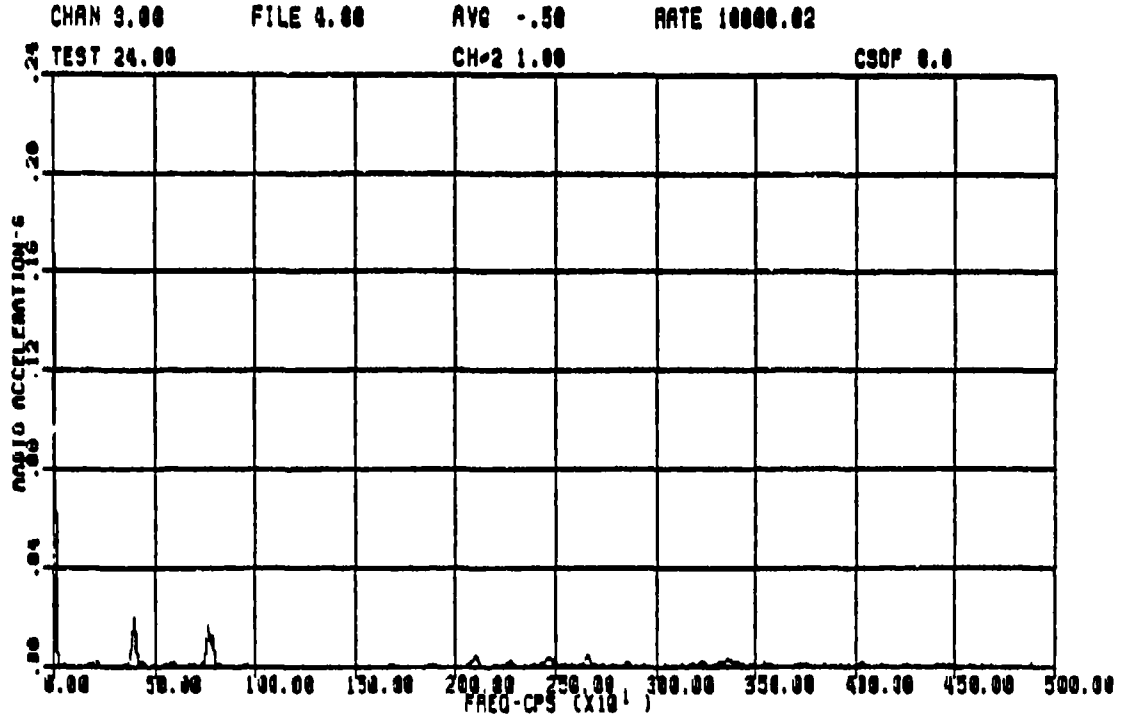

CHAN 1.000
FILE 4.000
AVG 1.000
RATE 10000.020
TEST 24.000
CH#2 3.000
CSOF 0.0
FORCE-KIPS
.20
.16
.12
.08
.04
.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00
FREQ-CPS (x10¹)

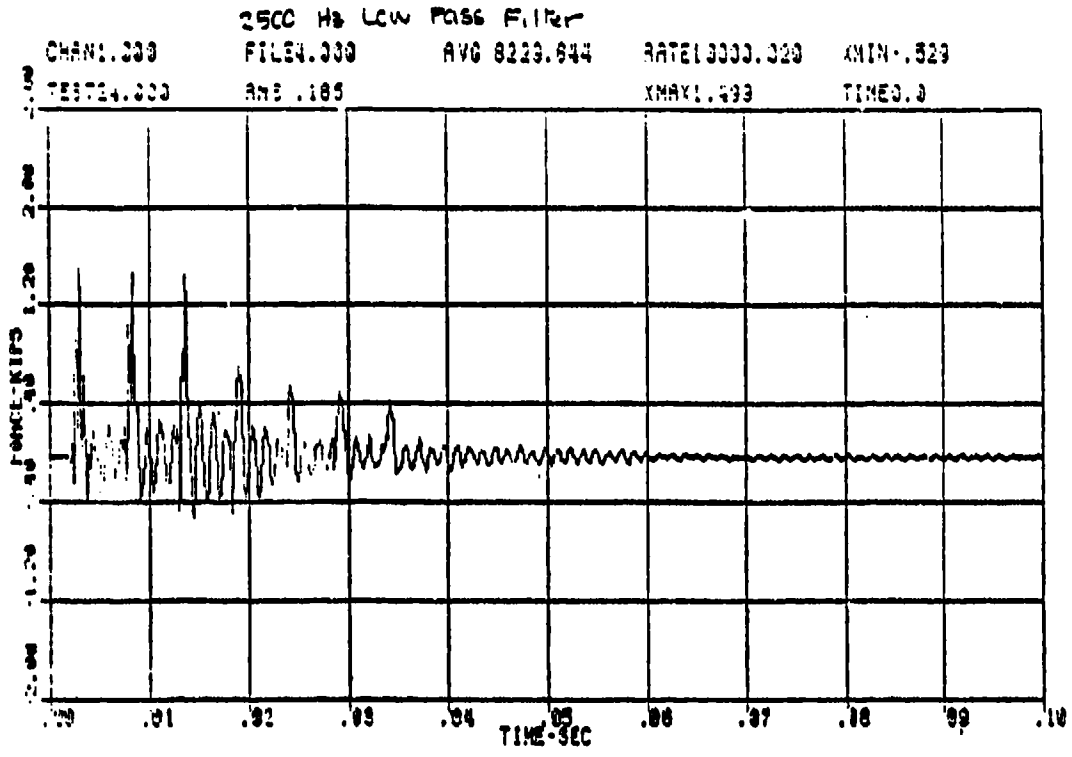

CHAN 1.000
FILE 4.000
AVG 1.000
RATE 10000.020
TEST 24.000
CH#2 2.000
CSOF 0.0
FORCE-KIPS
3.00
2.50
2.00
1.50
1.00
.50
0.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00
FREQ-CPS (x10¹)

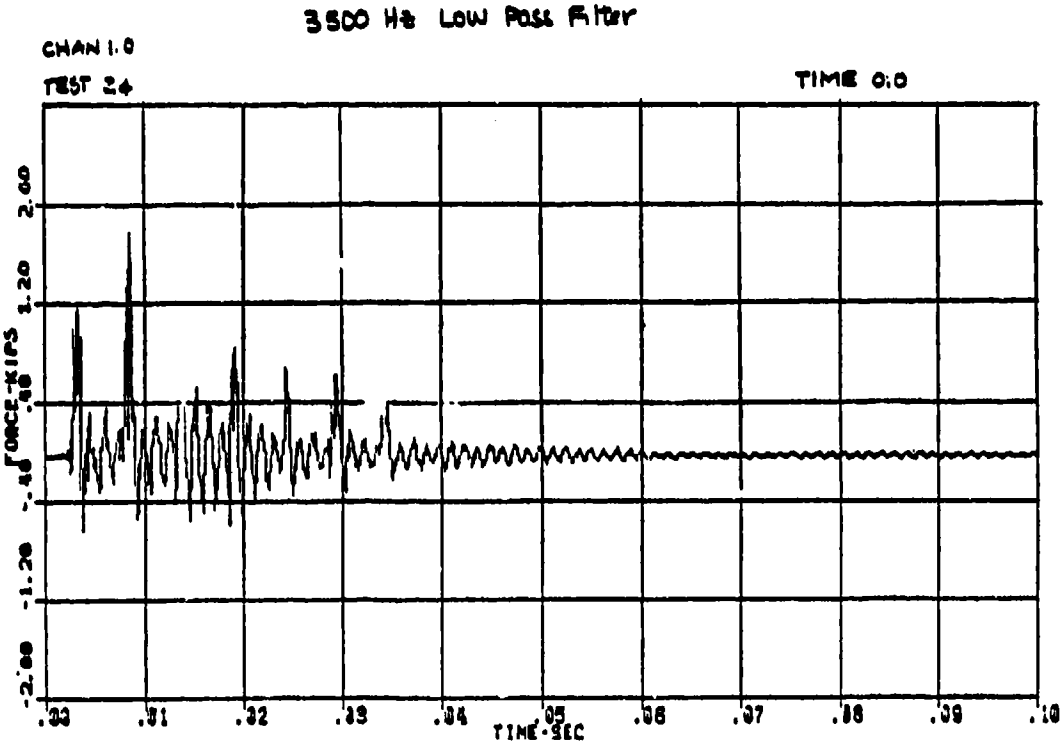

CHAN 2.00
FILE 4.00
AVG 8.19
RATE 10000.02
TEST 24.00
CH-2 3.00
CSOF 0.0
FRAME ACCELERATION
FREQ-CPS (X10¹)

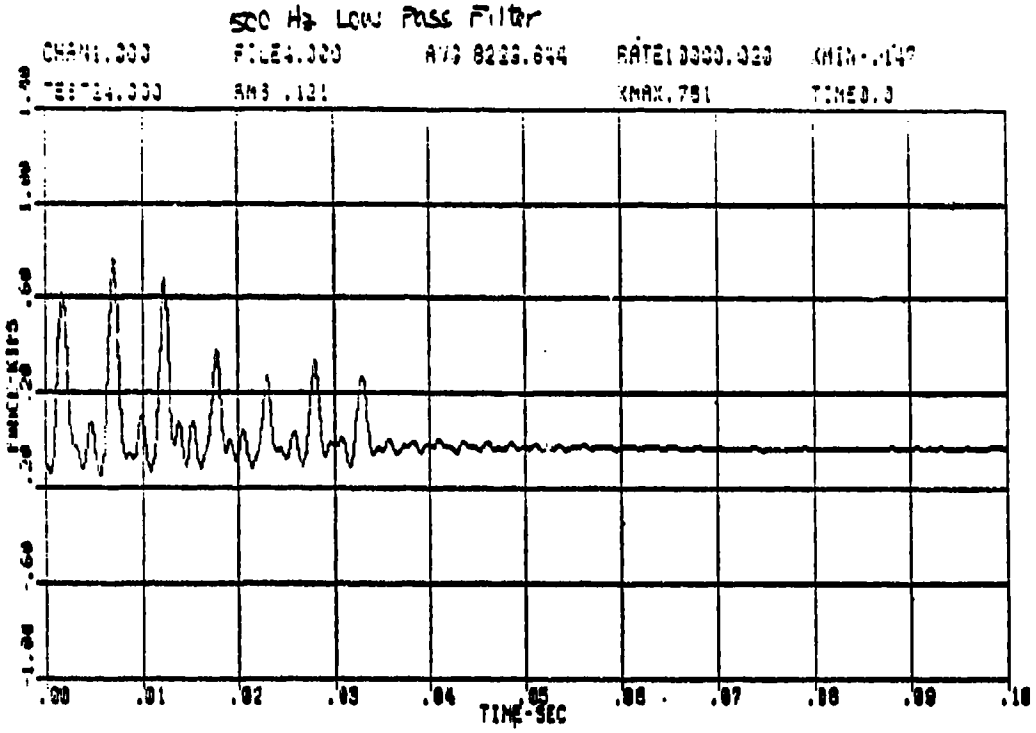

CHAN 2.00
FILE 4.00
AVG 8.19
RATE 10000.02
TEST 24.00
CH-2 1.00
CSOF 0.0
FRAME ACCELERATION
FREQ-CPS (X10¹)

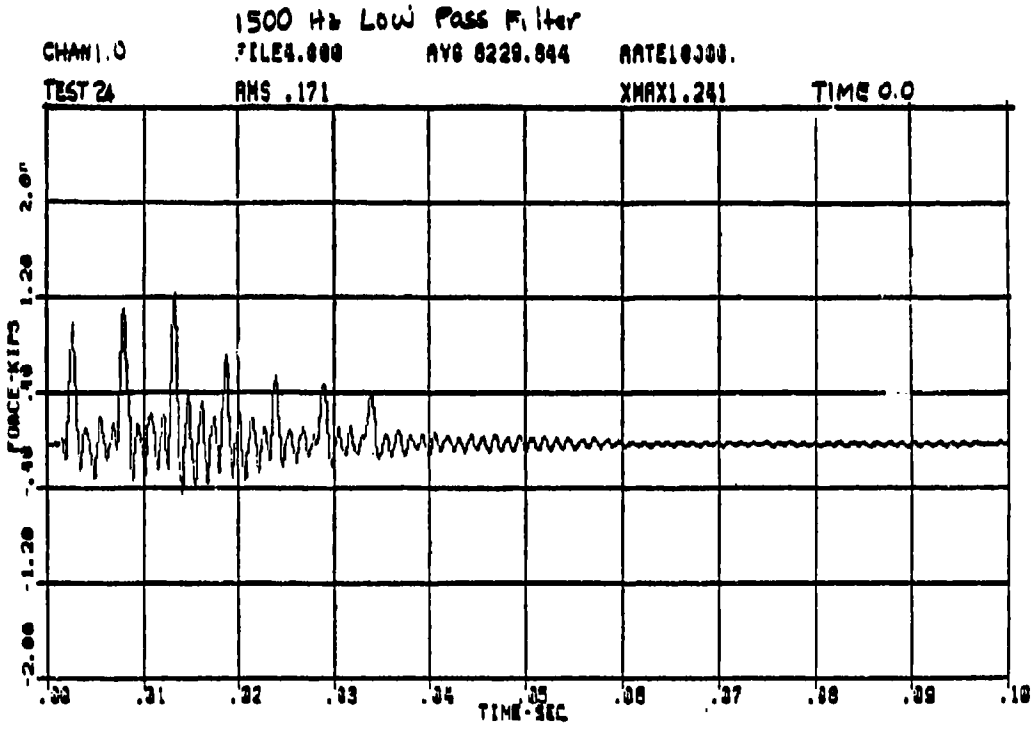

CHAN 3.00
FILE 4.00
AVG -.50
RATE 10000.02
TEST 24.00
CH-2 2.00
CSOF 0.3
FREQ-CPS (X10¹)

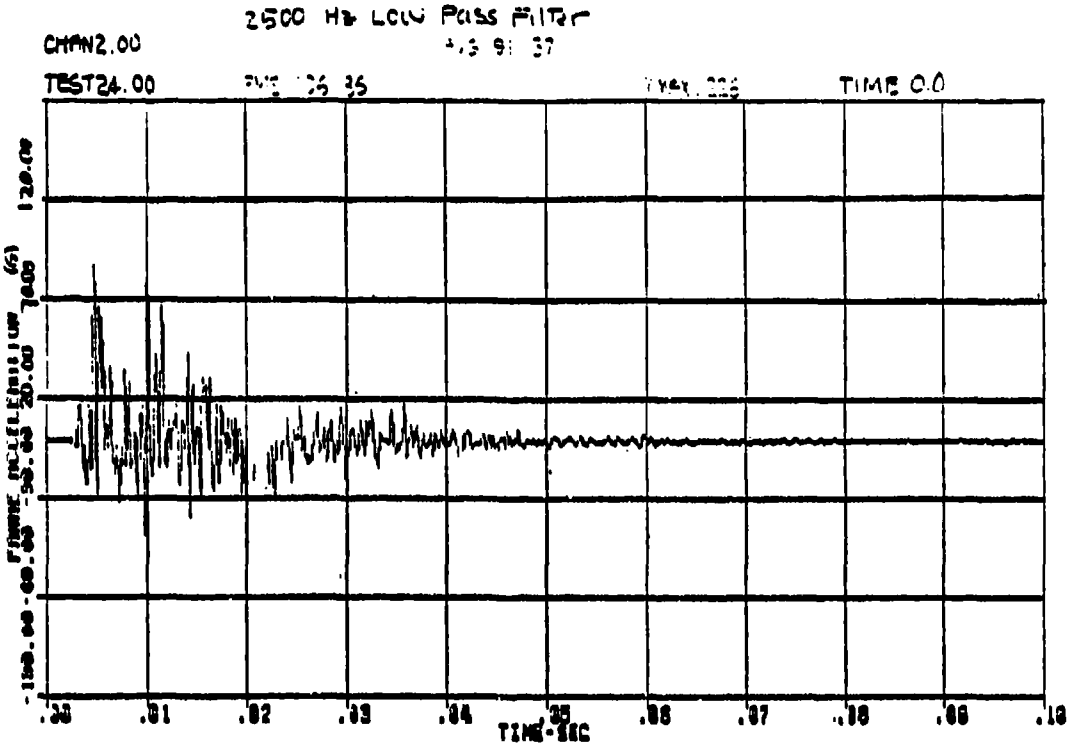

CHAN 3.00
FILE 4.00
AVG -.50
RATE 10000.02
TEST 24.00
CH-2 1.00
CSOF 0.0
FREQ-CPS (X10¹)

