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IMPACT CHARACTERIZATION OF NEW COMPOSITE MATERIALS

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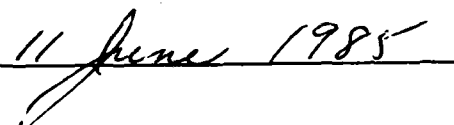
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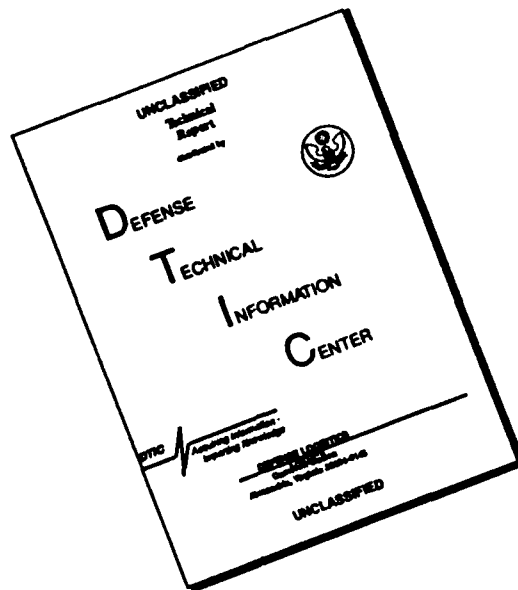
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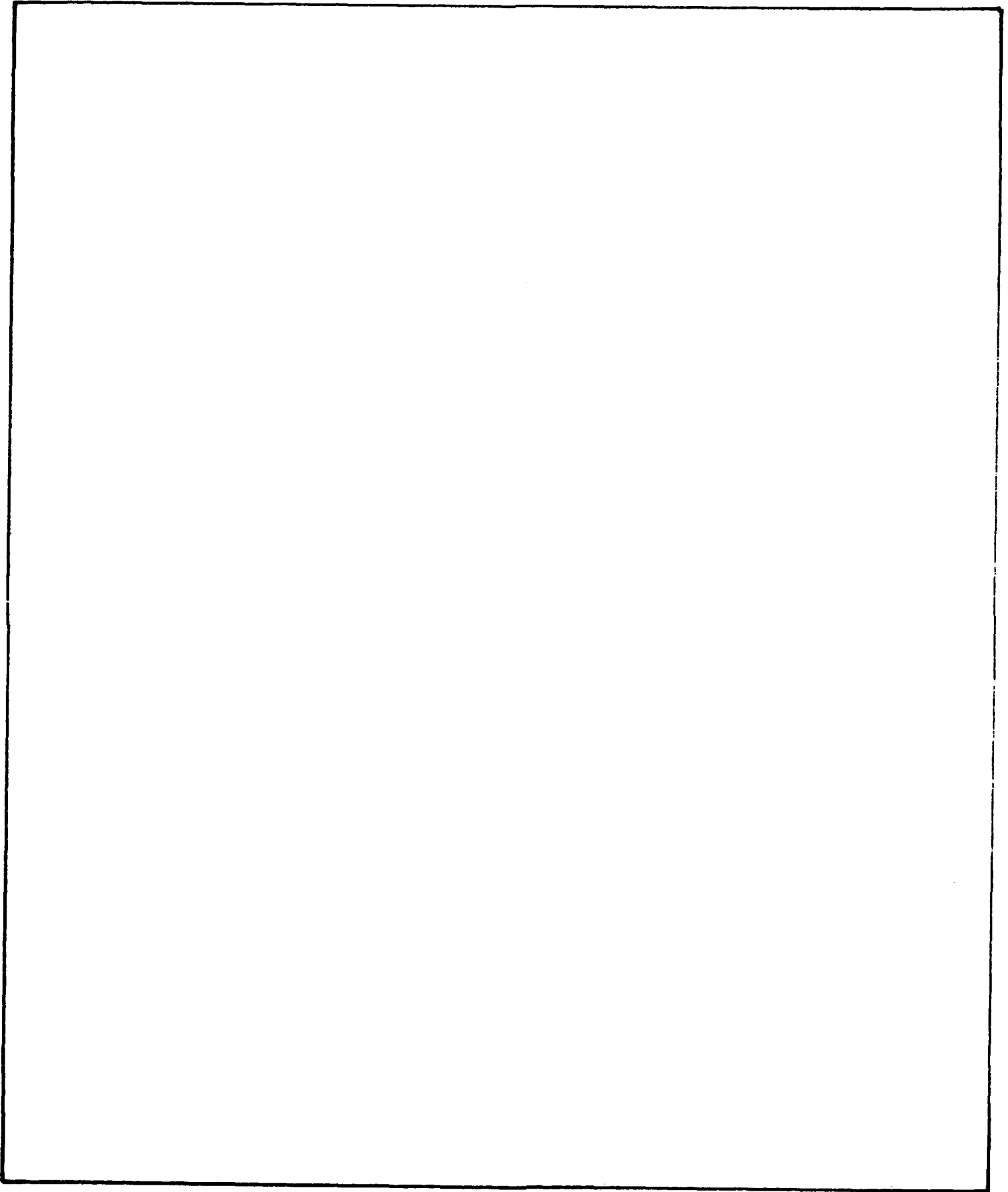


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19 ABSTRACT (Continue on reverse if necessary and identify by block number) Dropped-weight instrumented impact tests were used in conjunction with ultrasonic C-span inspection to characterize the impact response of several new graphite-fiber composite material systems. The AS4/Hercules 3501-6 graphite/epoxy was compared to the newer AS4/Hercules 2220-1, Celion High Strain/Narmco 5425 and IM6/Narmco 5245C systems in the 250° (121°C) service category. Materials tested in the 350°F (177°C) service category were: T300/Avco 130B, T300/Hexcel 81-5, T300/U.S. Polymeric V378A, XAS/Hysol 9102 and HX/Hexcel 1516 graphite/bismaleimides. A material ranking is given along with measured impact parameters and impact energy versus damage relationships. The impact behavior of all four 250°F (121°C) systems were similar except IM6/5245C had the highest impact resistance. The bismaleimides had similar incipient damage levels as the epoxies but were more easily punctured. Impact resistance of the five 350°F (177°C) systems were similar except T300/130B had the lowest impact resistance.						
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FOREWORD

This report presents the instrumented-impact test results for several new composite material systems. This effort is part of the Characterization of Composites Program being performed for the Naval Air Systems Command. Mr. Richard Schmidt is the materials technology administrator. All tests were performed at the Naval Air Development Center. Composite material test specimens were fabricated by Grumman Aerospace Company and the Naval Air Development Center. The authors gratefully acknowledge the contribution to this research effort of Mrs. D. Heal who assisted in the impact testing.

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INTRODUCTION

Graphite-fiber reinforced resin-matrix composites are firmly established as a major aerospace material expected to comprise over half the structural weight of near future aircraft. The widespread use and acceptance of graphite/epoxy composites in components of such advanced aircraft as F-18 and AV-8B results from the structural efficiency, extensive characterization and manufacturability of the current, mature systems, such as AS/3501-6 and T300/5208. The epoxy matrixes of these materials, however, have prevented the structural engineer from taking full advantage of the performance improvements possible through the use of graphite-fiber composites. While it is the high tensile strength and modulus of the fiber which is responsible for the strength and stiffness of a composite structure, the matrix is an essential element necessary to maintain fiber alignment, stabilize the fibers against buckling and provide for load transfer between fibers. The current epoxy resins are degraded by environmental moisture, drastically reducing their strength at elevated temperature and limiting their continuous service capabilities to below 250°F (121°C). They are brittle and easily damaged by low velocity impact, in some circumstances incurring substantial internal damage while showing no visual signs of being struck. The designer is thus forced to restrict these composites to load levels far below the capabilities of the fibers to compensate for environmental effects and possible impact damage. Bismaleimide resin systems have provided improved thermal resistance over epoxies but possess the same limitations. The material suppliers have undertaken to address these limitations by formulating new resin systems to provide better impact resistance, higher strain-to-failure, and improved hot-wet strength. The impact characterization described in this paper was one part of a larger overall program fully characterizing several new prepreg systems with respect to their physical and mechanical properties, see reference 1.

The materials being evaluated were divided into two classes based upon operational service temperature. The AS4/Hercules 3501-6 graphite/epoxy was compared to the newer AS4/Hercules 2201-1, Celion High-Strain/Narmco 5245, and IM6/Narmco 5245C toughened epoxy systems in the 250°F (121°C) service category. Materials tested in the 350°F (177°C) service category were: T300/Avco 130B, T300/Hexcel 81-5, T300/U.S. Polymeric V378A, XAS/Hysol 9101-3, and HX/Hexcel 1516 graphite/bismaleimides.

PROCEDURE

Equipment – A Dynatup Model 8200 Drop Tower with Dynatup Model 371 Instrumented Impact System was used for the impact tests, figure 1. Cross-head weight can be varied from 7.0 to 32 pounds and impact velocities up to 25 ft/sec achieved. This tower can impose impact energies in the range from 1 to 320 ft-lb so that the complete spectrum of composite failure mechanisms from incipient damage up to through-penetration can be studied. Impact-force versus time and velocimeter output from the instrumented impact system are captured on a Nicolett Explorer III model 206-2 digital oscilloscope. The cursor trigger feature of the digital oscilloscope simplifies testing as the force-time analog output itself is used to trigger signal capture. Further, the digitized wave form then stored by the oscilloscope is directly output to a Hewlett-Packard HP9826 desktop computer for analysis and data presentation.

Specimen Preparation. Quasi-isotropic, 16 ply laminates with $[\pm 45_2/(0/90)_2]_s$ stacking sequence were fabricated of each material system from which individual, 6 inch square impact test specimens were cut. Nominal specimen thickness was 1/8 inch. All specimens were fabricated from prepreg-tape except the T300/V378A specimens which were made from balanced plain weave cloth.

Procedure. Each plate impact specimen was clamped in the drop tower along its edges between two steel frames leaving a 5 inch by 5 inch square test section. A 1/2 inch radius hemispherical steel

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indenter was attached to the cross-head and each specimen was struck once at its center normal to its surface. The cross-head was caught after rebound to prevent multiple impacts. All specimens were inspected by ultrasonic C-scan before and after each test. All testing was performed at room temperature in a laboratory environment. Impact energy was controlled by adjusting the cross-head weight and drop height. Critical parameters determined for comparing the impact response of each type of materials are:

- (1) Load at incipient damage, P_{inc}
- (2) Energy absorbed at incipient damage, E_{inc}
- (3) Maximum load, P_{max}
- (4) Energy absorbed to maximum load, E_{max}
- (5) Total absorbed energy for through-penetration, E_{tot}

A typical instrumented-impact output for a through-penetration test of AS4/3501-6 specimen is shown in figure 2 identifying the various critical loads and energies. While the load and time response is directly measured, the absorbed energy and displacement values are incrementally computed from the measured initial velocity, cross-head mass, and the load-time history using the methods of reference 2.

Three impact energy levels were studied:

- (1) through-penetration (puncture)
- (2) maximum load impact energy, E_{max}
- (3) incipient damage

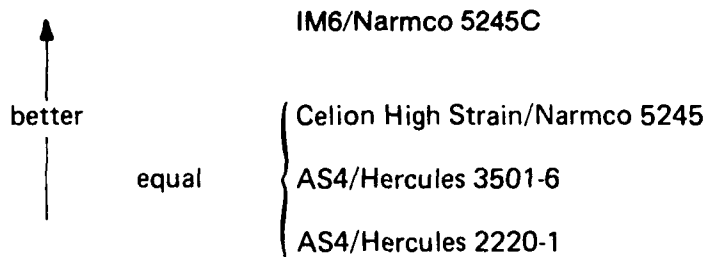
In this manner, a damage gradient is obtained for each prepreg system indicating its response over the entire range of damage mechanisms from incipient to total puncture. Only one test was performed per prepreg system per energy level. Through-penetration instrumented-impact test results were used to establish the peak load energy level. It was not obvious from the through-penetration test results when incipient damage had occurred. In most cases, incipient-damage impact levels could be determined from the peak-load impact energy level test or a lower impact energy level test. In those cases where none of the instrumented impact test traces clearly established incipient damage, it was determined by reducing the impact level until no damage was detectable by ultrasonic C-scan.

RESULTS

Table 1 presents a summary of the critical impact parameters measured during these tests. Table 2 and 3 present the individual test results for the 250°F and 350°F service systems, respectively. Detailed data sheets for each test specimen can be found in the appendix.

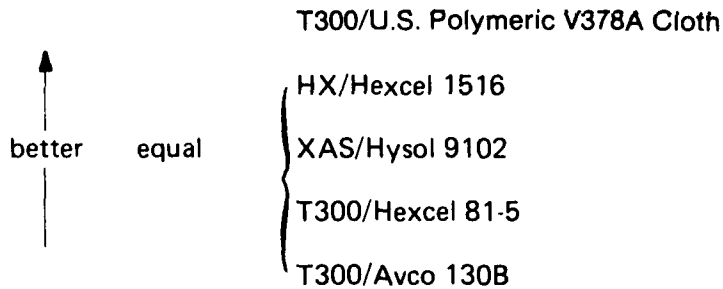
250°F Service Systems. Impact force versus displacement response of the four 250°F systems are plotted in figure 3. Figures 4 and 5 compare the energy and force results, respectively and figure 6 plots the C-scan damage area versus impact energy (cross-head kinetic energy at impact) results. The IM6/Narmco 5245C demonstrated the best impact resistance, requiring nearly twice the energy to cause incipient damage and a third more energy to penetrate as the other systems. There was little difference between the response of the other three materials. In C-scan damage area versus impact energy, the AS4/Hercules 3501-6 sustains the greatest damage at the 10 ft-lb impact level, but at higher energy levels the four systems are similar.

Our ranking of the impact resistance of the 250°F service systems is then:



350°F Service systems. The impact force versus displacement response of the five bismaleimide systems is shown in figure 7. Figures 8 and 9 present the energy and force result comparisons and figure 10 plots the C-scan damage area versus impact energy. Since the T300/U.S. Polymeric V378A test specimens were made from plane-weave cloth, its impact response can not be directly compared to the other, tape layup systems. The use of woven cloth generally results in smaller damage areas as the delamination is inhibited by the direct mechanical reinforcement of the interlocking fabric yarns. Of the tape systems, all had similar impact response, except for the T300/Avco 130B. It experienced incipient damage at a third the energy of the other systems and required only half the energy to be punctured. It also experienced the largest damage areas of all systems tested.

While the incipient damage levels of the better bismalimides were equal to the lower temperature materials, they were more easily punctured than the latter. Our ranking of the impact resistance of the bismaleimide systems is then:



DISCUSSION

It is normally assumed that the initiation of damage in the composite-plate impact specimen causes a reduction in stiffness which is indicated as a dip in the load-time trace. This point could not always be established from the impact test output due to the presence of higher frequency oscillations on the load analog signal which are the result of dynamic interactions between target-plate and cross-head, figure 1. Further, the initial damage experienced in the matrix of the composite plate may be so slight as to have negligible effect on the bending stiffness and so not appear on the impact test trace. Thus, ultrasonic C-scan inspection was essential to establish the presence of damage and aid in determining the incipient-damage impact level in three of the nine systems tested.

Due to the amount of material needed to fabricate the relatively large test specimens required for drop tower testing, only one impact test was performed per system per energy level. The 6 inch by 6 inch by 1/8 inch specimen size serves both to simulate typical service support conditions and to suppress the higher frequency oscillations present on the force analog output by reducing the

effective stiffness of the target plate relative to the cross-head. Since the same large amount of scatter can be expected in the impact test results as is typically encountered in composite static testing, this is a serious disadvantage.

In ranking the impact resistance of different materials, high resistance to incipient damage clearly is a desirable trait, so too is high maximum load. The maximum load can be interpreted as corresponding to the fiber failure while the incipient damage load corresponds to matrix failure. How the composite should be ranked based upon total absorbed energy, on the other hand, is not so clear cut. The total absorbed energy includes the energy absorbed by the composite in the creation of damage. It also includes the energy lost through the various dissipative mechanisms during the impact event. Such examples are damping in the cross-head and within the specimen and the frictional drag between the tup-shaft and specimen at the edge of the hole created in the specimen during the puncture test. We shall choose to ignore all these effects except for the creation of damage in the specimen. Here again, the use of the ultrasonic C-scan inspection was essential in interpreting the impact test results. Materials which incur large areas of delamination which could reduce a structure's compressive strength are less desirable than those materials which confine the damage to a relatively small area. Materials which absorb little total energy but produce a small, clean hole may be desirable in some applications, providing they also have high initial damage and peak load values. If the structure is such that holes can't be tolerated, then materials which absorb large amounts of energy in the creation of delamination surfaces may be preferable rather than the low velocity impact threat penetrating the component. Generally, the best materials are those which absorb the greatest amount of energy for the least amount of damage. Thus, total absorbed energy is not in itself a useful parameter in ranking material impact response. The extent of damage must also be known along with the type of damage the intended structure can best tolerate.

The incipient damage energy level for the AS4/Hercules 3501-6 is 1.2 foot-pounds. This represents the baseline level from which to assess the improvements achieved by the newer materials. The IM6/Narmco 5245C, which had the highest incipient damage level of the materials tested here, more than doubles this value with an incipient damage energy value of 2.7 foot-pounds. In practical terms, however, a two or three-fold improvement over the 1.2 foot-pounds level still results in an easily damaged material. The designer must still allow for the possibility of sub-visual damage occurring in the structure. Thus, residual strength and fatigue testing of damaged composite specimens is required to fully assess the effects of impact on the structural performance of a composite material system.

CONCLUSIONS AND RECOMMENDATIONS

1. The instrumented-impact testing was performed to make direct comparisons between the impact damage resistance of different composite material systems using geometrically identical test specimens. The through-penetration or puncture test, usually the single impact level investigated with drop-weight impact towers, provides the majority of impact response data, but by itself is insufficient to describe the range of composite damage levels likely to be experienced in service. Nor can it be relied upon to consistently provide incipient-damage impact data. A number of impact energy levels need to be imposed in concert with an adjunct damage measurement method, such as ultrasonic C-scan, to fully describe the impact response.
2. The IM6/Narmco 5245C demonstrated the best impact resistance of the four 250°F service temperature systems tested. The impact resistance of the Celion High-Strain/Narmco 5245, AS4/Hercules 3501-6, and AS4/Hercules 2220-1 were essentially identical.
3. In the 350°F service category, the HX/Hexcel 1516, XAS/Hysol 9101-3, and T300/Hexcel 81-5 had similar impact resistance. The T300/Avco 130B had the lowest impact resistance.

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4. The resistance of the bismaleimide composites to incipient damage was similar to that of the lower temperature systems, but the bismaleimides were more easily punctured.

5. The use of fabric composites seems to result in smaller damage areas than those of tape composite laminates.

6. Residual strength testing, particularly compression, needs to be performed in conjunction with instrumented-impact testing to fully assess the structural significance of impact damage in composite material systems.

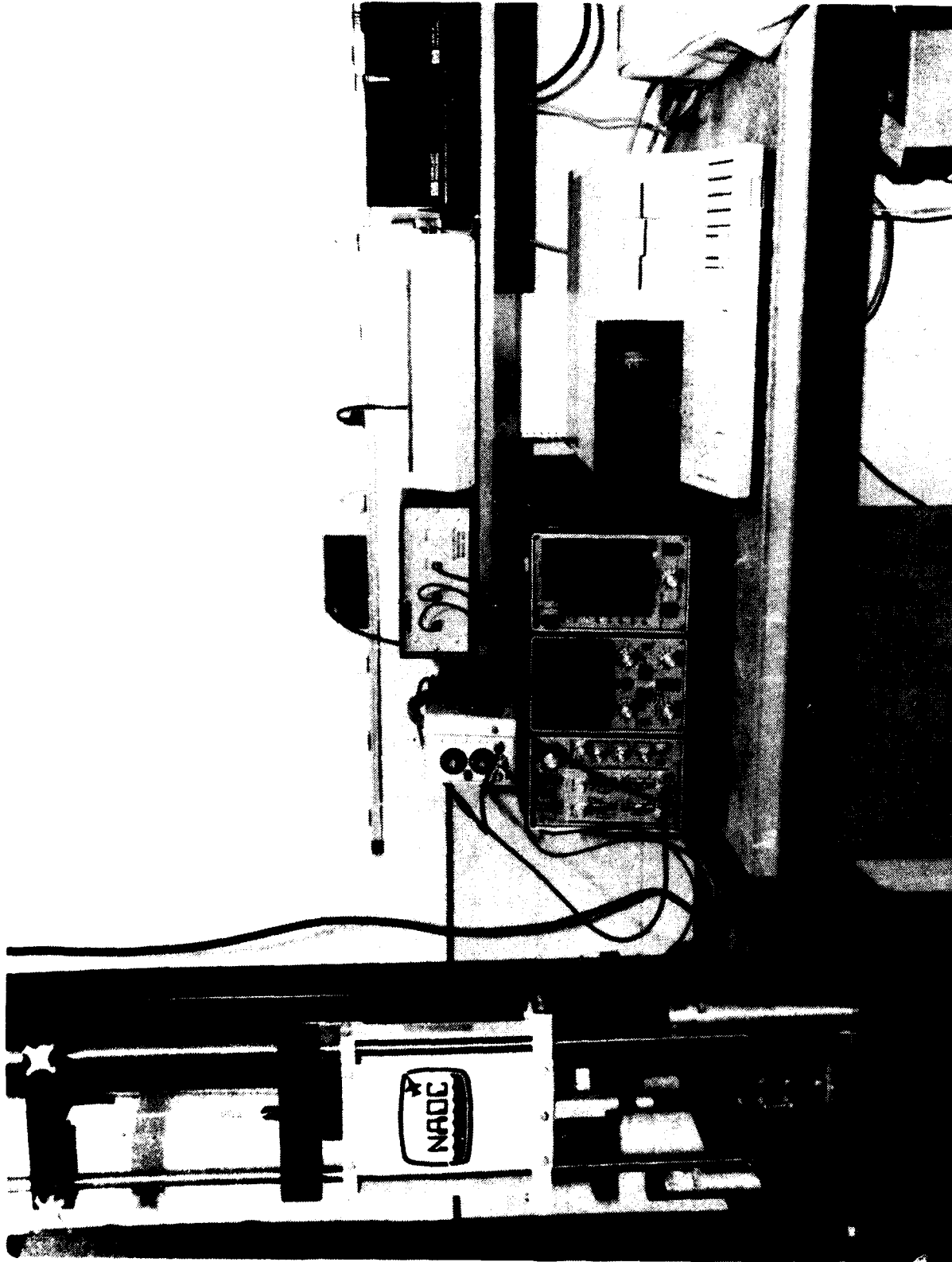


Figure 1. NADC Instrumented Drop Weight System

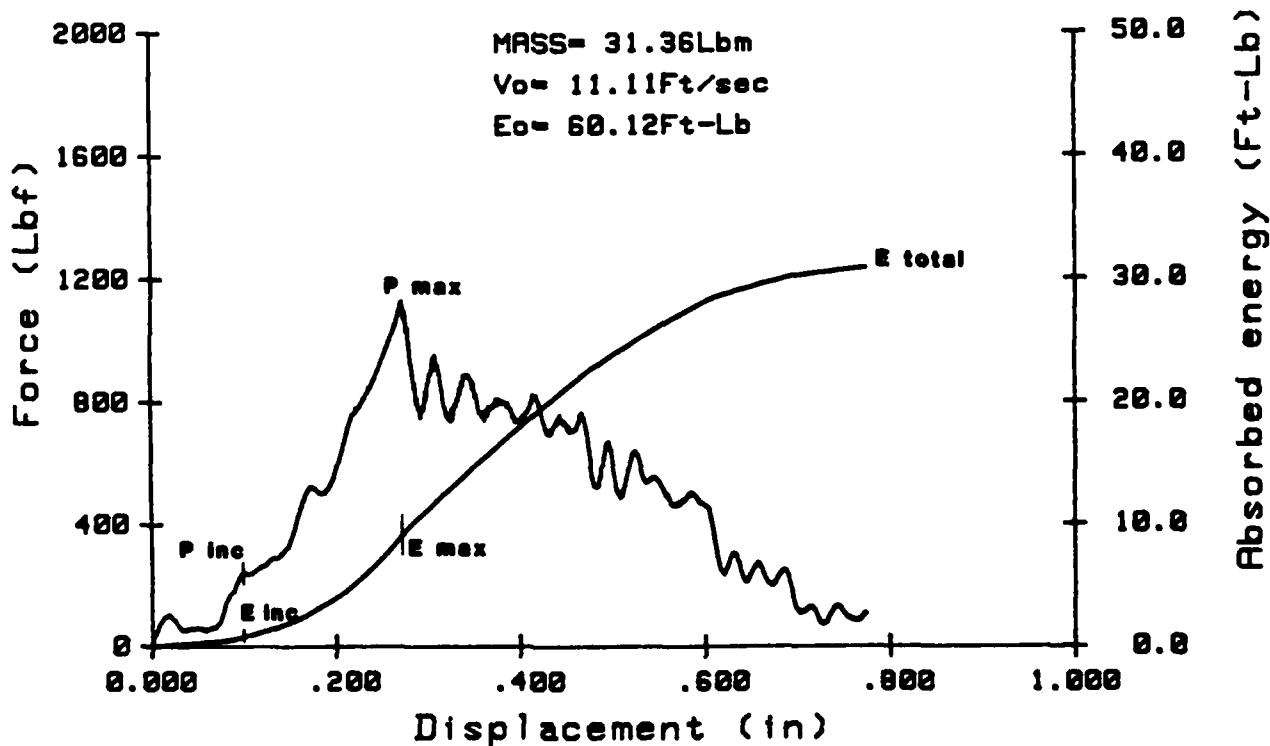
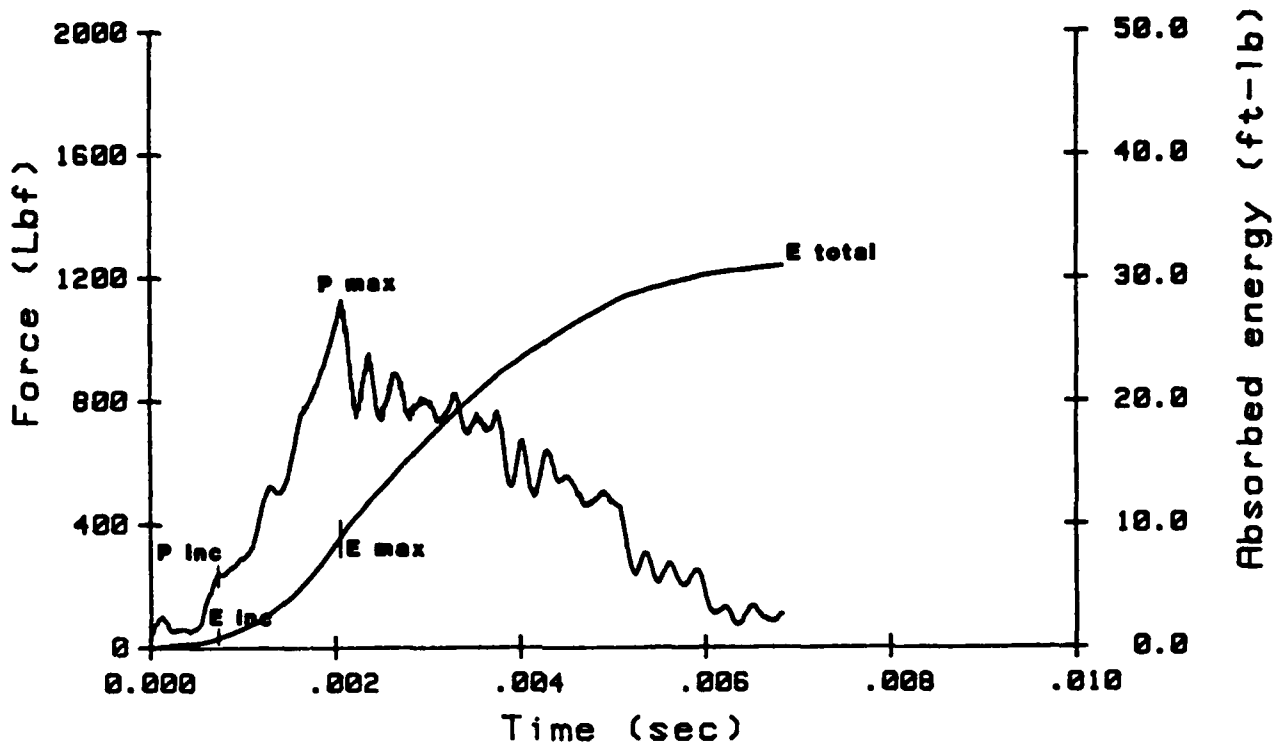


Figure 2. Instrumented Impact Test Output

1/8 INCH THICK 5X5 INCH CLAMPED PLATES

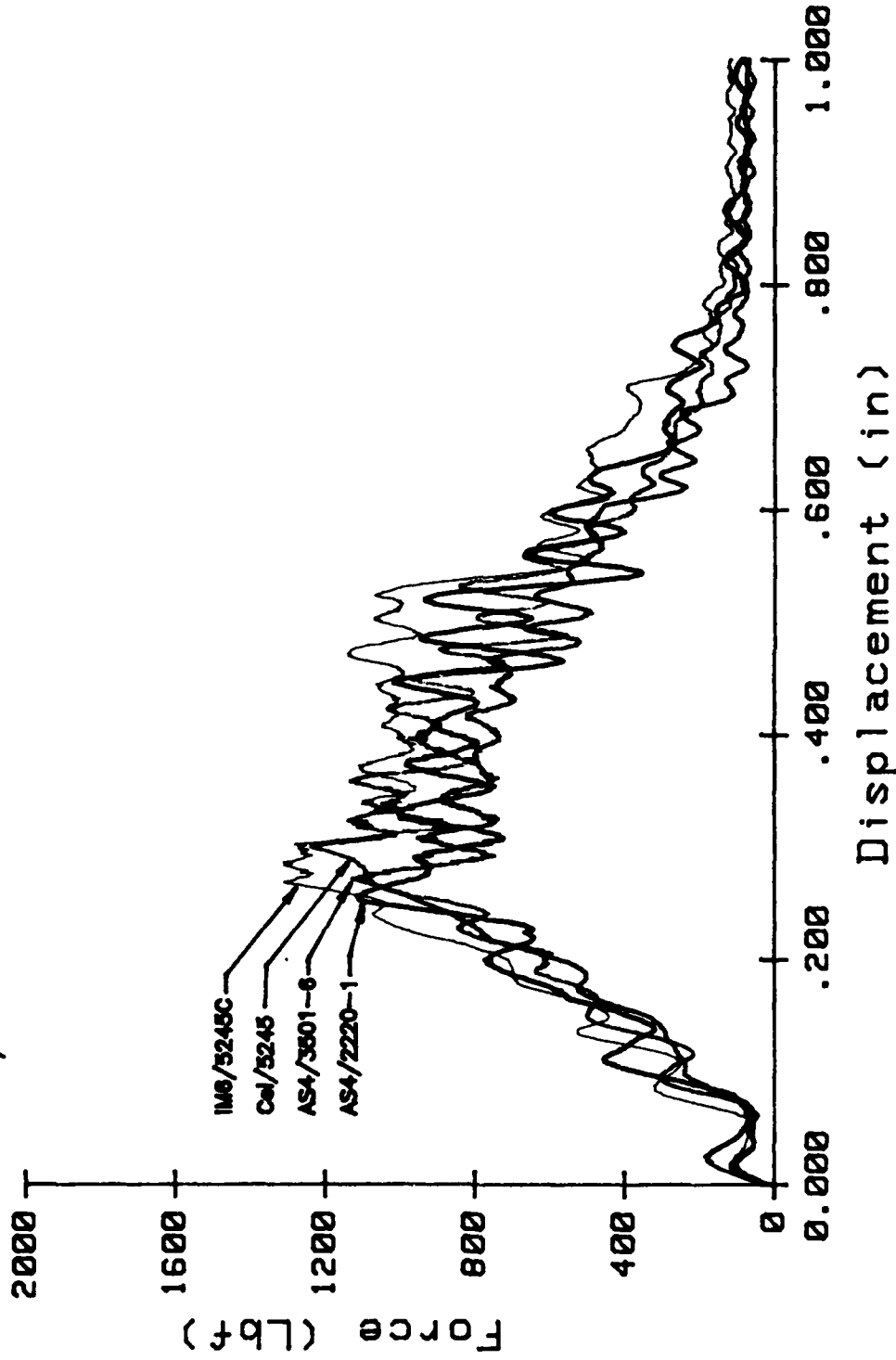
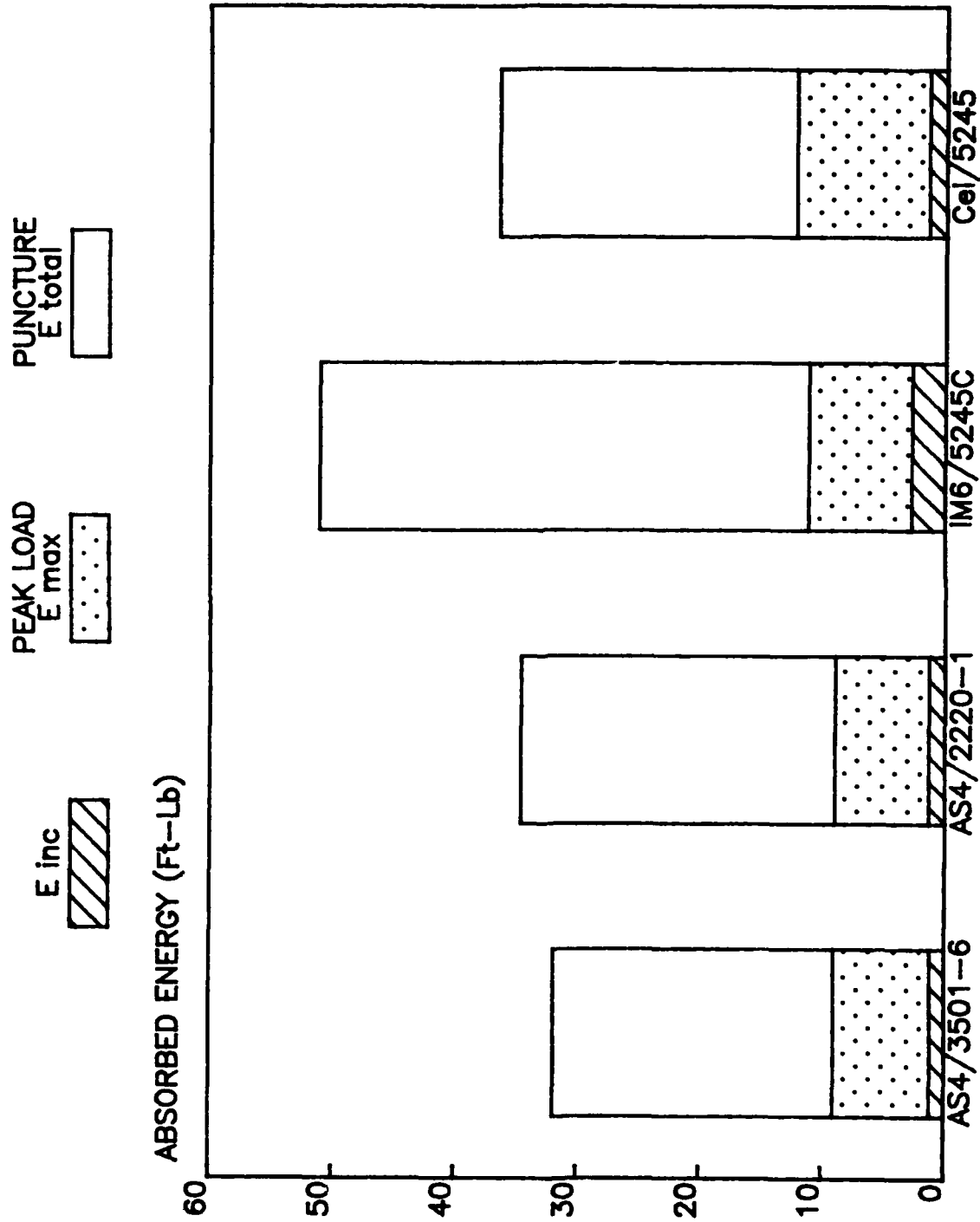
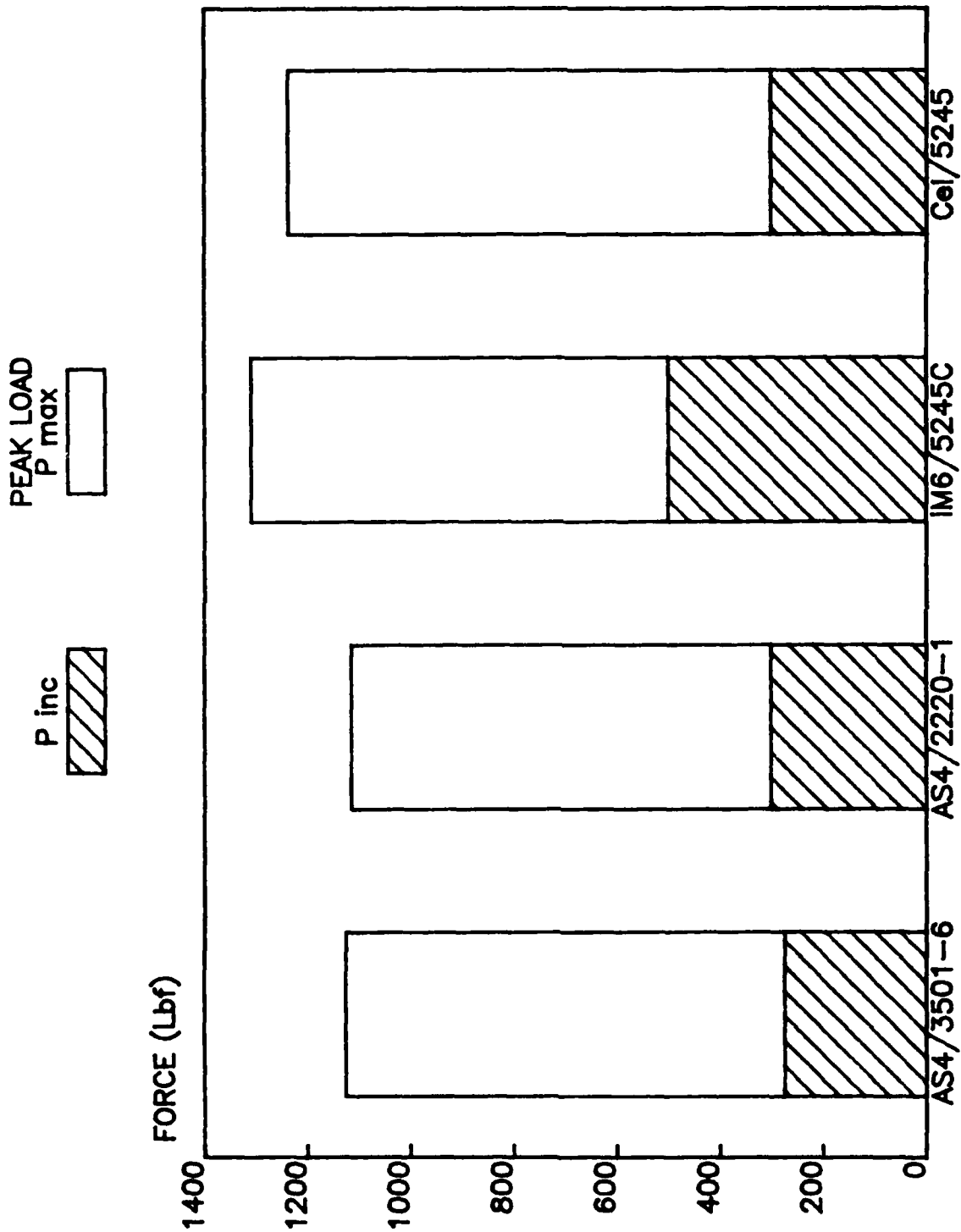


Figure 3. 250°F Service Materials — Impact Force Versus Displacement



1/8 INCH THICK 5X5 INCH CLAMPED PLATES

Figure 4. 250°F Service Materials - Energy Results



1/8 INCH THICK 5X5 INCH CLAMPED PLATES

Figure 5. 250°F Service Materials – Force Results

AS4/3501-6 AS4/2220-1 IM6/5245C Cel/5245

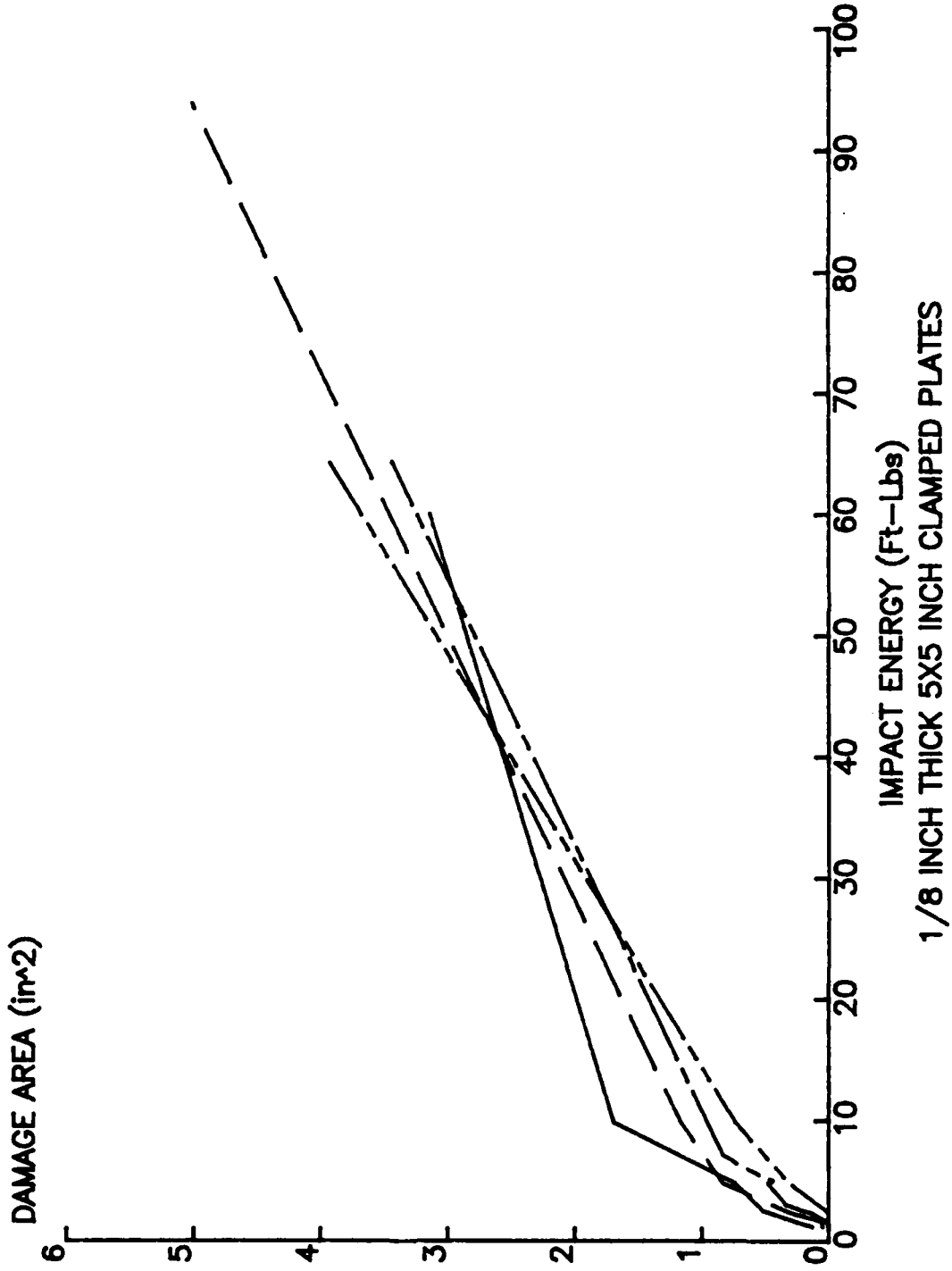


Figure 6. 250°F Service Materials - C-Scan Results

1/8 INCH THICK 5X5 INCH CLAMPED PLATES

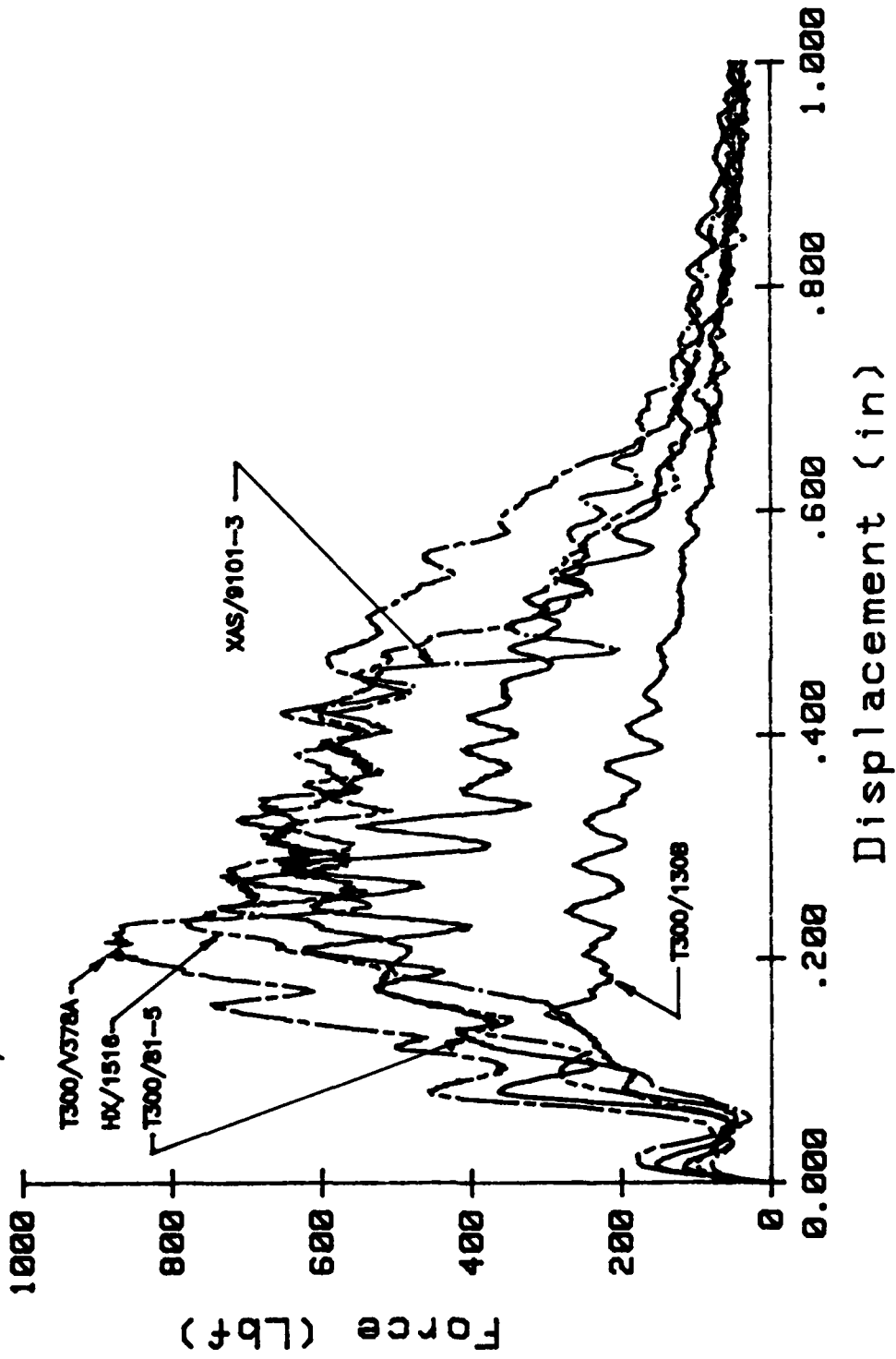
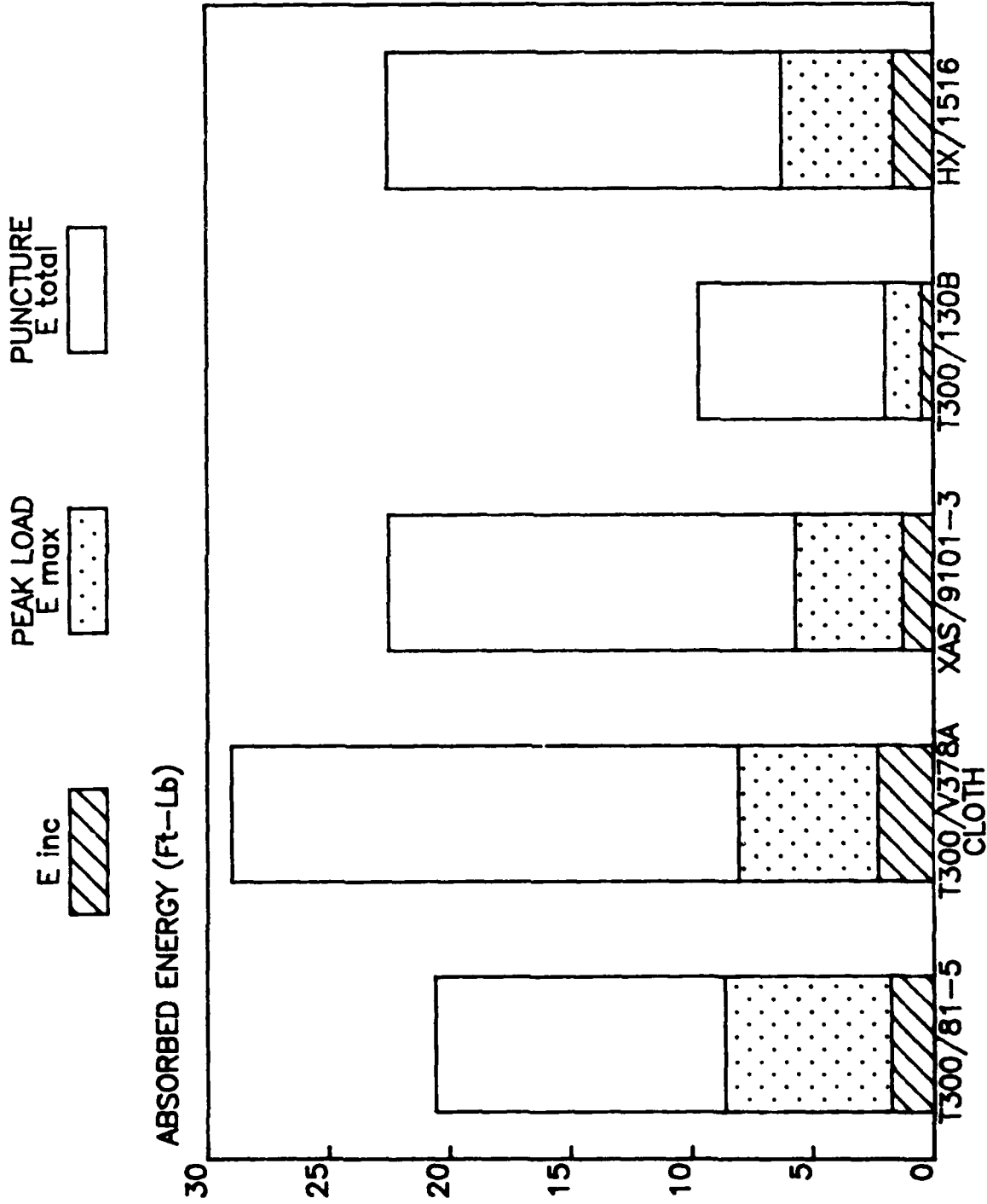
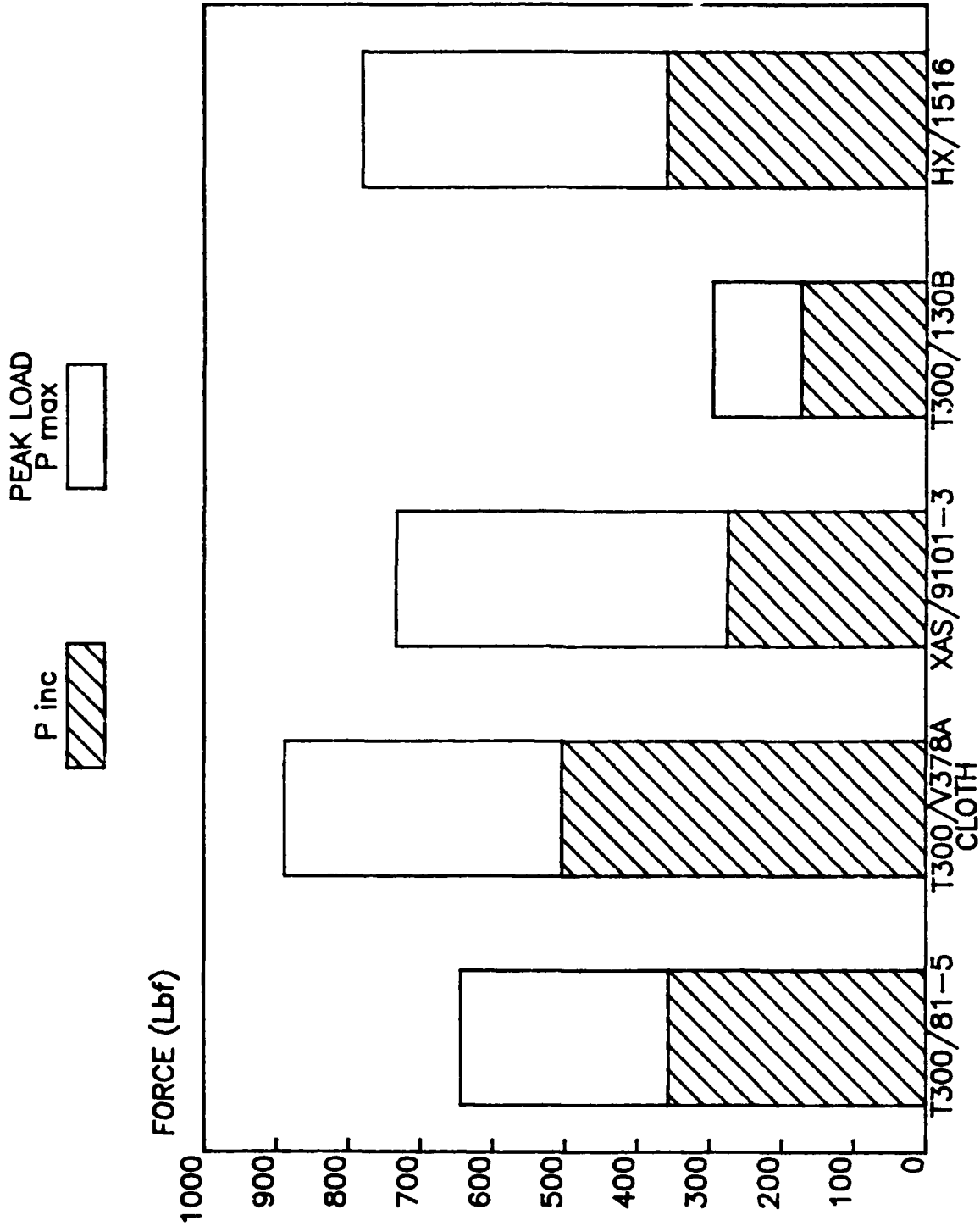


Figure 7. 350°F Service Materials — Impact Force Versus Displacement



1/8 INCH THICK 5X5 INCH CLAMPED PLATES

Figure 8. 350°F Service Materials — Energy Results



1/8 INCH THICK 5X5 INCH CLAMPED PLATES

Figure 9. 350°F Service Materials Force Results

T300/81-5 T300/V378A CLOTH XAS/9101-3 T300/130B HX/1516

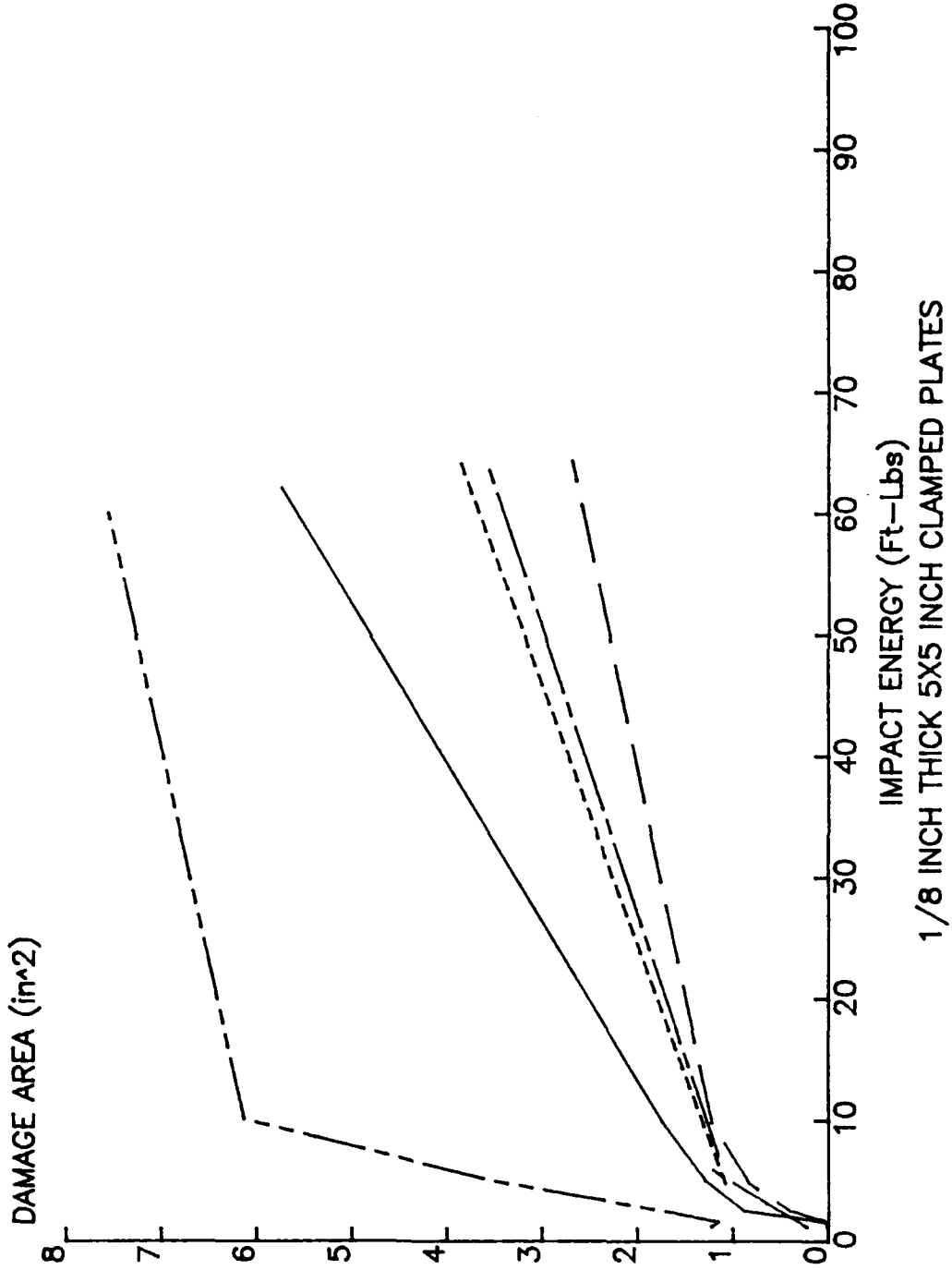


Figure 10. 305°F Service Materials - C-Scan Results

TABLE 1
SUMMARY OF IMPACT RESULTS

SERVICE TEMP. (F)	AT INCIPIENT DAMAGE		AT MAXIMUM LOAD		TOTAL ENERGY FOR PENETRATION	
	P inc (Lbs)	E inc (Ft-Lbs)	P max (Lbs)	E max (Ft-Lbs)	E total (Ft-Lbs)	E total (Ft-Lbs)
250	274.7	1.19	1125.8	9.07		31.90
ASA/3501-6						
250	<301.3 *	<1.30 *	1115.1	8.97		37.79
ASA/2220-1						
250	302.1 *	1.41 *	1237.3	12.21		37.85
Col/5245						
250	500.6	2.71	1309.3	11.14		51.06
IM6/5245C						
350	172.9	0.46	294.9	1.98		9.69
1300/1308						
350	356.3	1.77	643.9	8.63		20.58
T300/81-5						
350	<274.7 *	<1.26 *	733.8	5.71		22.50
XAS/s101-3						
350	358.8	1.65	780.5	6.26		22.53
HX/1516						
350	504.2	2.30	888.4	8.06		29.00
T300/V378A (CLOTH)						

* ESTIMATED FROM C-SCAN RESULTS

TABLE 2
2500°F SERVICE MATERIALS IMPACT TEST RESULTS

MATERIAL	SPECIMEN NO.	THICKNESS (in.)	IMPACT MASS M lb	VELOCITY V ft/sec	KINETIC ENERGY K.E. ft-lb	AT INITIAL DAMAGE			AT PEAK LOAD			TOTAL ABSORBED ETOT ft-lb	C-SCAN DAMAGE		
						P _{inc} lb	E _{inc} ft-lb	δ _{inc} in	P _{max} lb	E _{max} ft-lb	δ _{max} in		X in	Y in	$\frac{XY}{4}$ in ²
ASA/3501-6	8	0.081	7.00	3.38	1.24	*	*	*	277.4	1.31	0.1324	0.48	0.375	0.438	0.129
	7	0.082	7.00	3.83	1.60	*	*	*	313.5	1.62	0.1480	0.75	0.500	0.625	0.245
	4	0.080	7.00	4.83	2.54	274.7	1.19	1.380	423.5	2.62	0.1811	1.13	0.875	0.750	0.515
	3	0.080	7.00	6.67	4.83	*	*	*	663.6	4.87	0.2237	2.04	1.000	0.938	0.737
	2	0.081	7.00	9.52	9.86	*	*	*	1085.4	9.86	0.2983	4.55	1.500	1.438	1.694
Puncture	1	0.080	31.36	11.11	60.12	*	*	*	1125.8	9.07	0.2721	31.90	2.000	2.000	3.142
ASA/2220-1	7	0.096	7.00	3.37	1.23	*	*	*	301.2	1.30	0.1171	0.42	0.250	0.250	0.049
	6	0.097	7.00	3.92	1.67	*	*	*	351.2	1.75	0.1387	0.64	0.375	0.188	0.055
	4	0.100	7.00	4.69	2.40	*	*	*	438.4	2.43	0.1632	1.07	0.688	0.563	0.304
	3	0.099	7.00	6.67	4.83	*	*	*	658.2	4.81	0.2055	2.32	1.063	1.000	0.835
	2	0.098	7.00	9.52	9.86	*	*	*	989.2	9.74	0.3039	5.90	1.250	1.188	1.166
Puncture	1	0.098	31.36	13.89	93.93	*	*	*	1115.1	8.97	0.2565	37.79	3.000	2.125	5.007
IM6/5245C	6	0.085	7.00	3.35	1.22	*	*	*	291.4	1.22	0.1130	0.57	0	0	0
	5	0.085	7.00	3.92	1.67	*	*	*	372.3	1.71	0.1246	0.64	0.125	0.188	0.019
	9	0.085	7.00	4.63	2.33	*	*	*	453.2	2.38	0.1406	0.97	0.375	0.438	0.123
	10	0.086	7.00	4.63	2.33	*	*	*	440.6	2.39	0.1472	1.01	0.375	0.438	0.129
	4	0.084	7.00	5.29	3.04	*	*	*	510.8	2.90	0.1561	1.54	0.625	0.688	0.338
	7	0.085	7.00	6.67	4.83	519.8	2.82	1.581	680.7	4.88	0.2010	2.31	0.750	0.813	0.479
	8	0.085	7.00	6.80	5.03	500.0	2.73	1.509	689.7	4.94	0.1975	2.64	0.813	0.688	0.439
	3A	0.083	7.00	7.58	6.24	*	*	*	817.4	6.34	0.2314	2.94	0.875	1.000	0.687
	2	0.086	7.00	8.13	7.18	482.0	2.59	1.558	848.9	6.96	0.2390	4.14	1.063	1.000	0.835
	Puncture	1	0.085	31.36	11.49	64.34	*	*	*	1309.3	11.14	0.2692	51.06	2.000	2.188
Cell#5245	7	0.085	7.00	3.12	1.05	*	*	*	260.3	1.13	0.1240	0.41	0	0	0
	6	0.084	7.00	3.88	1.63	*	*	*	343.9	1.70	0.1446	0.60	*	*	*
	1	0.084	7.00	4.76	2.46	*	*	*	451.0	2.55	0.1723	0.93	0.08	0.10	0.006
	2	0.086	7.00	6.67	4.83	*	*	*	672.6	4.91	0.2260	2.13	0.625	0.625	0.307
Puncture	3	0.086	7.00	9.52	9.86	*	*	*	1034.1	9.94	0.2853	5.34	1.000	0.938	0.7367
	4	0.085	31.36	11.49	64.34	*	*	*	1237.3	12.21	0.3009	37.85	2.500	2.000	3.927

*UNABLE TO DETERMINE FROM RESULTS

TABLE 3
3500°F SERVICE MATERIALS IMPACT TEST RESULTS

MATERIAL	SPECIMEN NO.	THICKNESS (in.)	IMPACT MASS M lb	VELOCITY V ft/sec	KINETIC ENERGY KE ft-lb	AT INITIAL DAMAGE			AT PEAK LOAD			TOTAL ABSORBED E _{TOT} ft-lb	C-SCAN DAMAGE		
						P _{inc} lb	E _{inc} ft-lb	δ _{inc} in	P _{max} lb	E _{max} ft-lb	δ _{max} in		X in	Y in	$\frac{XY}{4}$ in ²
T300/81-5	11	0.097	7.00	3.27	1.16	*	*	*	287.8	1.21	0.1133	0.47	0	0	0
	7	0.085	7.00	3.88	1.63	231.8	1.03	0.1216	273.9	1.71	0.1571	0.94	0.188	0.250	0.037
	5	0.097	7.00	4.63	2.33	344.0	1.54	0.1220	392.1	2.07	0.1417	1.33	0.938	0.938	0.691
	4	0.097	7.00	4.83	2.54	387.6	1.83	0.1210	426.2	2.10	0.1300	*	1.063	1.063	0.888
	3	0.100	7.00	6.80	5.03	398.4	1.89	0.1234	584.5	4.85	0.2027	3.25	1.250	1.313	1.289
Puncture	2	0.102	7.00	9.52	9.86	419.9	2.56	0.1530	597.1	7.01	0.2582	8.95	1.313	1.688	1.741
	1	0.098	31.36	11.30	62.17	*	*	*	643.9	8.63	0.2853	20.58	3.000	2.438	5.744
T300/V378A (Cloth)	6	0.110	7.00	3.38	1.24	*	*	*	347.6	1.28	0.0950	0.45	-	-	-
	5	0.111	7.00	4.02	1.75	*	*	*	411.0	1.71	0.1131	0.71	0.250	0.250	0.049
	4	0.110	7.00	4.83	2.54	473.0	2.29	0.1235	521.1	2.49	0.1288	1.33	0.688	0.750	0.405
	3	0.110	7.00	6.67	4.83	516.2	2.15	0.1162	649.2	4.92	0.1778	2.58	1.000	1.063	0.835
	2	0.111	7.00	9.52	9.86	523.4	2.46	0.1224	787.7	6.82	0.2062	7.80	1.250	1.250	1.227
Puncture	1	0.110	31.36	11.49	64.34	*	*	*	888.4	8.06	0.2163	29.00	1.85	1.85	2.688
XAS/9101-3	5	0.077	7.00	3.17	1.10	*	*	*	234.3	1.13	0.1346	0.72	*	*	*
	6	0.077	7.00	3.30	1.18	*	*	*	274.7	1.25	0.1351	0.49	0.563	0.500	0.221
	4	0.076	7.00	5.38	3.14	*	*	*	464.5	3.15	0.1961	1.74	0.875	0.938	0.645
	3	0.075	7.00	7.41	5.96	*	*	*	766.1	5.54	0.2450	3.02	1.188	1.313	1.225
	2	0.077	7.00	8.13	7.18	*	*	*	741.0	5.86	0.2441	5.57	1.313	1.125	1.160
Puncture	1	0.076	31.36	11.49	64.34	*	*	*	733.8	5.71	0.2483	22.50	2.438	1.875	3.590
T300/130B	6	0.086	7.00	3.37	1.23	159.2	.43	.0801	234.7	1.26	0.1383	0.68	1.188	1.313	1.225
	5	0.085	7.00	3.88	1.63	182.4	.54	.0861	266.9	1.63	0.1526	1.01	1.125	1.313	1.160
	4	0.084	7.00	4.73	2.43	177.1	.42	.0595	265.3	2.14	0.1653	2.14	1.688	1.250	1.657
	3	0.086	7.00	6.80	5.03	*	*	*	265.3	1.91	0.1447	5.17	2.313	1.938	3.521
	2	0.088	7.00	9.66	10.15	*	*	*	291.4	3.11	0.2167	8.94	3.125	2.500	6.136
Puncture	1	0.086	31.36	11.11	60.12	*	*	*	294.9	1.98	0.1553	9.69	3.500	2.750	7.560
HX/1516	2	0.083	7.00	6.67	4.83	358.8	1.65	0.1299	632.2	4.76	0.2111	2.63	1.188	1.188	1.085
	1	0.084	31.36	11.49	64.34	*	*	*	780.5	6.26	0.2327	22.53	2.625	1.875	3.866

