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FINAL REPORT
FEBRUARY 1992

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REPORT NO. 92-03

RAIL IMPACT TESTS OF
MINIMUM DUNNAGE FOR
120MM PALLETS IN 20-FOOT
MILITARY VANS (MILVANS)

92-31017



3788

Prepared for:
U.S. Army Defense Ammunition
Center and School
ATTN: SMCAC-DE
Savanna, IL 61074-9639

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CENTER AND SCHOOL

VALIDATION ENGINEERING DIVISION
SAVANNA, ILLINOIS 61074-9639

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**U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
VALIDATION ENGINEERING DIVISION
SAVANNA, IL 61074-9639**

REPORT NO. 92-03

**RAIL IMPACT TESTS OF MINIMUM
DUNNAGE FOR 120MM PALLETS IN 20-FOOT
MILITARY VANS (MILVANS)**

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PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Logistics Engineering Office (SMCAC-DE), to verify rail transportation of 120mm tank ammunition in Military Vans (MILVANS). Tests were conducted following dunnage failures during rail movement of an untested blocking and bracing procedure authorized by the Transportation Engineering Division (SMCAC-DET). These failures occurred during blocking and bracing against the MILVAN doors on ammunition returning from Saudi Arabia (SA).

B. AUTHORITY. This program was conducted IAW mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL.

C. OBJECTIVE. The objective of this test is to verify if blocking and bracing procedures with authorized deviations to normal procedures are acceptable for the safe transportation of retrograde 120mm tank ammunition from SA.

D. CONCLUSION. The two blocking and bracing procedures tested with loading against the MILVAN doors failed prior to completing the tests. One design was loaded horizontally across the doors and at the center, with the other design loading vertically on the door edges opposite the hinges. As tested, the MILVAN doors and component parts were not strong enough to retain the load without MILVAN damage. Therefore, these procedures are not adequate for safe railroad shipment of 120mm tank ammunition in MILVANS.

E. RECOMMENDATION. Current procedures for reduced dunnage and loading against the MILVAN doors be terminated.

PART 2

22-23 OCTOBER 1991

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PART 3

TEST PROCEDURES

The test procedures outlined herein were extracted from TP-91-01, Transportability Testing Procedures, July 1991.

A. **MILVAN Load Preparation.** The MILVAN was loaded with 10 metal pallets of 120mm tank ammunition and blocked and braced in the same manner as authorized deviations to normal blocking and bracing procedures. The weight and physical characteristics of the load configuration were identical to the live (explosive) ammunition provided for in the outloading procedure; i.e., weights, physical dimensions, center of gravity, materials, etc. The ammunition packages used duplicated that of the live ammunition. When failures occurred during any part of testing, modifications were made to the load and/or blocking and bracing procedures and were entirely retested.

B. **Rail Impact Test.** The MILVAN was loaded onto a Trailer-on-flatcar (TOFC) and twist locked at each corner to the railcar. Equipment needed to perform the test included the specimen (hammer) car, five empty railroad cars connected together to serve as the anvil, and a railroad locomotive. These anvil cars were positioned on a level section of track with air and hand brakes set and with the draft gear compressed. The locomotive unit pulled the specimen car several hundred yards away from the anvil cars and, then, pushed the specimen car toward the anvil at a predetermined speed, then disconnected from the specimen car approximately 50 yards away from the anvil cars, which allowed the specimen car to roll freely along the track until it struck the anvil. This constituted an impact. Impacting was accomplished at speeds of 4, 6, and 8.1 mph in one direction and at a speed of 8.1 mph in the opposite direction. The 4 and 6 mph impact speeds were approximate; the 8.1 mph speed was a minimum. Impact speeds were determined by using an electronic counter to measure the time required for the specimen

traverse an 11-foot distance immediately prior to contact with the anvil cars (see figure 1). At the discretion of the test engineer, additional impacts at higher or lower speeds may be conducted on the specimen car for engineering test data after the conclusion of the four rail impacts have been conducted.

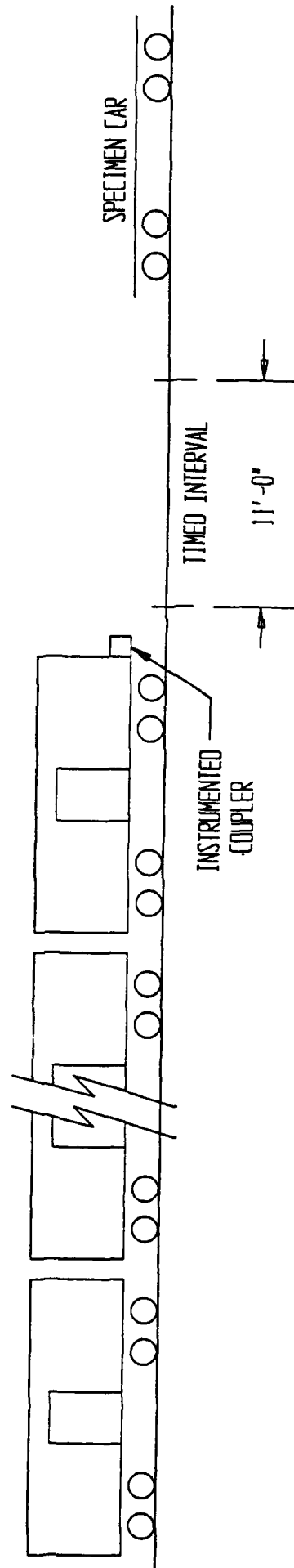
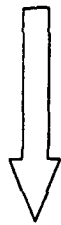
C. Data Collection. The specimen car was instrumented with accelerometers at the following locations as a minimum:

1. On the sill of the railcar.
2. At the top of the test load on one pallet.
3. At the bottom of the test load on one pallet.

After each rail impact, the recorded accelerations were downloaded to determine stresses, movement, forces, velocities, and accelerations during each impact. Data collected were suitable for use in investigating causes for failure and as a criteria for design when developing new procedures, if required.

D. Failure Criteria. At the conclusion of each impact, the load was examined for excessive shifting of contents, loosening or breaking of load restraints or blocking and bracing, or any visible damage to the items in the load or their packaging. Normally, testing will be stopped when it becomes apparent that the load will fail; however, the test may be continued until complete failure if the test engineer determines usable data will be developed and safety of personnel and equipment integrity are not violated.

ASSOCIATION OF AMERICAN RAILROADS (AAR) STANDARD TEST PLAN



SPECIMEN CAR
IS RELEASED BY
SWITCH ENGINE TO

5 BUFFER CARS (ANVIL) WITH DRAFT GEAR
COMPRESSED AND AIR BRAKES IN A SET
POSITION

ATTAIN: IMPACT NO. 1 @ 4 MPH
IMPACT NO. 2 @ 6 MPH
IMPACT NO. 3 @ 8.1 MPH

ANVIL CAR TOTAL WT 250,000 LBS (APPROX)

THEN THE CAR IS REVERSED AND
RELEASED BY SWITCH ENGINE TO
ATTAIN: IMPACT NO 4. @ 8.1 MPH

FIGURE 1

PART 4

TEST EQUIPMENT

A. 120mm Palletized Ammunition. (Test Samples)

- | | |
|--------------------|------------------------|
| 1. Drawing Number: | 19-48-4231/48-20PM1006 |
| 2. Width: | 40 1/8-inches |
| 3. Length: | 44 1/2-inches |
| 4. Height: | 51 3/4-inches |
| 5. Weight Empty: | 2,444 pounds |

B. MILVAN.

- | | |
|------------|--------------|
| 1. Width: | 8 feet |
| 2. Length: | 20 feet |
| 3. Height: | 8 feet |
| 4. Weight: | 5,785 pounds |

C. Railcar.

- | | |
|----------------|-------------------------|
| 1. Car Number: | TTWX 981502 |
| 2. Car Type: | TOFC |
| 3. Length: | 89 feet 4 inches |
| 4. Weight: | 10 feet (approximately) |
| 5. Draft Gear: | Friction |

D. Data Acquisition Equipment.

- | | |
|------------------------|--------------------|
| 1. Manufacturer: | Pacific Scientific |
| 2. Number of channels: | 3 |

PART 5

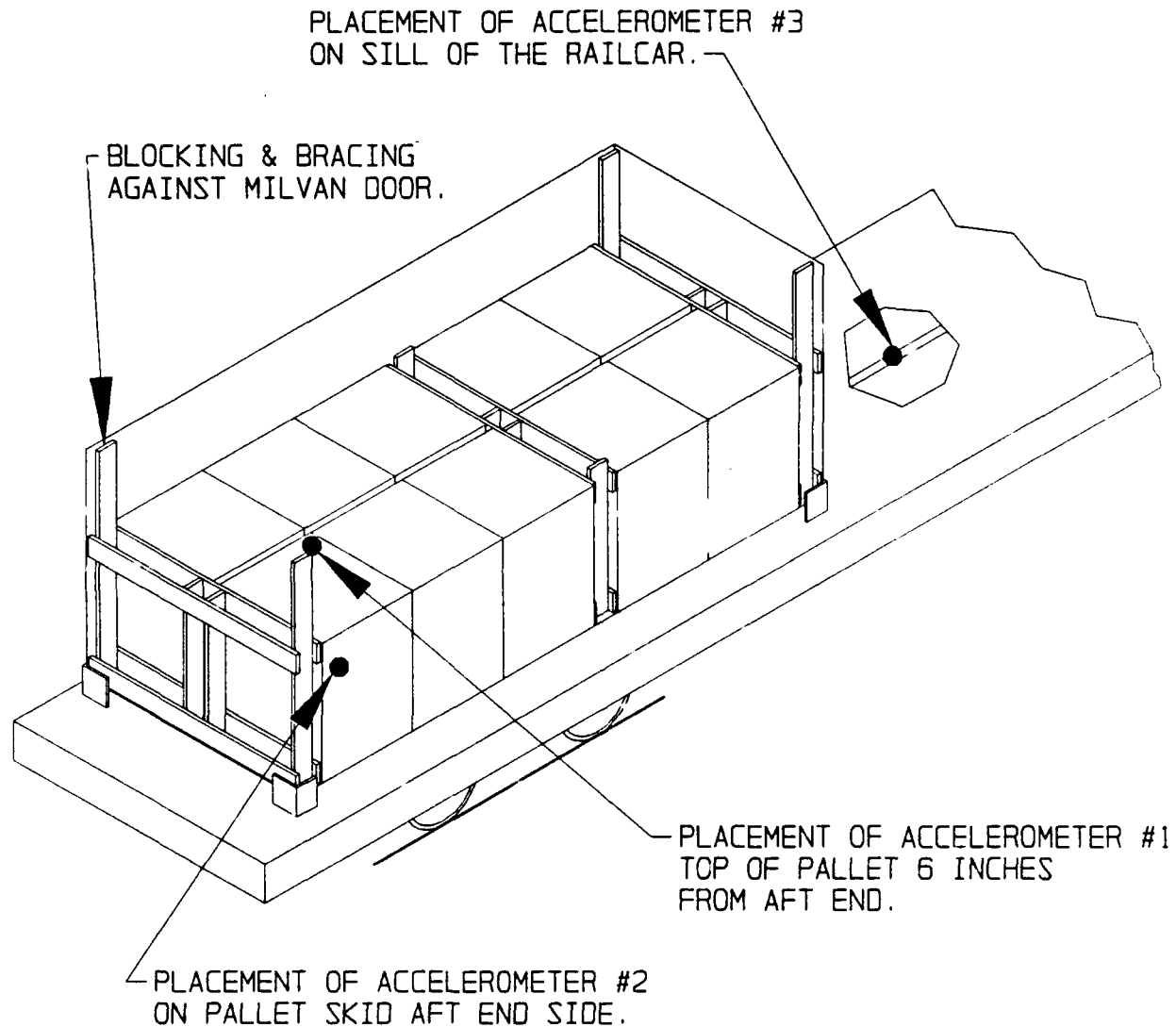
TEST RESULTS

Two separate blocking and bracing procedures were tested during this series of tests, with both procedures loaded against the MILVAN doors.

