

AD-A207 178

2

REPORT NO. EVT 7-87

MIL-STD-1660 TEST

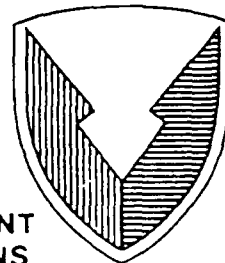
OF

ARENA ASSOCIATES STEEL REINFORCED  
PLASTIC PALLET

DECEMBER 1986

SDTIC  
ELECTE  
APR 25 1989  
E D

This document has been approved  
for public release and only its  
distribution is unlimited.



US ARMY  
ARMAMENT  
MUNITIONS  
CHEMICAL COMMAND

US ARMY DEFENSE AMMUNITION  
CENTER AND SCHOOL

EVALUATION DIVISION  
SAVANNA, ILLINOIS 61074-9639

89

4 25 037



20. ABSTRACT (continued)

design/material to pass final MIL-STD-1660 testing. Results of the testing indicate that the pallet, if redesigned to meet Army standards (increased capacity to 4,000 pounds, double-wing design, etc.) would have high probability of passing final MIL-STD-1660 testing.

REPORT NO. EVT 7-87  
MIL-STD-1660 TEST  
OF  
ARENA ASSOCIATES STEEL REINFORCED PLASTIC PALLET

DECEMBER 1986



<b>Accession For</b>	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
<b>Justification</b>	
By _____	
<b>Distribution/</b>	
<b>Availability Codes</b>	
<b>Dist</b>	<b>Avail and/or Special</b>
A-11	

Evaluation Division  
U.S. Army Defense Ammunition Center and School  
Savanna. IL 61074-9639

AVAILABILITY NOTICE

A copy of this report is furnished each attendee on automatic distribution. Additional copies or authority for reprinting may be obtained by written request from Director, U.S. Army Defense Ammunition Center and School.  
ATTN: SMCAC-DEV, Savanna, IL 61074-9639.

DISPOSITION INSTRUCTIONS

Destroy this report when no longer needed. Do not return.

\* \* \*

Citation of trade names in this report does not constitute an official endorsement.

\* \* \*

The information contained herein will not be used for advertising purposes.

\*\*\*ABSTRACT\*\*\*

The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV), has been tasked by the U.S. Army Armament, Munitions and Chemical Command, SMCAR-AEP, Picatinny Arsenal, NJ to perform engineering tests of the Arena Associates Steel Reinforced Plastic Pallet to assess potential for passing MIL-STD-1660, Military Standard Design Criteria for Ammunition Unit Loads. The 44- by 54-inch steel reinforced plastic pallet was subjected to an engineering test to assess the potential for this pallet design/material to pass final MIL-STD-1660 testing. Results of the testing indicate that the pallet, if redesigned to meet Army standards (increased capacity to 4,000 pounds, double-wing design, etc.) would have high probability of passing final MIL-STD-1660 testing.

U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL  
Evaluation Division  
Savanna, IL 61074-9639

REPORT NO. EVT 7-87

MIL-STD-1660 TEST  
OF  
ARENA ASSOCIATES STEEL REINFORCED PLASTIC PALLET

TABLE OF CONTENTS

PART	PAGE NO.
I. INTRODUCTION . . . . .	I-1
A. BACKGROUND . . . . .	I-1
B. AUTHORITY. . . . .	I-1
C. OBJECTIVE. . . . .	I-1
II. ATTENDEES. . . . .	II-1
III. TEST PROCEDURES. . . . .	III-1
IV. TEST EQUIPMENT . . . . .	IV-1
V. TEST RESULTS . . . . .	V-1
VI. CONCLUSIONS AND RECOMMENDATIONS . . . . .	VI-1
VII. PHOTOGRAPHS. . . . .	VII-1

PART I.

INTRODUCTION

A. INTRODUCTION. The U.S. Army Defense Ammunition Center and School, Evaluation Division, was tasked by the U.S. Army Armament, Munitions, and Chemical Command to test and evaluate the Arena Associates Steel Reinforced Plastic Pallet in accordance with MIL-STD-1660 testing requirements. Subject test specimen was loaded with ammunition boxes to a load weight of approximately 2,500 pounds and subjected to the test procedures. Although pallets are normally tested at 4,000 pounds, the available Arena Associates Pallet was only rated for 2,500 pounds and test weight was adjusted accordingly.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command.

C. OBJECTIVE. The objectives of these tests are to assess whether Arena Associates Steel Reinforced Plastic Pallet, if redesigned/modified, will meet Army functional/operating requirements covered for MIL-STD-1660, Design Criteria for Ammunition Unit Loads.