*UNABLE TO DETERMINE FROM RESULTS

APPENDIX A
Instrumented Impact Test Data Sheets
and
C-Scan Results

Material System	Page
AS4/3501-6	A-2
AS4/2220-1	A-16
Celion high strain/5245	A-30
IM6/5245C	A-44
T300/81-5	A-66
T300/V378A Cloth	A-82
XAS/9101-3	A-95
T300/130B	A-108
HX/1516	A-122

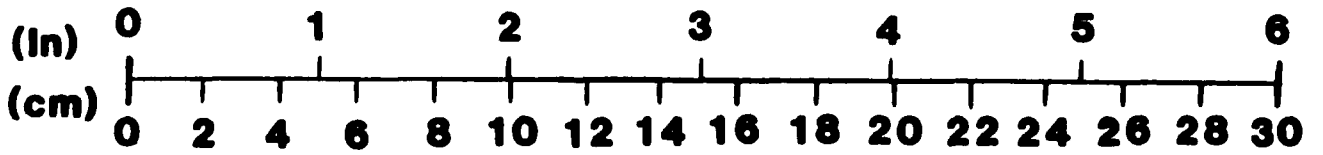
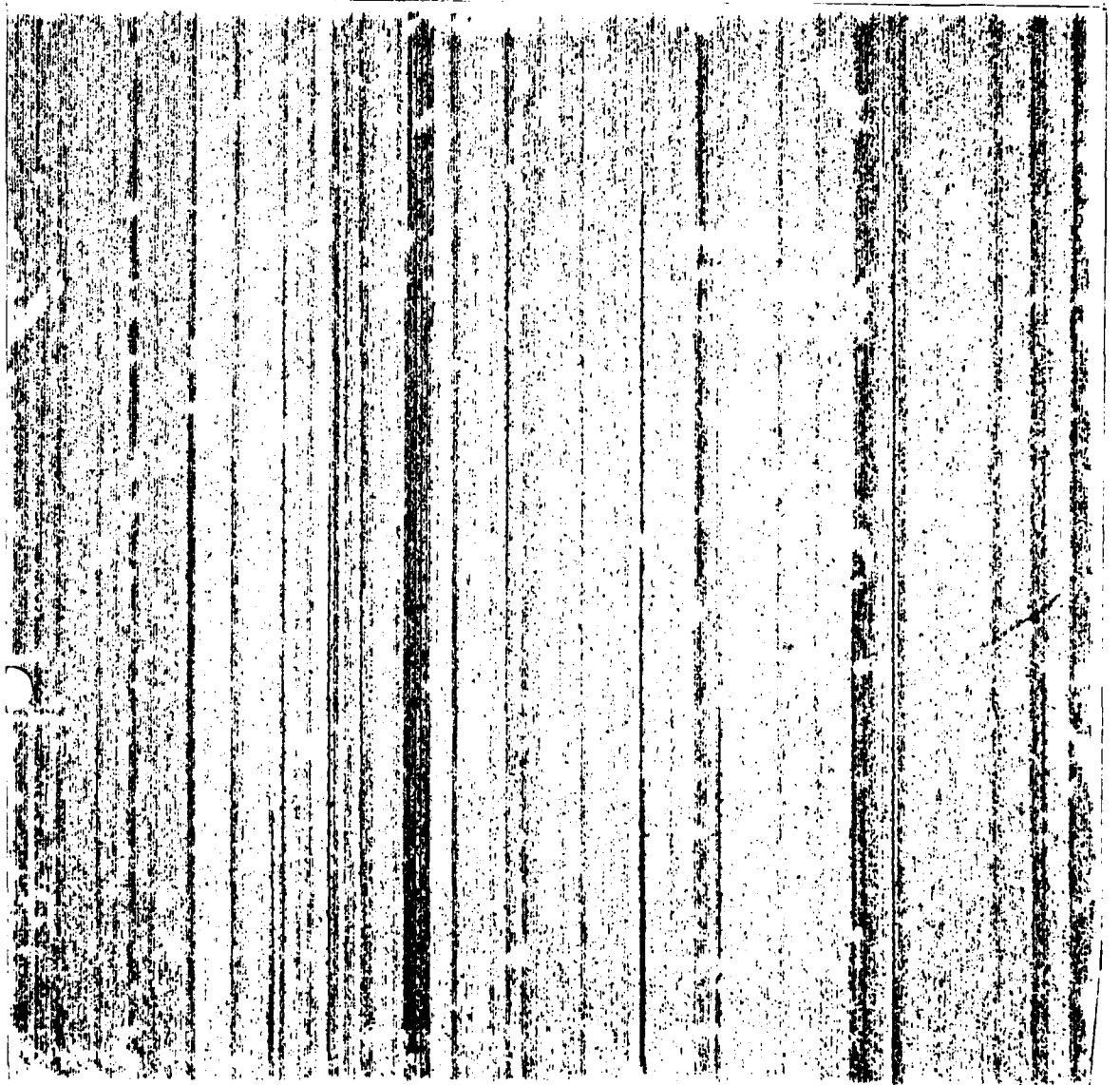
NADC-85023-60

AS4/3501-6

NADC-85023-60

AS4/3501-6

#15



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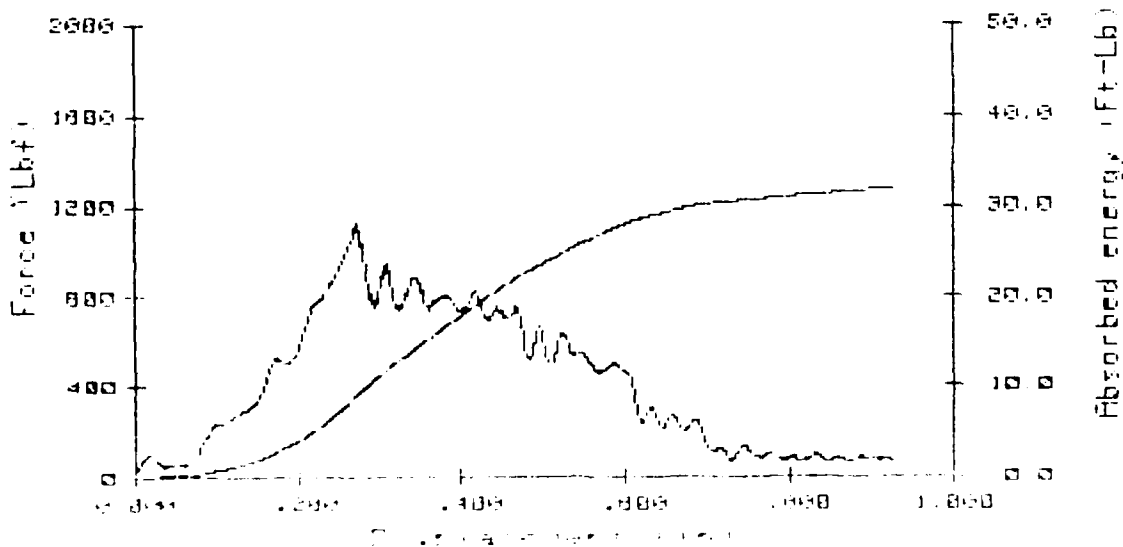
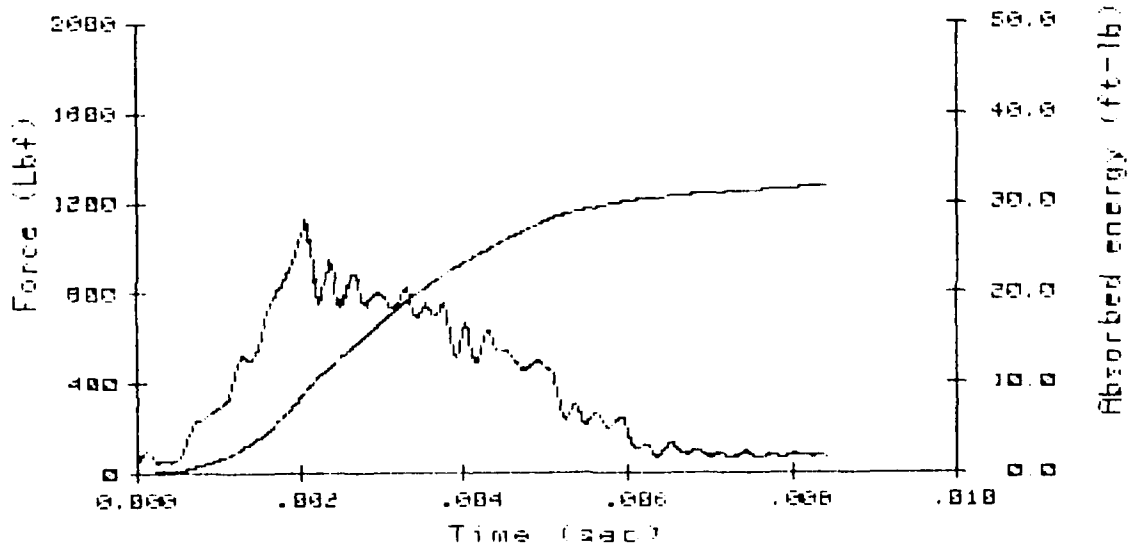
INSTRUMENTED IMPACT TEST

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GR/EP 3501-6 #1

Drop weight	=	31.36Lb	Data disk	MAT00804
Tip radius	=	.500in	DRM scale	.8Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	11.11ft/s		
K.E.	=	60.12ft-Lb	Vf(calc) =	7.93ft/s

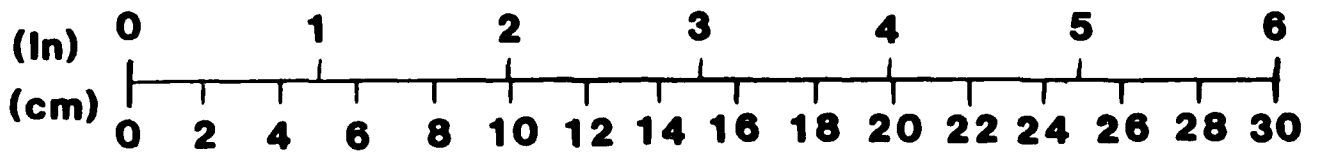
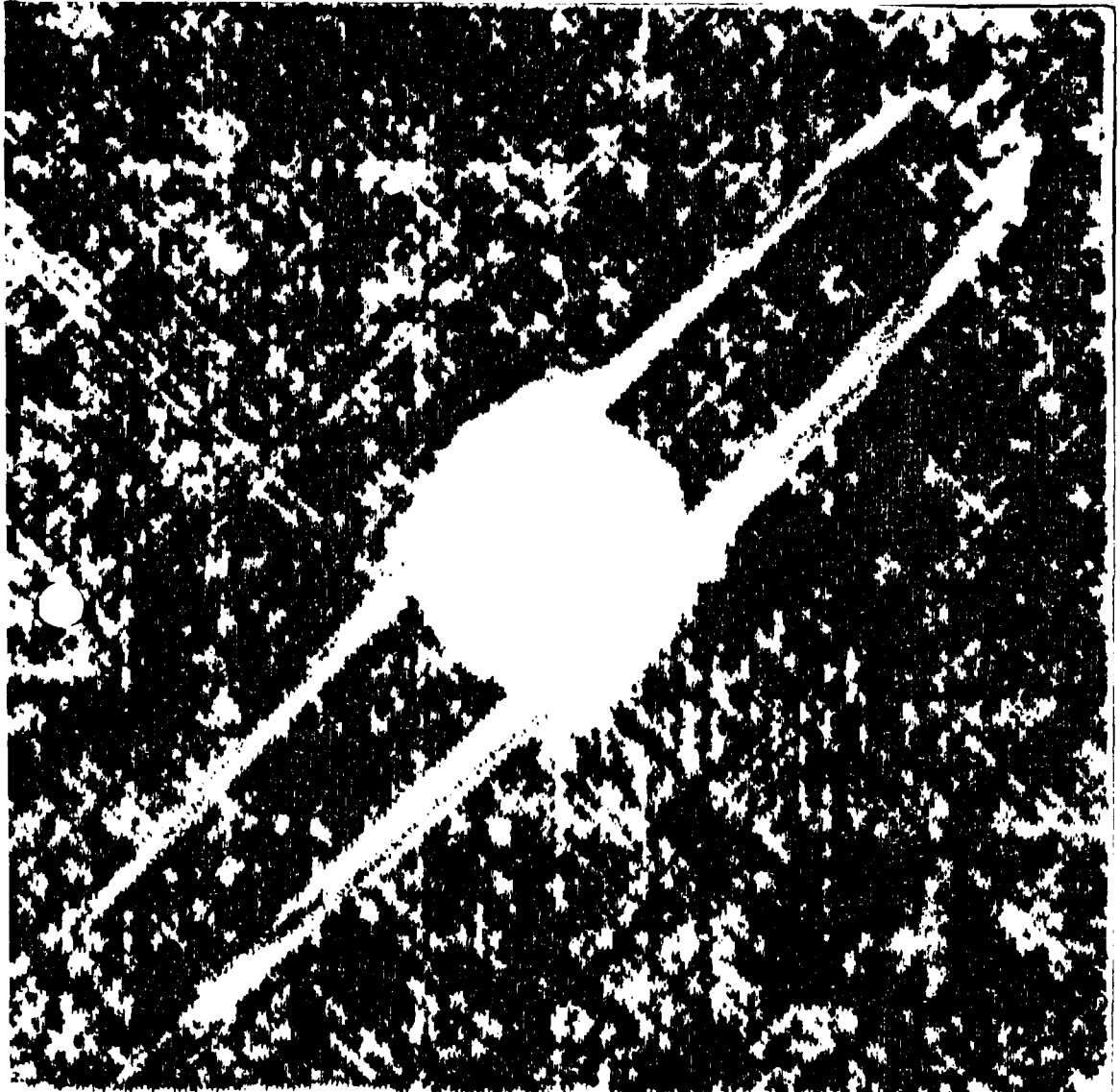
Load (Lb)	Time (s)	E0 (Ft-Lb)	Disp (in)	
1125.8	2.065E-3	9.07	.2721	Maximum force
73.7	8.415E-3	31.90	.9260	Maximum energy
73.7	8.415E-3	31.90	.9260	Maximum displacement
73.7	8.415E-3	31.90	.9260	Final values



NADC-85023-60

GR/EP 3501-6

#1



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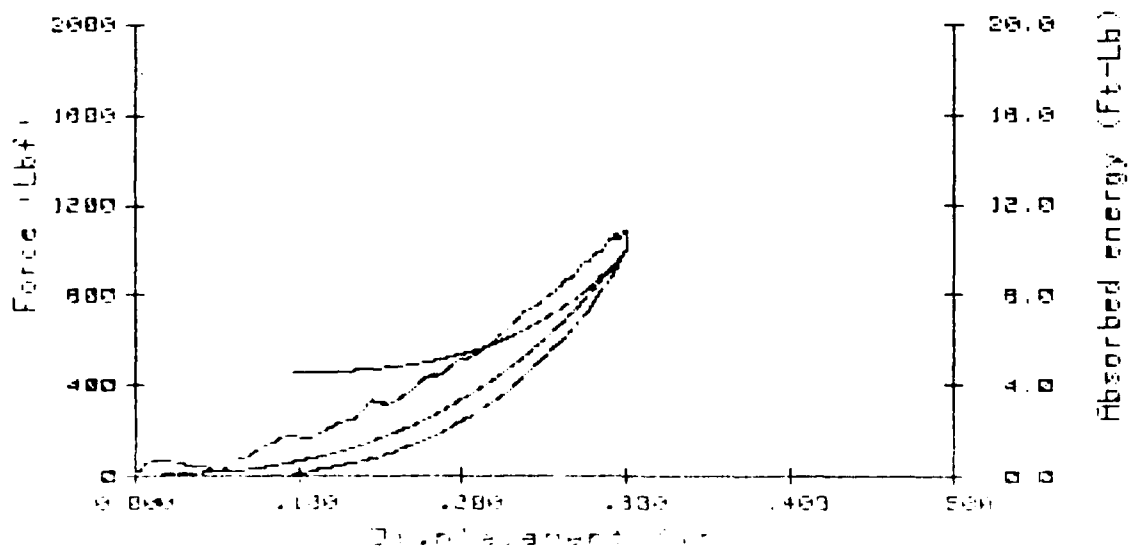
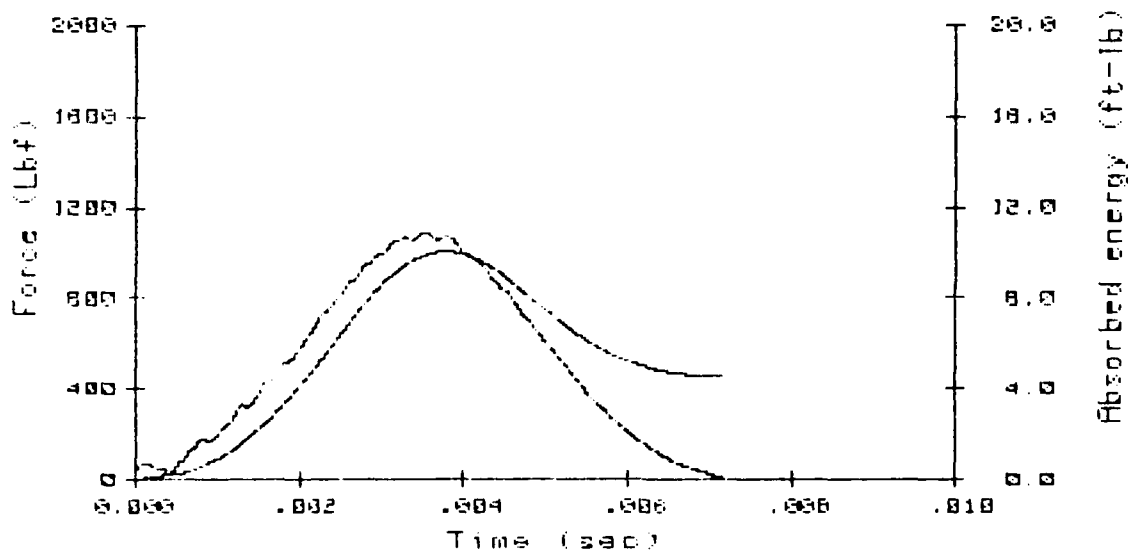
INSTRUMENTED IMPACT TEST

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GR/EP 3501-6 #2

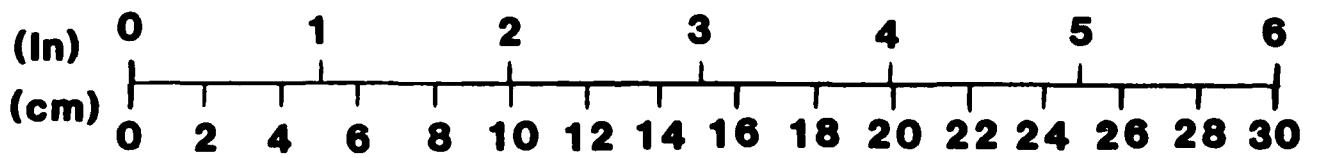
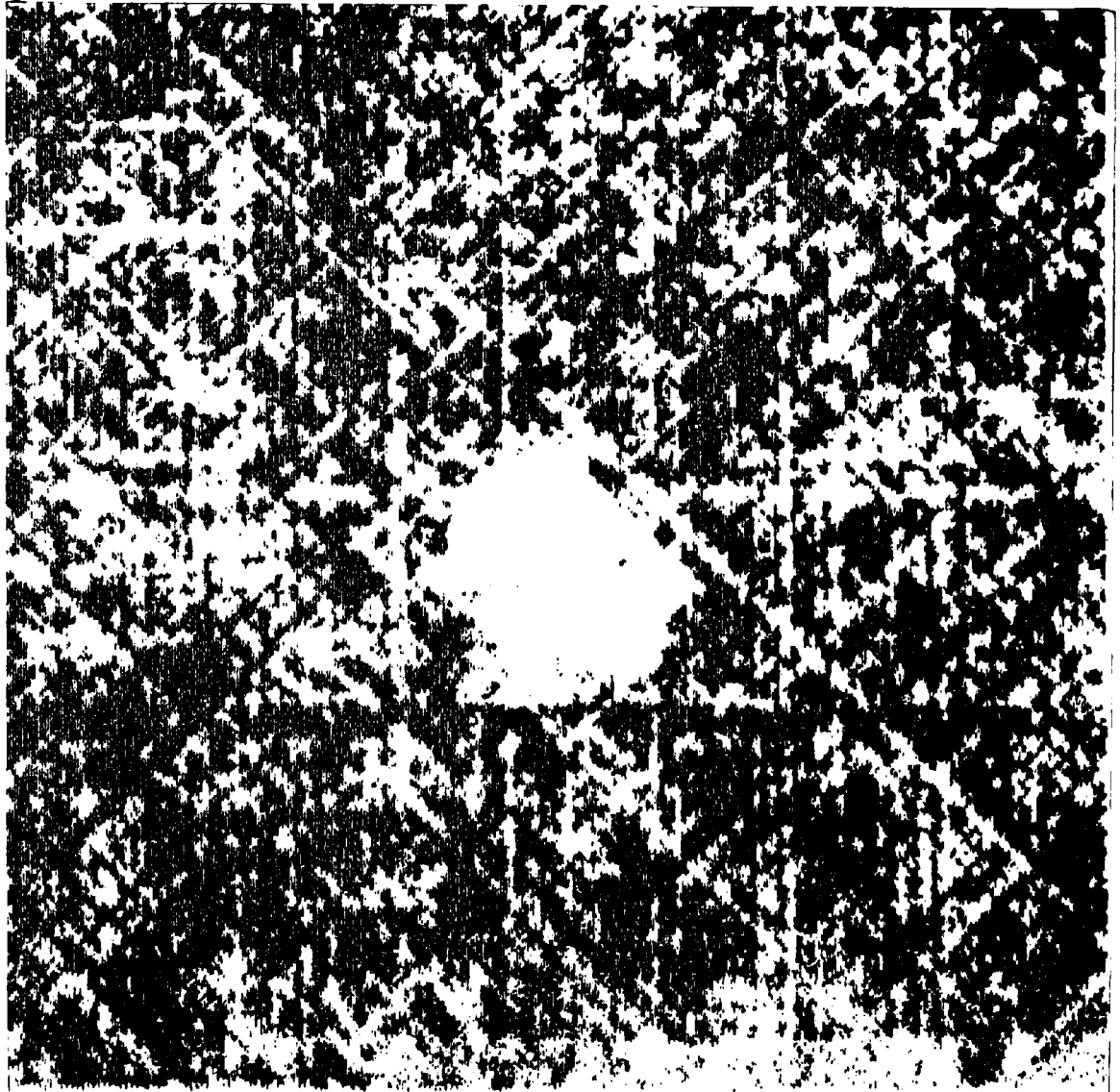
Drop weight	=	7.00Lb	Data disk	MAT00803
Top radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	9.52ft/s	abs(Vf) =	8.55ft/s
K.E.	=	9.86ft-Lb	Vf(calc) =	-7.03ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
1085.4	3.505E-3	9.86	.2983	Maximum force
1070.1	3.765E-3	10.03	.3002	Maximum energy
1070.1	3.765E-3	10.03	.3002	Maximum displacement
7.2	7.135E-3	4.55	.0963	Final values



GR/EP 3501-6

#2

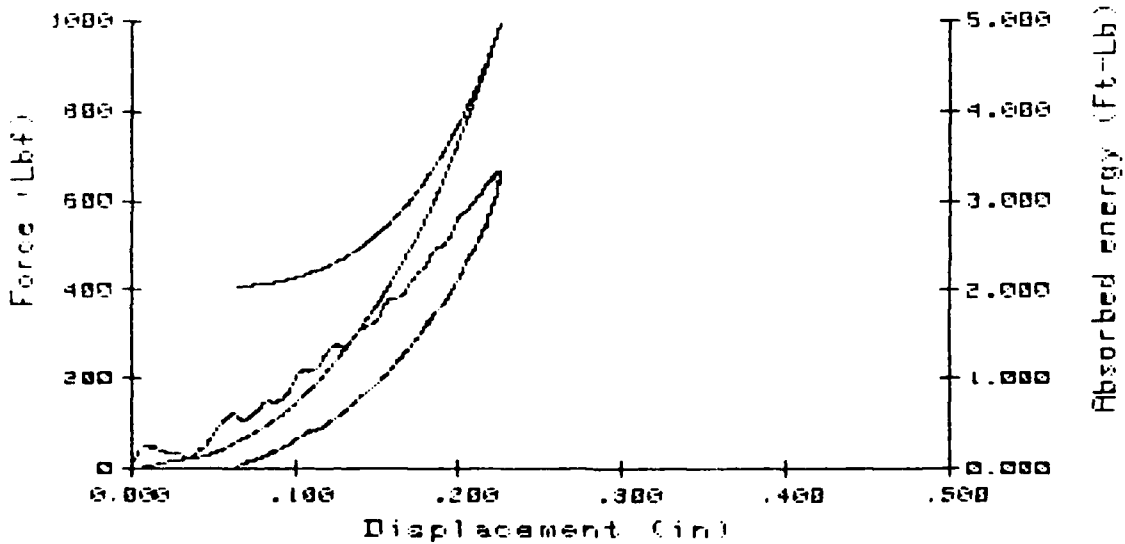
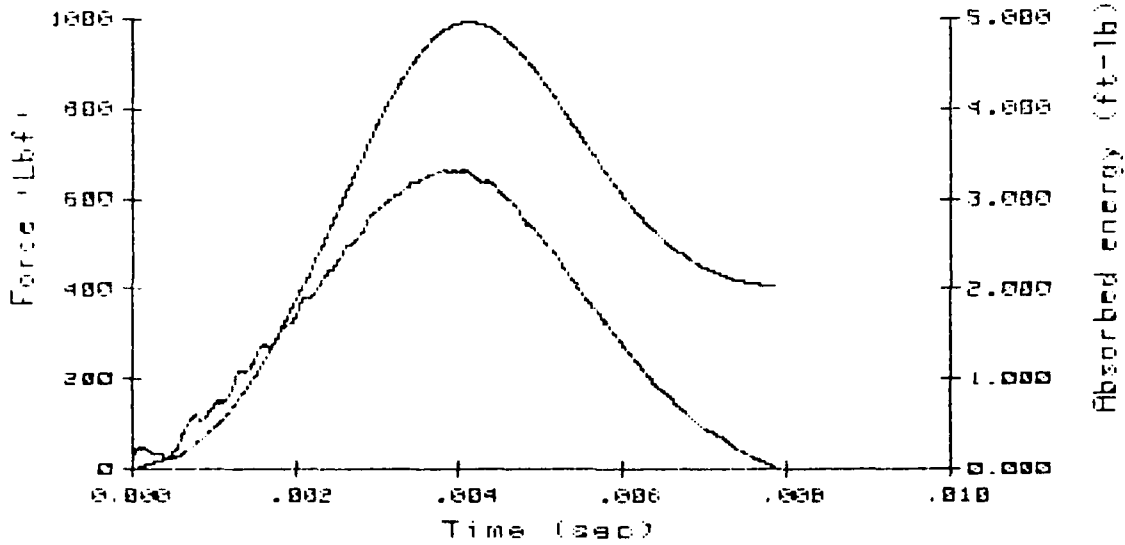


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 INSTRUMENTED IMPACT TEST
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GR/EP 3501-6 #3

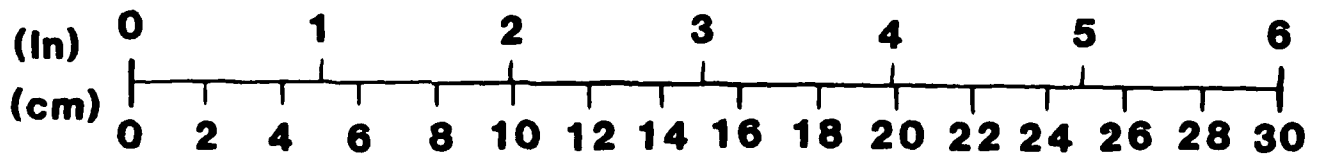
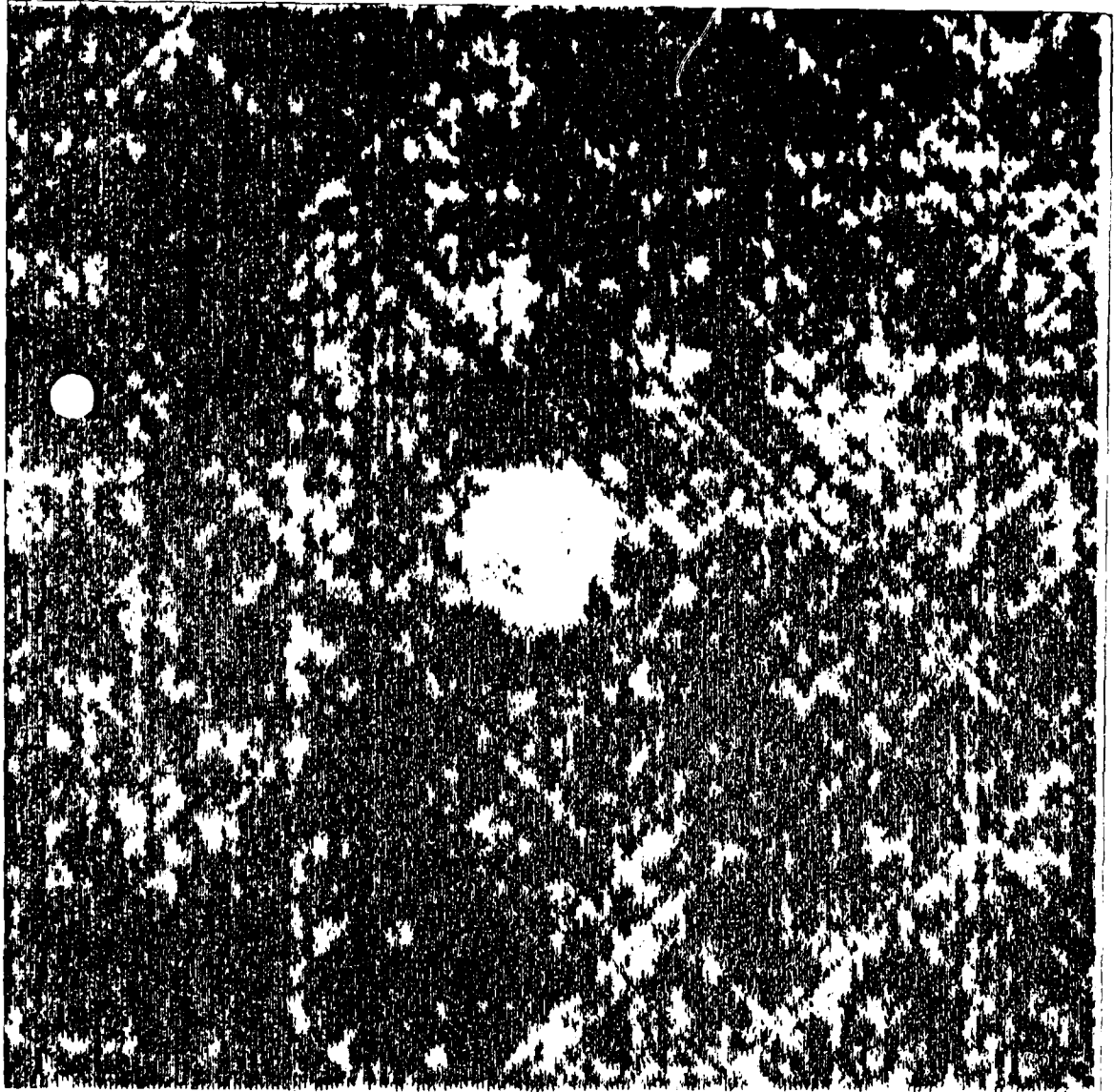
Drop weight	=	7.00Lb	Data disk	MAT00802
Tip radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	6.67ft/s	abs(Vf)	6.17ft/s
F.E.	=	4.83ft-Lb	Vf(calc)	-5.10ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
663.6	3.805E-3	4.87	.2237	Maximum force
658.2	4.115E-3	4.96	.2254	Maximum energy
658.2	4.115E-3	4.96	.2254	Maximum displacement
7.2	7.835E-3	2.04	.0652	Final values



GR/EP 3501-6

#3



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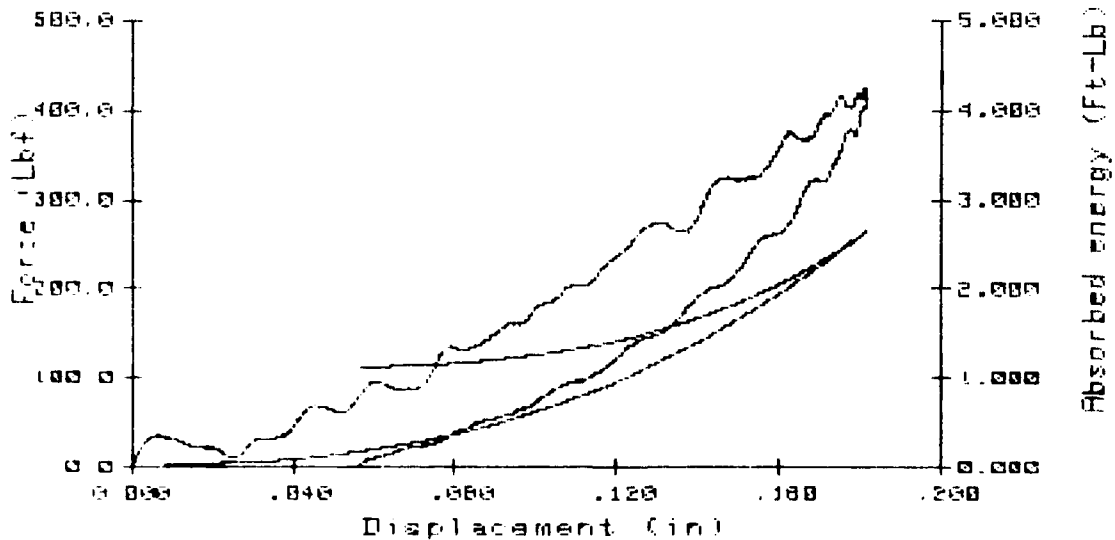
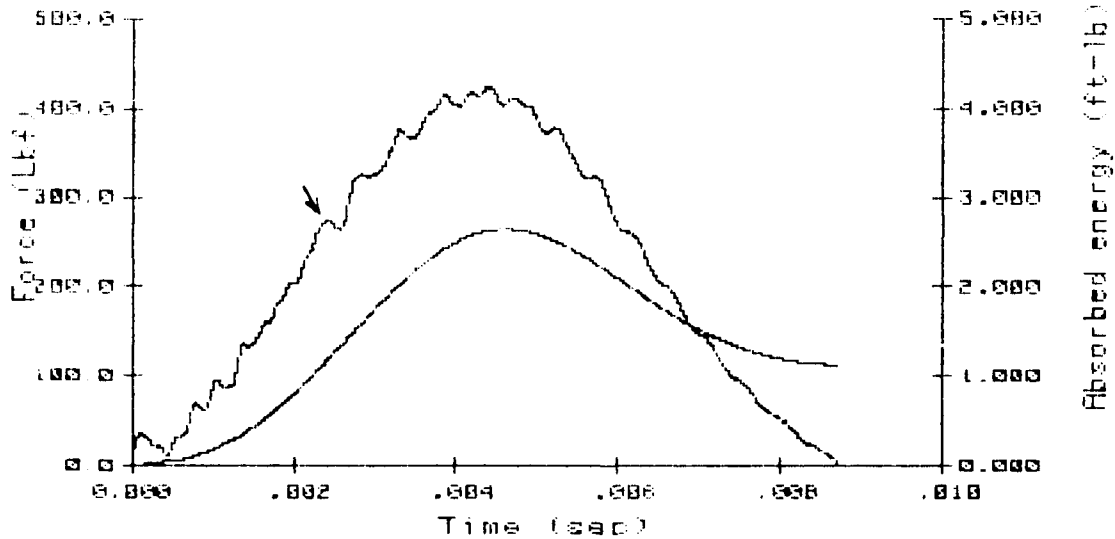
INSTRUMENTED IMPACT TEST

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GR/EP 3501-6 #4

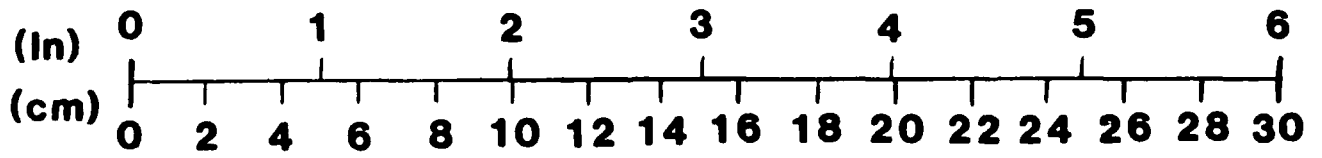
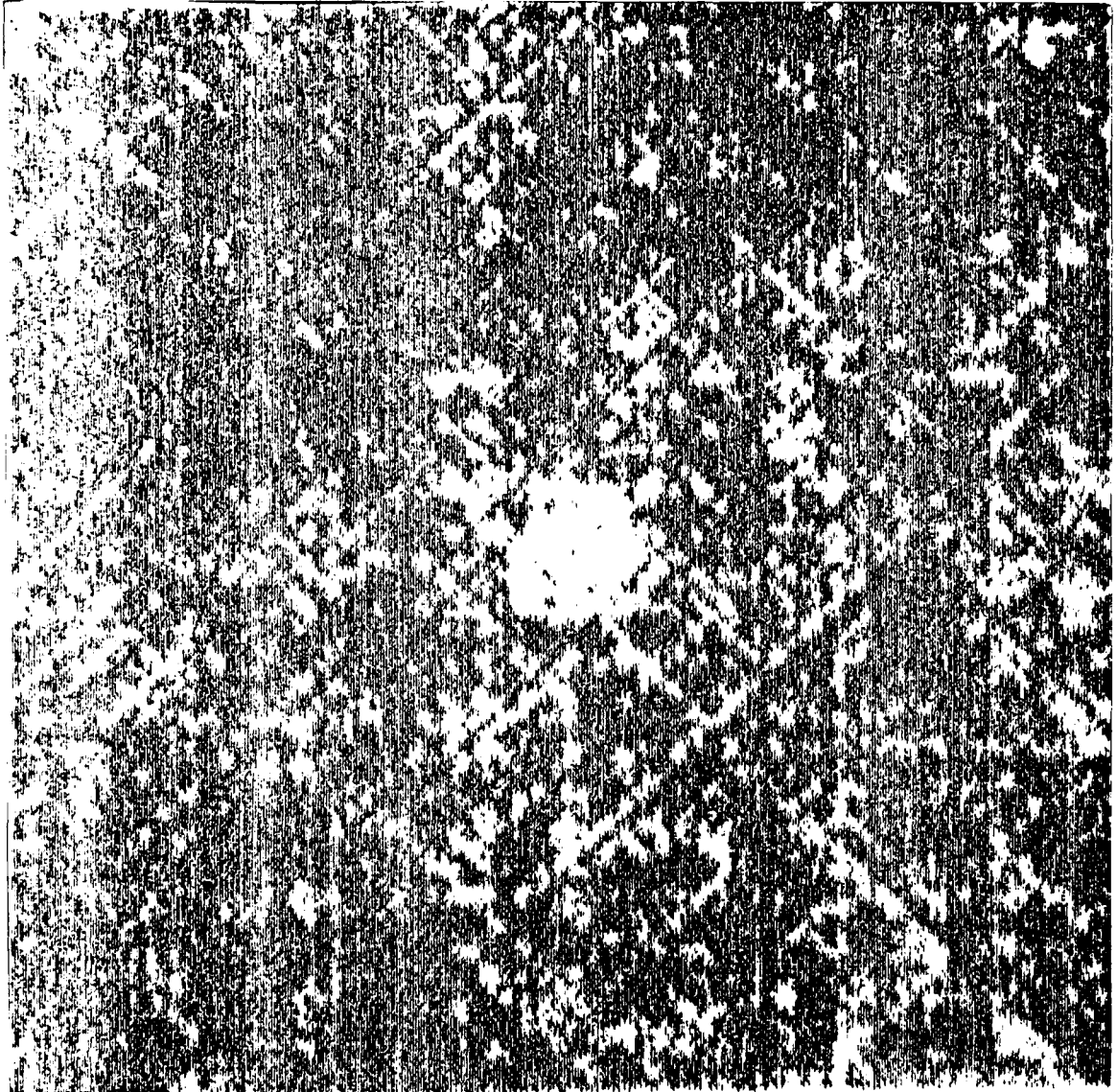
Drop weight	=	7.00Lb	Data disk	MAT00801
Top radius	=	.500in	DRM scale	.2kn, Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	4.83ft/s		
K.E.	=	2.54ft-Lb	Vf (calc) =	-3.64ft/s

Load (Lb)	Time (s)	EO (Ft-Lb)	Disp (in)	
274.7	2.428E-3	1.19	.1308	Initial damage
423.5	4.393E-3	2.62	.1811	Maximum force
403.3	4.613E-3	2.64	.1816	Maximum energy
403.3	4.613E-3	2.64	.1816	Maximum displacement
4.0	8.718E-3	1.13	.0567	Final values



GR/EP 3501-6

#4

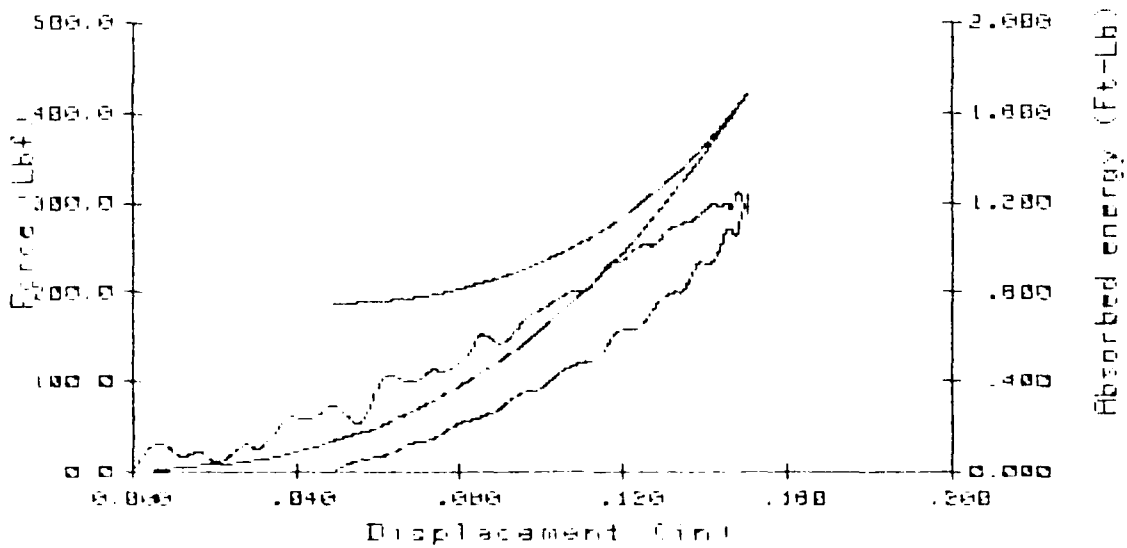
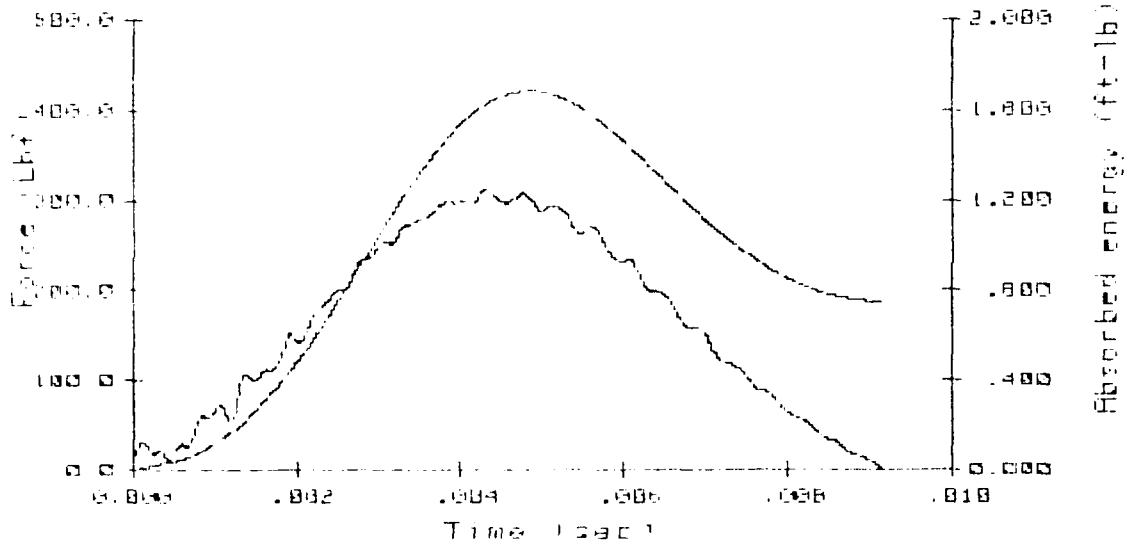


INSTRUMENTED IMPACT TEST

1591-6 GR/BMI #7

Drop weight = 7.00lb Pota disk MAT00901
 Top radius = .500in OIM scale = .2in/Div
 Temperature = 74.0 F Flag grid = .040in
 V0 = 3.80ft/s abs(Vf) = 3.44ft/s
 F.E. = 1.60ft-lb Vf(calc) = -2.80ft/s

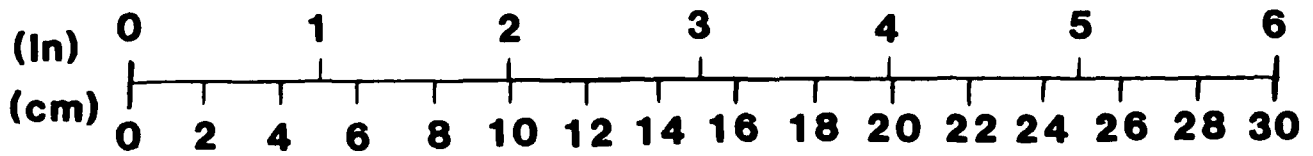
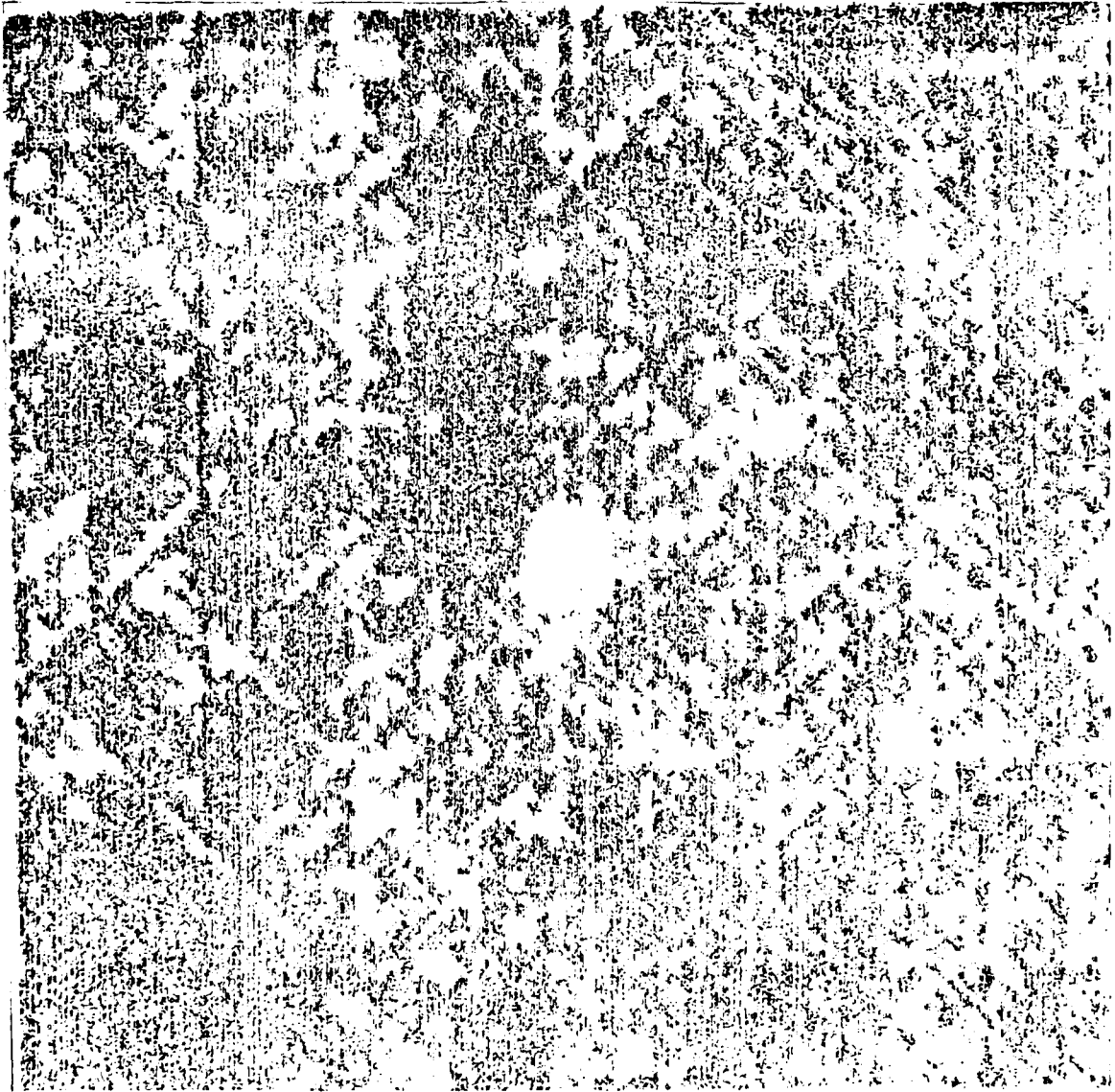
Load (lb)	Time (s)	Ev (Ft-lb)	Disp (in)	
217.5	4.305E-3	1.62	.1480	Maximum force
302.0	4.845E-3	1.68	.1503	Maximum energy
302.0	4.845E-3	1.68	.1503	Maximum displacement
1.4	9.145E-3	.75	.0493	Final values



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#7

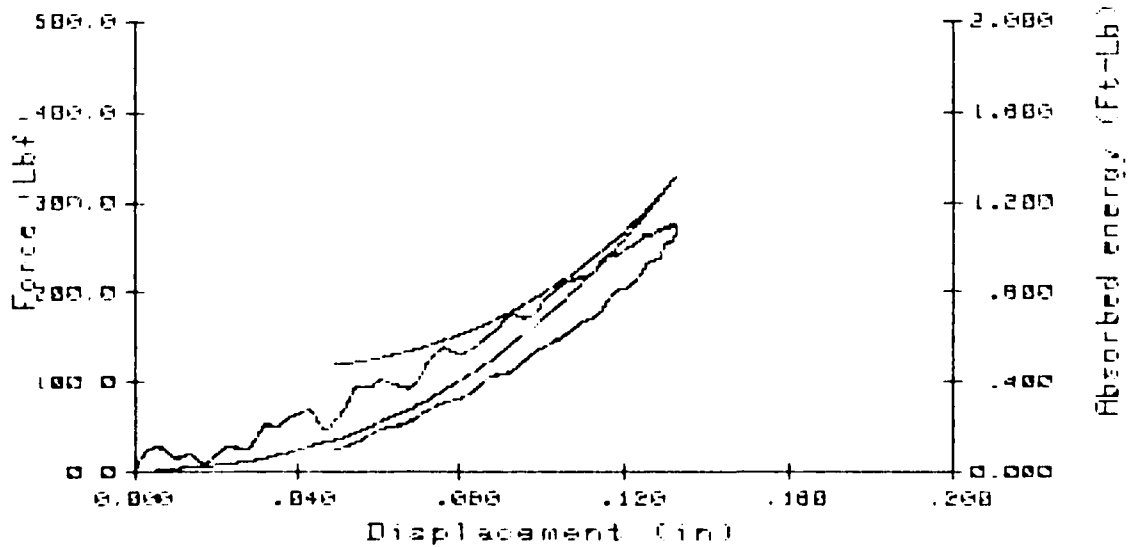
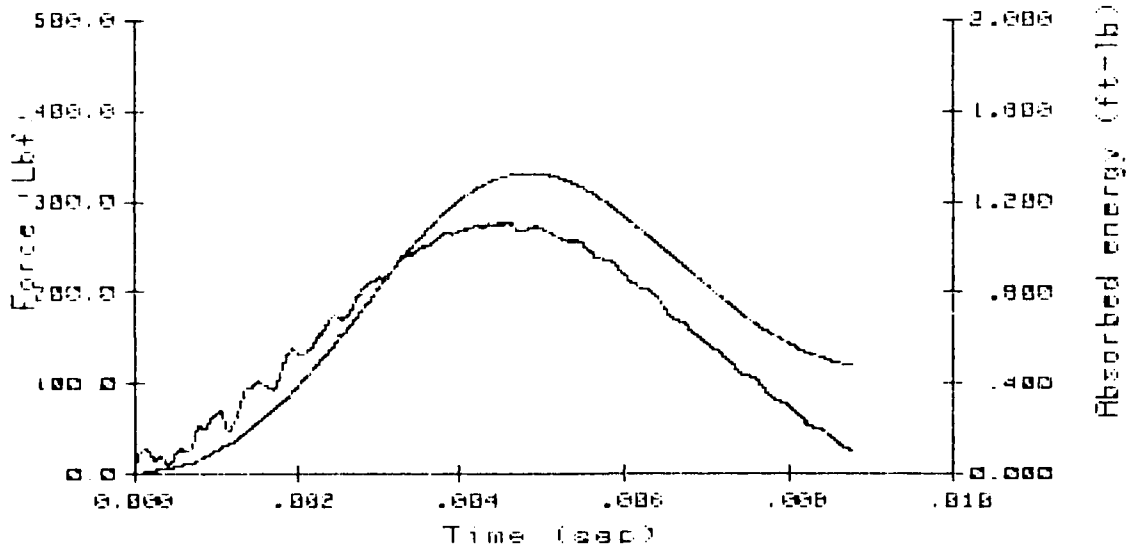


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 INSTRUMENTED IMPACT TEST
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AS4/3501-6 #8

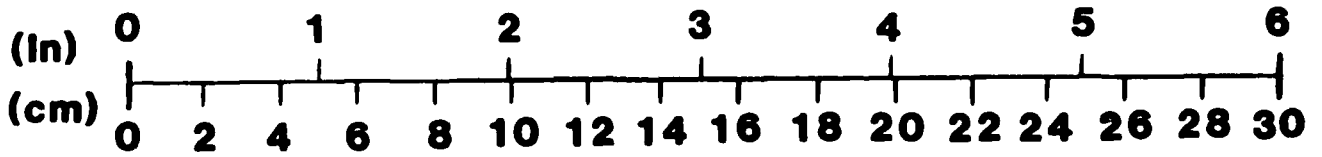
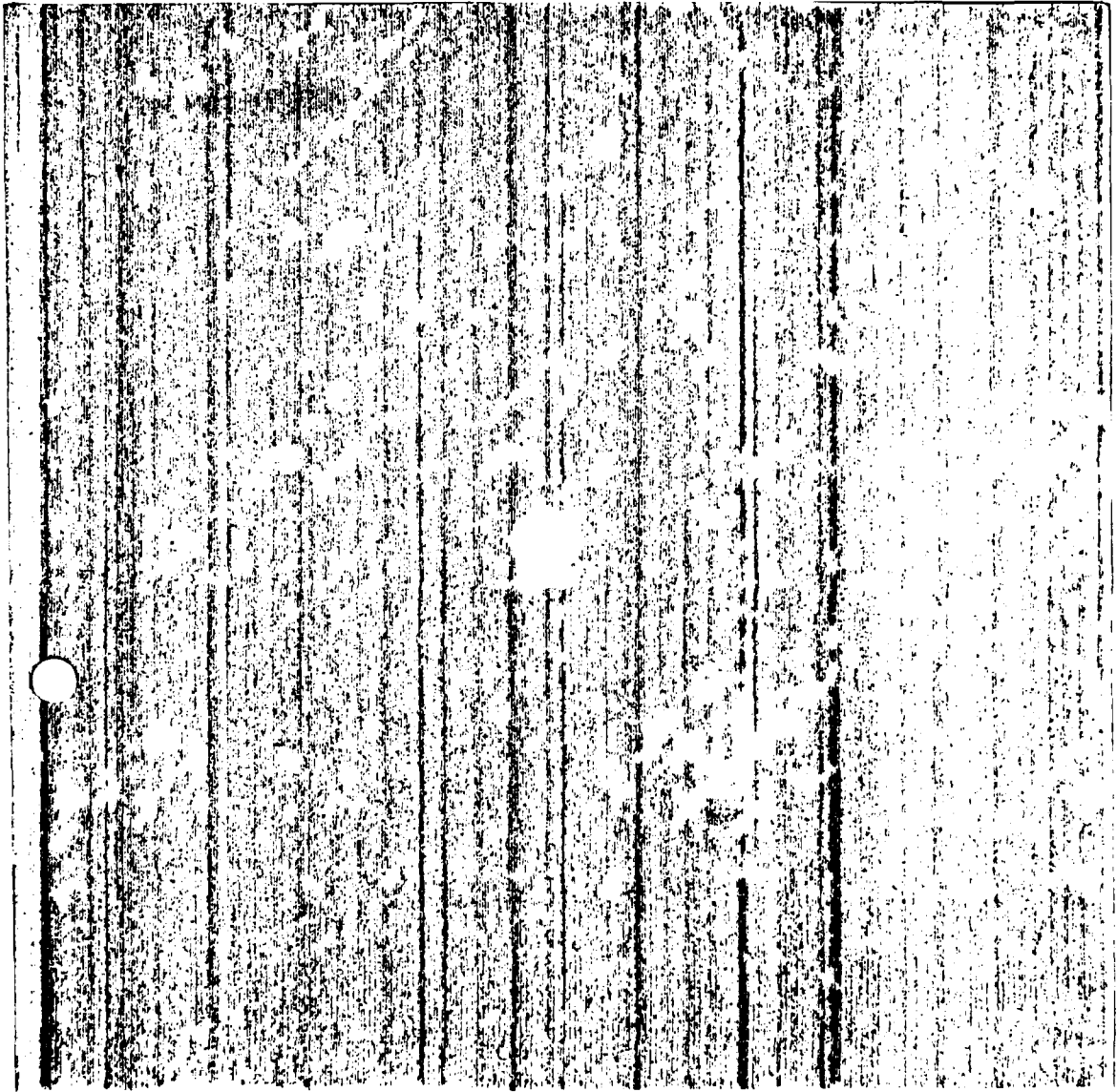
Drop weight = 7.00Lb Data disk MAT01002
 Tip radius = .500in DRM scale .2Kn/Div
 Temperature = 74.0 F Flag grid= .040in
 VO = 3.38ft/s
 I.E. = 1.24ft-Lb Vf(calc) = -2.71ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
277.4	4.617E-3	1.31	.1324	Maximum force
269.3	4.843E-3	1.32	.1327	Maximum energy
269.3	4.843E-3	1.32	.1327	Maximum displacement
25.6	8.792E-3	.48	.0492	Final values



GR/EP 3501-6

#8



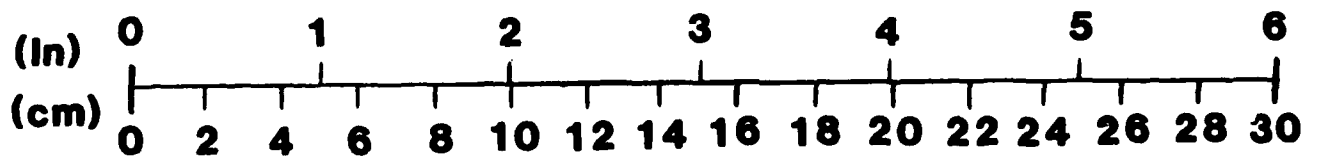
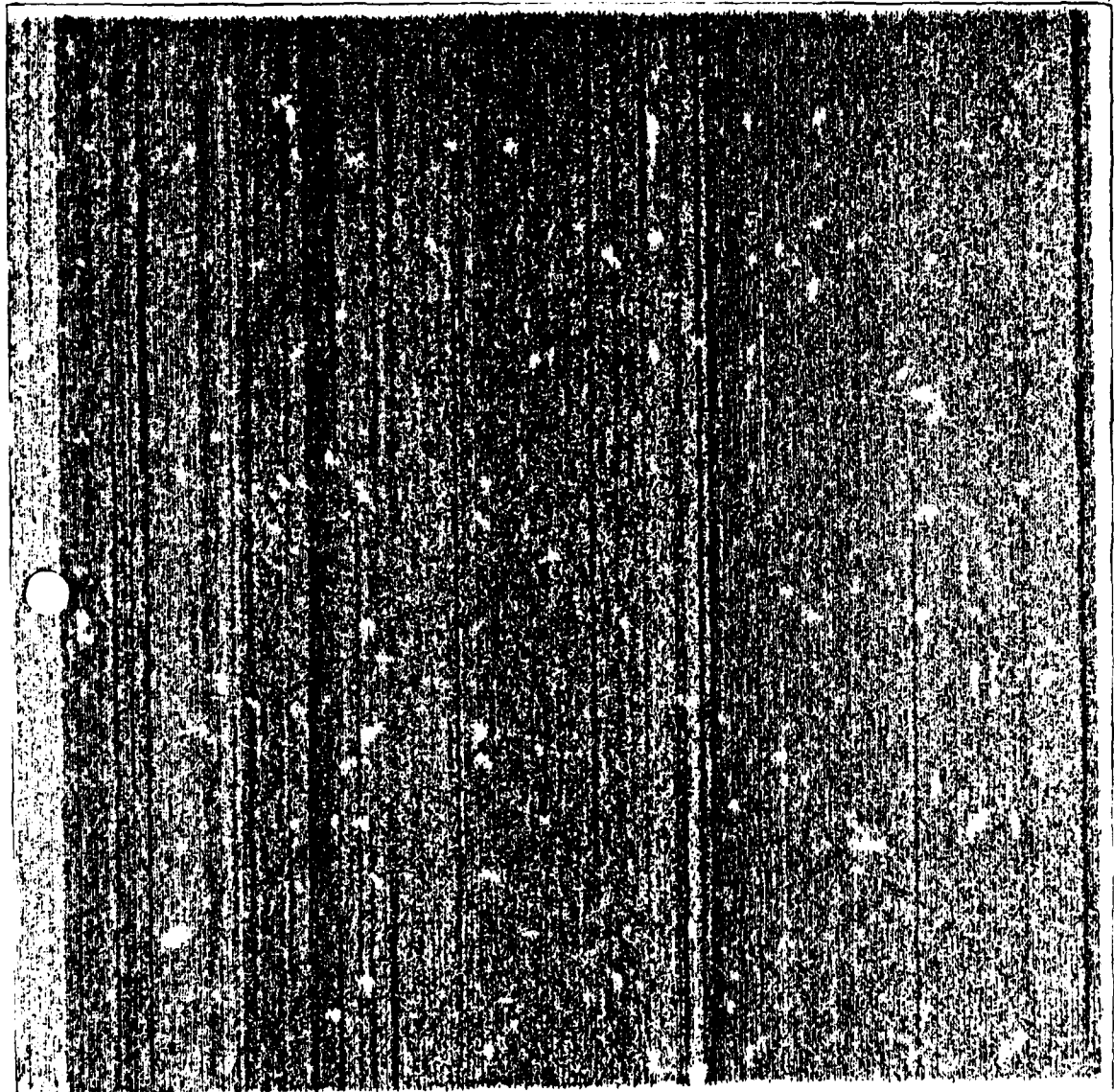
NADC-85023-60

AS4/2220-1

NADC-85023-60

2220-1 GR/EP

#8



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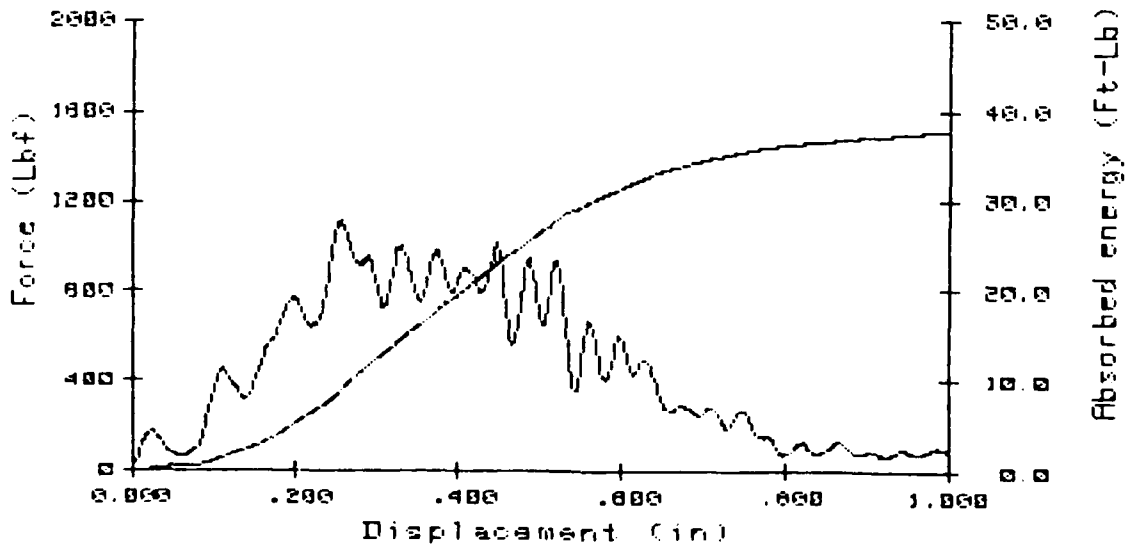
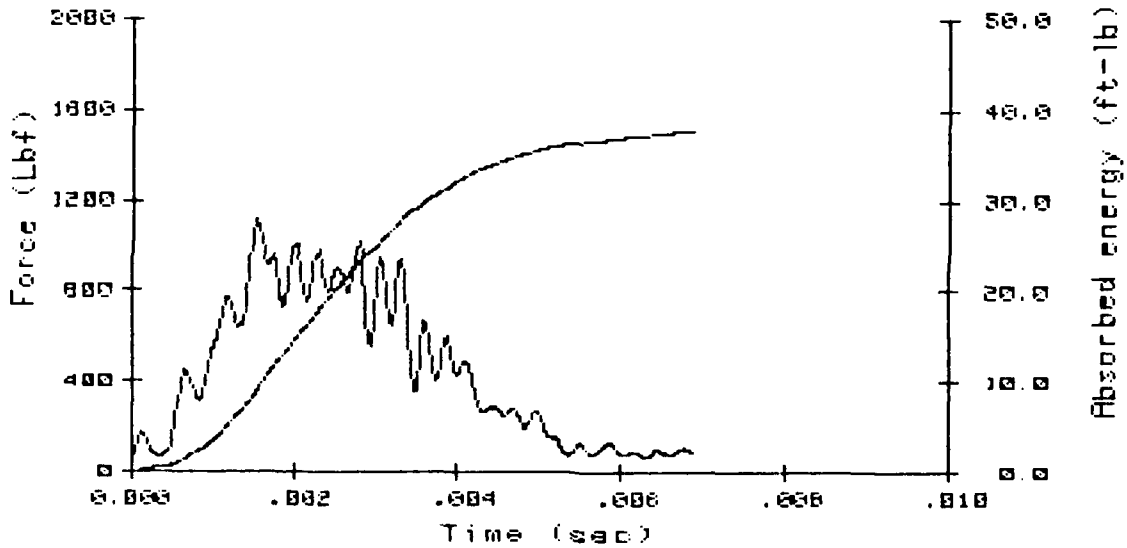
INSTRUMENTED IMPACT TEST