Procedure No. 1. The load was blocked and braced horizontally across and vertically at the center of the MILVAN doors (see drawing no. 1 for details). The first impact was at 4.46 mph with no damage occurring. The second impact at 6.41 mph caused the doors to bow outward at the center approximately 1 inch (see photos nos. 1 and 2). This test was terminated to avoid permanent deformation to the MILVAN. Accelerations experienced during this test are in part 7 of this report.

Procedure No. 2. The load was blocked and braced using a box beam across the palletized load which transmitted all load forces vertically to the MILVAN door hinges (see drawing no. 2 for details). Impact no. 1 was conducted at 4.6 mph with slight deformation to the doors at the bottom corners, below the hinges. After this impact, the door corners were shifted outward approximately 1 inch. Impact no. 2 was conducted at 6.41 mph with the door bottom corners now shifted outward approximately 2 inches. After this impact clear permanent deformation was apparent to the lower door corners and hinges. This damage was in line with the lower box beam. The upper beam appeared to have no adverse effect on the middle of the door or hinges. This test was also terminated prior to any additional deformation to the MILVAN (see photos nos. 3 - 6). Accelerations experienced during this test can be found in part 7 of this report.

RAIL TEST OF 120MM PALLETS IN 20-FOOT END-OPENING MILVAN



NOTES:

1. RAILCAR 89'-4" LONG BY 9'-2" WIDE

FOR INFORMATION ONLY

TITLE

TEST #1 WITH AUTHORIZED
MODIFICATIONS TO
APPROVED PROCEDURES

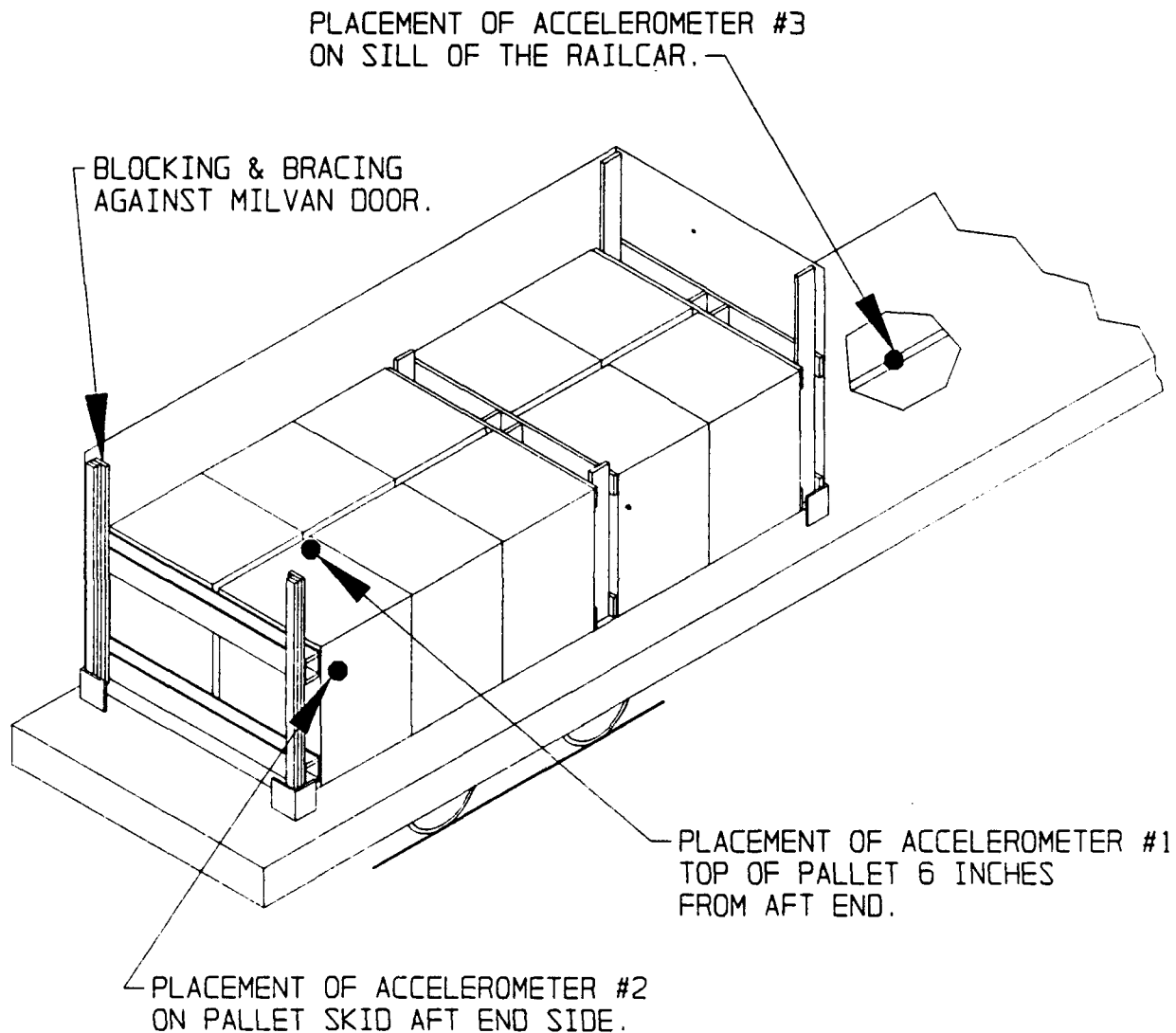
DWG NO

92-003-0-T00049

VALIDATION ENGINEERING DIVISION

SHEET

RAIL TEST OF 120MM PALLETS IN 20-FOOT END-OPENING MILVAN



NOTES:

1. RAILCAR 89'-4" LONG BY 9'-2" WIDE

FOR INFORMATION ONLY

TITLE

TEST #2 ALTERNATIVE
PROPOSED BLOCKING
PROCEDURE

DWG NO

92-003-0-T00050

VALIDATION ENGINEERING DIVISION

SHEET

PART 6

PHOTOGRAPHS



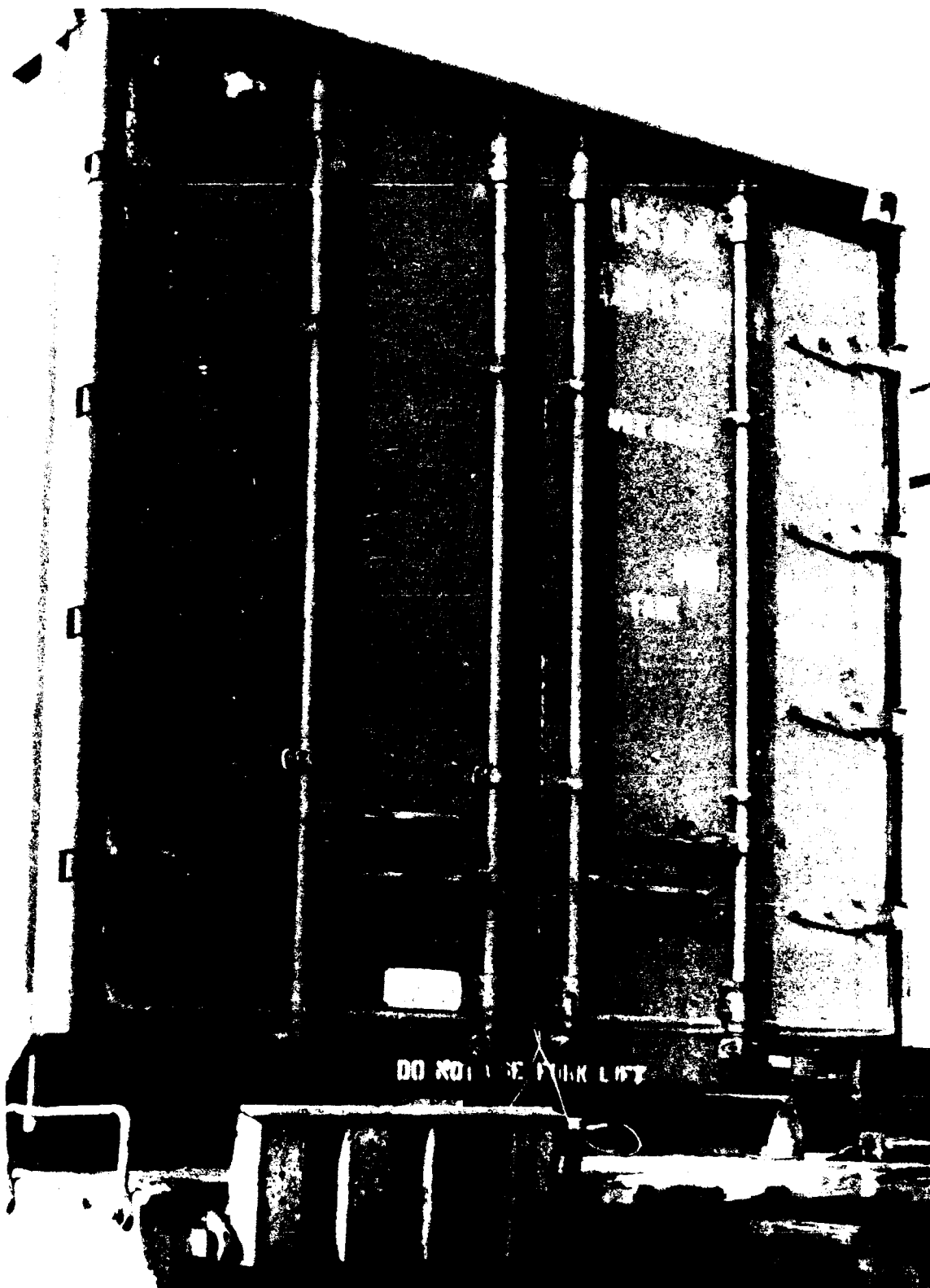
	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
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Photo No. AO317-SPN-92-18-524. This photo shows blocking and bracing procedure no. 1 after the second rail impact test. Note, center of doors bowed outward.