PART II.

ATTENDEES

A. C. McIntosh, Jr.  
Test Engineer

U.S. Army Defense Ammunition Center and School  
ATTN: SMCAC-DEV  
Savanna, IL 61074-9639  
AV 585-8989

Gayle Zajicek  
Project Engineer

U.S. Army Defense Ammunition Center and School  
ATTN: SMCAC-DEV  
Savanna, IL 61074-9639  
AV 585-8929

### PART III.

#### TEST PROCEDURES

The test procedures outlined in this section are extracted from MIL-STD 1660, Design Criteria for Ammunition Unit Loads dated 8 April 1977. This standard identifies nine steps that a unitized load must undergo if it is considered to be acceptable. These tests are synopsized below:

1. STACKING TESTS. The unit load shall be loaded to simulate a stack of identical unit loads stacked 16-feet high, for a period of one hour. This stacking load is simulated by subjecting the unit load to a compression of weight equal to an equivalent 16-foot stacking height. The compression load is calculated in the following manner. The unit load weight is divided by the unit load height in inches and multiplied by 192. The resulting number is the equivalent compressive force of a 16-foot high load.
2. REPETITIVE SHOCK TEST. The repetitive shock test shall be conducted in accordance with Method 5019, Federal Standard 101. The test procedure is as follows. The test specimen shall be placed on, but not fastened to, the platform. With the specimen in one position, vibrate the platform at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of about 3-cycles per second. Steadily increase the frequency until the package leaves the platform. The resonant frequency is achieved when a 1/16-inch thick feeler may be momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or a platform acceleration achieves one plus or minus zero point one G. Midway into the testing period

the specimen shall be rotated 90-degrees and the test continued for the duration. If failure occurs, the total time of vibration shall be two hours if the specimen is tested in one position; and if tested in more than one position, the total time shall be three hours.

3. EDGEWISE DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the Edgewise Drop (Rotational) Test is as follows: The specimen shall be placed on its bottom with one end of the base of the container supported on a sill nominally 6-inches high. The height of the sill shall be increased if necessary to ensure that there will be no support for the base between the ends of the container when dropping takes place, but should not be high enough to cause the container to slide on the supports when the dropped end is raised for the drops. The unsupported end of the container shall then be raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection shall conform to the following tabulation.

GROSS WEIGHT NOT EXCEEDING	DIMENSIONS ON ANY EDGE NOT EXCEEDING	HEIGHT OF DROP LEVEL A PROTECTION
Pounds	Inches	Inches
600	72	36
3,000	no limit	24
no limit	no limit	12

4. IMPACT TEST. This test shall be conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the Incline-Impact Test is as follows:

The specimen shall be placed on the carriage with the surface or edge which is to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage shall be brought to a predetermined position on the incline and released. If it is desired to concentrate the impact on any particular position on the container, a 4x4-inch timber may be attached to the bumper in the desired position before the test. No part of the timber shall be struck by the carriage. The position of the container on the carriage and the sequence in which surfaces and edges are subjected to impacts may be at the option of the testing activity and will depend upon the objective of the tests. When the test is to determine satisfactory requirements for a container or pack, and unless otherwise specified, the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact shall be 7 feet per second.

5. TIP OVER TEST. This test shall be performed only if the weight and balance of the specimen are such that the unit load will tip over when an edge is lifted significantly to form a 20-degree angle with the floor. The procedure for this test is Method 5018 of Federal Standard 101.

The procedure for the Tip Over Test is as follows: The specimen shall be placed on its bottom and slowly tipped until it falls freely (by its own weight) on its side to a smooth level concrete slab or similar unyielding

surface. Unless otherwise specified, two of these tip overs shall be made, one on each side or 180-degrees apart on a cylinder. A record shall be made of any changes or breaks in the container, such as apparent racking, nail poke, or broken parts and their locations. The packing (blocks, braces, cushions, or other devices) and the contents shall be examined carefully and a record made of their condition.

6. FORKLIFTING TEST. This test shall be conducted by using the procedures of Method 5011 of Federal Standard 101, Procedure 6.2, Lifting and Transporting by Forklift Truck. The forklift hazard course that will be used is shown in Figure 1.