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2220-1 GR/EP #1

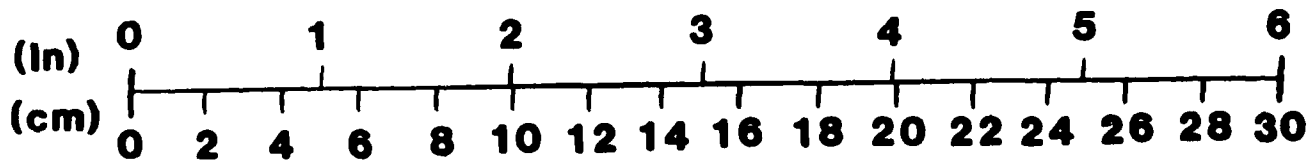
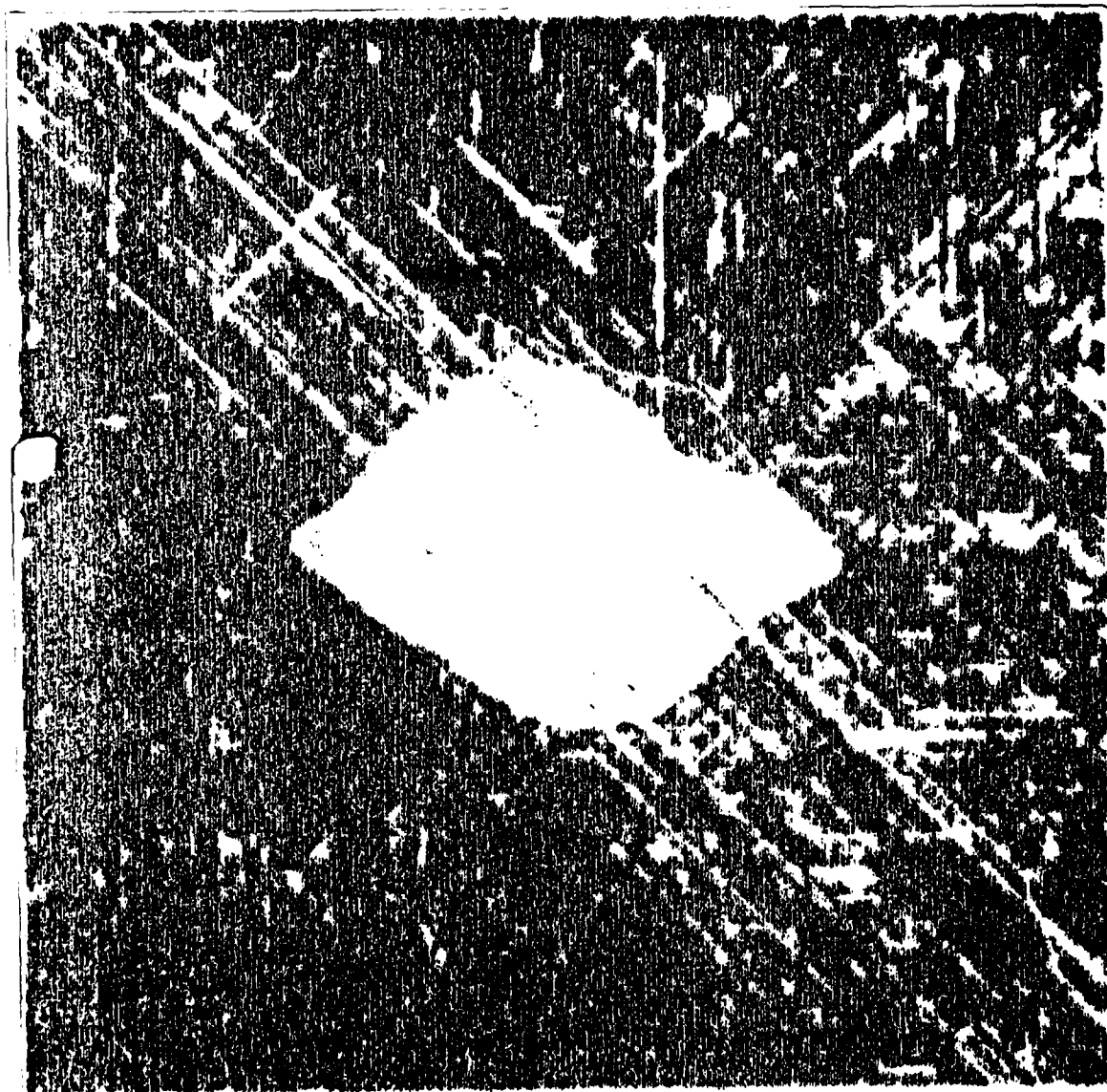
Drop weight	=	31.36Lb	Data disk	MAT00601
Tup radius	=	.500in	DRM scale	.8Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	13.89ft/s		
K.E.	=	93.93ft-Lb	Vf(calc) =	10.98ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
1115.1	1.545E-3	8.97	.2565	Maximum force
89.9	6.865E-3	37.79	.9989	Maximum energy
89.9	6.865E-3	37.79	.9989	Maximum displacement
89.9	6.865E-3	37.79	.9989	Final values



2220-1 GR/EP

#1



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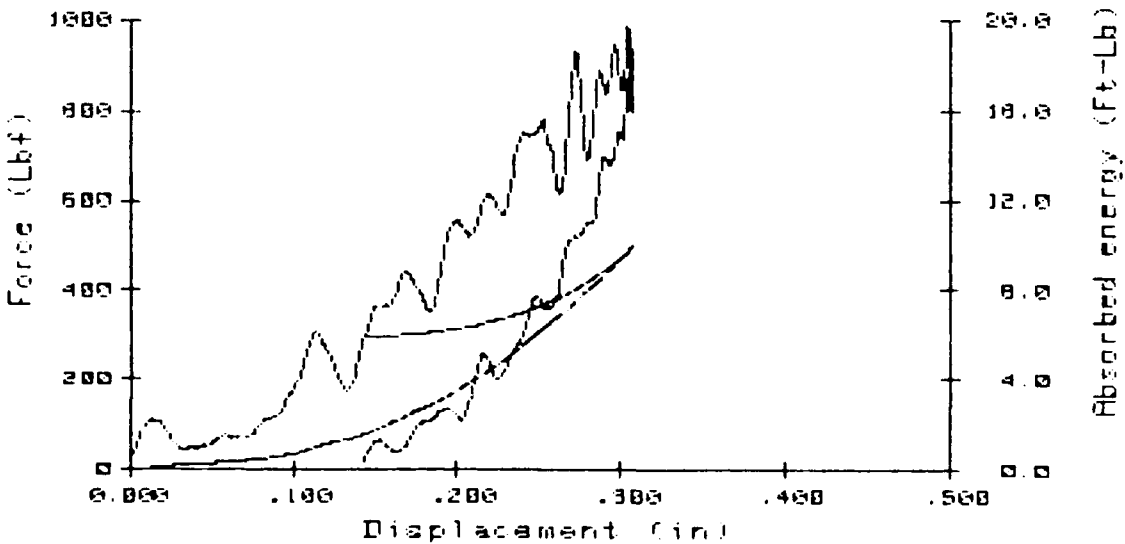
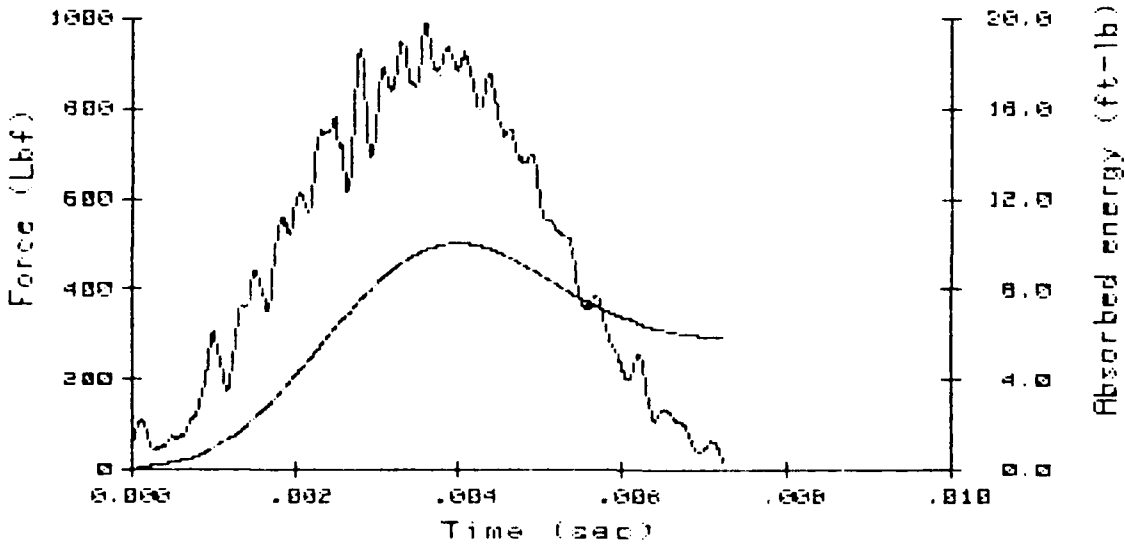
INSTRUMENTED IMPACT TEST

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2220-1 GR/EP #2

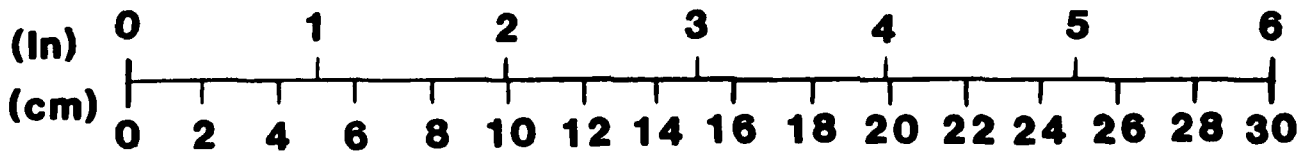
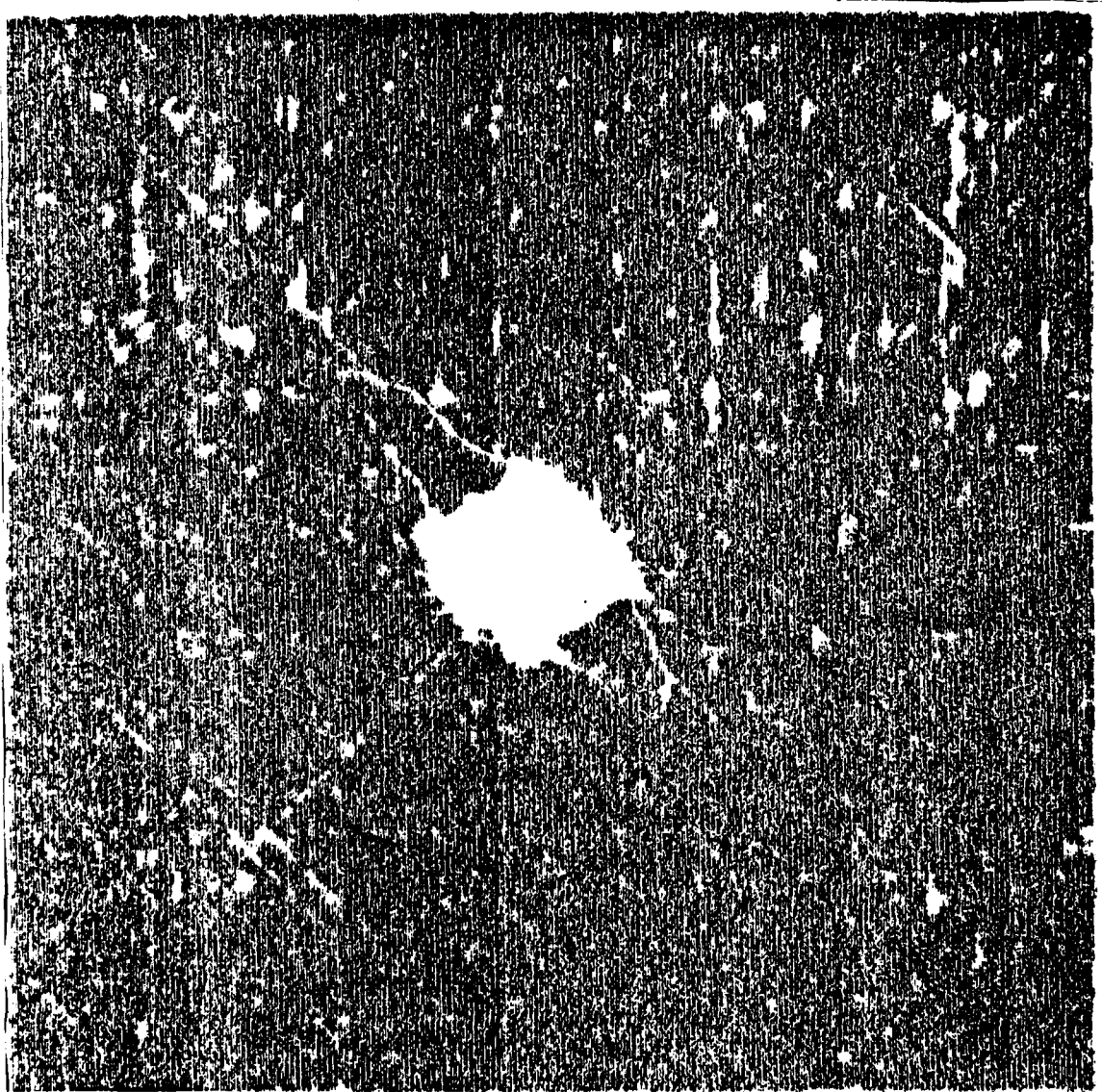
Drop weight	=	7.00Lb	Data disk	MAT00602
Tip radius	=	.500in	DRM scale	.8Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	9.52ft/s	abs(Vf) =	7.75ft/s
K.E.	=	9.86ft-Lb	Vf(calc) =	-6.10ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
989.2	3.595E-3	9.74	.3039	Maximum force
888.4	3.995E-3	10.04	.3078	Maximum energy
888.4	3.995E-3	10.04	.3078	Maximum displacement
16.2	7.225E-3	5.90	.1426	Final values



2220-1 GR/EP

#2



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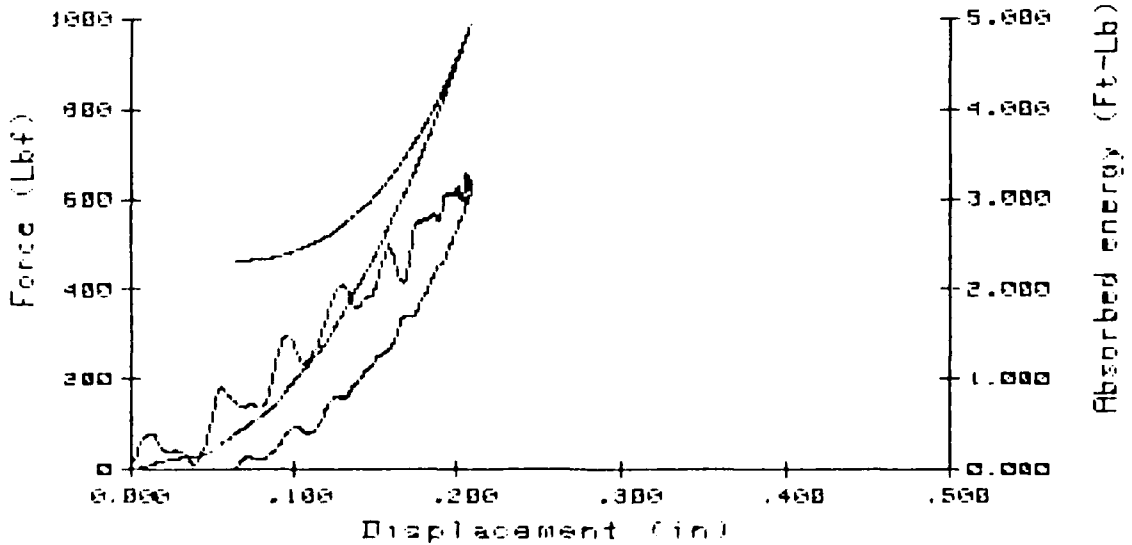
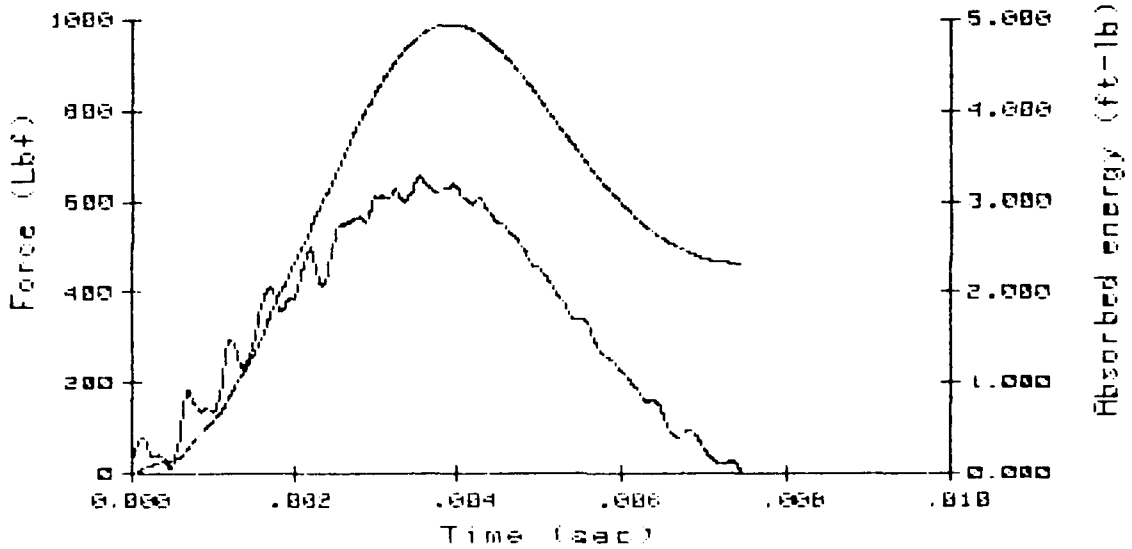
INSTRUMENTED IMPACT TEST

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2220-1 GR/EP #3

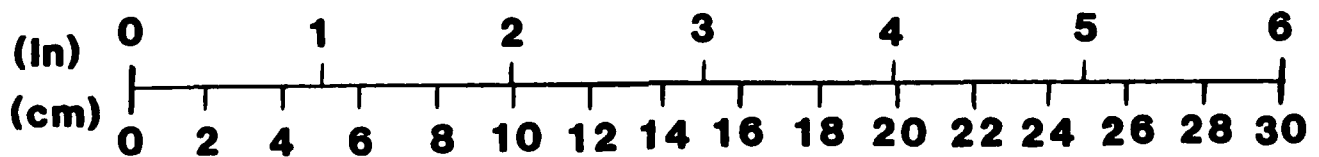
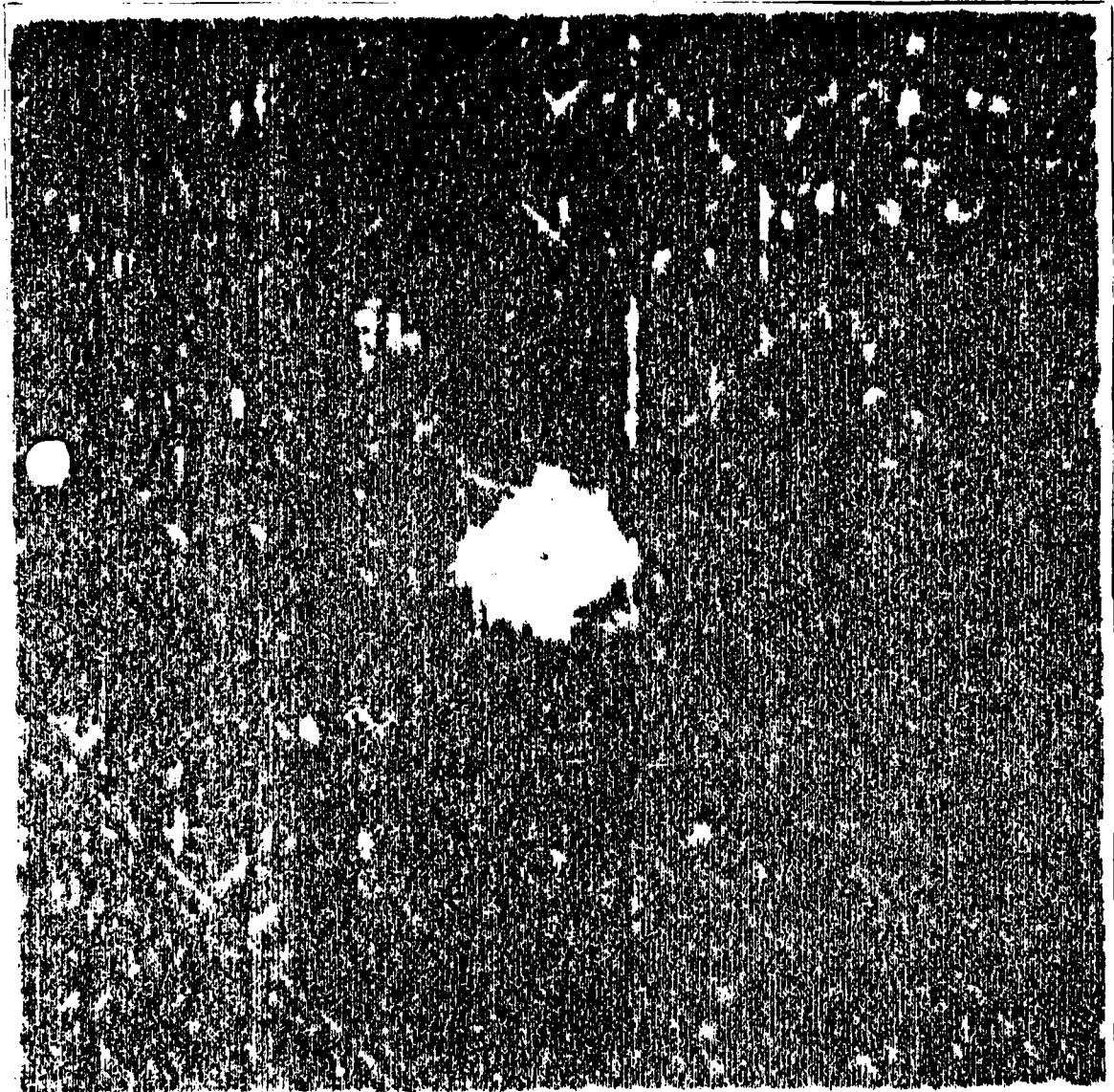
Drop weight	=	7.00Lb	Data disk	MAT00603
Tip radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	6.67ft/s	abs(Vf) =	5.95ft/s
K.E.	=	4.83ft-Lb	Vf(calc) =	-4.85ft/s

Load(Lb)	Time(s)	EO(Ft-Lb)	Disp(in)	
658.2	3.525E-3	4.81	.2055	Maximum force
634.0	3.915E-3	4.95	.2081	Maximum energy
634.0	3.915E-3	4.95	.2081	Maximum displacement
7.2	7.435E-3	2.32	.0663	Final values



2220-1 GR/EP

#3

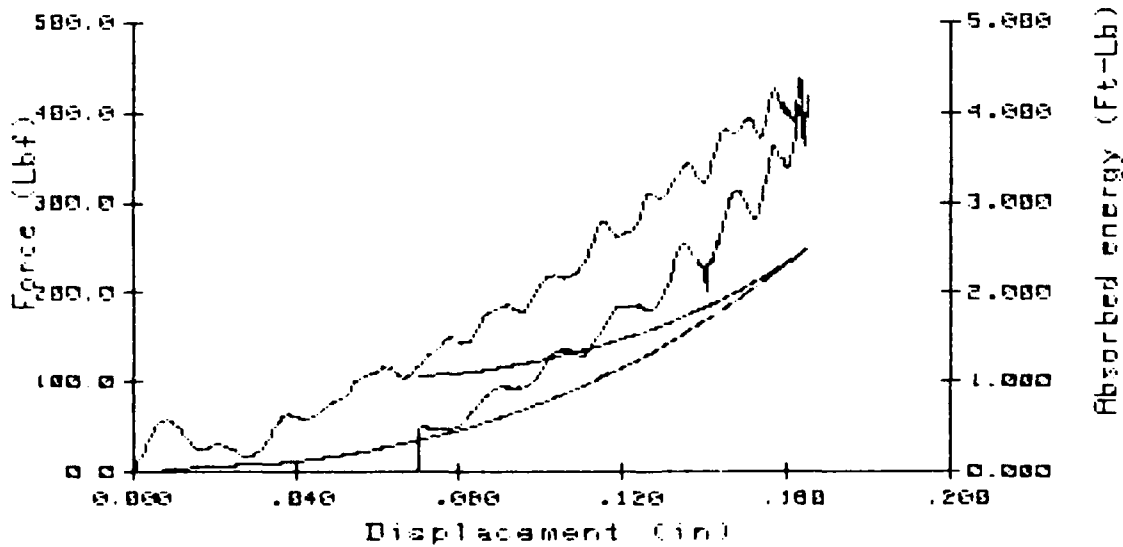
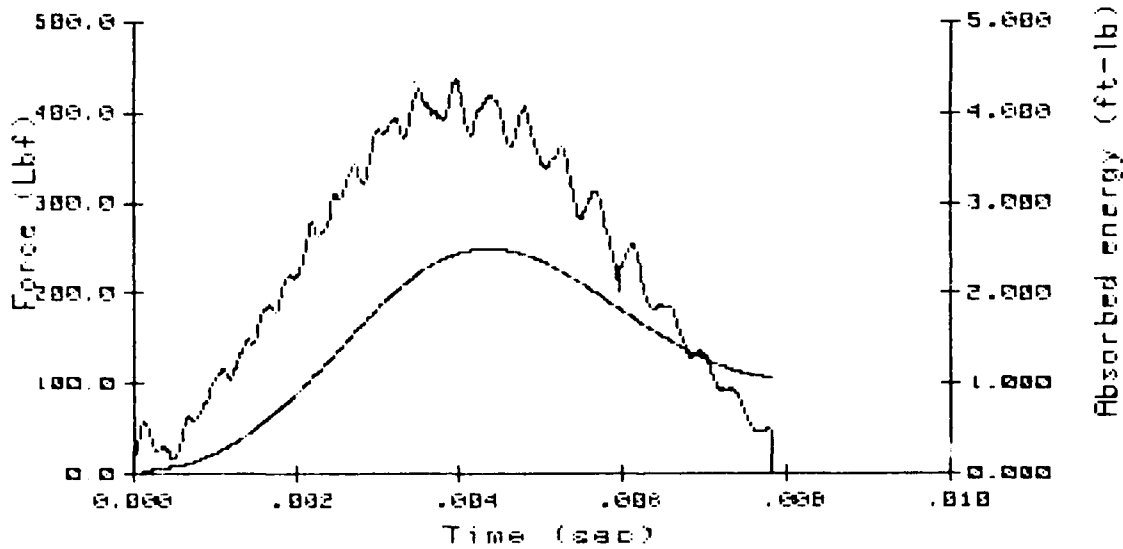


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 INSTRUMENTED IMPACT TEST
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2220-1 GR/EP #4

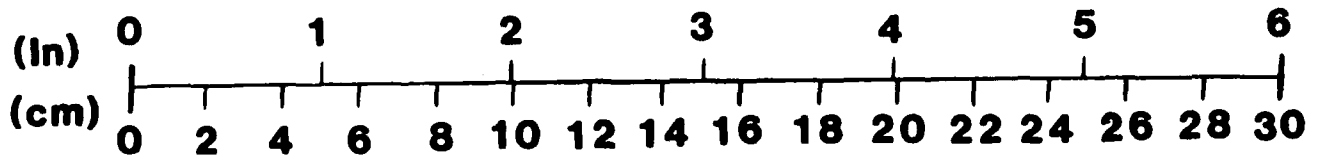
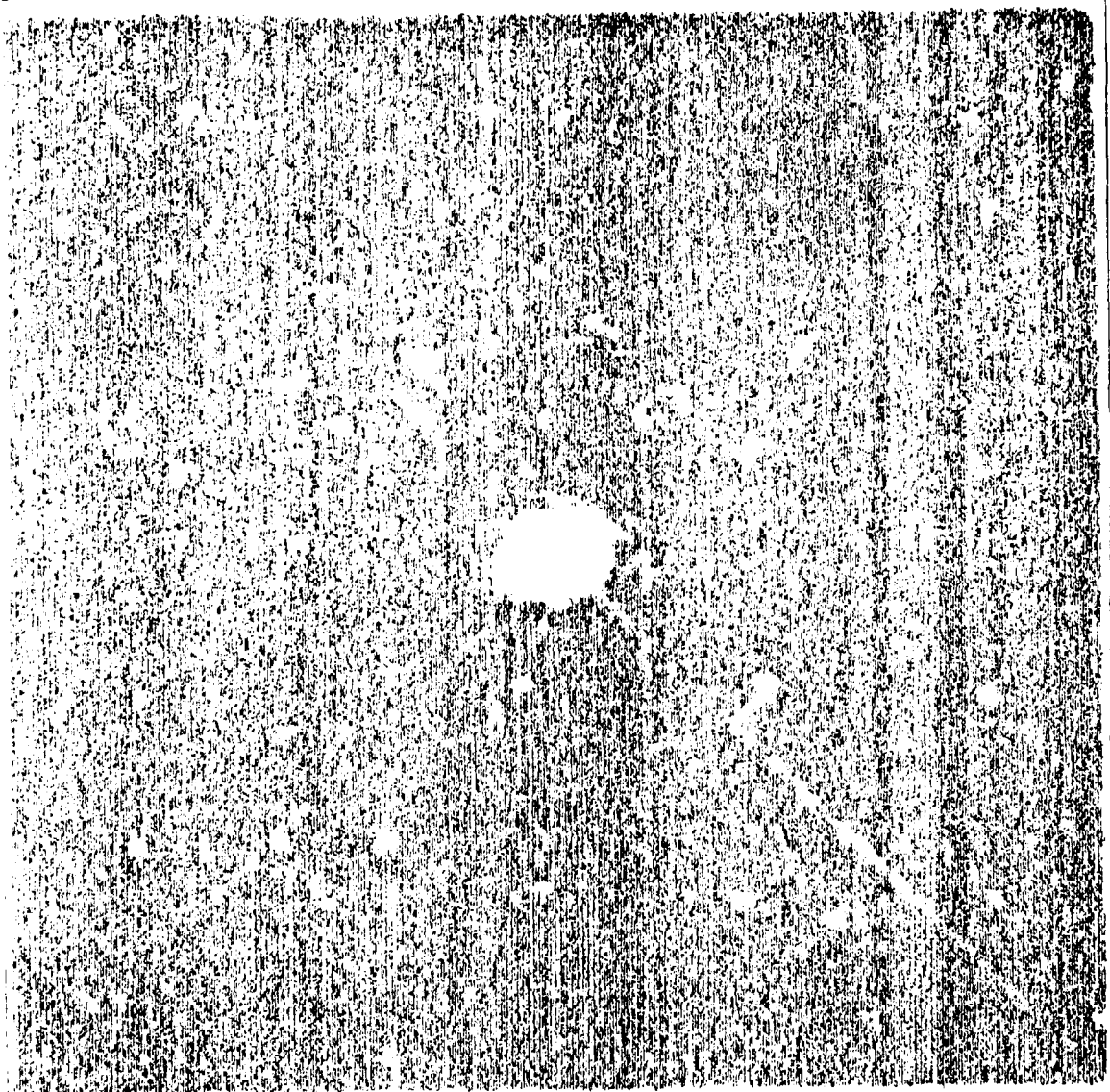
Drop weight	=	7.00Lb	Data disk	MAT00604
Tip radius	=	.500in	DRM scale	.2Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	4.69ft/s	abs(Vf) =	4.27ft/s
K.E.	=	2.40ft-Lb	Vf(calc) =	-3.54ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
438.4	3.945E-3	2.43	.1632	Maximum force
417.7	4.355E-3	2.49	.1651	Maximum energy
417.7	4.355E-3	2.49	.1651	Maximum displacement
-218.5	7.805E-3	1.07	.0699	Final values



2220-1 GR/EP

#4



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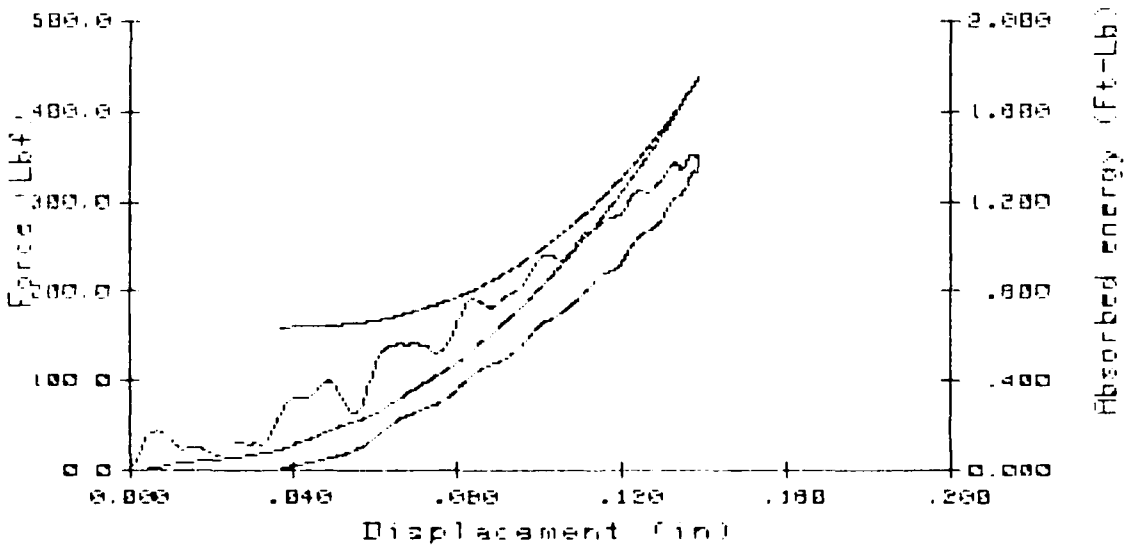
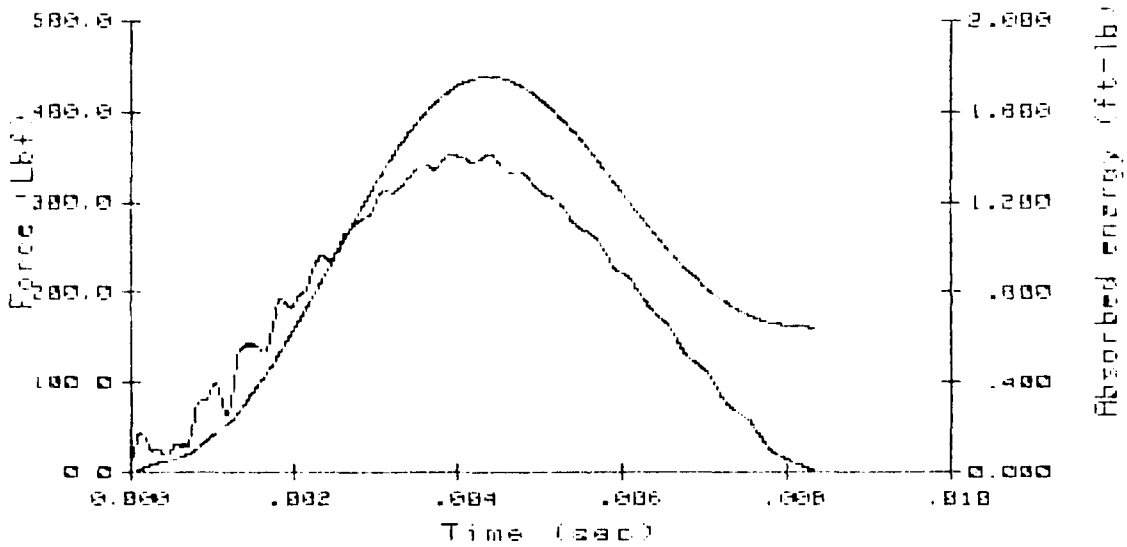
INSTRUMENTED IMPACT TEST

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100-1 GR/EP #6

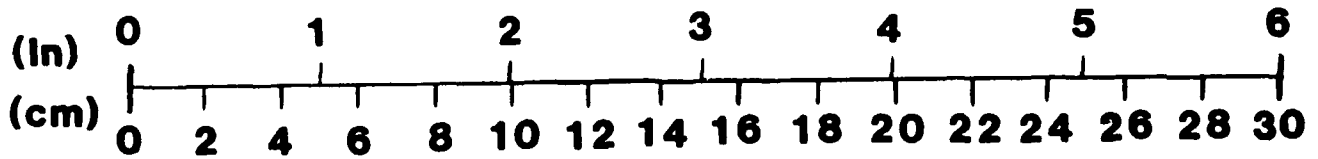
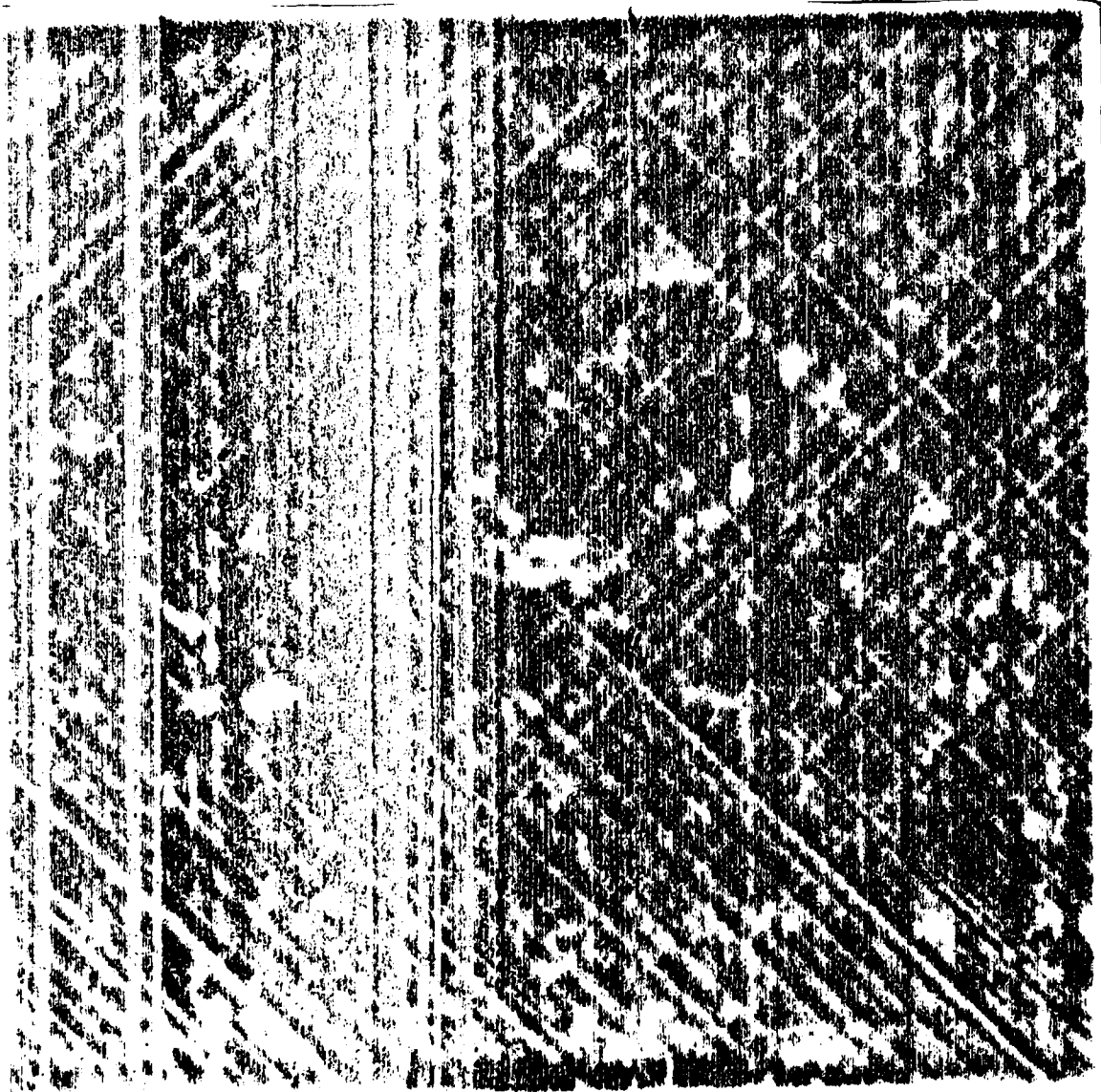
Drop weight	=	7.00Lb	Data dist	MAT00807
Tip radius	=	.500in	DRM scale	.2kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	3.92ft/s	abs(Vf) =	3.75ft/s
I.E.	=	1.67ft-Lb	Vf(calc) =	-3.11ft/s

Load (Lb)	Time (s)	E0 (Ft-Lb)	Disp (in)	
351.2	4.375E-3	1.75	.1387	All maximum
1.6	8.325E-3	.64	.0370	Final values



2220-1 GR/EP

#6

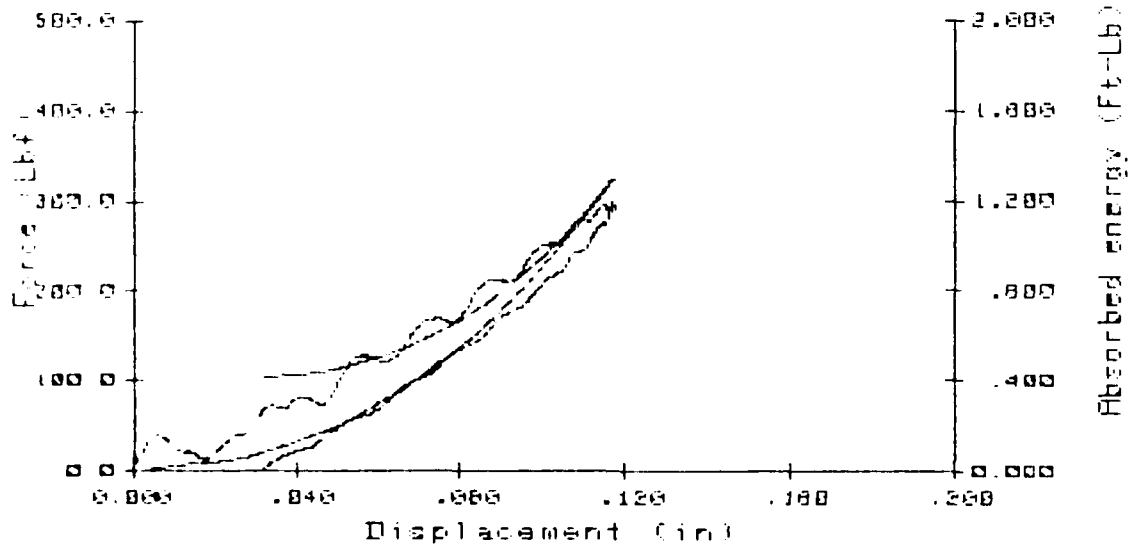
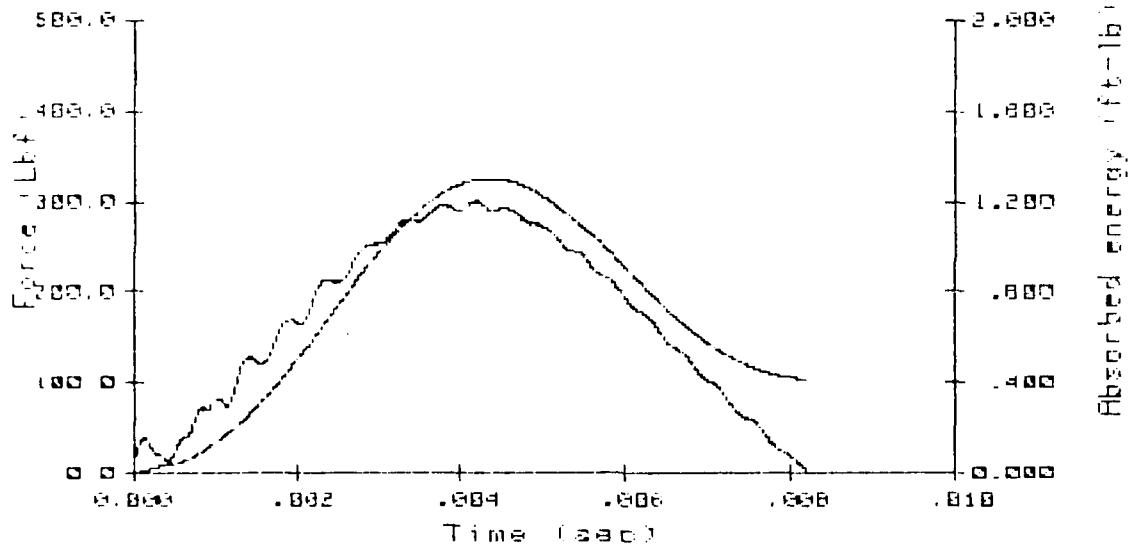


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 INSTRUMENTED IMPACT TEST
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2020-1 GR/EP #7

Drop weight	=	7.00Lb	Date dist	MAT01004
Tip radius	=	.500in	DRM scale	.25in Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	3.37ft/s	abs(Vf) =	3.24ft/s
F.E.	=	1.23ft-Lb	Vf (calc) =	-2.77ft/s

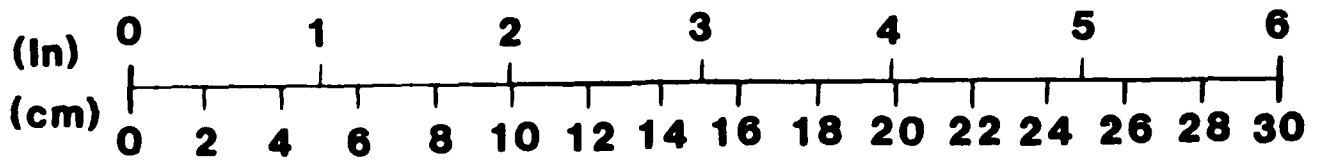
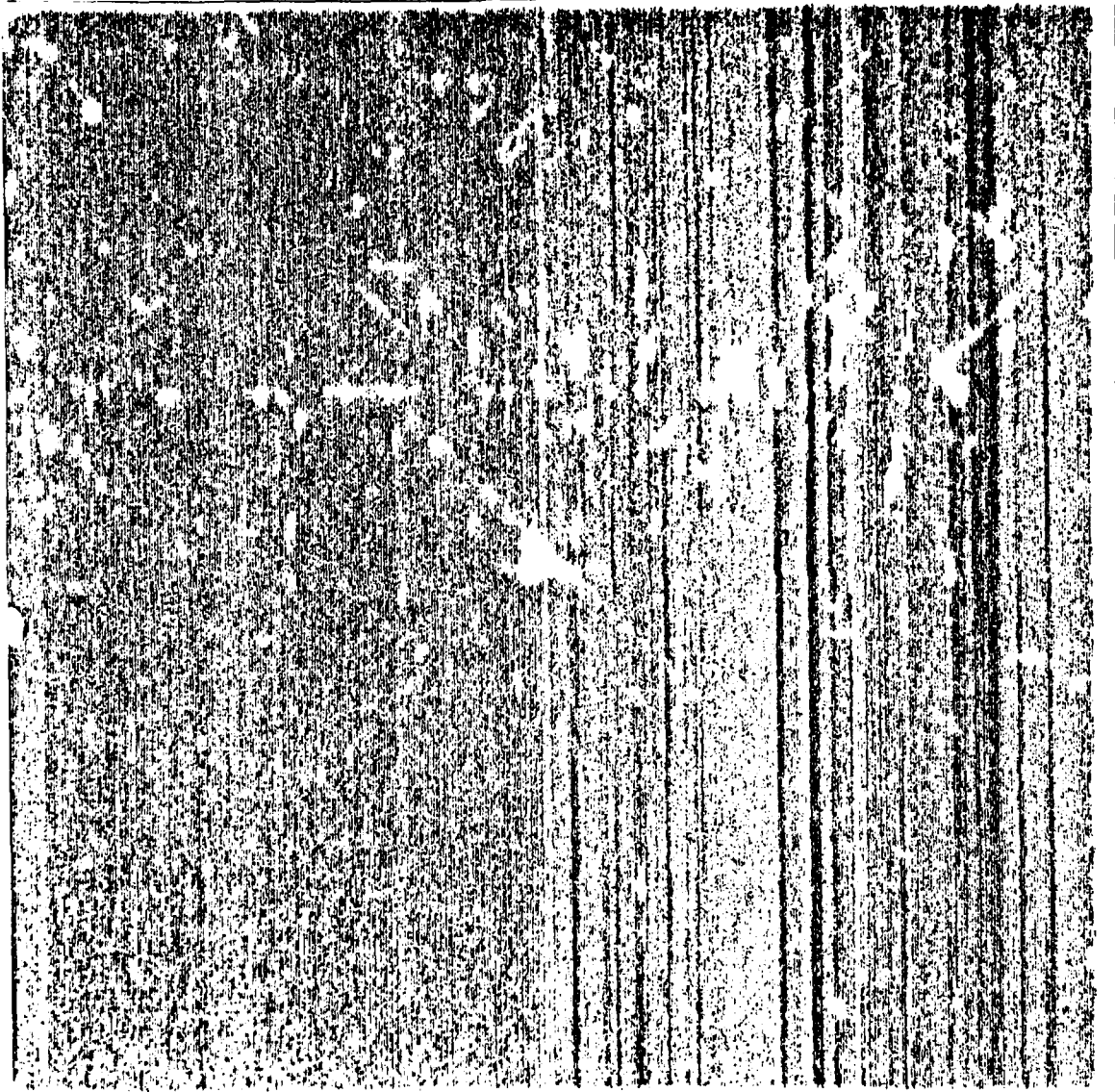
Load (Lb)	Time (s)	E0 (Ft-Lb)	Disp (in)	
301.2	4.195E-3	1.30	.1171	Maximum force
291.8	4.345E-3	1.30	.1172	Maximum energy
291.8	4.345E-3	1.30	.1172	Maximum displacement
3.6	8.185E-3	.42	.0321	Final values



NADC-85023-60

2220-1 GR/EP

#7

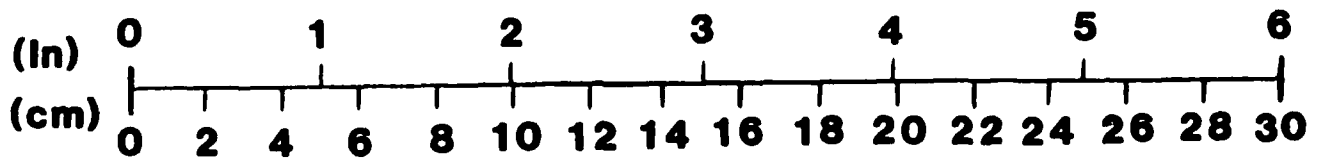
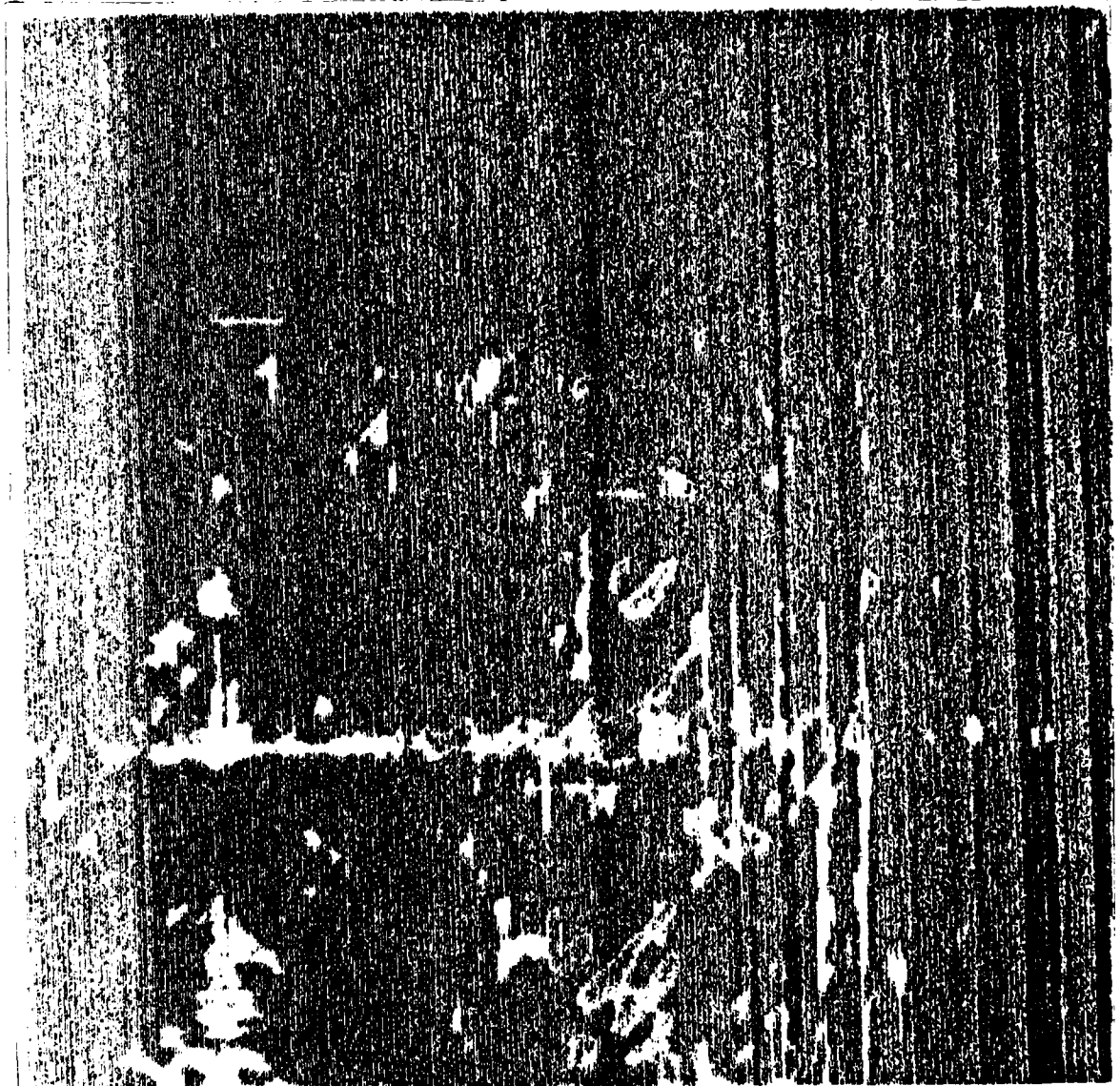


NADC-85023-60

Celion high strain/5245

5245 GR/BMI

#10



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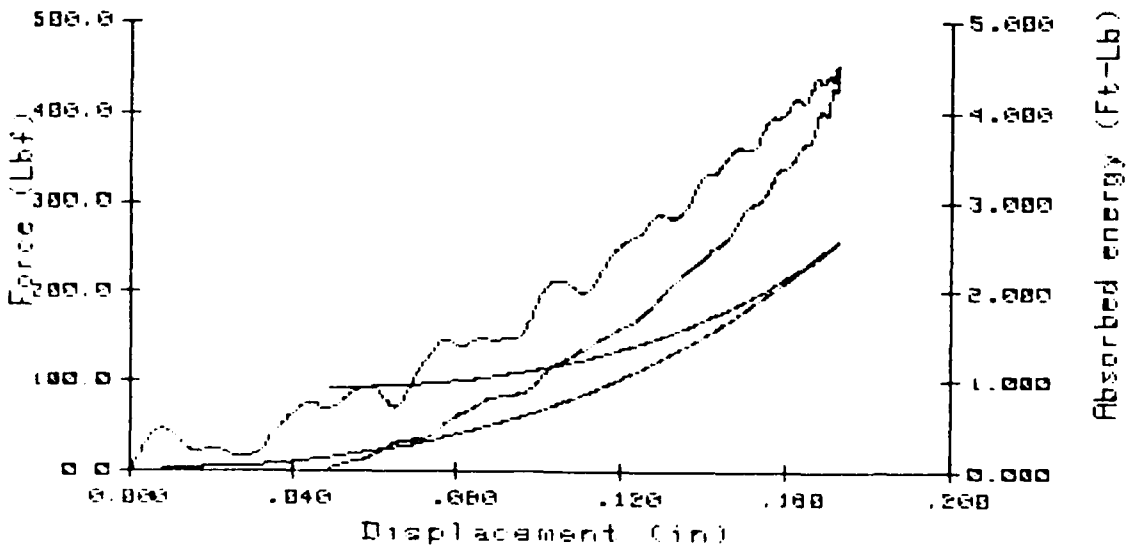
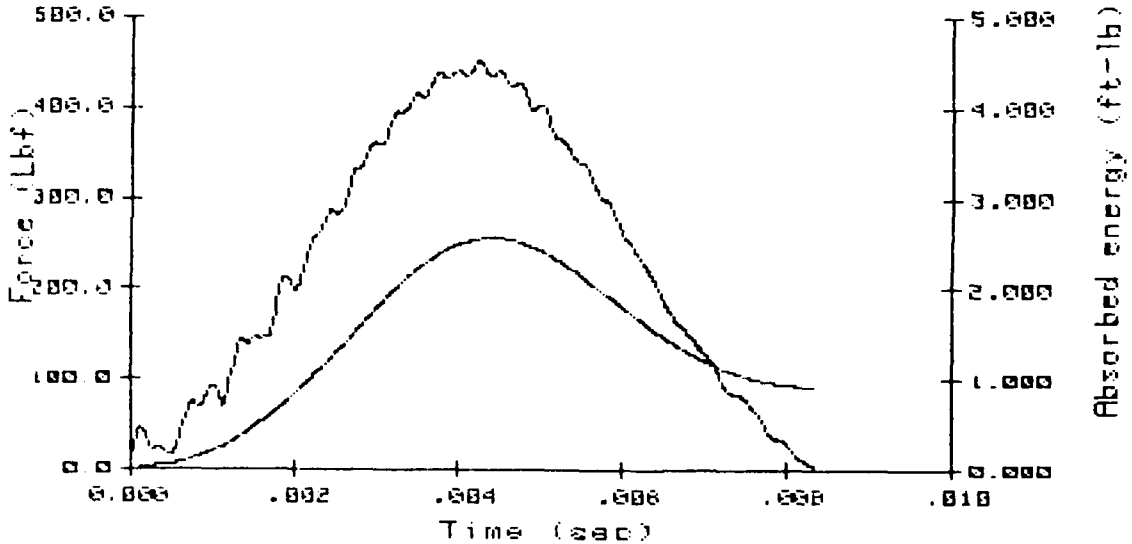
INSTRUMENTED IMPACT TEST

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5245 GR/BMI #1

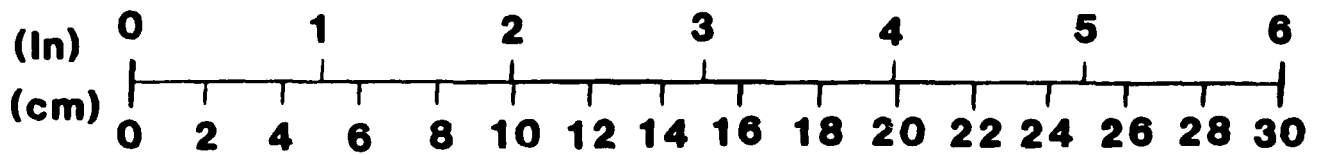
Drop weight	=	7.00Lb	Data disk	MAT00605
Tip radius	=	.500in	DRM scale	.2Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	4.76ft/s	abs(Vf) =	4.50ft/s
K.E.	=	2.46ft-Lb	Vf(calc) =	-3.79ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
451.0	4.225E-3	2.55	.1723	Maximum force
435.2	4.405E-3	2.57	.1727	Maximum energy
435.2	4.405E-3	2.57	.1727	Maximum displacement
3.6	8.325E-3	.93	.0494	Final values



5245 GR/BMI

#1



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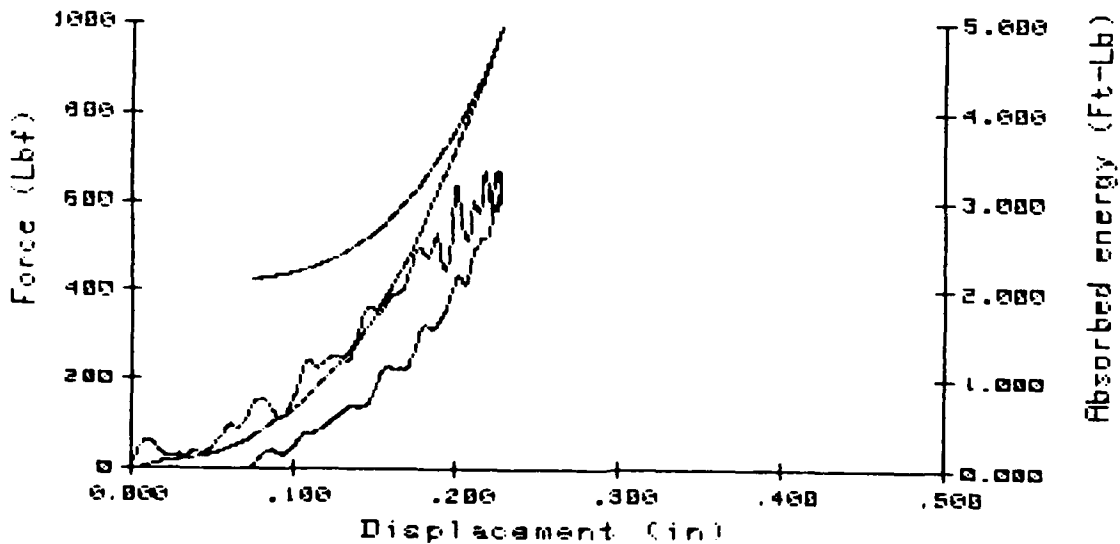
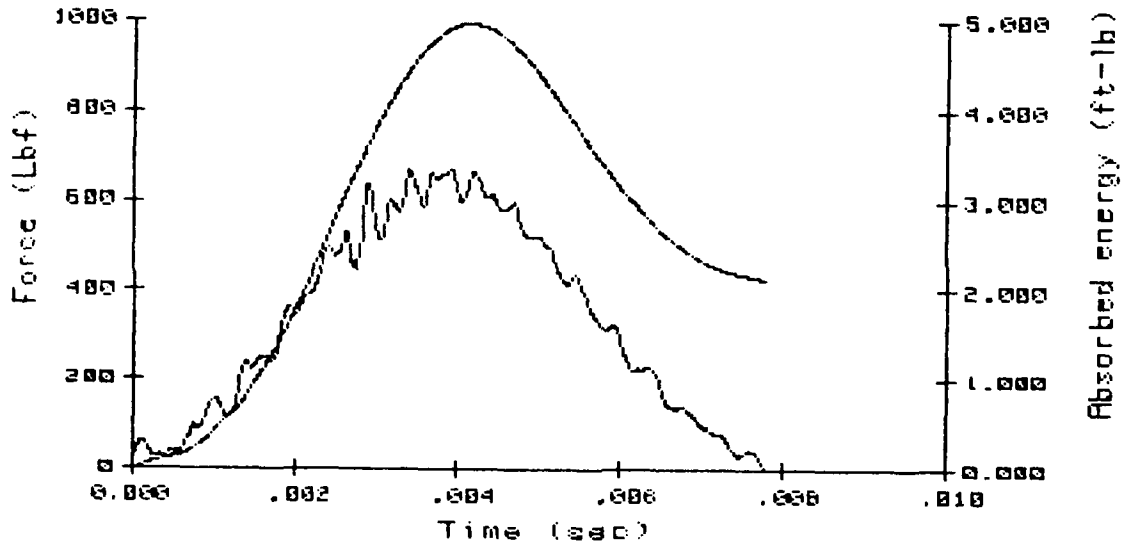
INSTRUMENTED IMPACT TEST

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5245 GR/BMI #2

Drop weight	=	7.00Lb	Data disk	MAT00606
Top radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	6.67ft/s	abs(Vf) =	6.06ft/s
K.E.	=	4.83ft-Lb	Vf(calc) =	-5.02ft/s

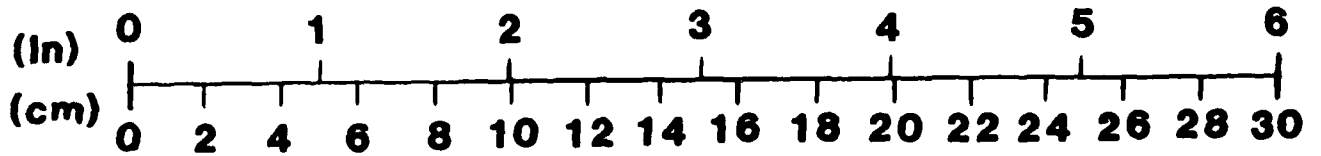
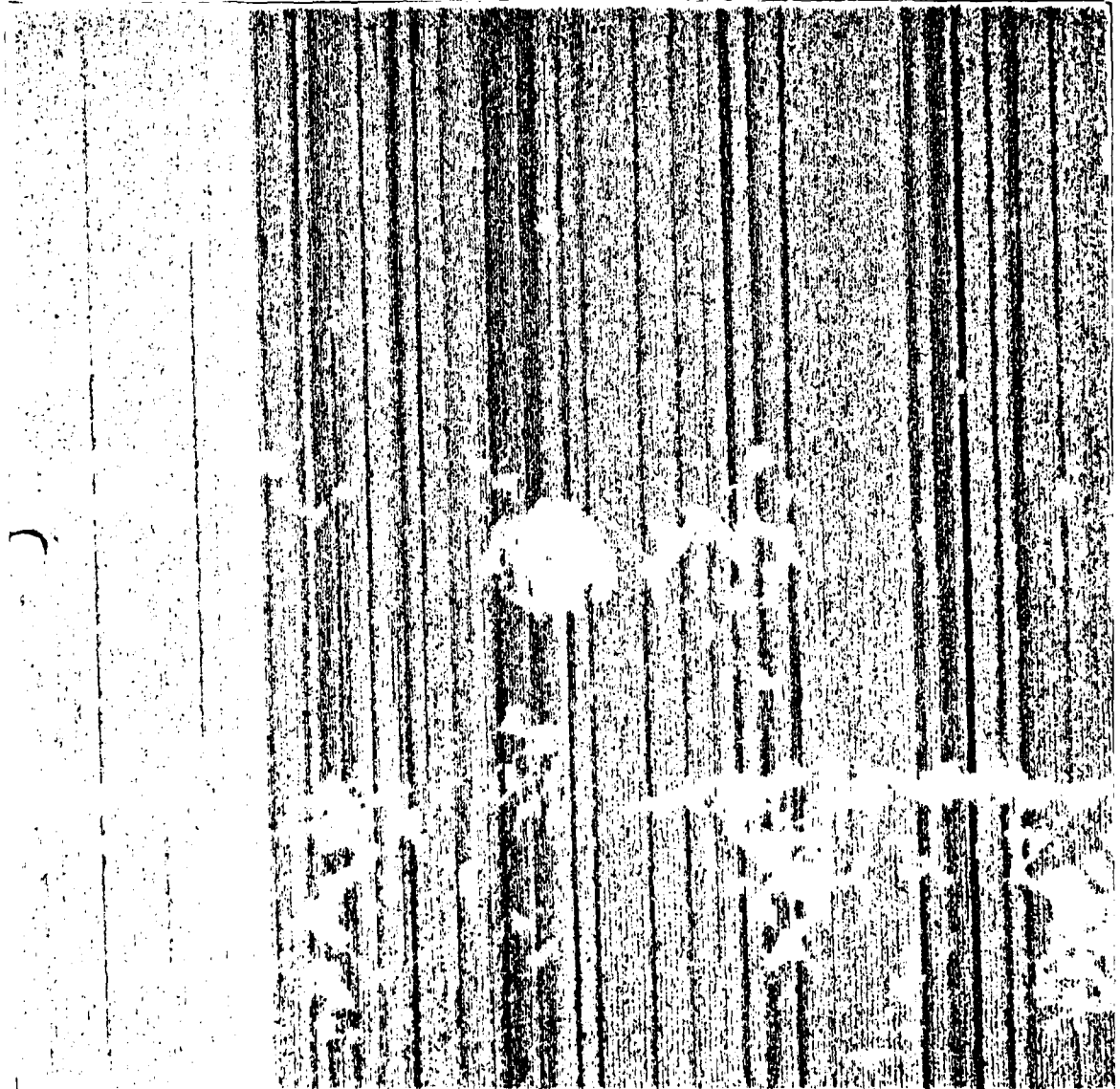
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
672.6	3.895E-3	4.91	.2260	Maximum force
649.2	4.145E-3	4.96	.2270	Maximum energy
649.2	4.145E-3	4.96	.2270	Maximum displacement
7.2	7.775E-3	2.13	.0754	Final values