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Photo No. AO317-SPN-92-18-523. This photo shows blocking and bracing procedure no. 1. Note, the top of the doors bowed out after the second rail impact test.
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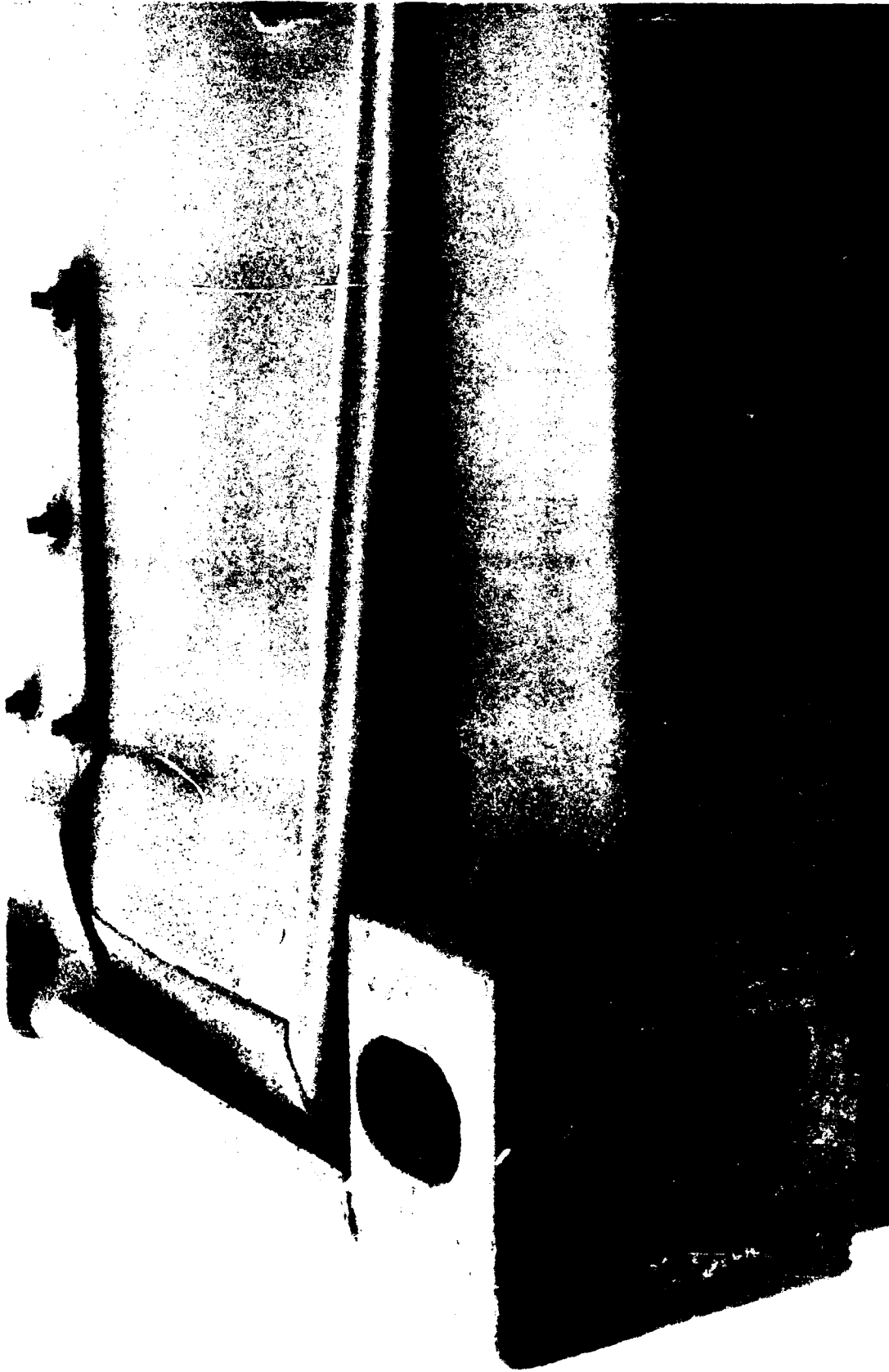
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Photo No. AO317-SPN-92-18-538. This photo shows blocking and bracing procedure no. 2, the overall view of MILVAN doors after the second rail impact test. Note, permanent deformation to the corner of the doors and hinges.



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
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Photo No. AO317-SPN-92-18-534. This photo shows blocking and bracing procedure no. 2. Shown is a closeup view of permanent deformation to the corner of the door and hinges.



U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. AC317-SPN-92-40-554. This photo shows blocking and bracing procedure no. 2. Shown is permanent deformation to the door. Note, exposure of wooden dunnage.



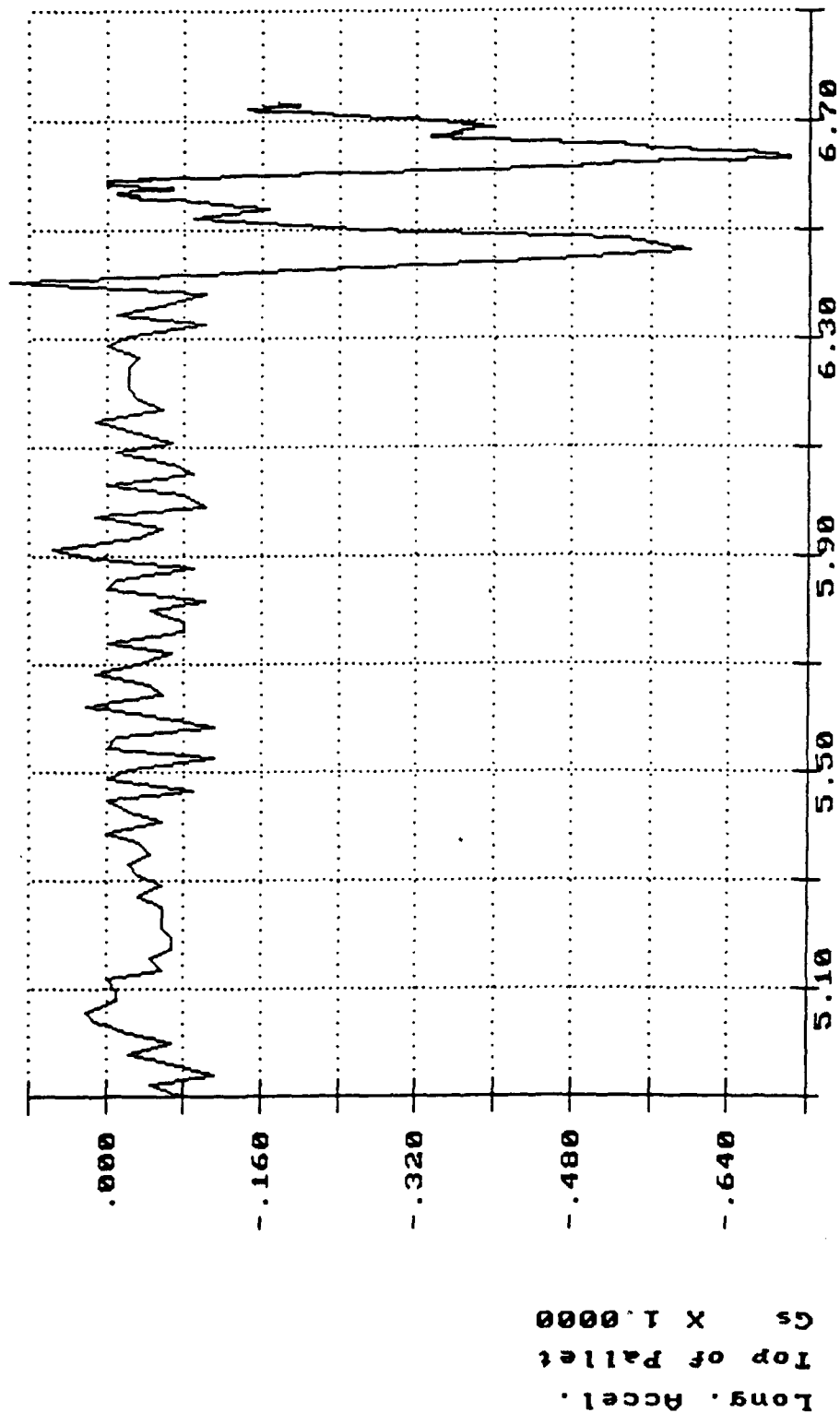
	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
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Photo No. AO317-SPN-92-40-557. This photo shows blocking and bracing procedure no. 2. Note, wooden dunnage extending beyond the door's threshold as well as permanent deformation of the door around the lower hinge.