The procedure for the lifting and transporting by forklift truck test is as follows. The specimen shall be lifted clear of the ground by a forklift truck at one side of the specimen and transported on the forks in the level or back tilt position across the alternate hazard course. The forklift must carry the specimen over the hazard course in about 23 seconds and then shall be brought to a stop. The specimen shall be carefully observed during the traverse and while the forklift is at a stop for any damage, evidence of inadequacy, or deflection of the specimen that might cause damage or displacement of the contents. The specimen shall be then lowered onto the ground. The forklift shall be moved from the side to the end of the specimen. The forks shall be run under the specimen as far as possible and then operated to lift the end 6 inches. Observe the specimen, particularly in the vicinity of the ends of the forks and record observations. If the specimen can thus be lifted clear of the floor, transported on the forks over the same hazard course, record

observation. If it cannot be thus lifted, report the length of forks used and state that the specimen could not be carried on the forklift truck at either end.

7. PALLET TRUCK TEST. Unit loads which are designed to accept pallet trucks shall be lifted clear of the ground, transported a distance of at least 50-feet and lowered. Tests shall be conducted four times, i.e., forks entering the pallet from each side of the load. Any tendency for the unit load to be unstable while on forks, or any difficulty in searching or moving forks, shall be cause for rejection.

8. SLING COMPATIBILITY TEST. Unit loads utilizing special design for non-standard pallets shall be lifted, slung, lowered, and otherwise handled as necessary using slings of the types normally used for handling the unit loads under consideration. Slings shall be easily attached and removed. Danger of slippage or disengagement when load is suspended shall be cause for rejection of the unit load.

9. DISASSEMBLY TEST. Following all rough handling tests, the unit load may be squared up within 2 inches of its original shape and on a flat level surface. The strapping shall then be cut and removed from the palletized load. Assembly of the load shall be such that it retains its unity upon removal of the strapping.

PART IV.

TEST EQUIPMENT

1. TEST SPECIMEN.

- a. Width: 44 inches
- b. Length: 54 inches
- c. Height: 48-3/4 inches
- d. Weight: 2,545 pounds

2. COMPRESSION TESTER.

- a. Manufacturer: Conbur Incline
- b. Platform: 60 inches by 60 inches
- c. Compression Limit: 50,000 pounds
- d. Tension Limit: 50,000 pounds

3. TRANSPORTATION SIMULATOR.

- a. Manufacturer: Gaines Laboratory
- b. Capacity: 6,000-pound pallet
- c. 1/2-inch Amplitude
- d. Speed: 50 to 3000 cpm
- e. Platform: 5 foot by 8 foot

4. INCLINED RAMP.

- a. Manufacturer: Conbur Incline
- b. Impact Tester
- c. 10% Incline
- d. 12-foot Incline

5. Forklift Rough Handling Course.

PART V.

TEST RESULTS

1. STACKING TEST. Pallet Weight - 2,545 pounds  
Pallet Height - 48.75 inches  
Test Load - 10,023 pounds

The subject pallet was loaded to 11,000 pounds compression for a period of one hour. At the end of this period of time, the compressive load had decreased to 10,000 pounds. When the compression load was removed and test specimen removed from the Compression Tester, no measurable deformation in the load was evident.

2. REPETITIVE SHOCK TEST. Subject pallet successfully passed a longitudinal transportation test simulation for a 90-minute test period. Rotating the pallet 90 degrees and subjecting it to a second 90-minute period in the Transportation Simulator caused no damage to the pallet or strapping. In order to achieve a 1/16th clearance between the pallet and the transportation simulator bed, the equipment was operated at 3.3 hertz.

3. EDGEWISE DROP TEST. Each side of the pallet base is placed on a beam displacing it six inches above the floor. The opposite side is raised to a height of 24 inches above the floor and then dropped. This process is repeated in either a clockwise or counterclockwise direction on all four sides of the pallet. In performing this test, no damage occurred to the unit load contents. Some of the webs in the pallet collapsed and several cracks developed in the skid base during this test, although the damage to the pallet was not significantly enough to cause the unitized load to come



apart. The damage experienced creates concern over continued use of the pallet and the increased areas for nuclear, biological, chemical (NBC) contamination. Any further design efforts should consider correction of this problem area.

4. IMPACT TEST. The loaded pallet was subjected to impact testing once on each side. A web strap was used to hold subject pallet on the impact sled. A transducer was attached opposite the side for each impact to record the amount of deceleration imparted to the load on impact. Recorded data is tabulated as follows:

<u>SIDE IMPACTED</u>	<u>G's RECORDED</u>
Longitudinal	1.6
Lateral	2.9
Longitudinal	1.9
Lateral	2.5

5. TIP OVER TEST. The center of gravity of the loaded pallet was low enough that it did not present an unstable load when lifted above 20 degrees from the loading surface. On this basis, this test was not performed.

6. FORKLIFTING TEST. The Forklifting Test was accomplished while moving the pallet between test stations and a storage building over a gravel road. All forks were engaged in the fork pockets provided on the pallet. When engaging a load from a lateral side, the fork tines became entangled with the banding used to secure the load. This was the only drawback noted in this particular unitization. Any redesign efforts undertaken should include elimination or mitigation of this problem area.