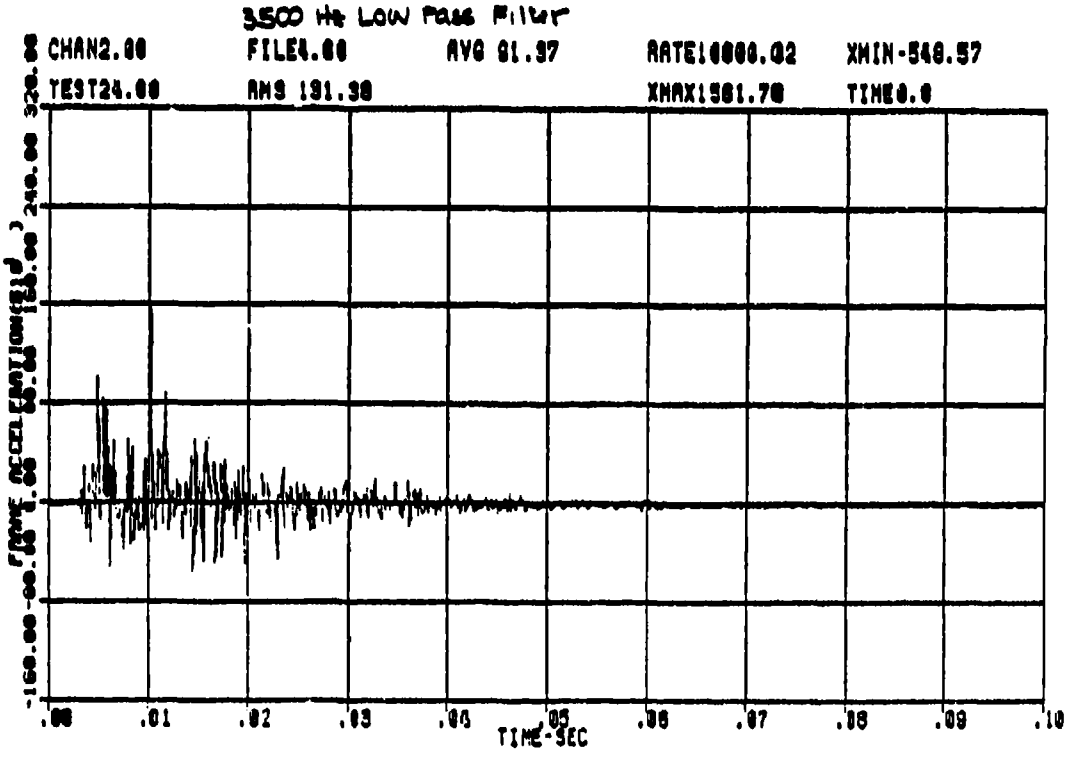

2500 Hz Low Pass Filter
CHAN1.000
FILE4.000
AVG 8223.644
RATE13333.328
XMIN-.529
TEST24.000
RMS .185
XMAX1.493
TIME0.0
FORCE-KIPS
2.00
1.20
.40
-.40
-1.20
-2.00
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC


3500 Hz Low Pass Filter
CHAN 1.0
TEST 24
TIME 0.0
FORCE-KIPS
2.00
1.20
.40
-.40
-1.20
-2.00
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
TIME-SEC

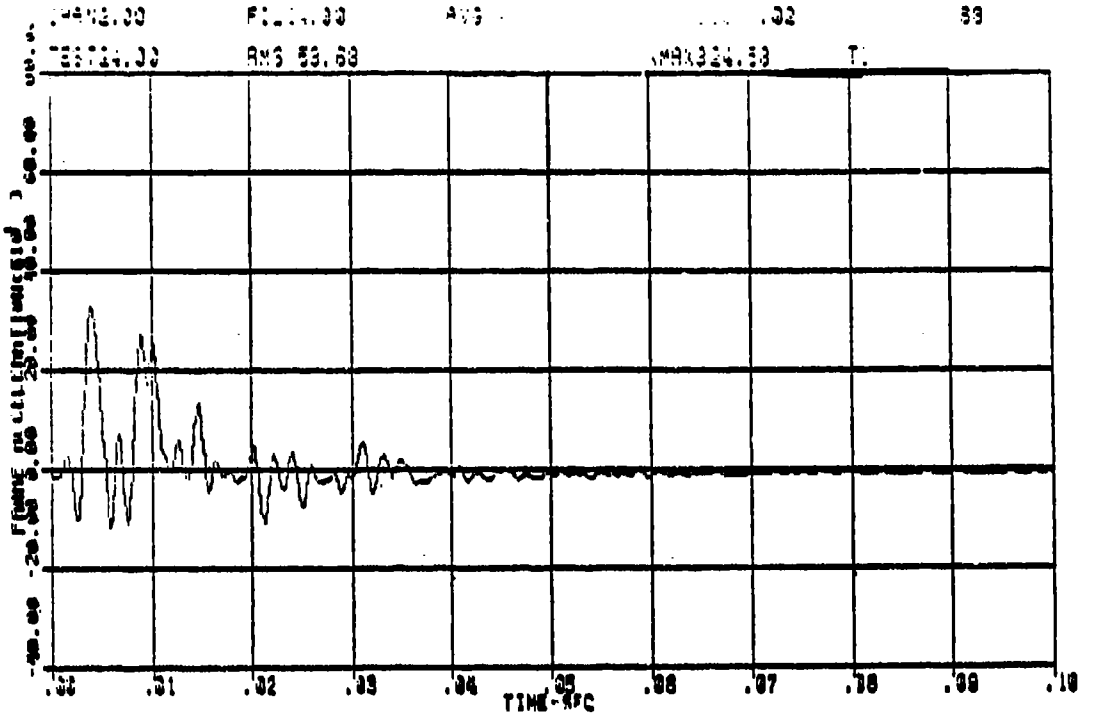

500 Hz Low Pass Filter
CHAN1.000
FILE4.000
AVG 8228.844
RATE10000.000
XMIN-.140
TEST24.000
RMS .121
XMAX.791
TIME0.0
FORCE-KIPS
TIME-SEC


1500 Hz Low Pass Filter
CHAN1.0
FILE4.000
AVG 8228.844
RATE10000.
TEST 24
RMS .171
XMAX1.241
TIME 0.0
FORCE-KIPS
TIME-SEC

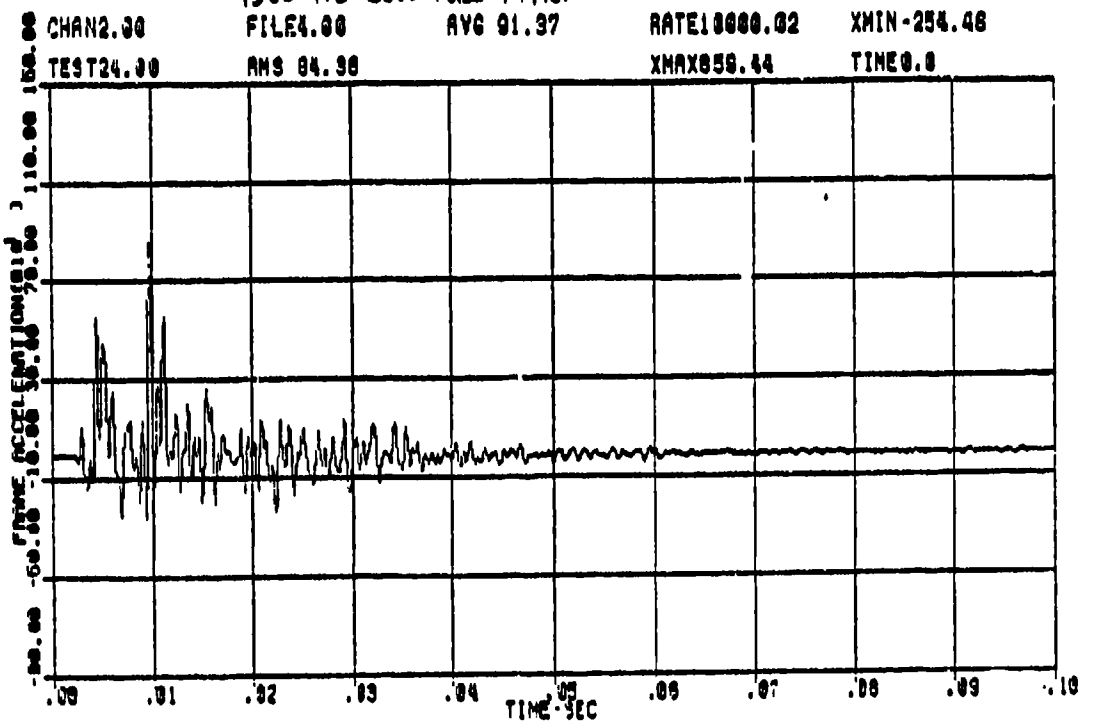

2500 Hz LOW Pass Filter
CHAN2.00
TEST24.00
TIME 0.0
TIME-SEC

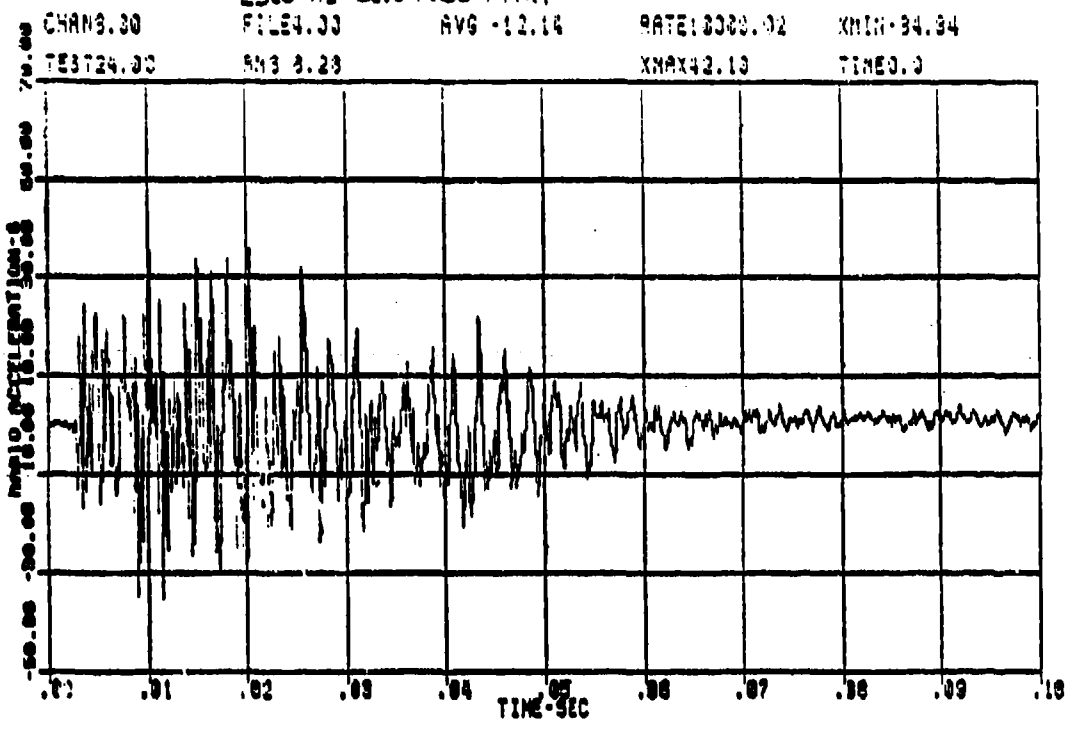

3500 Hz Low Pass Filter
CHAN2.00
FILE4.00
AVG 81.97
RATE16000.02
XMIN-548.57
TEST24.00
RMS 191.38
XMAX1981.78
TIME0.0
TIME-SEC