PART 7

GRAPHS

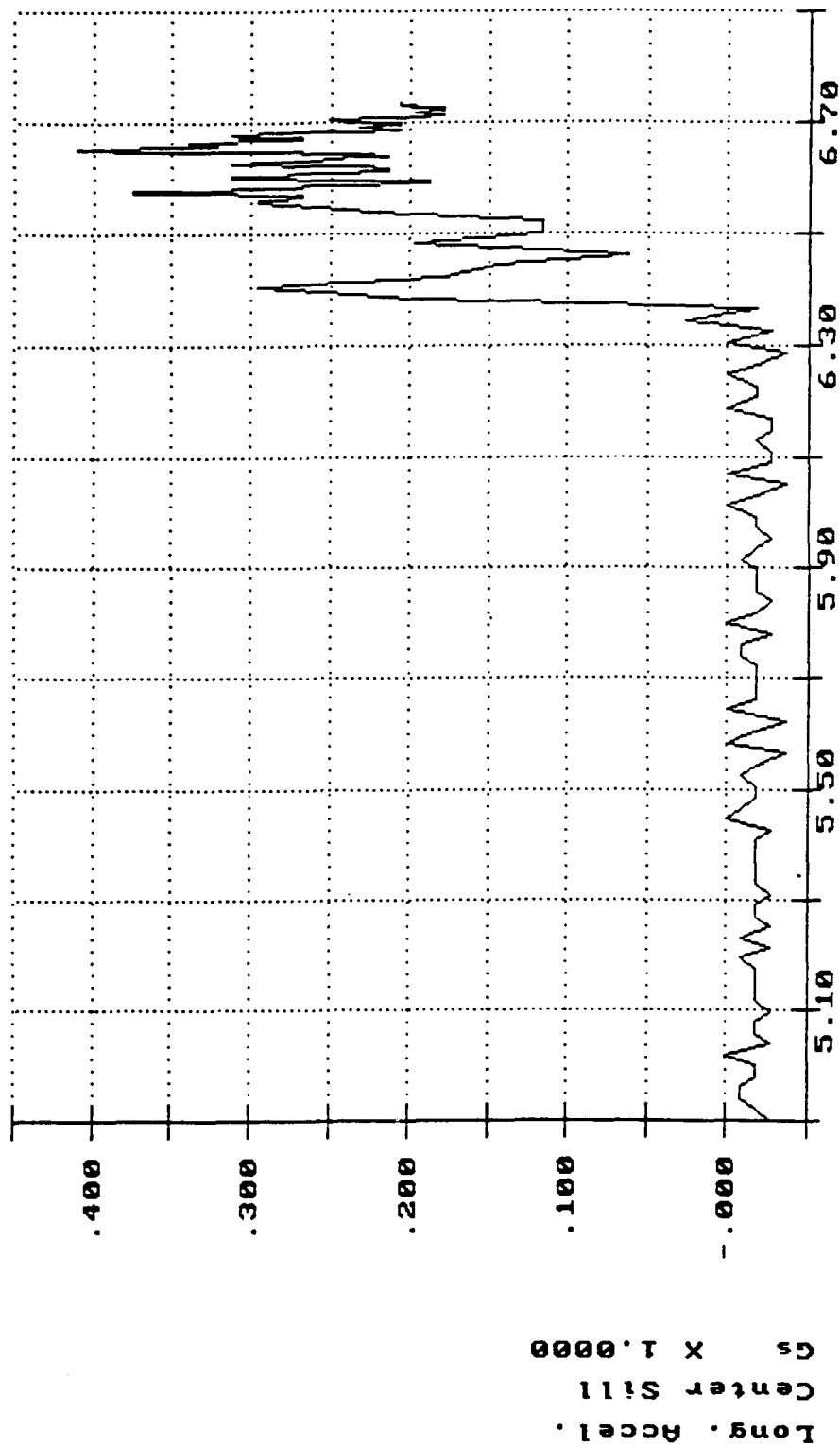
R.I. of 120mm Pallet, Impact 1: 4.46 MPH Oct 22 14:12:12 1991



Time of Sample

Seconds X 1.0000

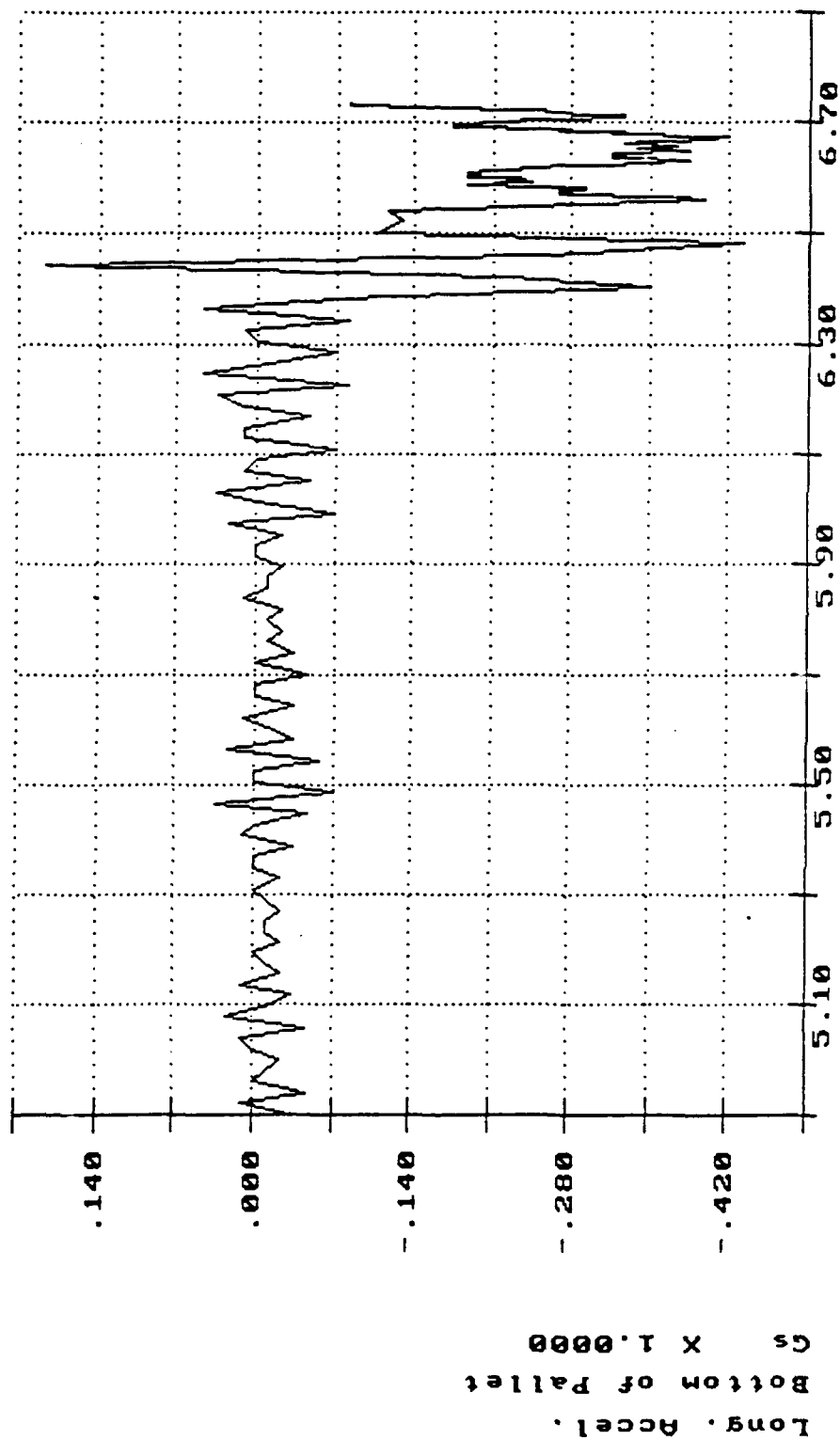
R.I. of 120mm Pallet, Impact 1: 4.46 MPH Oct 22 14:12:12 1991



