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FINAL REPORT  
FEBRUARY 1992

REPORT NO. 92-04

RAIL IMPACT TEST OF 120MM  
PALLETS IN 20-FOOT  
COMMERCIAL CONTAINERS

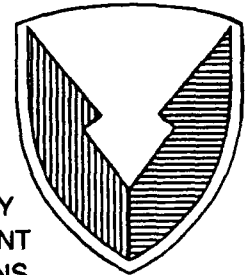
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ABSTRACT <i>(Continue on reverse if necessary and identify by block number)</i> <p>The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Logistics Engineering Office (SMCAC-DE), to verify rail transportation of 120mm tank ammunition in commercial containers. Blocking and bracing procedures used during this test were restrained against door corner post restraint bars. As tested, the blocking and bracing procedures were suitable for safe transportation of 120mm ammunition in commercial containers.</p>			
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U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL  
VALIDATION ENGINEERING DIVISION  
SAVANNA, IL 61074-9639

REPORT NO. 92-04

RAIL IMPACT TEST OF 120MM PALLETS IN 20-FOOT  
COMMERCIAL CONTAINERS

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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 commercial containers. Blocking and bracing procedures tested were restrained against steel door post vertical retainers, avoiding contact with the container doors. This test was conducted due to dunnage failures and door damage from authorized deviations from the Transportation Engineering Division (SMCAC-DET) to normal blocking and bracing procedures within Military Vans (MILVANS) and commercial-type intermodal freight containers.

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 was to verify that specified blocking and bracing procedures in commercial containers were acceptable for safe transportation of retrograde 120mm tank ammunition from Southwest Asia (SWA).

D. CONCLUSION. The 120mm tank ammunition load and dunnage as tested was extremely stable even at higher than normal impact speeds; i.e., 9.33 mph. As tested, the design is safe for rail transportation of 120mm tank ammunition in commercial containers.

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**PART 2**

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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. Commercial Container Load Preparation. The commercial containers were loaded with 10 pallets of 120mm tank ammunition on metal pallets and the same blocking and bracing procedures were used as specified in normal outloading 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. If failures occur during any part of testing, modifications will be made to the load and/or blocking and bracing procedures and will be entirely retested.

B. Rail Impact Test. The commercial container was loaded onto a Container-on-flatcar (COFC) 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, 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 car to

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.

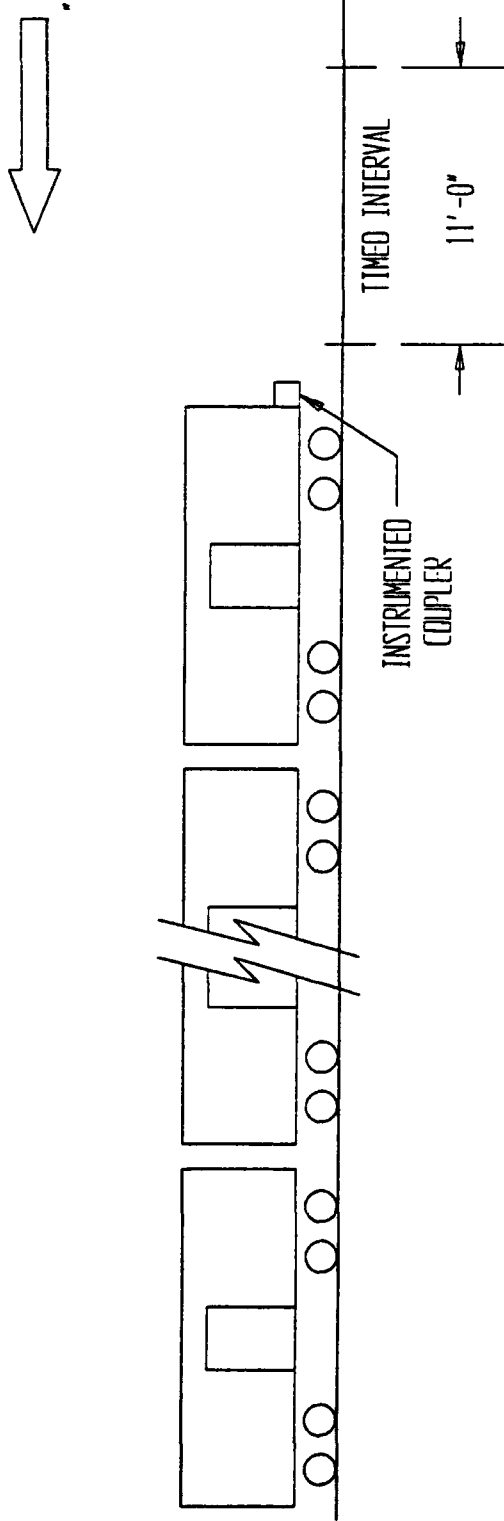
C. Data Collection. The specimen car was instrumented with accelerometers at the following locations as a minimum:

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 is not violated.

**ASSOCIATION OF AMERICAN RAILROADS (AAR)  
STANDARD TEST PLAN**



**SPECIMEN CAR  
IS RELEASED BY  
SWITCH ENGINE TO  
ATTAIN: IMPACT NO. 1 @ 4 MPH  
IMPACT NO. 2 @ 6 MPH  
IMPACT NO. 3 @ 8.1 MPH  
THEN THE CAR IS REVERSED AND  
RELEASED BY SWITCH ENGINE TO  
ATTAIN: IMPACT NO 4. @ 8.1 MPH**

**5 BUFFER CARS (ANVIL) WITH DRAFT GEAR  
COMPRESSED AND AIR BRAKES IN A SET  
POSITION  
ANVIL CAR TOTAL WT 250,000 LBS (APPROX)**

**FIGURE 1**

**PART 4**

**TEST EQUIPMENT**

**A. 120mm Palletized Ammunition.**  
**(Test Samples)**

- |                 |                           |
|-----------------|---------------------------|
| 1. Drawing No.: | 19-48-4231/48-20PM1006    |
| 2. Width:       | 40-1/8"                   |
| 3. Length:      | 44-1/2"                   |
| 4. Height:      | 51-3/4"                   |
| 5. Weight:      | 2,444 lbs (approximately) |

**B. Commercial Container.**

- |            |           |
|------------|-----------|
| 1. Width:  | 8'        |
| 2. Length: | 20'       |
| 3. Height: | 8'-6"     |
| 4. Weight: | 4,700 lbs |

**C. Railcar.**

- |                |             |
|----------------|-------------|
| 1. Car Number: | TTWX 981502 |
| 2. Car Type:   | COFC        |
| 3. Length:     | 89'-4"      |
| 4. Draft Gear: | Friction    |

**D. Data Acquisition Equipment.**

- |                   |                    |
|-------------------|--------------------|
| 1. Manufacturer:  | Pacific Scientific |
| 2. Sampling Rate: | 3                  |

## PART 5

### TEST RESULTS

Four rail impact tests were conducted on a commercial container containing 120mm tank ammunition. The commercial container was blocked and braced against steel door post vertical retainers. The procedures utilized a box beam design for longitudinal blocking/load retention (details depicted in drawing).