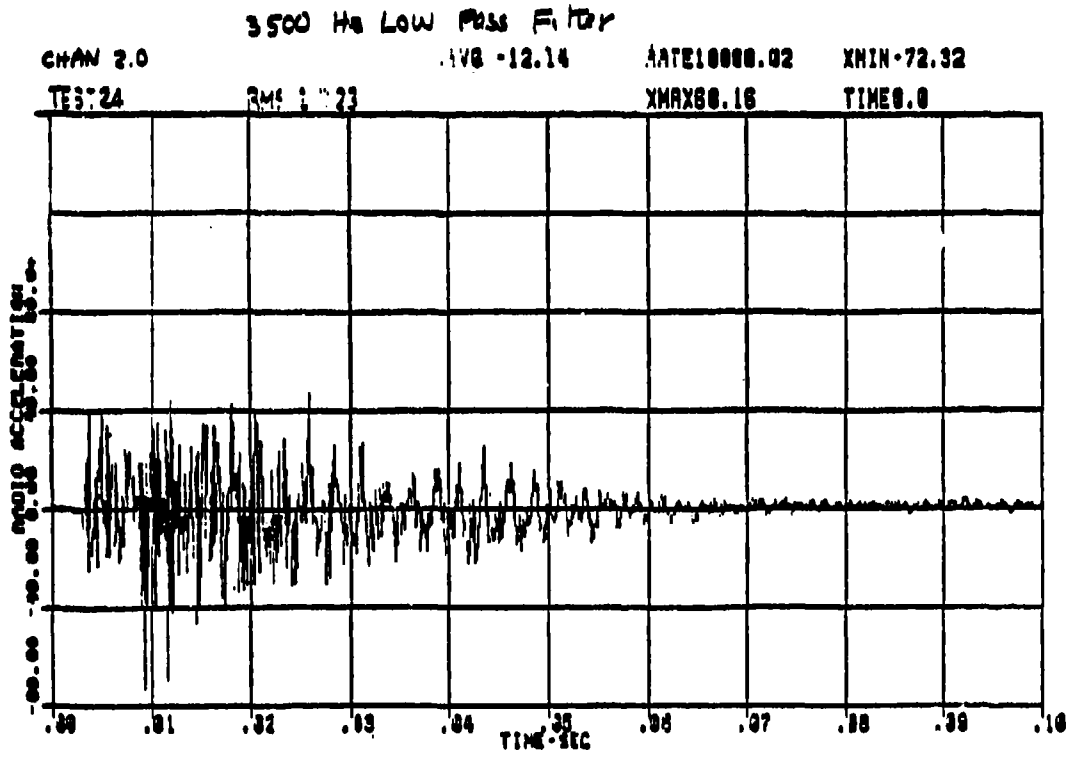
500 Hz Low Pass Filter

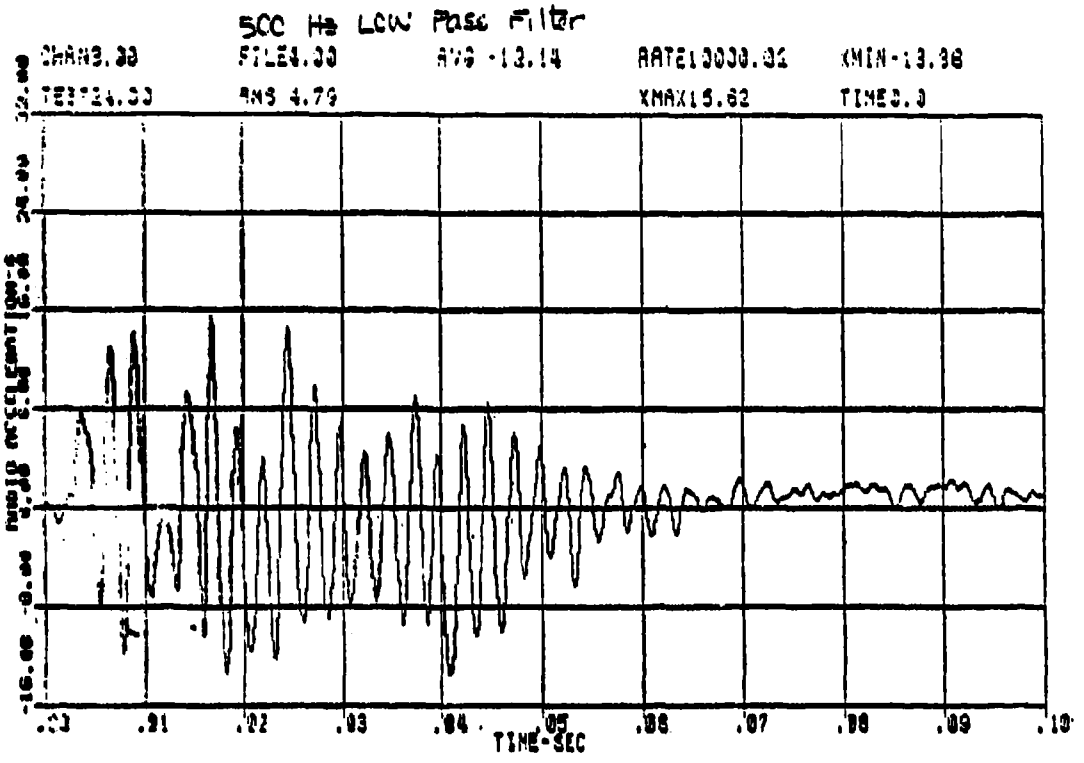


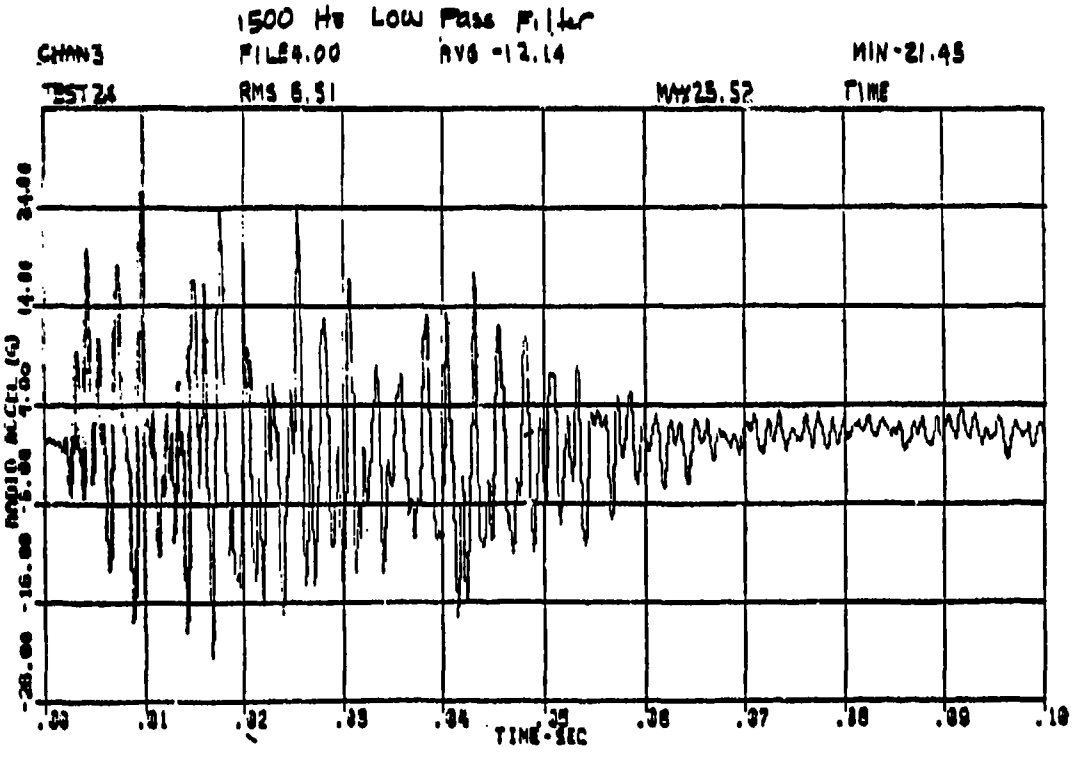
1500 Hz Low Pass Filter




2500 Hz Low Pass Filter
CHAN3.00
FILE4.00
AVG -12.14
RATE10000.02
XMIN-34.34
TEST24.00
RMS 8.28
XMAX42.10
TIME0.0
TIME-SEC

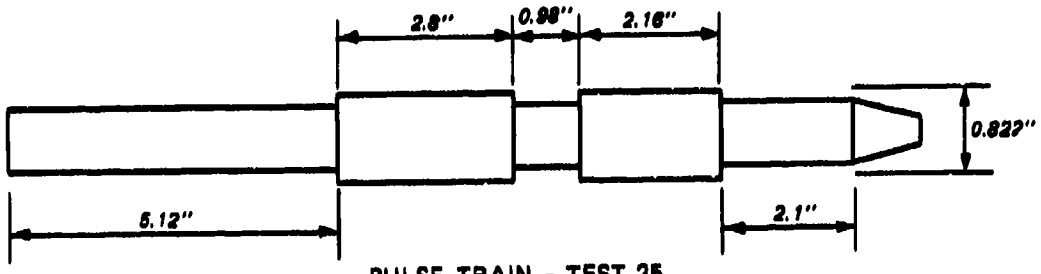

3500 Hz Low Pass Filter
CHAN 2.0
AVG -12.14
RATE10000.02
XMIN-72.32
TEST24
XMAX68.16
TIME0.0
TIME-SEC


500 Hz Low Pass Filter
CHAN3.00
FILE4.00
AVG -12.14
RATE13000.31
XMIN-13.98
TEST24.00
RMS 4.79
XMAX15.62
TIME0.0
RADIO ACCEL (G)
TIME-SEC


1500 Hz Low Pass Filter
CHAN3
FILE4.00
AVG -12.14
MIN-21.45
TEST24
RMS 8.51
MAX25.52
TIME
RADIO ACCEL (G)
TIME-SEC

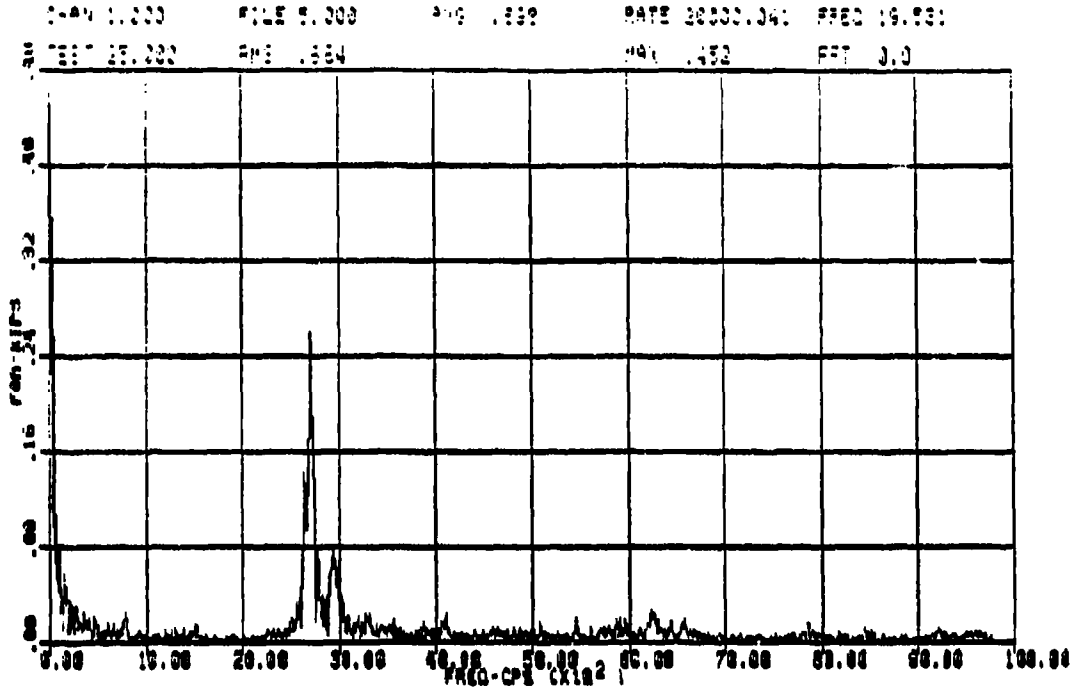
APPENDIX K: TEST 25 RESULTS

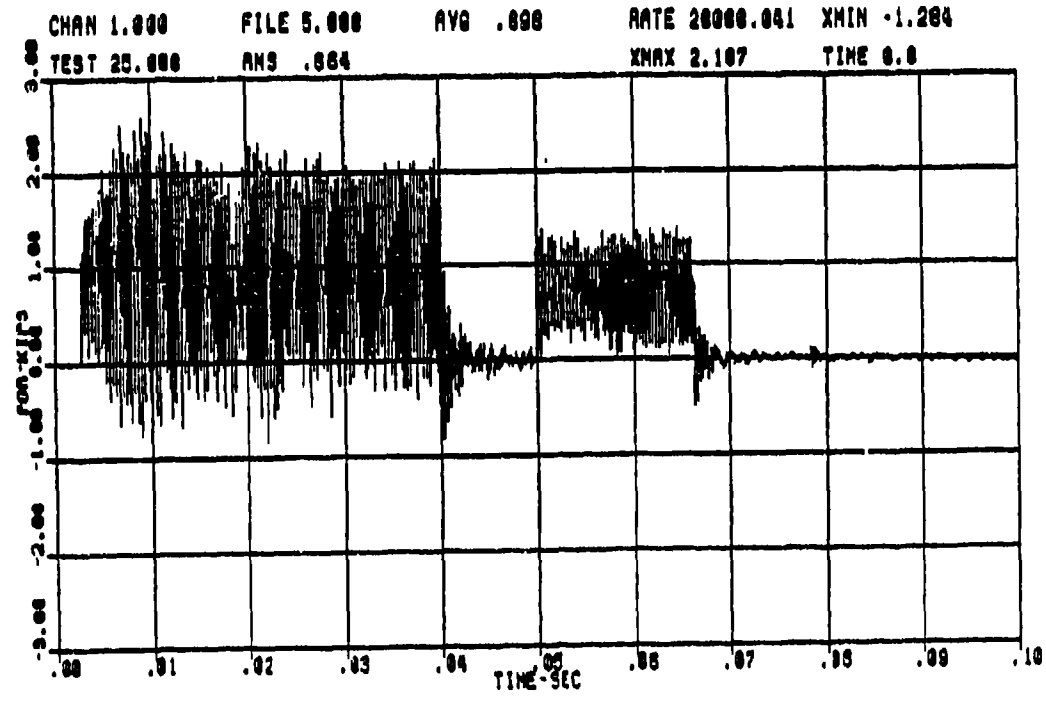
Test 25
Equipment Rack Soft-Mounted
AN/GRC-103 in Rack, Off-Line

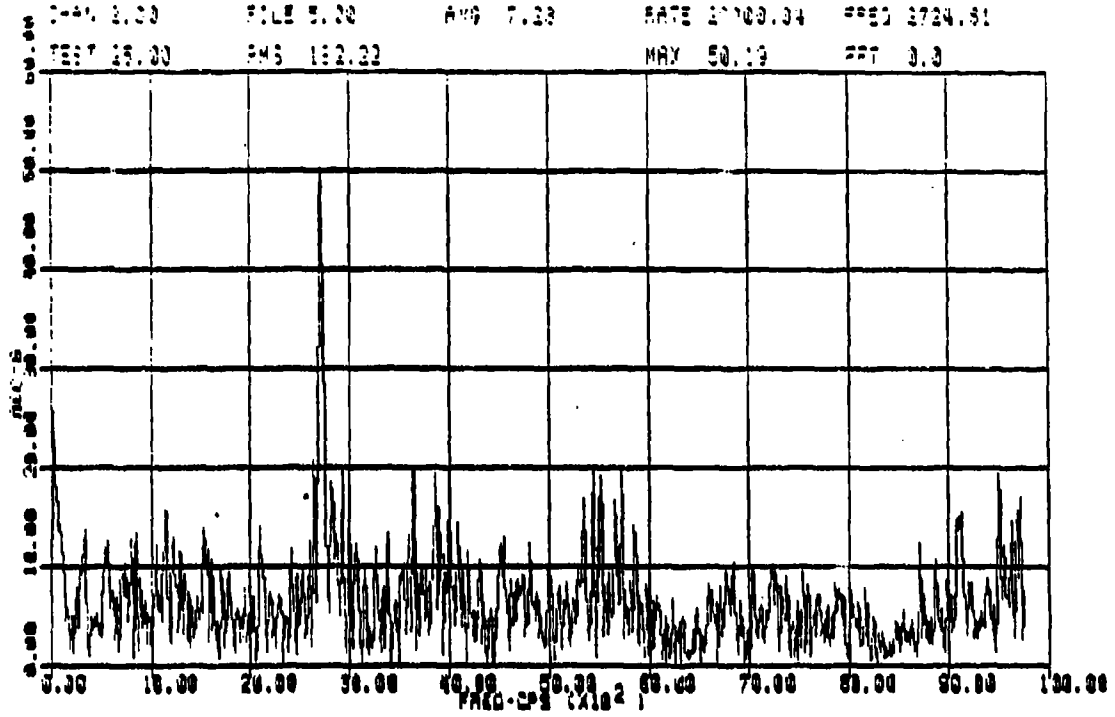


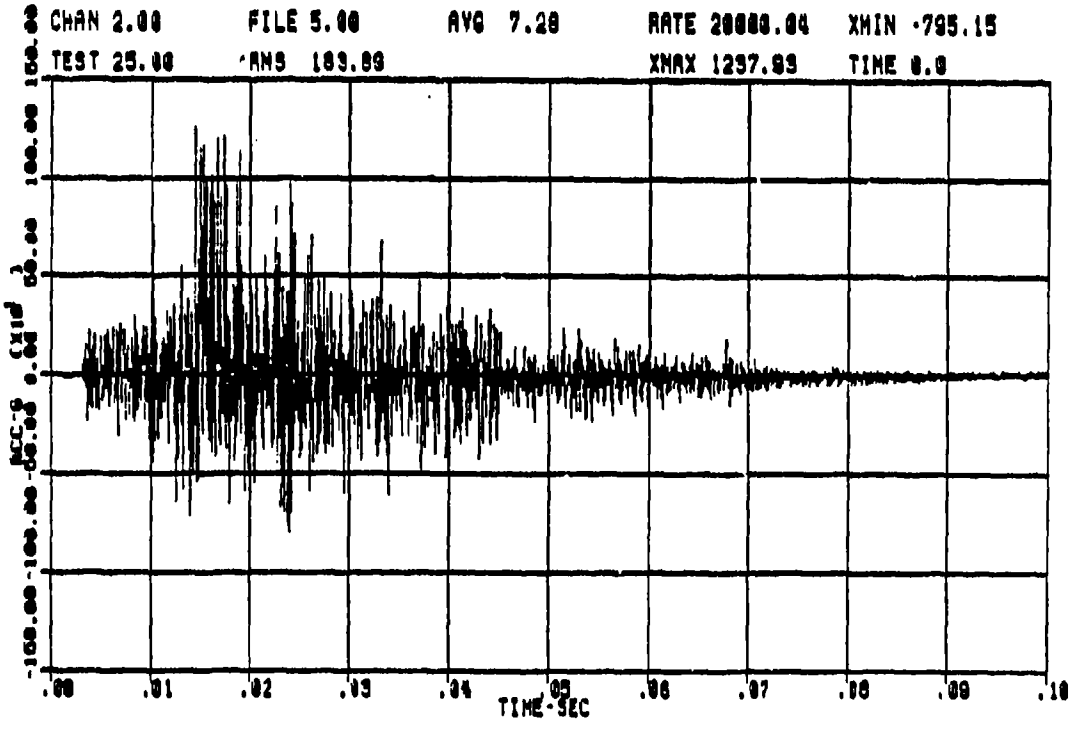
PULSE TRAIN - TEST 25

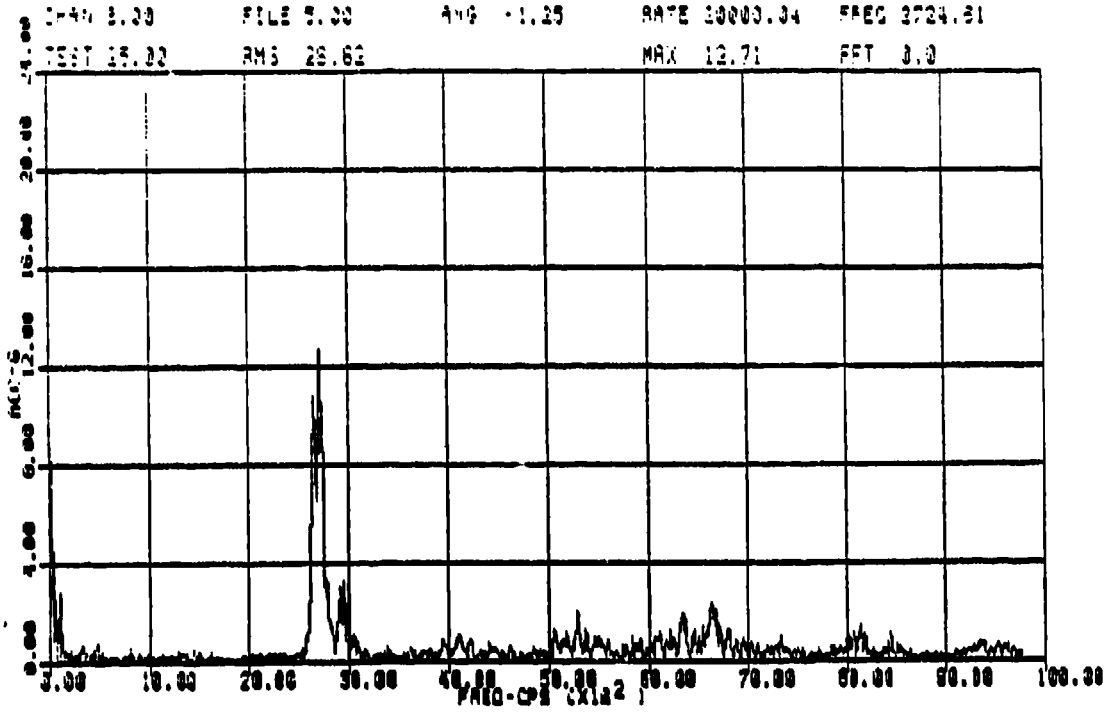
PRECHARGE PRESSURE = 1250 PSI
SYSTEM PRESSURE = 2000 PSI
FLOW CONTROL #6½
AIR BAG PRESSURE = 50 PSI