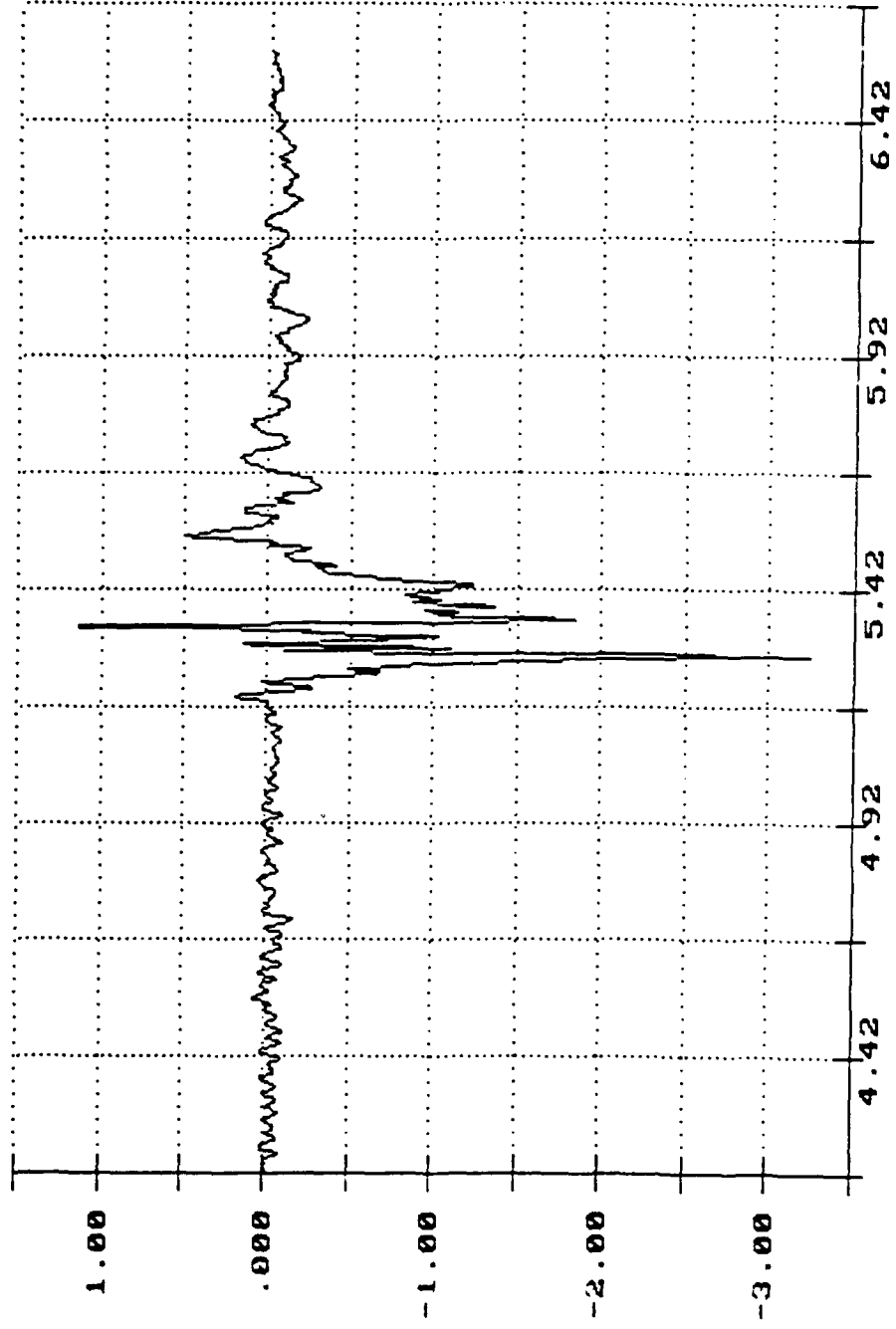
Time of Sample

Seconds X 1.0000

R.I. of 120mm Pallet, Impact 1: 4.46 MPH Oct 22 14:12:12 1991



R.I. of 120mm Pallet, Impact 2: 6.41 MPH Oct 22 14:22:24 1991

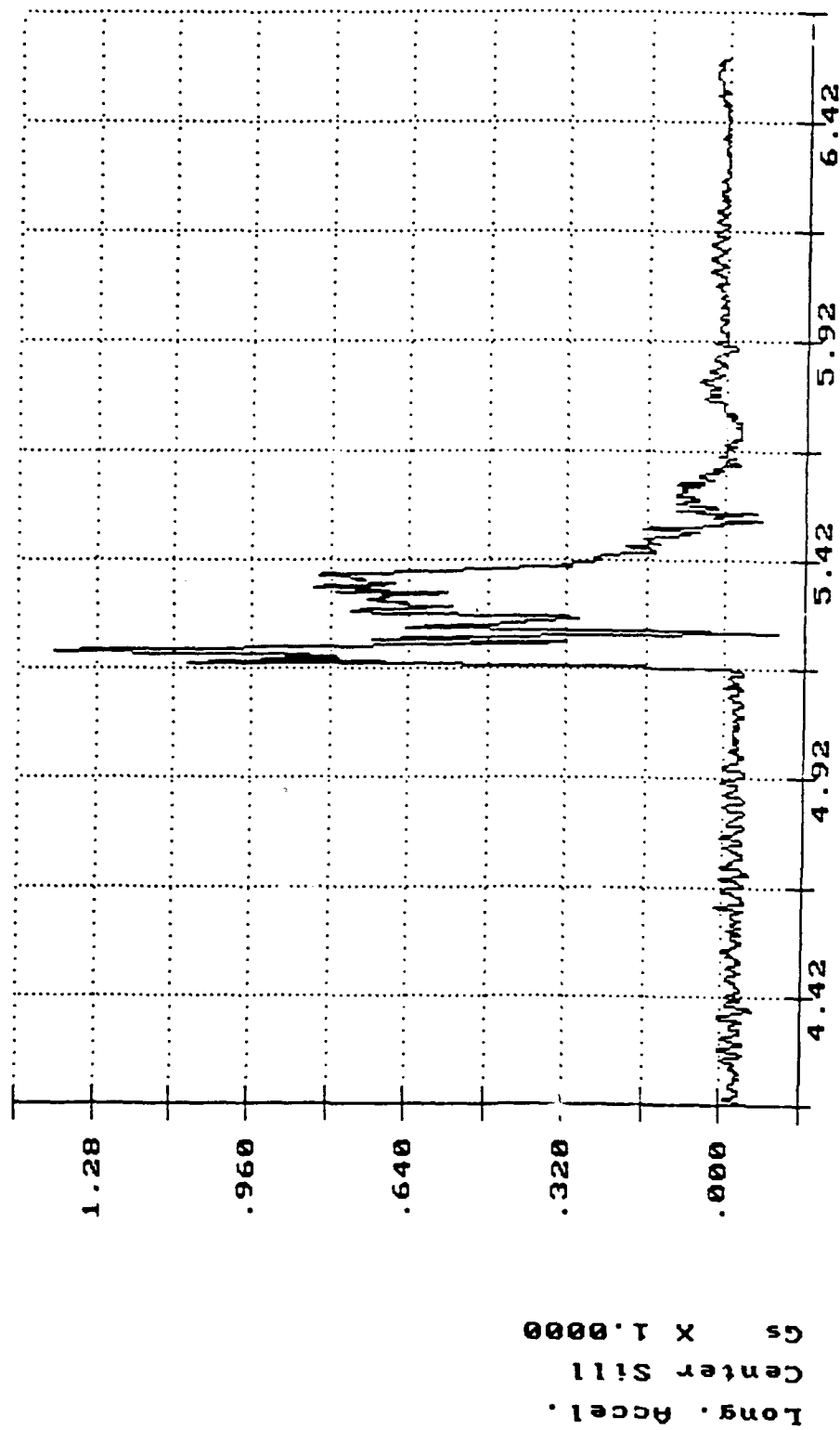


Long. Accel.
Top of Pallet
Gs X 1.0000

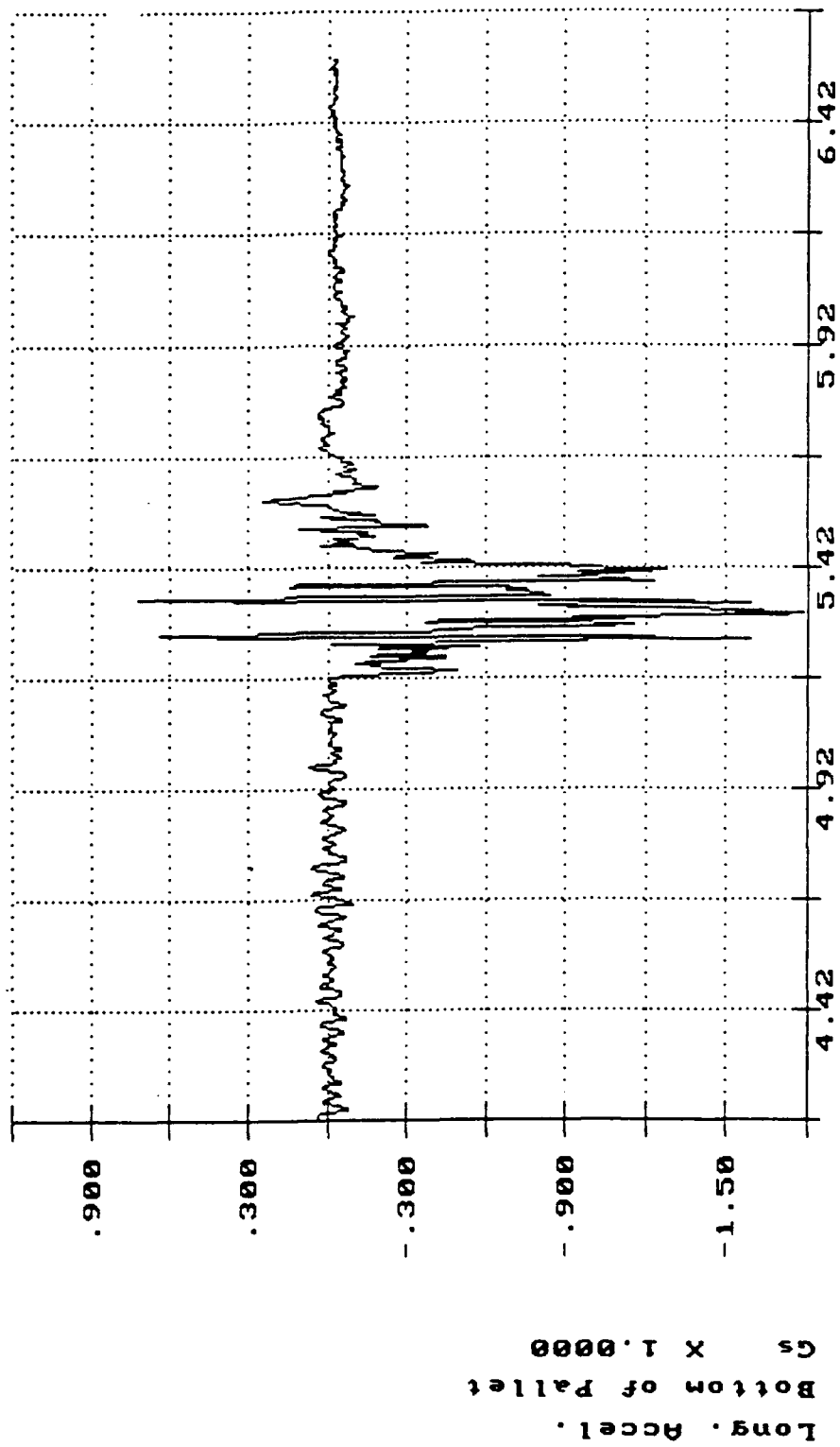
Time of Sample

Seconds X 1.0000

R.I. of 120mm Pallet, Impact 2: 6.41 MPH Oct 22 14:22:24 1991



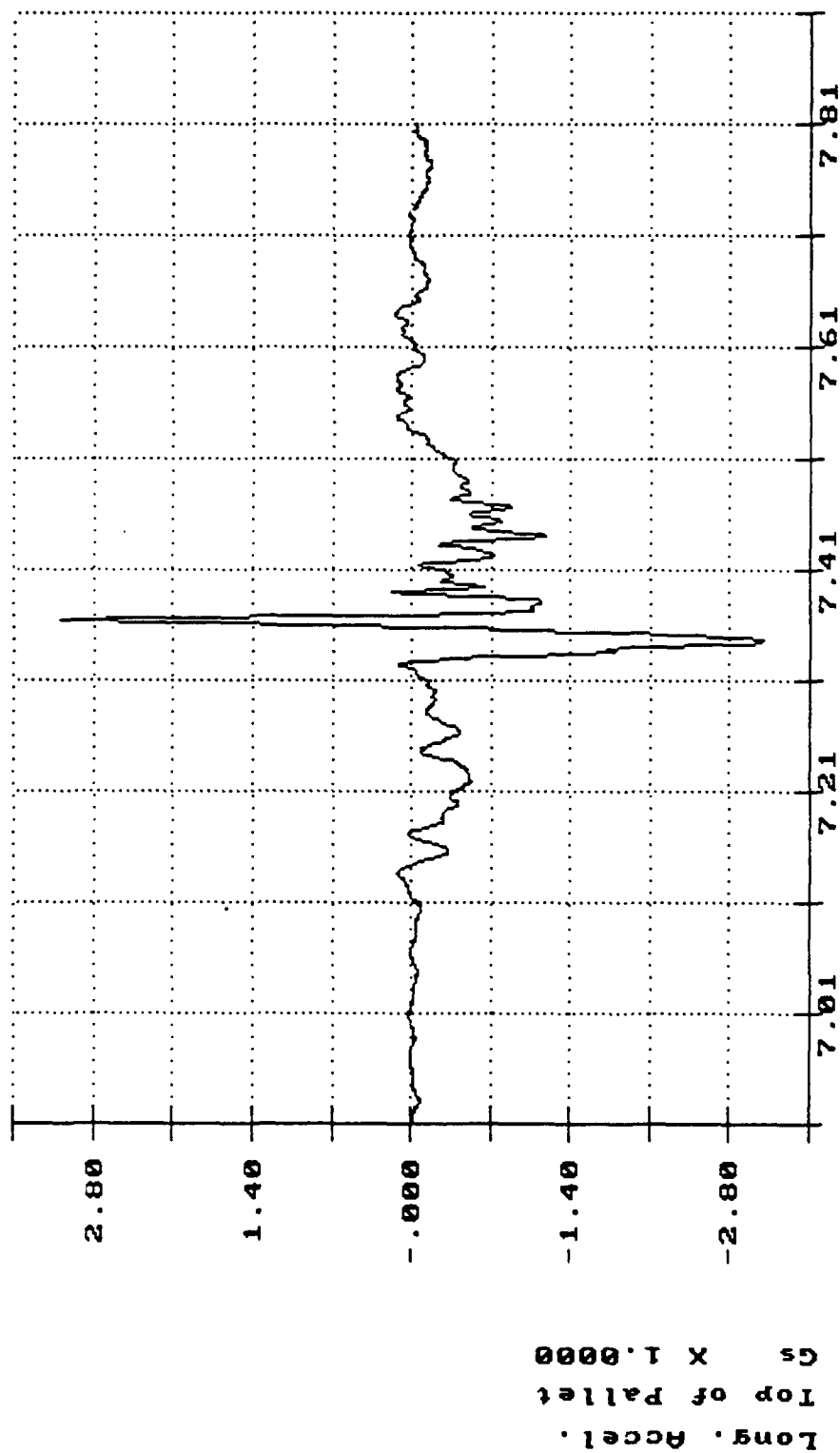
R.I. of 120mm Pallet, Impact 2: 6.41 MPH Oct 22 14:22:24 1991