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5245 GR/BMI

#2

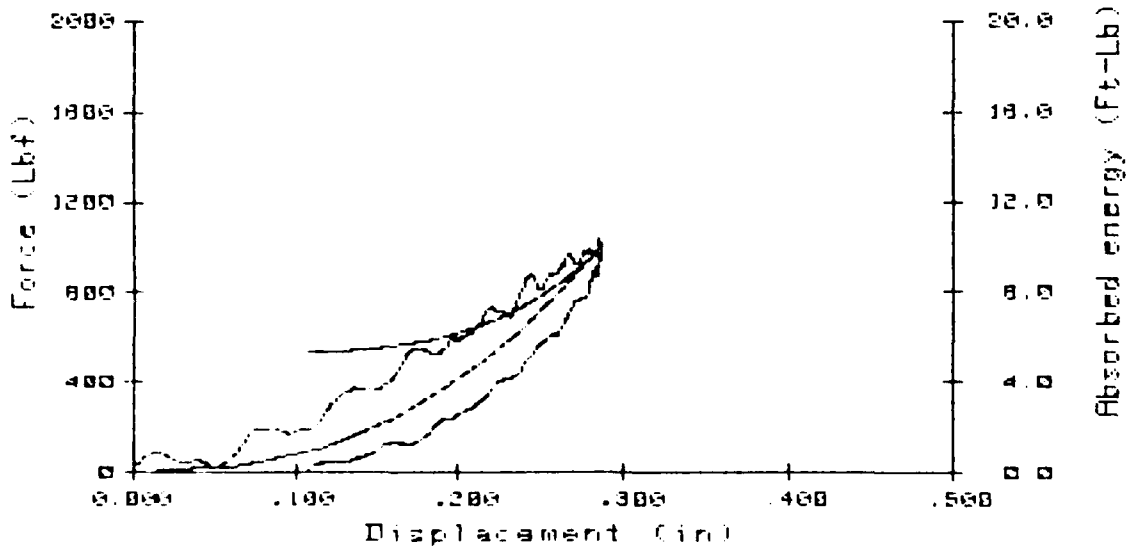
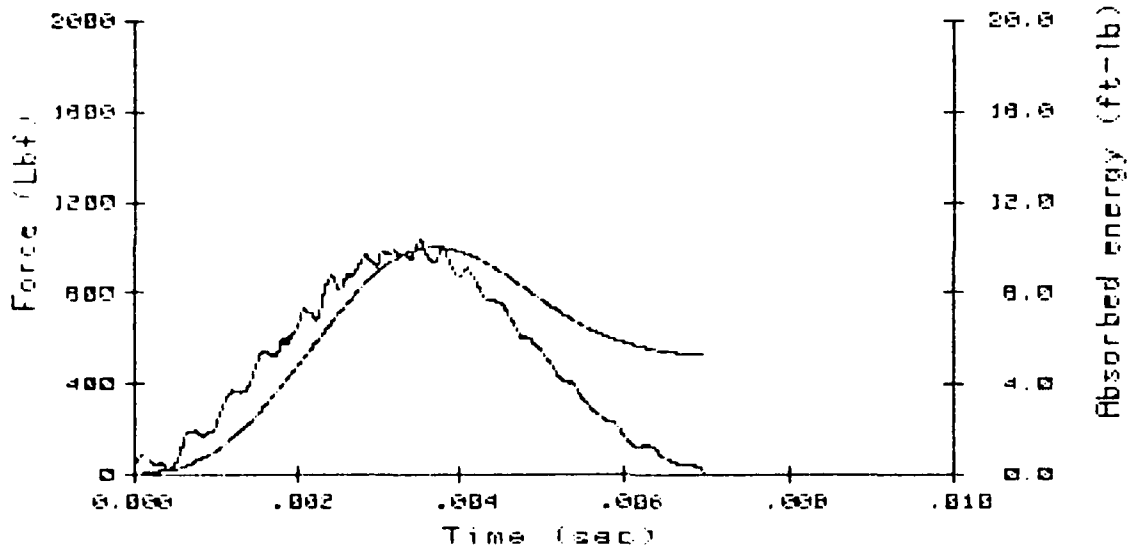


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 INSTRUMENTED IMPACT TEST
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5245 GR/BMI #3

Drop weight	=	7.00Lb	Data disk	MAT00607
Tup radius	=	.500in	DRM scale	.8Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	9.52ft/s	abs(Vf) =	8.13ft/s
K.E.	=	9.86ft-Lb	Vf(calc) =	-6.49ft/s

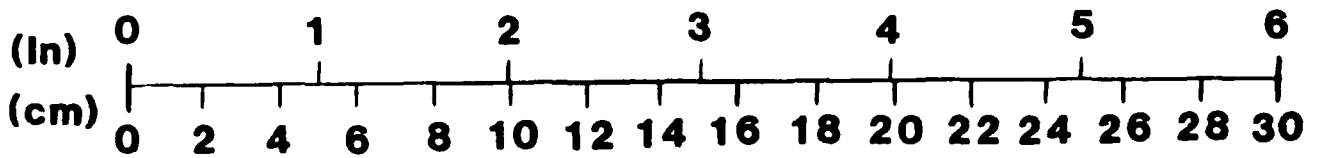
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
1034.1	3.505E-3	9.94	.2853	Maximum force
944.2	3.705E-3	10.03	.2863	Maximum energy
944.2	3.705E-3	10.03	.2863	Maximum displacement
16.2	6.945E-3	5.34	.1086	Final values



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5245 GR/BMI

#3



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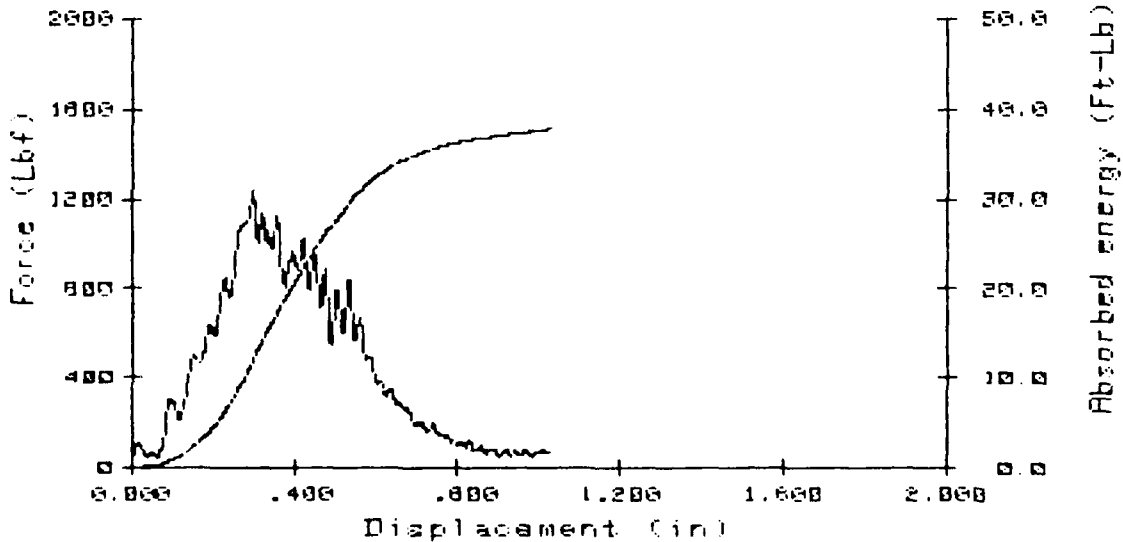
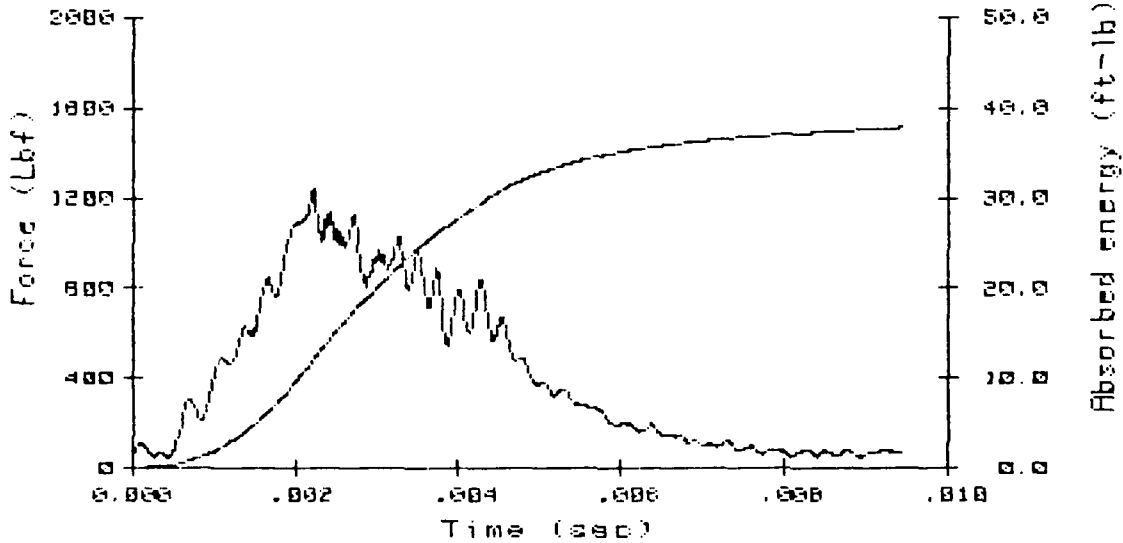
INSTRUMENTED IMPACT TEST

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5245 GR/BMI #4 *CELION ↑ ←*

Drop weight	=	31.36Lb	Data disk	MAT00608
Tip radius	=	.500in	DRM scale	.8Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	11.49ft/s		
K.E.	=	64.34ft-Lb	Vf(calc) =	7.74ft/s

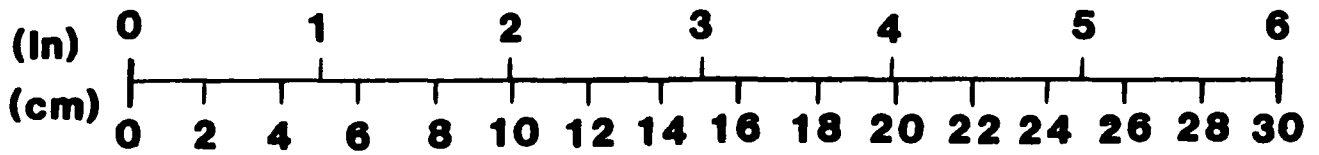
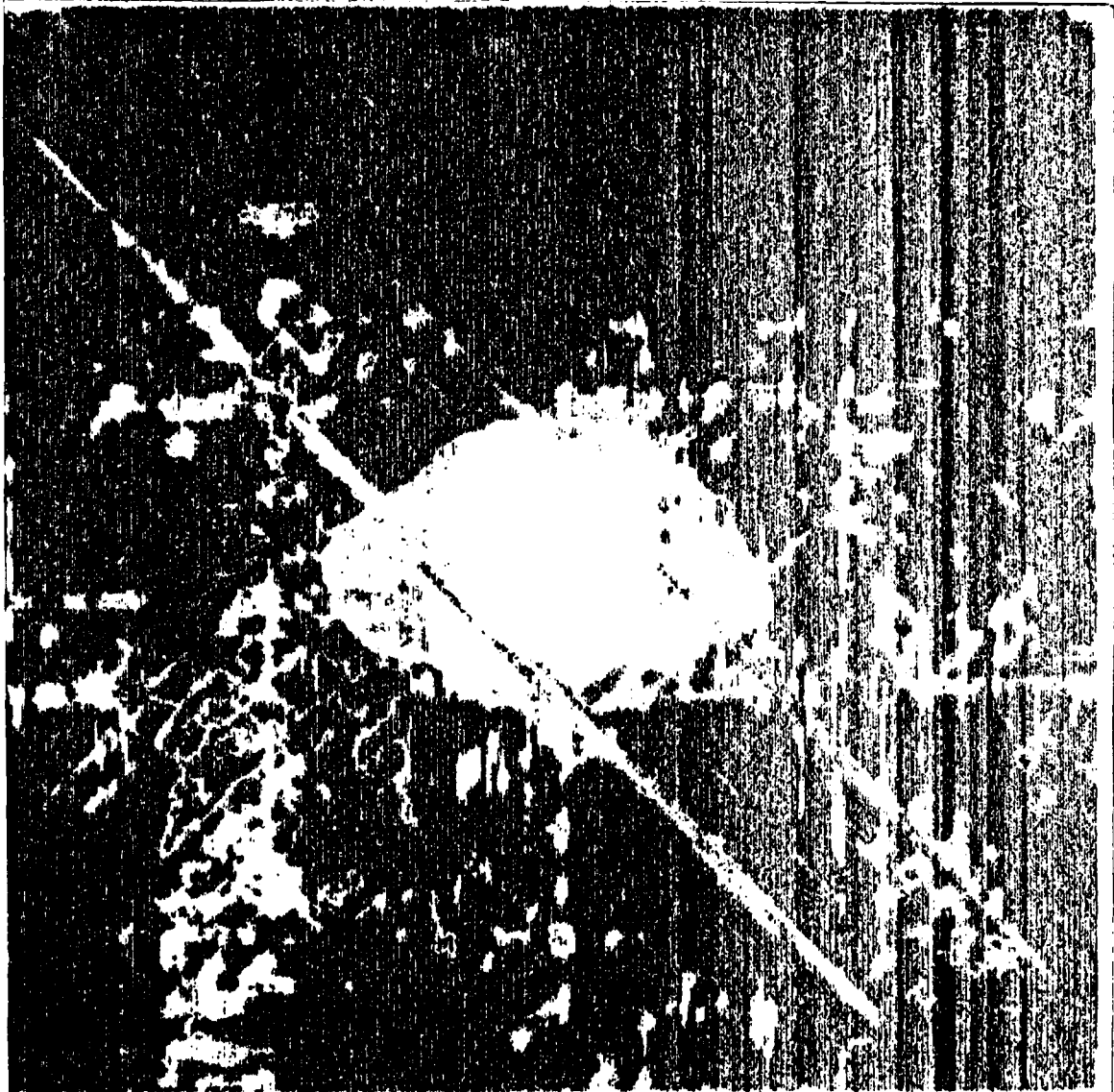
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
1237.3	2.225E-3	12.21	.3009	Maximum force
64.7	9.445E-3	37.85	1.0271	Maximum energy
64.7	9.445E-3	37.85	1.0271	Maximum displacement
64.7	9.445E-3	37.85	1.0271	Final values



NADC-85023-60

5245 GR/BMI

#4

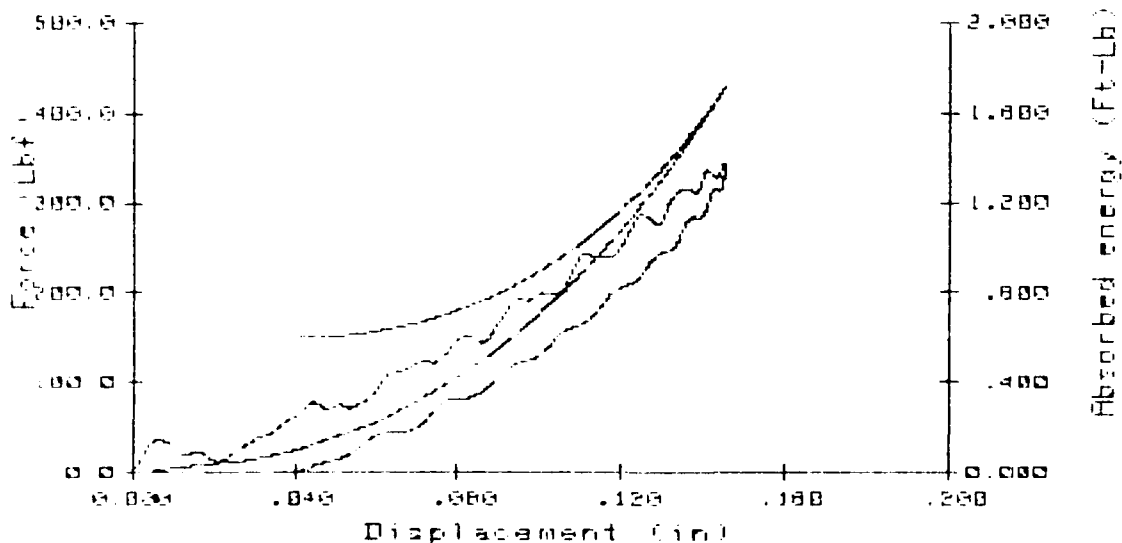
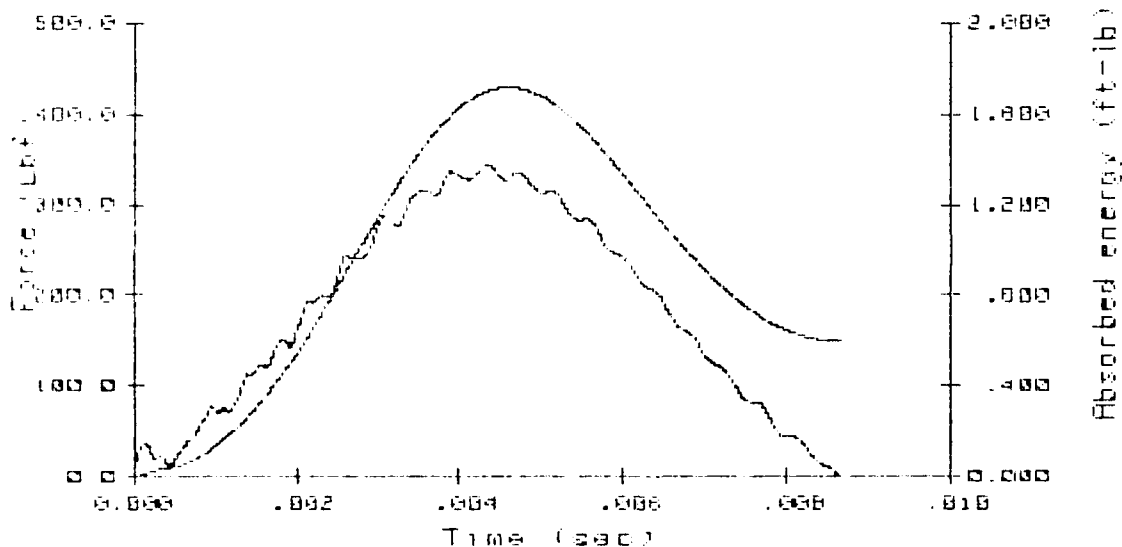


INSTRUMENTED IMPACT TEST

9245 UNIMI #6

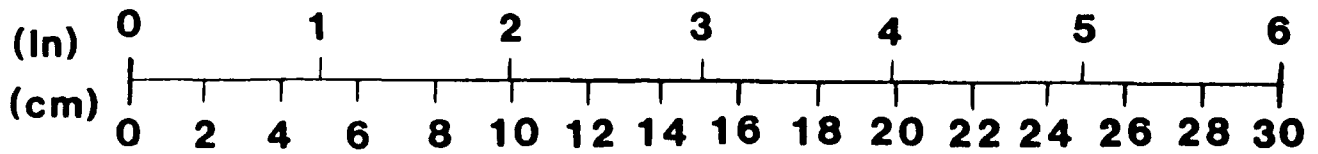
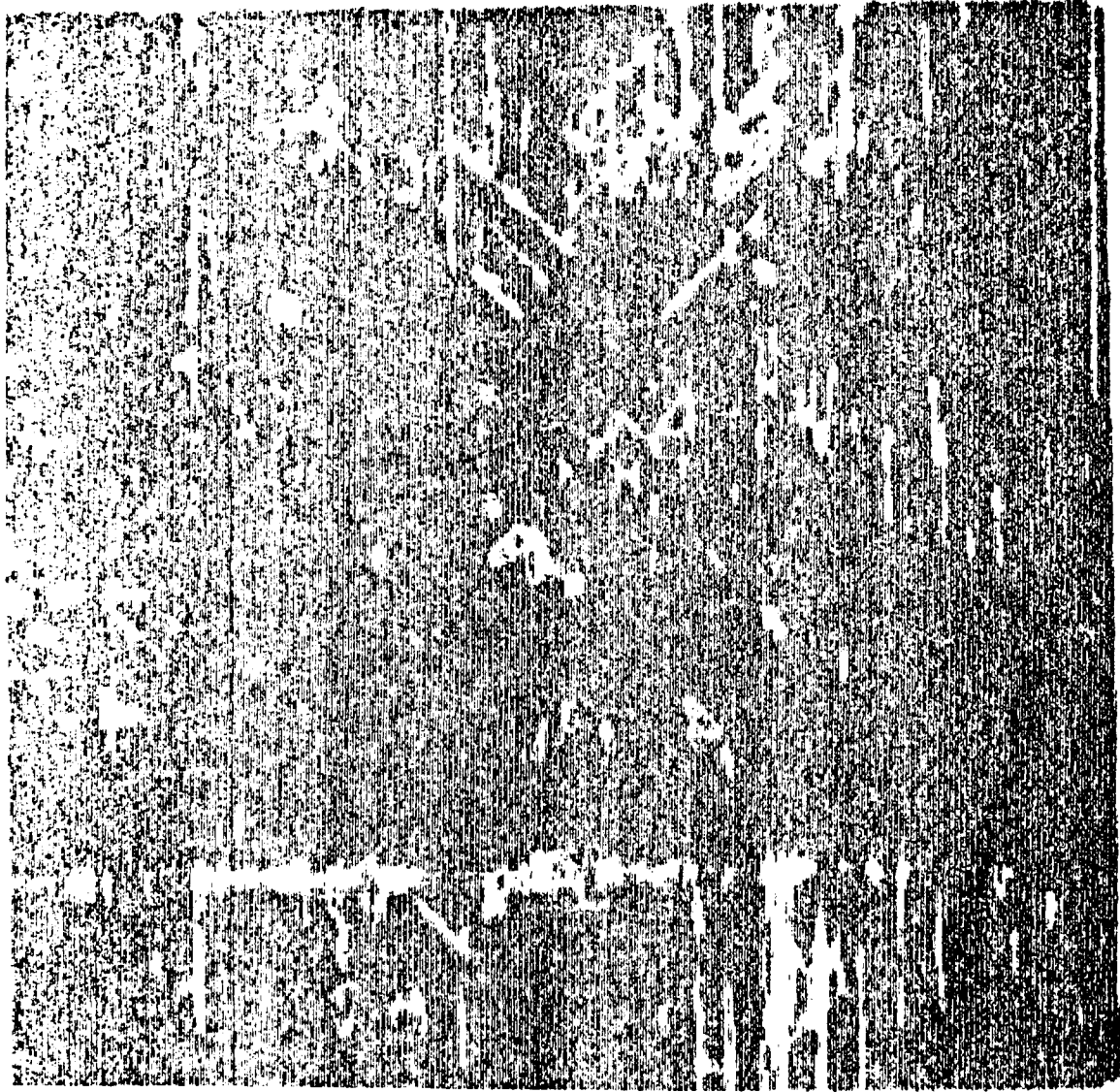
Drop weight	=	7.00lb	Data disk	MAT00902
Tip radius	=	.500in	DRM scale	.2kn/Div
Temperature	=	74.0 F	Flag grid	.040in
V ₀	=	3.88ft/s	abs(V _f)	3.70ft/s
F.E.	=	1.63ft-Lb	V _f (calc)	-3.12ft/s

Load (Lb)	Time (s)	E0 (Ft-Lb)	Disp (in)	
343.9	4.385E-3	1.70	.1446	Maximum force
327.9	4.595E-3	1.72	.1451	Maximum energy
327.9	4.595E-3	1.72	.1451	Maximum displacement
1.4	8.665E-3	.60	.0411	Final values



5245 GR/BMI

#6



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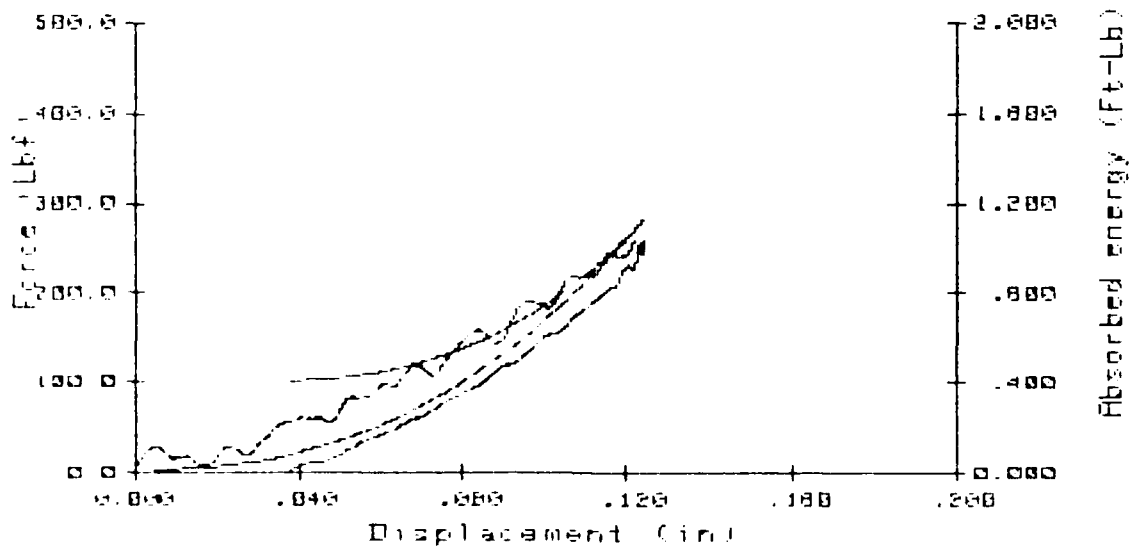
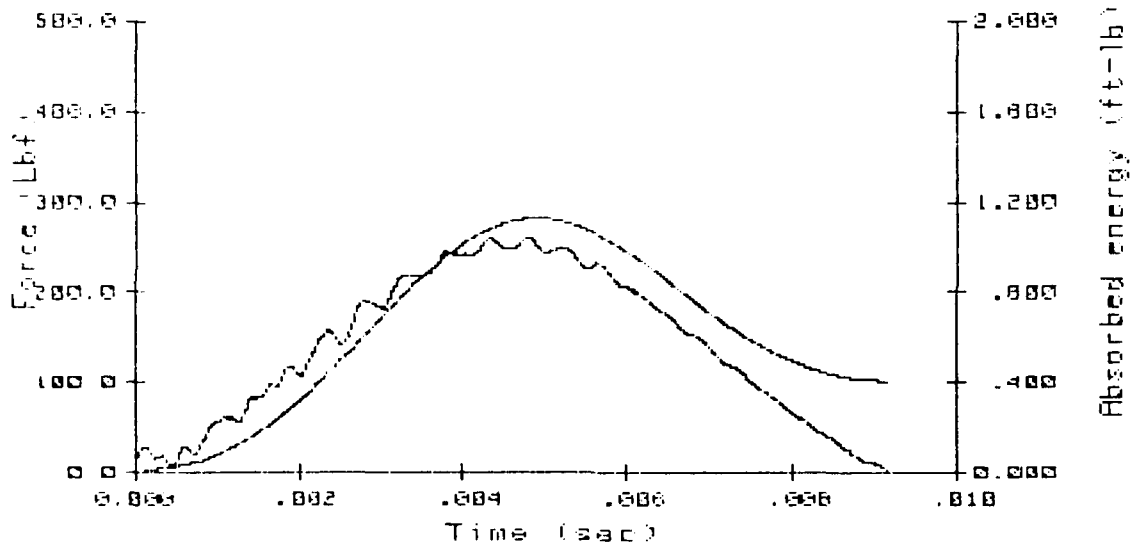
INSTRUMENTED IMPACT TEST

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5245 GR/BMI #7

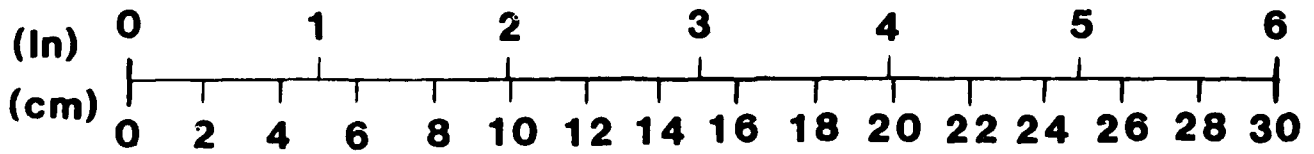
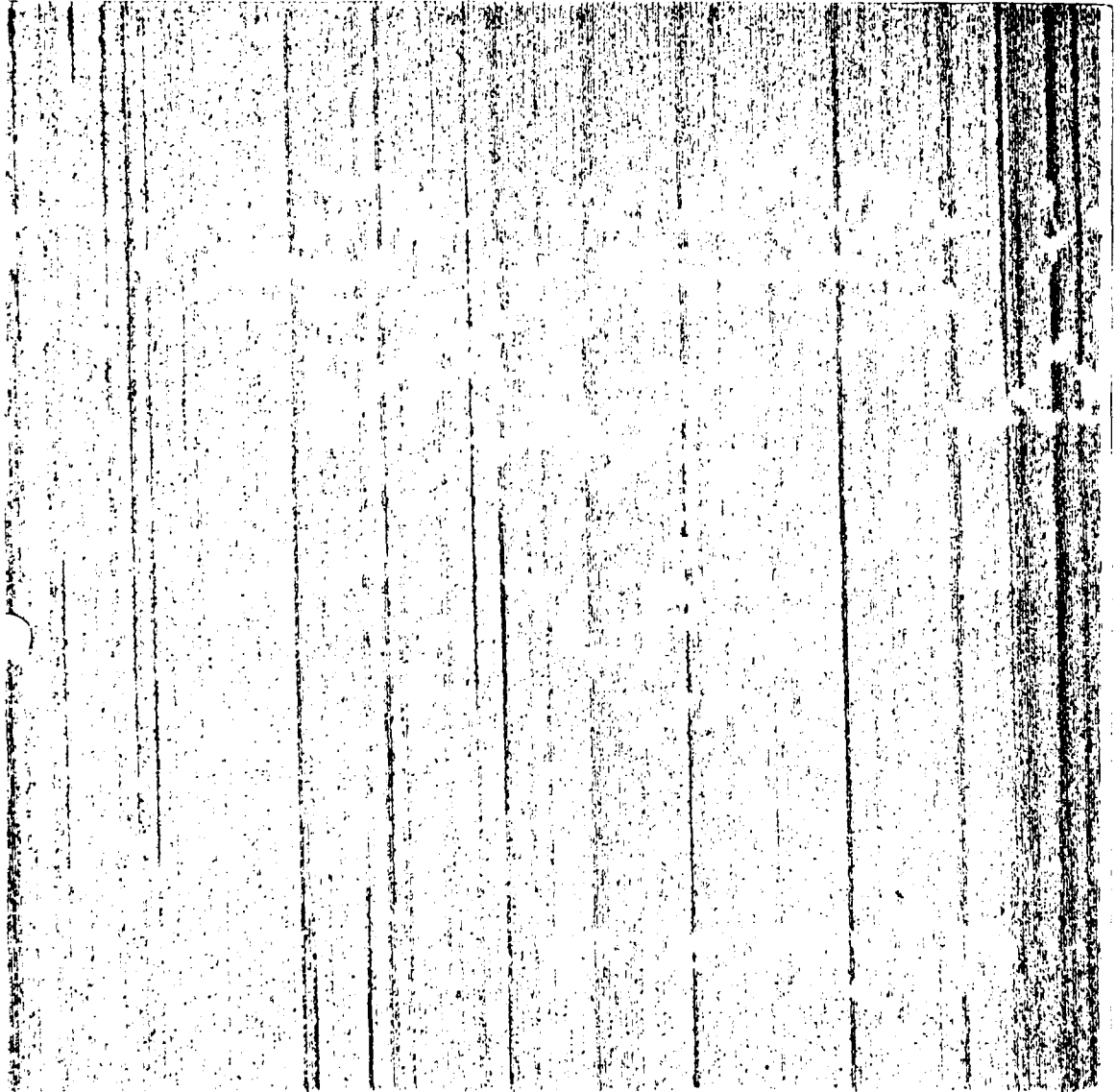
Drop weight	=	7.00Lb	Data disk	MAT01005
Tip radius	=	.500in	DRM scale	.2Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	3.12ft/s	abs(Vf)	3.00ft/s
I.E.	=	1.05ft-Lb	Vf(calc)	-2.48ft/s

Load (Lb)	Time (s)	EO (Ft-Lb)	Disp (in)	
260.3	4.785E-3	1.13	.1240	Maximum force
251.8	4.895E-3	1.13	.1241	Maximum energy
251.8	4.895E-3	1.13	.1241	Maximum displacement
4.0	9.135E-3	.41	.0383	Final values



5245 GR/BMI

#7



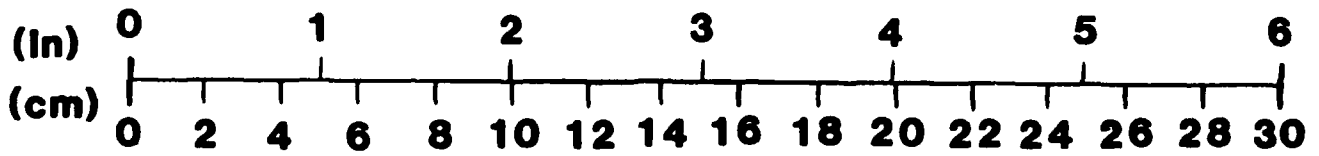
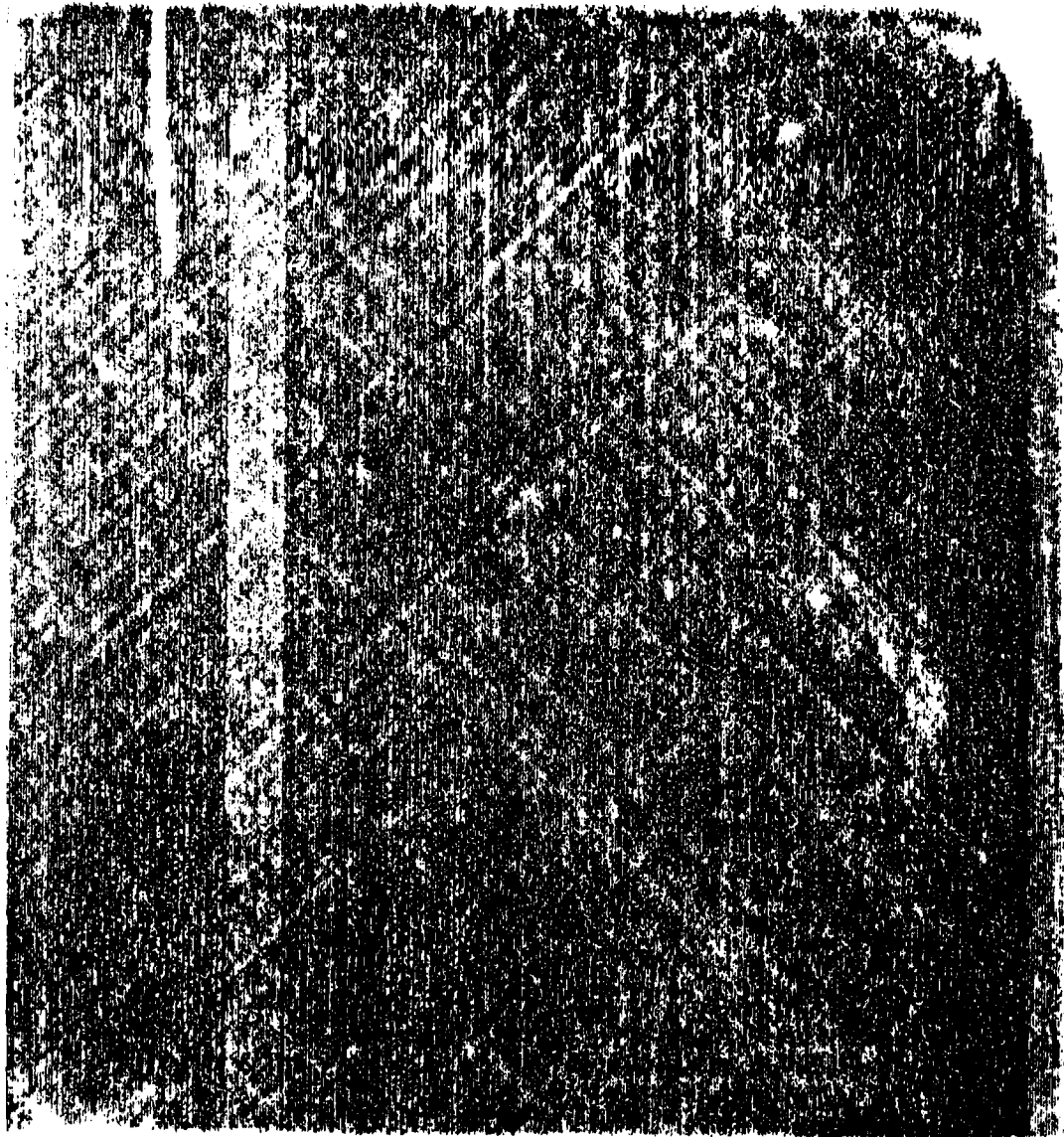
NADC-85023-60

IM6/5245C

NADC-85023-60

GR/BMI 5245C

CONTROL



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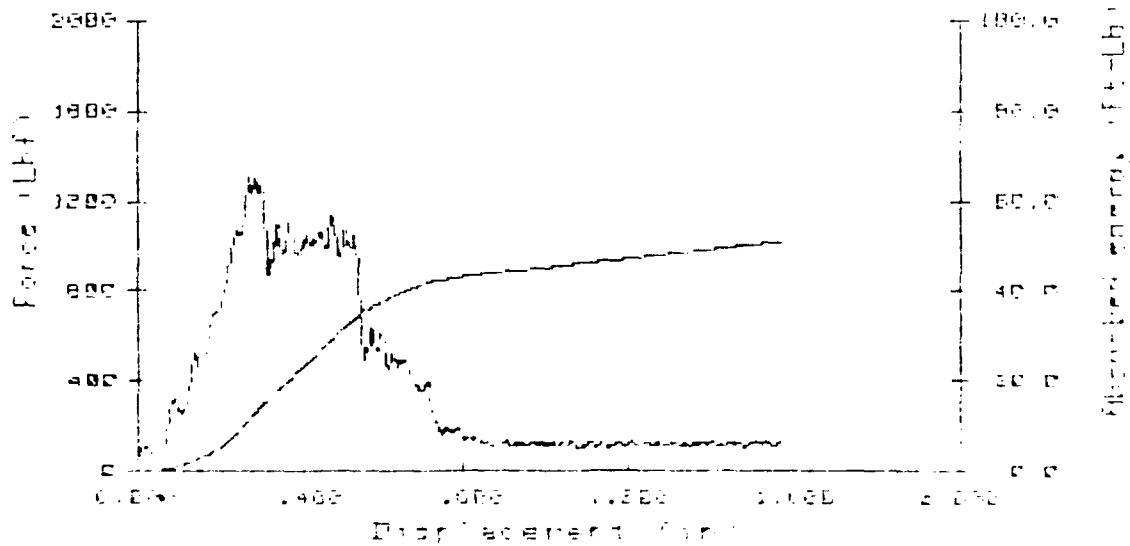
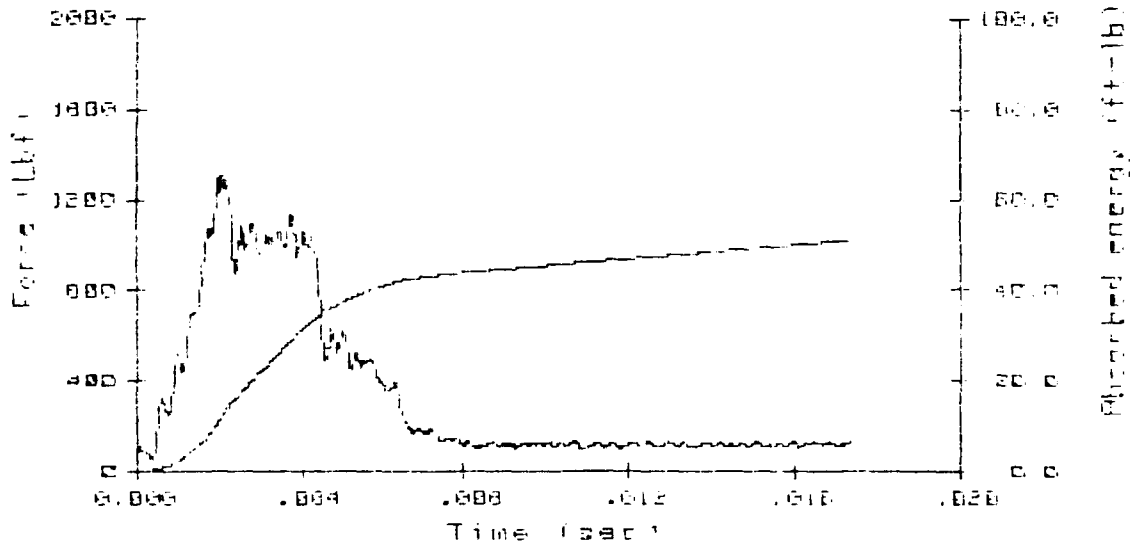
INSTRUMENTED IMPACT TEST

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GR/BMI 52450 #1

Drop weight	=	31.36Lb	Data disk	MAT01108
Tip radius	=	.500in	DRM scale	.8Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	11.49ft/s		
I.E.	=	64.34ft-Lb	Vf (calc) =	5.97ft/s

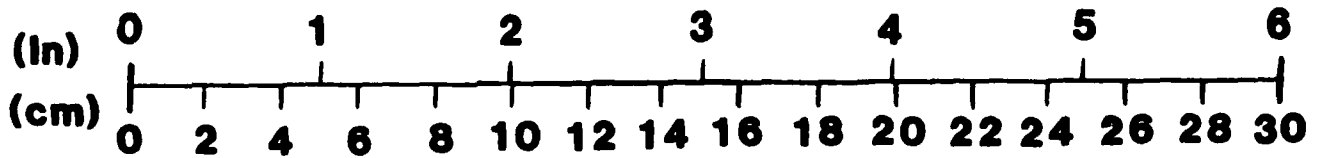
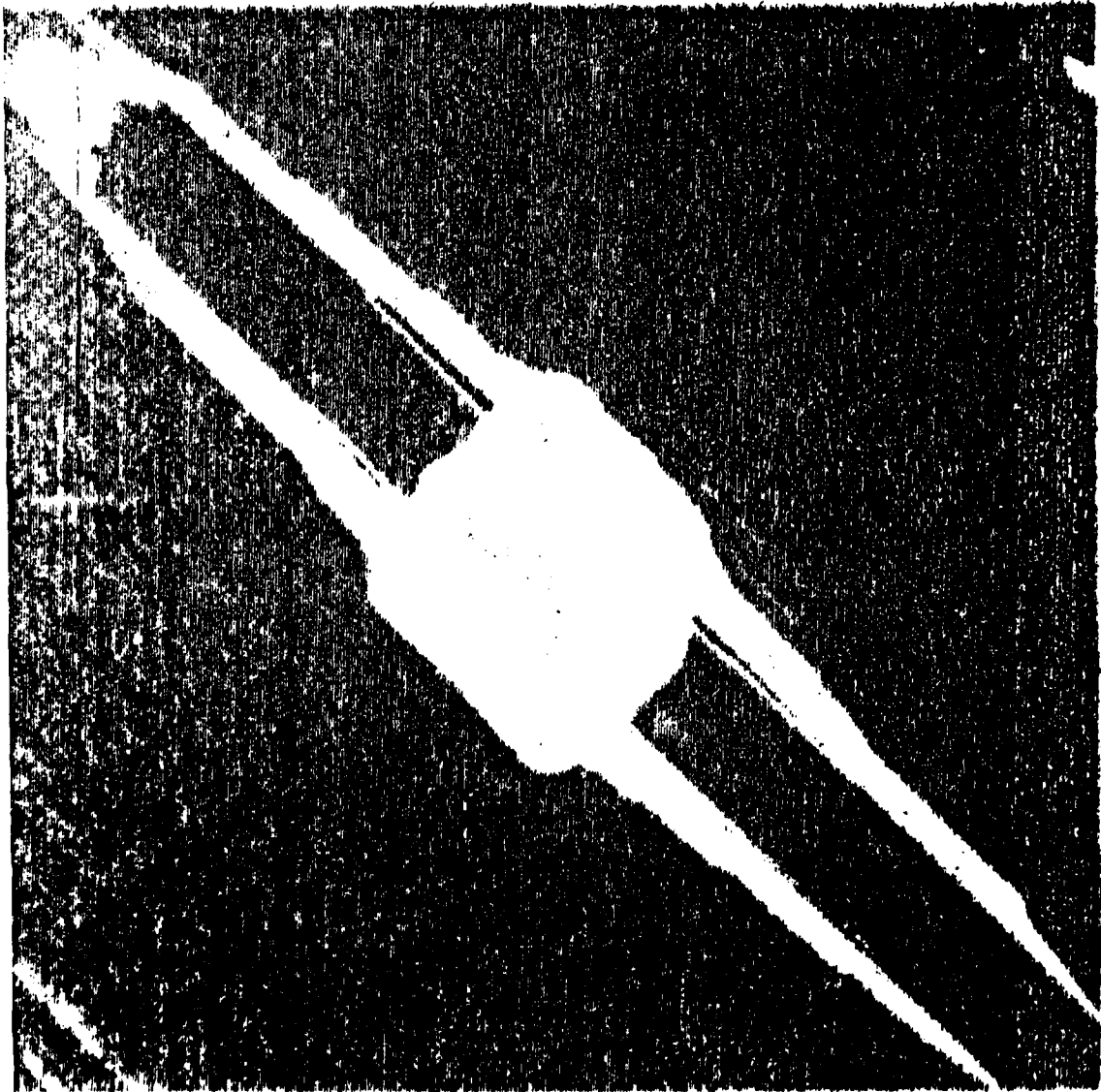
Load (Lb)	Time (s)	E0 (Ft-Lb)	Disp (in)	
1309.3	1.985E-3	11.14	.2692	Maximum force
127.7	1.735E-2	51.06	1.5661	Maximum energy
127.7	1.735E-2	51.06	1.5661	Maximum displacement
127.7	1.735E-2	51.06	1.5661	Final values



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GR/BMI 5245C

#1



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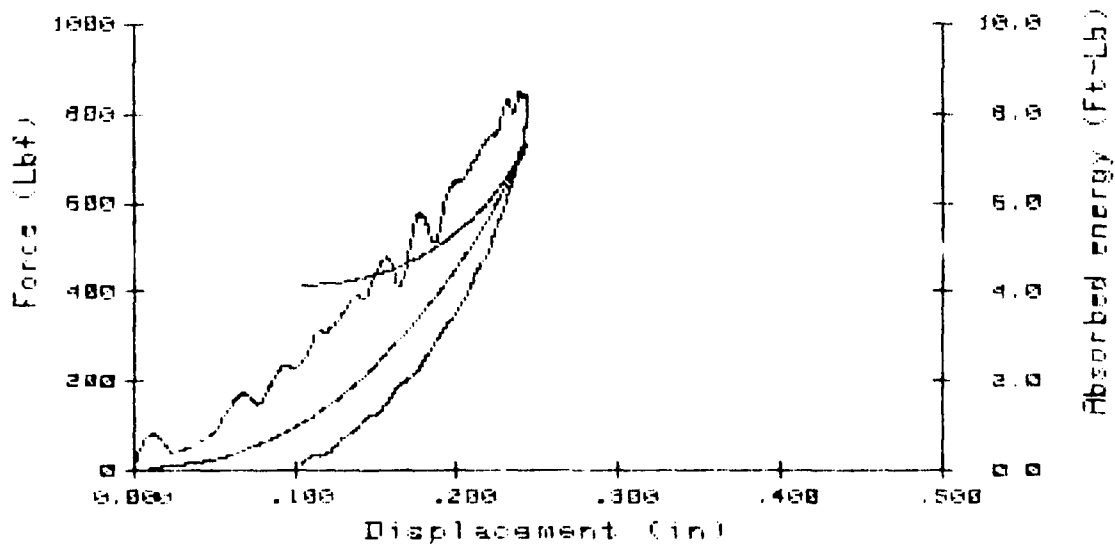
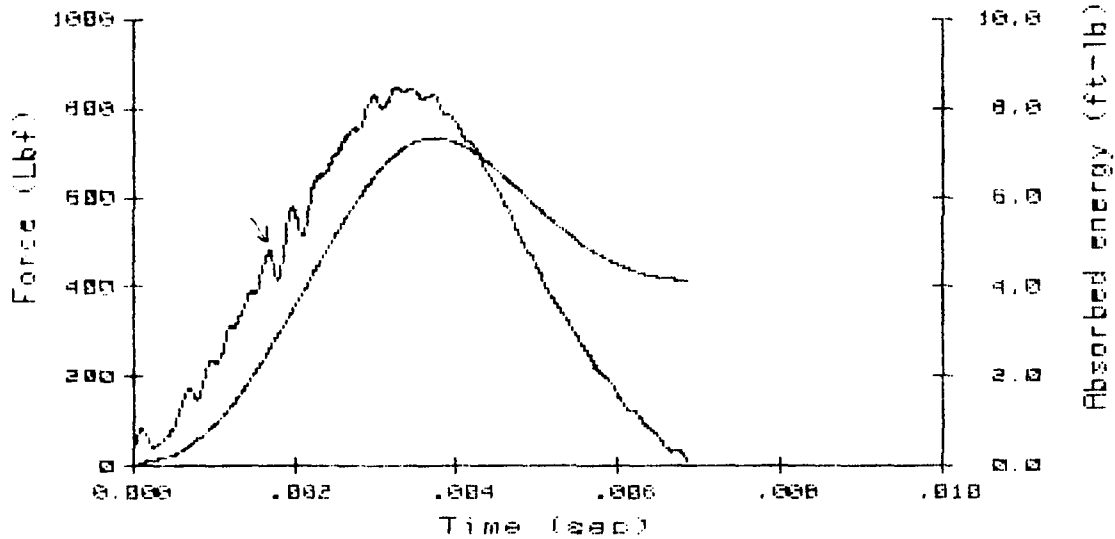
INSTRUMENTED IMPACT TEST

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GR/BMI 5245C #2

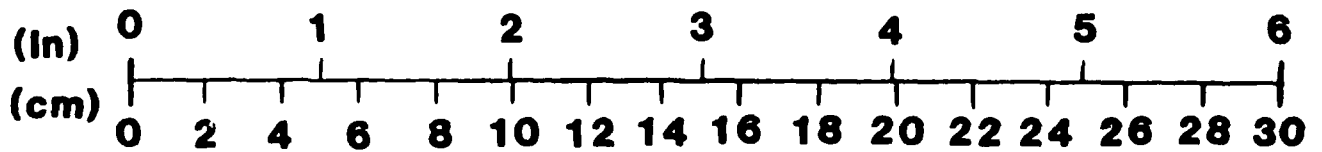
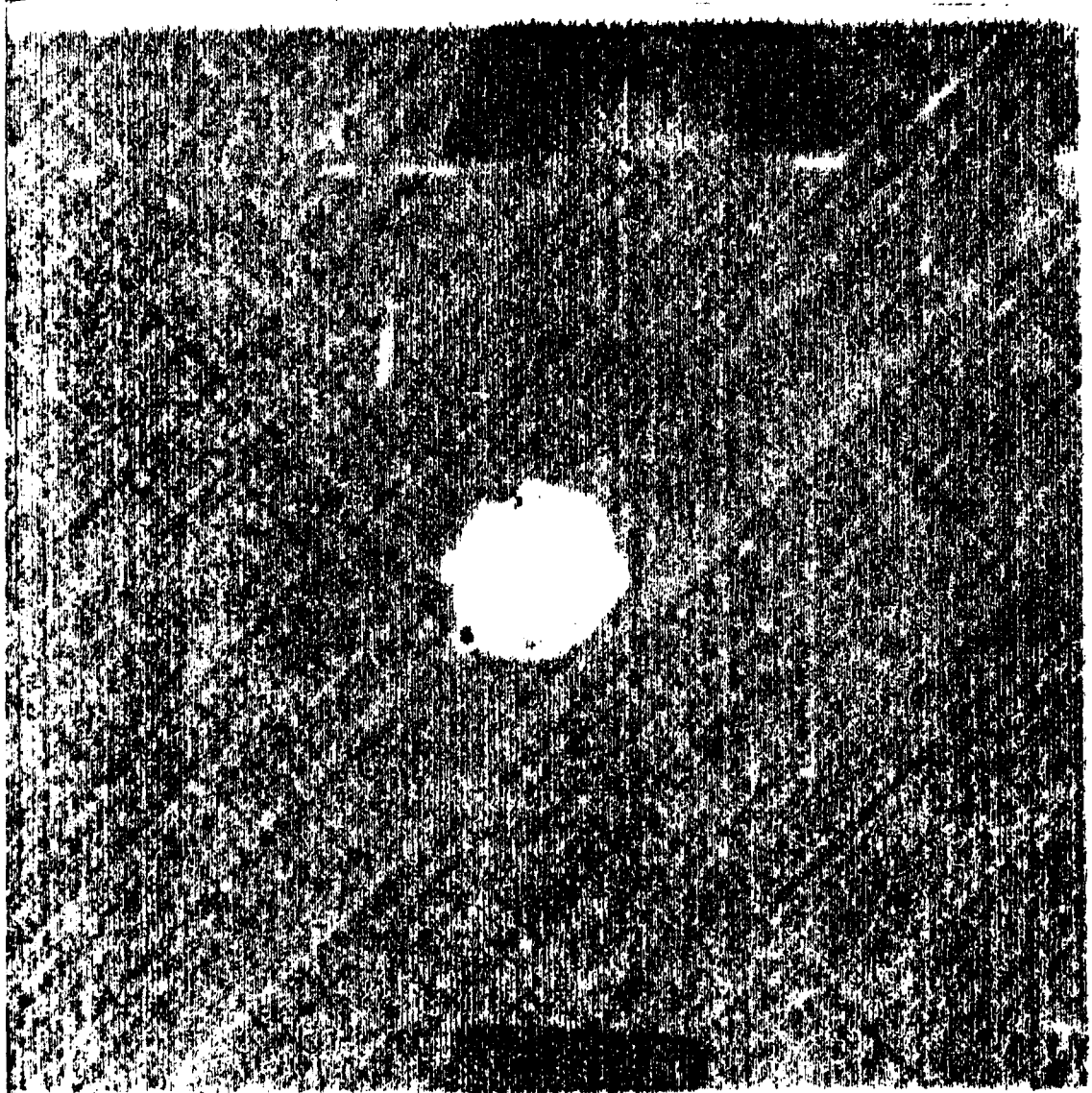
Drop weight	=	7.00lb	Data disk	MAT01106
Tip radius	=	.500in	DRM scale	.8Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	8.13ft/s	abs(Vf) =	7.09ft/s
K.E.	=	7.18ft-Lb	Vf(calc) =	-5.35ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
482.0	1.685E-3	2.59	.1558	Initial damage
848.9	3.245E-3	6.96	.2390	Maximum force
832.7	3.725E-3	7.33	.2442	Maximum energy
832.7	3.725E-3	7.33	.2442	Maximum displacement
14.4	6.855E-3	4.14	.1042	Final values



GR/BMI 5245C

#2



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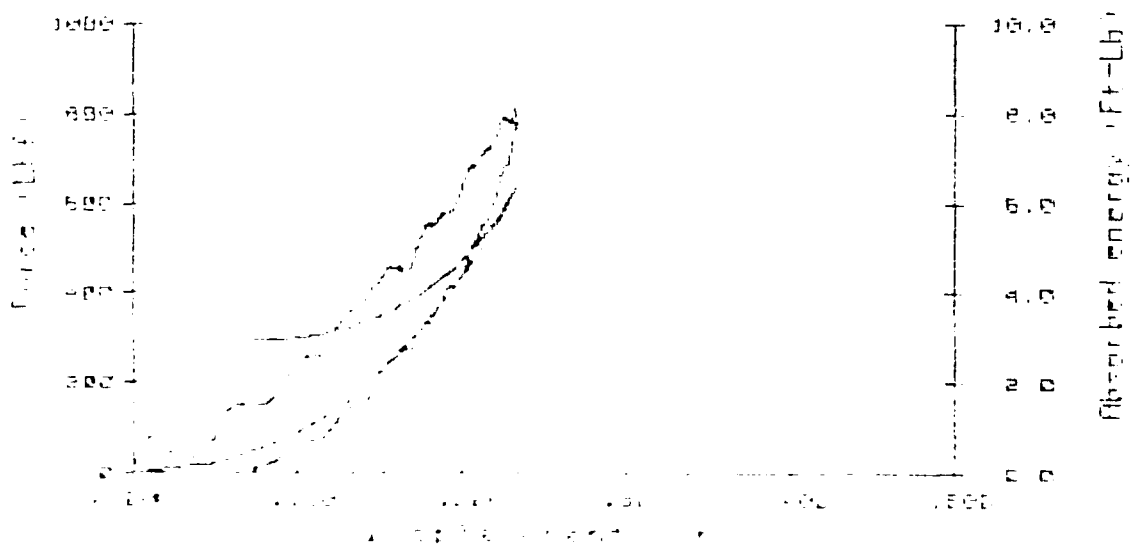
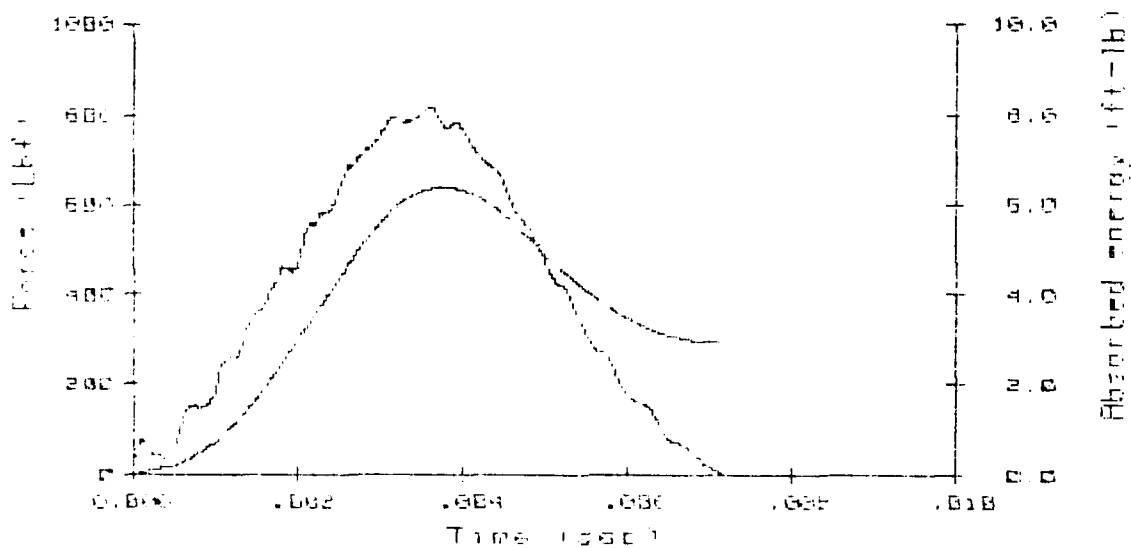
INSTRUMENTED IMPACT TEST

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GR/BNI 52450 #3A

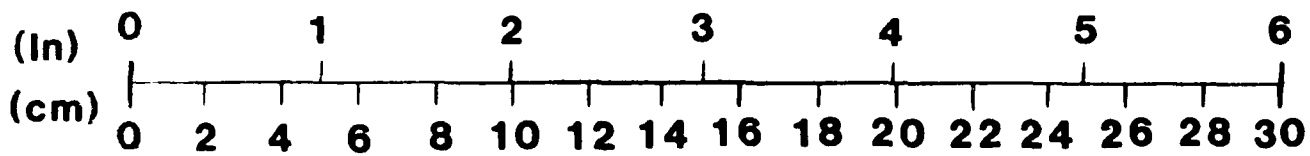
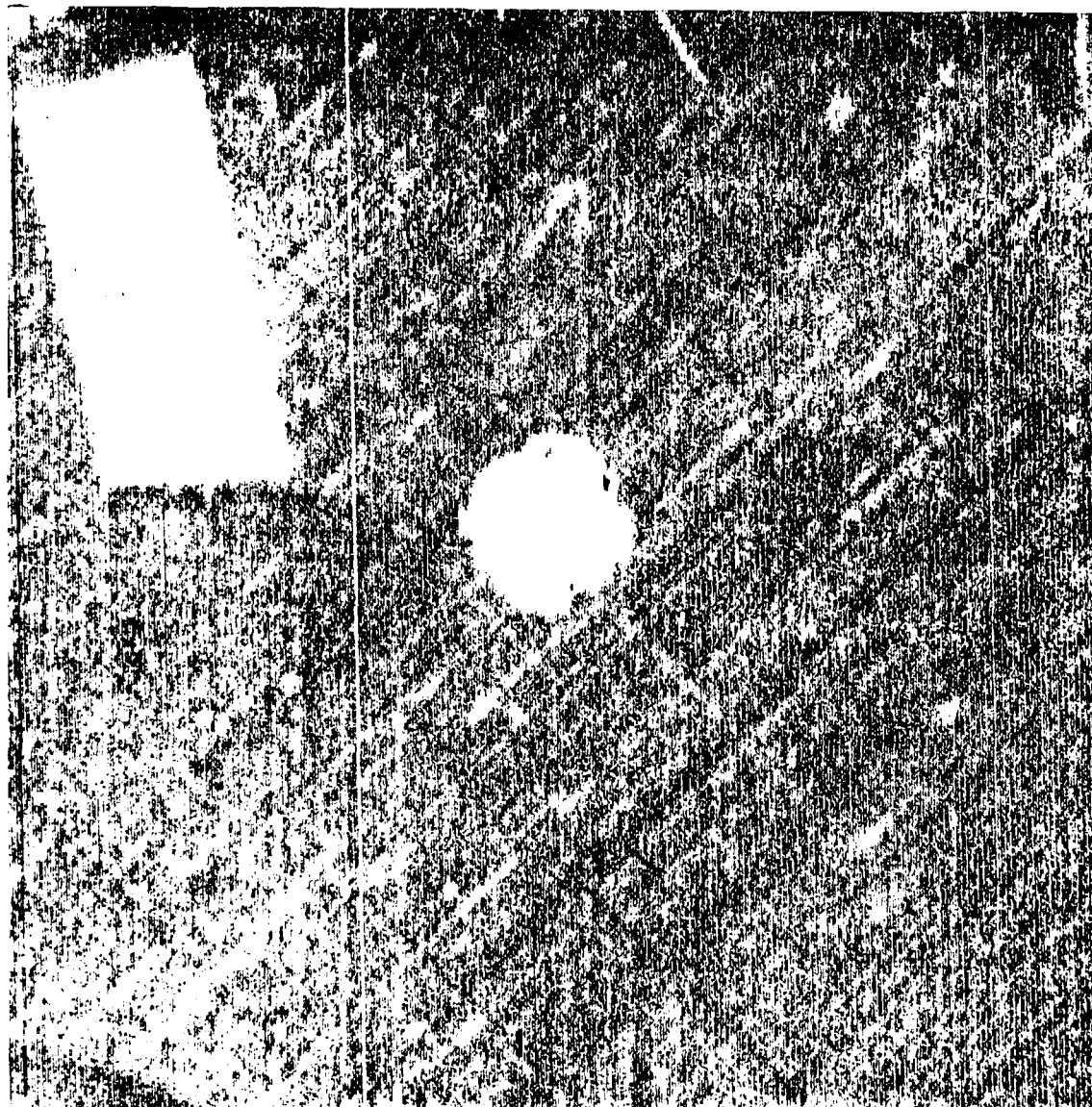
Drop weight	=	7.00Lb	Data disk	MAT01105
Tip radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	7.58ft/s	abs(Vf)	= 6.94ft/s
H.E.	=	6.24ft-Lb	Vf(calc)	= -5.54ft/s

Load(Lb)	Time(s)	EO(Ft-Lb)	Disp(in)	
817.4	3.605E-3	6.34	.2314	Maximum force
774.2	3.755E-3	6.37	.2318	Maximum energy
774.2	3.755E-3	6.37	.2318	Maximum displacement
8.1	7.125E-3	2.94	.0743	Final values



GR/BMI 5245C

#3

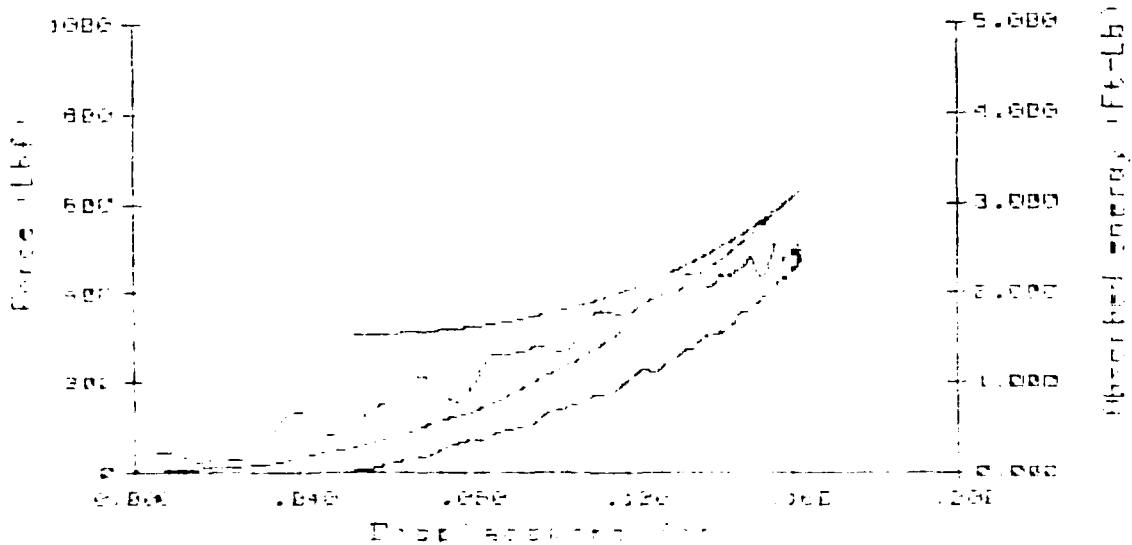
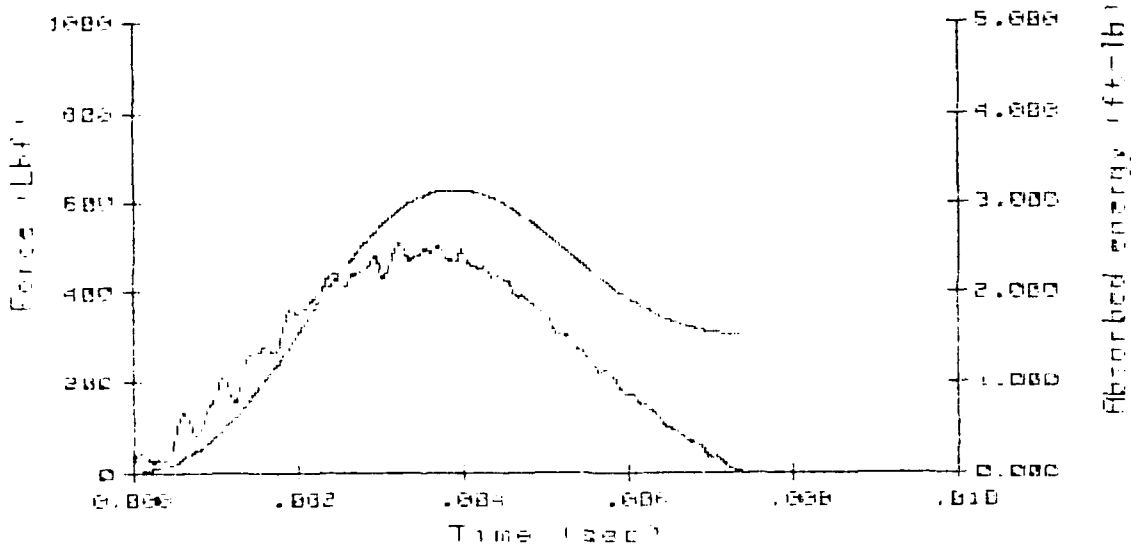


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 INSTRUMENTED IMPACT TEST
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GR/BMI 52450 #4

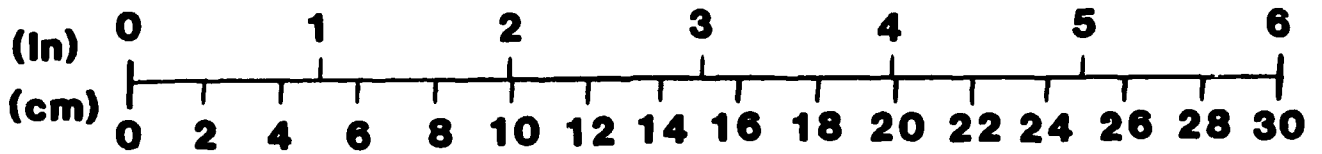
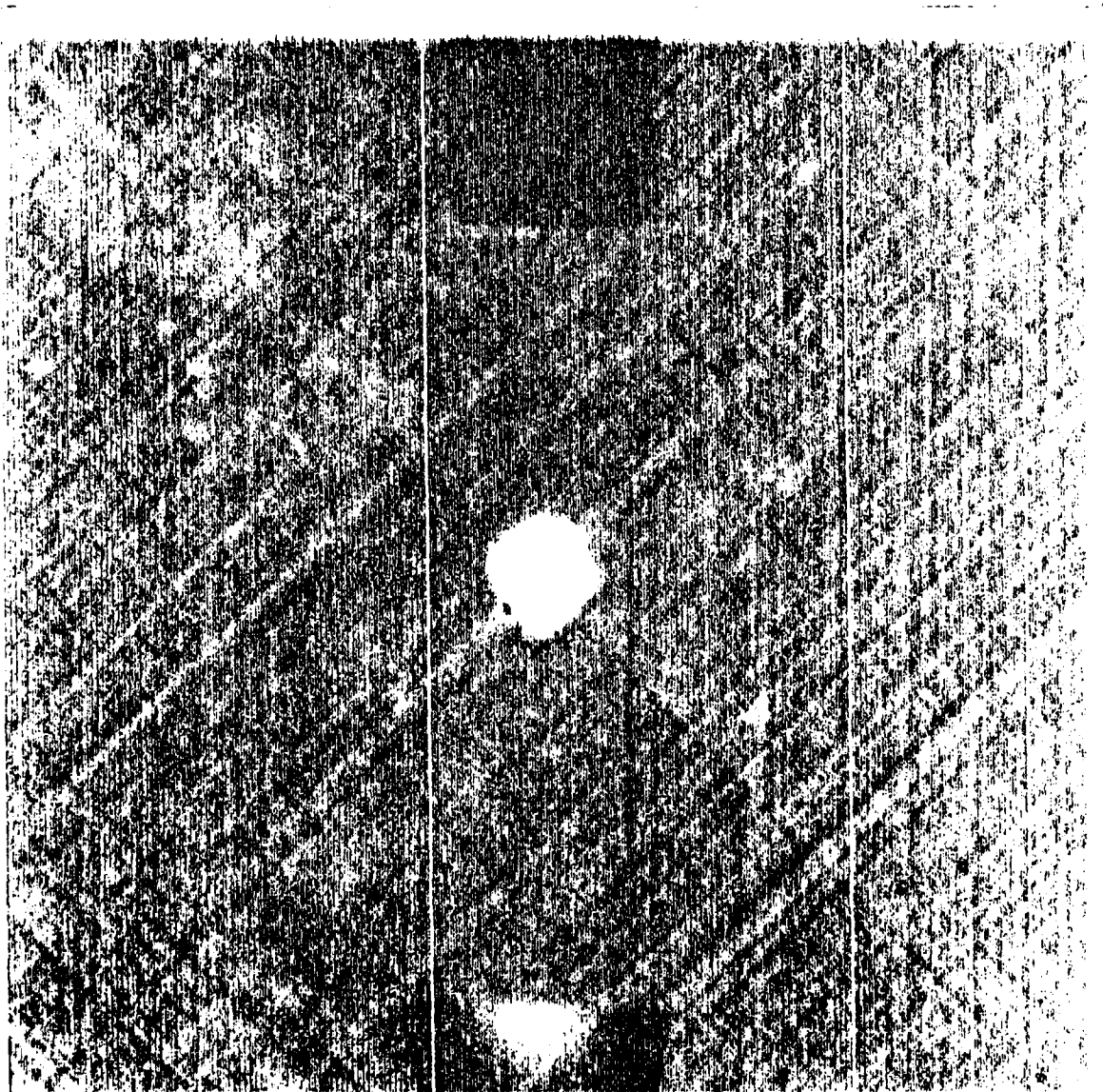
Drop weight	=	7.00Lb	Data disk	MAT01102
Tip radius	=	.500in	DRM scale	.2Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V ₀	=	5.29ft/s	abs(V _f) =	4.76ft/s
F.E.	=	3.04ft-Lb	V _f (calc) =	-3.76ft/s