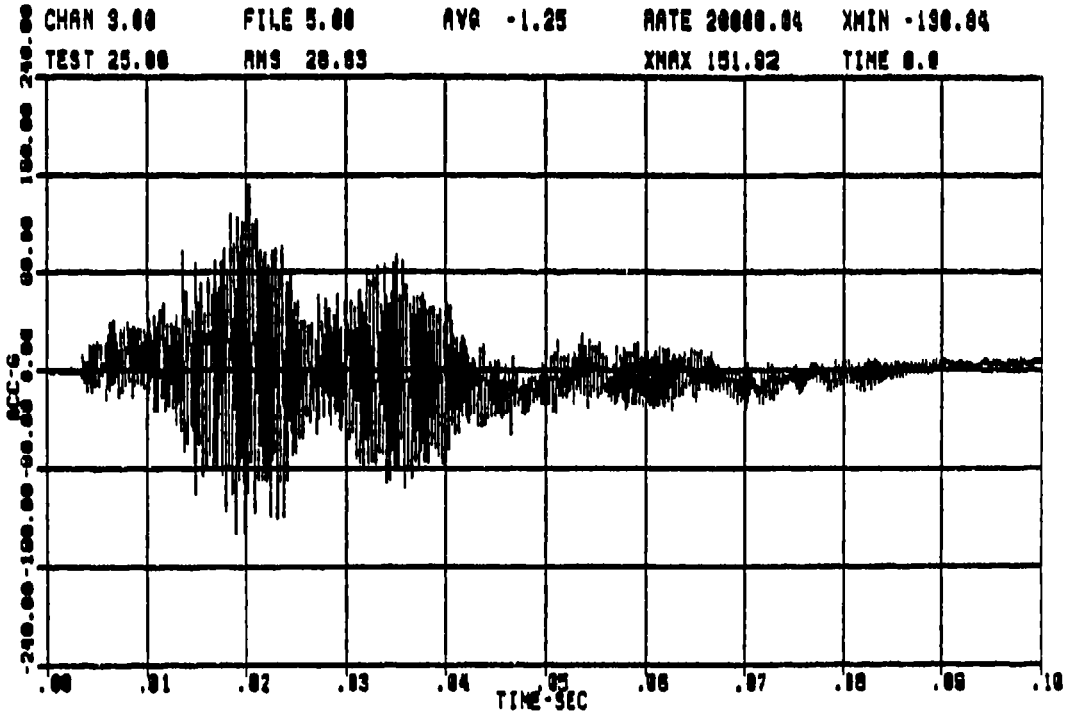

FREQ-CPS (X10^2)

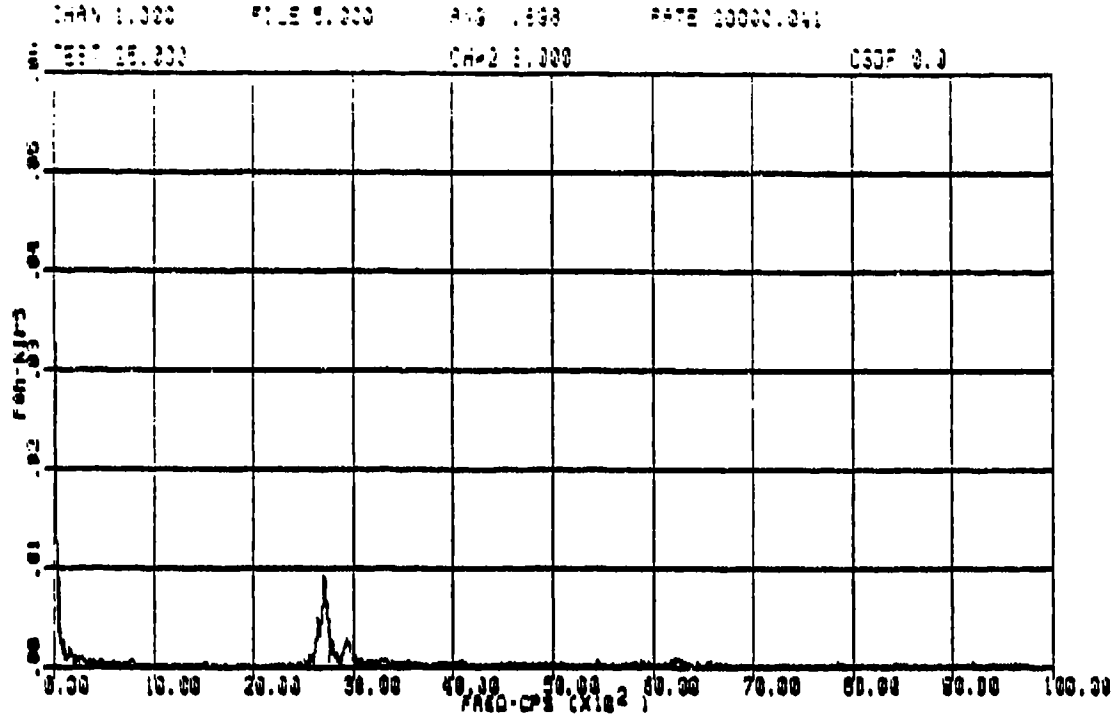

CHAN 1.000
FILE 5.000
AVG .898
RATE 20000.041
XMIN -1.284
TEST 25.000
RMS .664
XMAX 2.107
TIME 0.0
TIME-SEC

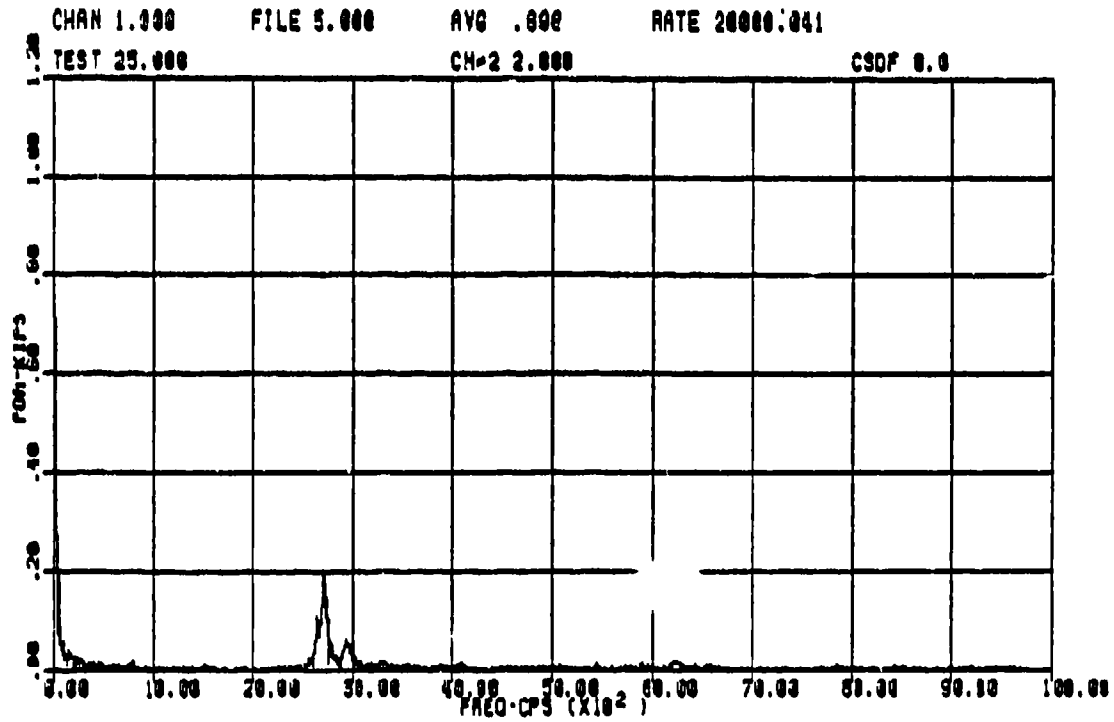

TEST 25.00
RMS 182.22
MAX 50.19
FREQ-CPS (X10^2)

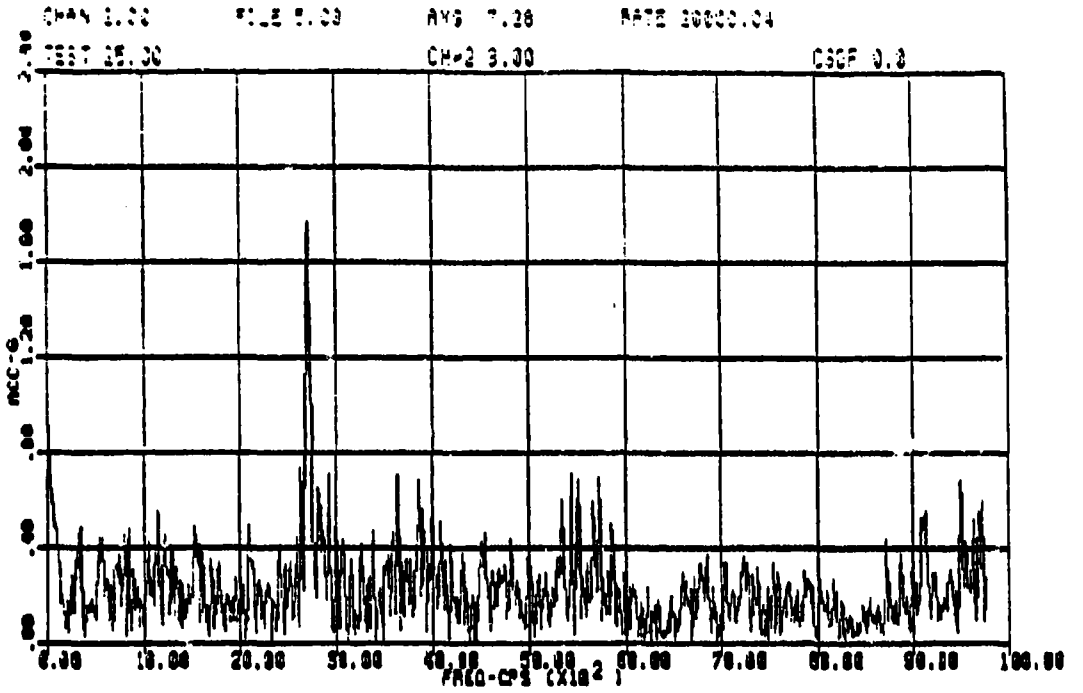

CHAN 2.00
FILE 5.00
AVG 7.28
TEST 25.00
RMS 189.89
XMAX 1237.99
TIME 0.0
TIME-SEC

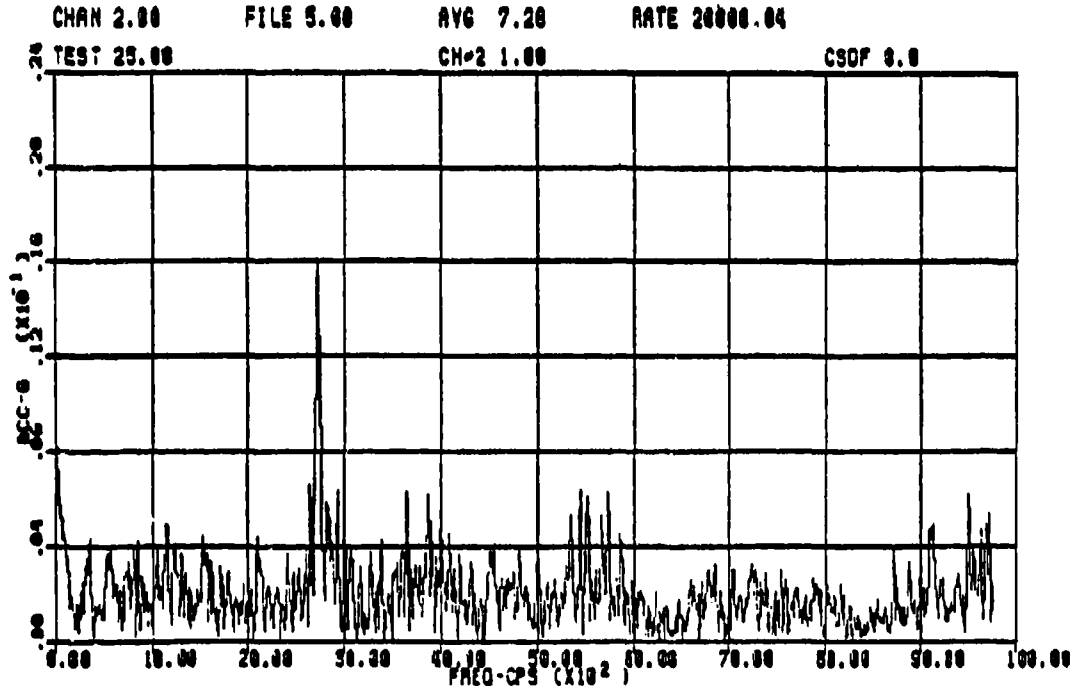

CHAN 9.00
FILE 5.00
AVG -1.25
RATE 10000.04
FREQ 3724.81
TEST 25.00
RMS 28.62
MAX 12.71
FFT 8.0
ACC-G
FREQ-CPS (X10^2)

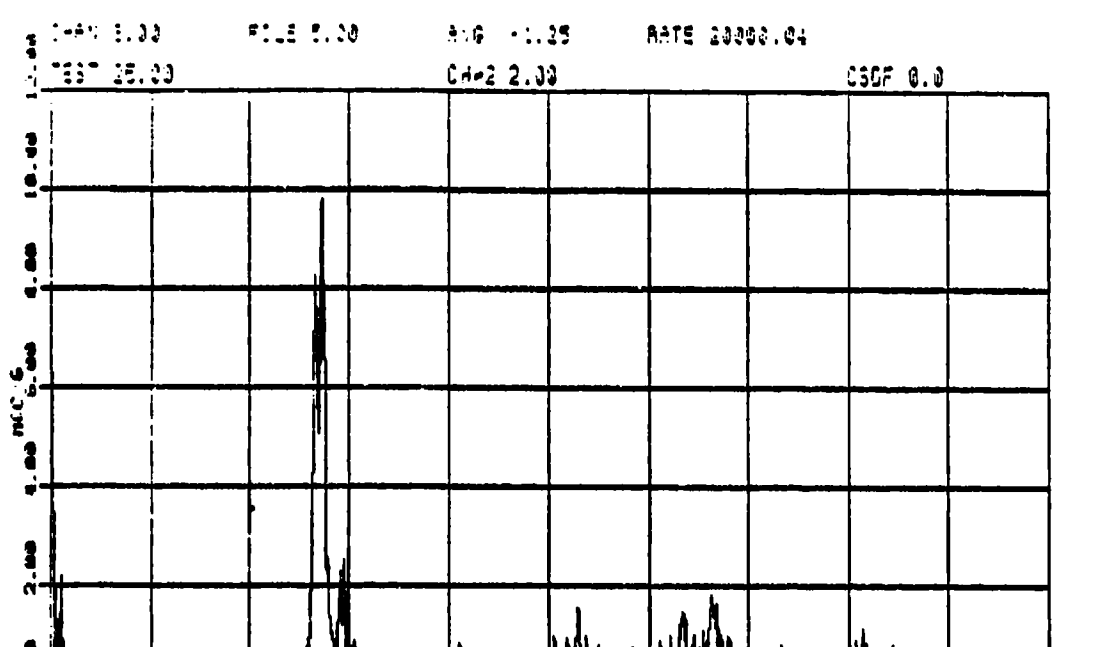

CHAN 9.00
FILE 5.00
AVG -1.25
RATE 20000.04
XMIN -190.04
TEST 25.00
RMS 28.83
XMAX 151.92
TIME 0.0
ACC-G
TIME-SEC

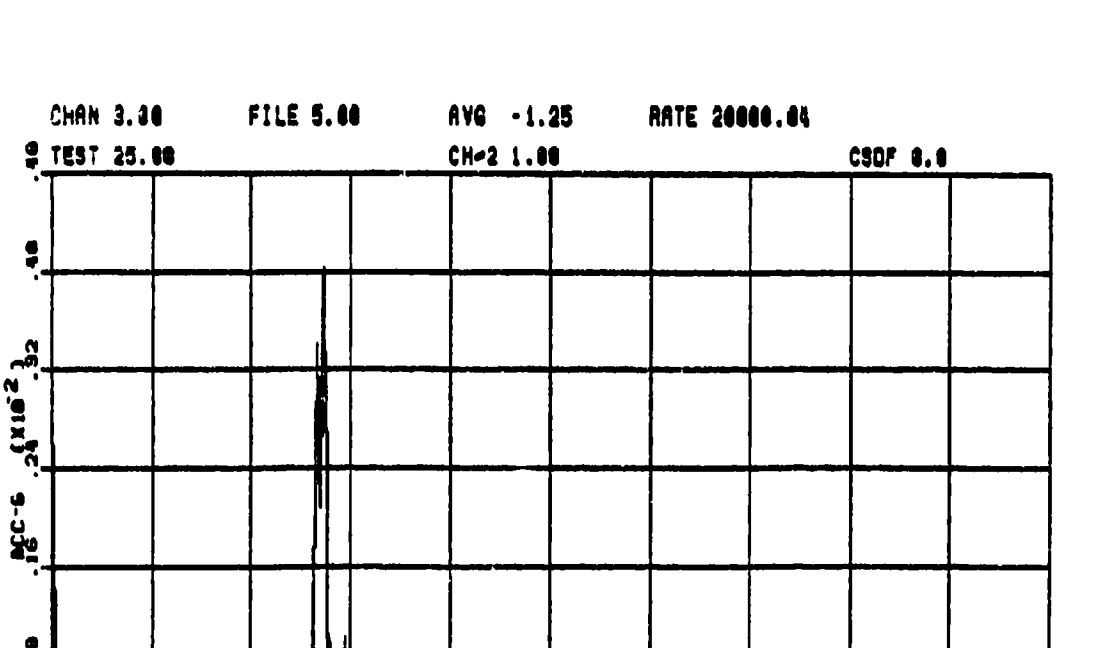

CHAN 1.000
TEST 25.000
CH=2 1.000
CSDF 0.0
FREQ-CPS (X10^2)