Rail impact no. 1 was conducted at 4.41 mph with no visible damage occurring to the load or commercial container. "G" forces during this impact were as follows (see section 8 of this report for graphs of "G" forces):

#### "G" FORCES

Top of pallet.	0.83
Bottom of pallet.	0.56
Sill of railcar.	0.60

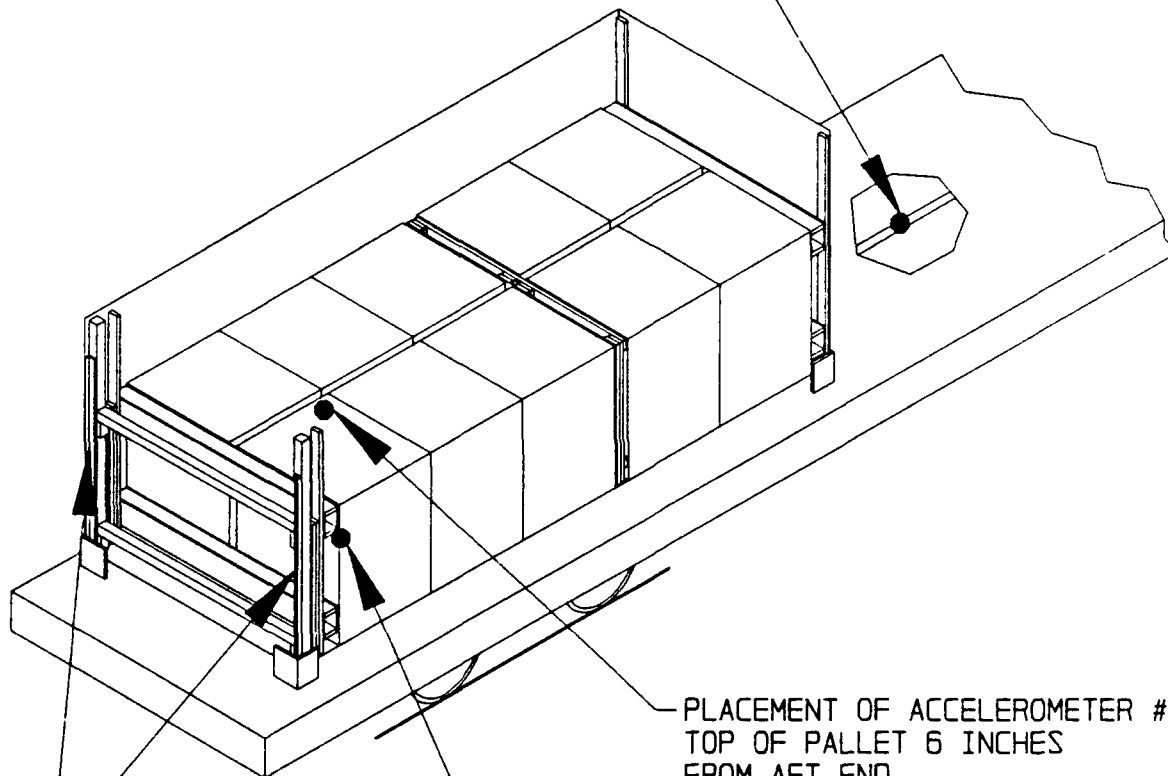
Rail impact no. 2 was conducted at 6.25 mph with a slight racking of upper box beam due to the top pallet adapter contacting the upper half of the box beam. "G" forces during this impact were as follows (see section 8 of this report for graphs of "G" forces):

#### "G" FORCES

Top of pallet.	1.21
Bottom of pallet.	1.24
Sill of railcar.	1.06

# RAIL TEST OF 120MM PALLETS IN 20-FOOT COMMERCIAL CONTAINERS WITH STEEL DOOR POST VERTICAL RETAINERS

PLACEMENT OF ACCELEROMETER #3  
ON SILL OF THE RAILCAR.



PLACEMENT OF ACCELEROMETER #1  
TOP OF PALLET 6 INCHES  
FROM AFT END.

VERTICAL DOOR  
POST RESTRAINTS.

PLACEMENT OF ACCELEROMETER #2  
ON PALLET SKID AFT END SIDE.

## NOTES:

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

## FOR INFORMATION ONLY

TITLE  
BOX BEAM METHOD OF  
120MM PALLETS IN  
20-FOOT COMMERCIAL  
CONTAINERS

DWG NO

92-004-0-T00051

VALIDATION ENGINEERING DIVISION

SHEET 1 OF 1

Rail impact no. 3 was conducted at 8.33 mph with no changes in the dunnage or test load. "G" forces during this impact were as follows (see section 8 of this report for graphs of "G" forces):

"G" FORCES

Top of pallet.	1.59
Bottom of pallet.	1.84
Sill of railcar.	2.00

At the option of the test and design engineers, a fourth rail impact test was conducted at 9.33 mph with no changes occurring to the load or dunnage. "G" forces during this impact were as follows (see section 8 of this report for graphs of "G" forces):

"G" FORCES

Top of pallet.	2.02
Bottom of pallet.	1.59
Sill of railcar.	2.58

At the option of test and design engineers, the reverse 8 mph rail impact test was not conducted. The main purpose for testing this load was to verify the blocking and bracing procedures against door post vertical retainers, not the container end wall loading strength, which was previously verified.

PART 6

PHOTOGRAPHS



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

Photo No. AO317-SPN-92-40-540. This photo shows an overall view of the test load.



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

Photo No. AO317-SPN-92-50-544. This photo shows the side view of the box beam.



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

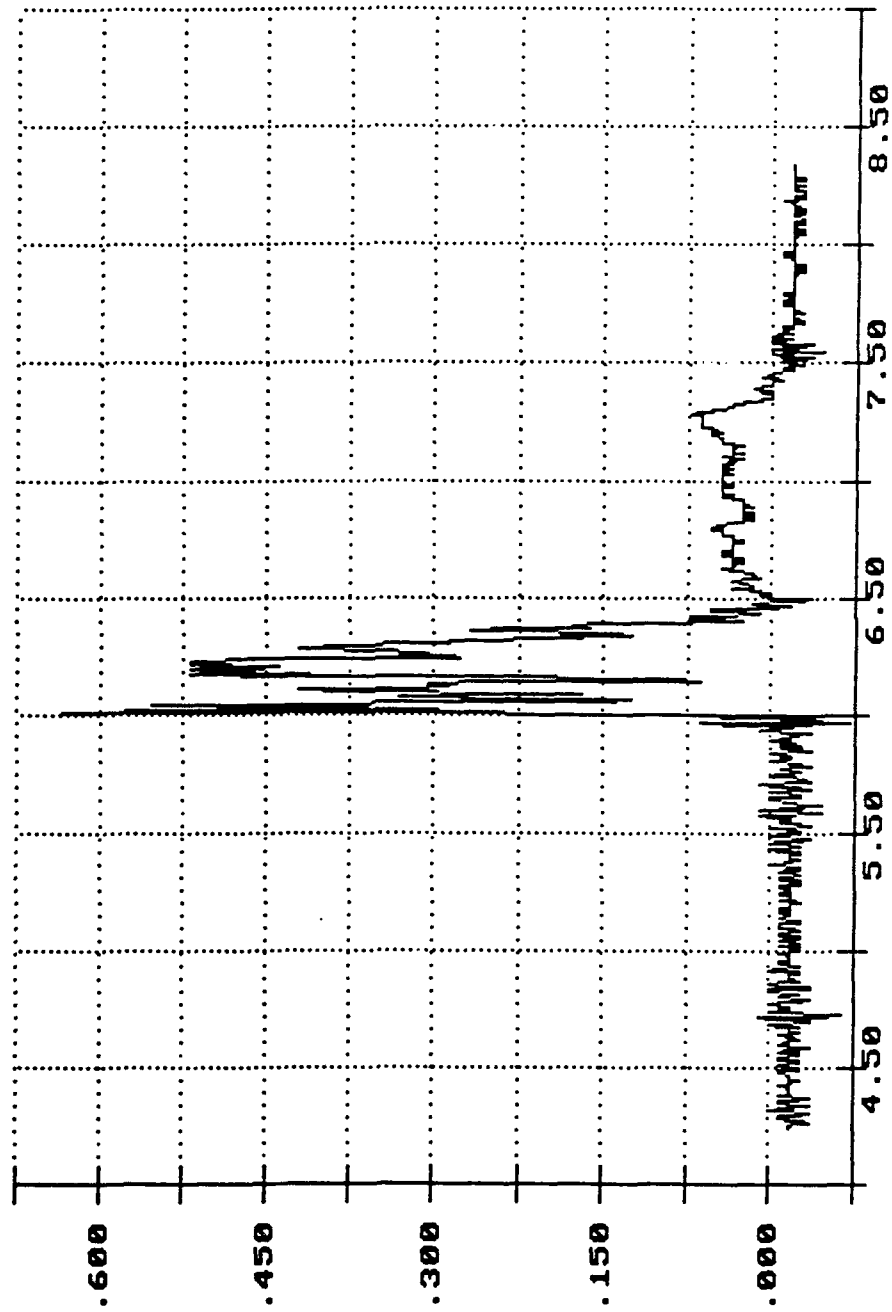
Photo No. AO317-SPN-92-40-546. This photo shows a closeup view of the door post vertical retainer supporting the dunnage and the box beam.