Load (Lb)	Time (s)	EO (Ft-Lb)	Disp (in)	
510.8	1.215E-3	2.90	.1561	Maximum force
469.4	3.875E-3	3.14	.1619	Maximum energy
469.4	1.875E-3	3.14	.1619	Maximum displacement
4.0	7.375E-3	1.54	.0537	Final values



GR/BMI 5245C

#4



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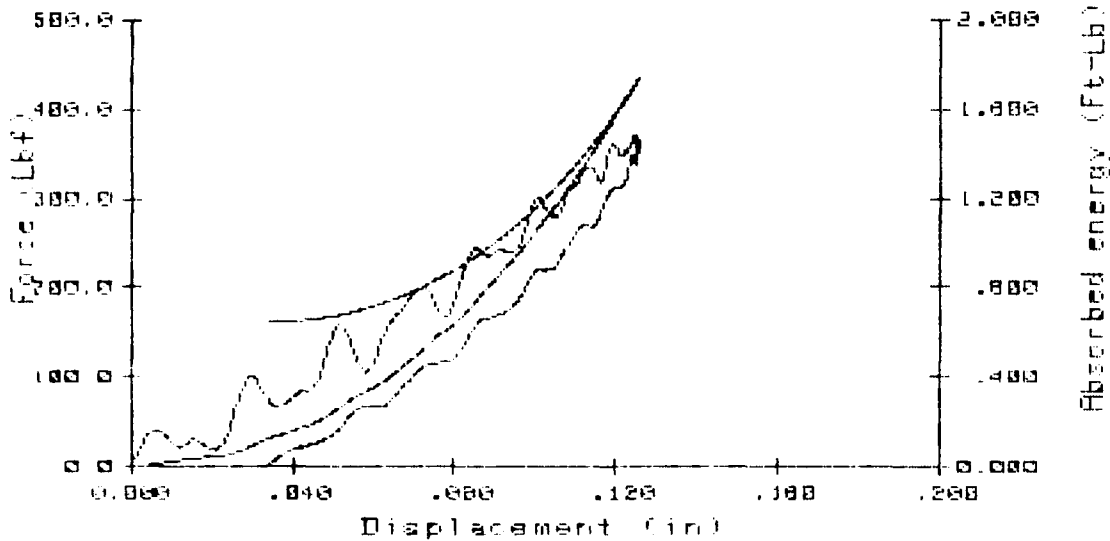
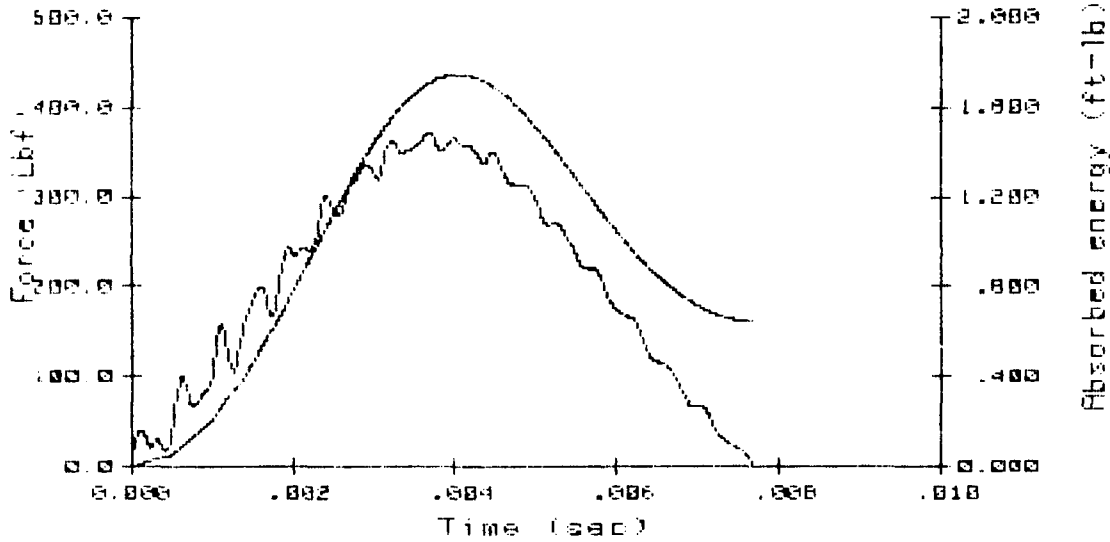
INSTRUMENTED IMPACT TEST

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GR/BMI 5245C #5

Drop weight	=	7.00Lb	Data disk	MAT01008
Tip radius	=	.500in	DRM scale	.2Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	3.92ft/s	abs(Vf) =	3.66ft/s
K.E.	=	1.67ft-Lb	Vf(calc) =	-3.10ft/s

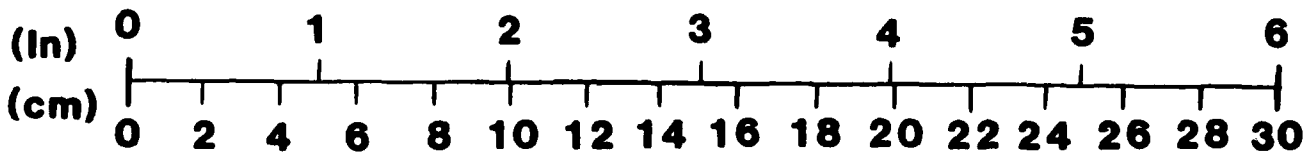
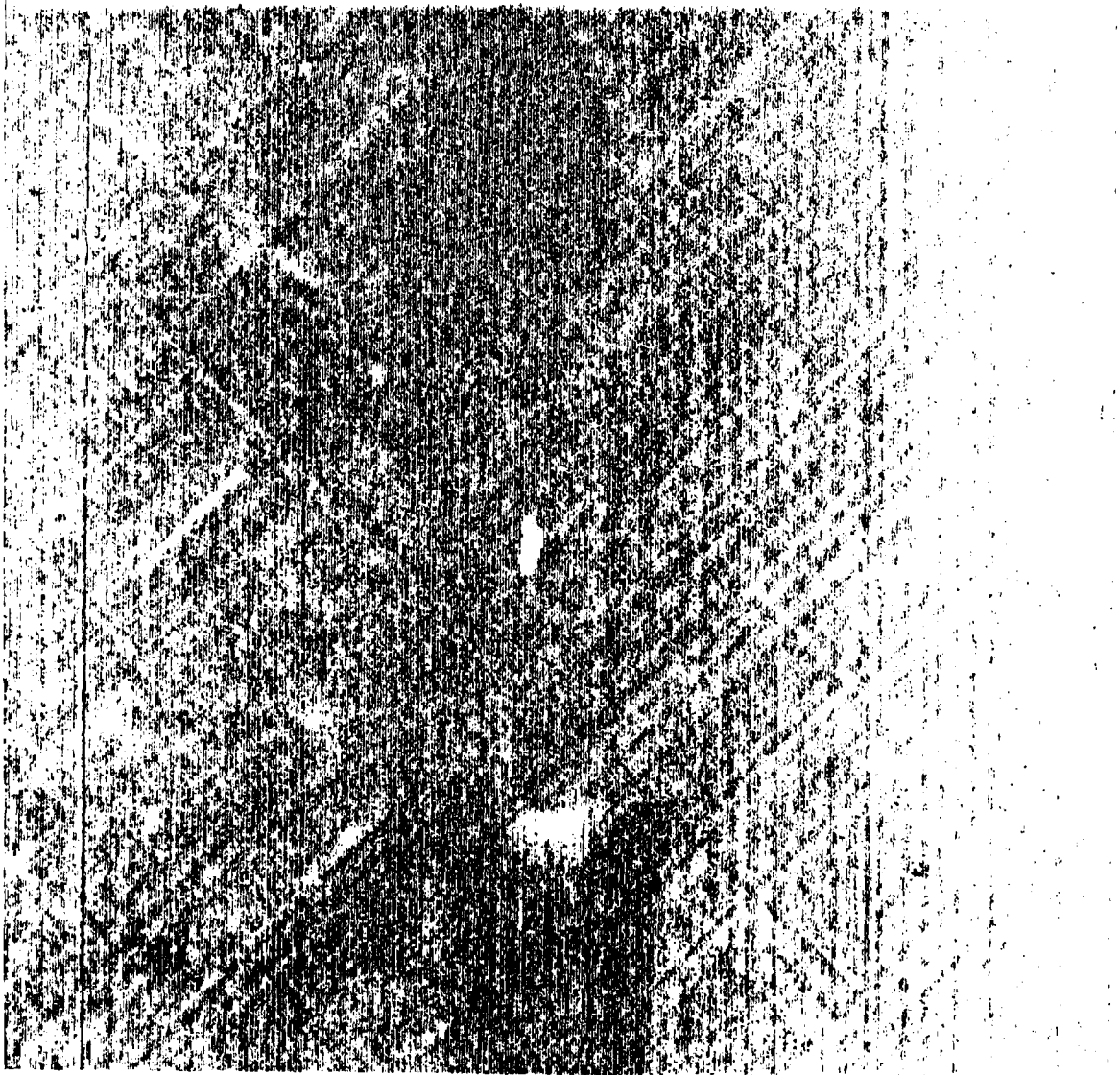
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
372.3	3.685E-3	1.71	.1246	Maximum force
362.4	4.035E-3	1.74	.1258	Maximum energy
362.4	4.035E-3	1.74	.1258	Maximum displacement
3.6	7.665E-3	.64	.0347	Final values



NADC-85023-60

GR/BMI 5245C

#5



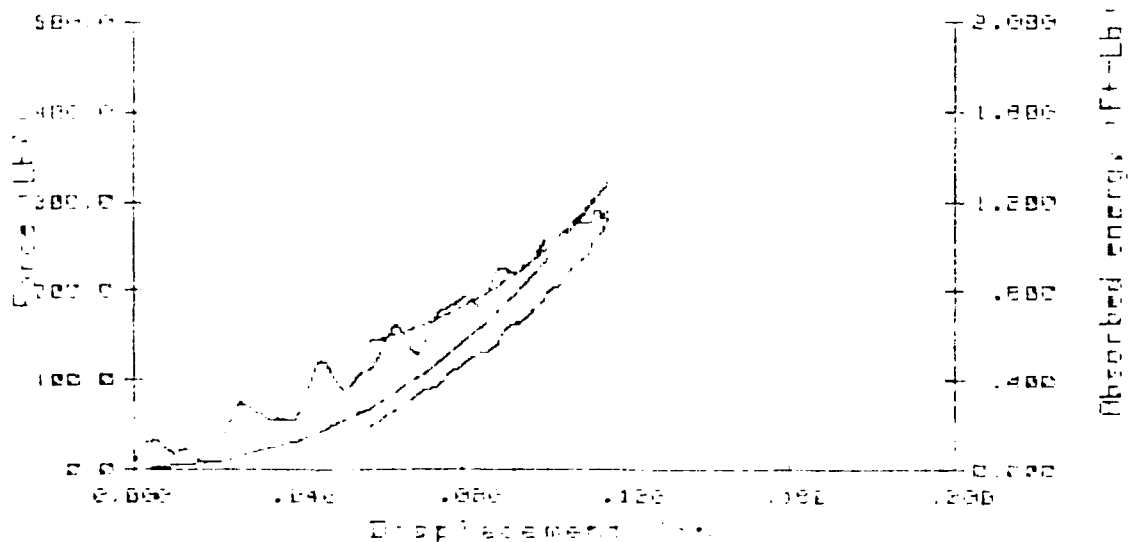
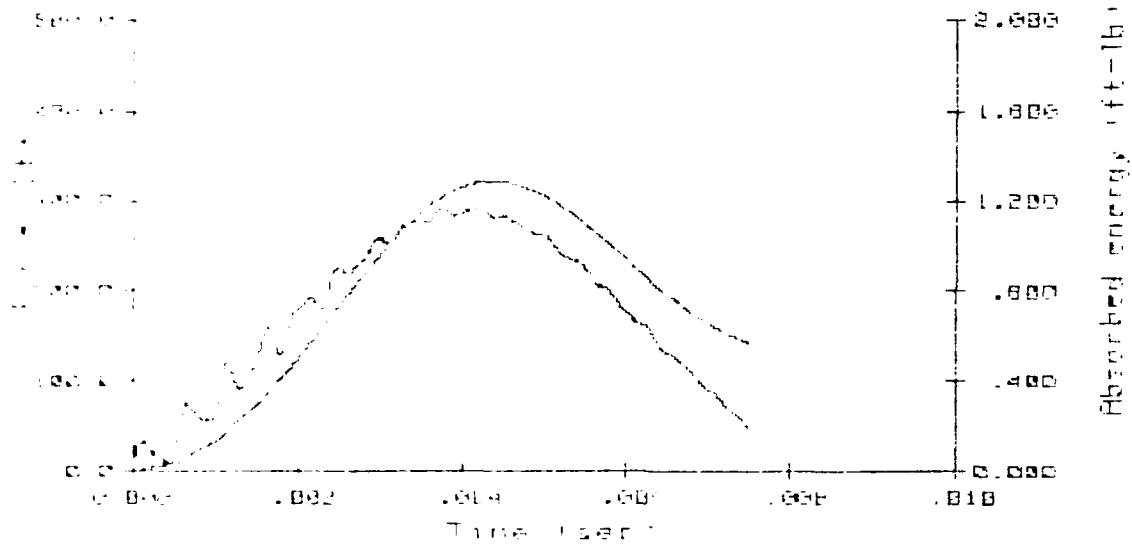
INSTRUMENTED IMPACT TEST

EMG

GM-BMI 51450 #6

Drop weight = 7.00Lb Data disk MAT01006
 Top radius = .500in DRM scale .2Kn/Div
 Temperature = 74.0 F Flag grid= .040in
 V0 = 3.35ft/s
 F.E. = 1.22ft-Lb Vf (calc) = -2.50ft/s

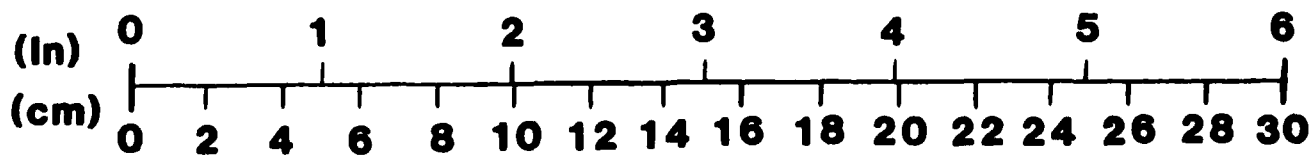
Load (Lb)	Time (s)	E0 (Ft-Lb)	Displ (in)	
281.4	3.747E-03	1.22	.1130	Maximum force
281.4	4.307E-03	1.25	.1159	Maximum energy
281.4	4.350E-03	1.29	.1159	Maximum displacement
48.8	7.507E-03	.57	.0572	Final values



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GR/BMI 5245C

#6



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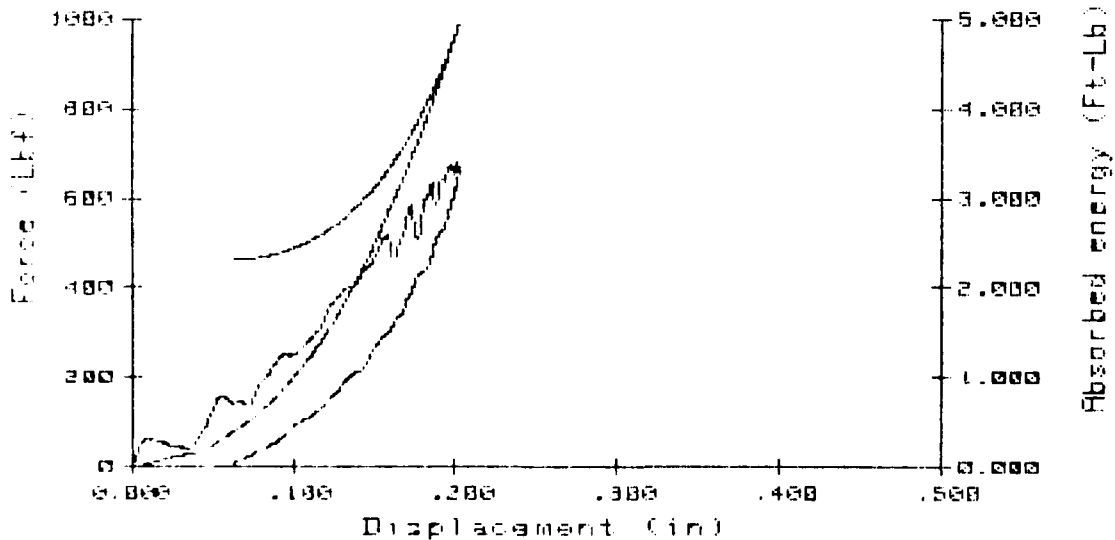
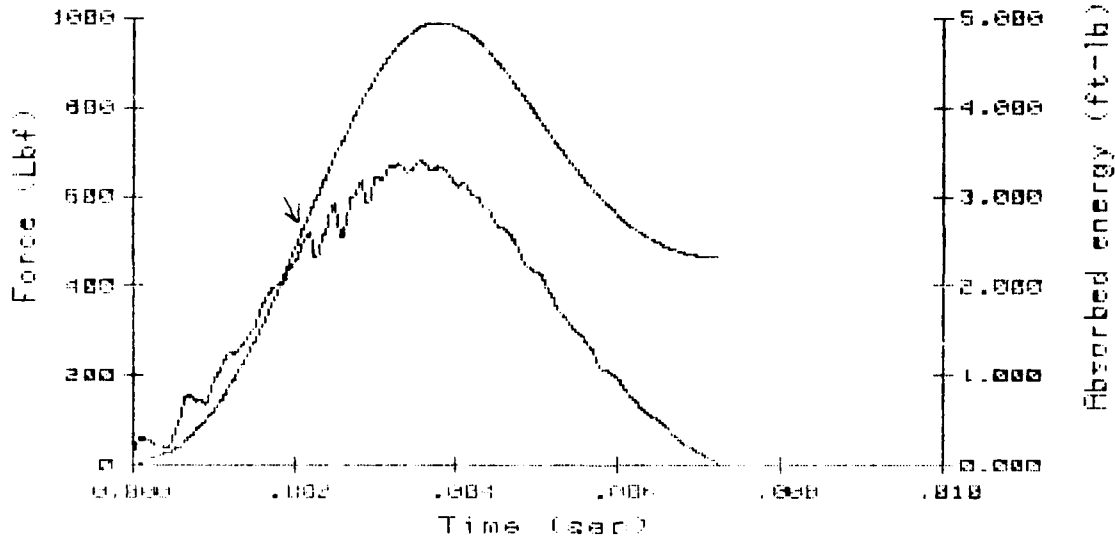
INSTRUMENTED IMPACT TEST

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GR/BMI #7

Drop weight	=	7.00Lb	Data disk	MAT01204
Top radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	6.67ft/s	abs(Vf) =	5.85ft/s
K.E.	=	4.83ft-Lb	Vf(calc) =	-4.85ft/s

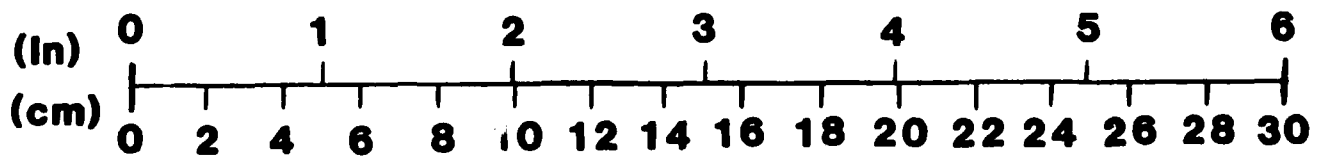
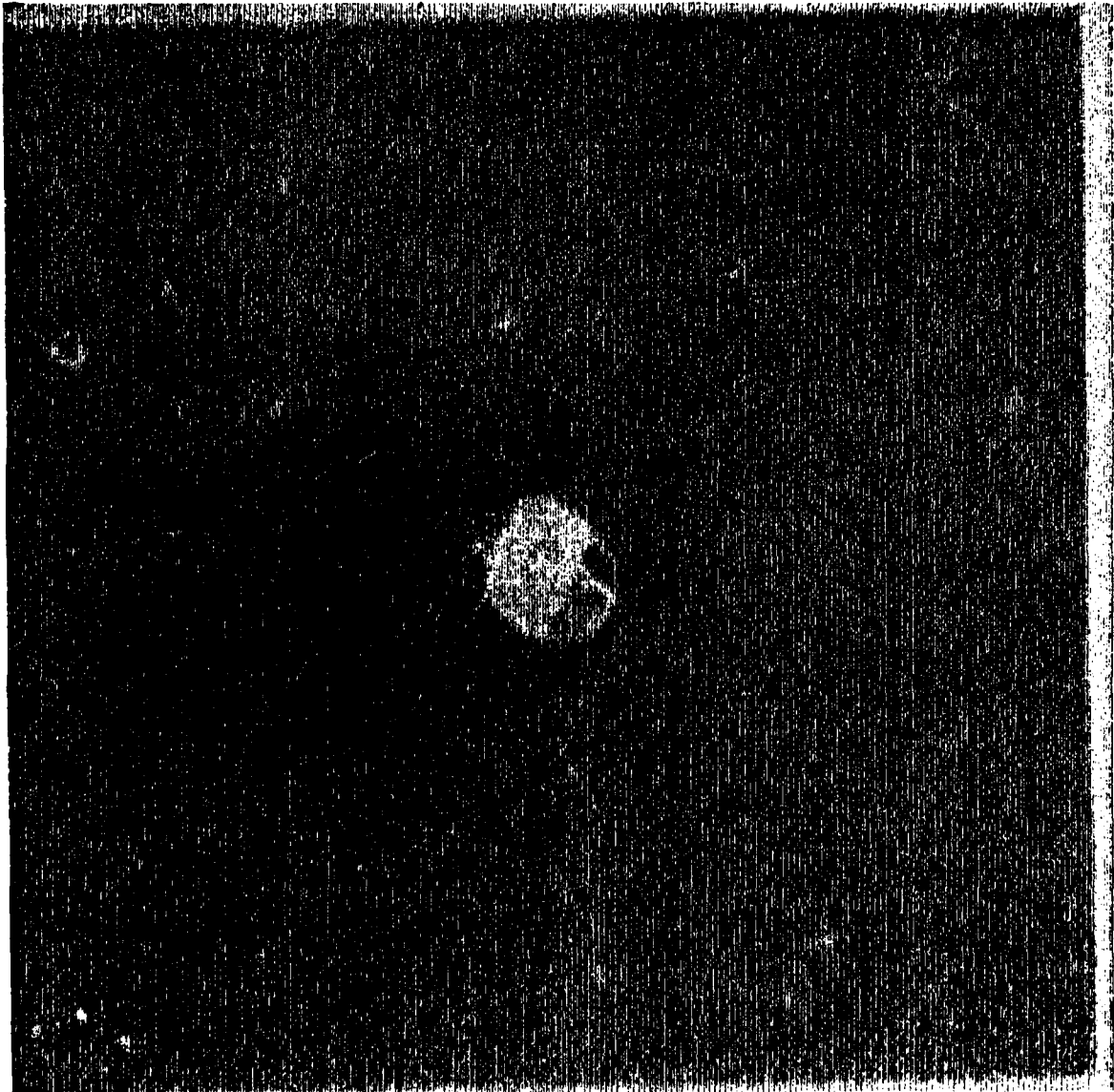
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
519.8	2.195E-3	2.82	.1581	Initial damage
680.7	3.525E-3	4.88	.2010	Maximum force
667.2	3.775E-3	4.95	.2022	Maximum energy
667.2	3.775E-3	4.95	.2022	Maximum displacement
8.1	7.205E-3	2.31	.0635	Final values



NADC-85023-60

GR/BMI 5245C

#7



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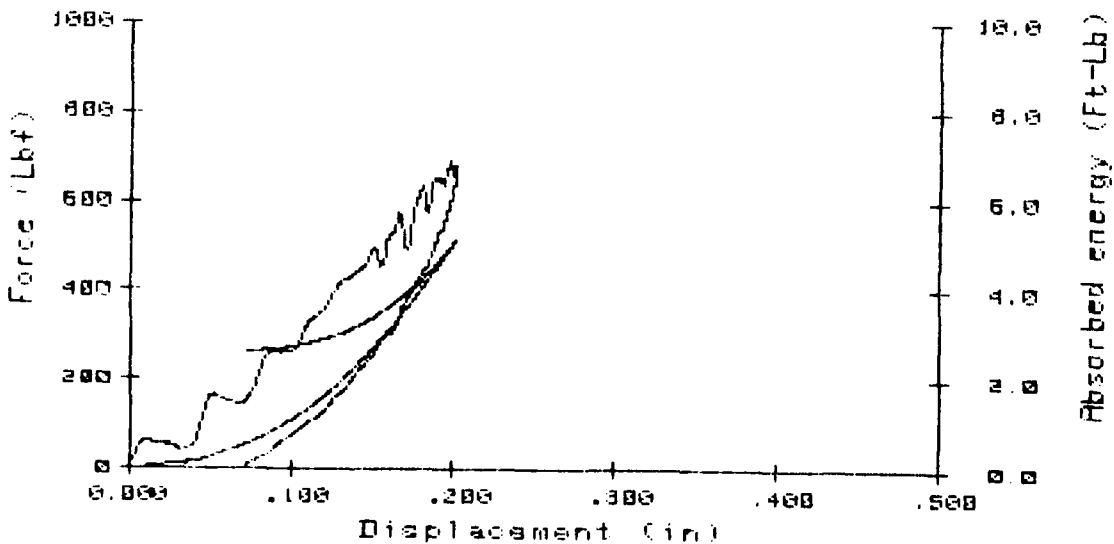
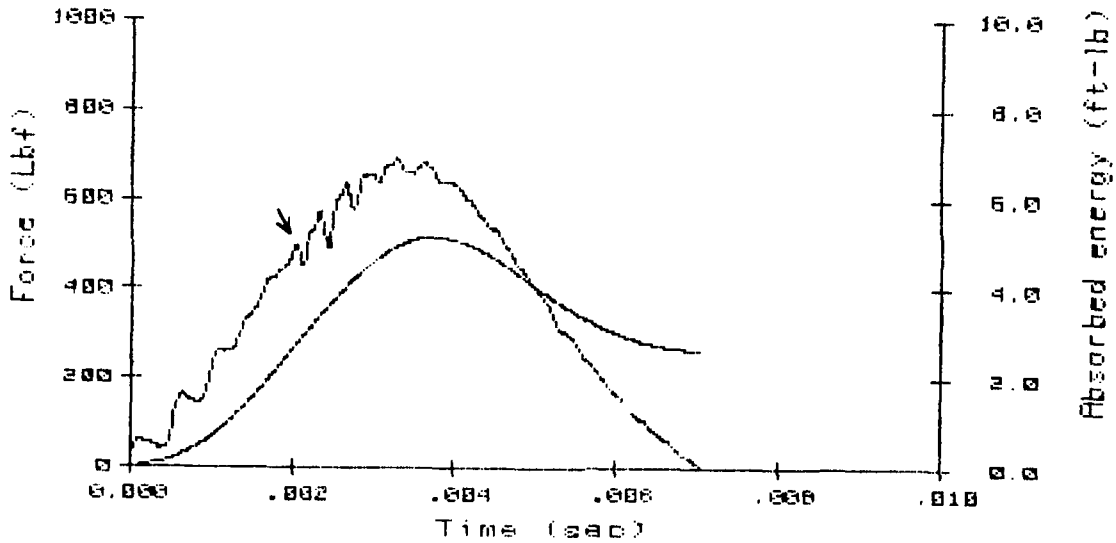
INSTRUMENTED IMPACT TEST

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GR/BMI #8

Drop weight	=	7.00Lb	Data disk	MAT01205
Top radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	6.80ft/s	abs(Vf) =	5.95ft/s
K.E.	=	5.03ft-Lb	Vf(calc) =	-4.73ft/s

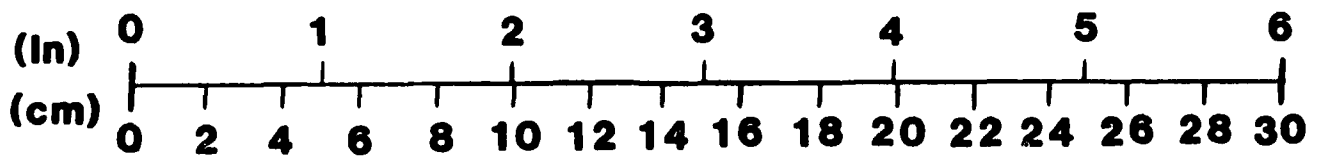
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
500.0	2.035E-3	2.73	.1509	Initial damage
689.7	3.275E-3	4.94	.1975	Maximum force
666.3	3.725E-3	5.15	.2012	Maximum energy
666.3	3.725E-3	5.15	.2012	Maximum displacement
7.2	7.015E-3	2.64	.0723	Final values



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GR/BMI 5245C

#8

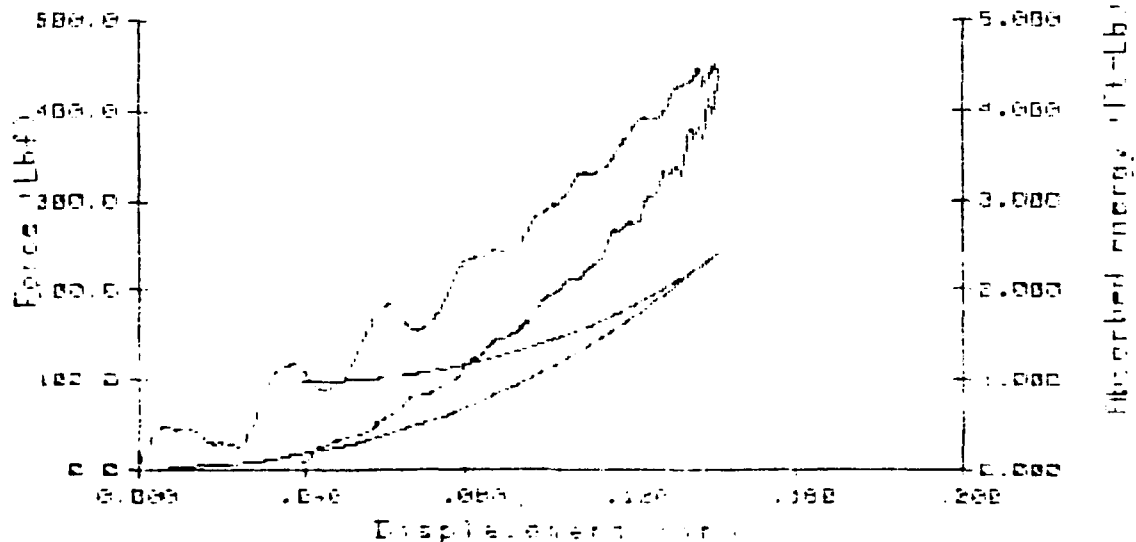
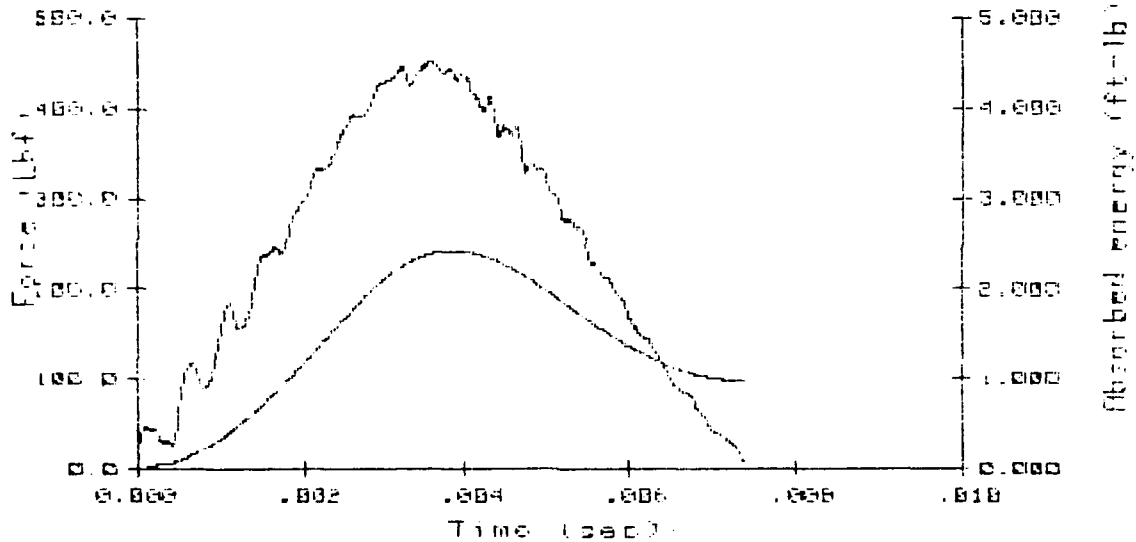


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 INSTRUMENTED IMPACT TEST
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GR/BMI #9

Drop weight	=	7.00Lb	Data disk	MAT01206
Tip radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	4.63ft/s	abs(Vf) =	4.22ft/s
K.E.	=	2.33ft-Lb	Vf(calc) =	-3.56ft/s

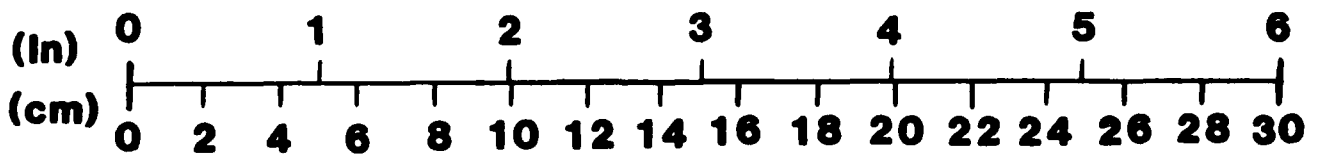
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
453.2	3.575E-3	2.38	.1406	Maximum force
437.9	3.855E-3	2.41	.1415	Maximum energy
437.9	3.855E-3	2.41	.1415	Maximum displacement
8.1	7.385E-3	.97	.0398	Final values



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GR/BMI 5245C

#9



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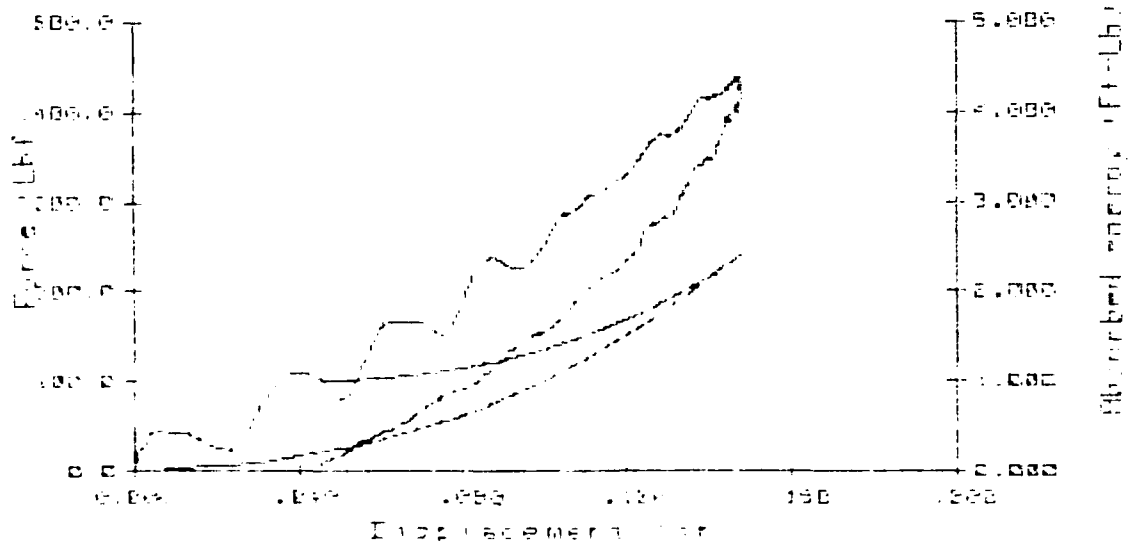
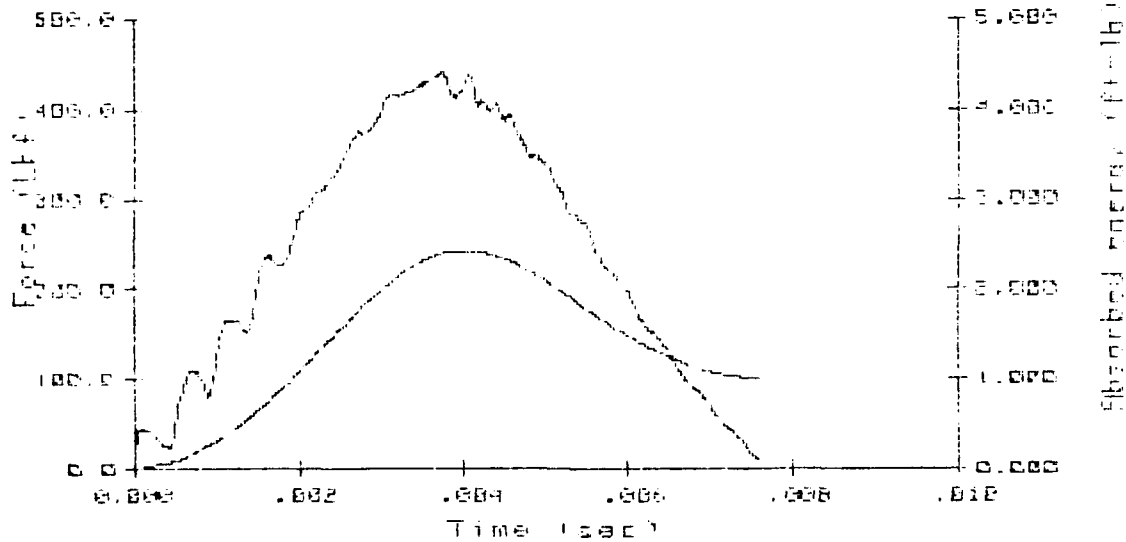
INSTRUMENTED IMPACT TEST

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GR/BMJ #10

Drop weight	=	7.00Lb	Data disk	MAT01207
Top radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VC	=	4.63ft/s	abs(Vf) =	4.33ft/s
i.E.	=	2.33ft-Lb	Vf(calc) =	-3.52ft/s

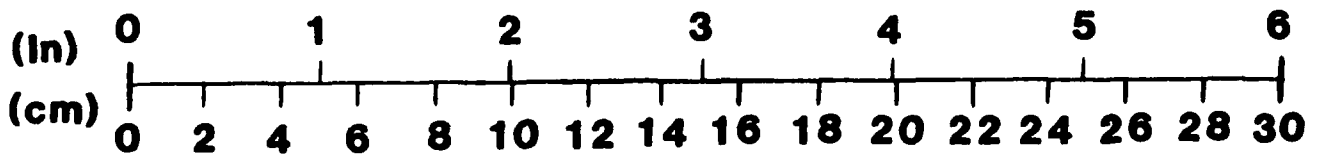
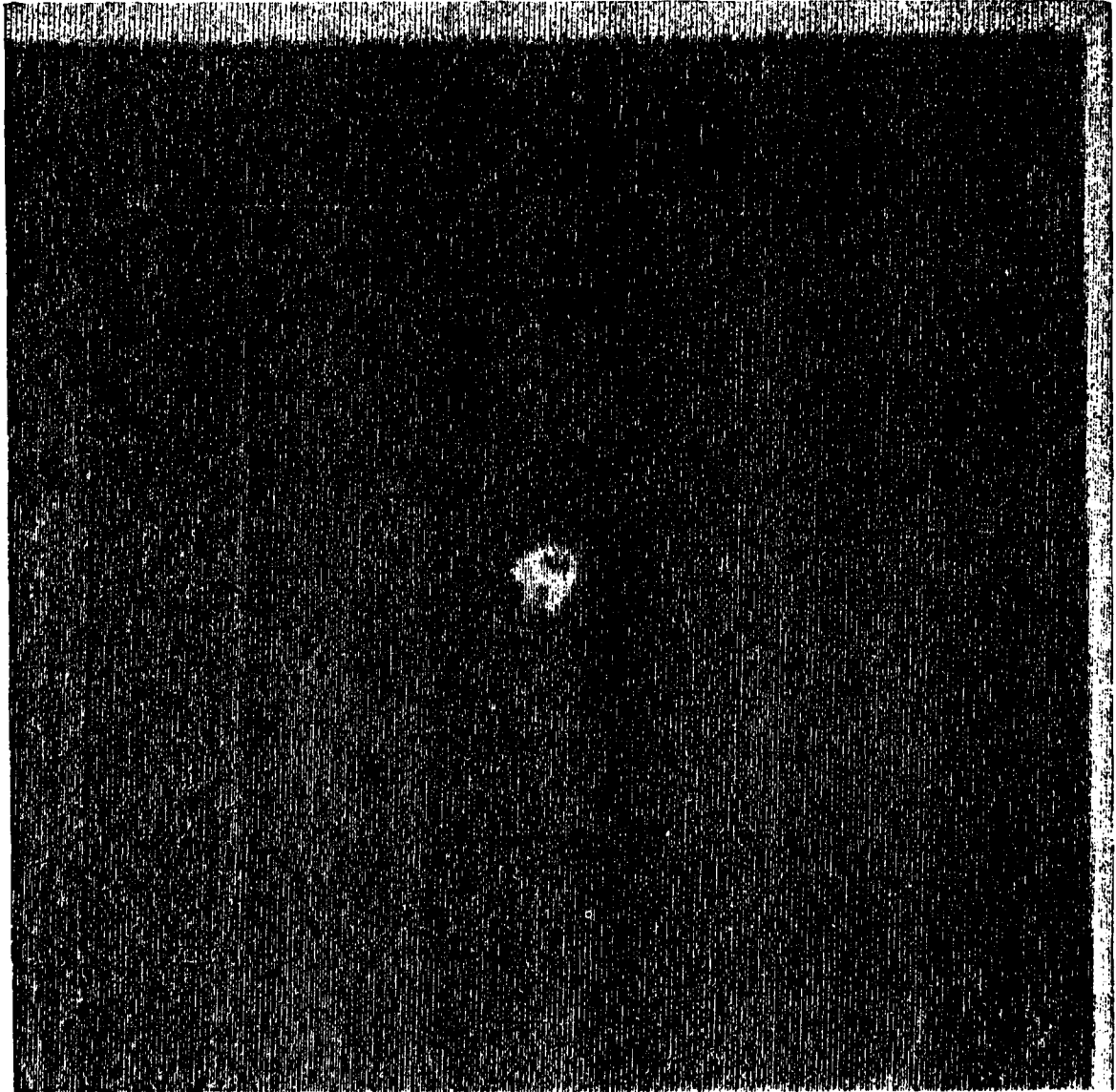
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
440.6	3.745E-3	2.39	.1472	Maximum force
432.5	4.025E-3	2.42	.1481	Maximum energy
402.5	4.025E-3	2.42	.1481	Maximum displacement
7.2	7.615E-3	1.01	.0454	Final values



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GR/BMI 5245C

#10



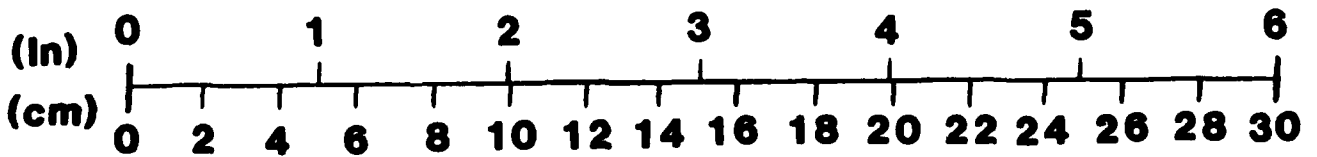
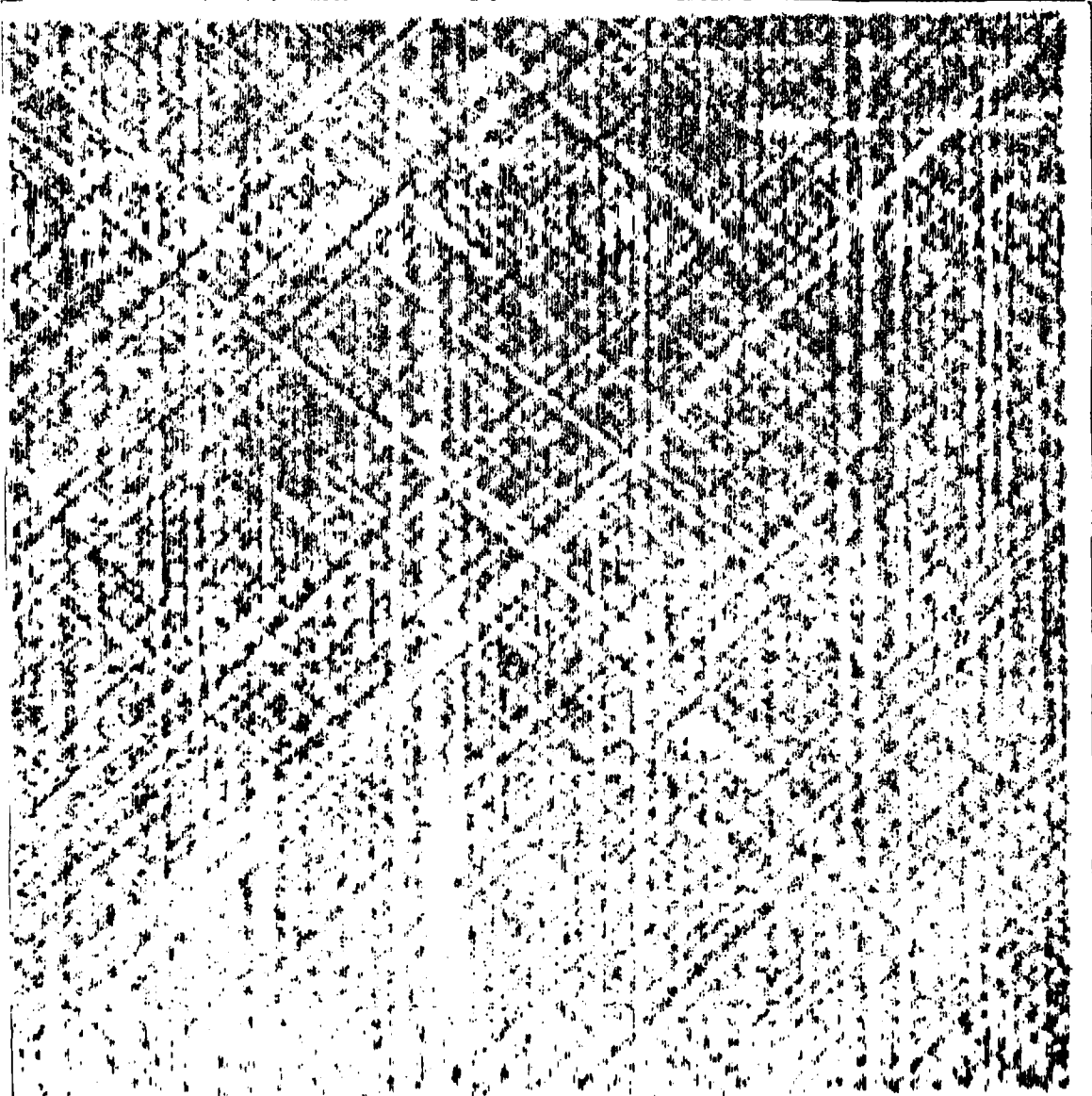
NADC-85023-60

T300/81-5

NADC-85023-60

81-5 GR/BMI

#12



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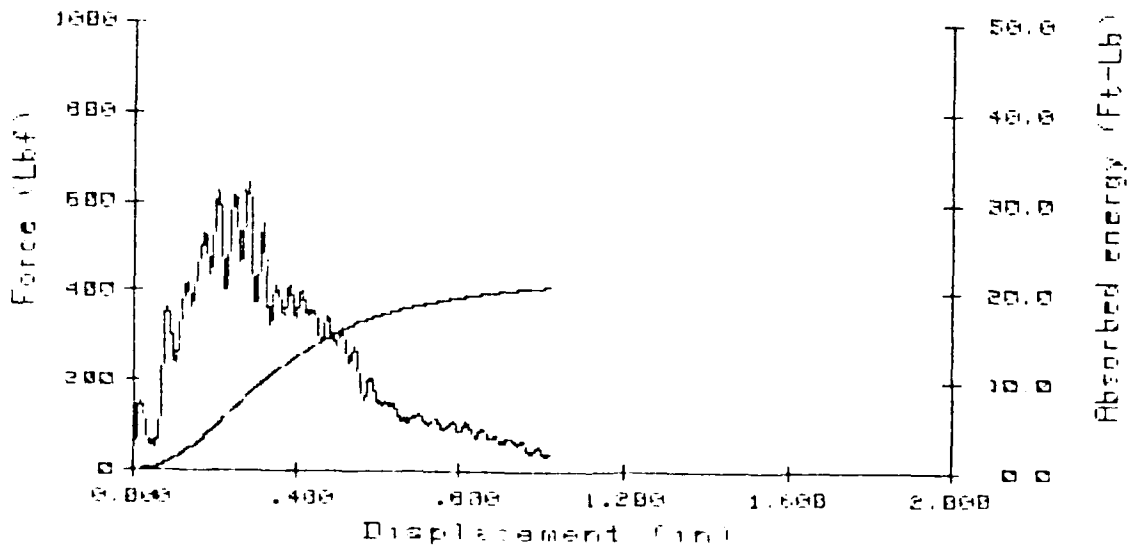
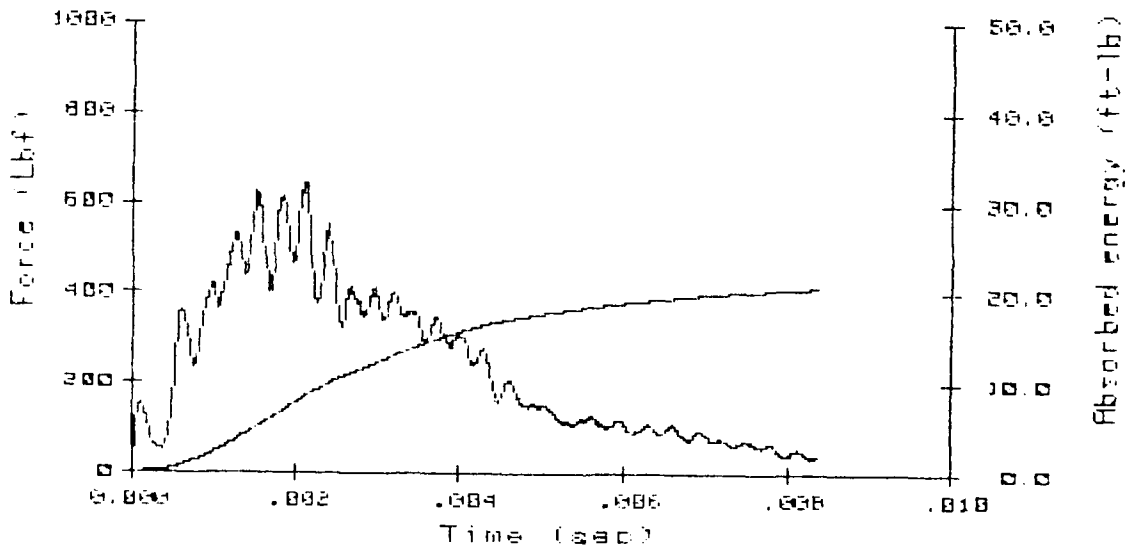
INSTRUMENTED IMPACT TEST

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B1-5 GR/BMI #1

Drop weight = 31.36Lb Data disk MAT00702
 Tip radius = .500in DRM scale .4Kn/Div
 Temperature = 74.0 F Flag grid= .040in
 VO = 11.30ft/s
 K.E. = 62.17ft-Lb Vf(calc) = 9.53ft/s

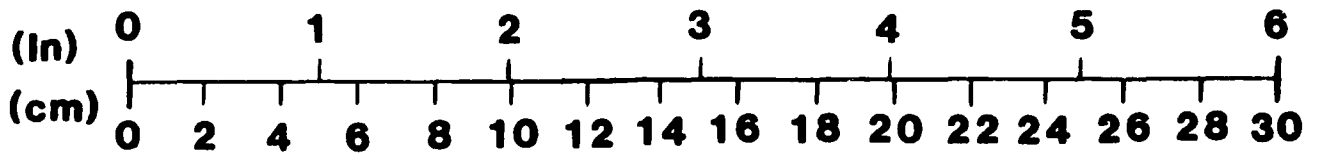
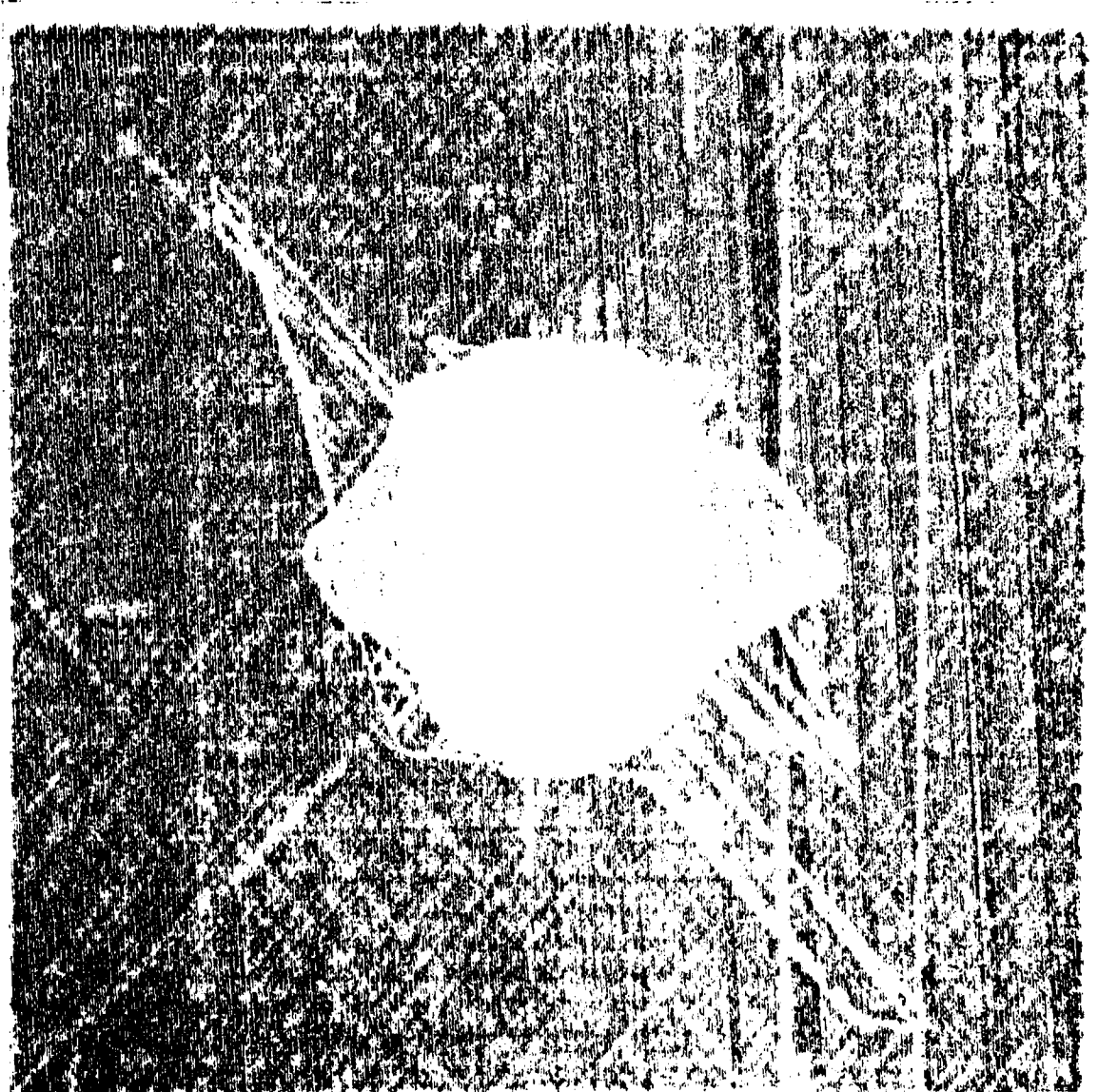
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
643.9	2.147E-3	8.63	.2853	Maximum force
37.8	8.378E-3	20.58	1.0191	Maximum energy
37.8	8.378E-3	20.58	1.0191	Maximum displacement
37.8	8.378E-3	20.58	1.0191	Final values



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81-5 GR/BMI

#1



AD-A160 953

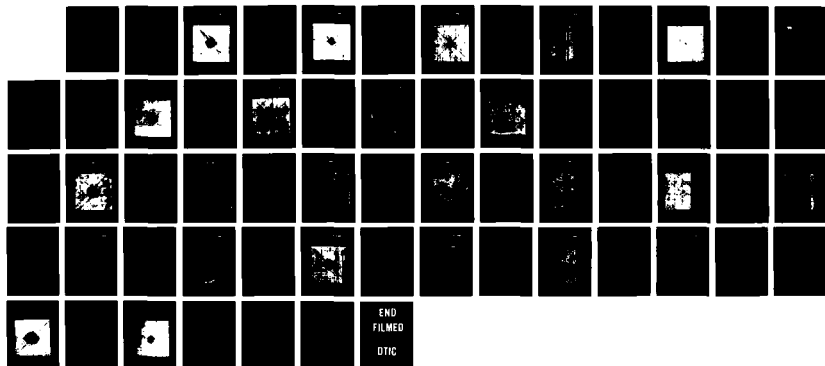
IMPACT CHARACTERIZATION OF NEW COMPOSITE MATERIALS(U)
NAVAL AIR DEVELOPMENT CENTER WARRINSTER PA AIRCRAFT AND
CREW SYSTEMS TECHNOLOGY DIRECTORATE L M GAUSE ET AL.
FEB 85 NADC-85023-60

2/2

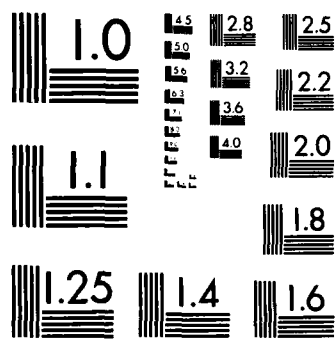
UNCLASSIFIED

F/G 11/4

NL



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DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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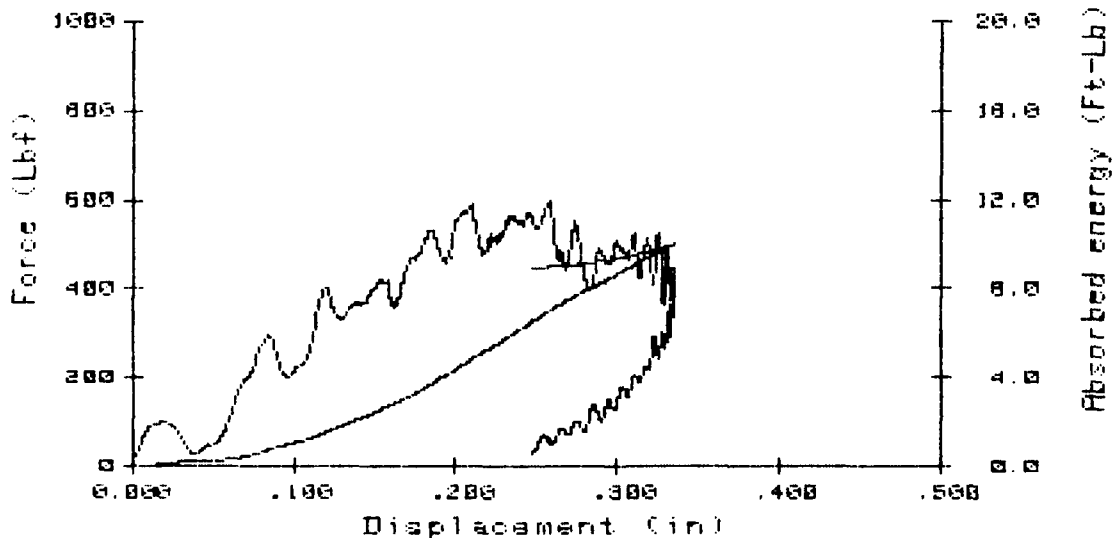
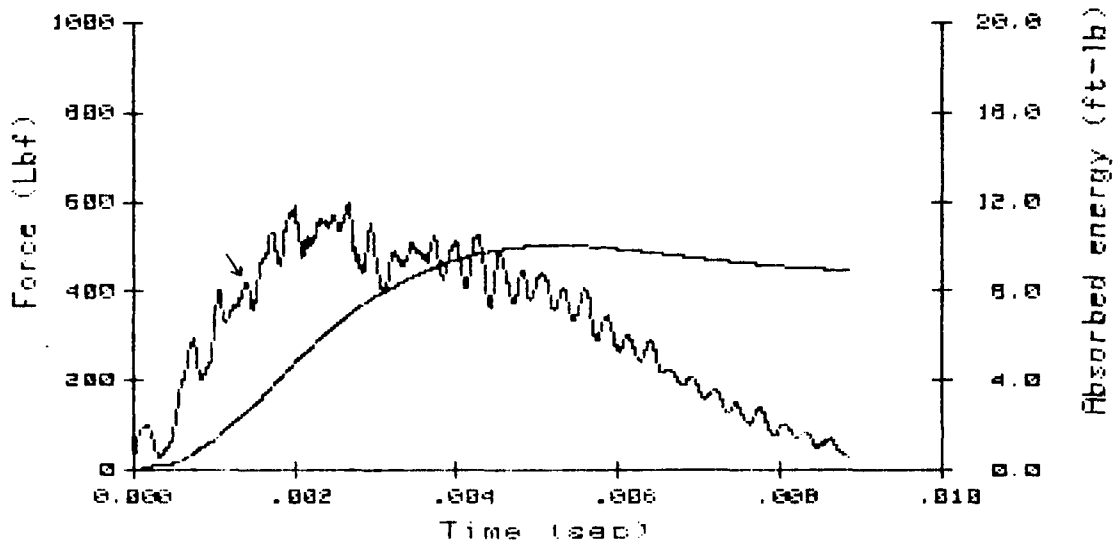
INSTRUMENTED IMPACT TEST

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1-5 GR/BMI #2

Drop weight = 7.00Lb Data disk MAT00704
 Tip radius = 500ip DRM scale .4Kn/Div
 Temperature = 74.0 F Flag grid= .040in
 V0 = 9.52ft/s
 K.E. = 9.86ft-Lb Vf(calc) = -3.11ft/s

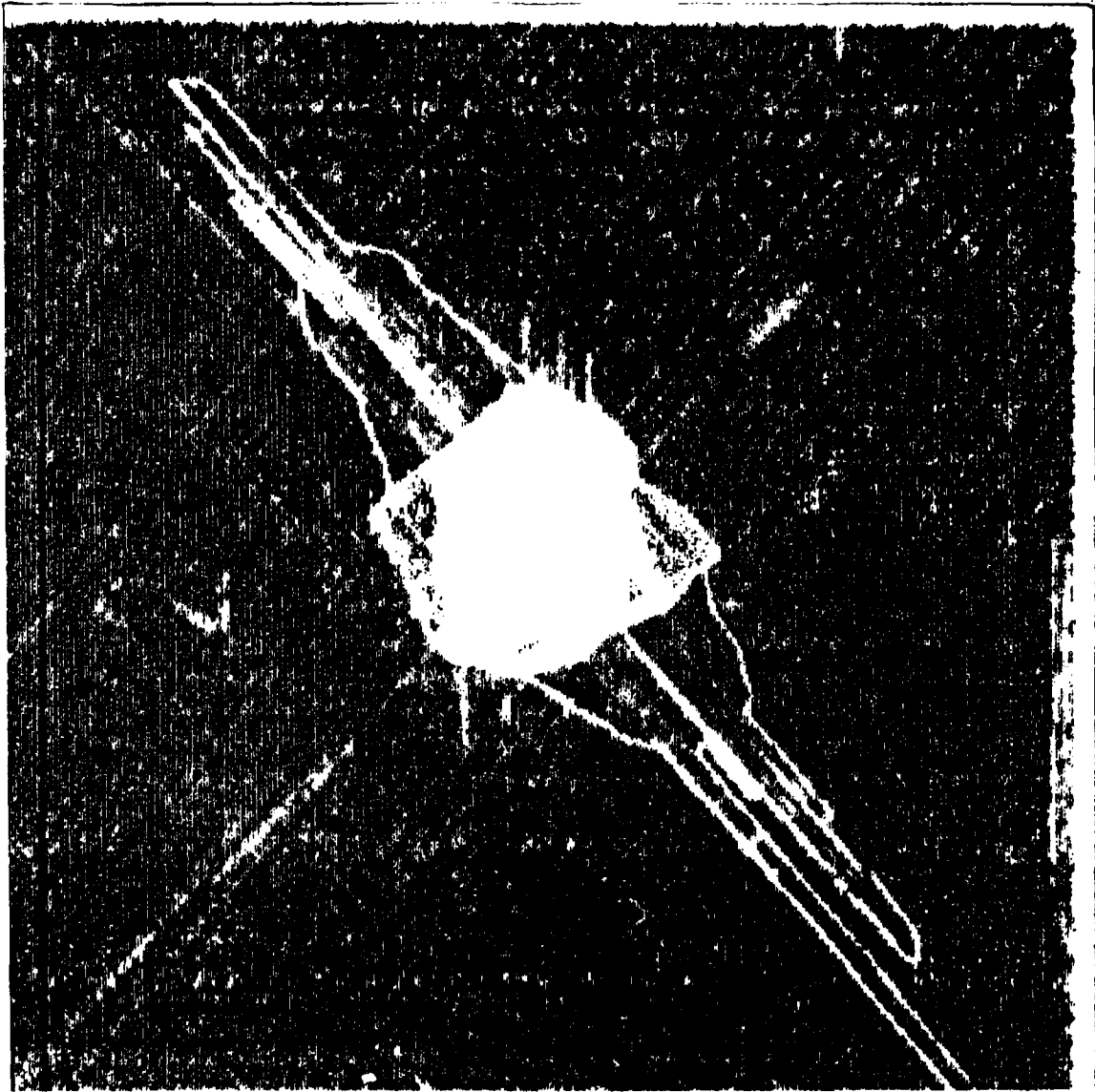
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
419.9	1.3933	2.56	.1530	Initial damage
97.1	.2670	7.01	.3080	Maximum force
62.4	.2220	10.05	.3307	Maximum energy
62.4	.2220	10.05	.3357	Maximum displacement
31.5	0.0000	8.95	.2466	Final values