Time of Sample

Seconds X 1.0000

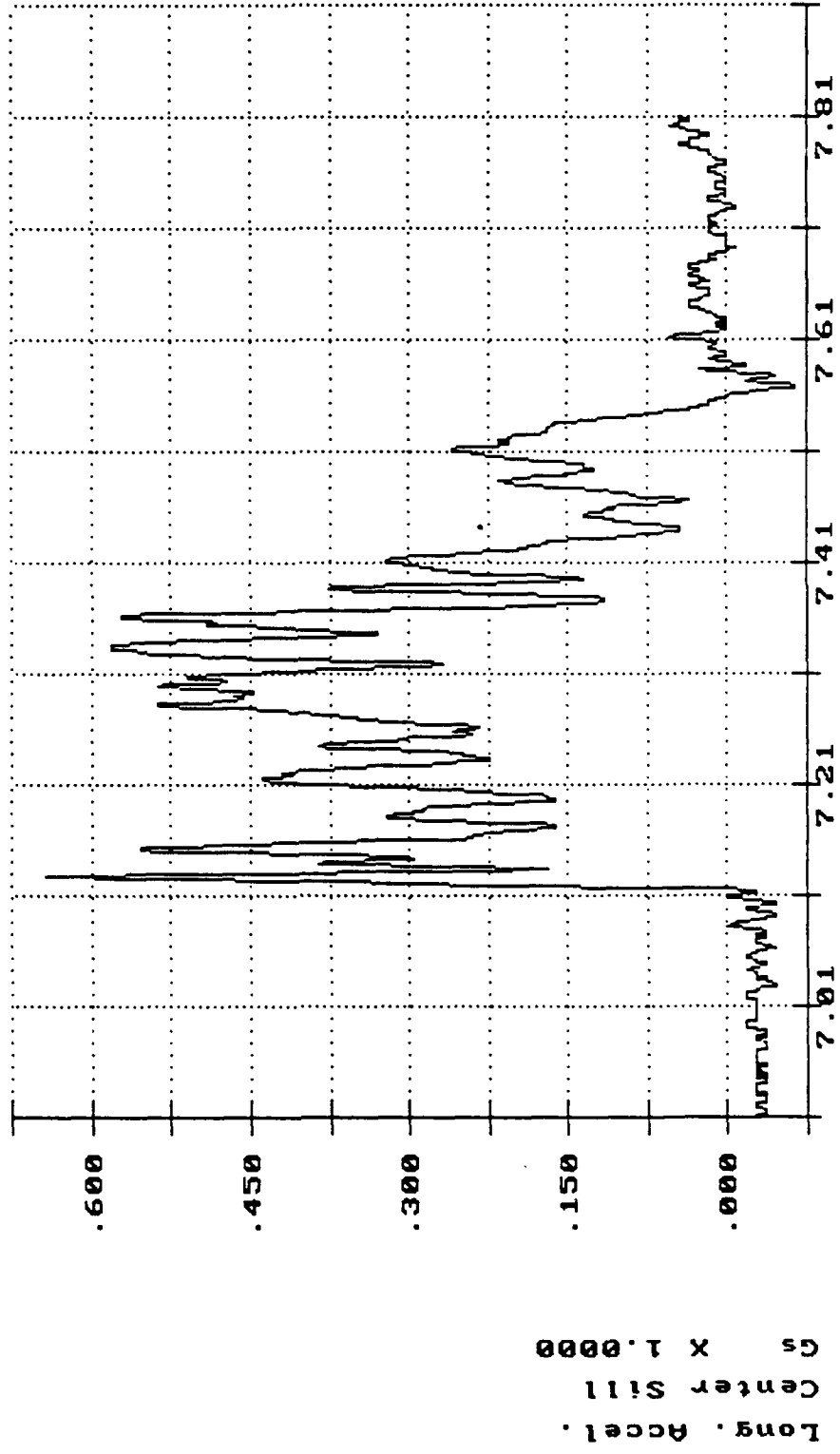
R.I. of 120mm Pallet, Impact 1: 4.60 MPH Oct 23 12:29:20 1991



Time of Sample

Seconds X 1.0000

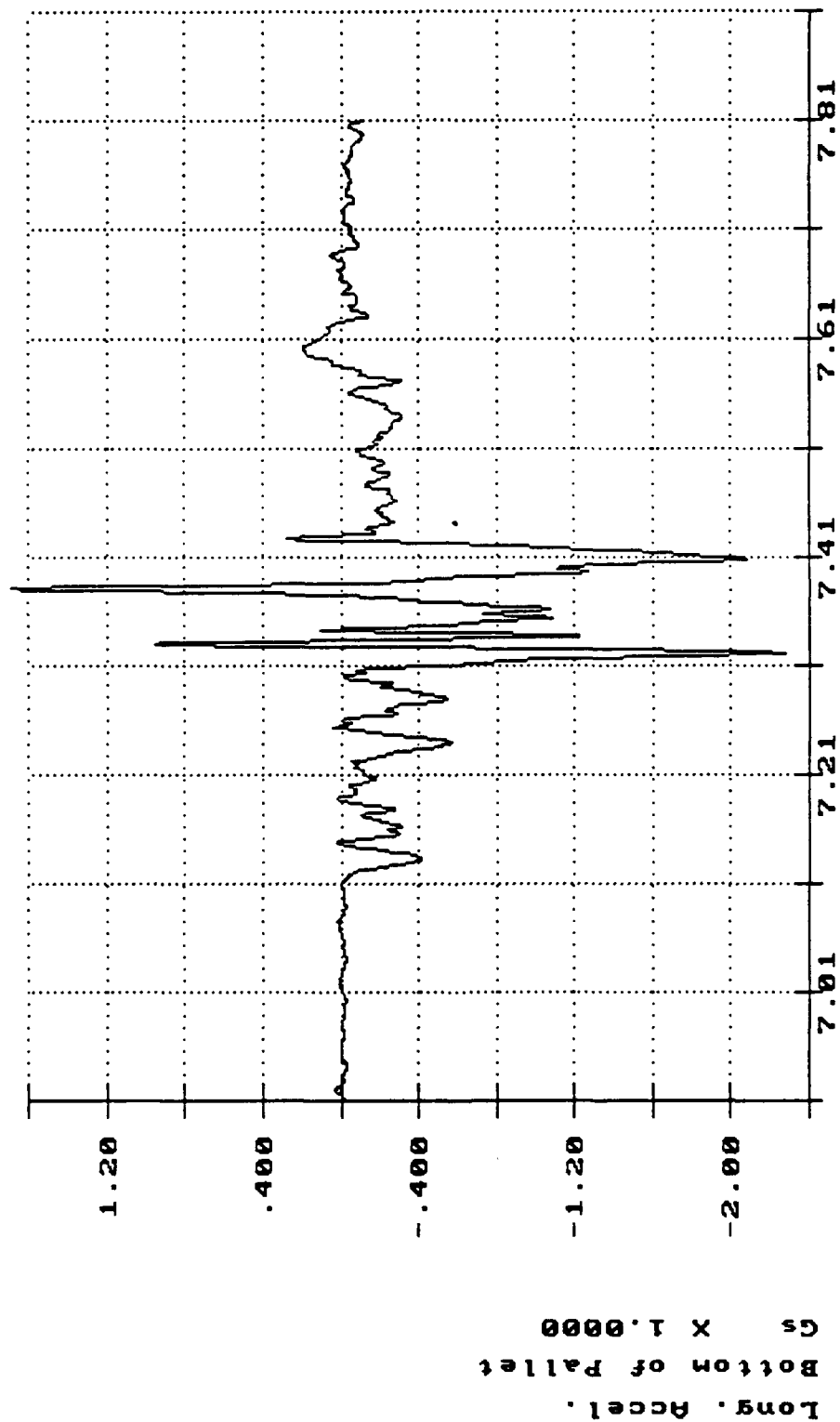
R.I. of 120mm Pallet, Impact 1: 4.60 MPH Oct 23 12:29:20 1991