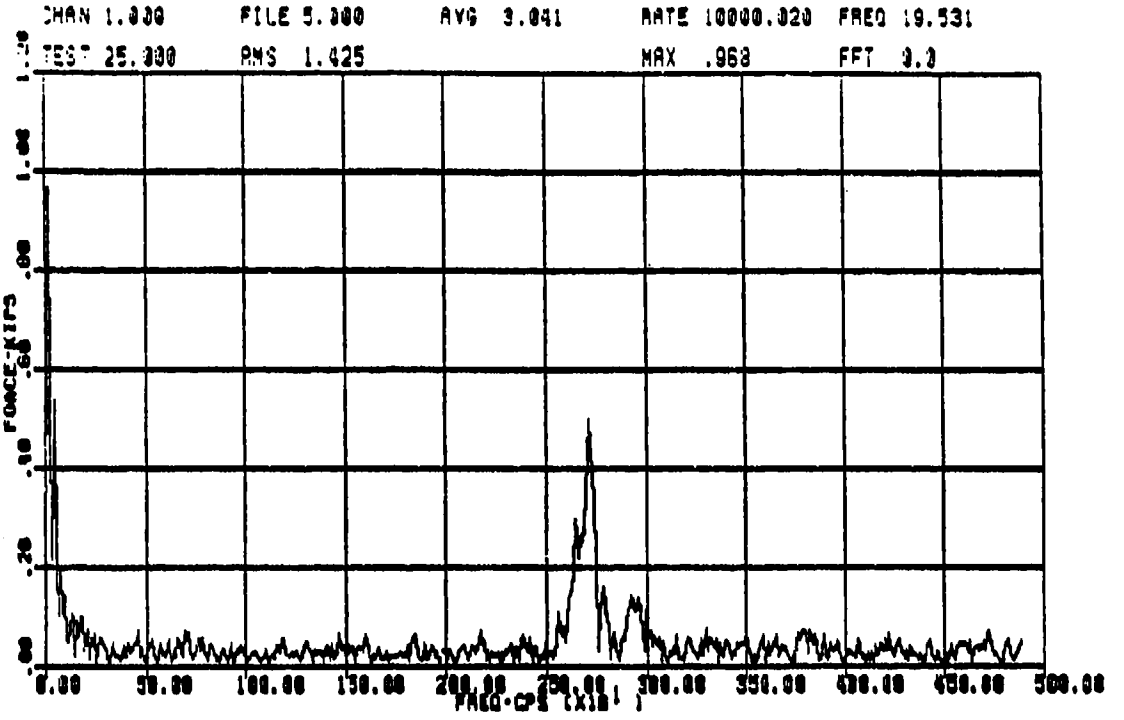

CHAN 1.000
FILE 5.000
AVG .000
RATE 20000.041
TEST 25.000
CH=2 2.000
CSDF 0.0
FREQ-CPS (X10^2)

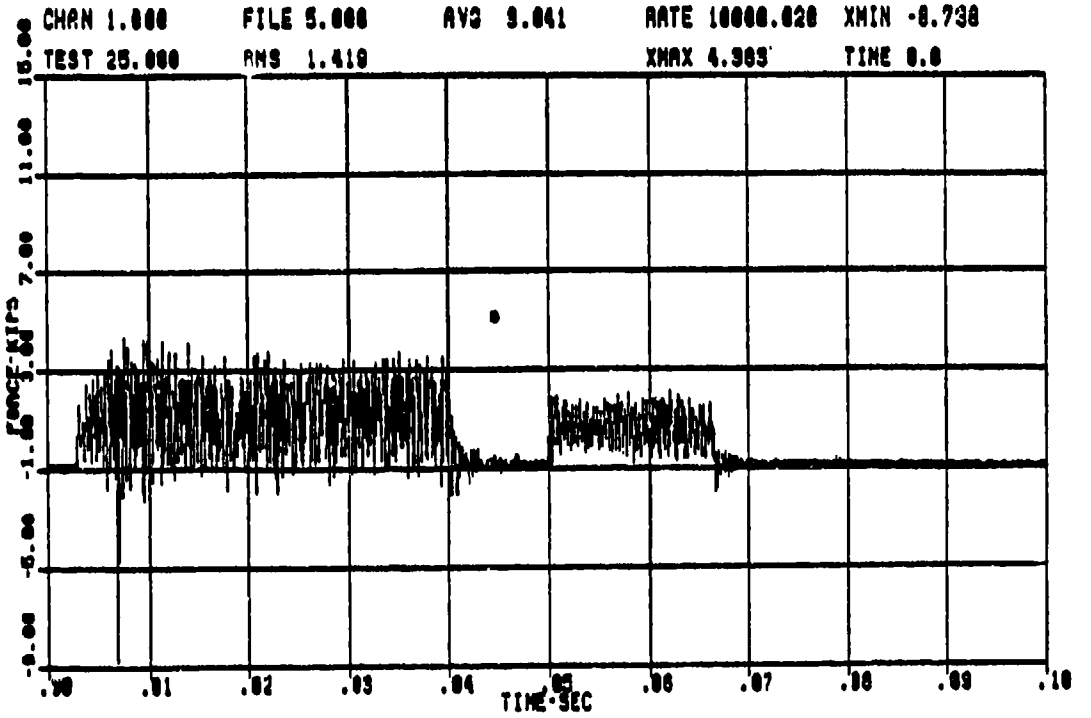

CHAN 1.00
FILE 5.00
AVG 7.20
RATE 20000.04
TEST 25.00
CH-2 3.00
CSOF 0.0
MCC-6
FREQ-CPS (X10²)

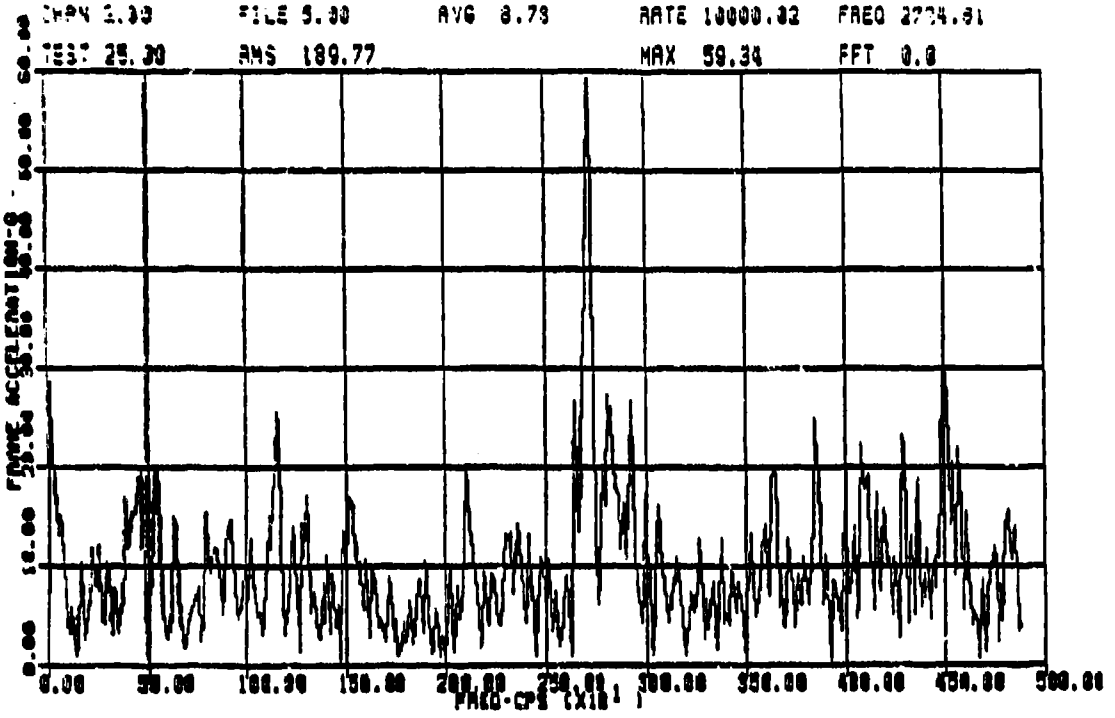

CHAN 2.00
FILE 5.00
AVG 7.20
RATE 20000.04
TEST 25.00
CH-2 1.00
CSOF 0.0
MCC-6 (X10⁻¹)
FREQ-CPS (X10²)

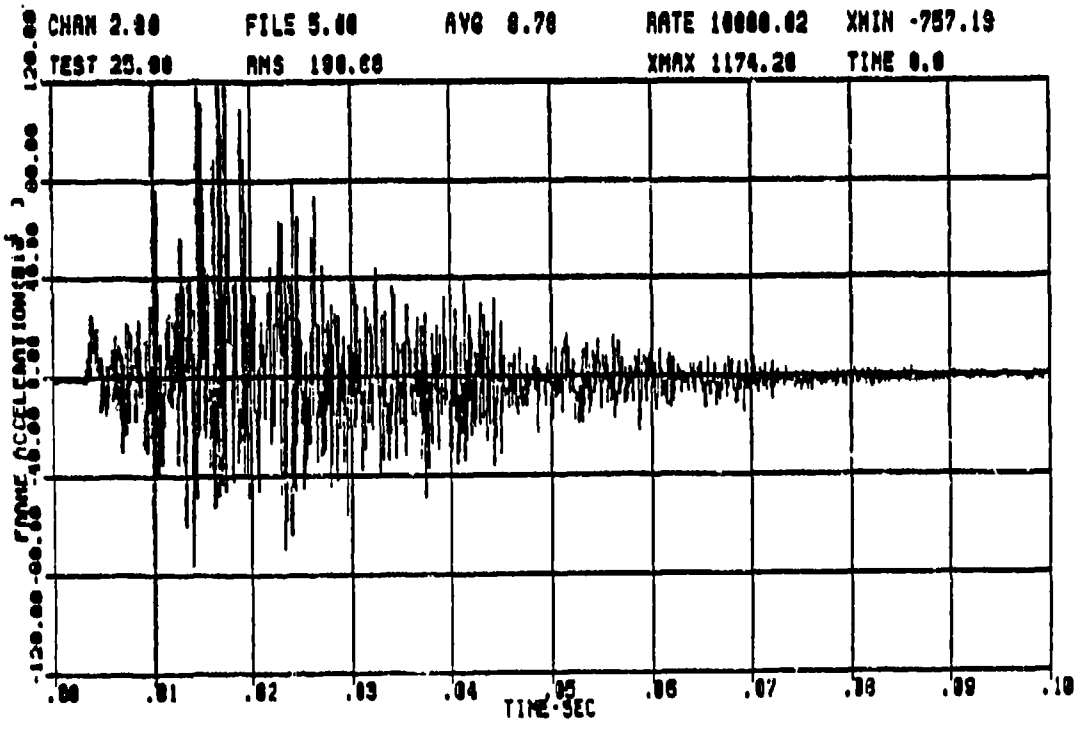

FILE 5.00
AVG -1.25
RATE 20000.04
TEST 25.00
CH=2 2.00
CSOF 0.0
MCC-6
FREQ-CPS (X10^2)


CHAN 3.00
FILE 5.00
AVG -1.25
RATE 20000.04
TEST 25.00
CH=2 1.00
CSOF 0.0
MCC-6 (X10^2)
FREQ-CPS (X10^2)


CHAN 1.000
FILE 5.000
AVG 3.041
RATE 10000.020
FREQ 19.531
TEST 25.000
RMS 1.425
MAX .968
FFT 0.0
FORCE-KIPS
FREQ-CPS (X10)


CHAN 1.000
FILE 5.000
AVG 3.041
RATE 10000.020
XMIN -0.738
TEST 25.000
RMS 1.410
XMAX 4.983
TIME 0.0
FORCE-KIPS
TIME-SEC


CHAN 2.00
FILE 5.00
AVG 8.78
RATE 10000.02
FREQ 2734.81
TEST 25.00
RMS 189.77
MAX 59.34
FFT 0.0
FREQ-CPS (X10¹)


CHAN 2.00
FILE 5.00
AVG 8.78
RATE 10000.02
XMIN -757.19
TEST 25.00
RMS 190.66
XMAX 1174.26
TIME 0.0
.00
.01
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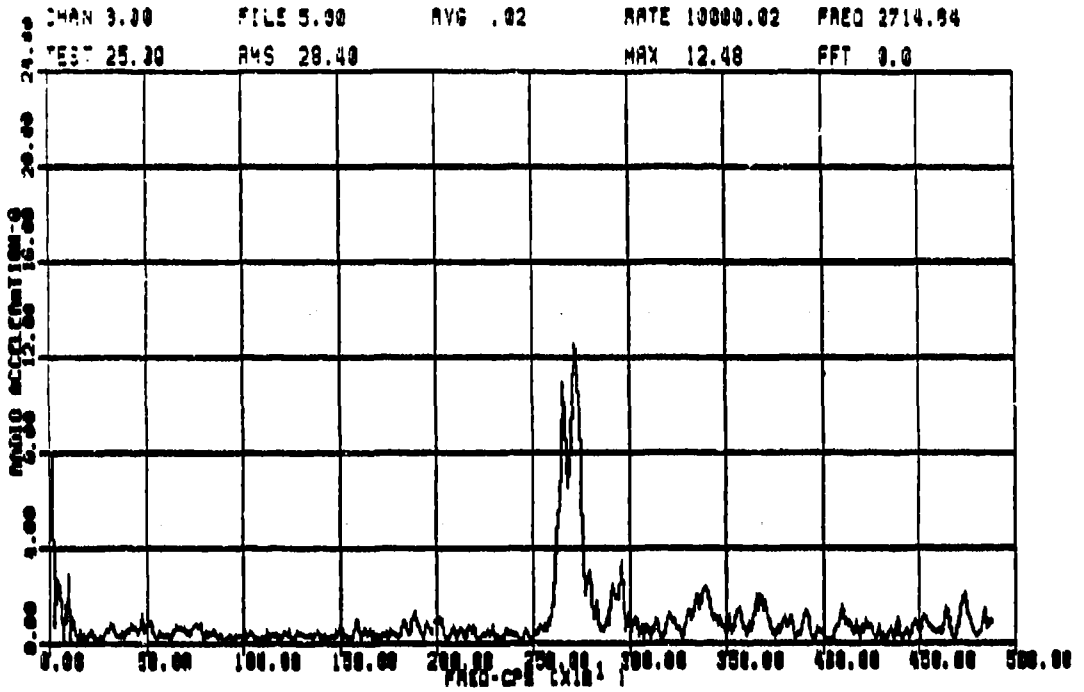
.08
.09
.10
TIME-SEC