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81-5 GR/BMI

#2



(In) 0 1 2 3 4 5 6
(cm) 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

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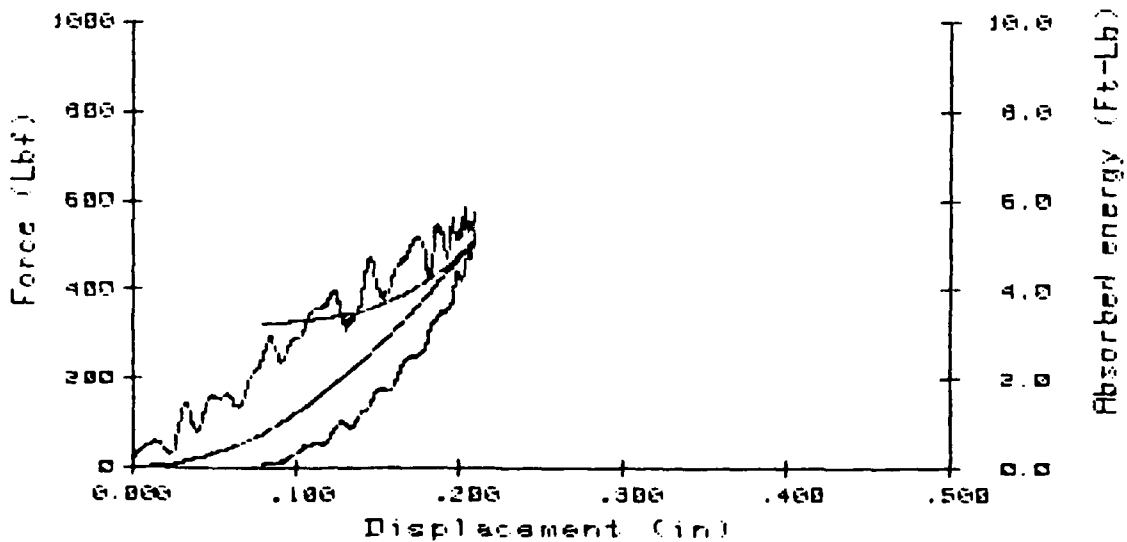
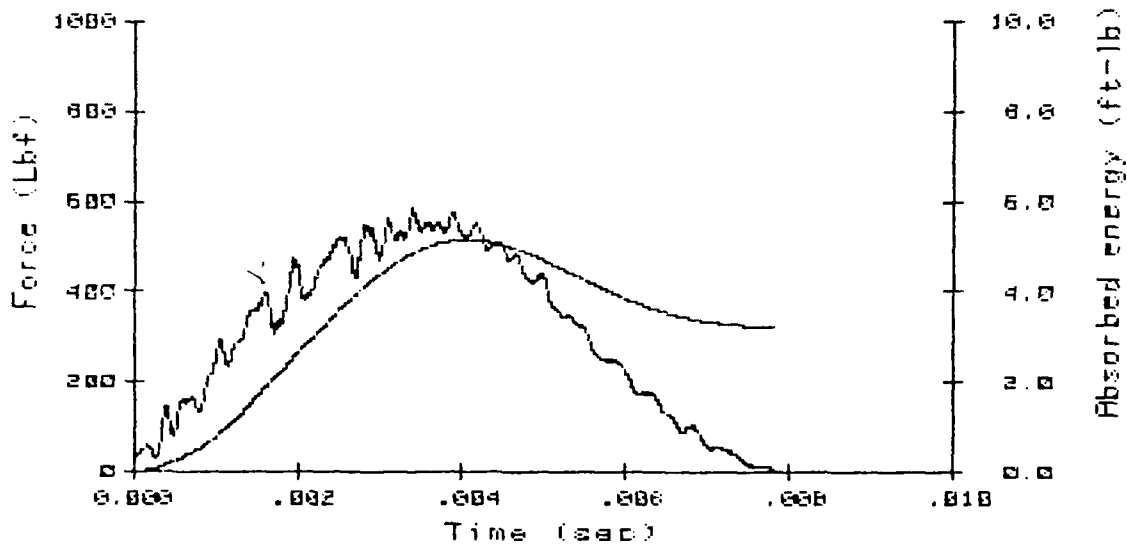
INSTRUMENTED IMPACT TEST

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81-5 GR/BMI #3

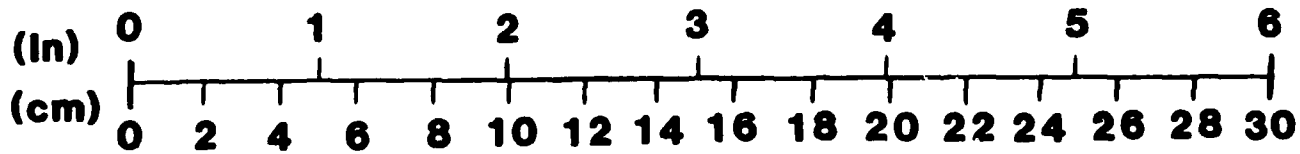
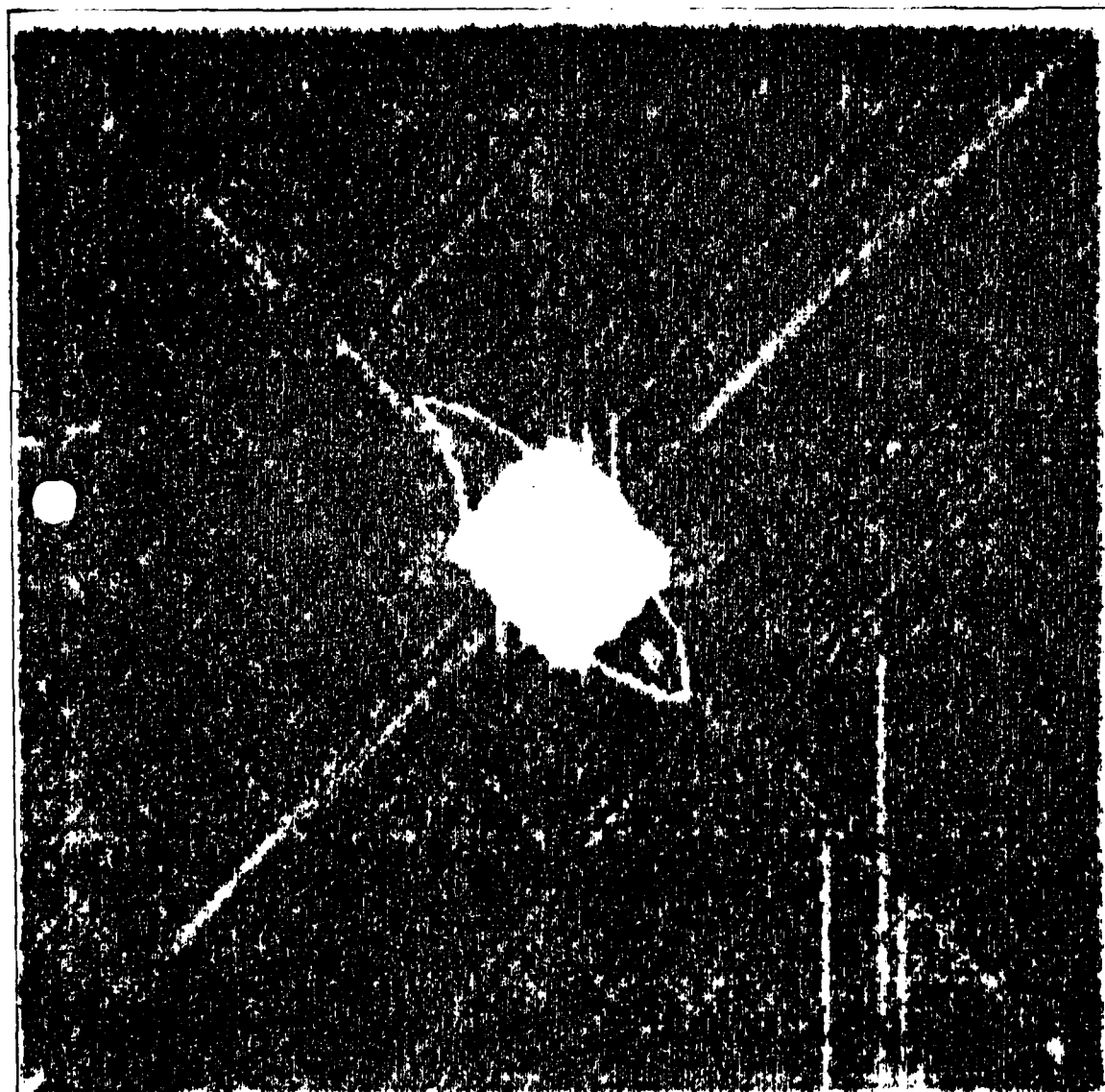
Drop weight	=	7.00Lb	Data disk	MAT00706
Tip radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	6.80ft/s	abs(Vf) =	5.25ft/s
K.E.	=	5.03ft-Lb	Vf(calc) =	-4.10ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
398.4	1.613E-3	1.89	.1234	Initial damage
584.5	3.408E-3	4.85	.2027	Maximum force
524.3	4.073E-3	5.15	.2092	Maximum energy
524.3	4.073E-3	5.15	.2092	Maximum displacement
8.1	7.798E-3	3.25	.0798	Final values



81-5 GR/BMI

#3



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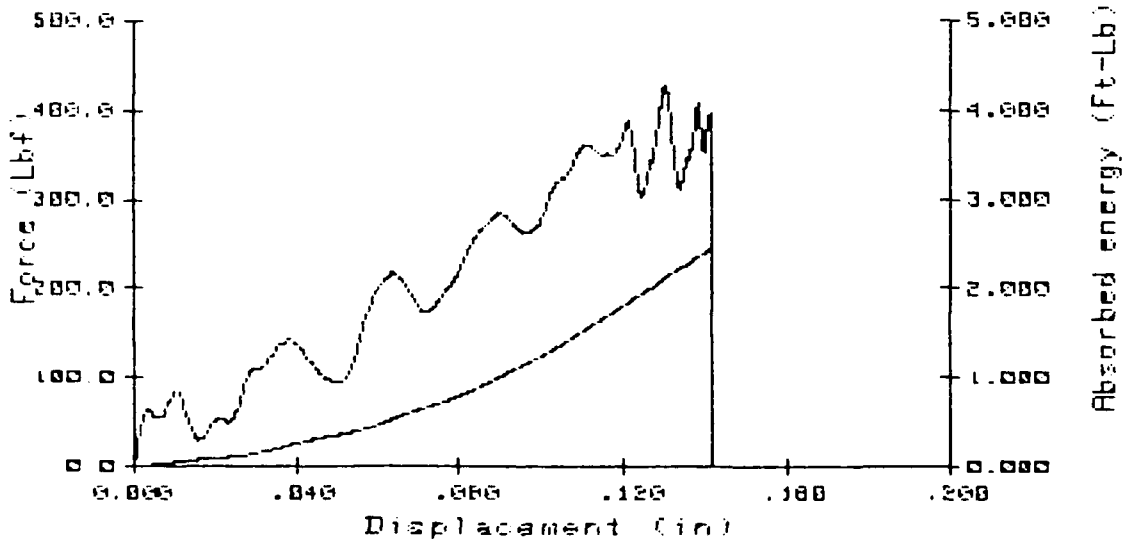
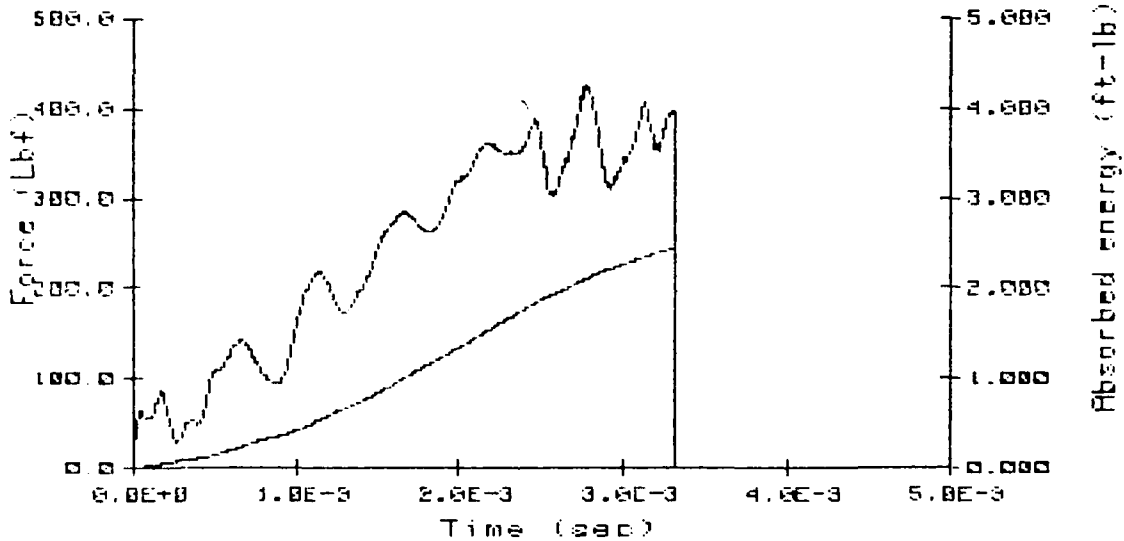
INSTRUMENTED IMPACT TEST

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B1-5 GR/BMI #4

Drop weight = 7.00Lb Data disk MAT0070B
 Tip radius = .500in DRM scale .2Kn/Div
 Temperature = 74.0 F Flag grid= .040in
 V0 = 4.83ft/s
 K.E. = 2.54ft-Lb Vf(calc) = 1.28ft/s

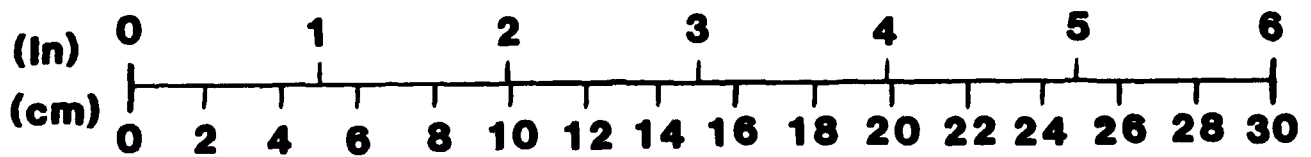
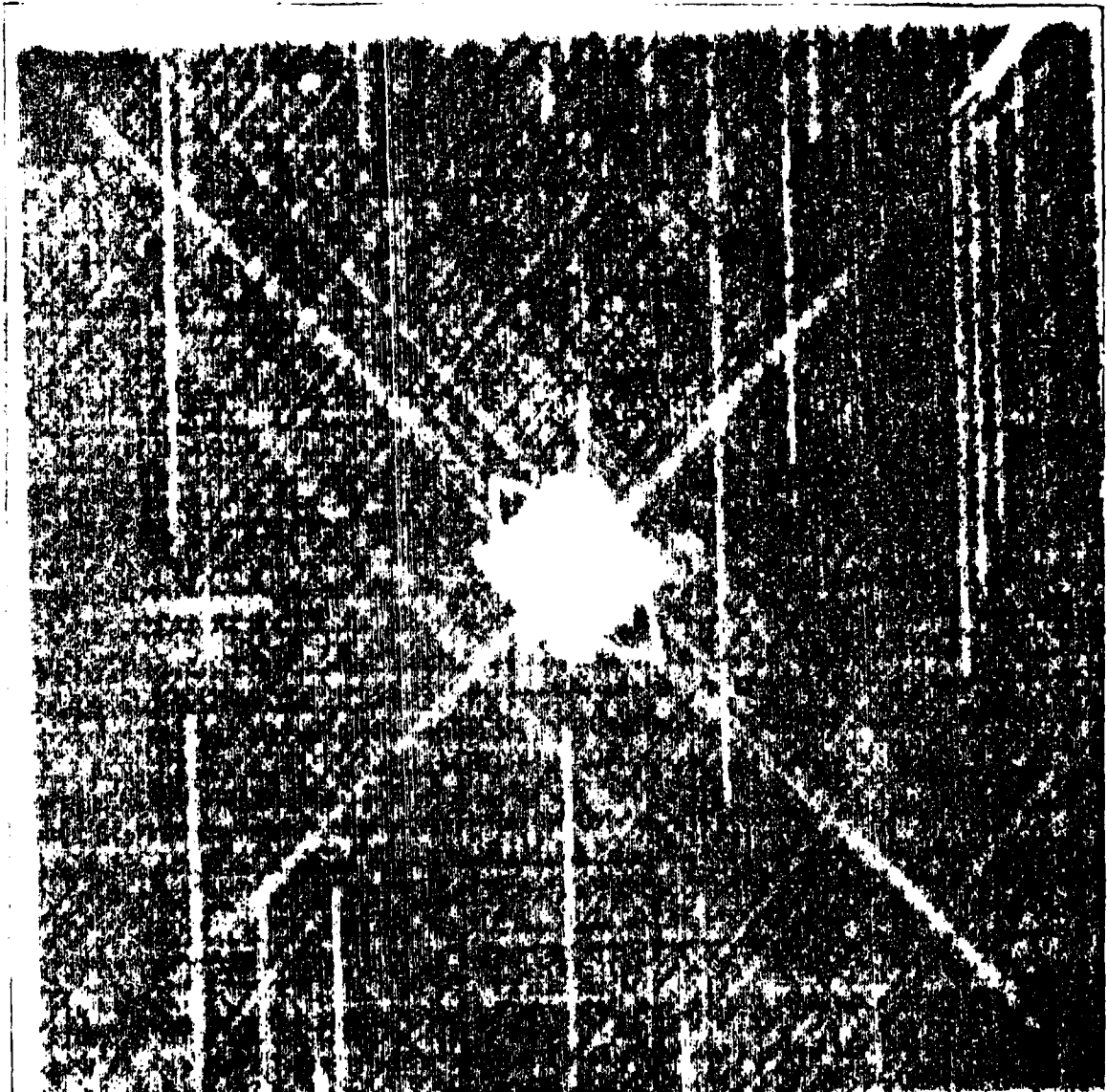
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
387.6	2.457E-3	1.83	.1210	Initial damage
426.2	2.768E-3	2.10	.1300	Maximum force
393.4	3.313E-3	2.44	.1414	Maximum energy
0.0	3.317E-3	2.44	.1415	Maximum displacement
0.0	3.317E-3	2.44	.1415	Final values



NADC-85023-60

81-5 GR/BMI

#4



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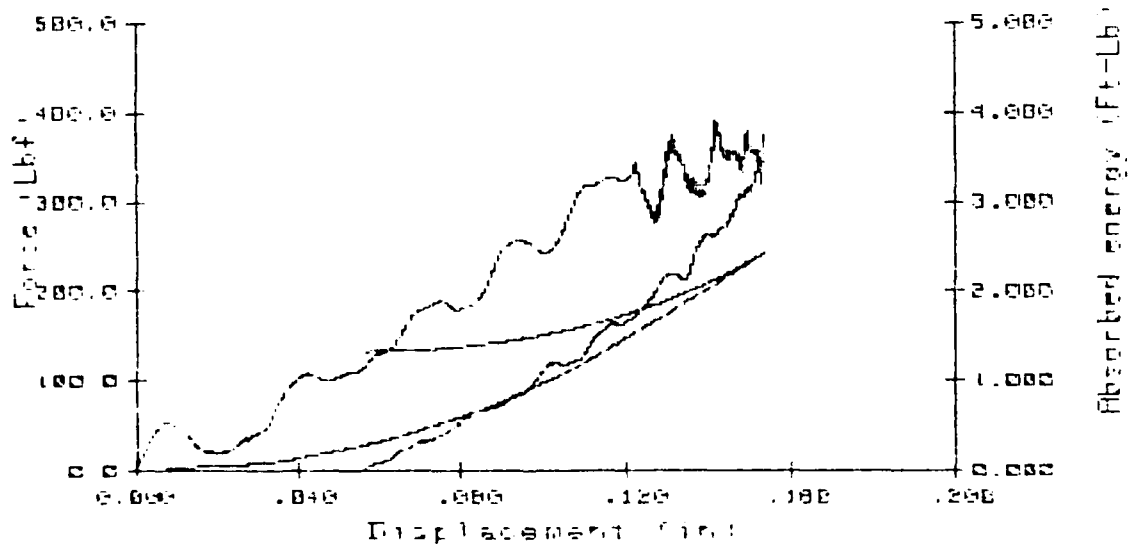
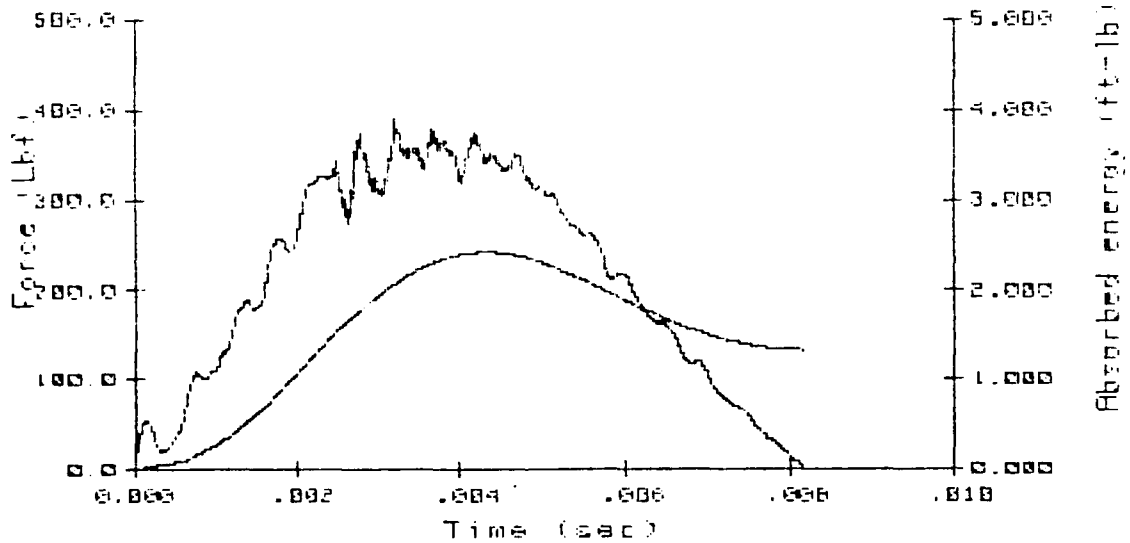
INSTRUMENTED IMPACT TEST

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B1-5 GR/BMI #5

Drop weight = 7.00Lb Data disk MAT00805
 Tip radius = .500in DRM scale .2Kn/Div
 Temperature = 74.0 F Flag grid= .040in
 VO = 4.63ft/s
 K.E. = 2.33ft-Lb Vf(calc) = -3.08ft/s

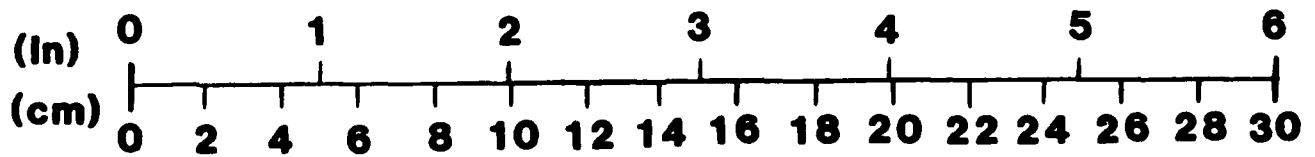
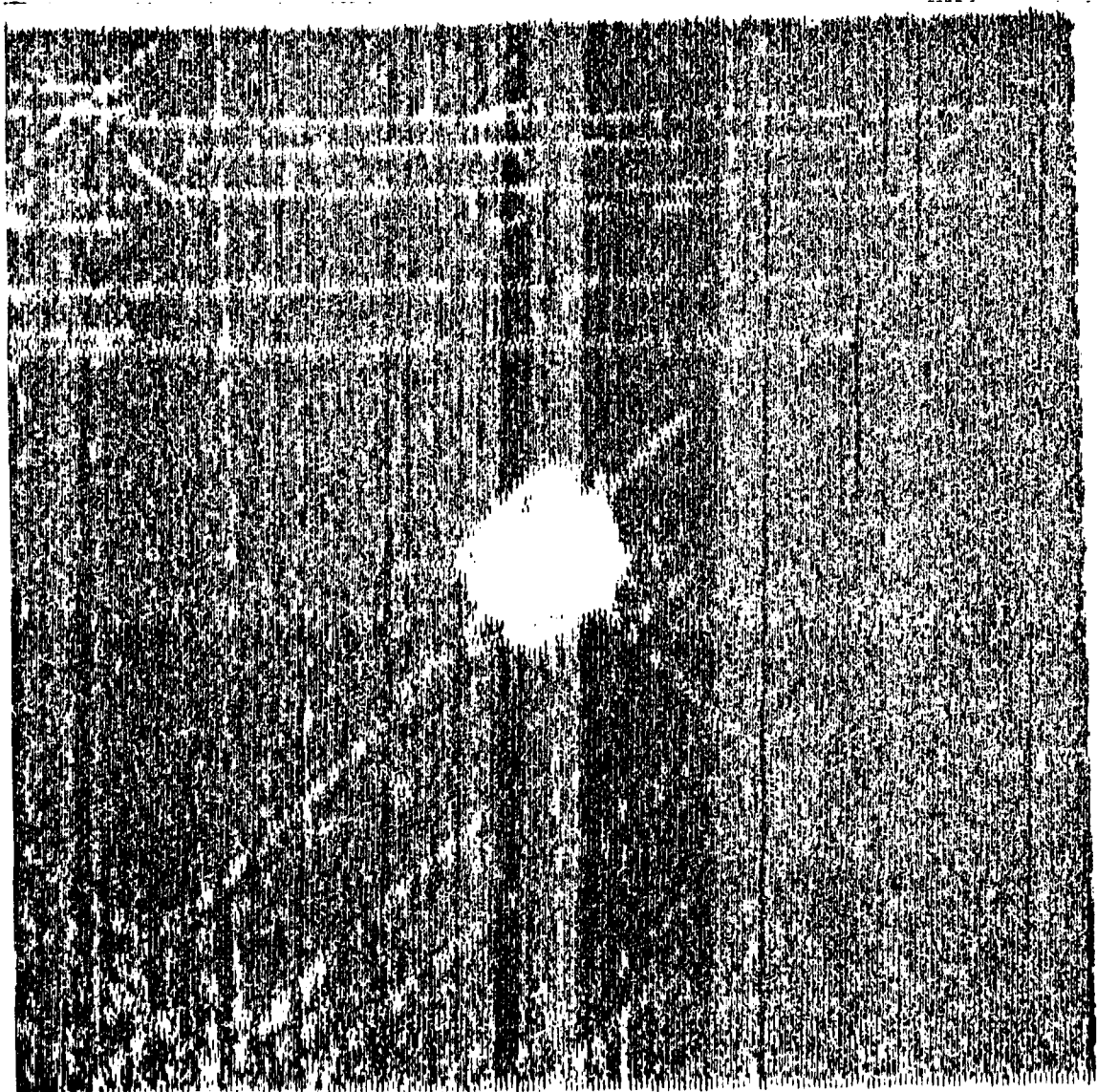
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
344.0	2.498E-3	1.54	.1220	Initial damage
392.1	3.213E-3	2.07	.1417	Maximum force
344.0	4.318E-3	2.42	.1533	Maximum energy
344.0	4.318E-3	2.42	.1533	Maximum displacement
4.0	8.147E-3	1.33	.0570	Final values



NADC-85023-60

81-5 GR/BMI

#5



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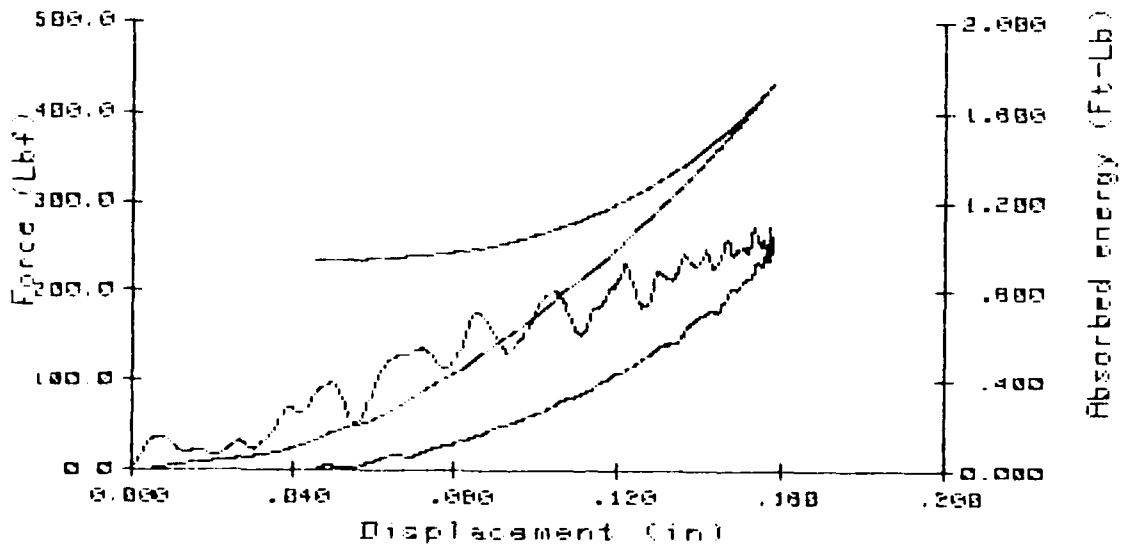
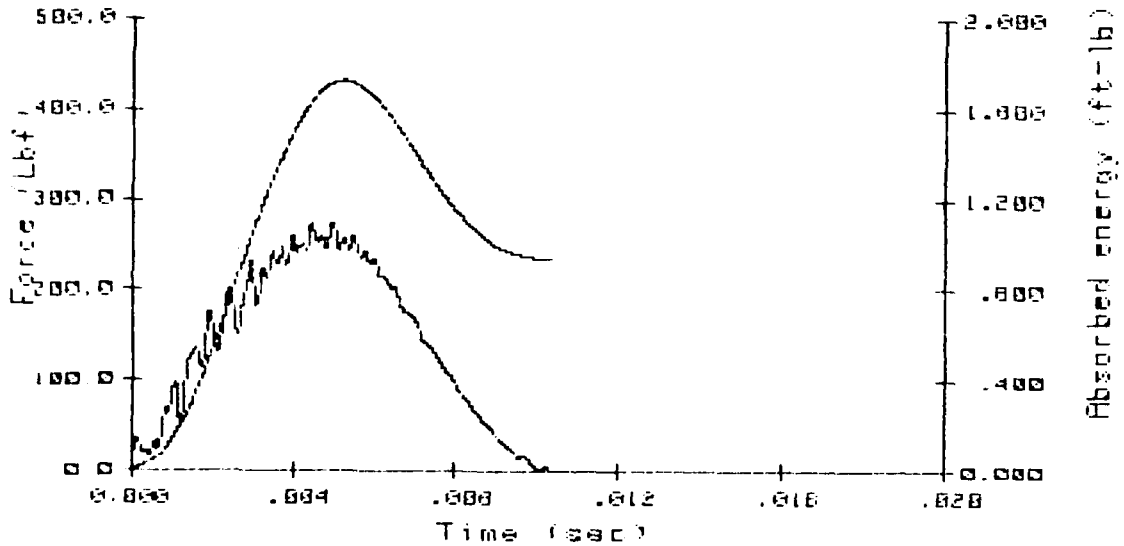
INSTRUMENTED IMPACT TEST

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B1-5 GR/BMI #7

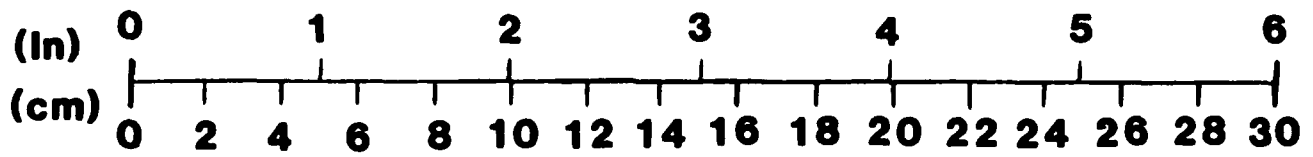
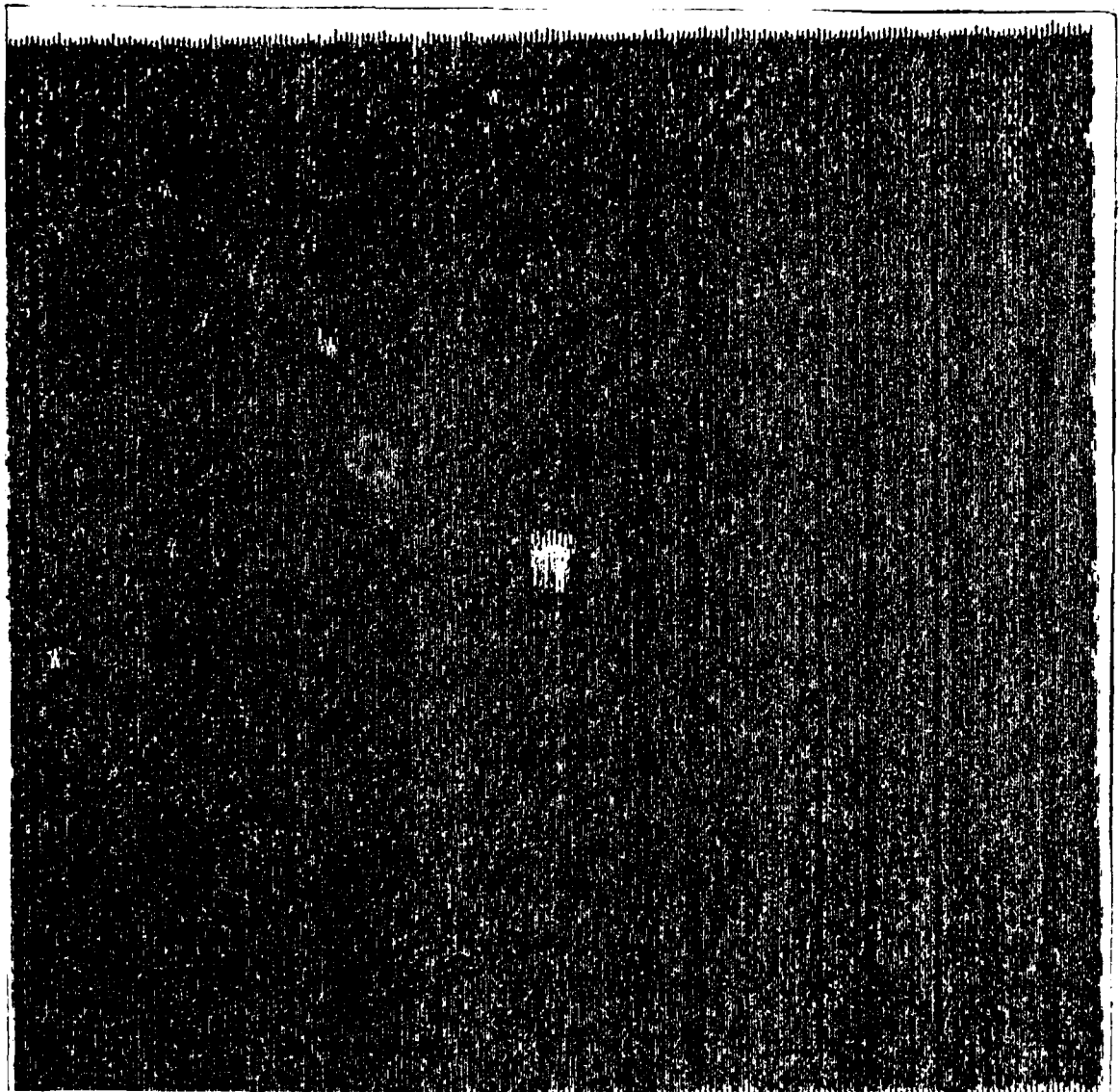
Drop weight	=	7.00Lb	Data disk	MAT00808
Top radius	=	.500in	DRM scale	.2Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	3.88ft/s	abs(Vf) =	3.09ft/s
K.E.	=	1.63ft-Lb	Vf(calc) =	-2.57ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
231.8	2.945E-3	1.03	.1216	Initial damage
273.9	4.965E-3	1.71	.1571	Maximum force
255.0	5.265E-3	1.72	.1577	Maximum energy
255.0	5.265E-3	1.72	.1577	Maximum displacement
1.3	1.033E-2	.94	.0455	Final values



81-5 GR/BMI

#7



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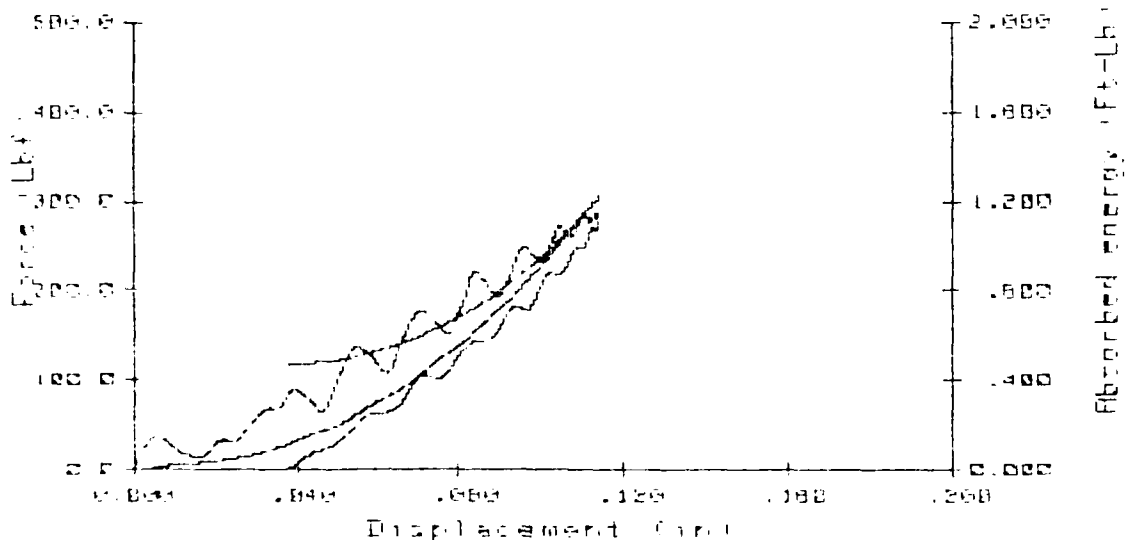
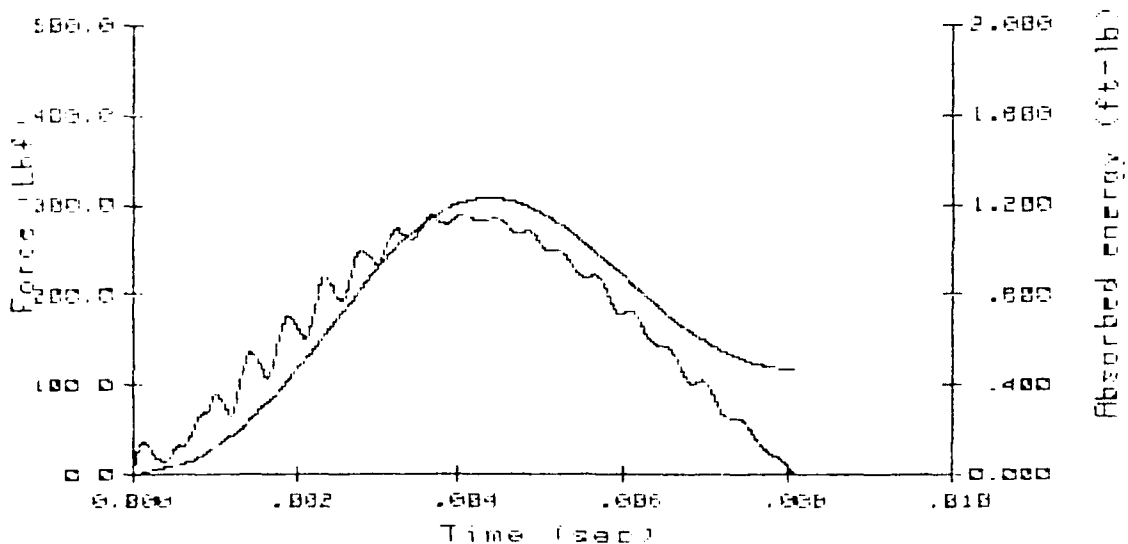
INSTRUMENTED IMPACT TEST

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B1-5 GR/BMI #11

Drop weight = 7.00Lb Data disk MAT00806
 Top radius = .500in DRM scale .2Kn/Div
 Temperature = 74.0 F Flag grid= .040in
 V0 = 3.27ft/s
 I.E. = 1.16ft-Lb Vf(calc) = -2.56ft/s

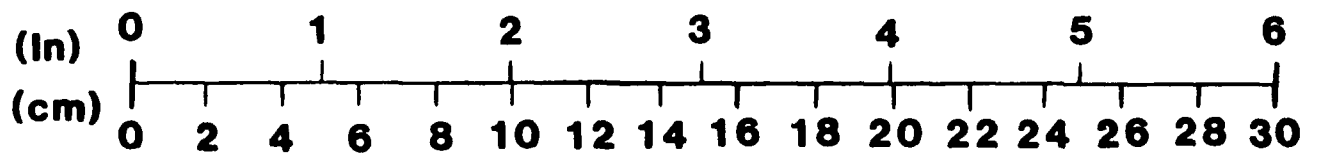
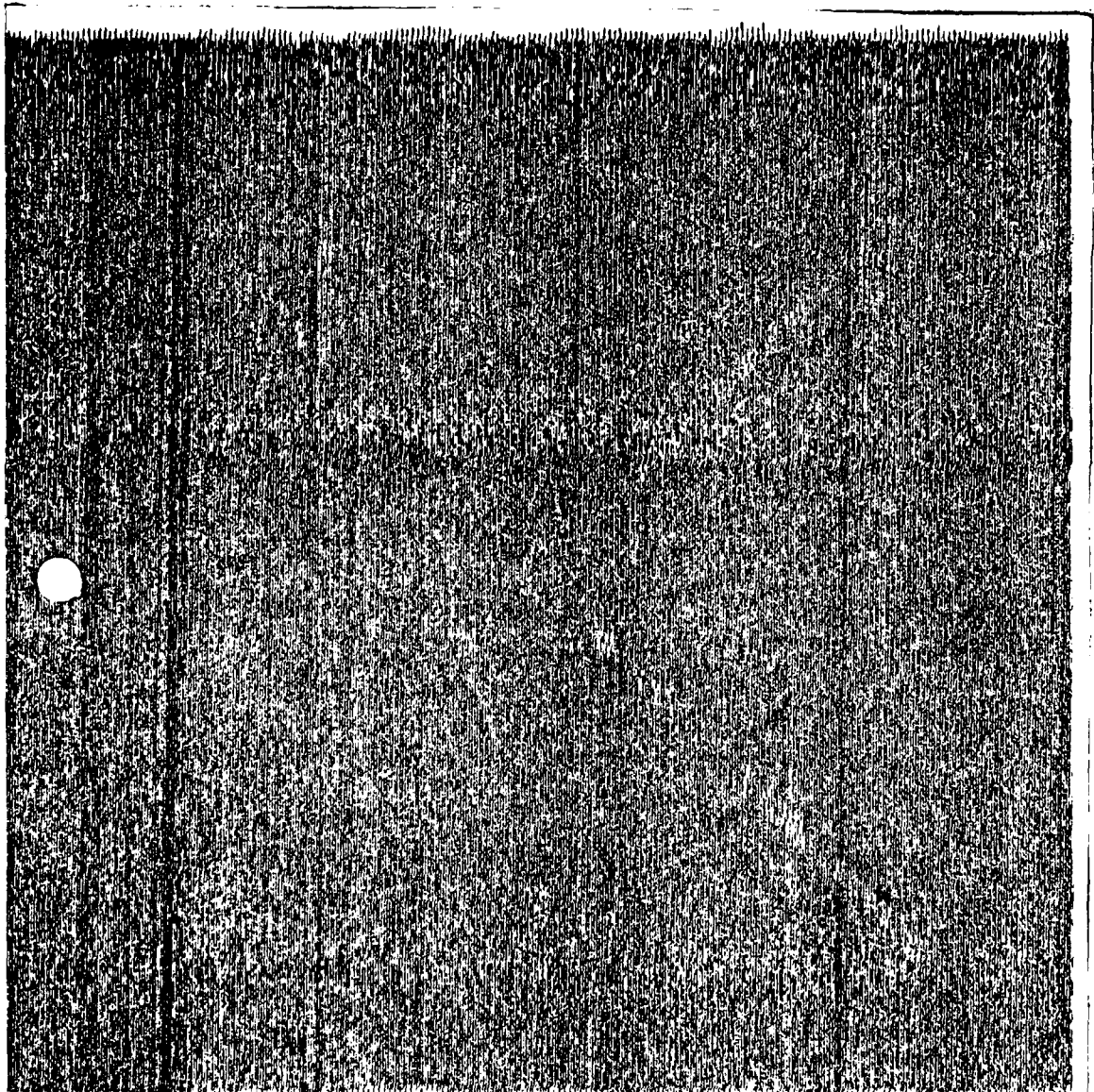
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
287.8	4.033E-3	1.21	.1133	Maximum force
283.6	4.378E-3	1.23	.1142	Maximum energy
283.6	4.378E-3	1.23	.1142	Maximum displacement
1.6	8.088E-3	.47	.0380	Final values



NADC-85023-60

81-5 GR/BMI

#11



NADC-85023-60

T-300/V378A Cloth

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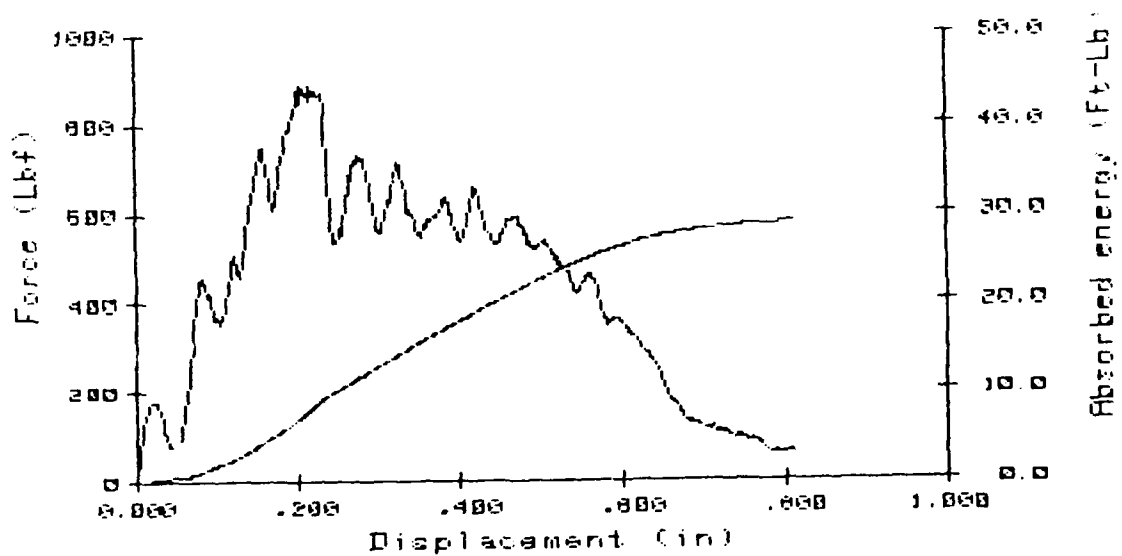
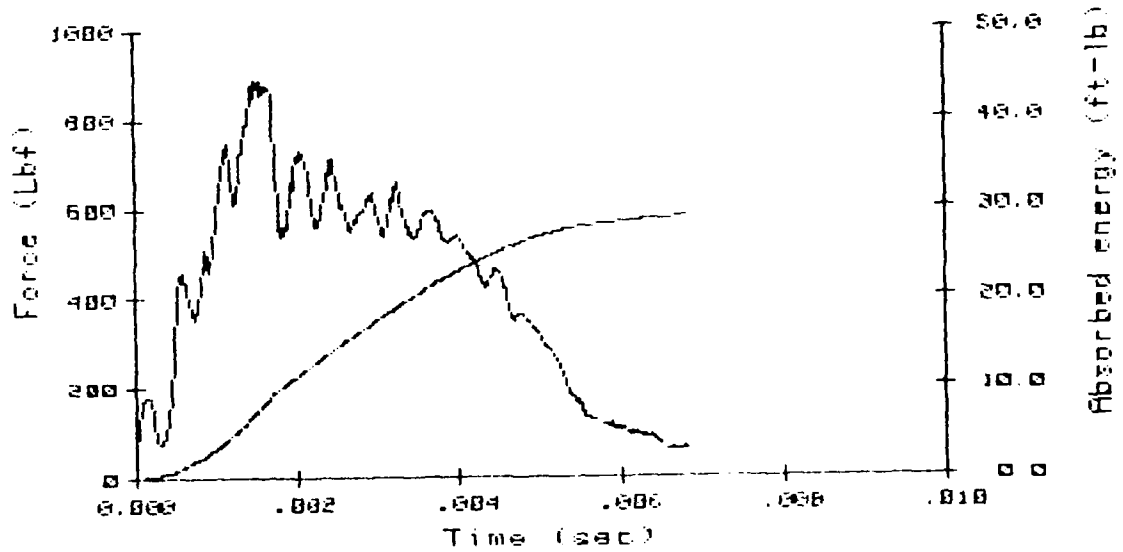
INSTRUMENTED IMPACT TEST

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T300/V378A #1

Drop weight	= 31.36Lb	Data diel	MAT00907
Tip radius	= 0.000in	DRM scale	.8Kn/Div
Temperature	= 74.0 F	Flag grid=	.040in
V0	= 11.49ft/s	Vf (calc) =	8.77ft/s
K.E.	= 64.34ft-Lb		

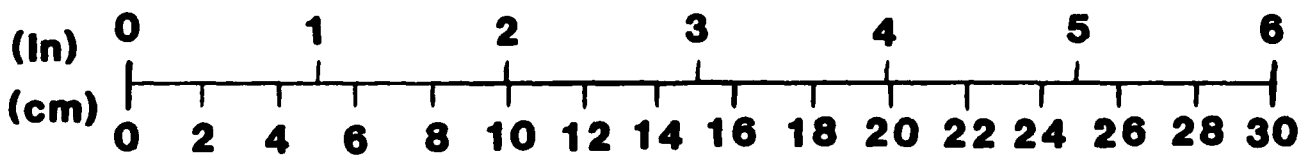
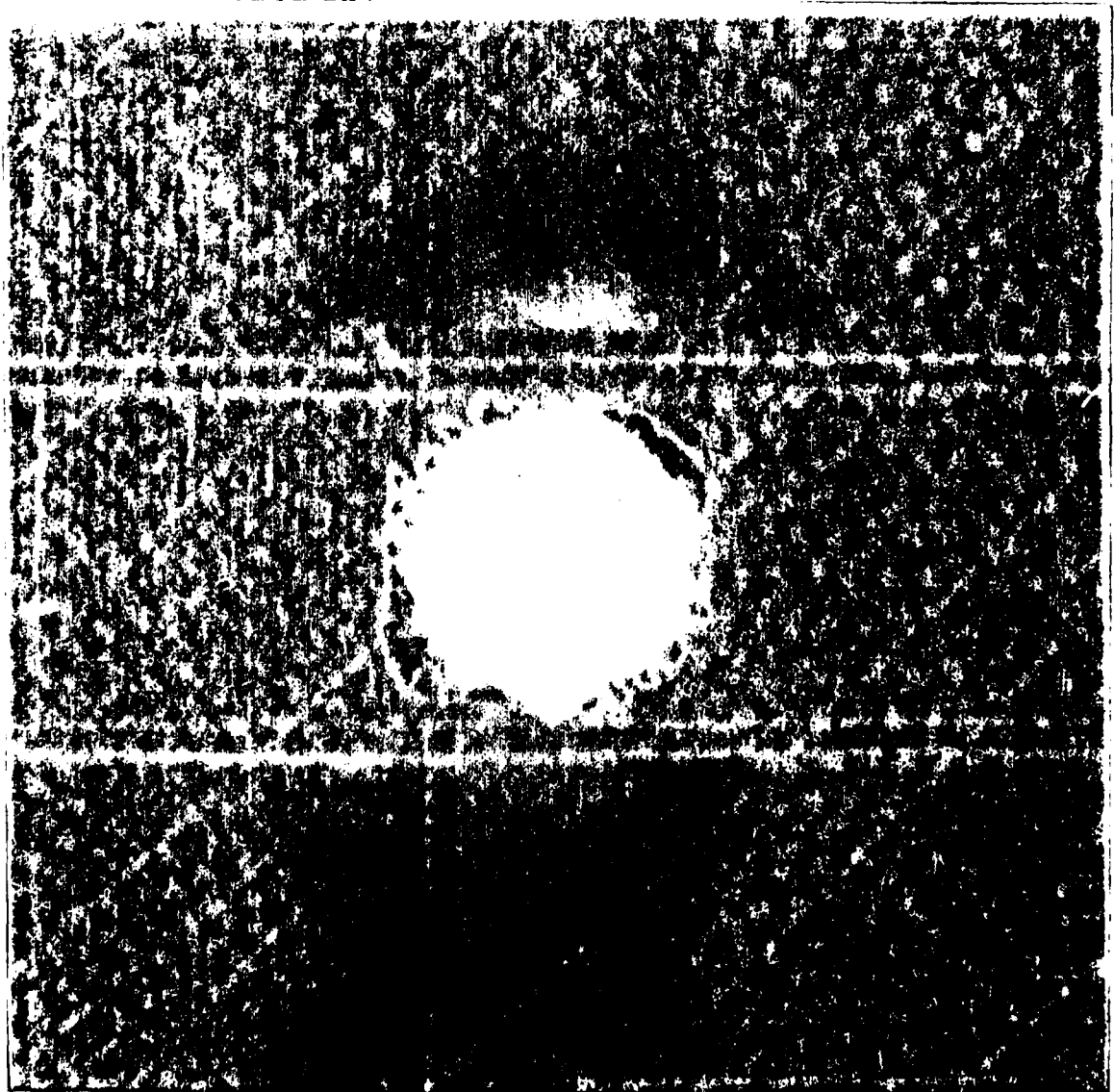
Load (Lb)	Time (s)	EO (Ft-Lb)	Disp (in)	
888.4	1.585E-3	8.06	.2163	Maximum force
62.9	6.815E-3	29.00	.8095	Maximum energy
62.9	6.815E-3	29.00	.8095	Maximum displacement
62.9	6.815E-3	29.00	.8095	Final values



NADC-85023-60

T300/V378A

1



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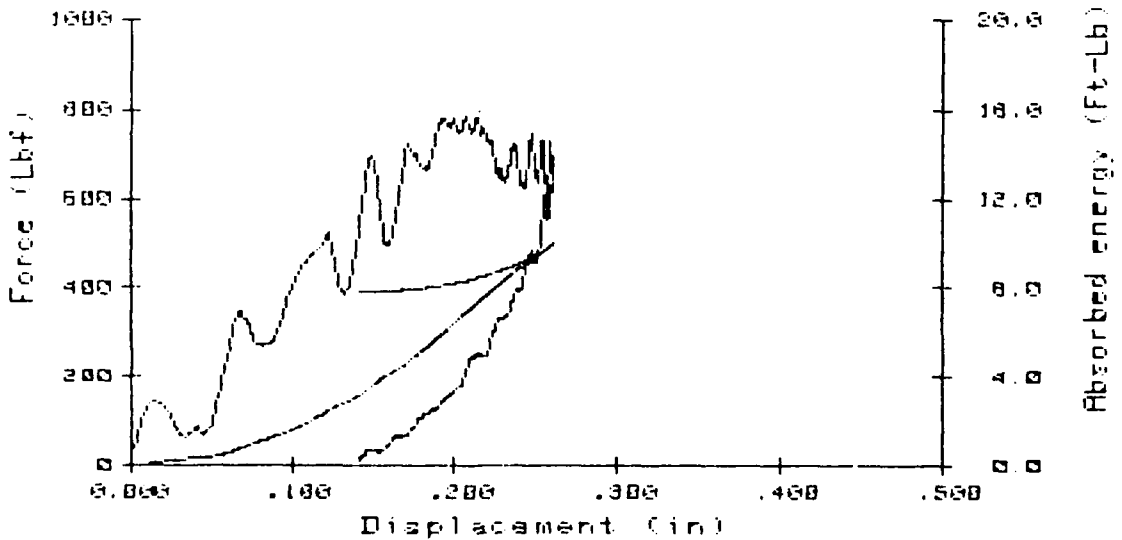
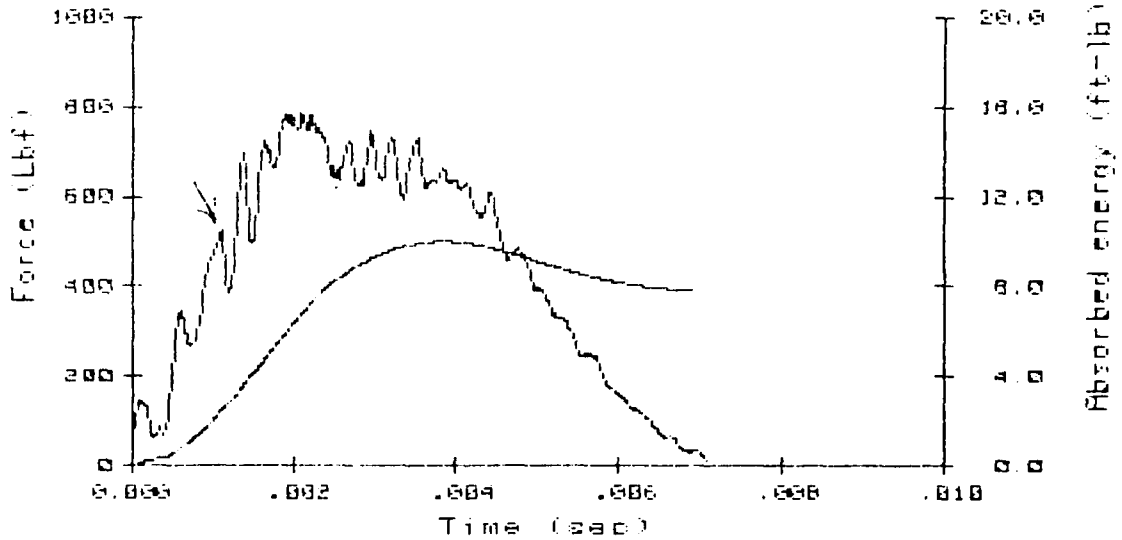
INSTRUMENTED IMPACT TEST

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T300/V378A #2

Drop weight	=	7.00Lb	Data disk	MAT00906
Top radius	=	.500in	DRM scale	.8Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	9.52ft/s	abs(Vf) =	5.95ft/s
K.E.	=	9.86ft-Lb	Vf(calc) =	-4.44ft/s

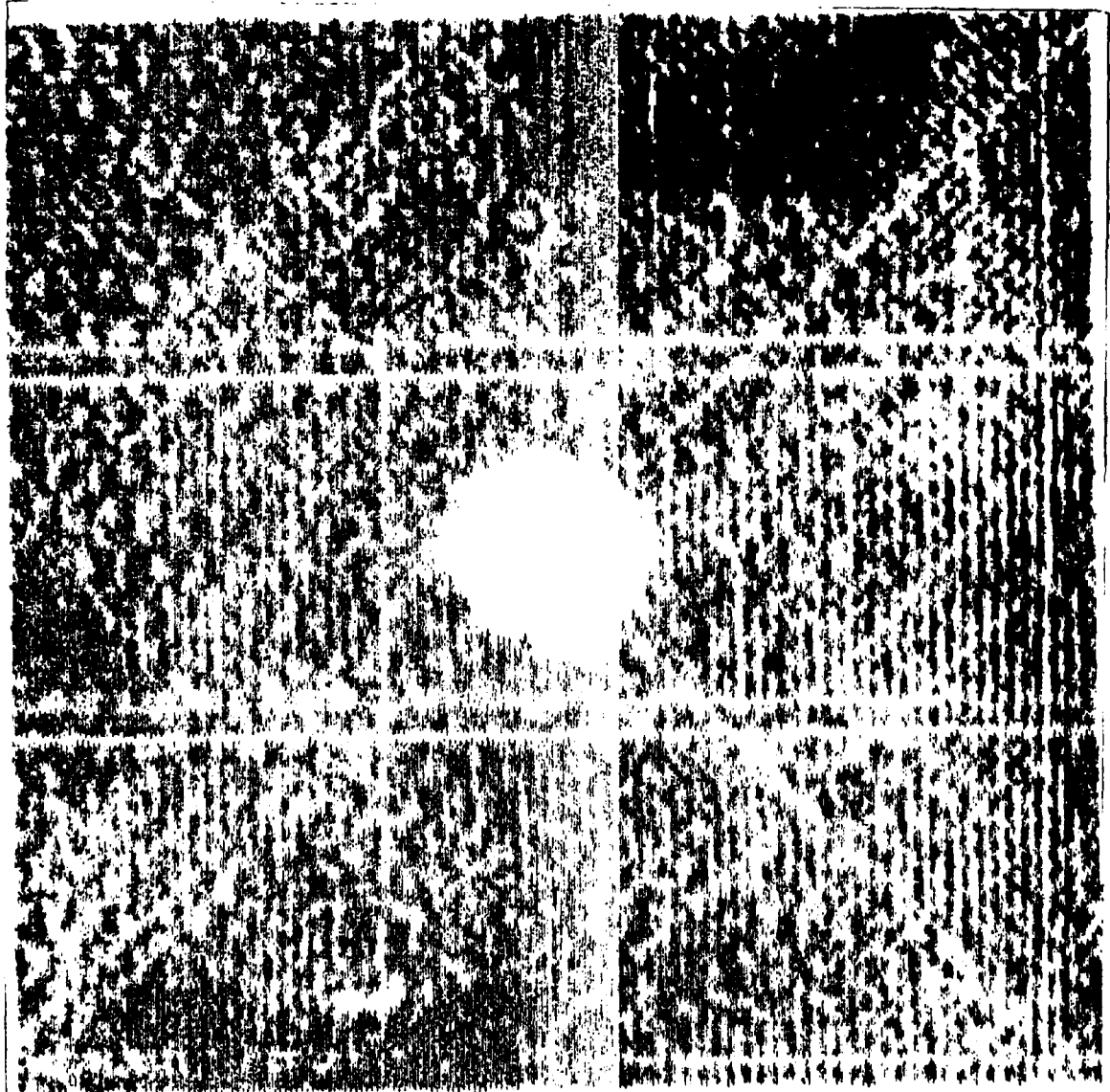
Load (Lb)	Time (s)	E0 (Ft-Lb)	Disp (in)	
523.4	1.105E-3	2.46	.1224	Initial damage
787.7	2.105E-3	6.82	.2062	Maximum force
660.0	3.835E-3	10.01	.2610	Maximum energy
660.0	3.835E-3	10.01	.2610	Maximum displacement
14.4	7.055E-3	7.80	.1420	Final values



NADC-85023-60

T300/V378A

#2



(In) 0 1 2 3 4 5 6
(cm) 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

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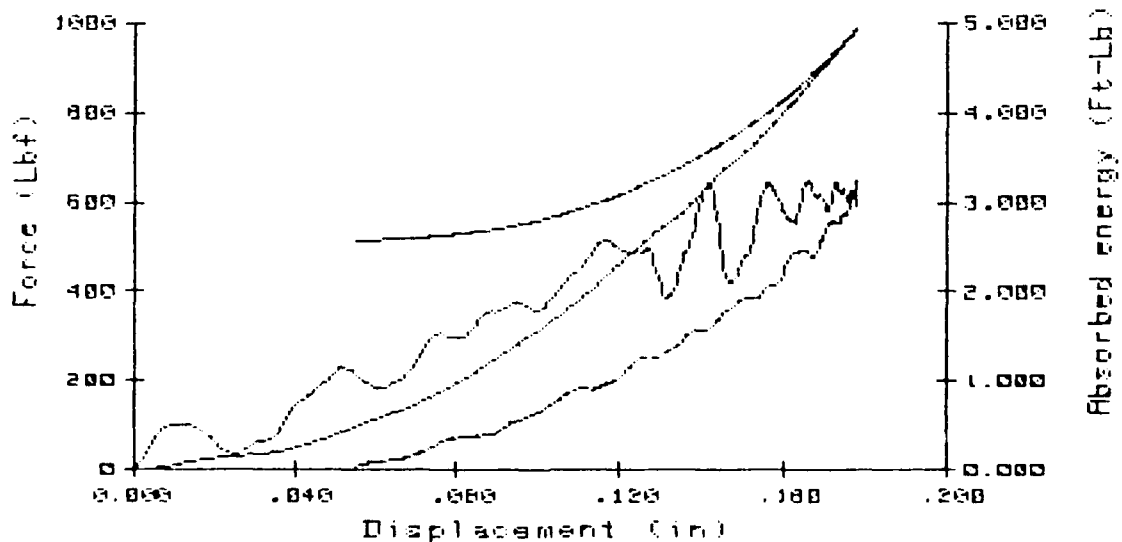
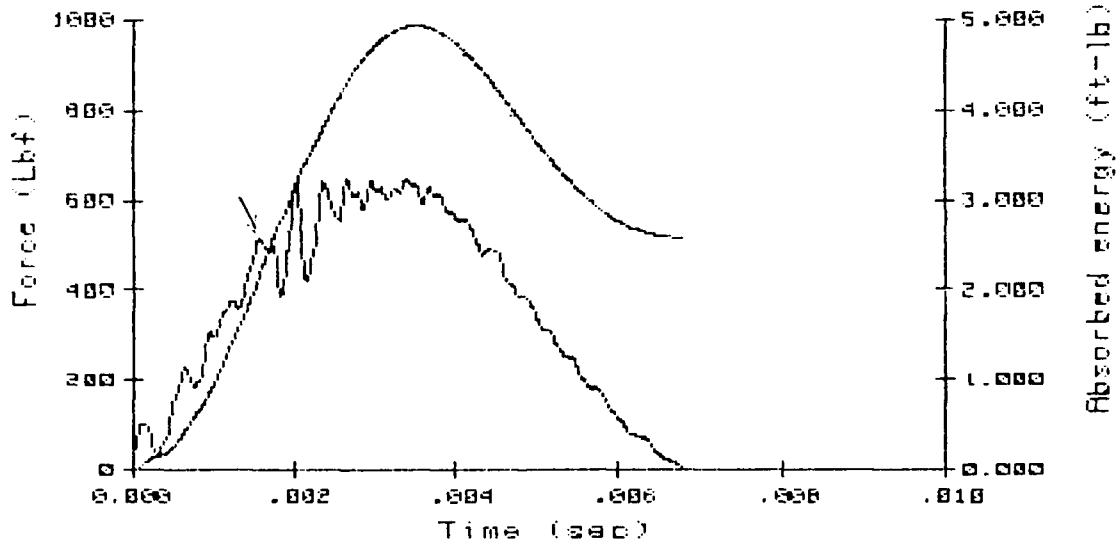
INSTRUMENTED IMPACT TEST

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T300/V378A #3

Drop weight	=	7.00Lb	Data disk	MAT00905
Top radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	6.67ft/s	abs(Vf) =	5.56ft/s
K.E.	=	4.83ft-Lb	Vf(calc) =	-4.59ft/s

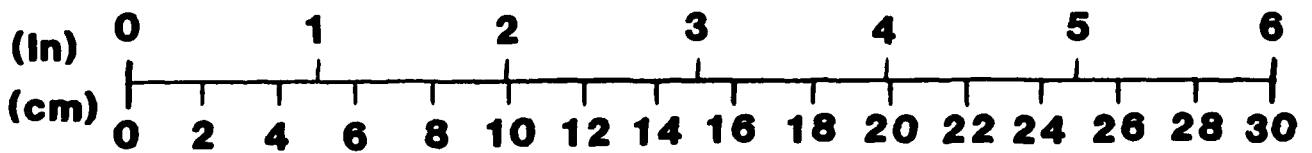
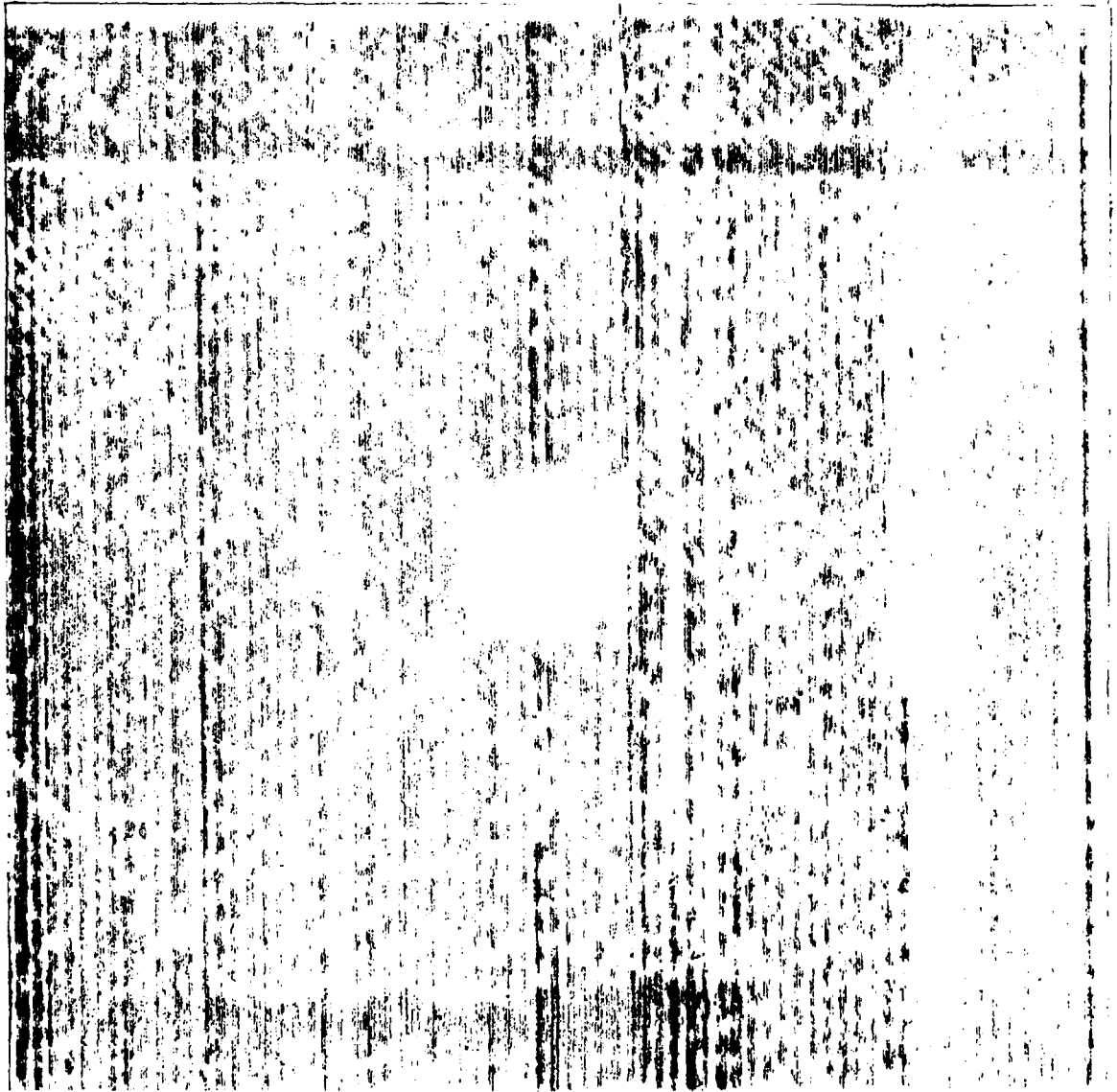
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
516.2	1.565E-3	2.15	.1162	Initial damage
649.2	3.385E-3	4.92	.1778	Maximum force
635.8	3.505E-3	4.93	.1780	Maximum energy
635.8	3.505E-3	4.93	.1780	Maximum displacement
7.2	6.755E-3	2.58	.0551	Final values