Time of Sample

Seconds X 1.0000

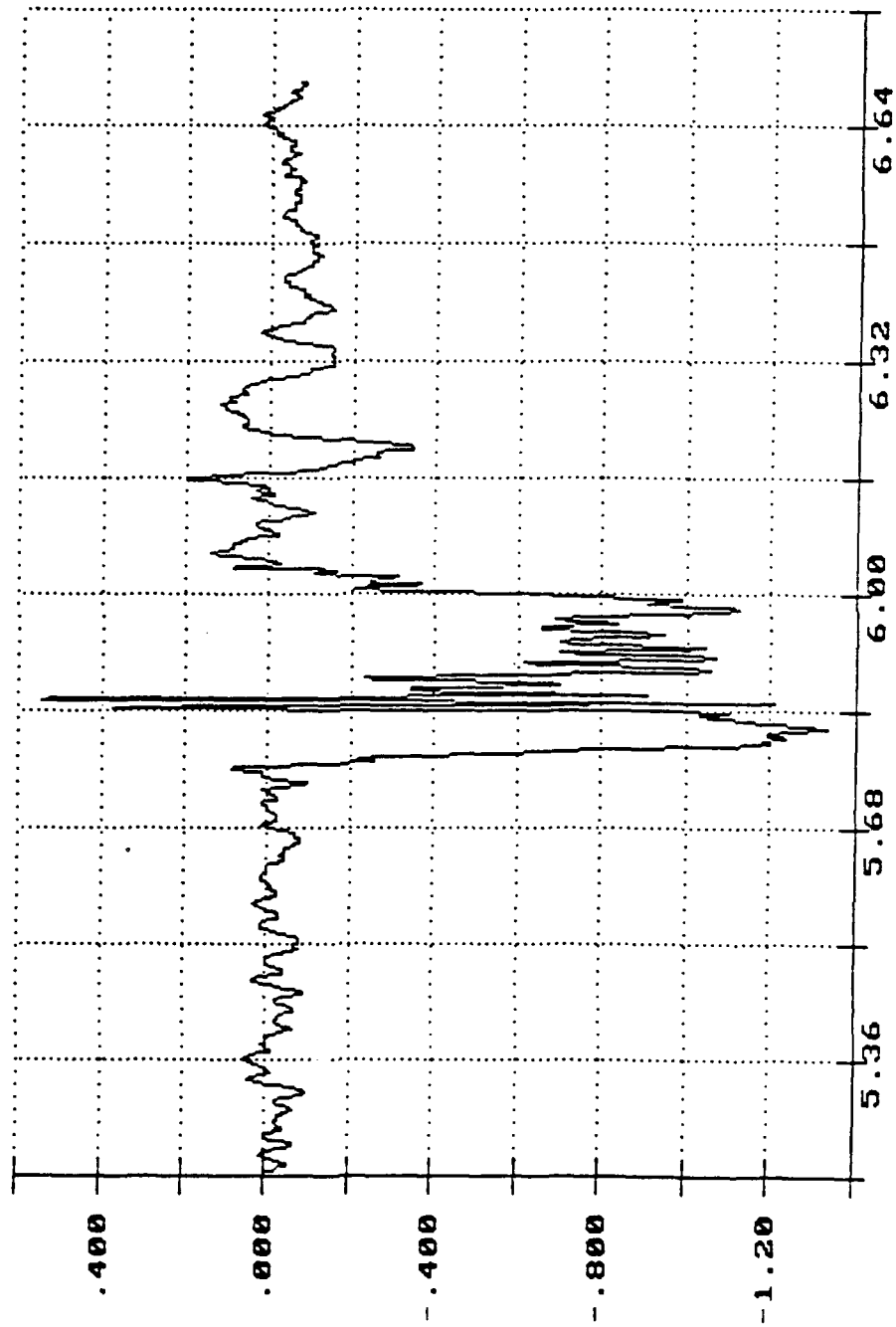
R.I. of 120mm Pallet, Impact 1: 4.60 MPH Oct 23 12:29:20 1991



Time of Sample

Seconds X 1.0000

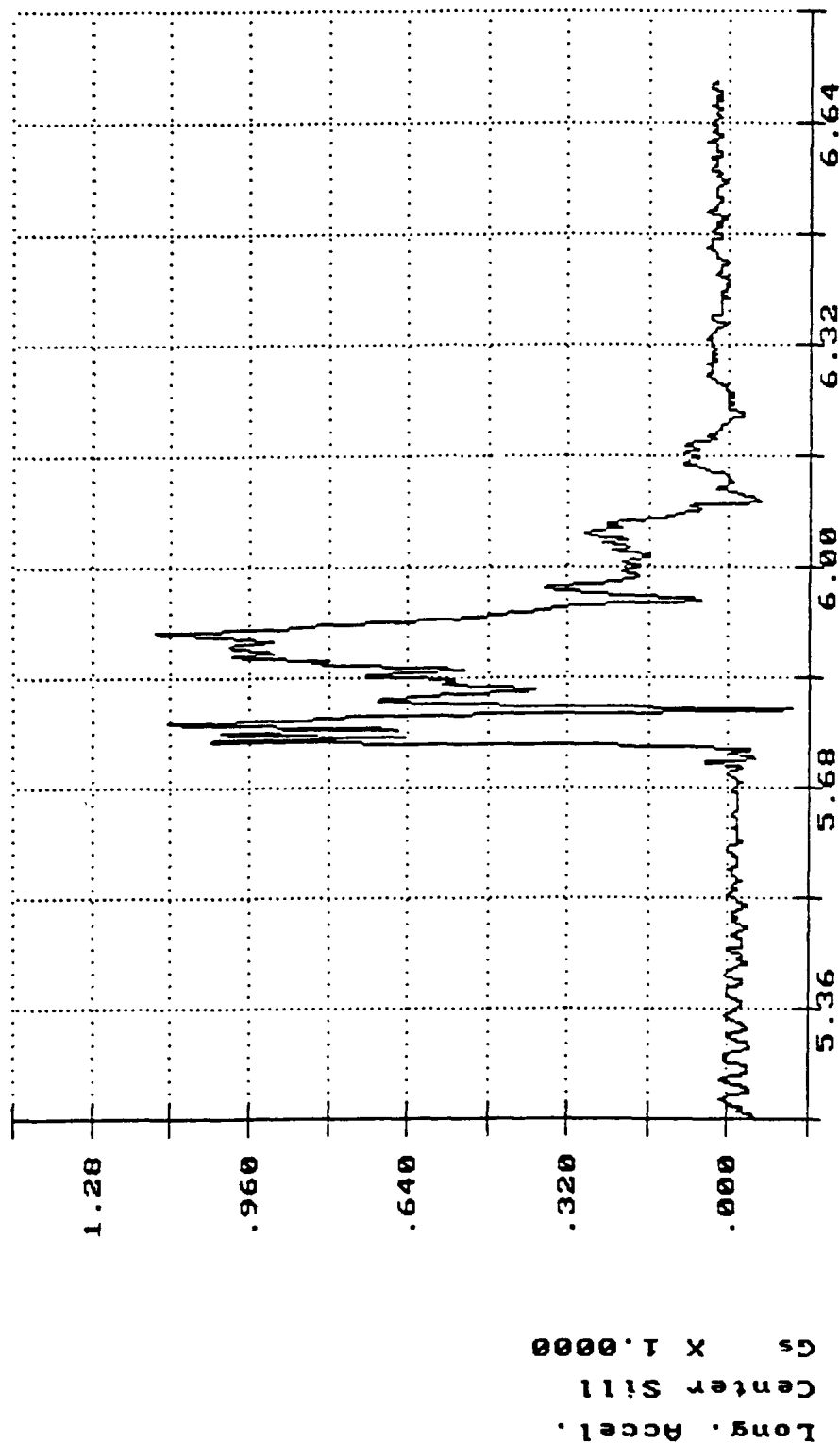
R.I. of 120mm Pallet, Impact 2: 6.41 MPH Oct 23 12:39:10 1991



Time of Sample

Seconds X 1.0000

R.I. of 120mm Pallet, Impact 2: 6.41 MPH Oct 23 12:39:10 1991

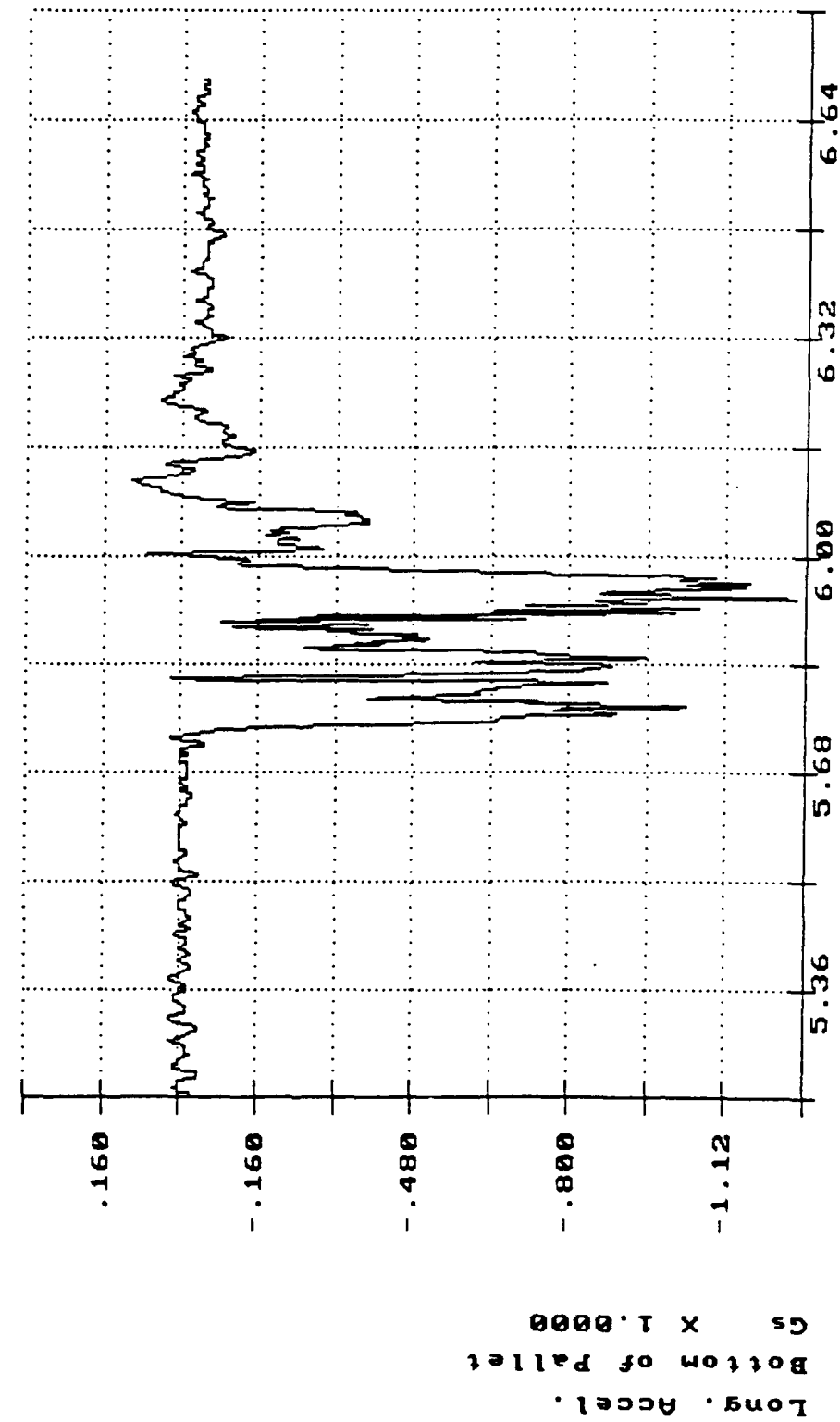


Time of Sample

Seconds X 1.0000

R.I. of 120mm Pallet, Impact 2: 6.41 MPH Oct 23 12:39:10 1991

7



Time of Sample

Seconds X 1.0000

PART 8

DRAWING

APPENDIX 48

UNITIZATION PROCEDURES FOR AMMUNITION AND COMPONENTS PACKED IN CYLINDRICAL METAL OR PLASTIC CONTAINERS ON 4 - WAY ENTRY METAL PALLETS