7. PALLET TRUCK TEST. The Pallet Truck Test was marginal in the fact that the fork pockets along the 54-inch length of the pallet have a 2-inch vertical opening. This narrow window restricts insertion of a pallet truck for lifting and transporting the load. Fork pockets along the width of the pallet are adequate for handling the unit with a pallet truck. This problem identified should be considered in any future design efforts.

8. SLING COMPATIBILITY TEST. This pallet is of a non-standard design and does not necessarily conform to the design guidelines of MIL-P-15011 in the fact that they require a double-wing design so that slings can be emplaced at the outer edge of the pallet. The design of this pallet is such that all corners are rounded and filled out. The overhang provided by MIL-P-15011 requires that skids be indented from the edge of the pallet to permit acceptance of slings for movement. It is possible to sling this pallet, however, the sling must be manually fed through a fork pocket on either side of the pallet. In order to get a sling through the pallet, an additional tool is required to extend the sling out the opposite side in order to complete the loop. This is not an acceptable method to sling due to the added time and special tool required. Removal of the sling is quite simple. During the tests, there was no slippage or disengagement of the load while it was suspended in the manner described.

9. DISASSEMBLY TEST. When all of the tests were completed, the unit load strapping was removed and the unit load retained its unity.

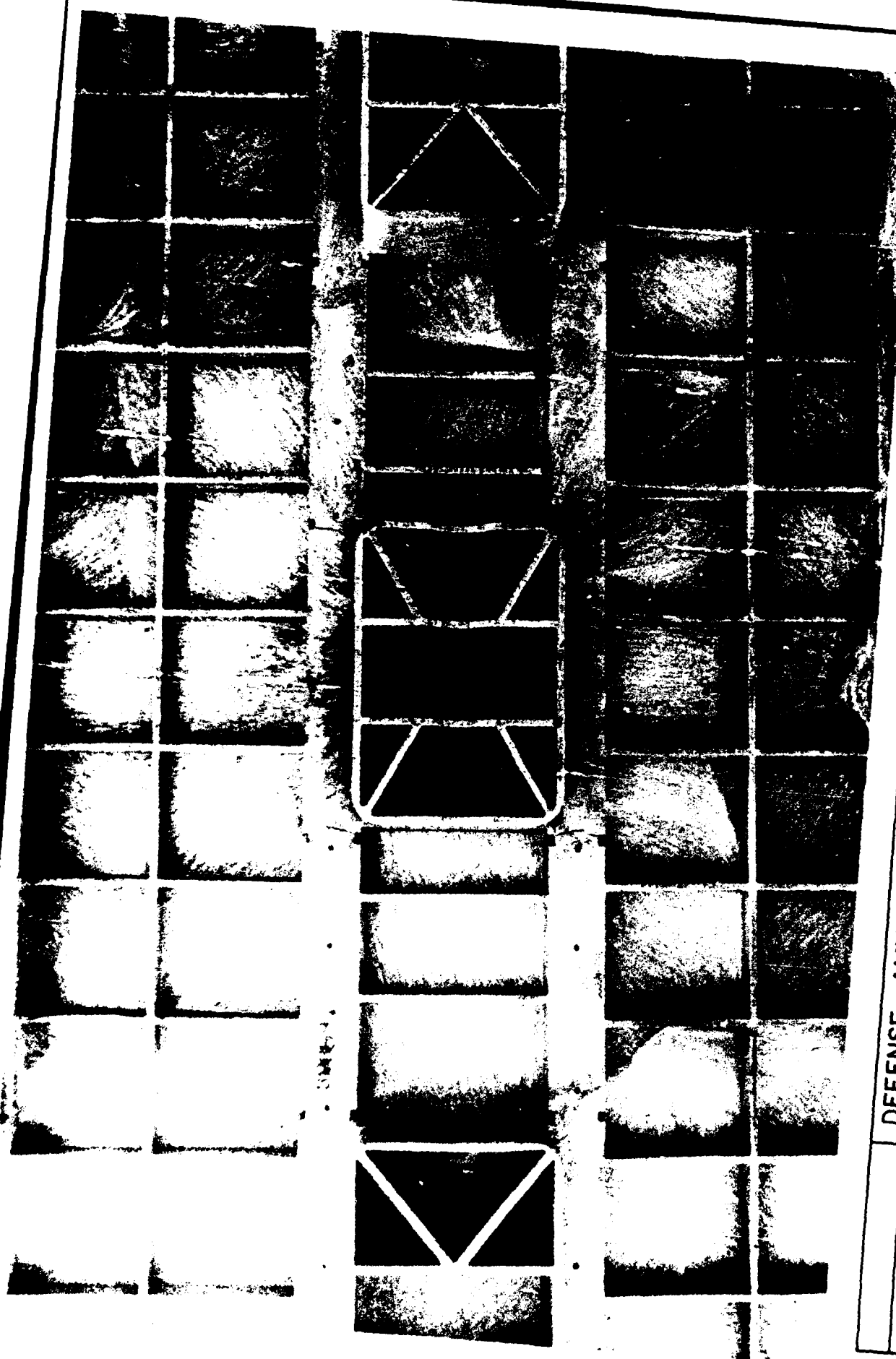
PART VI.