CHAN 3.00
FILE 5.00
AVG .02
RATE 10000.02
FREQ 2714.84
TEST 25.00
RMS 28.40
MAX 12.48
FFT 0.0
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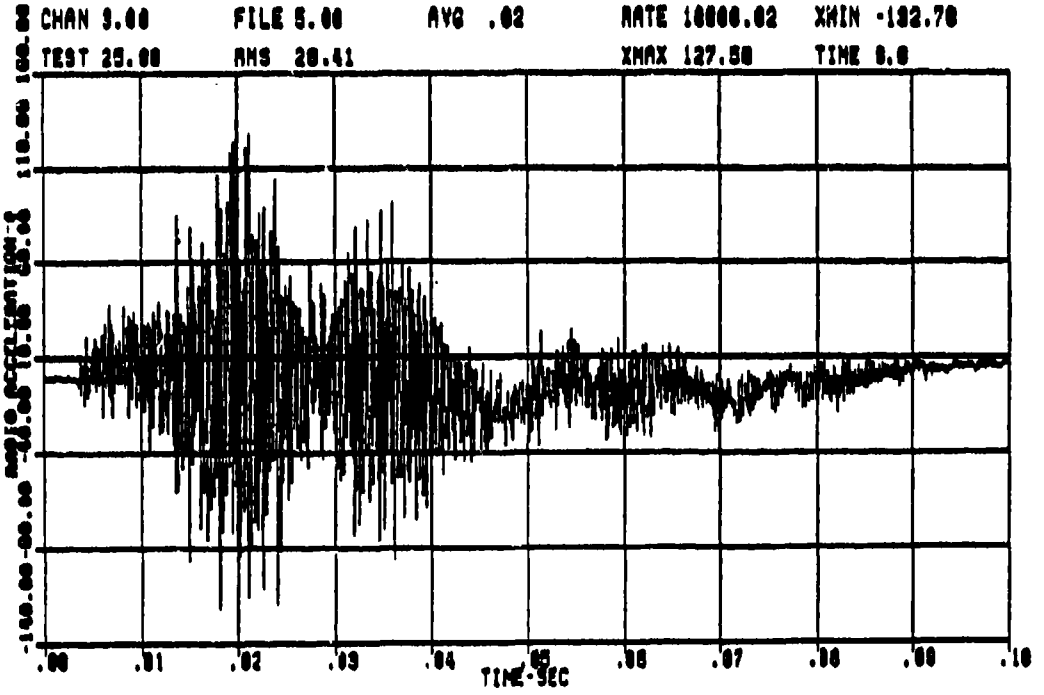
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00


CHAN 3.00
FILE 5.00
AVG .02
RATE 10000.02
XMIN -192.70
TEST 25.00
RMS 28.41
XMAX 127.50
TIME 0.0
.00
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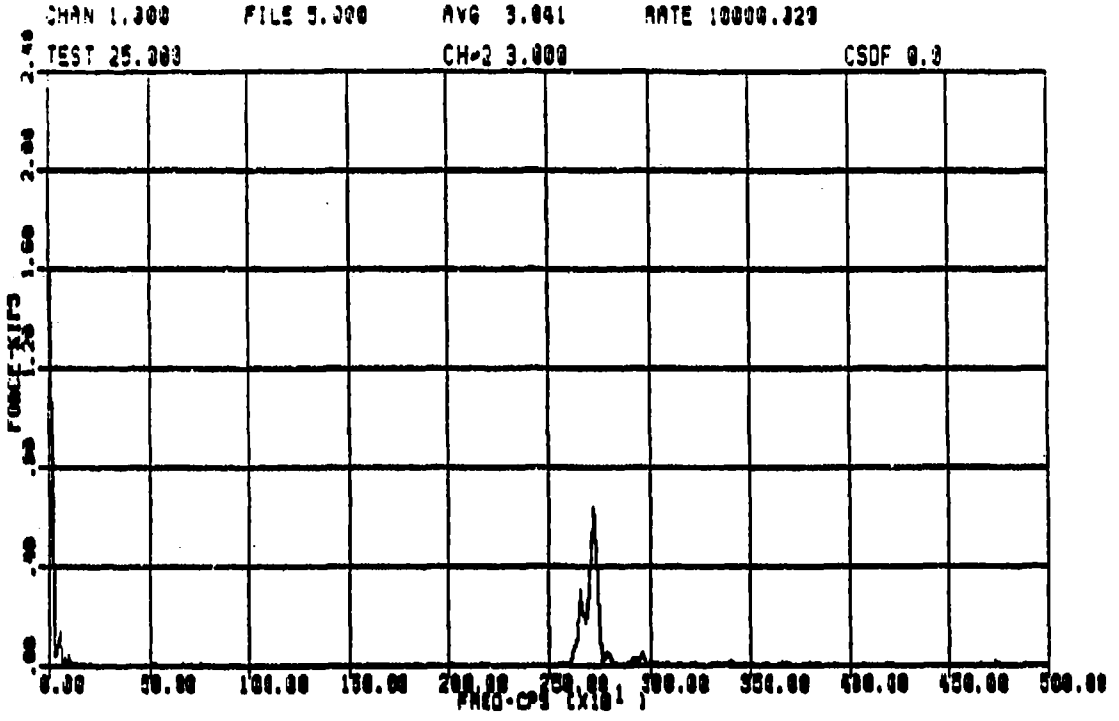
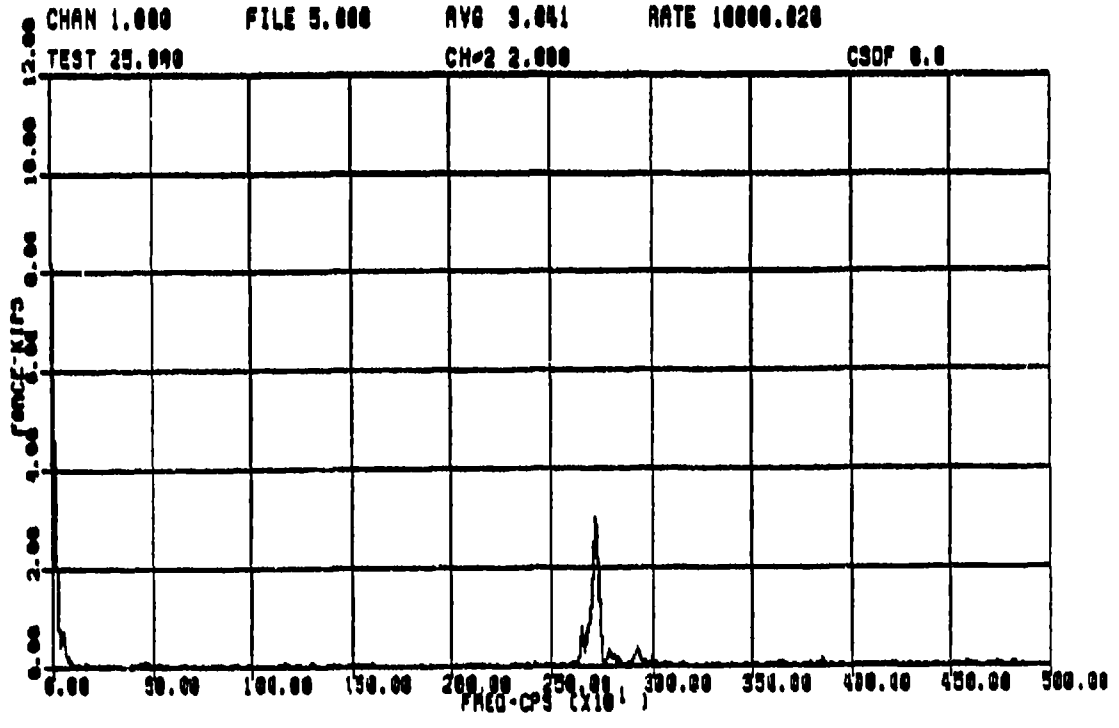
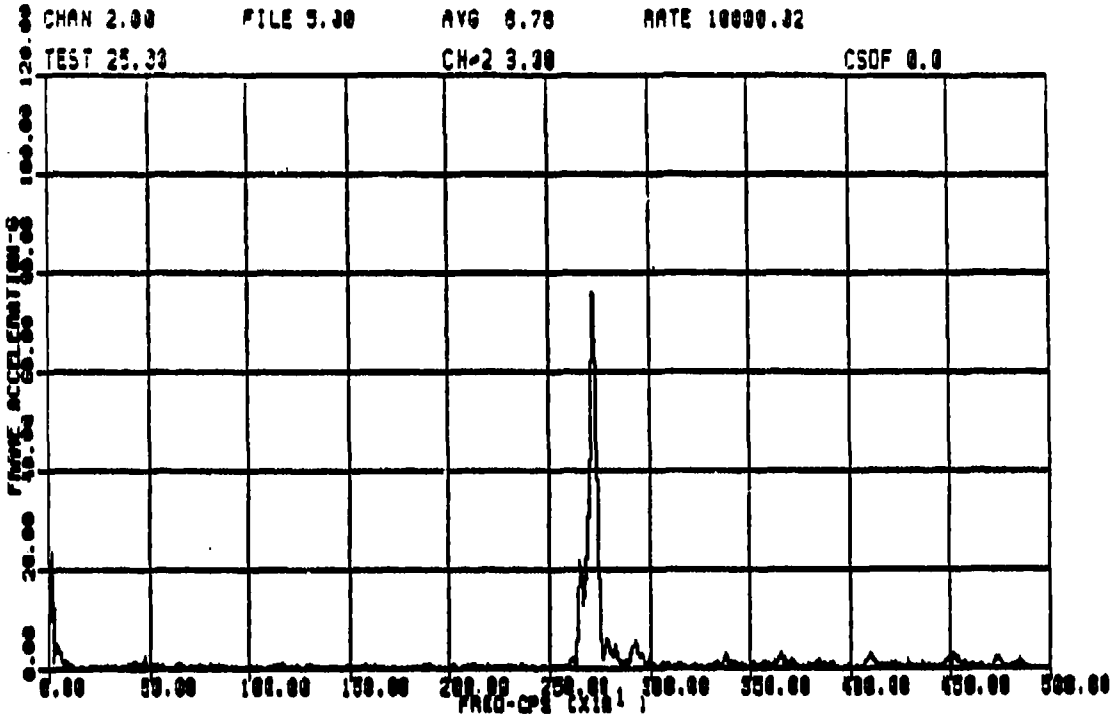
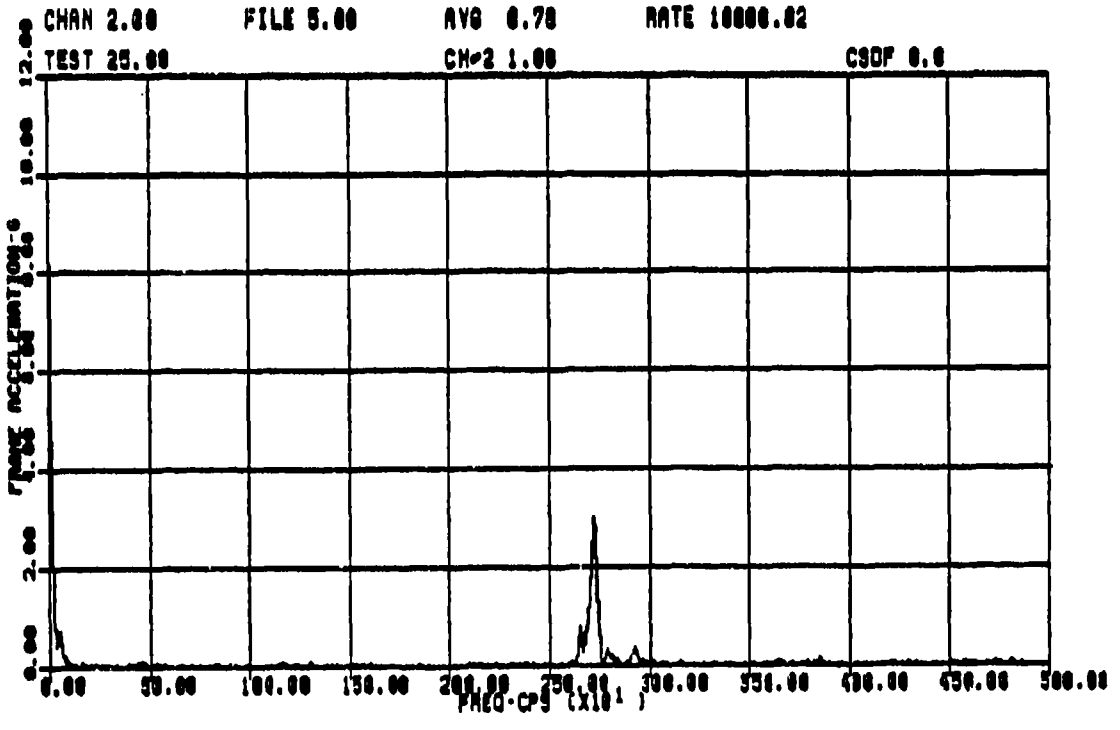
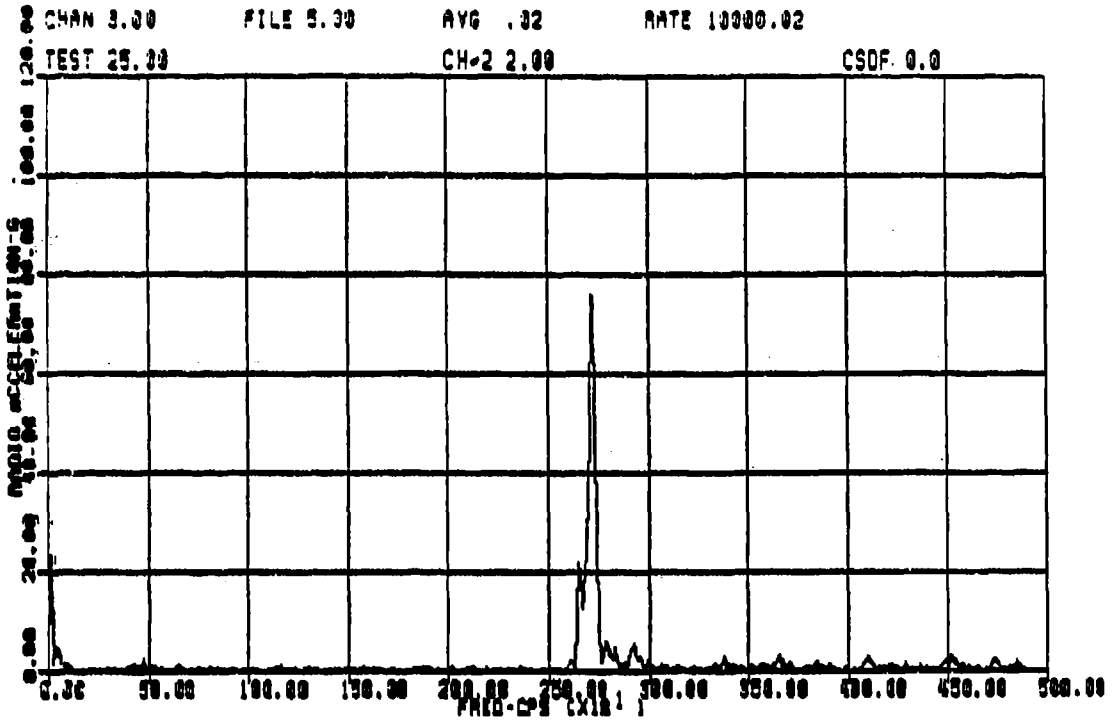
.10
TIME-SEC

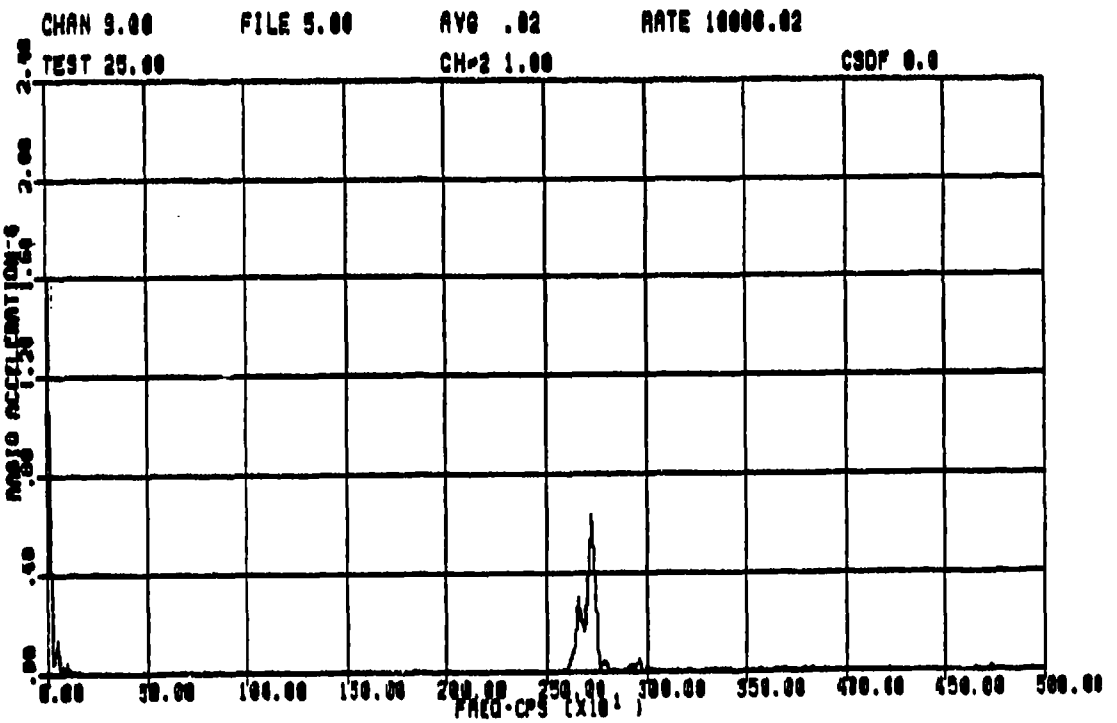

CHAN 1.000 FILE 5.000 AVG 3.041 RATE 10000.020
TEST 25.000 CH#2 3.000 CSOF 0.0
FORCE-KIPS
FREQ-CPS (X10)
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00