**PART 7**

**GRAPHS**

R.I. of 120mm Pallet, Impact 1: 4.41 MPH Nov 5 14:04:50 1991

7

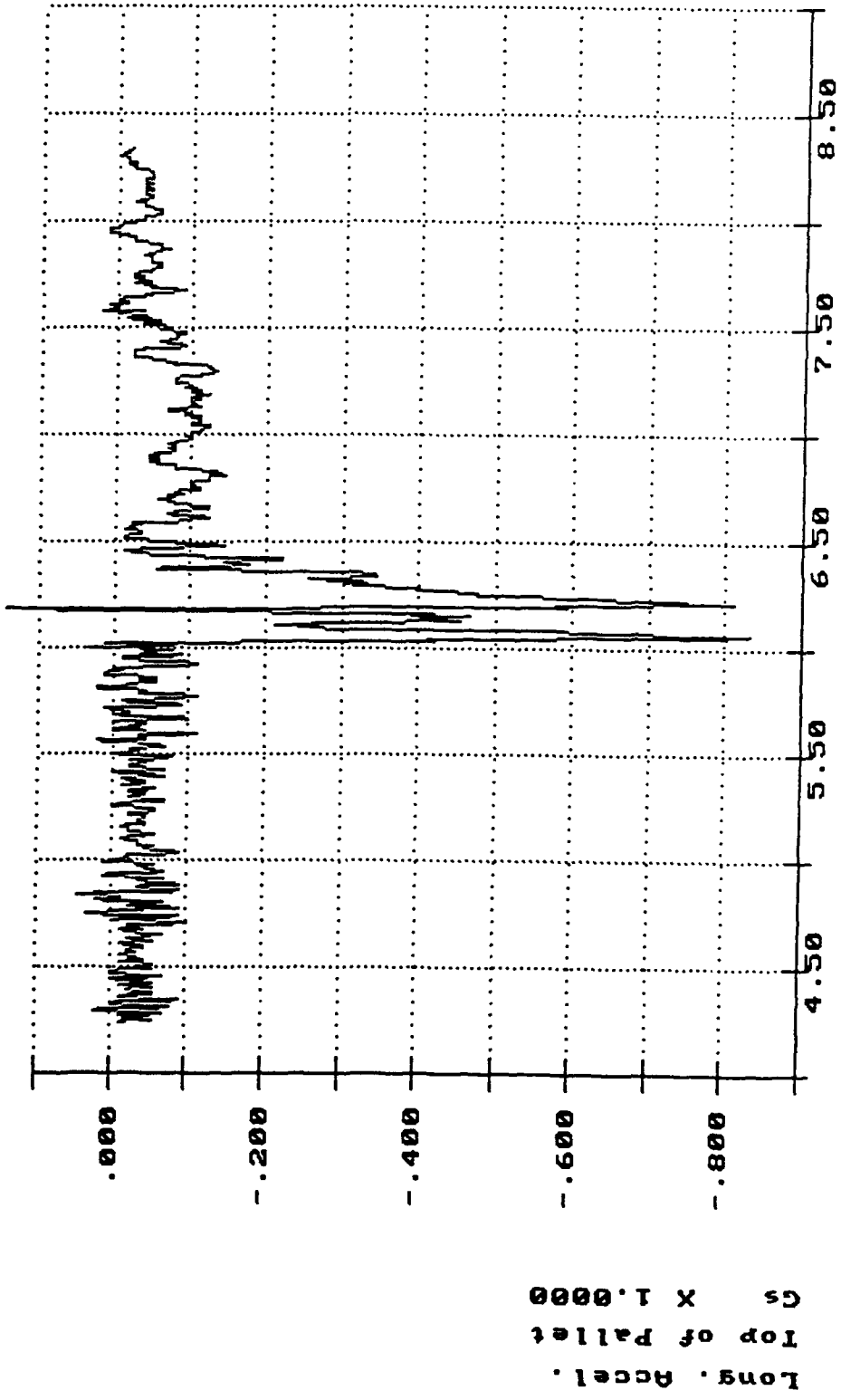


Time of Sample

Seconds X 1.0000

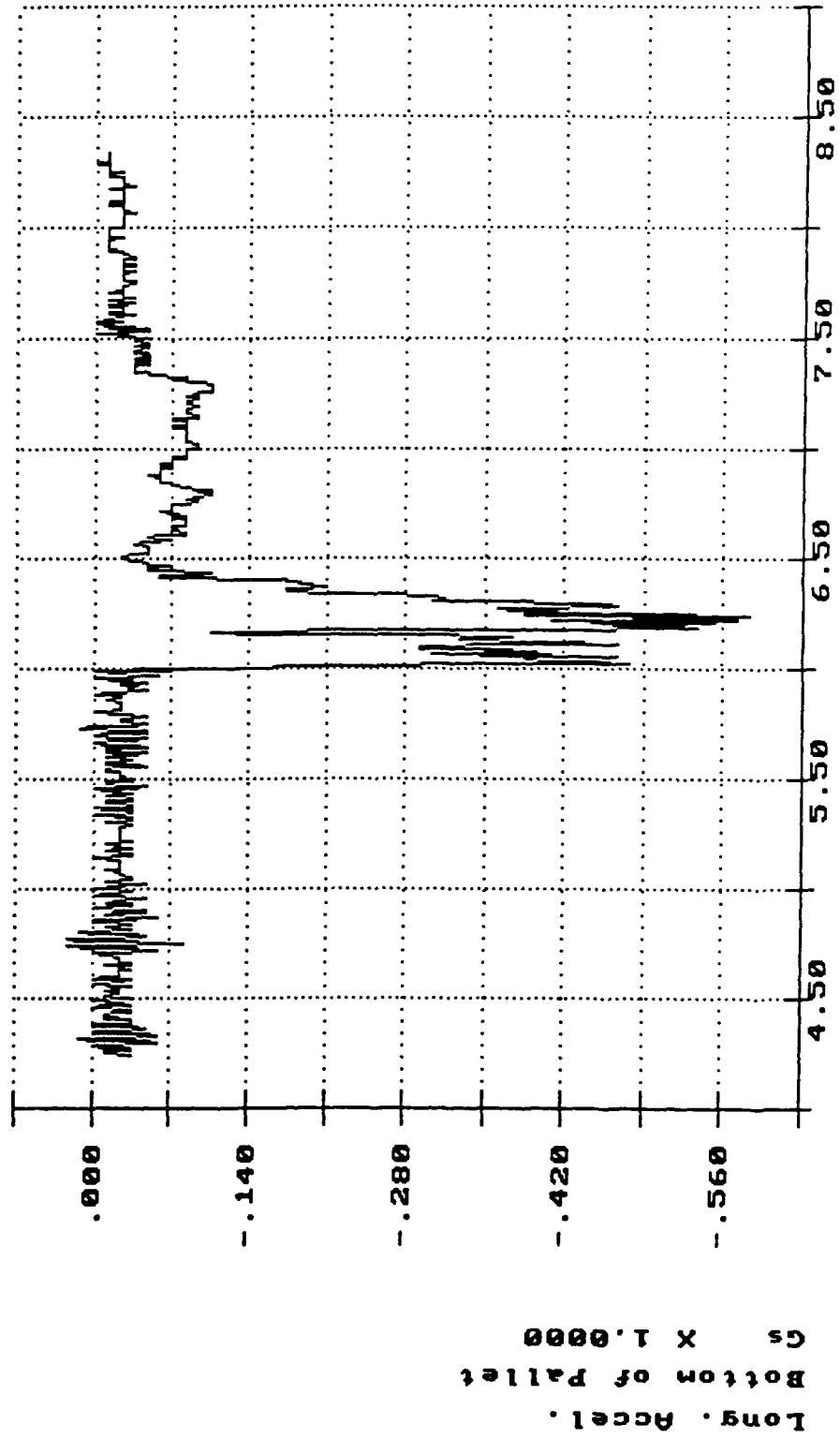
R.I. of 120mm Pallet, Impact 1: 4.41 MPH Nov 5 14:04:50 1991