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS. The Arena Associates Steel Reinforced Plastic Pallet remained intact while being tested. Some deformation of the pallet bridges in the fork pockets collapsed because of metal banding used to secure the load to the pallet. During Transportation Simulation and Edgewise Drop Test, the pallet covering had a tendency to crack and in some cases chip. This breakage did not detract from the strength of the unitization nor in its ability to remain intact. Attempts to sling this pallet required more effort than pallets designed to MIL-P-15011 due to the fact that the pallet was not designed with a double-wing configuration. The pallet width and length of 44 and 54 inches, respectively, is larger than the sizes specified in MIL-P-15011 and NATO STANAG 2828. The available pallet was only rated to 2,500 pounds, so testing could not be accomplished with the required 4,000 pound load.

2. RECOMMENDATIONS. The Arena Associates Steel Reinforced Plastic Pallet does not conform to the physical configuration required in STANAG 2828 and MIL-P-15011, and is not suitable for transportation of ammunition in the submitted design configuration. If the pallet were properly configured and designed to correct the deficiencies noted within this test report, it would, based on the test results, appear to have high probability of meeting MIL-STD-1660 requirements.

PART VII.  
PHOTOGRAPHS



**DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL**

Photo No. EVT 7-87-6. This photo shows a bottom view of the Arena Associates Steel Reinforced Plastic Pallet as it arrived at the U.S. Army Defense Ammunition Center and School.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. EVT 7-87-8. This photo shows the Arena Associates Steel Reinforced Plastic Pallet loaded with a test load and ready for a Compression Test.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

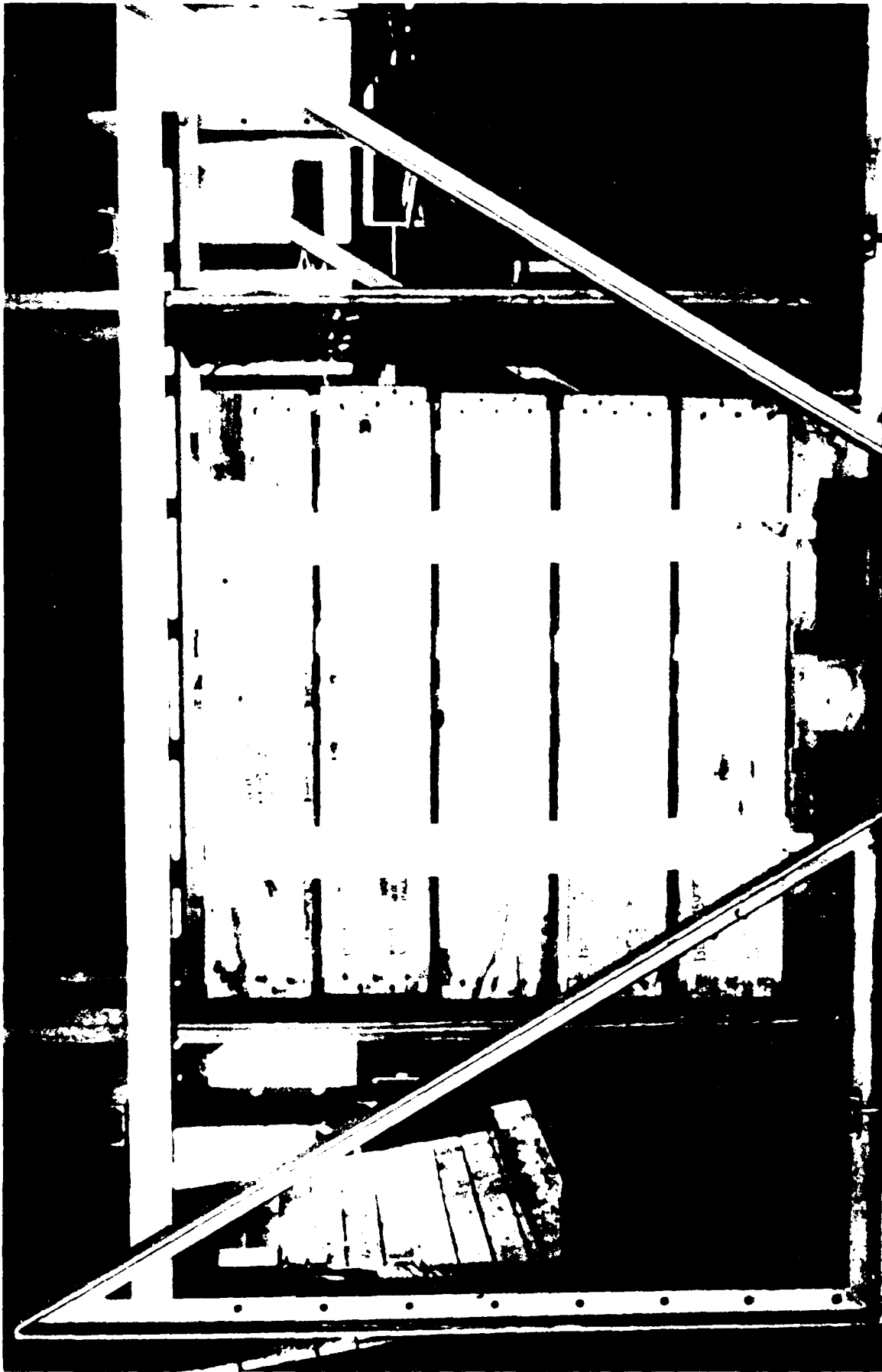
Photo No. EVT 7-87-11. This photo shows the breakup experienced in the side fork pockets of the Arena Associates Steel Reinforced Plastic Pallet from normal strap tightening.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. EVT 7-87-20. This photo shows a bottom view of the Arena Associates Steel Reinforced Plastic Pallet showing a crack developing on the underneath side where a retaining screw for the metal reinforcement rod is placed.