NADC-85023-60

T300/V378A

#3

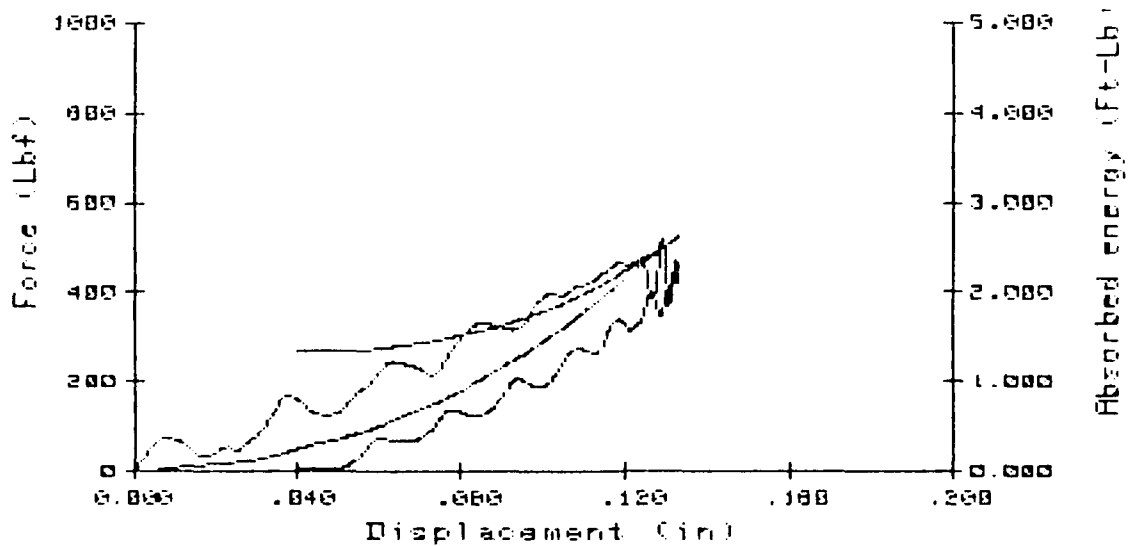
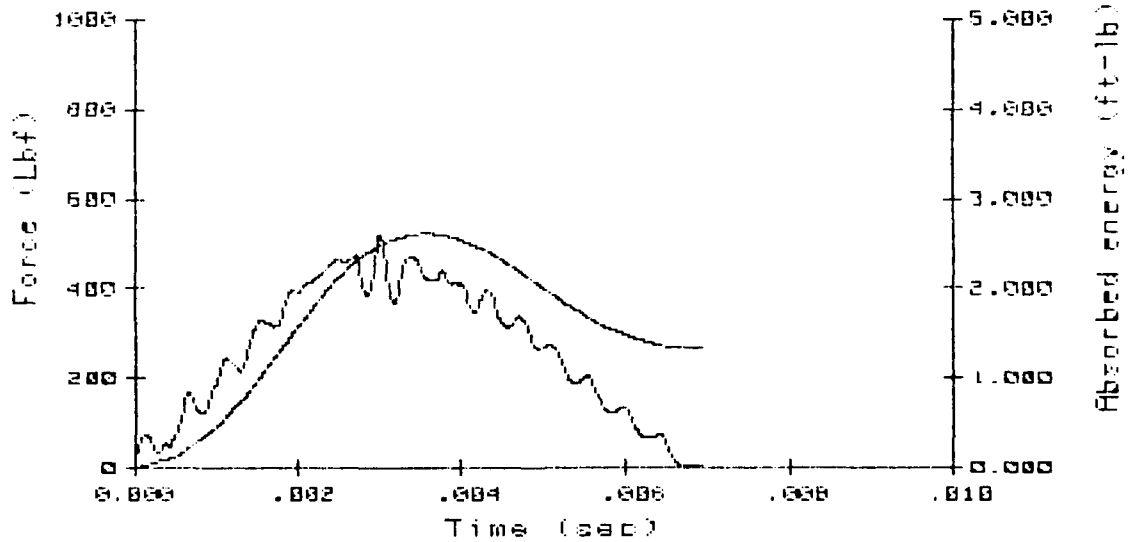


INSTRUMENTED IMPACT TEST

T300/V378A #4

Drop weight	=	7.00Lb	Data disk	MAT00904
Top radius	=	.500in	DRM scale	.2Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	4.83ft/s	abs(Vf)	4.12ft/s
K.E.	=	2.54ft-Lb	Vf(calc)	-3.36ft/s

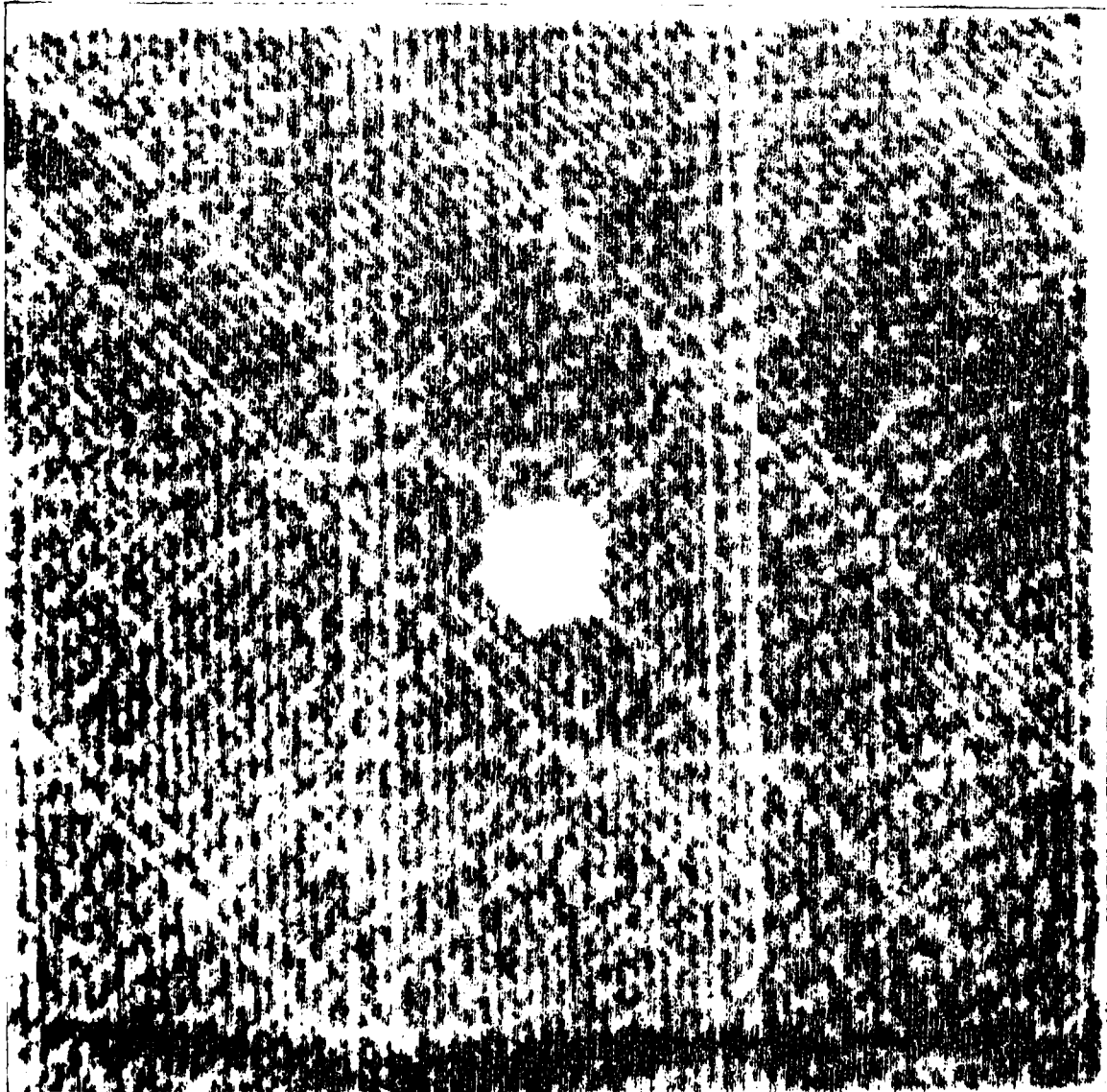
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
473.0	2.705E-3	2.29	.1235	Initial damage
521.1	3.025E-3	2.49	.1288	Maximum force
423.1	3.555E-3	2.61	.1323	Maximum energy
423.1	3.555E-3	2.61	.1323	Maximum displacement
4.0	6.905E-3	1.33	.0403	Final values



NADC-85023-60

T300/V378A

#4



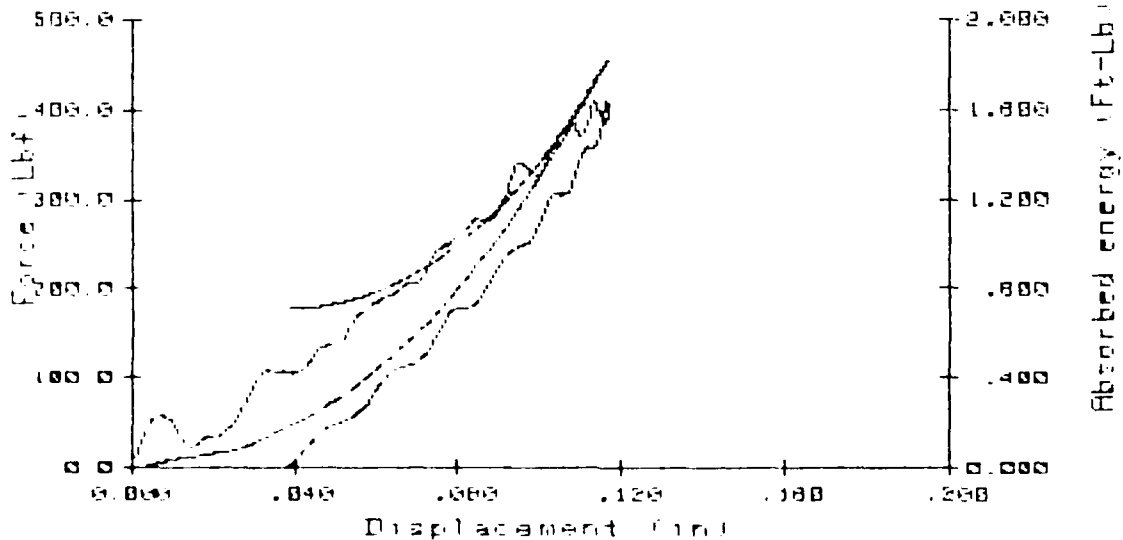
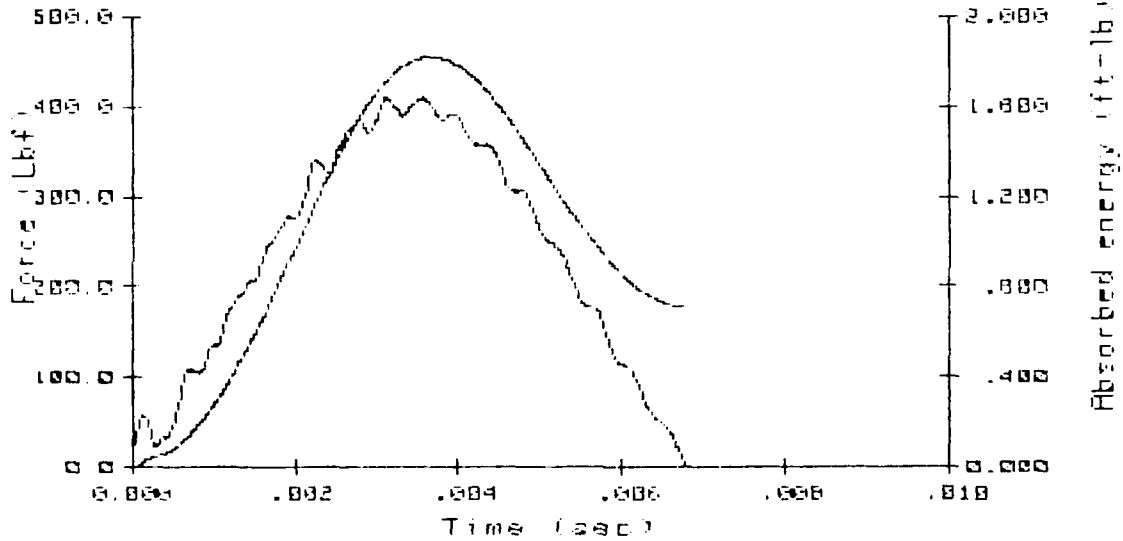
(In) 0 1 2 3 4 5 6
(cm) 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

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 INSTRUMENTED IMPACT TEST
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T300/V378A 15

Drop weight = 7.00Lb Data disk MAT00908
 Tip radius = .500in DRM scale .2In/Div
 Temperature = 74.0 F Flag grid= .040in
 VO = 4.02ft/s abs(Vf) = 3.88ft/s
 F.E. = 1.75ft-Lb Vf(calc) = -3.13ft/s

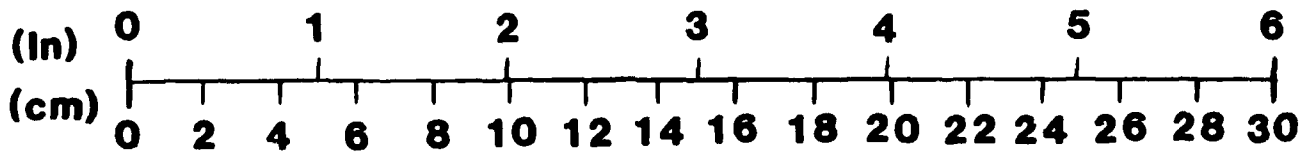
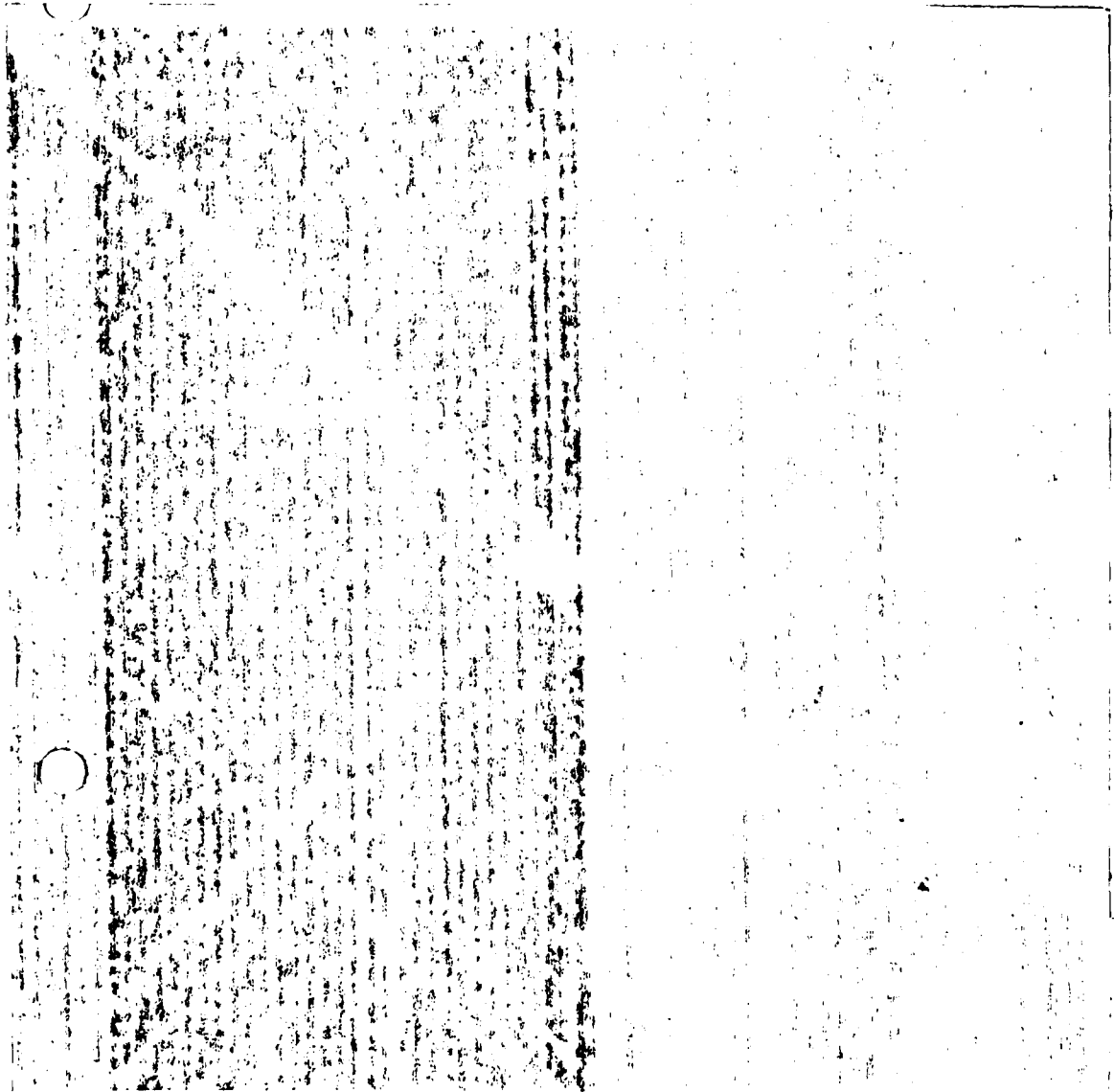
Load (Lb)	Time (s)	EO (Ft-Lb)	Disp (in)	
411.0	3.105E-3	1.71	.1131	Maximum force
402.0	3.665E-3	1.82	.1165	Maximum energy
402.0	3.665E-3	1.82	.1165	Maximum displacement
3.1	6.785E-3	.71	.0391	Final values



NADC-85023-60

T300/V378A

#5

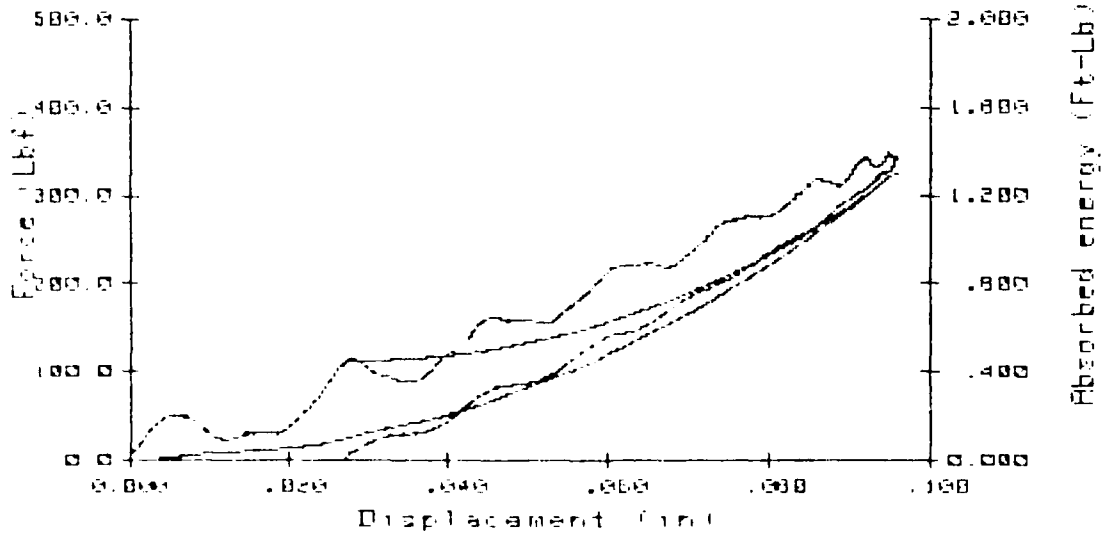
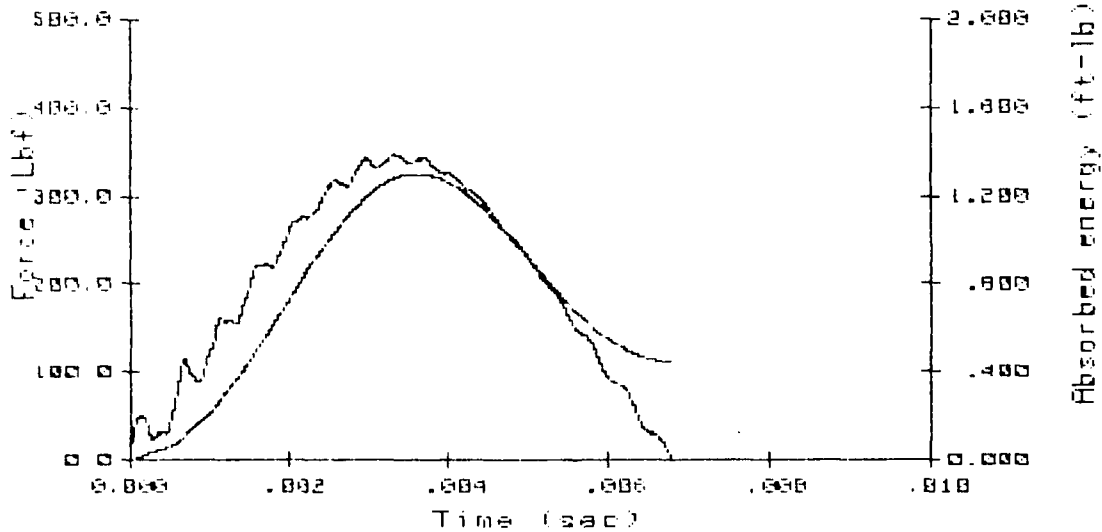


INSTRUMENTED IMPACT TEST

T300/V378A #6

Drop weight	=	7.00Lb	Data dist	MAT01001
Top radius	=	.500in	DRM scale	.2in/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	3.38ft/s	abs(Vf)	3.25ft/s
N.E.	=	1.24ft-Lb	Vf(calc)	-2.74ft/s

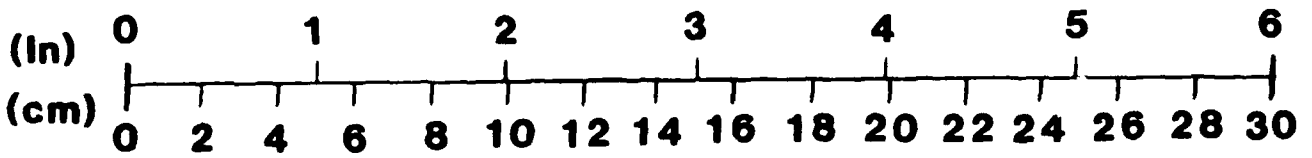
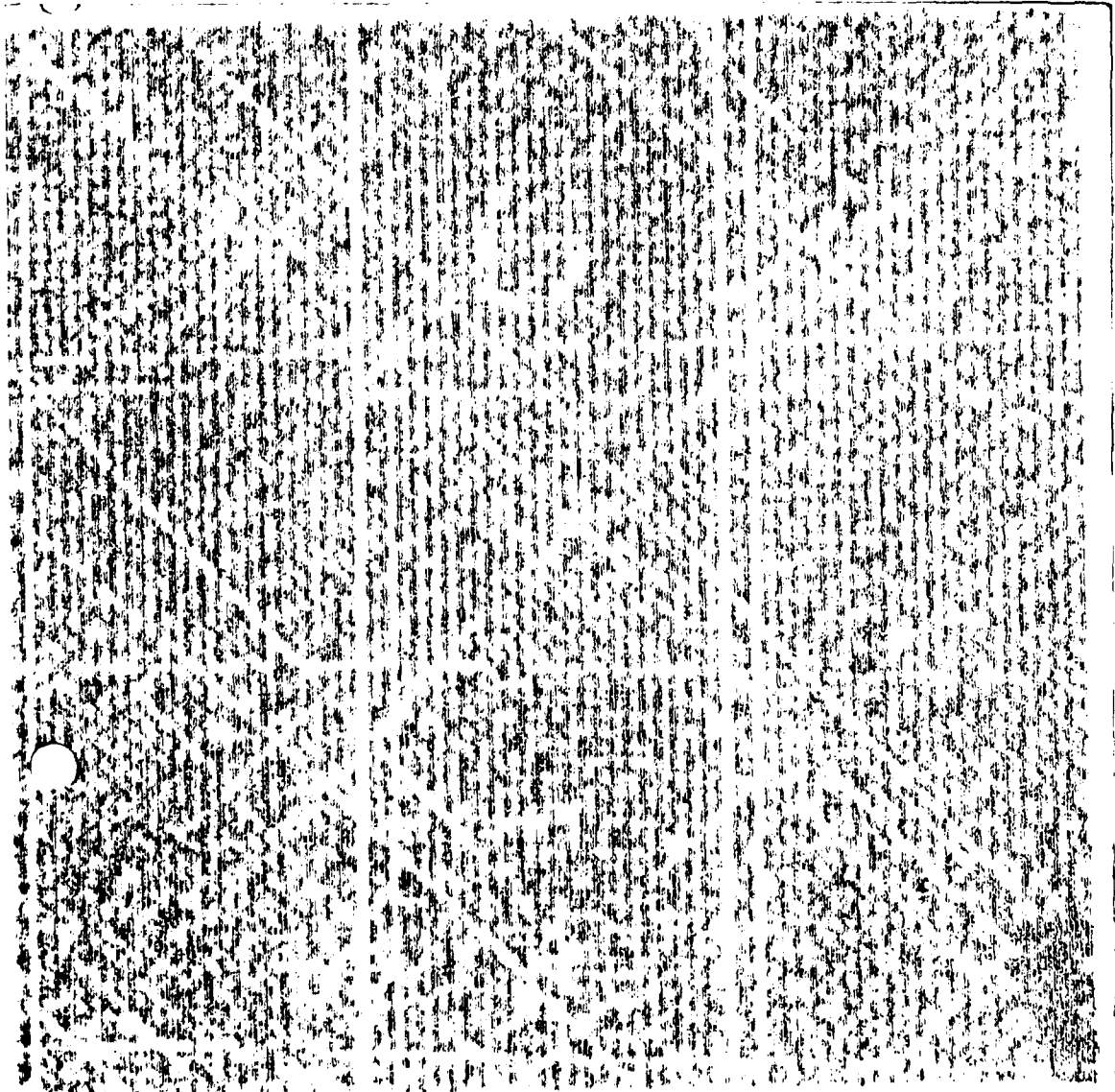
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
347.6	3.313E-3	1.28	.0950	Maximum force
342.2	3.603E-3	1.30	.0958	Maximum energy
342.2	3.603E-3	1.30	.0958	Maximum displacement
4.0	6.768E-3	.45	.0271	Final values



NADC-85023-60

T300/V378A

#6



NADC-85023-60

XAS/9101-3

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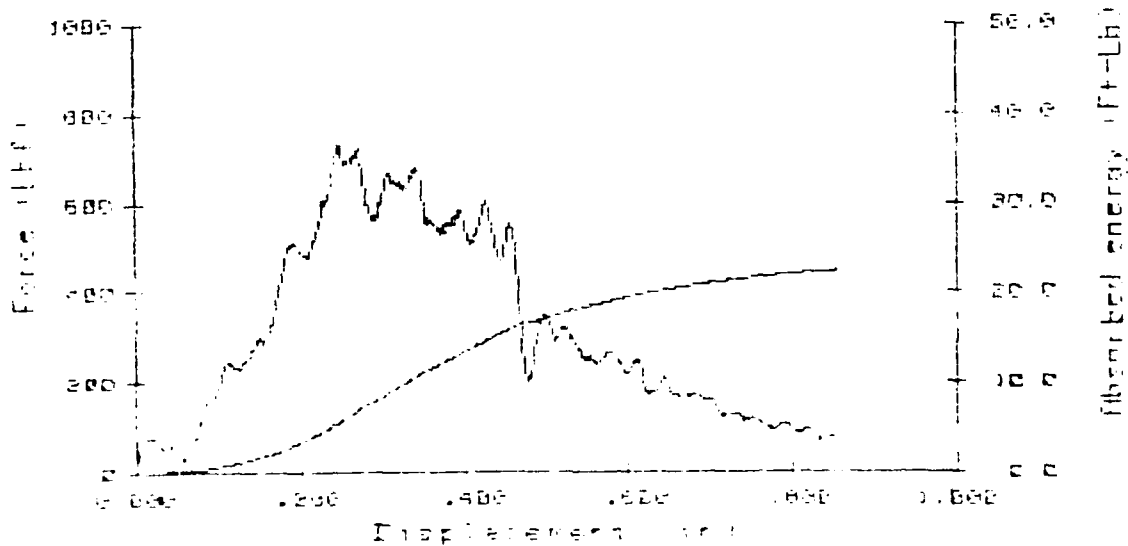
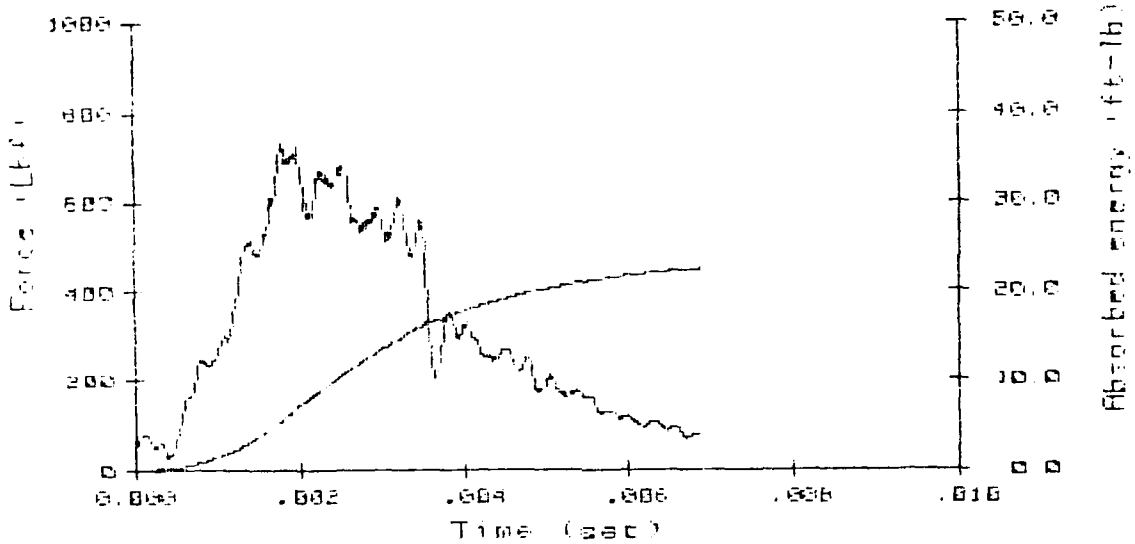
INSTRUMENTED IMPACT TEST

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SRVBM1 5101-3 #1

Drop weight	=	31.36Lb	Data disk	MAT01201
Top radius	=	.500in	DRM scale	.8Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	11.49ft/s		
I.E.	=	64.34ft-Lb	Vf(calc) =	9.51ft/s

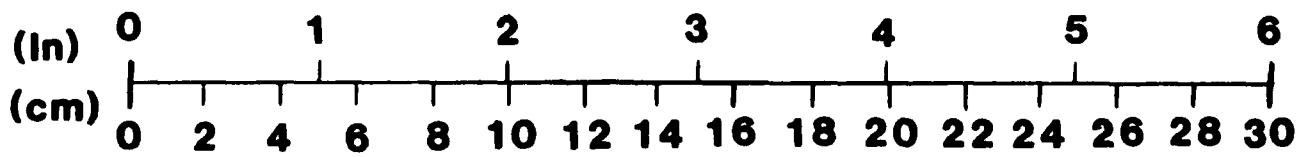
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
730.8	1.805E-3	5.71	.2483	Maximum force
77.3	6.885E-3	22.50	.8565	Maximum energy
77.3	6.885E-3	22.50	.8565	Maximum displacement
77.3	6.885E-3	22.50	.8565	Final values



NADC-85023-60

GR/BMI 9101-3

#1



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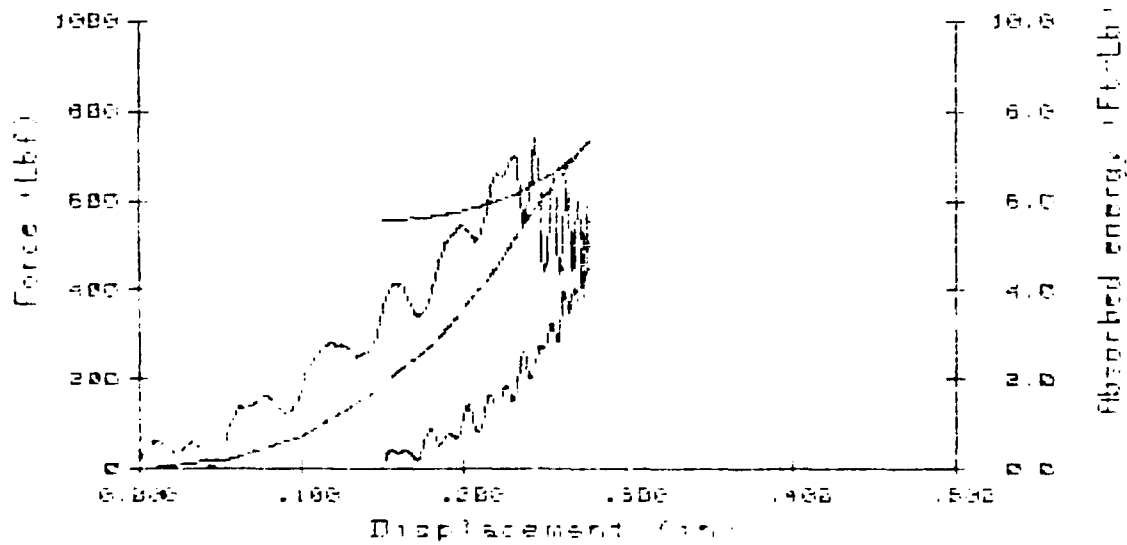
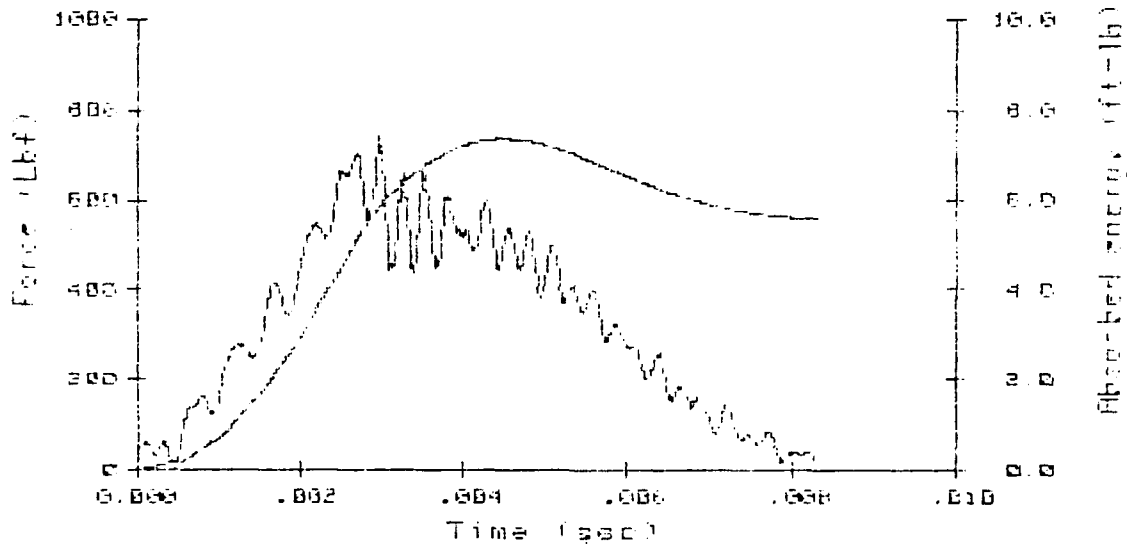
INSTRUMENTED IMPACT TEST

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GR/BM1 9101-3 #2

Drop weight	=	7.00Lb	Data disk	MAT01107
Tip radius	=	.500in	DRM scale	.8Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	8.13ft/s	abs(Vf)	= 5.21ft/s
H.E.	=	7.18ft-Lb	Vf(calc)	= -3.96ft/s

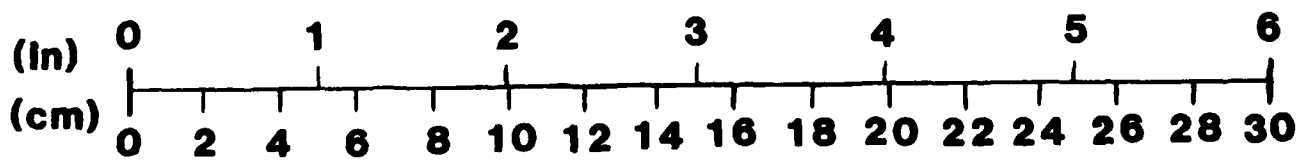
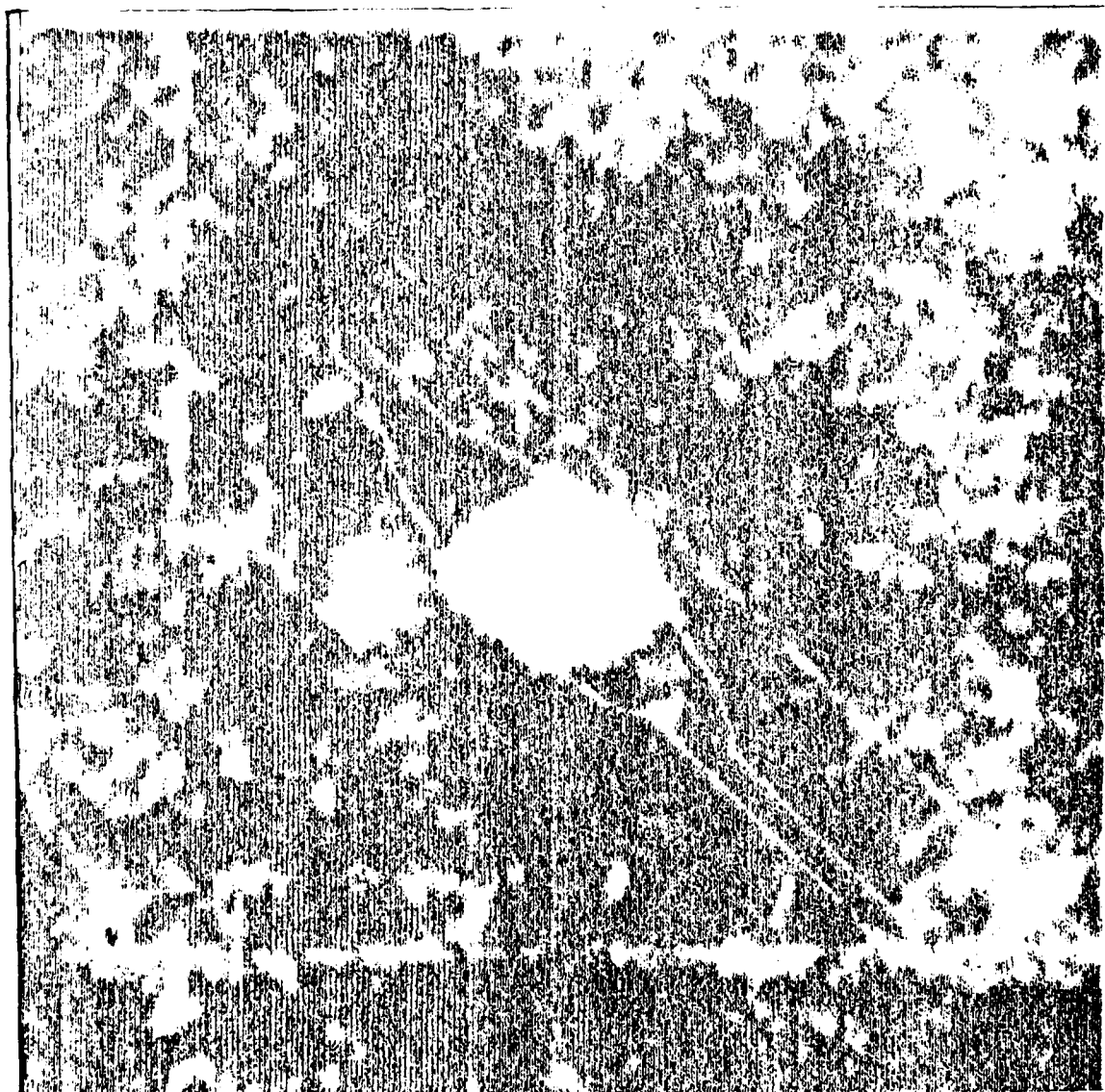
Load(Lb)	Time(s)	EO(Ft-Lb)	Disp(in)	
741.0	2.995E-3	5.86	.2441	Maximum force
509.0	4.505E-3	7.35	.2767	Maximum energy
509.0	4.505E-3	7.35	.2767	Maximum displacement
14.4	8.295E-3	5.57	.1514	Final values



NADC-85023-60

GR/BMI 9101-3

#2



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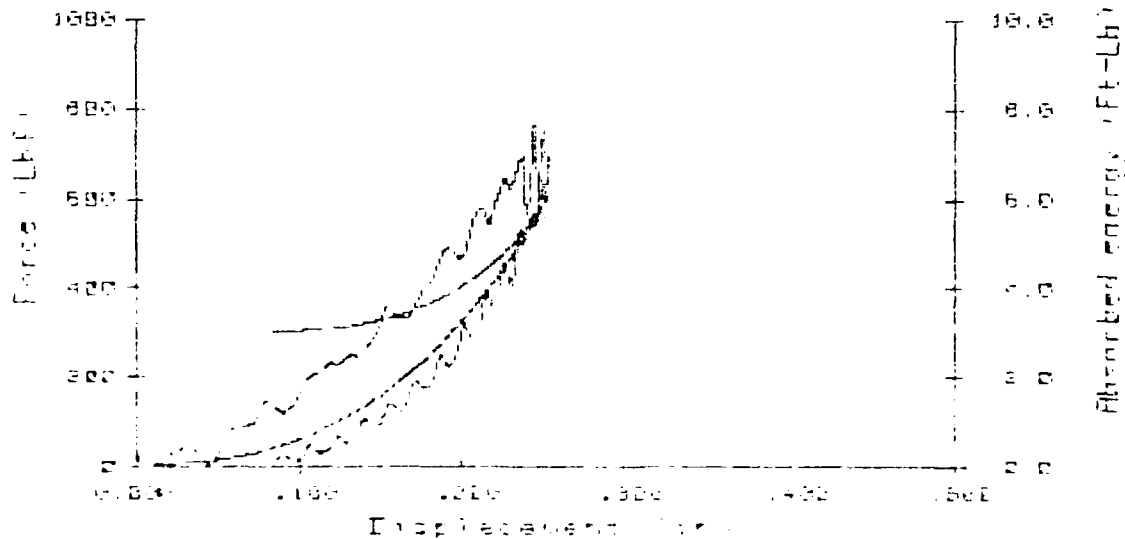
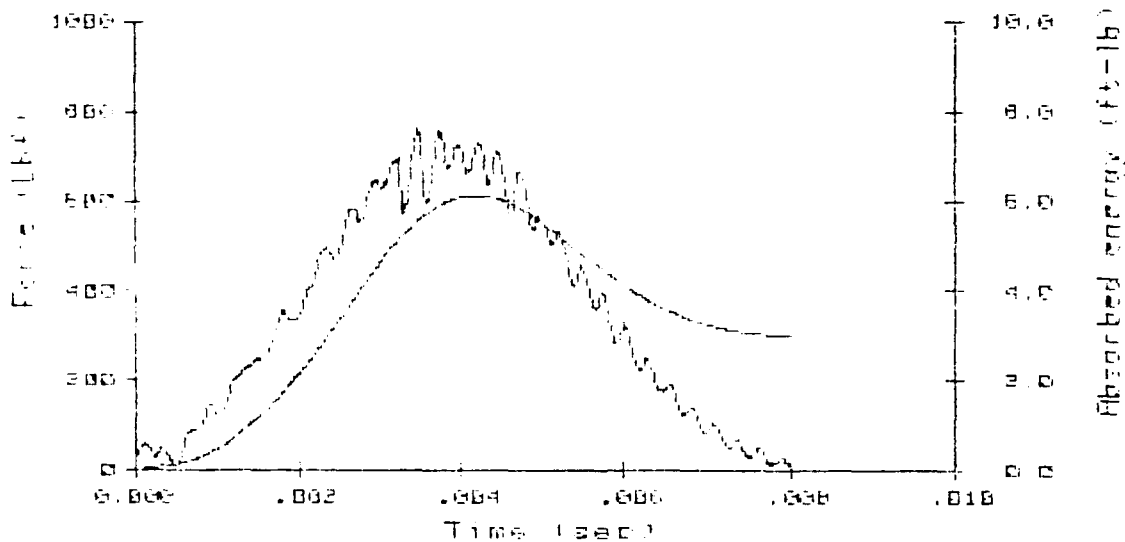
INSTRUMENTED IMPACT TEST

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667891 9101-3 #3

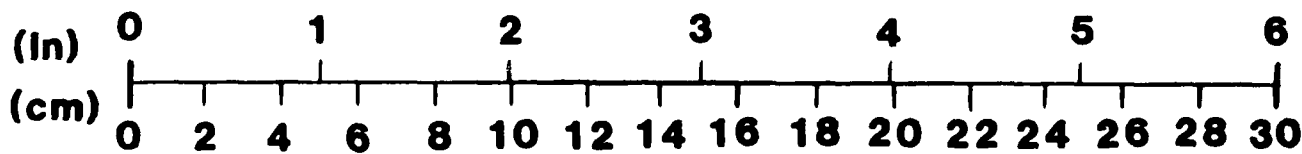
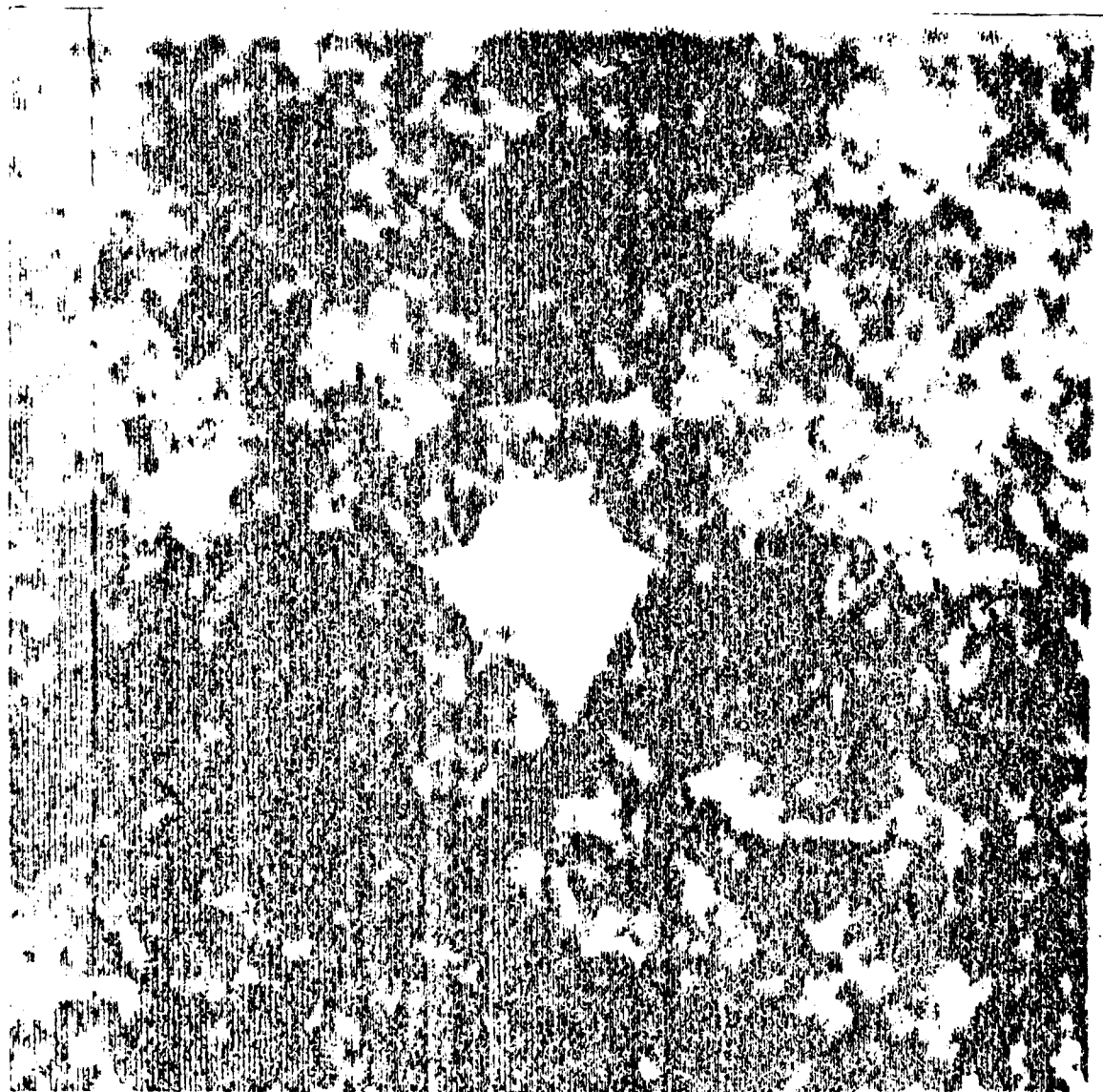
Drop weight	=	7.00Lb	Data disk	MAT01104
Tip radius	=	.500in	DRM scale	.4kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	7.41ft/s	abs(Vf) =	6.29ft/s
I.E.	=	5.96ft-Lb	Vf(calc) =	-5.25ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
766.1	2.465E-3	5.54	.2450	Maximum force
718.5	4.185E-3	6.11	.2549	Maximum energy
718.5	4.185E-3	6.11	.2549	Maximum displacement
6.3	7.585E-3	3.02	.0841	Final values



GR/BMI 9101-3

#3



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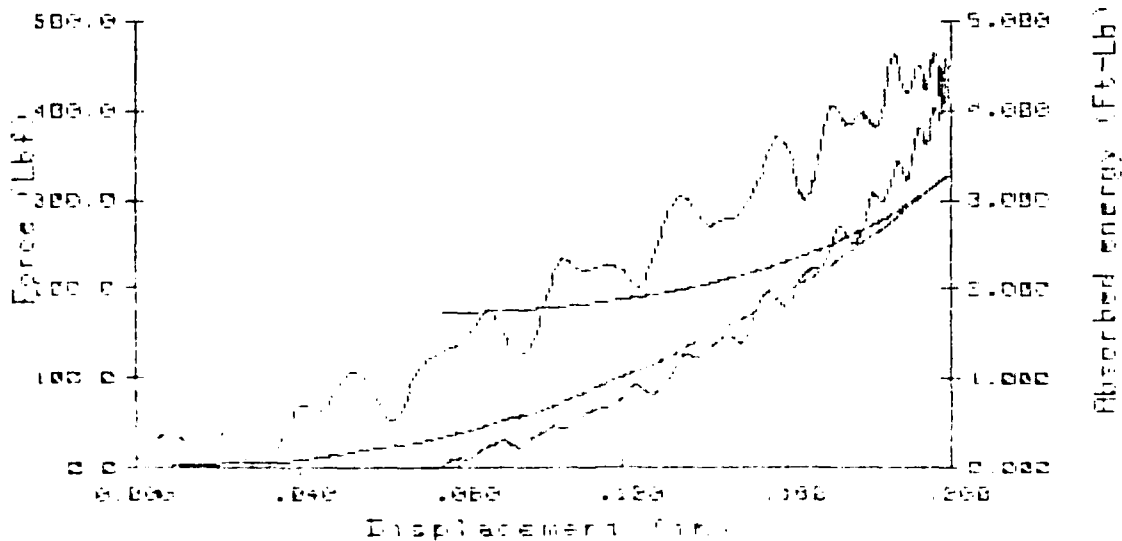
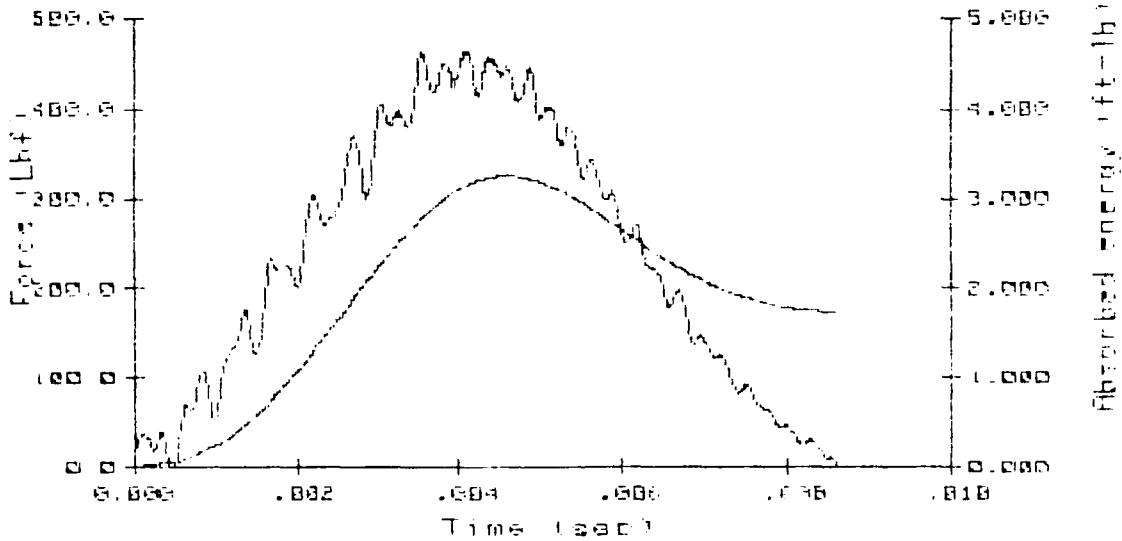
INSTRUMENTED IMPACT TEST

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GR/EMI 9101-3 #4

Drop weight	=	7.00Lb	Data disk	MAT01103
Tip radius	=	.500in	DRM scale	.2in/Div
Temperature	=	74.0 F	Flag grid=	.040in
V ₀	=	5.38ft/s	abs(V _f)	4.57ft/s
F.E.	=	3.14ft-Lb	V _f (calc)	-3.65ft/s

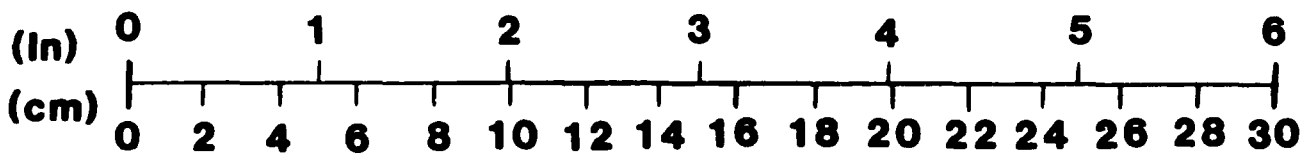
Load(Lb)	Time(s)	ED(Ft-Lb)	Insp(in)	
464.5	4.095E-3	3.15	.1961	Maximum force
446.0	4.595E-3	3.26	.1991	Maximum energy
446.0	4.595E-3	3.26	.1991	Maximum displacement
3.6	8.505E-3	1.74	.0760	Final values



NADC-85023-60

GR/BMI 9101-3

#4



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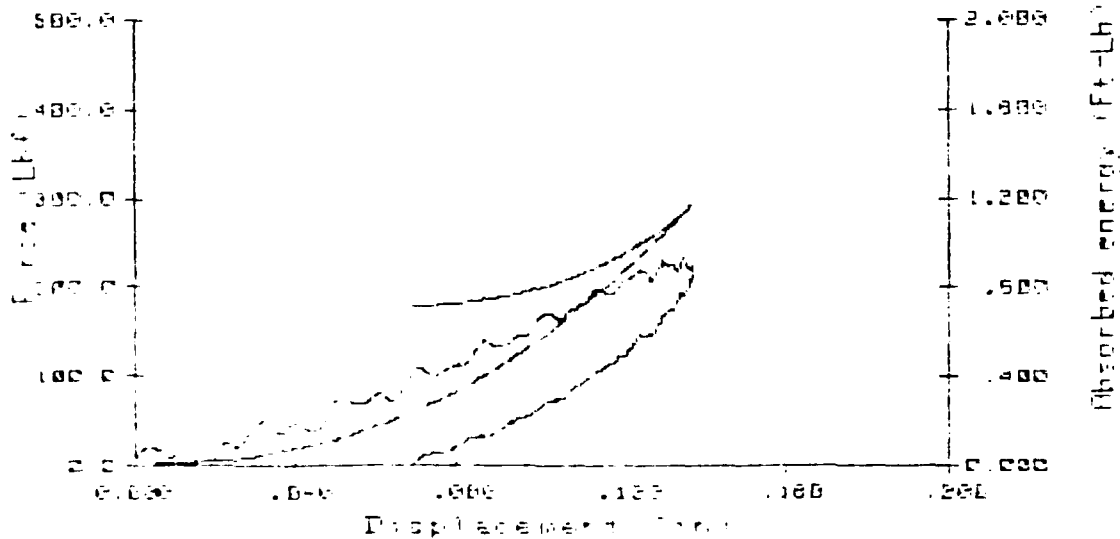
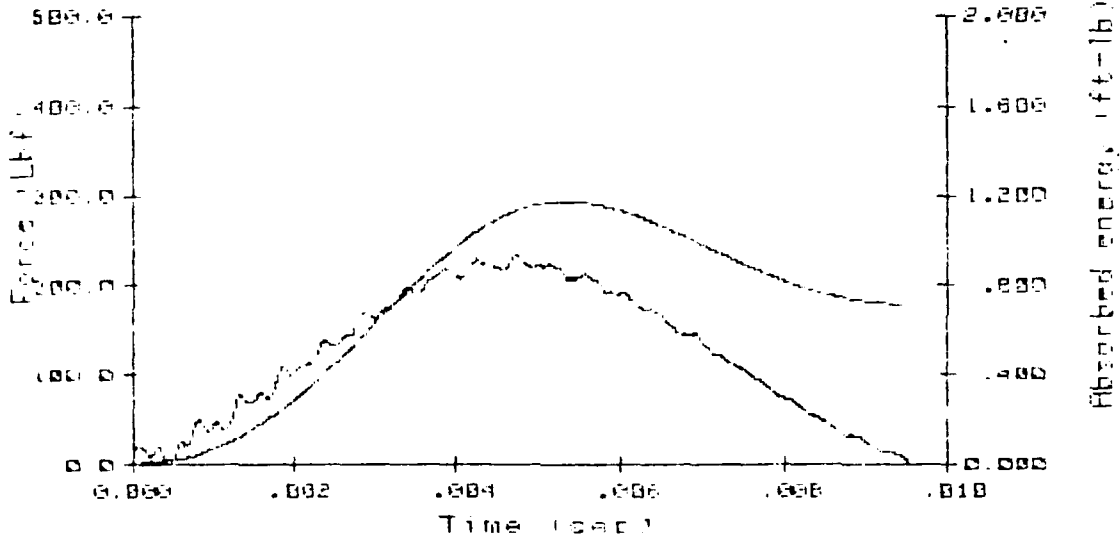
INSTRUMENTED IMPACT TEST

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GR/BMI 9101-3 #5

Drop weight	=	7.00Lb	Data disk	MAT01101
Tip radius	=	.500in	DRM scale	.2Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	3.17ft/s	abs(Vf) =	2.87ft/s
K.E.	=	1.10ft-Lb	Vf(calc) =	-1.97ft/s

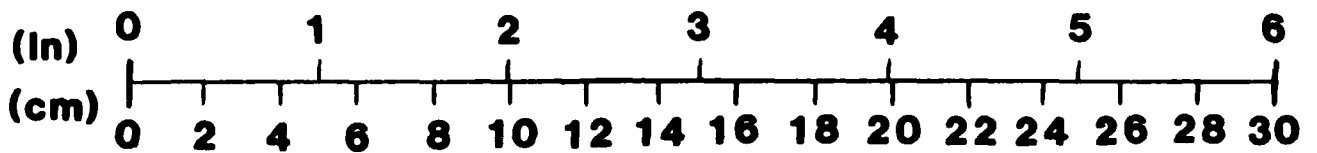
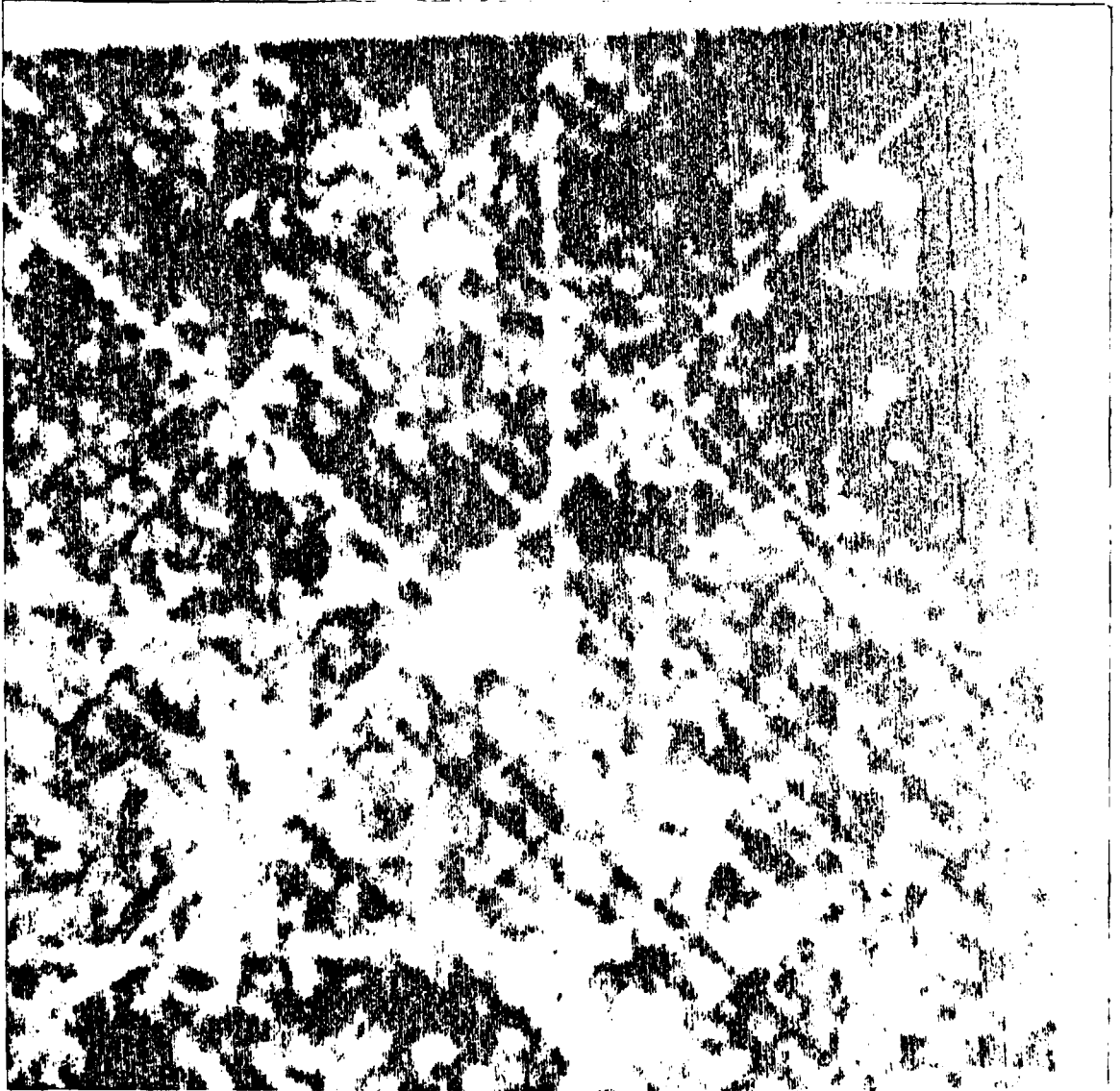
Load(Lb)	Time(s)	EO(Ft-Lb)	Disp(in)	
234.3	4.725E-3	1.13	.1346	Maximum force
209.5	5.355E-3	1.18	.1370	Maximum energy
209.5	5.355E-3	1.18	.1370	Maximum displacement
4.0	9.525E-3	.72	.0696	Final values



NADC-85023-60

GR/BMI 9101-3

#5



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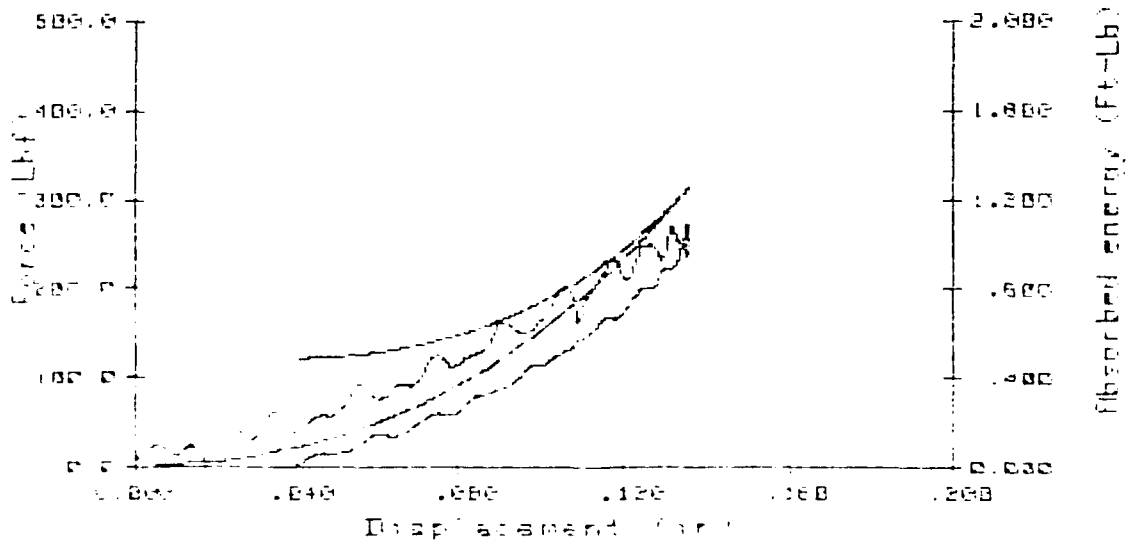
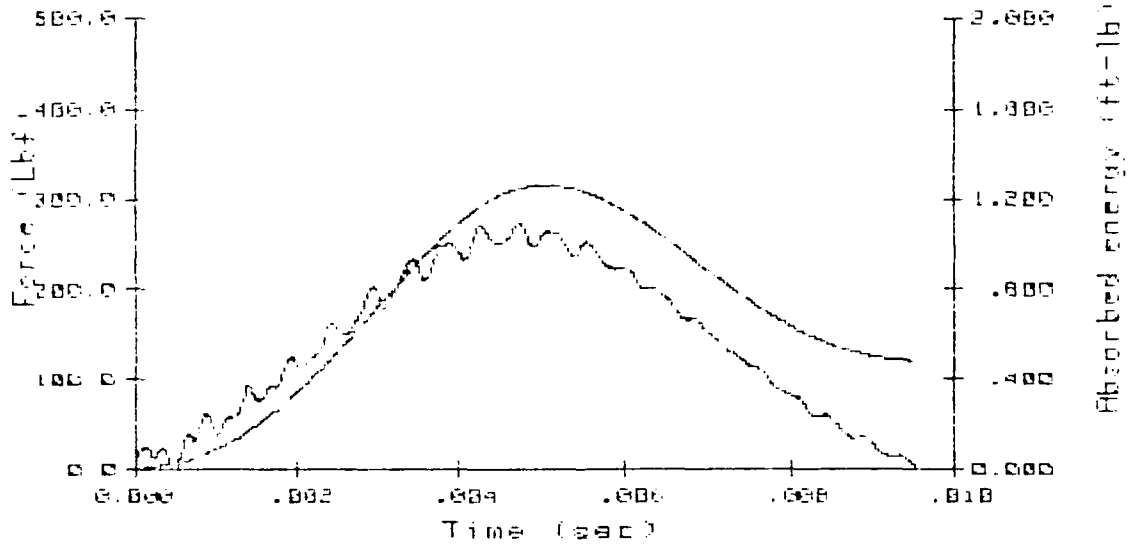
INSTRUMENTED IMPACT TEST