7



Time of Sample  
Seconds X 1.0000

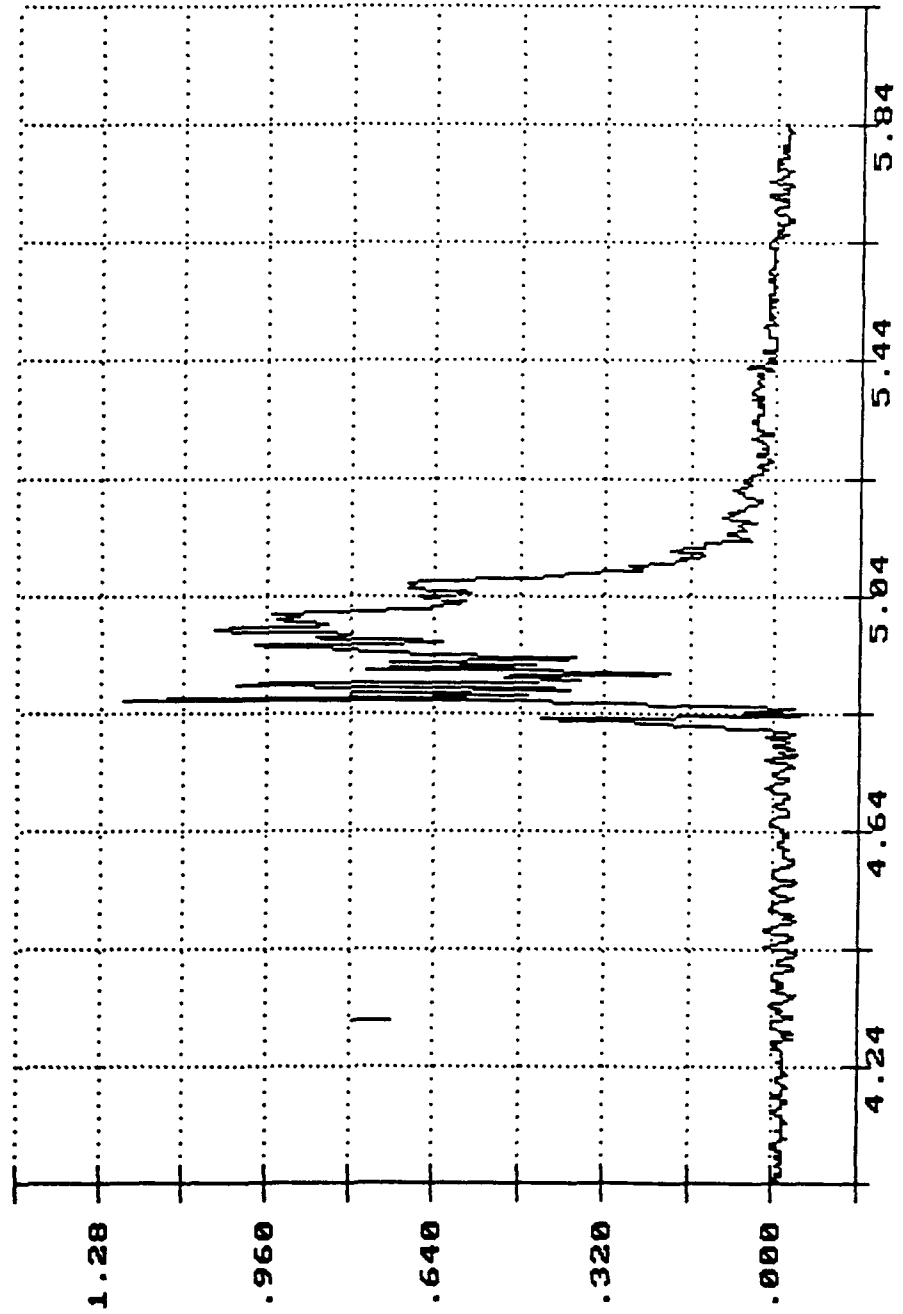
R.I. of 120mm Pallet, Impact 1: 4.41 MPH Nov 5 14:04:50 1991