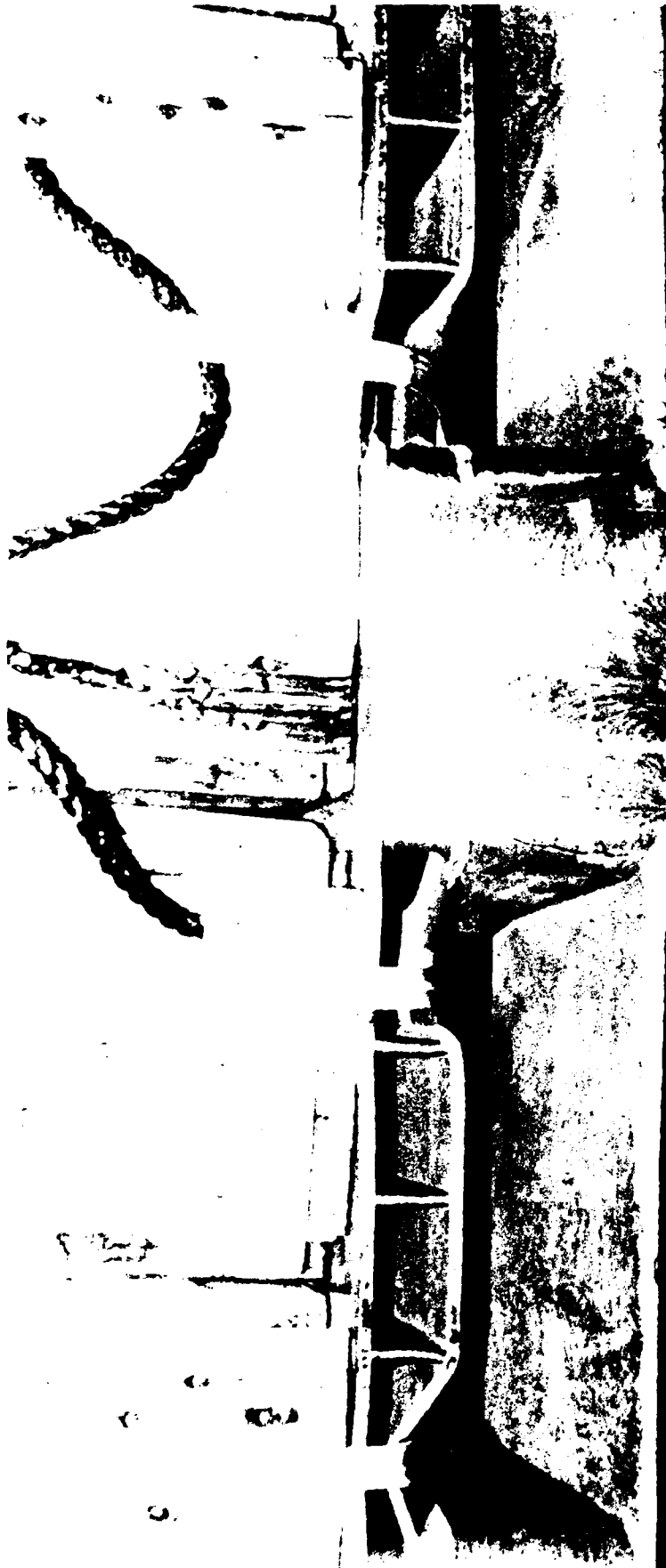
DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. EVT 7-87-22. This photo shows the Arena Associates Steel Reinforced Plastic Pallet mounted in the Transportation Simulator in the lateral configuration.