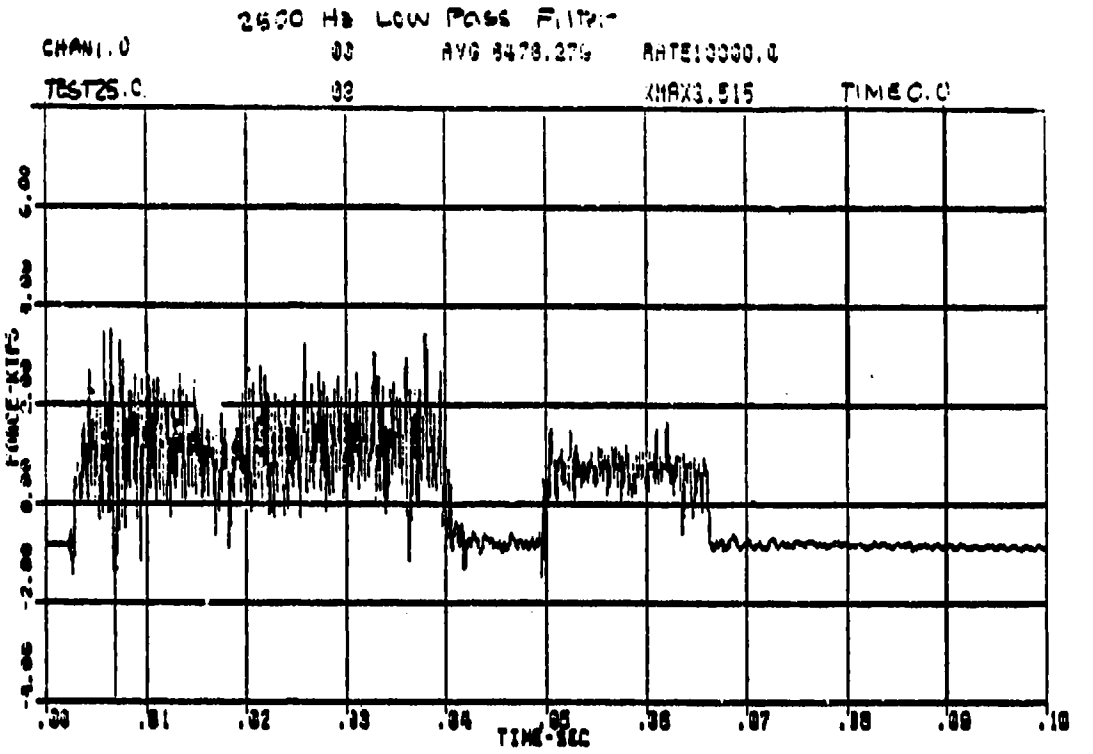

CHAN 1.000 FILE 5.000 AVG 3.041 RATE 10000.020
TEST 25.000 CH#2 2.000 CSOF 0.0
FORCE-KIPS
FREQ-CPS (X10)
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00

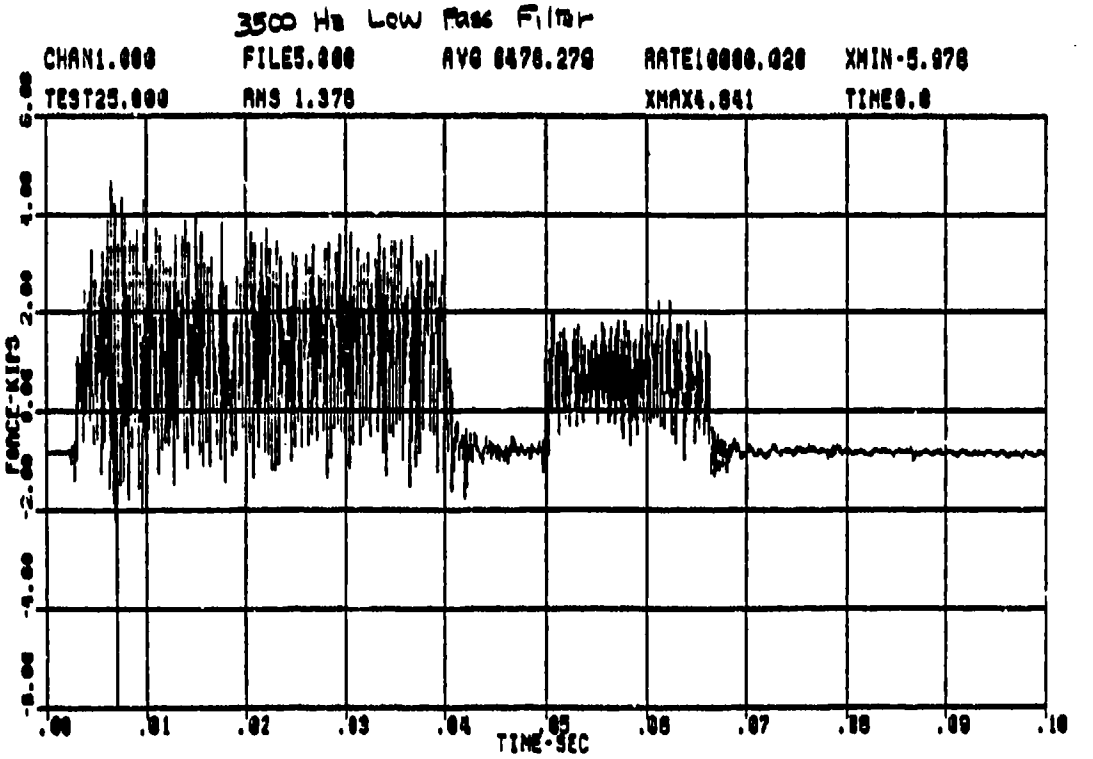

CHAN 2.00
FILE 5.30
AVG 8.78
RATE 10000.32
TEST 25.33
CH#2 3.30
CSOF 0.0
FREQ-CPS (X10¹)


CHAN 2.00
FILE 5.00
AVG 8.78
RATE 10000.32
TEST 25.00
CH#2 1.00
CSOF 0.0
FREQ-CPS (X10¹)

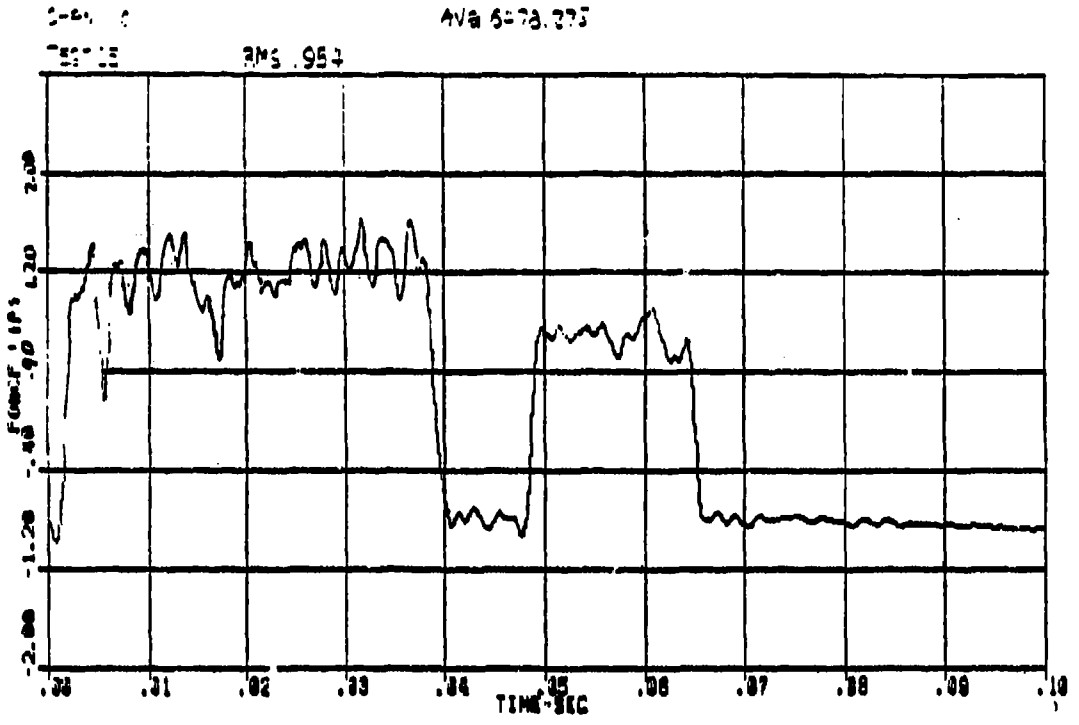

CHAN 3.00
FILE 5.00
AVG .02
RATE 10000.02
TEST 25.00
CH-2 2.00
CSDF 0.0
FREQ-CPS (X10^1)


CHAN 3.00
FILE 5.00
AVG .02
RATE 10000.02
TEST 25.00
CH-2 1.00
CSDF 0.0
FREQ-CPS (X10^1)

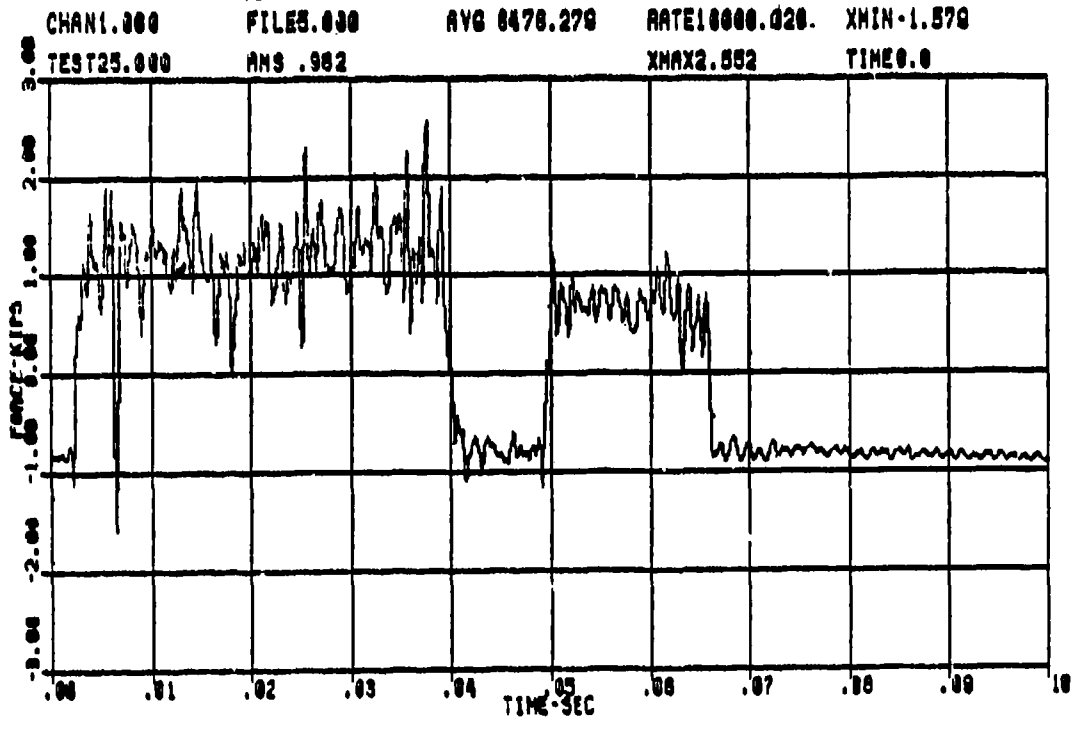

2500 Hz Low Pass Filter
CHAN1.0
AVG 8478.279
RATE10000.0
TEST25.C
XMAX3.515
TIME0.0
FORCE-KIPS
TIME-SEC

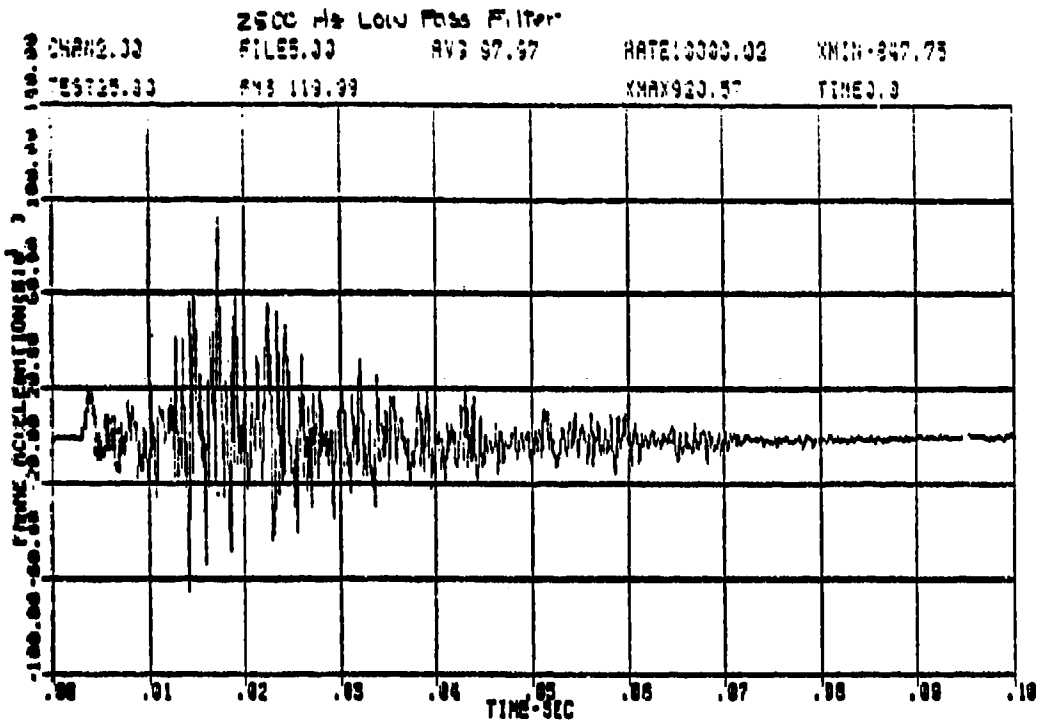

3500 Hz Low Pass Filter
CHAN1.000
FILE5.000
AVG 8478.279
RATE10000.020
XMIN-5.078
TEST25.000
RMS 1.378
XMAX4.841
TIME0.0
FORCE-KIPS
TIME-SEC

500 Hz Low Pass Filter



1500 Hz Low Pass Filter




2500 Hz Low Pass Filter
CHAN2.00
FILE5.00
AVG 97.97
RATE:3333.02
XMIN-847.75
TEST25.00
RMS 119.99
XMAX920.57
TIME0.0
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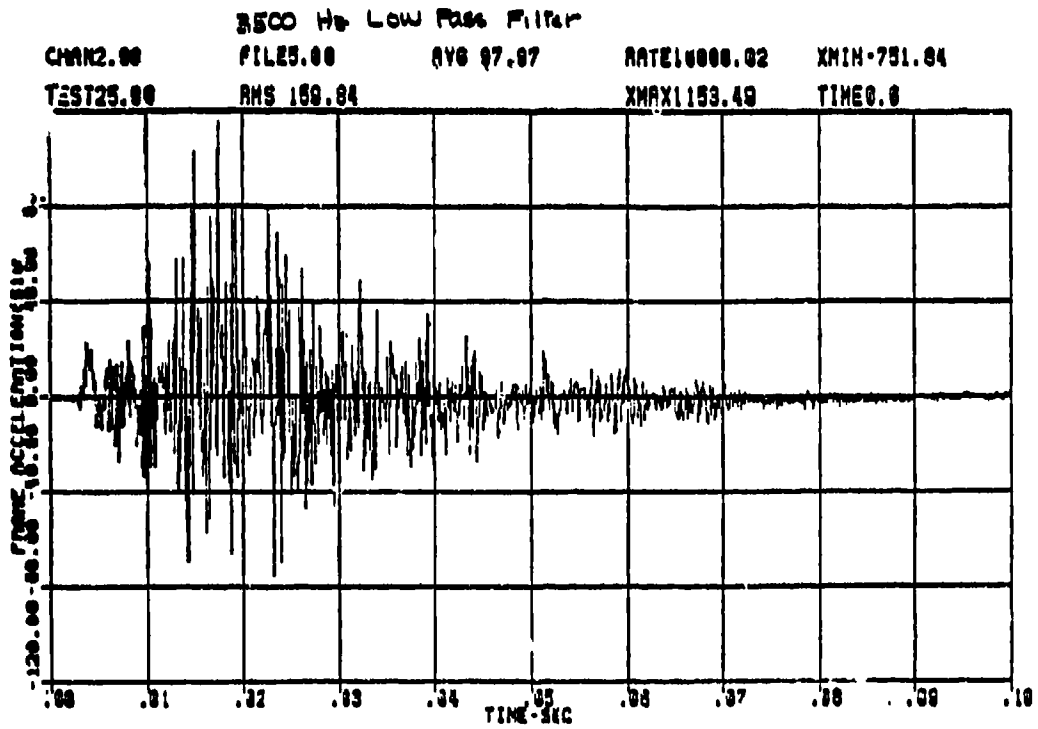
TIME-SEC