Time of Sample

Seconds X 1.0000

R.I. of 120mm Pallet, Impact 2: 6.25 MPH Nov 5 14:15:56 1991

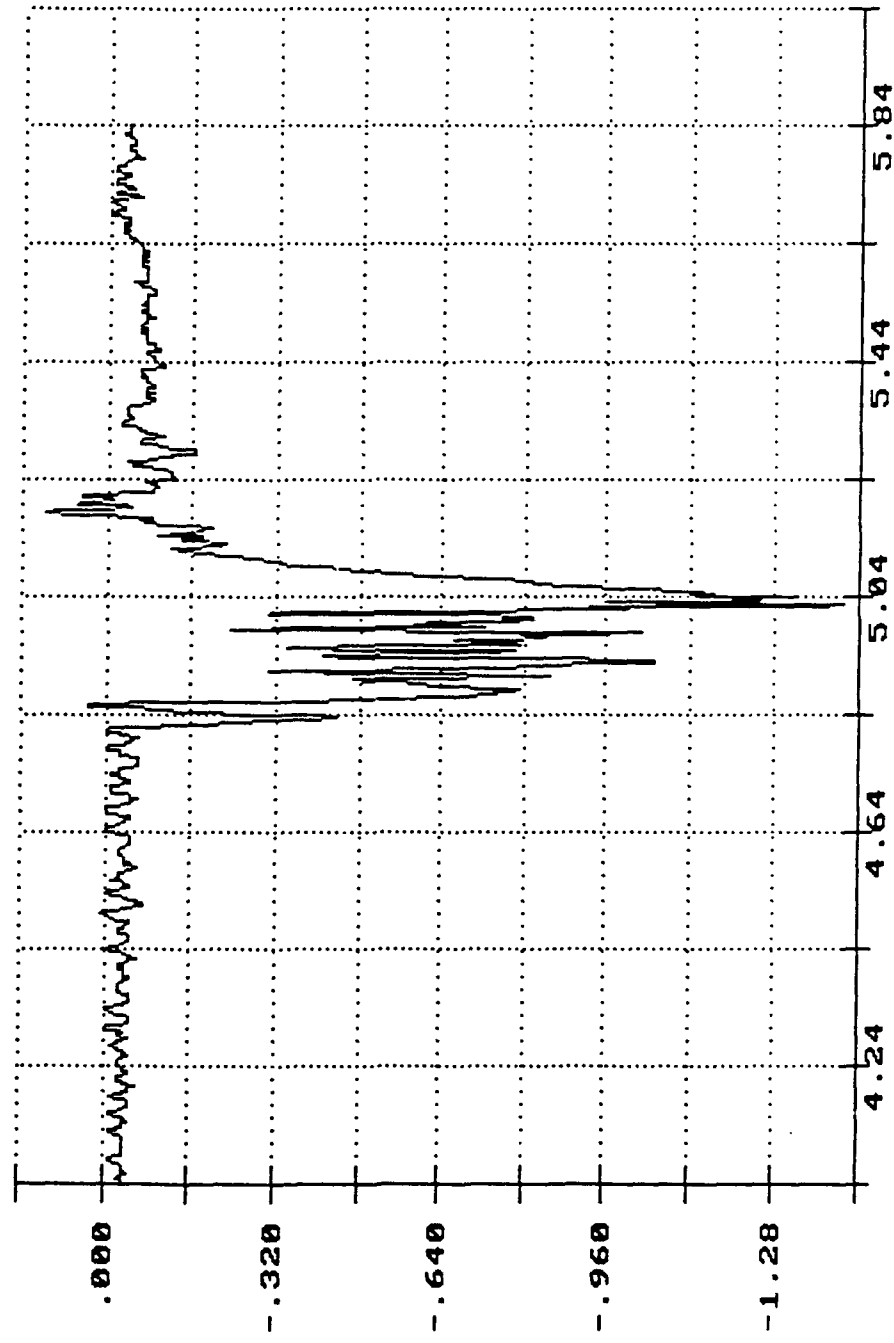


Long. Accel.  
Center Sill  
Gs X 1.0000

Time of Sample

Seconds X 1.0000

R.I. of 120mm Pallet, Impact 2: 6.25 MPH Nov 5 14:15:56 1991

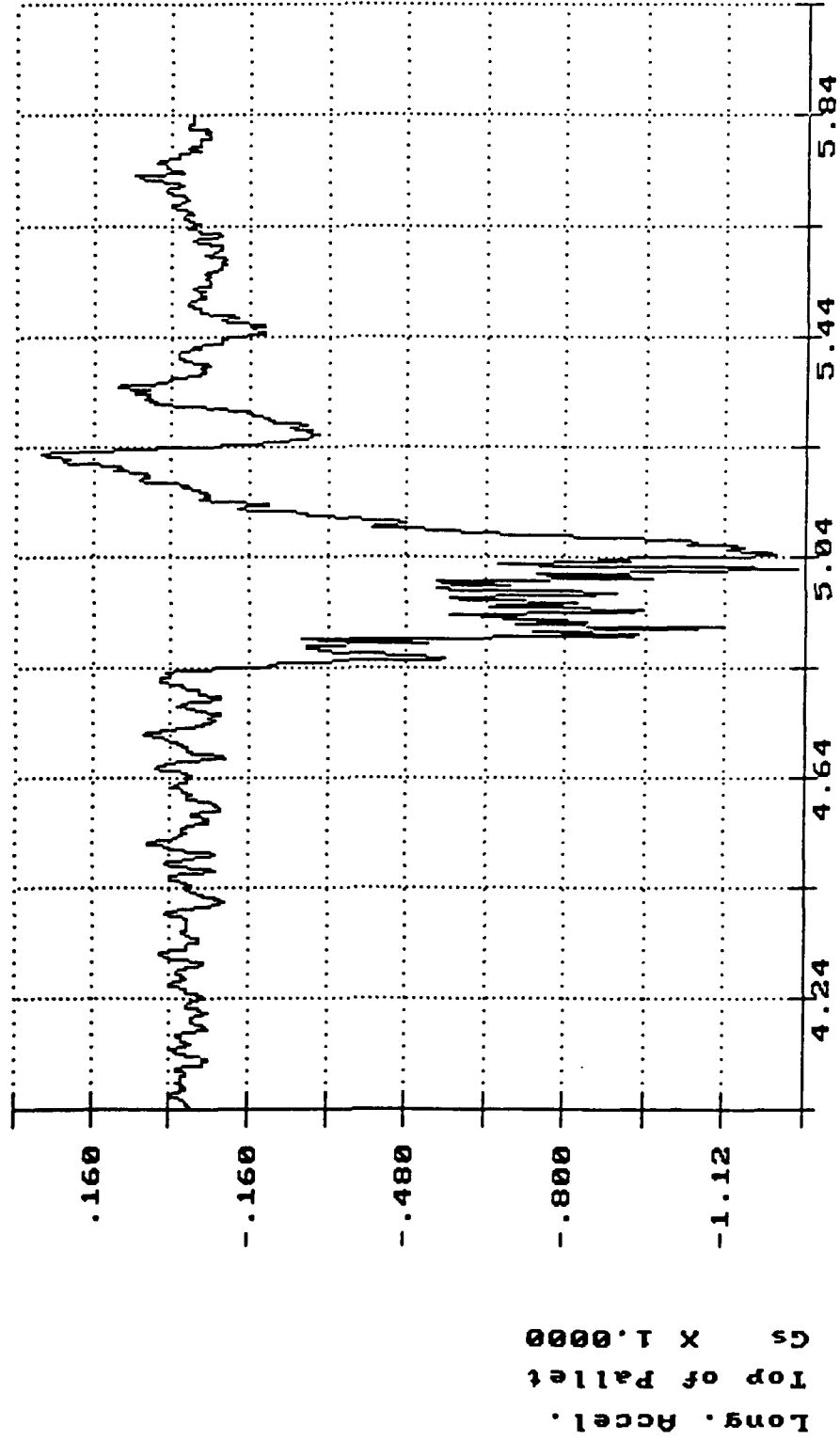


Long. Accel.  
Bottom of Pallet  
X 1.0000

Time of Sample