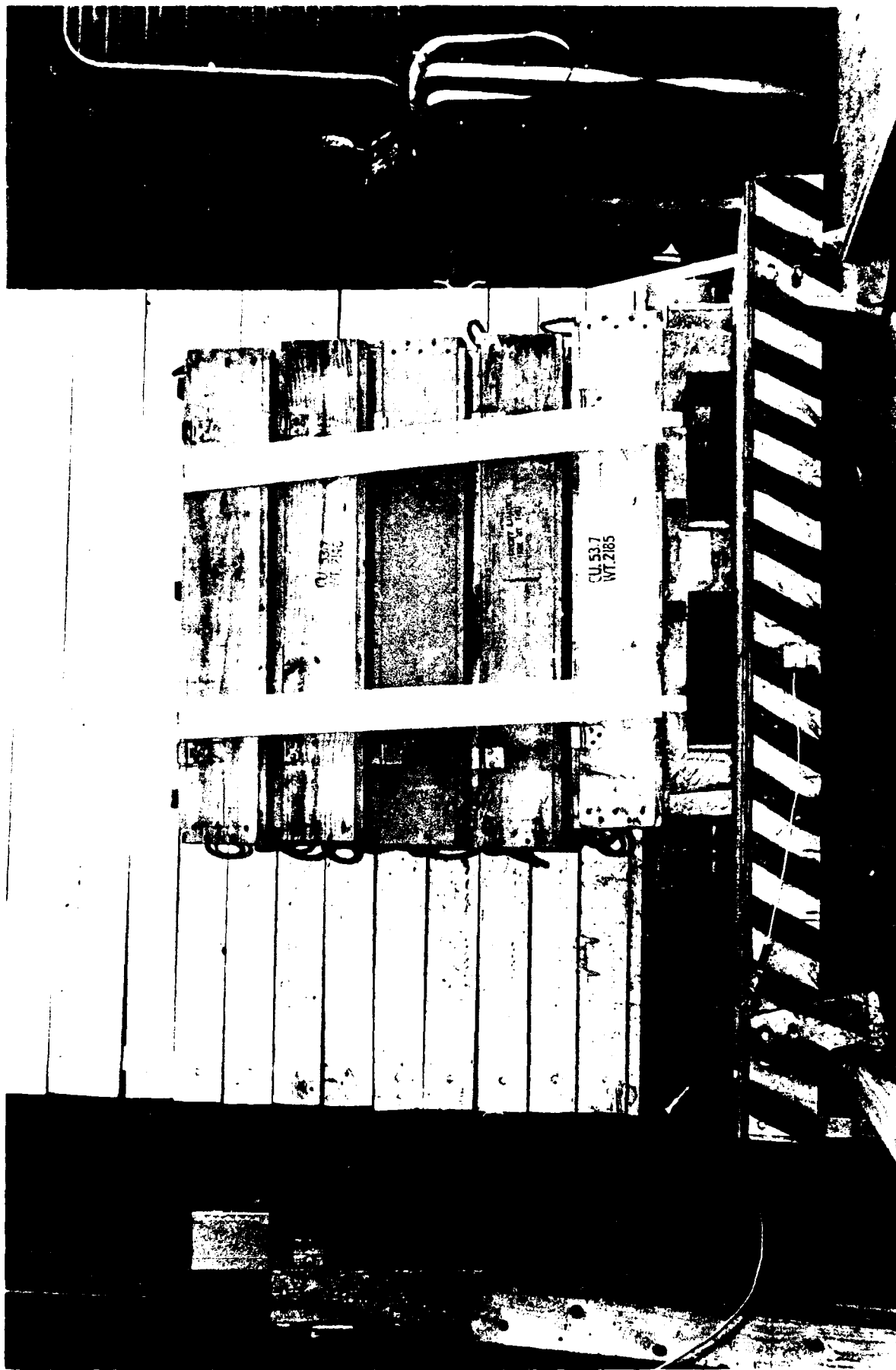
DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. EVT 7-87-24. This photo shows the Arena Associates Steel Reinforced Plastic Pallet raised for the Rotational Drop Test. The pallet is dropped once from a 24-inch height on each side of the pallet.