CARTRIDGE, 120 MM, PACKED 1 PER PA116 CYLINDRICAL
METAL CONTAINER, UNITIZED 30 PER 44" X 40"
PALLET; APPROX CONTAINER SIZE $44\frac{1}{2}"$ L X $7\frac{3}{4}"$ W
X $7\frac{3}{4}"$ H

PALLET UNIT DATA						
ITEMS INCLUDED		HAZARD CLASSIFICATION ①				WEIGHT (LBS)
NSN	DODIC	DOT CLASS	CG CLASS	QD CLASS	COMP CLASS	
1315-						
01-269-2256	C380	B	II-B	(08)1.2	C	2.264
01-226 7418	C786	B	II-B	(08)1.2	C	2.114
01-232-4638	C787	A	IV	(08)1.2	E	2.444

NOTICE: THIS APPENDIX CANNOT STAND ALONE BUT MUST
BE USED IN CONJUNCTION WITH THE BASIC UNITIZATION
PROCEDURES DRAWING 19-48-4231-20PM1006.

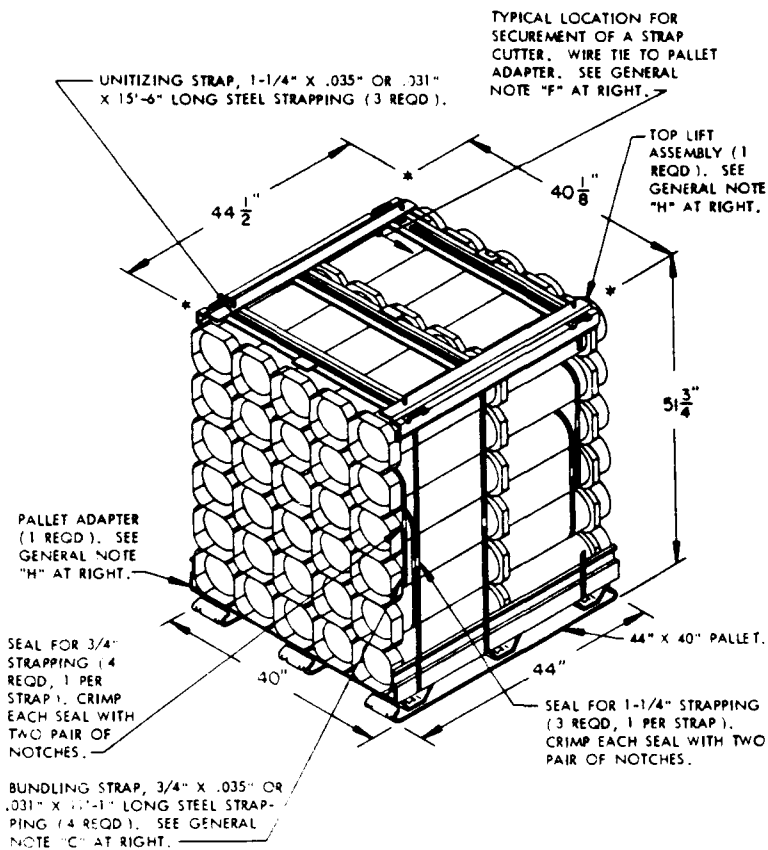
① HAZARD CLASSIFICATION DATA CONTAINED IN THE ABOVE CHART
IS FOR GUIDANCE AND INFORMATIONAL PURPOSES ONLY. VERIF-
ICATION OF THE SPECIFIED DATA SHOULD BE MADE BY CONSULTING
THE MOST RECENT JOINT HAZARD CLASSIFICATION SYSTEM
LISTING OR OTHER APPROVED LISTING(S).

DO NOT SCALE

REVISIONS				DRAFTSMAN	TM	PROJ ENG	LAF	WCE
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				APPROVED BY ORDER OF COMMANDING GENERAL, U.S. ARMY MATERIEL COMMAND (AMC)				
				U.S. ARMY AMC DRAWING				
				DECEMBER 1988				
				CLASS	DIVISION	DRAWING	FILE	
				19	48	4231/ 48	20PM 1006	

GENERAL NOTES

- A. THIS APPENDIX CANNOT STAND ALONE BUT MUST BE USED IN CONJUNCTION WITH THE BASIC UNITIZATION PROCEDURES DRAWING 19-48-4231-20PM1006. TO PRODUCE AN APPROVED UNIT LOAD, ALL PERTINENT PROCEDURES, SPECIFICATIONS AND CRITERIA SET FORTH WITHIN THE BASIC DRAWING WILL APPLY TO THE PROCEDURES DELINEATED IN THIS APPENDIX. ANY EXCEPTIONS TO THE BASIC PROCEDURES ARE SPECIFIED IN THIS APPENDIX.
- B. DIMENSIONS, CUBE AND WEIGHT OF A PALLET UNIT WILL VARY SLIGHTLY DEPENDING UPON THE ACTUAL DIMENSIONS OF THE CONTAINER AND THE WEIGHT OF THE SPECIFIC ITEM BEING UNITIZED.
- C. BUNDLING STRAPS MUST BE TENSIONED AND SEALED PRIOR TO THE APPLICATION OF THE UNITIZING STRAPS. INSTALL BUNDLING STRAPS AS CLOSE TO THE OUTER CONTAINER RINGS AS POSSIBLE, TO AVOID DAMAGE TO THE CONTAINERS.
- D. ALTHOUGH THE CONTAINERS DEPICTED IN THE UNIT LOAD AT LEFT ARE CONSTRUCTED WITH INTERLOCKING DEVICES, THE INTERLOCKS WILL NOT FUNCTION PROPERLY UNLESS THE CONTAINERS ARE POSITIONED SO THAT THE "PINS" OF THE INTERLOCKS ARE FACING UPWARD. THIS ORIENTATION WILL AID IN THE PREVENTION OF CONTAINER MOVEMENT, BOTH Laterally AND LONGITUDINALLY, DURING SHIPMENT OF THE UNIT LOAD.
- E. THE FOLLOWING AMC (DARCOM) DRAWINGS ARE APPLICABLE FOR OUTLOADING AND STORAGE OF THE ITEMS COVERED BY THIS APPENDIX.
 CARLOADING ----- DRAWING 19-48-4246-5PM1011.
 TRUCKLOADING ----- DRAWING 19-48-4247-11PM1011.
 STORAGE ----- DRAWING 19-48-4250-1-2-3-4-14-22PM1005.
 MILVAN ----- DRAWING 19-48-4244-15PM1007.
 COMMERCIAL CONTAINER-DRAWING 19-48-4245-15PM1008.
- F. FOR METHOD OF SECURING A STRAP CUTTER TO THE PALLET UNIT, SEE DARCOM DRAWING 19-48-4127-20PM1000.
- G. IF ITEMS COVERED HEREIN ARE UNITIZED PRIOR TO ISSUANCE OF THIS APPENDIX, THE CONTAINERS NEED NOT BE REUNITIZED SOLELY TO CONFORM TO THIS APPENDIX.
- H. FOR DETAILS OF THE PALLET ADAPTER AND TOP LIFT ASSEMBLY, SEE MILITARY SPECIFICATION MIL-A-70754.
- J. THE UNITIZATION PROCEDURES DEPICTED HEREIN MAY ALSO BE USED FOR UNITIZING 120MM CARTRIDGES WHEN IDENTIFIED BY DIFFERENT NATIONAL STOCK NUMBERS (NSN) THAN WHAT IS SHOWN ON THE TITLE PAGE, PROVIDED THE CONTAINER PACK DOES NOT VARY FROM WHAT IS DELINEATED HEREIN. THE EXPLOSIVE CLASSIFICATION OF OTHER ITEMS MAY BE DIFFERENT THAN WHAT IS SHOWN.
- K. EMPTY OR REJECT Pallet CONTAINERS WILL BE USED AS FILLER CONTAINERS AS NECESSARY. FILLER CONTAINERS MUST BE INSTALLED IN THE MIDDLE OF THE TOP LAYER (S) OF CONTAINERS. IF FIVE FULL CONTAINERS ARE TO BE OMITTED, ONE FULL LAYER OF CONTAINERS WILL BE OMITTED. WHEN (EMPTY) FILLER CONTAINERS ARE USED IN PLACE OF OMITTED CONTAINERS TO COMPLETE A LAYER ON A PALLET, THEY WILL BE MARKED AS SPECIFIED WITHIN MIL-STD-129.
- L. FOR NSN 1315-01-226-7418-C786 ONLY, THE TOP COVER OF THE PALLET WILL BE MARKED "DOT-E-9649" IN ONE-INCH WHITE LETTERS NEAR THE CLOSED END OF THE CONTAINERS.



PALLET UNIT

SEE GENERAL NOTE "B" AT RIGHT.

30 CONTAINERS OF 120MM CARTRIDGES (1 PER CONTAINER)	75 LBS	2,250 LBS (APPROX)
DUNNAGE	89 LBS	
PALLET	105 LBS	
TOTAL WEIGHT		2,444 LBS (APPROX)
CUBE		53.5 CU FT (APPROX)

BILL OF MATERIAL

METAL PALLET, 44" X 40"	1 REQD	105 LBS
PALLET ADAPTER	1 REQD	41 LBS
TOP LIFT ASSEMBLY	1 REQD	38 LBS
STEEL STRAPPING, 1-1/4"	44.33' REQD	3.17 LBS
STEEL STRAPPING, 3/4"	46.50' REQD	6.64 LBS
SEAL FOR 3/4" STRAPPING	4 REQD	NIL
SEAL FOR 1-1/4" STRAPPING	3 REQD	NIL