3500 Hz Low Pass Filter
CHAN2.00
FILE5.00
AVG 97.97
RATE:4000.02
XMIN-751.84
TEST25.00
RMS 159.84
XMAX1153.49
TIME0.0
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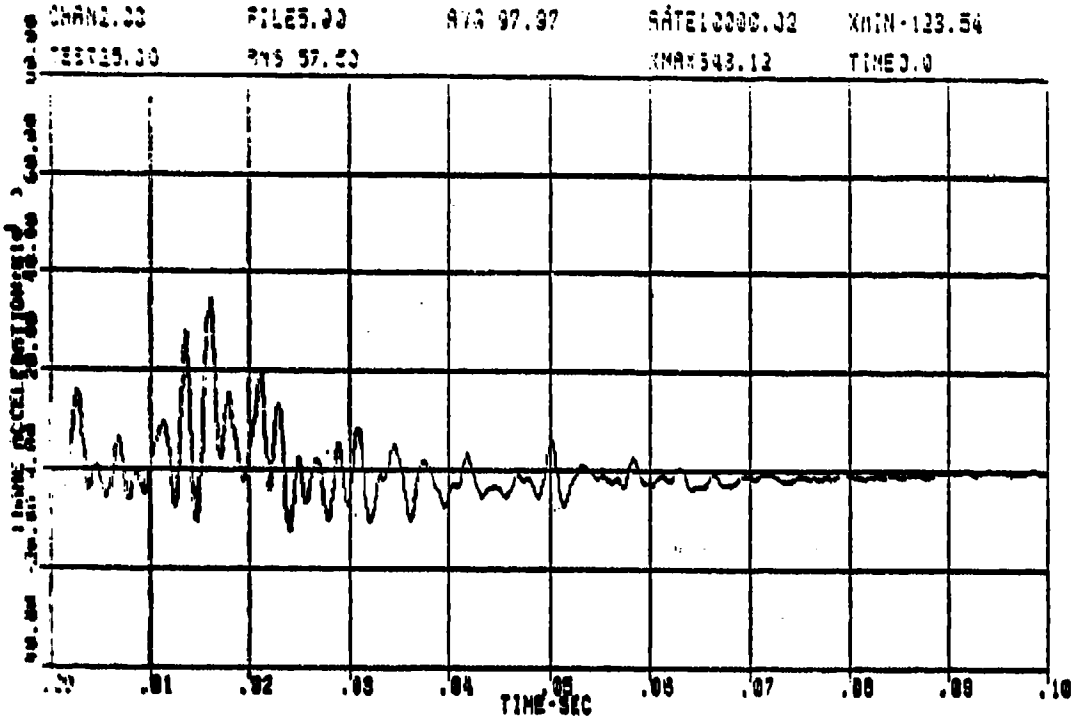
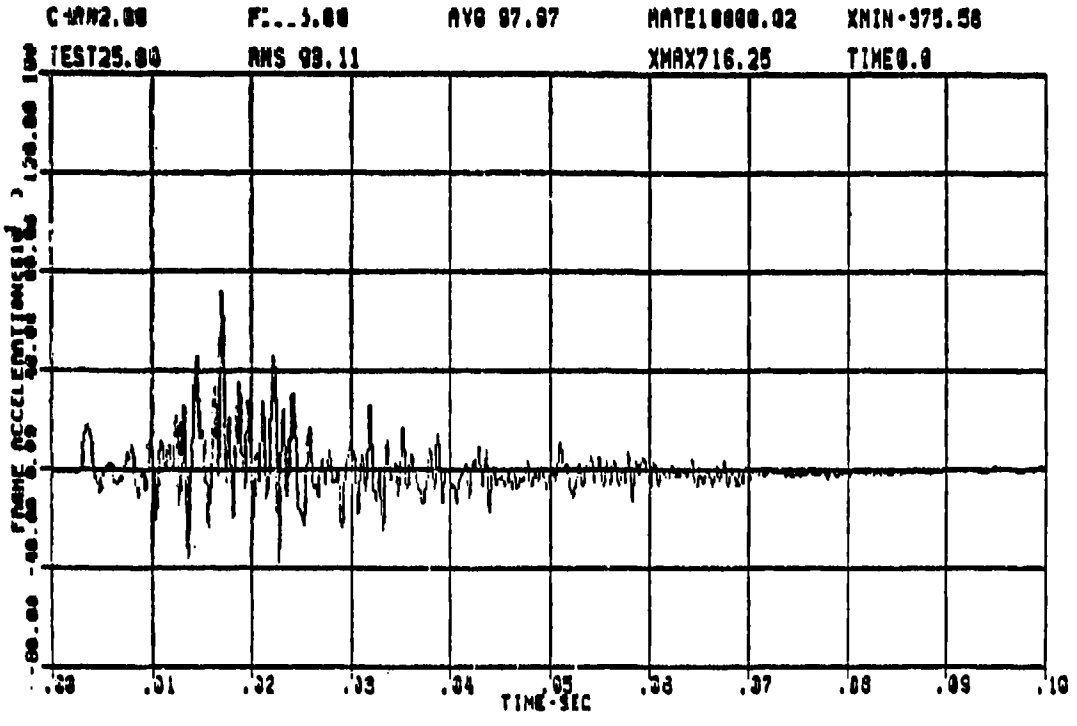
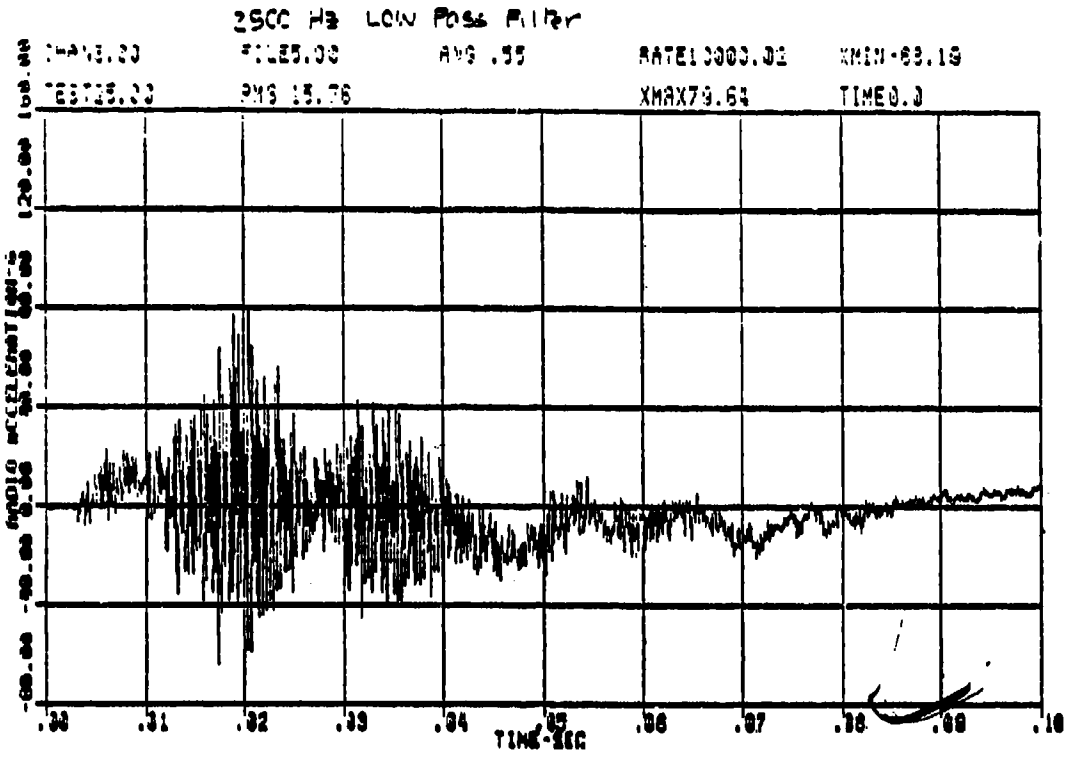
TIME-SEC

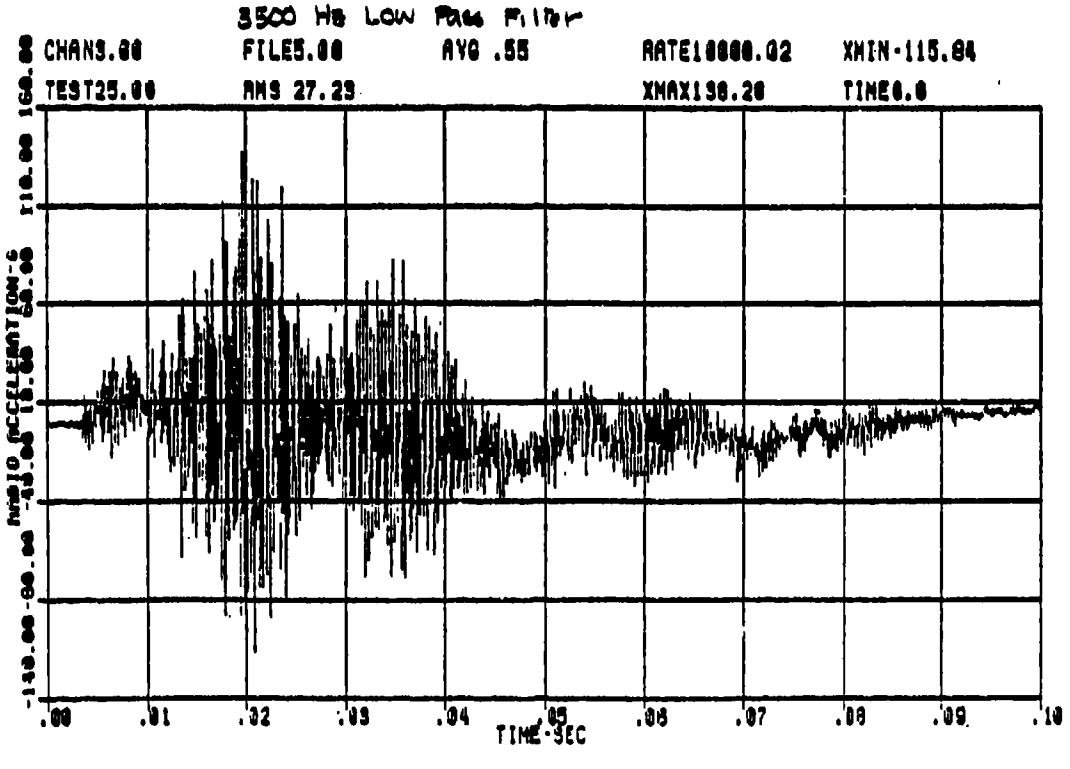
500 Hz Low Pass Filter

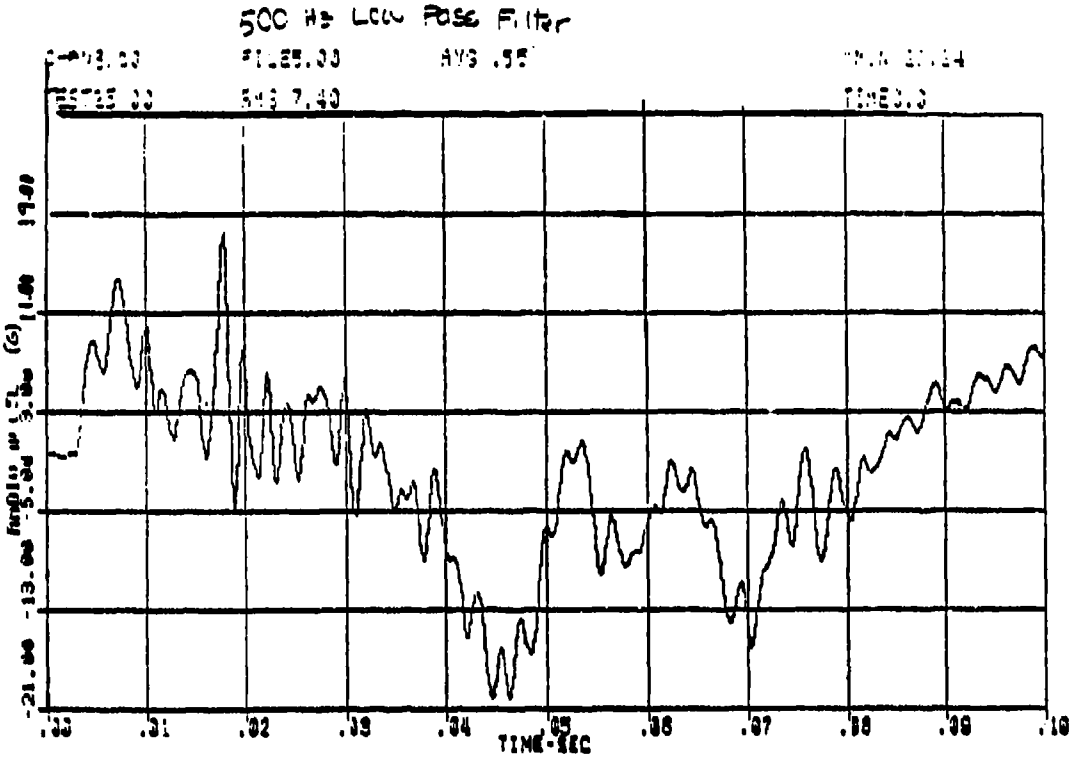


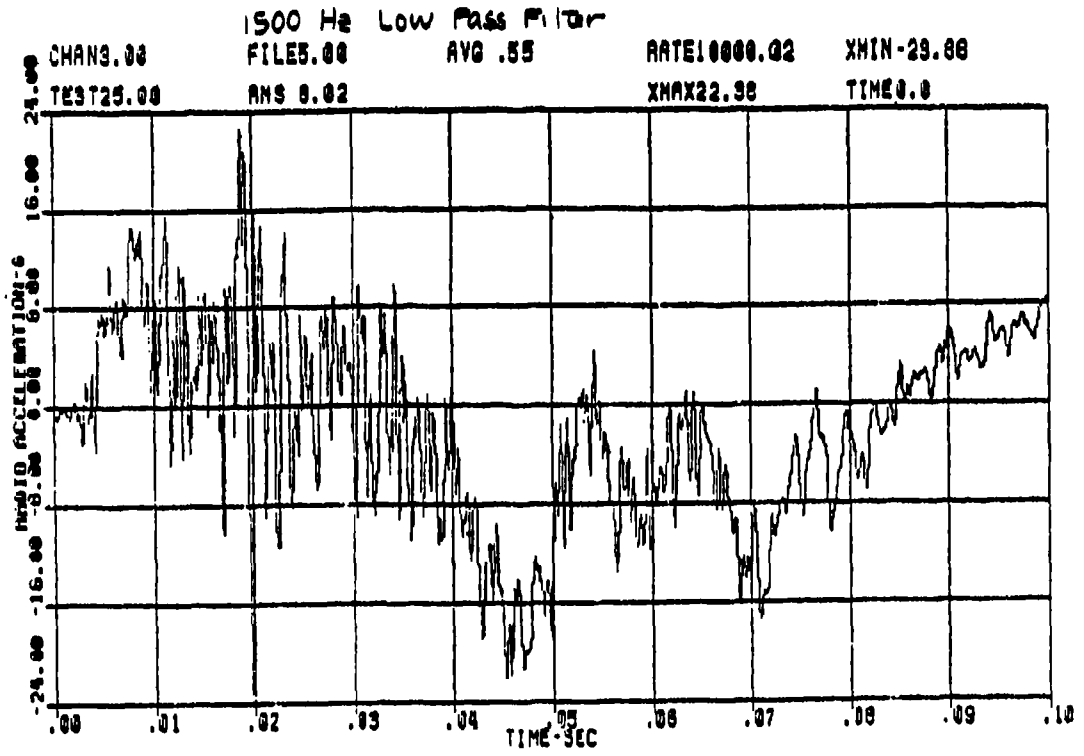
1500 Hz Low Pass Filter




2500 Hz Low Pass Filter
CHAN3.00
FILE5.00
AVG .55
RATE10000.02
XMIN-69.19
TEST25.00
RMS 15.76
XMAX79.64
TIME0.0
TIME-SEC


3500 Hz Low Pass Filter
CHAN3.00
FILE5.00
AVG .55
RATE10000.02
XMIN-115.84
TEST25.00
RMS 27.23
XMAX198.20
TIME0.0
TIME-SEC


500 Hz Low Pass Filter
AVG .55
TIME0.0
TIME-SEC


1500 Hz Low Pass Filter
CHAN3.00
FILE5.00
AVG .55
RATE10000.02
XMIN-29.00
TEST25.00
RMS 0.02
XMAX22.98
TIME0.0
TIME-SEC