Seconds X 1.0000

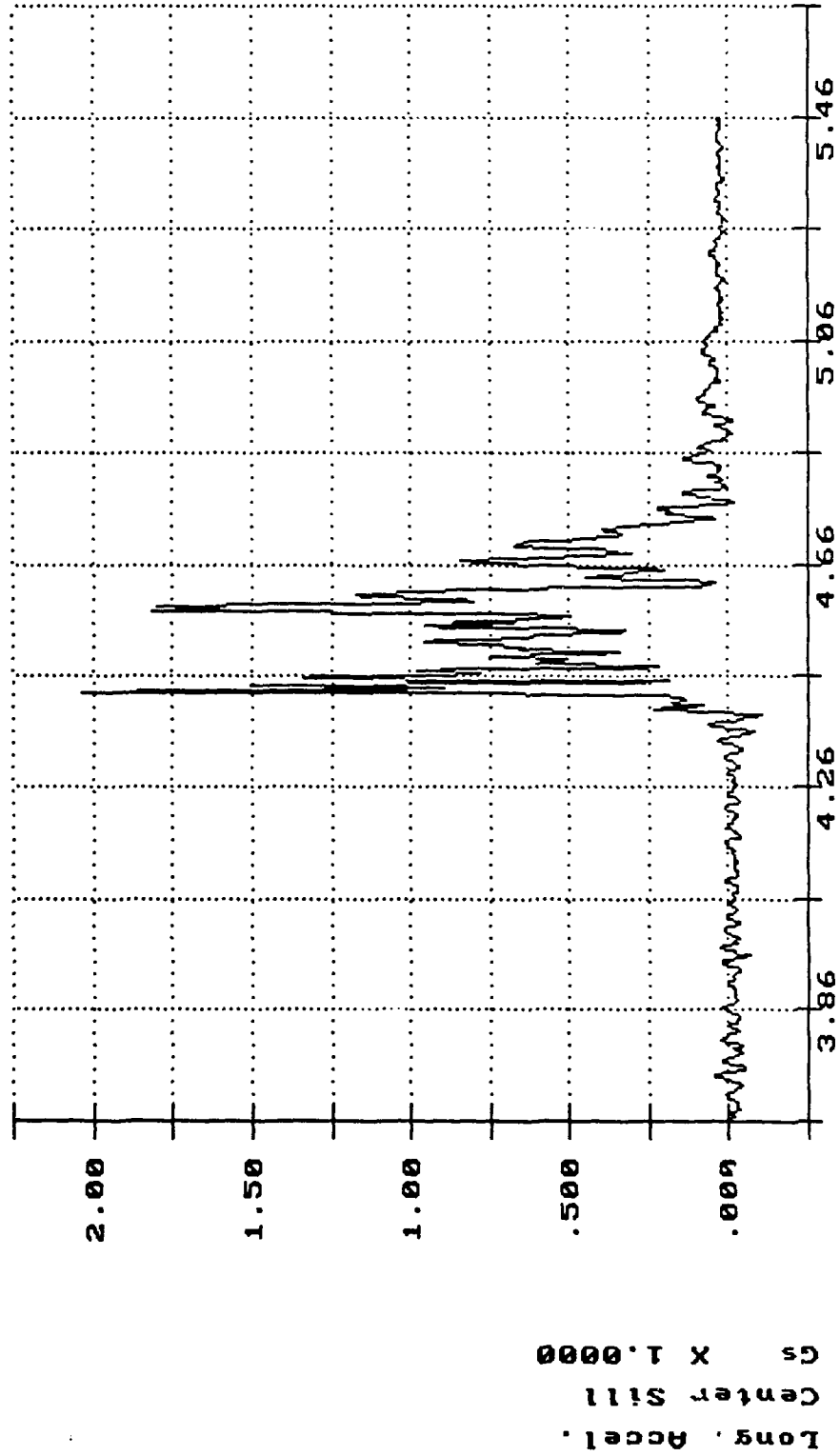
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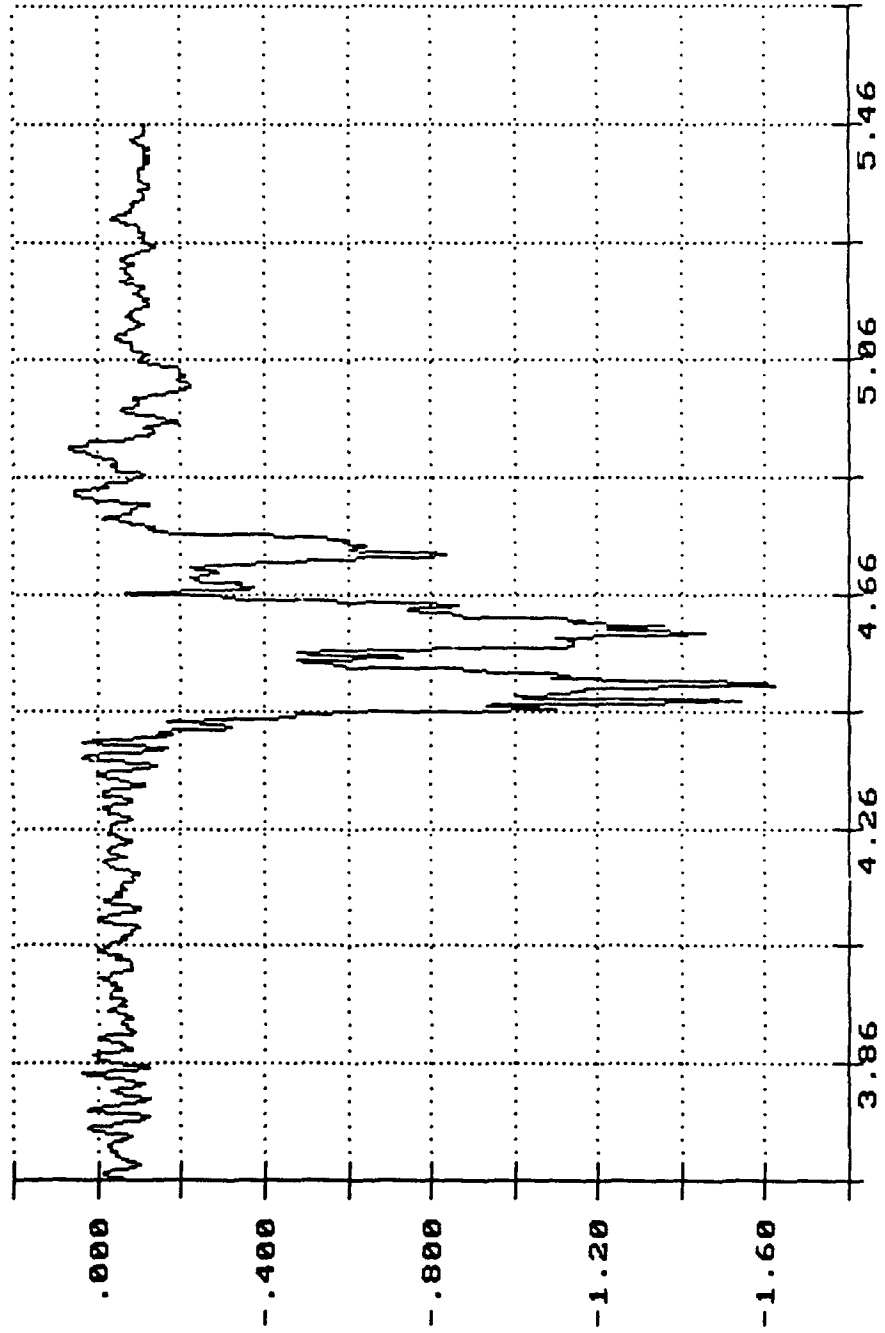
Time of Sample

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R.I. of 120mm Pallet, Impact 3: 8.33 MPH Nov 5 14:26:24 1991



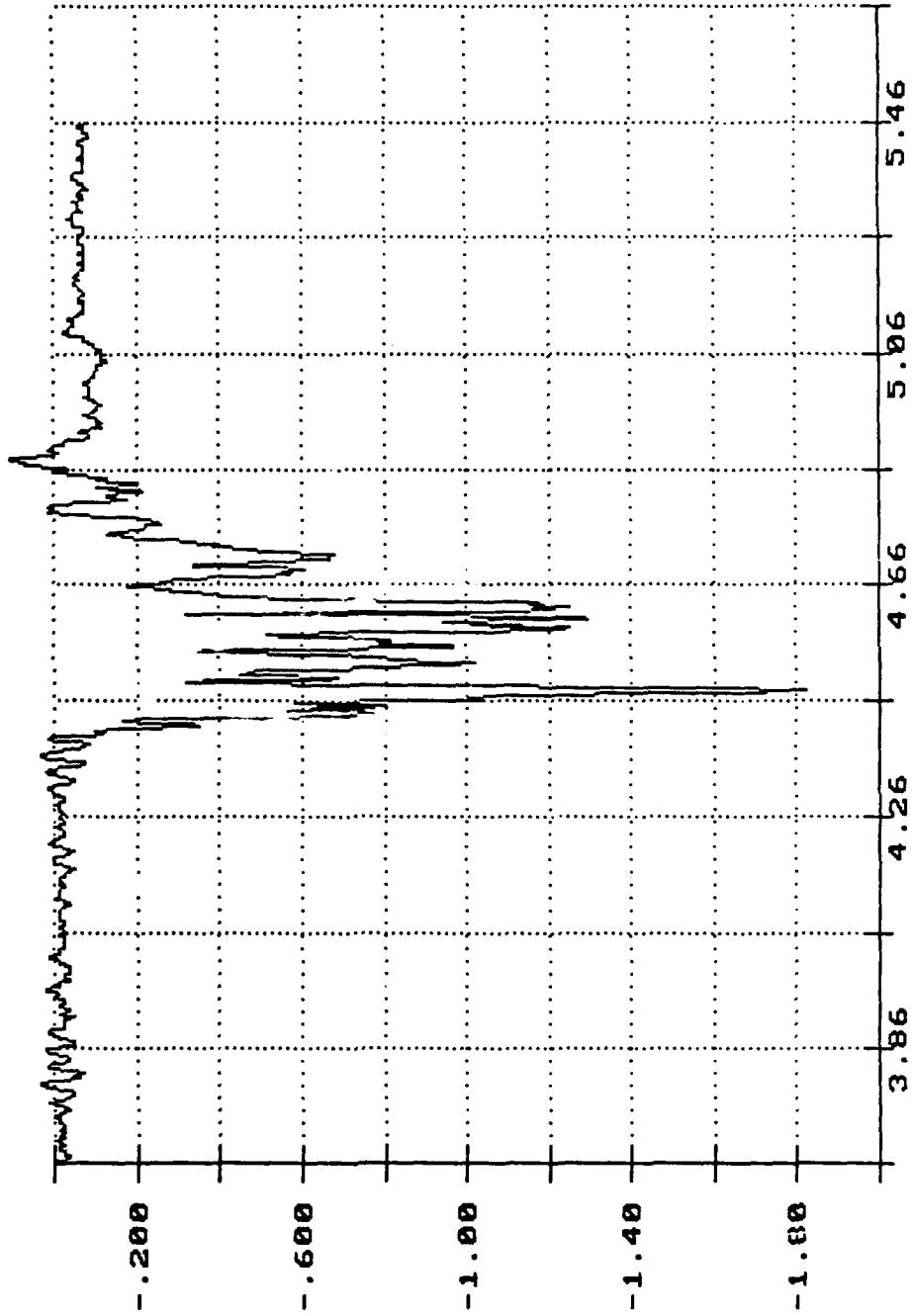
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Time of Sample