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GRFEMI 9101-2 #6

Drop weight	=	7.00Lb	Data disk	MAT01007
Tip radius	=	.500in	DRM scale	.2kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	3.30ft/s	abs(Vf) =	3.14ft/s
K.E.	=	1.18ft-Lb	Vf(calc) =	-2.58ft/s

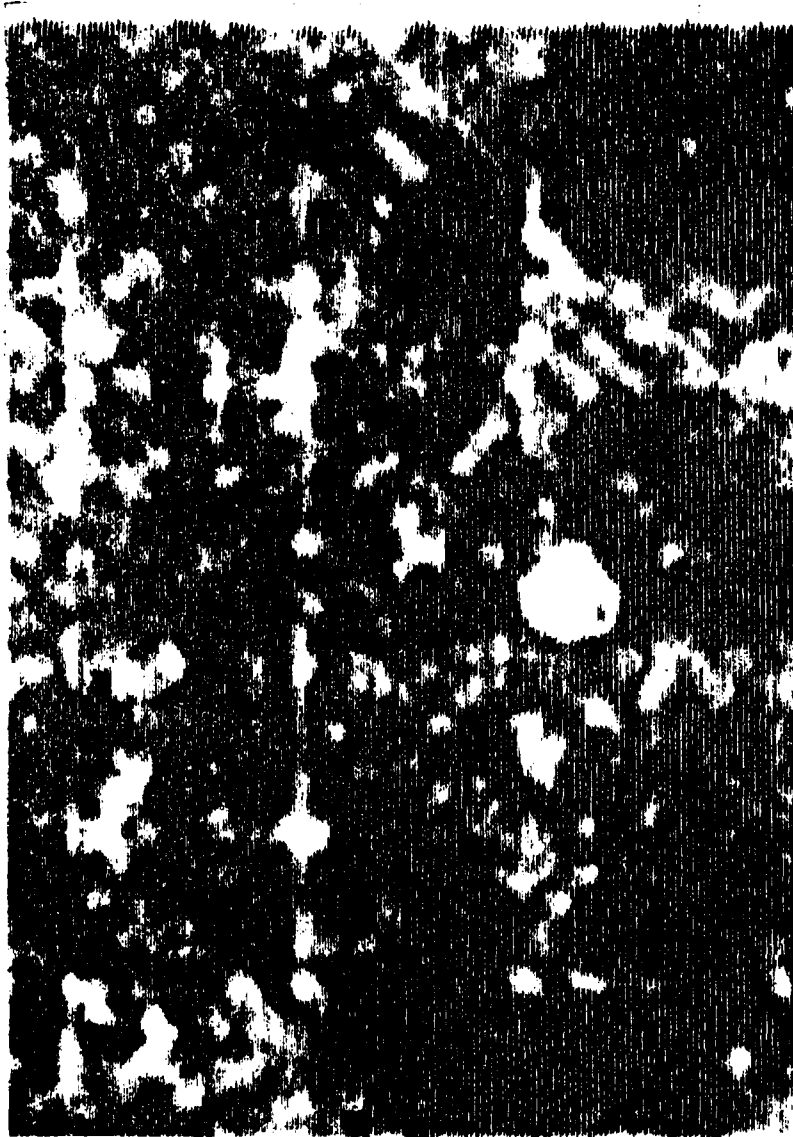
Load (Lb)	Time (s)	E0 (Ft-Lb)	Disp (in)	
274.7	4.735E-3	1.25	.1351	Maximum force
264.4	5.055E-3	1.26	.1358	Maximum energy
264.4	5.055E-3	1.26	.1358	Maximum displacement
3.6	9.515E-3	.49	.0413	Final values



NADC-85023-60

GR/BMI 9101-3

#6



(In) 0 1 2 3 4 5 6
(cm) 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

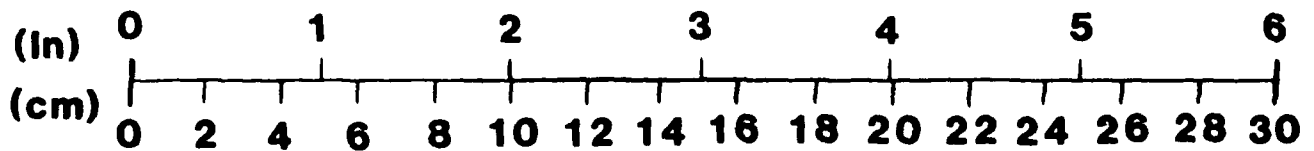
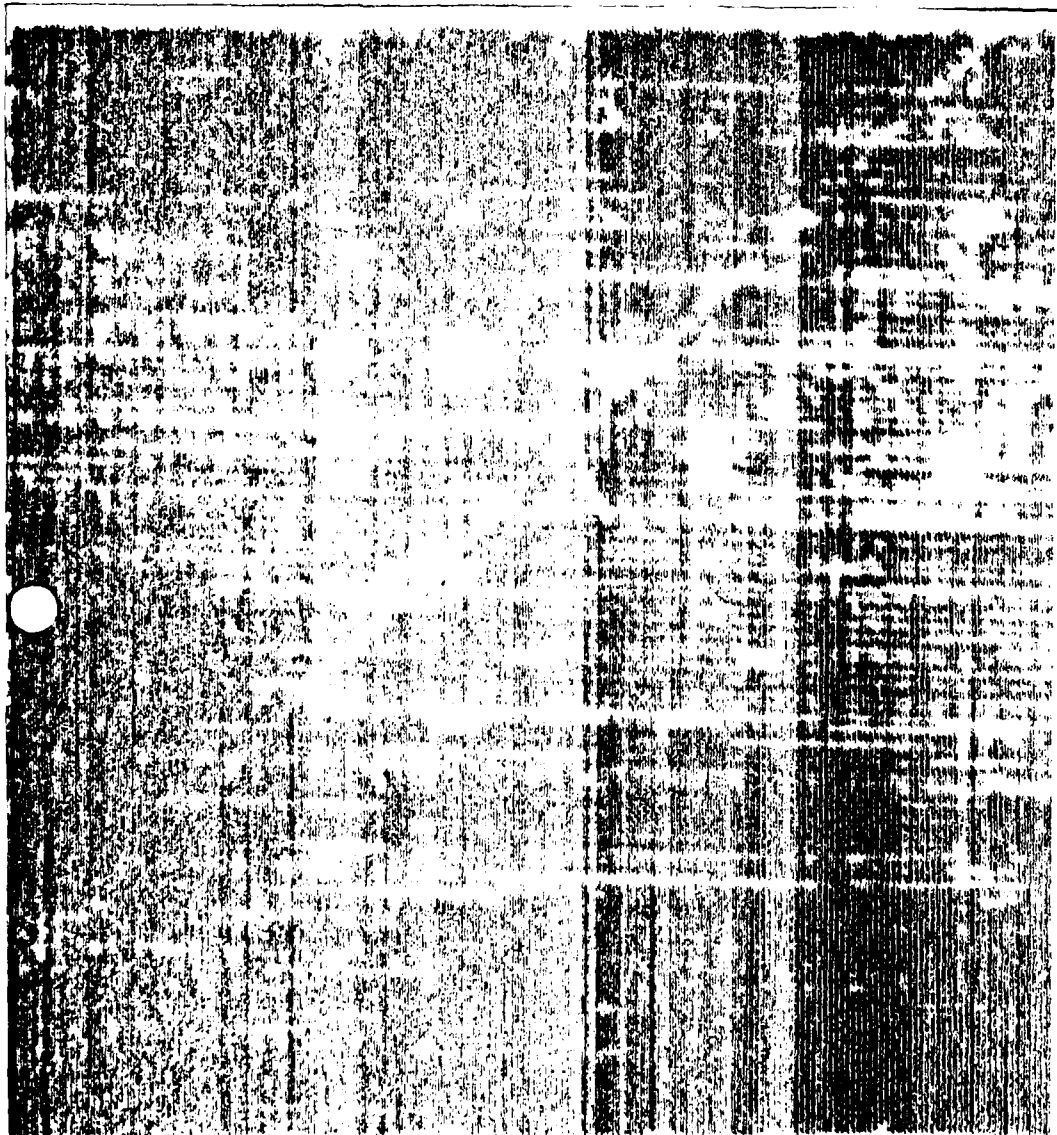
NADC-85023-60

T300/130B

NADC-85023-60

A130 GR/BMI

#8



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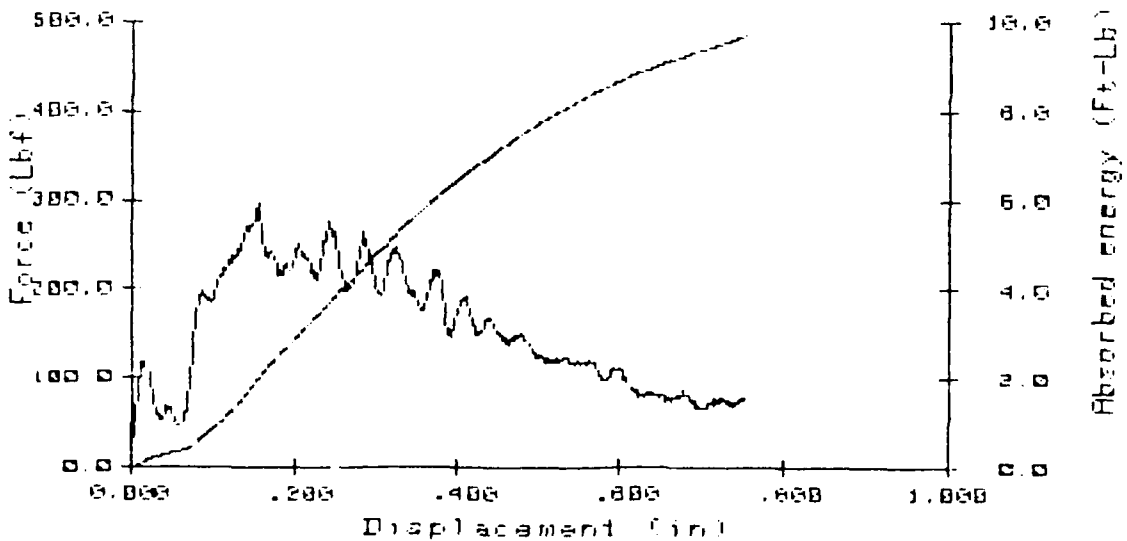
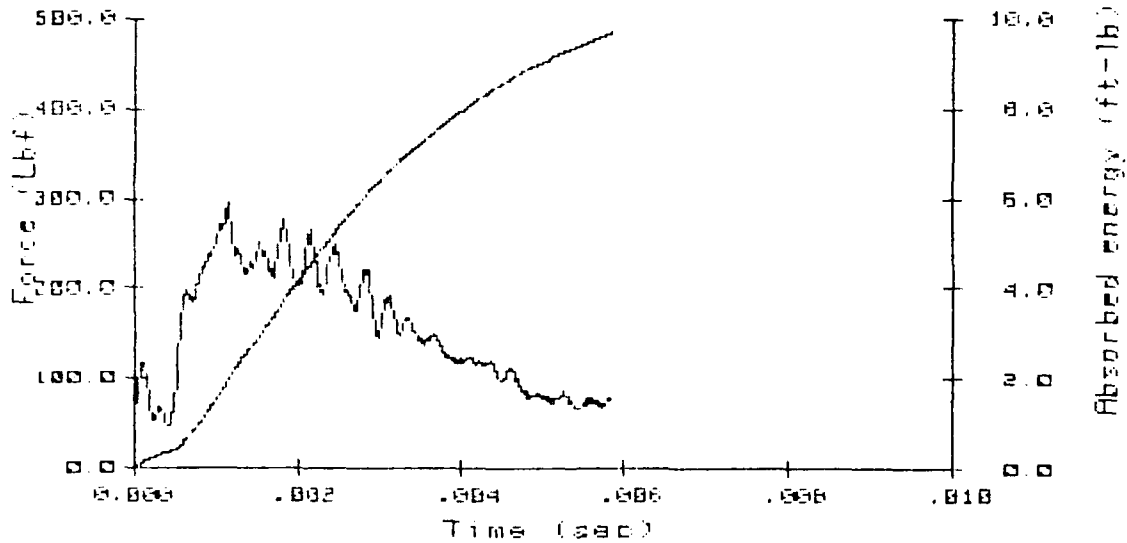
INSTRUMENTED IMPACT TEST

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A130 GR/BMI 41

Drop weight =	31.36Lb	Data disk	MAT00701
Tip radius =	.500in	DRM scale	.8Kn/Div
Temperature =	74.0 F	Flag grid=	.040in
VO =	11.11ft/s		
K.E. =	60.12ft-Lb	Vf(calc) =	10.37ft/s

Load(Lb)	Time(s)	EO(Ft-Lb)	Disp(in)	
294.9	1.155E-3	1.98	.1553	Maximum force
77.3	5.845E-3	9.69	.7511	Maximum energy
77.3	5.845E-3	9.69	.7511	Maximum displacement
77.3	5.845E-3	9.69	.7511	Final values



NADC-85023-60

A130 GR/BMI

#1



(In) 0 1 2 3 4 5 6
(cm) 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

A-111

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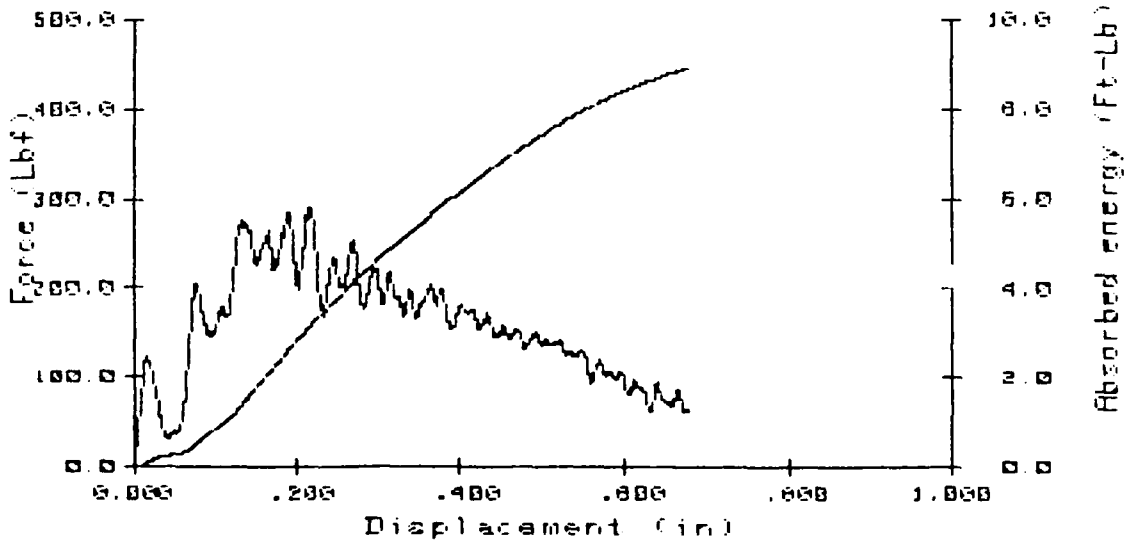
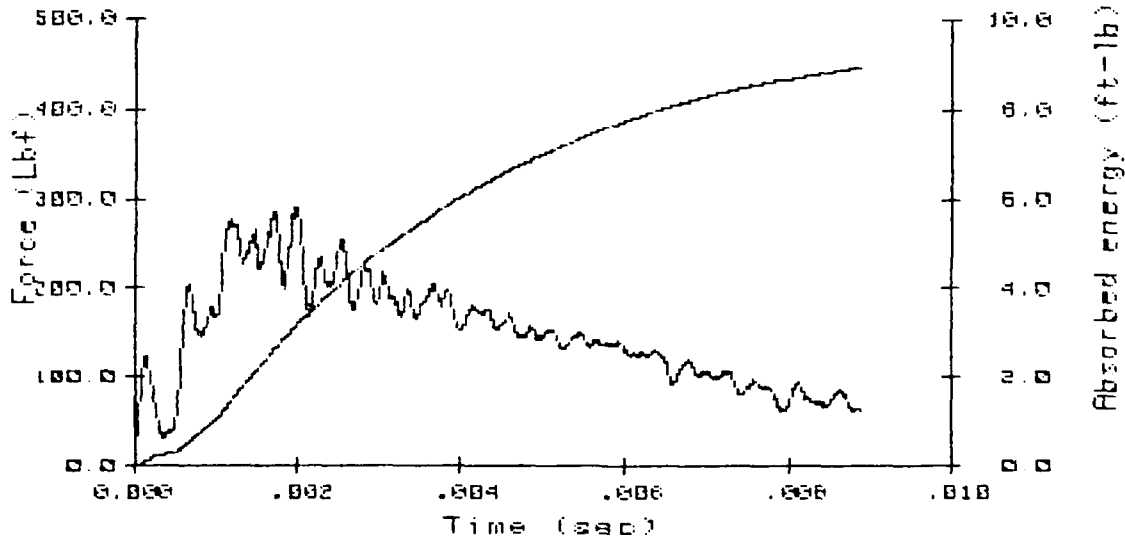
INSTRUMENTED IMPACT TEST

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A130 GR/BMI #2

Drop weight	=	7.00Lb	Data disk	MAT00703
Tip radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	9.66ft/s		
K.E.	=	10.15ft-Lb	Vf(calc) =	3.84ft/s

Load(Lb)	Time(s)	EO(Ft-Lb)	Disp(in)	
291.4	1.983E-3	3.11	.2167	Maximum force
62.9	8.888E-3	8.94	.6762	Maximum energy
62.9	8.888E-3	8.94	.6762	Maximum displacement
62.9	8.888E-3	8.94	.6762	Final values



NADC-85023-60

A 130 GR/BMI

#2



(In) 0 1 2 3 4 5 6
(cm) 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

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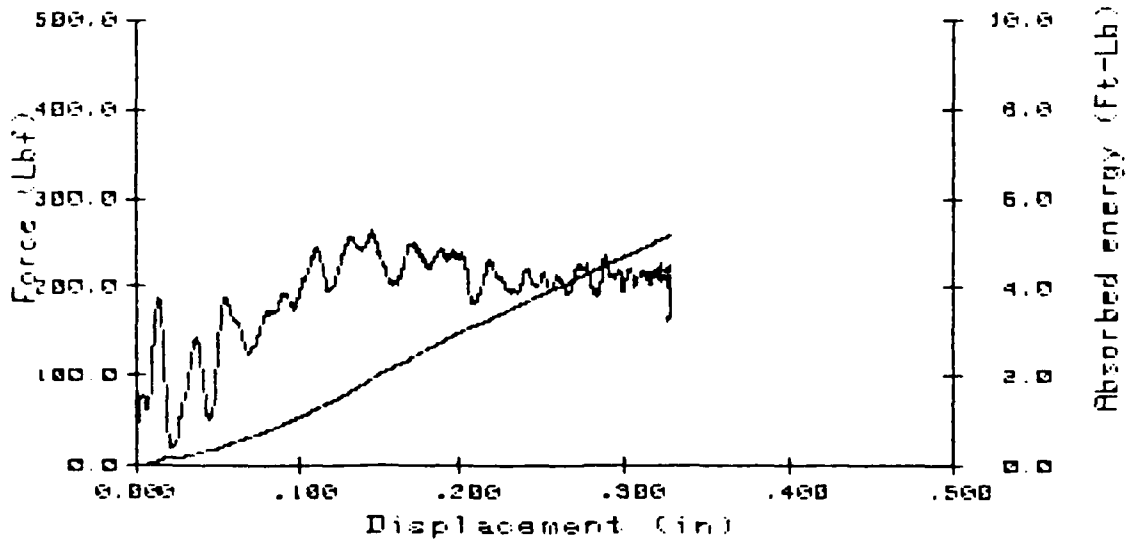
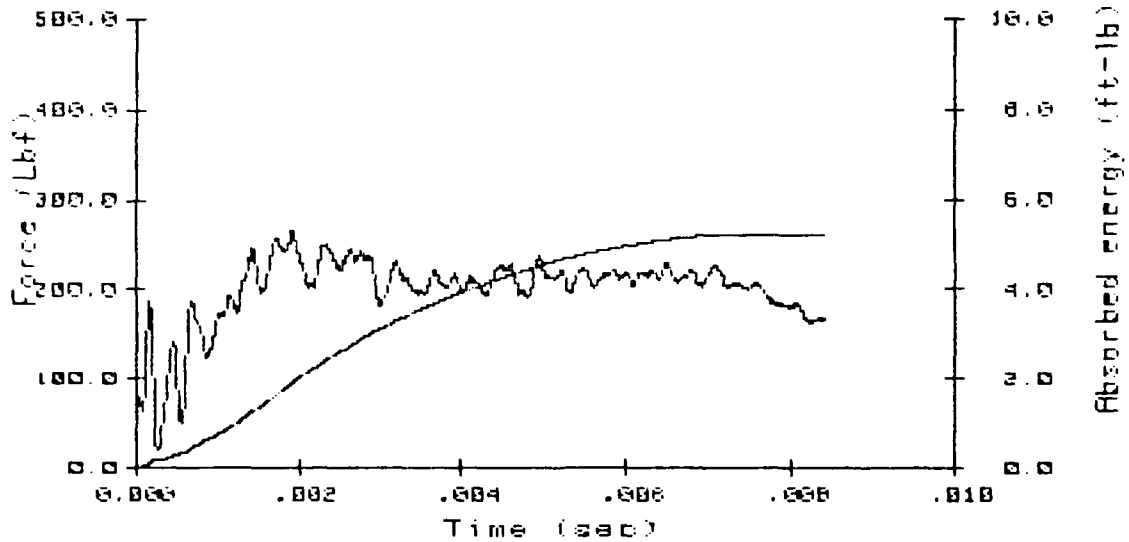
INSTRUMENTED IMPACT TEST

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A130 GR/BMI #3

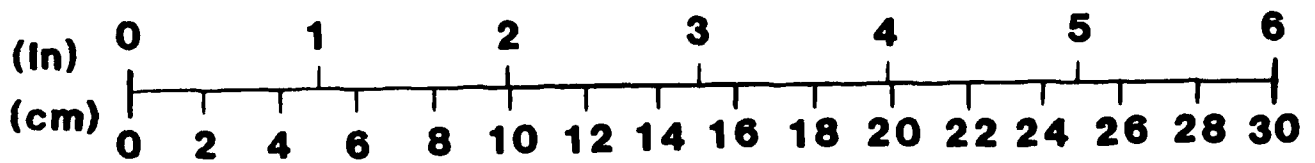
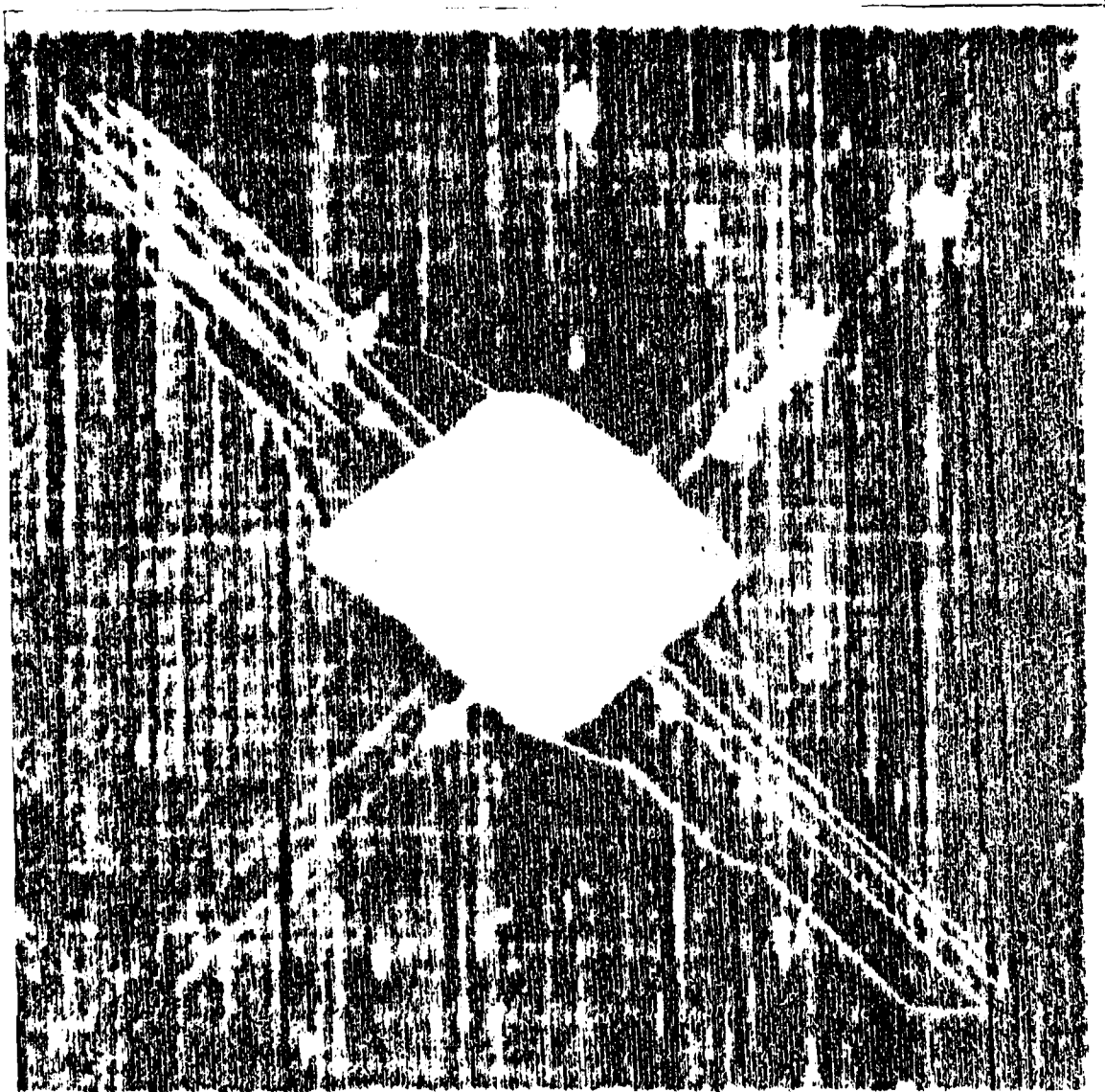
Drop weight	=	7.00Lb	Data disk	MAT00705
Tip radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
VO	=	6.80ft/s		
K.E.	=	5.03ft-Lb	Vf(calc) =	-.64ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
265.3	1.918E-3	1.91	.1447	Maximum force
205.0	7.608E-3	5.22	.3282	Maximum energy
205.0	7.608E-3	5.22	.3282	Maximum displacement
164.6	8.423E-3	5.17	.3250	Final values



A 130 GR/BMI

#3

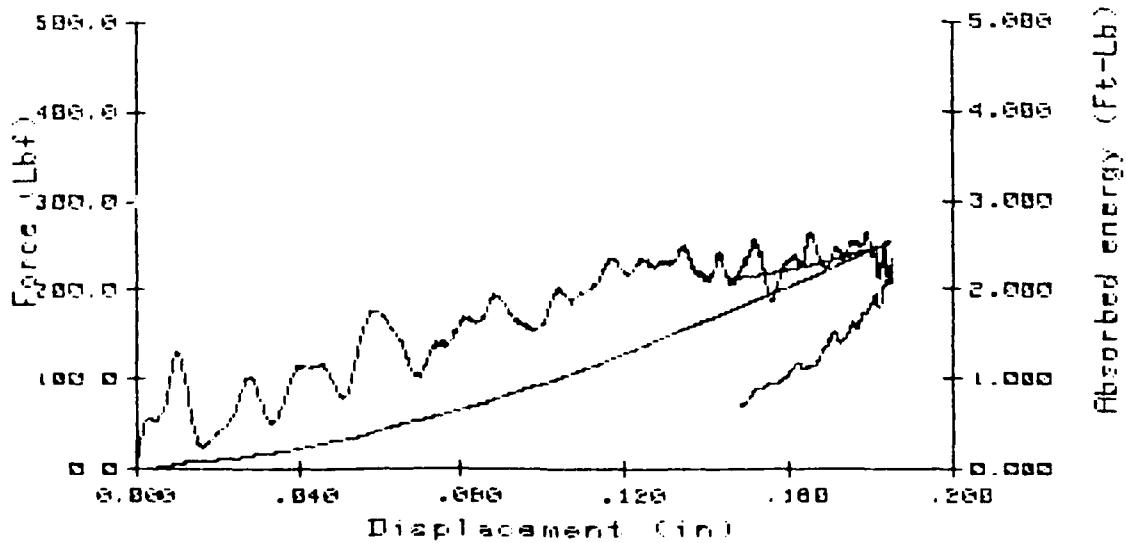
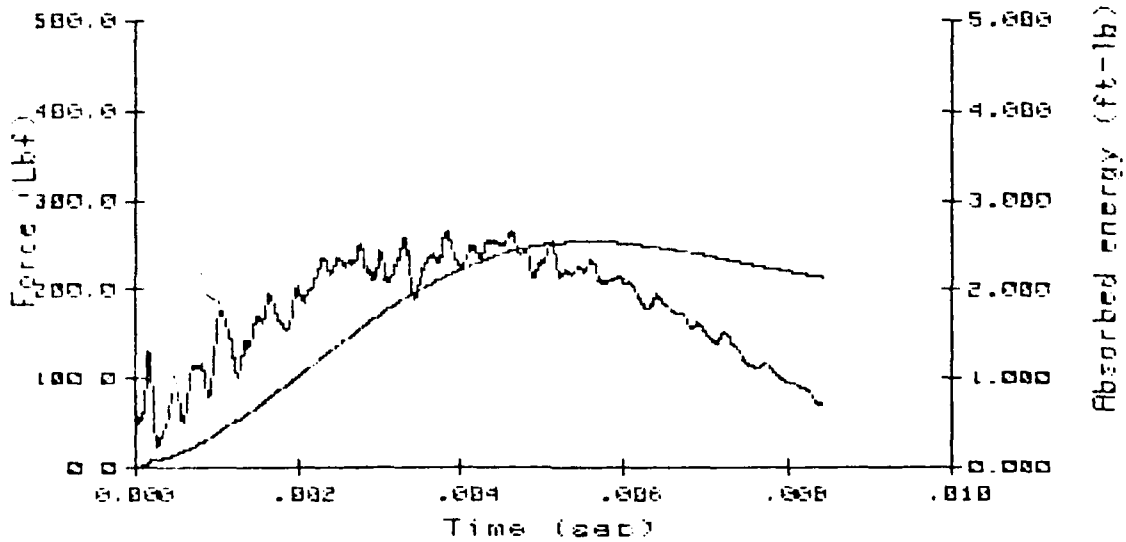


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 INSTRUMENTED IMPACT TEST
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A130 GR/BMI #4

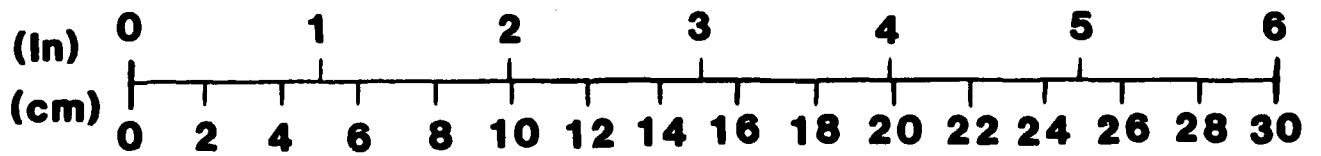
Drop weight = 7.00Lb Data disk MAT00707
 Tip radius = .500in DRM scale .2Kn/Div
 Temperature = 74.0 F Flag grid= .040in
 V0 = 4.73ft/s
 K.E. = 2.43ft-Lb Vf(calc) = -1.87ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
177.1	1.078E-3	.42	.0595	Initial damage
265.3	3.818E-3	2.14	.1653	Maximum force
232.0	5.593E-3	2.54	.1850	Maximum energy
232.0	5.593E-3	2.54	.1850	Maximum displacement
71.9	8.412E-3	2.14	.1478	Final values



A 130 GR/BMI

#4



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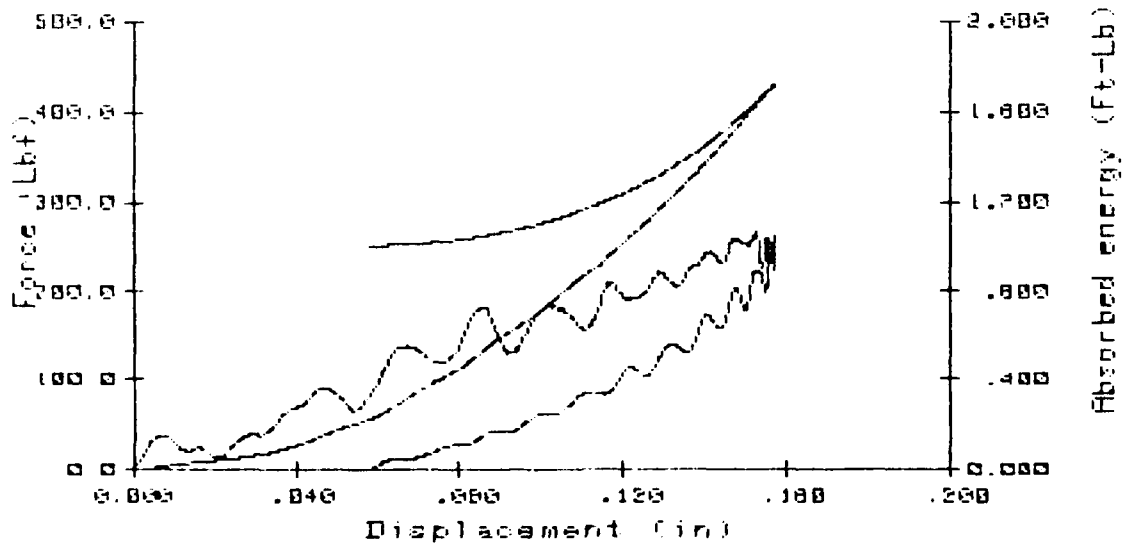
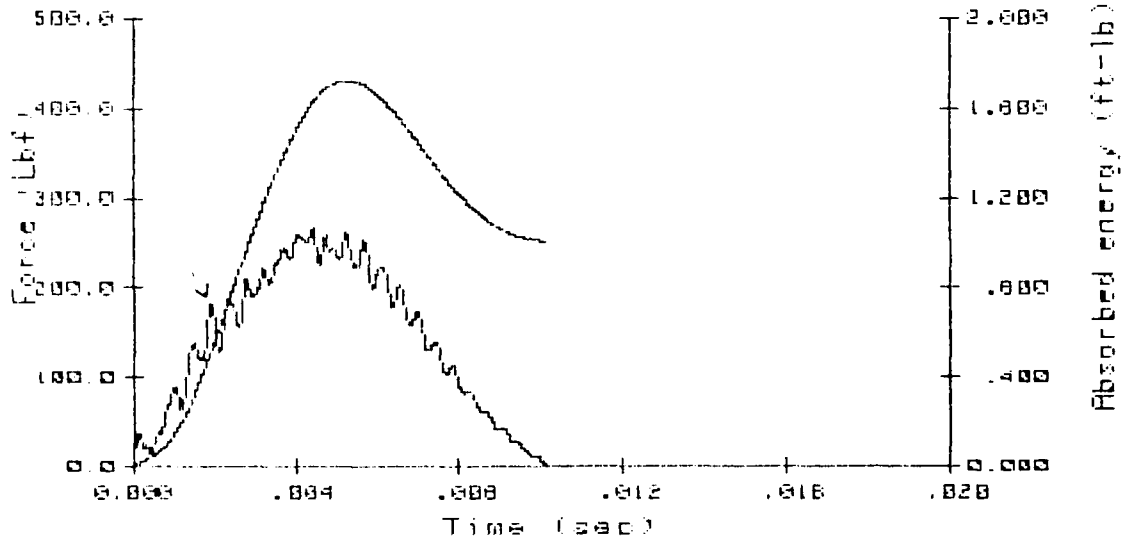
INSTRUMENTED IMPACT TEST

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A130 GR/BMI #5

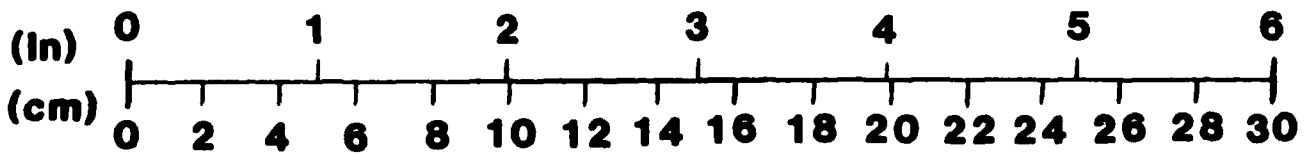
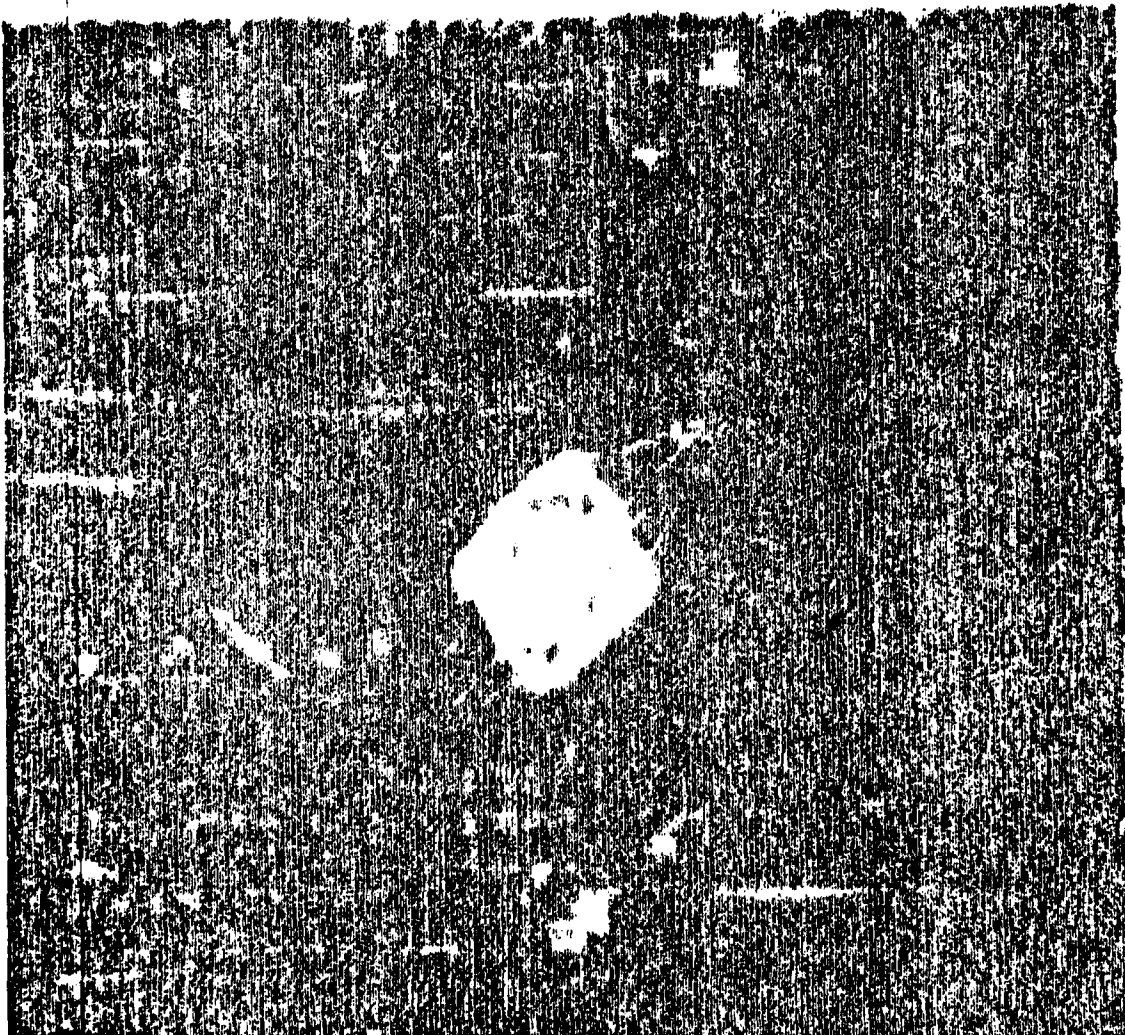
Drop weight	=	7.00Lb	Data disk	MAT00903
Tip radius	=	.500in	DRM scale	.2Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	3.88ft/s	abs(Vf)	3.00ft/s
K.E.	=	1.63ft-Lb	Vf(calc)	-2.46ft/s

Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
182.4	1.935E-3	.54	.0861	Initial damage
266.9	4.465E-3	1.63	.1526	Maximum force
249.6	5.295E-3	1.72	.1572	Maximum energy
249.6	5.295E-3	1.72	.1572	Maximum displacement
1.3	1.011E-2	1.01	.0582	Final values



A 130 GR/BMI

#5

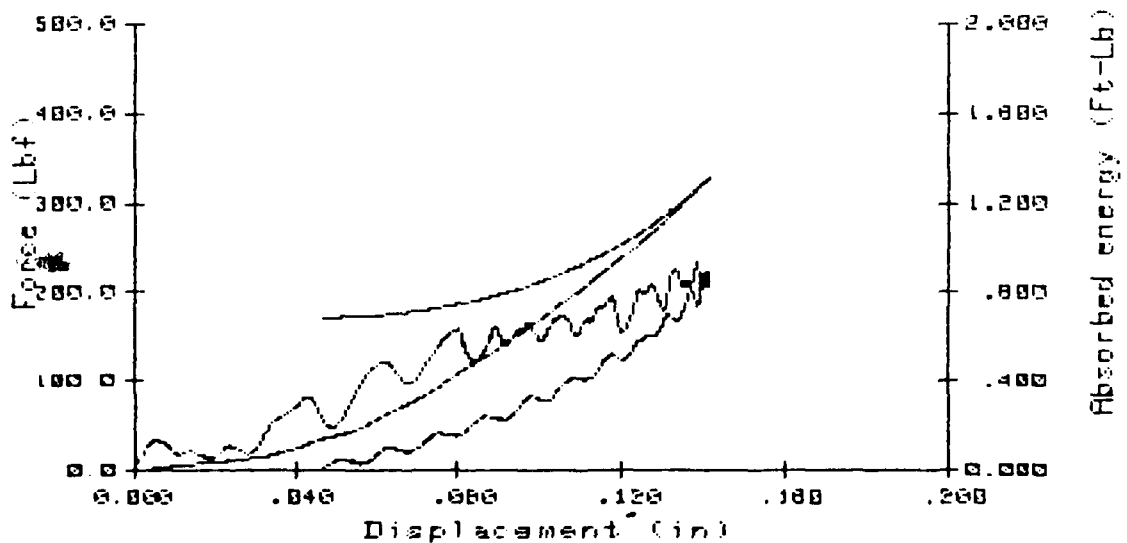
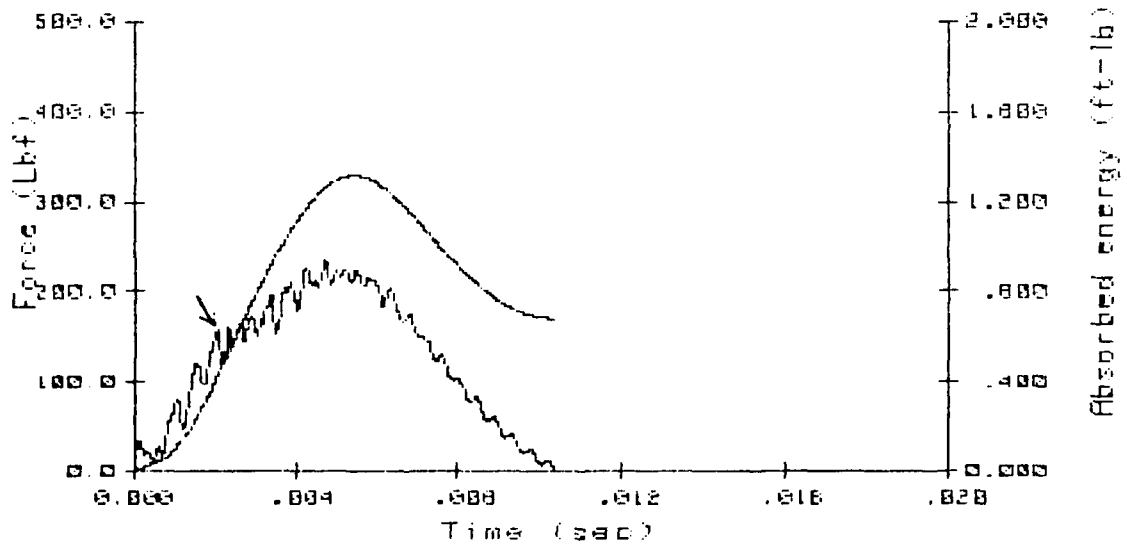


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 INSTRUMENTED IMPACT TEST
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A130 GR/BMI #6

Drop weight	=	7.00Lb	Data disk	MAT01003
Tip radius	=	.500in	DRM scale	.2Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	3.37ft/s	abs(Vf) =	2.73ft/s
K.E.	=	1.23ft-Lb	Vf(calc) =	-2.30ft/s

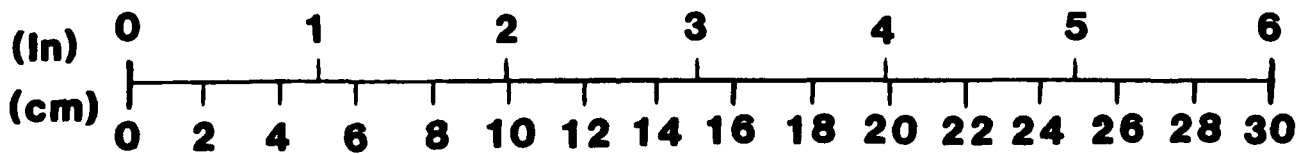
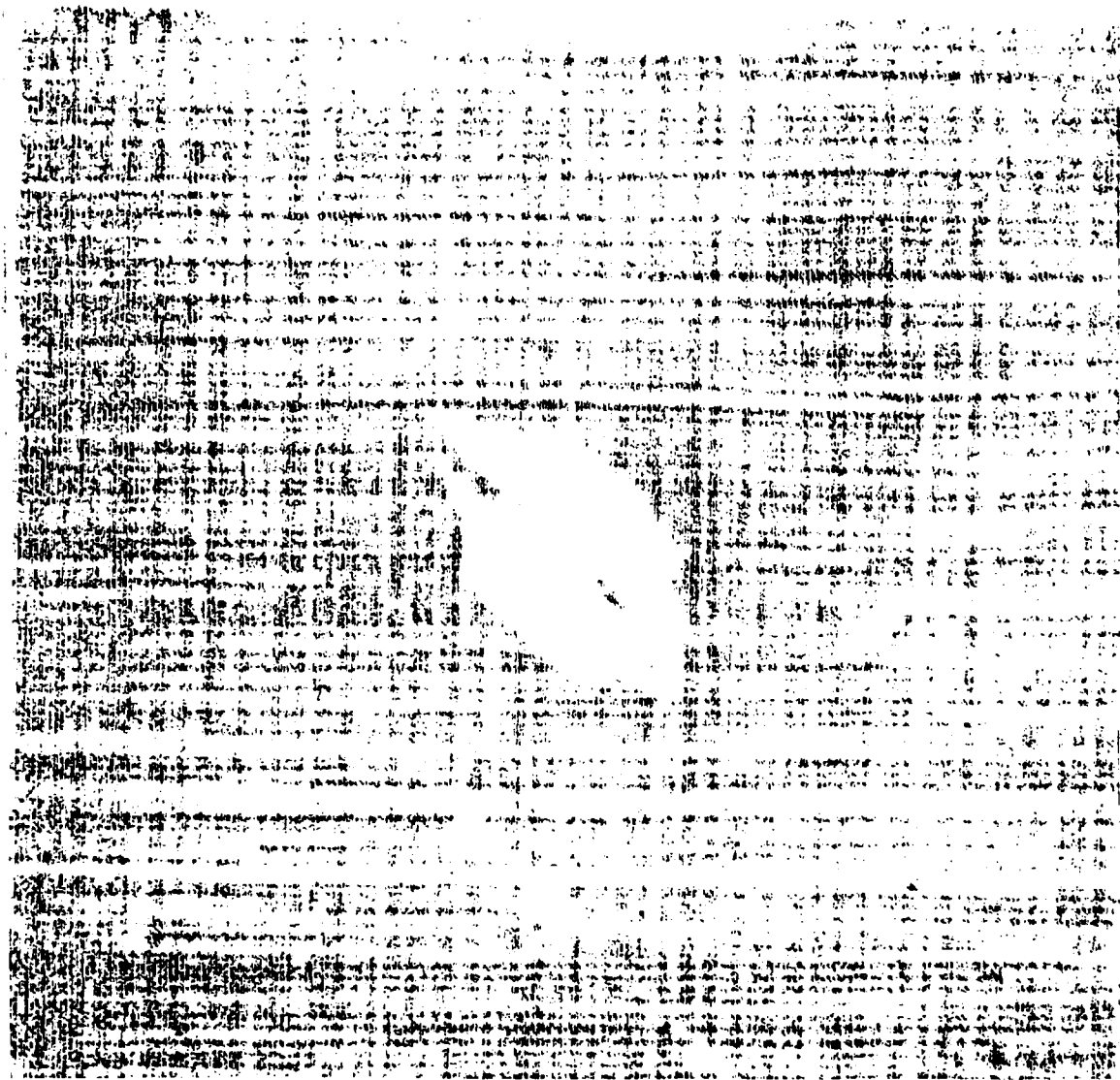
Load(Lb)	Time(s)	EO(Ft-Lb)	Disp(in)	
159.2	2.075E-3	.43	.0801	Initial damage
234.7	4.715E-3	1.26	.1383	Maximum force
218.5	5.445E-3	1.31	.1414	Maximum energy
218.5	5.445E-3	1.31	.1414	Maximum displacement
4.0	1.037E-2	.68	.0470	Final values



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A130 GR/BMI

#6



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HX-1516

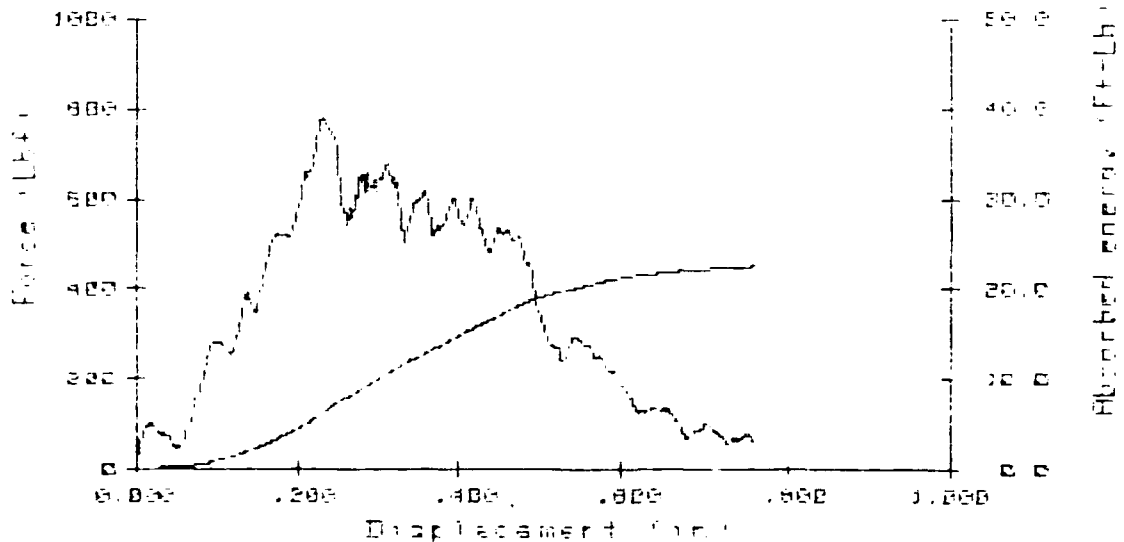
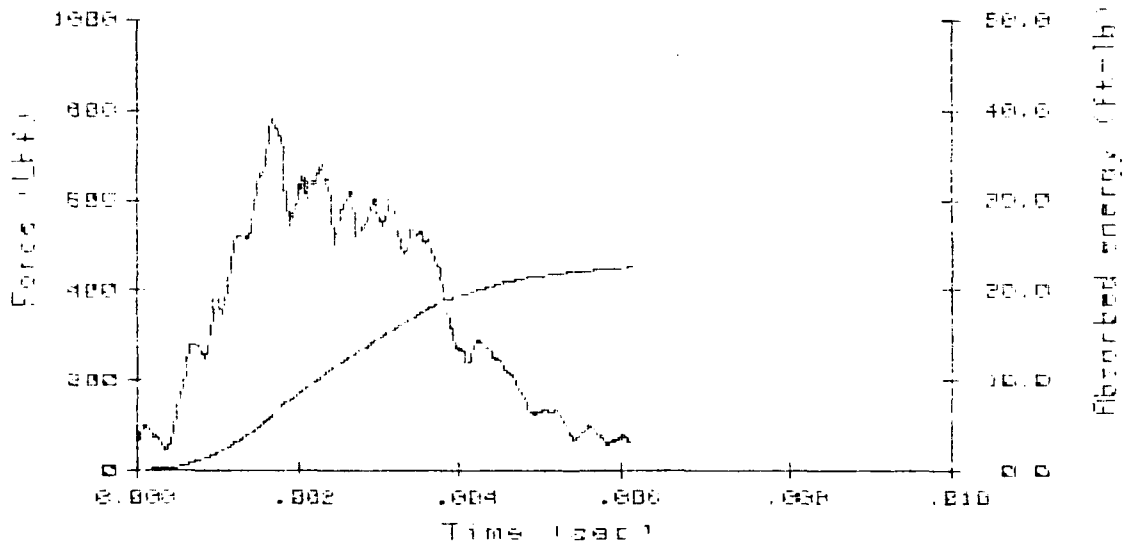
A-122

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INSTRUMENTED IMPACT TEST
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HX1516 #1

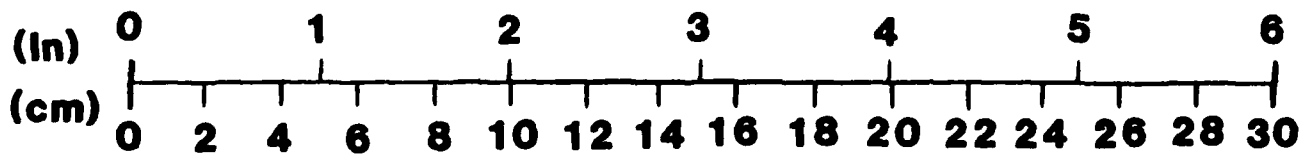
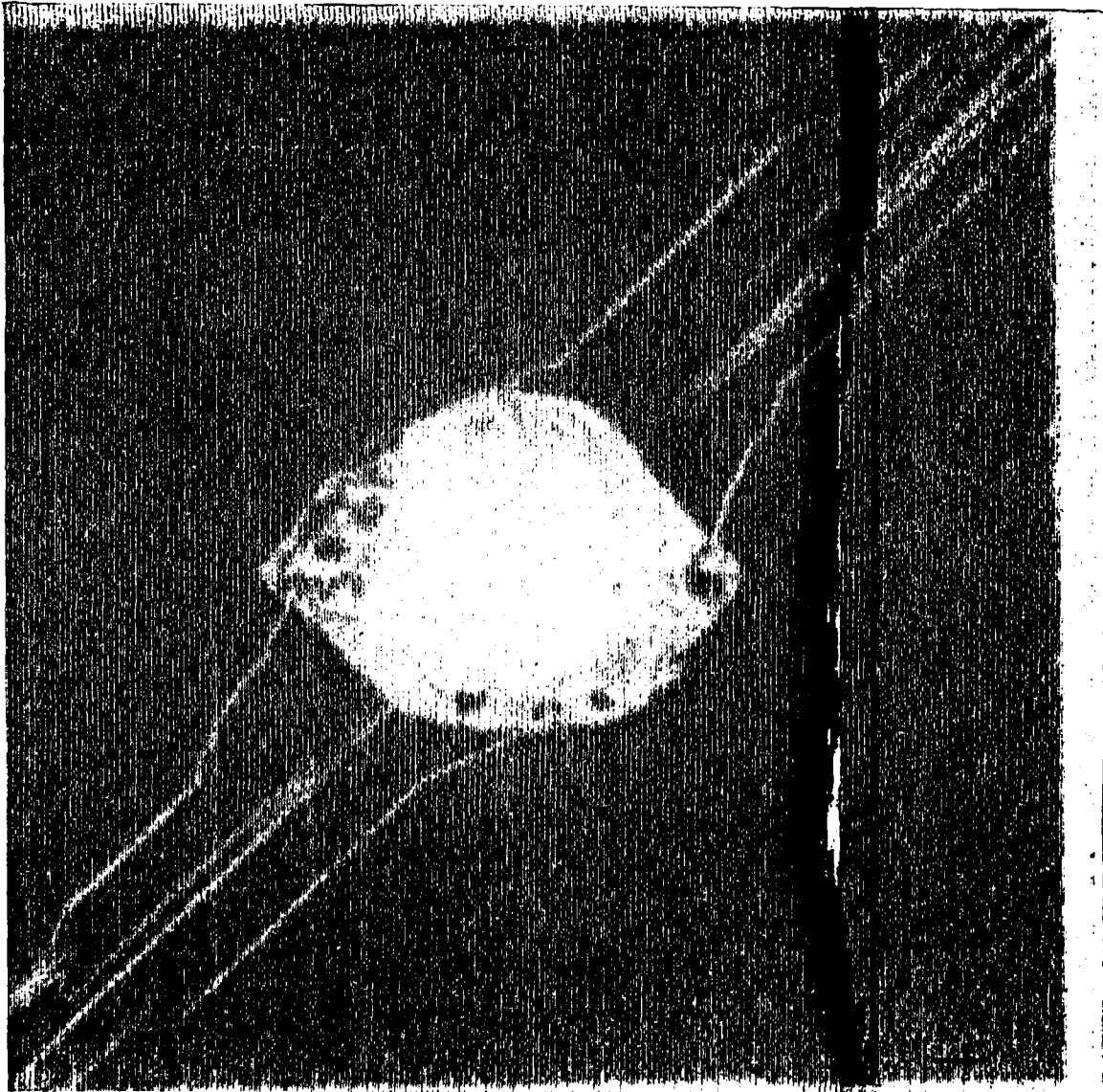
Drop weight	=	31.36Lb	Data disk	MAT01202
Tip radius	=	.500in	DRM scale	.8Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	11.49ft/s	abs(Vf)	9.01ft/s
K.E.	=	64.34ft-Lb	Vf(calc)	9.48ft/s

Load(Lb)	Time(s)	EO(Ft-Lb)	Disp(in)	
780.5	1.695E-3	6.26	.2527	Maximum force
66.5	6.125E-3	22.53	.7618	Maximum energy
66.5	6.125E-3	22.53	.7618	Maximum displacement
66.5	6.125E-3	22.53	.7618	Final values



HX/1516

#1

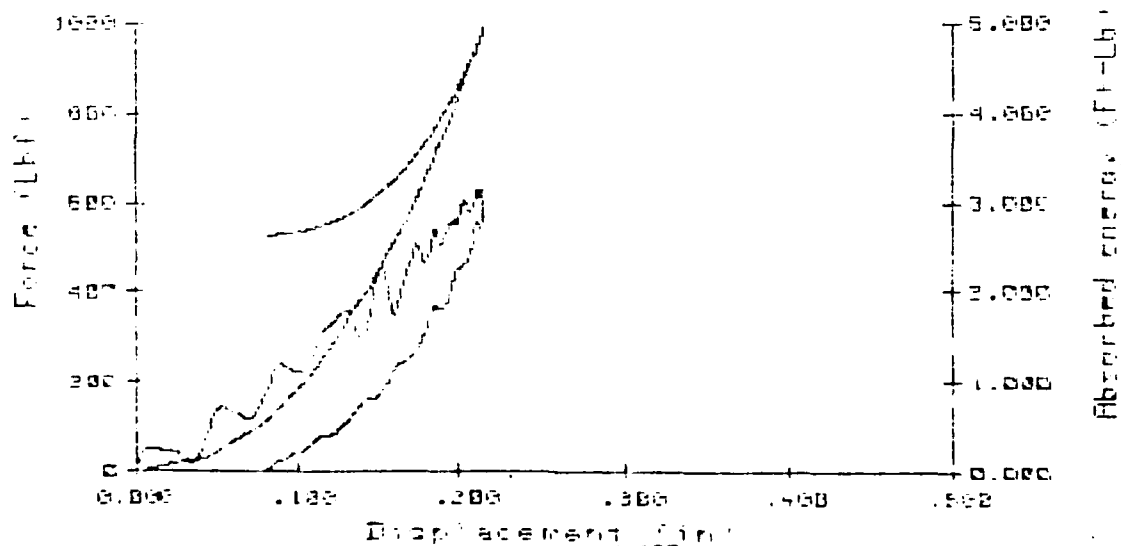
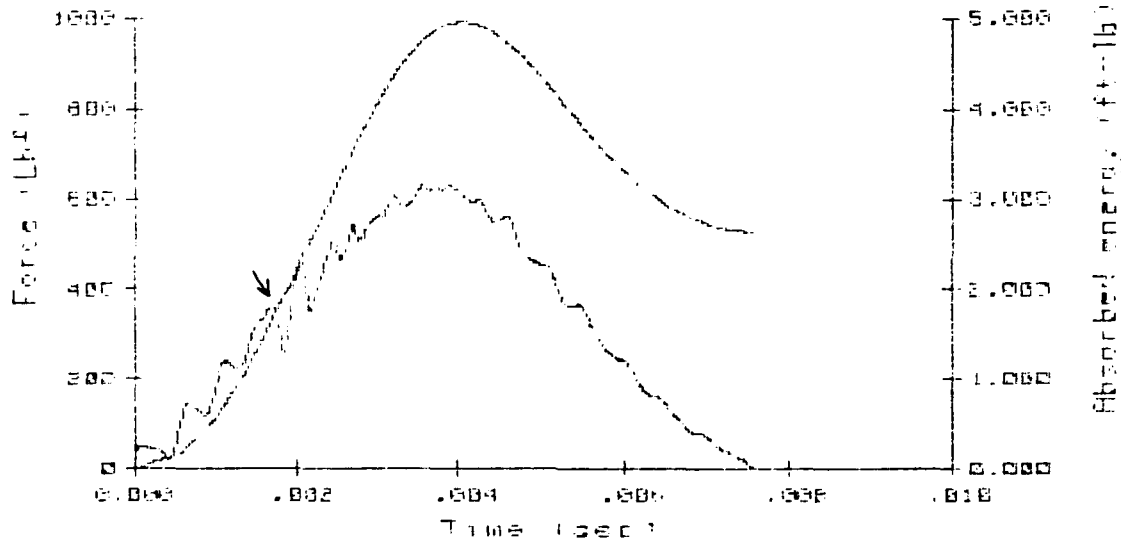


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 INSTRUMENTED IMPACT TEST
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HX1516 #2

Drop weight	=	7.00Lb	Data disk	MAT01203
Tip radius	=	.500in	DRM scale	.4Kn/Div
Temperature	=	74.0 F	Flag grid=	.040in
V0	=	6.67ft/s	abs(Vf) =	5.85ft/s
K.E.	=	4.83ft-Lb	Vf(calc) =	-4.55ft/s

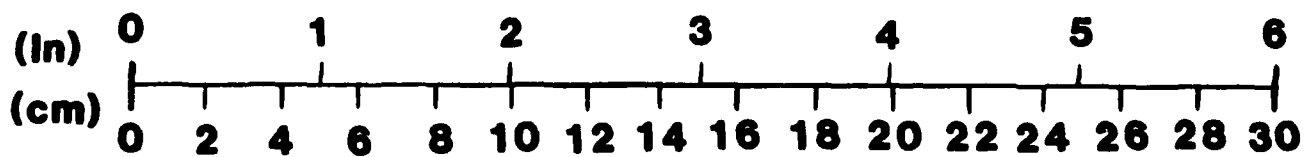
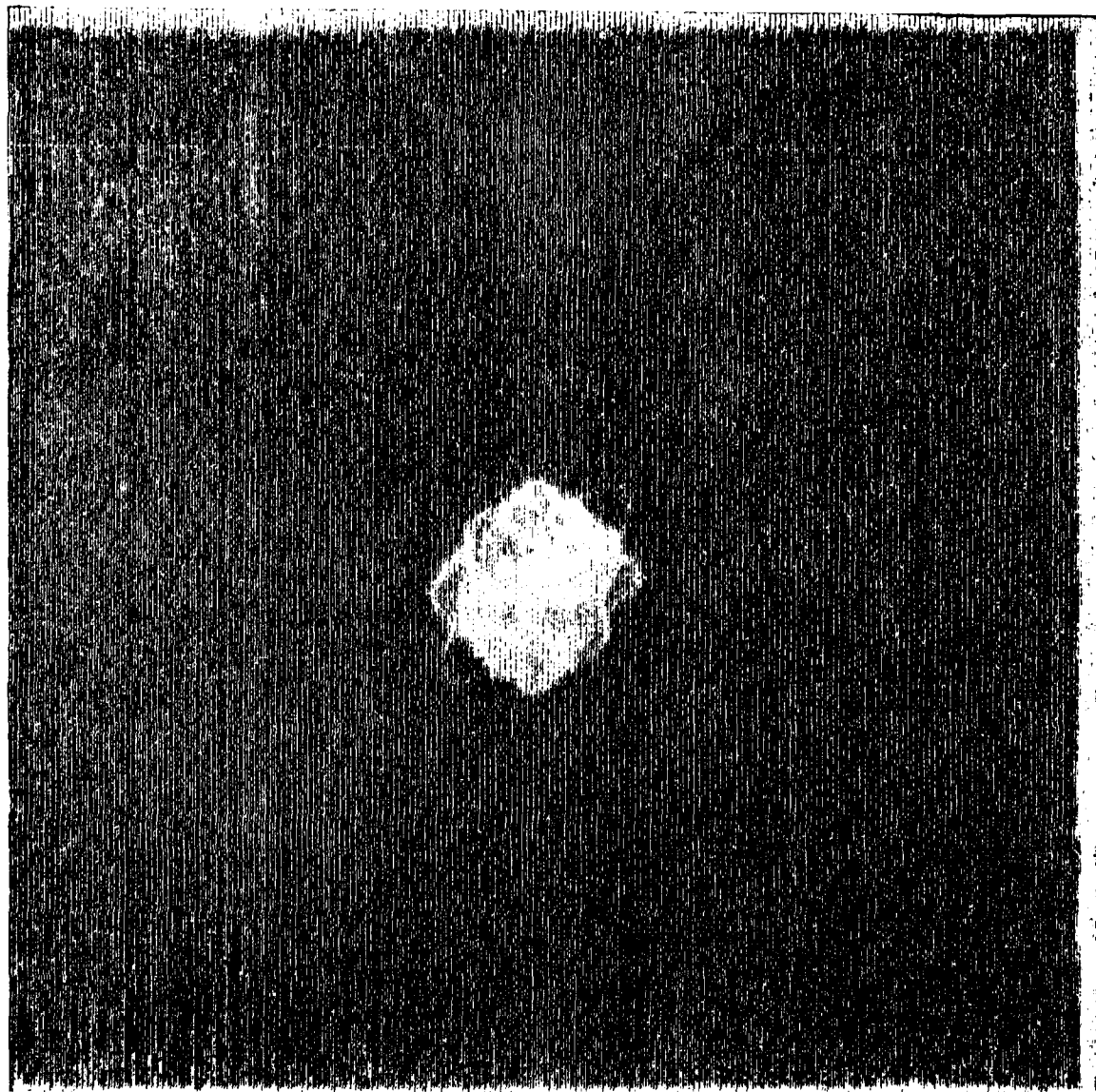
Load(Lb)	Time(s)	E0(Ft-Lb)	Disp(in)	
358.8	1.705E-3	1.65	.1299	Initial damage
632.2	3.565E-3	4.76	.2111	Maximum force
609.7	4.045E-3	4.96	.2149	Maximum energy
609.7	4.045E-3	4.96	.2149	Maximum displacement
7.2	7.545E-3	2.63	.0920	Final values



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HX/1516

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