Seconds X 1.0000

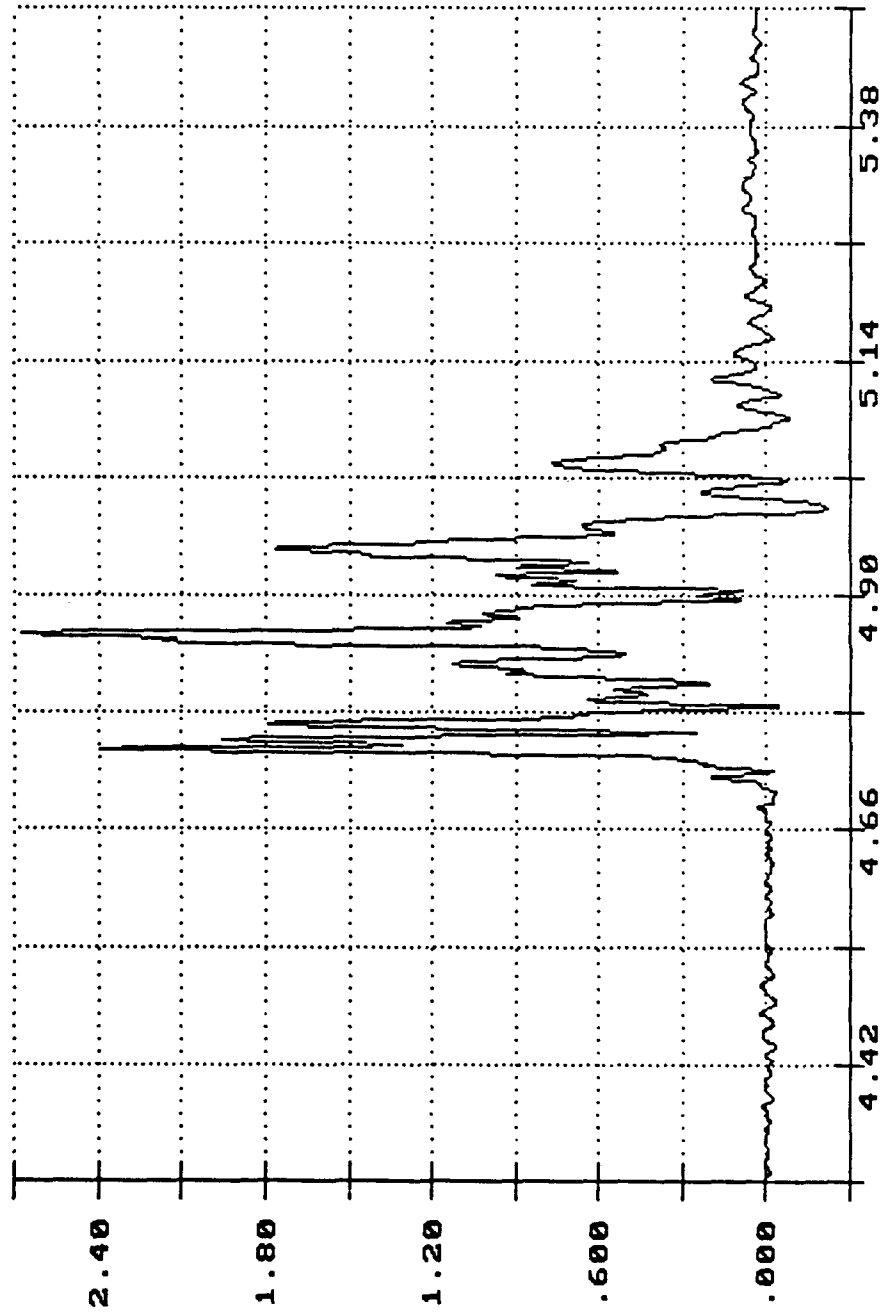
R.I. of 120mm Pallet, Impact 3: 8.33 MPH Nov 5 14:26:24 1991



Long. Accel.  
Bottom of Pallet  
Gs X 1.0000

Time of Sample  
Seconds X 1.0000

R.I. of 120mm Pallet, Impact 4: 9.38 MPH Nov 5 14:37:44 1991

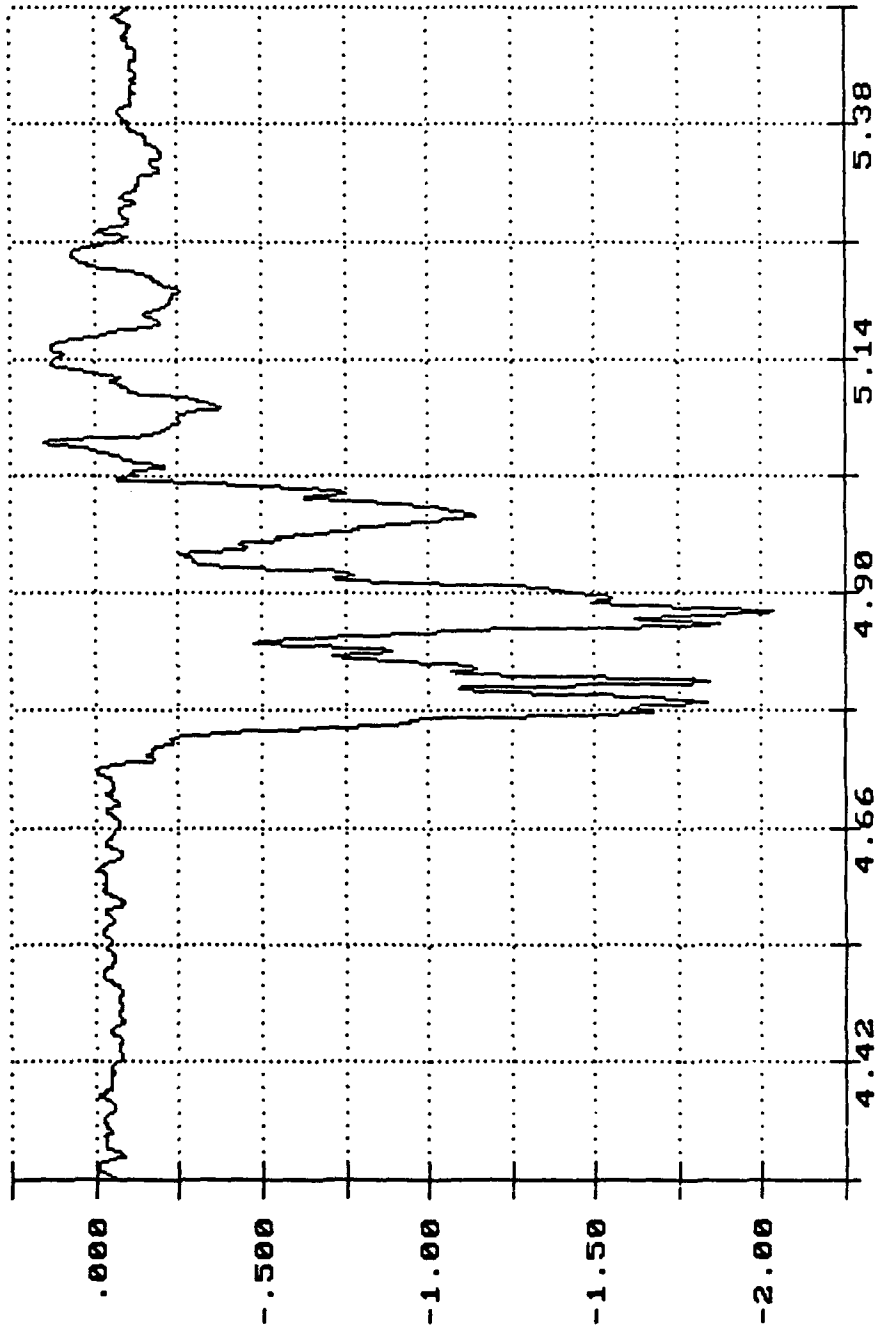


Long. Accel.  
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Cs X 1.0000

Time of Sample

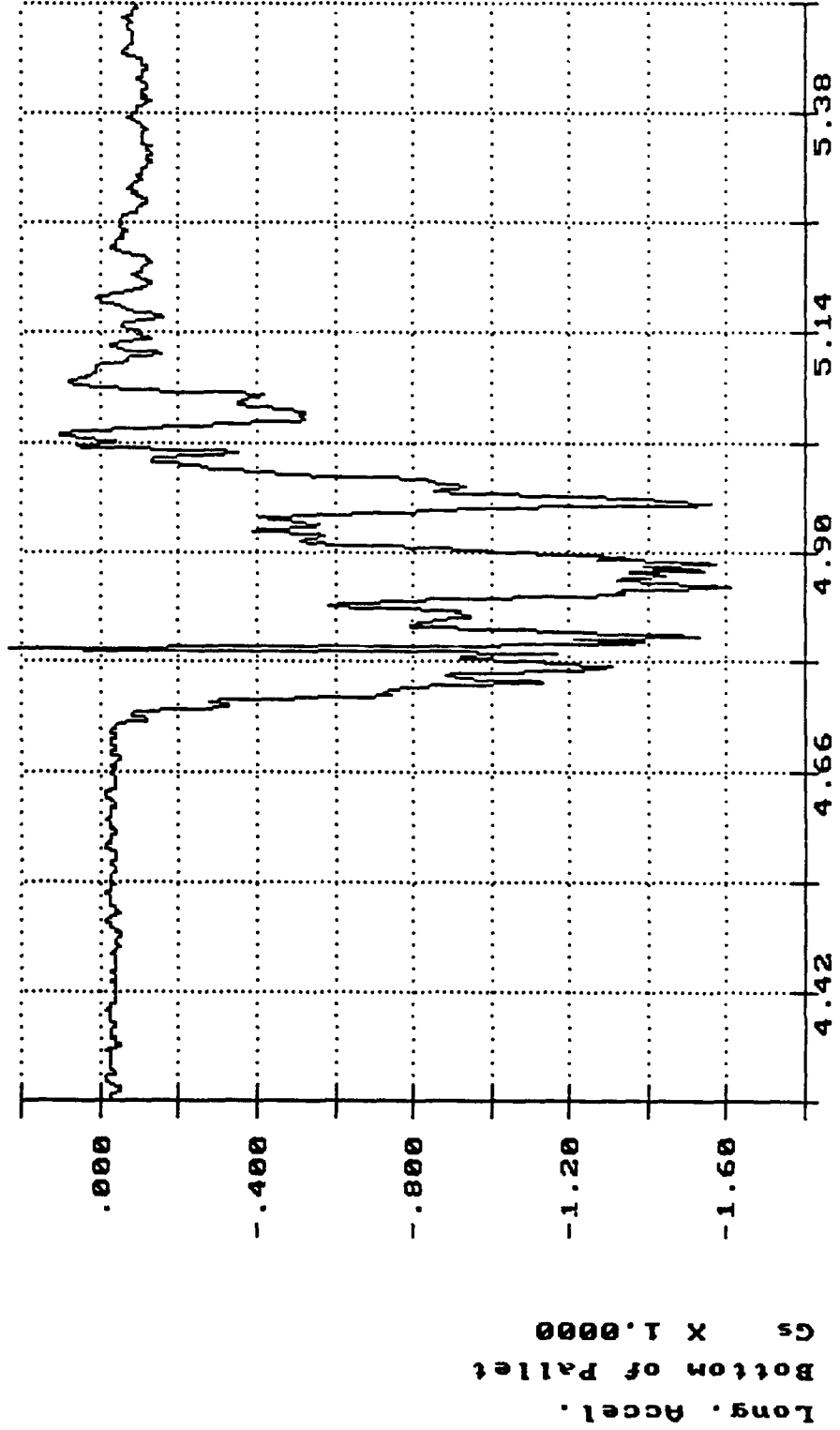
Seconds X 1.0000

R.I. of 120mm Pallet, Impact 4: 9.38 MPH Nov 5 14:37:44 1991



Time of Sample  
Seconds X 1.0000

R.I. of 120mm Pallet, Impact 4: 9.38 MPH Nov 5 14:37:44 199:



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
NSN	DODIC	DOT CLASS	CG CLASS	QD CLASS	COMP CLASS	(LBS)
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.

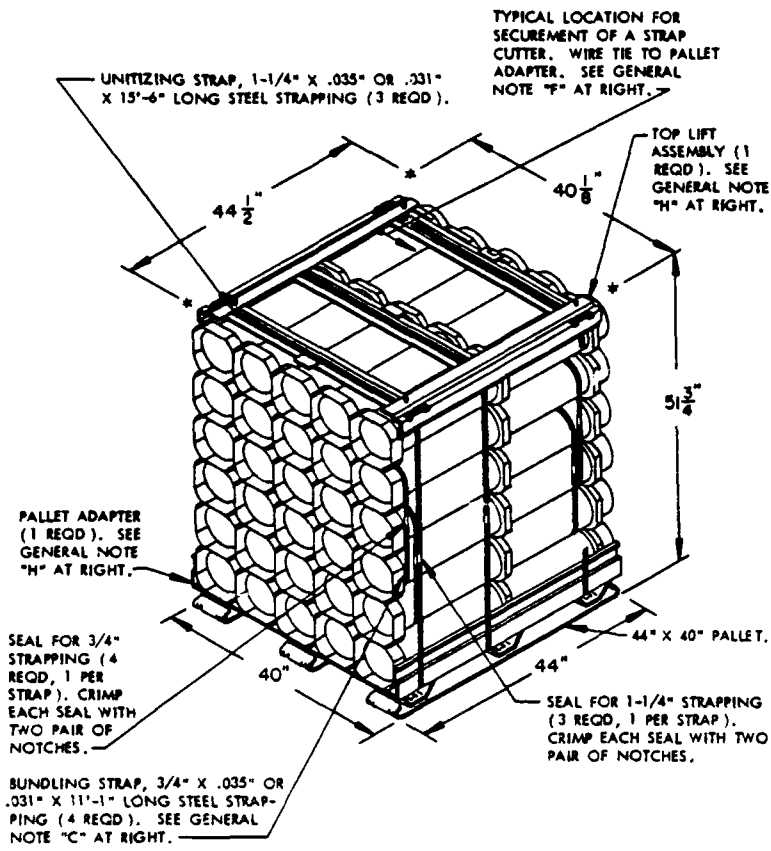
① HAZARD CLASSIFICATION DATA CONTAINED IN THE ABOVE CHART IS FOR GUIDANCE AND INFORMATIONAL PURPOSES ONLY. VERIFICATION OF THE SPECIFIED DATA SHOULD BE MADE BY CONSULTING THE MOST RECENT JOINT HAZARD CLASSIFICATION SYSTEM LISTING OR OTHER APPROVED LISTING(S).

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				<small>APPROVED BY ORDER OF COMMANDING GENERAL, U.S. ARMY AMMUNITION CENTER AND SCHOOL</small>		
				<small>U.S. ARMY AMMUNITION CENTER AND SCHOOL</small>		
				<b>U.S. ARMY AMC DRAWING</b>		
				<b>DECEMBER 1988</b>		
				CLASS	DIVISION	DRAWING
				19	48	4231/ 48
						FILE
						20PM 1006

**GENERAL NOTES**

- A. THIS APPENDIX CANNOT STAND ALONE BUT MUST BE USED IN CONJUNCTION WITH THE BASIC UNITIZATION PROCEDURES DRAWING 19-48-4231-20P M1006. 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 19-48-4127-20P1000.
- 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 (5) 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	
<b>TOTAL WEIGHT</b>		<b>2,444 LBS (APPROX)</b>
<b>CUBE</b>		<b>53.5 CU FT (APPROX)</b>

**BILL OF MATERIAL**

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