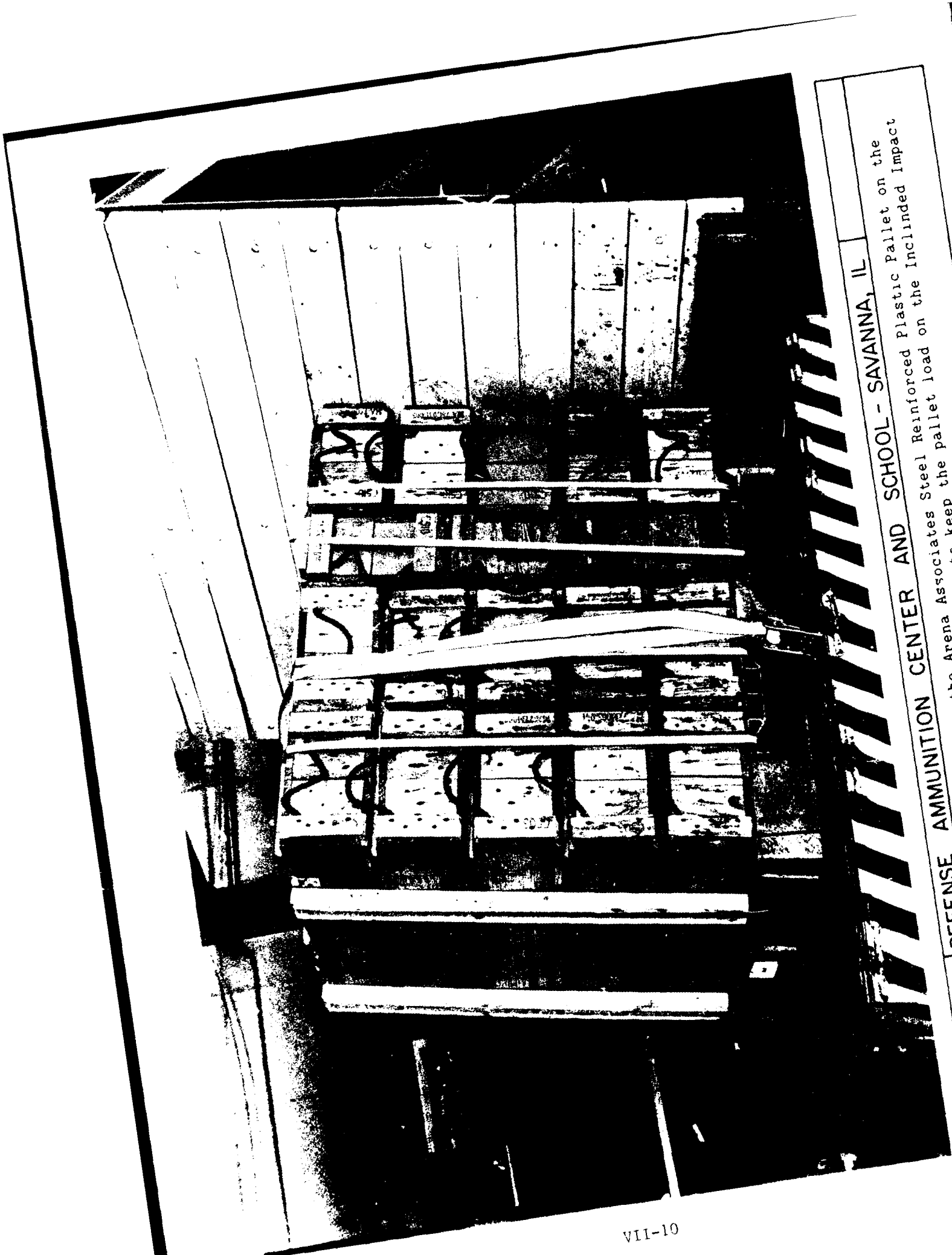
DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. EVT 7-87-31. This photo shows a close-up view of the side fork pockets and the damage to the pallet reinforcement webs caused by banding as it is progressed through the Rotational Drop Test.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. EVT 7-87-33. This photo shows the Arena Associates Steel Reinforced Plastic Pallet with its load on the Inclined Impact Tester. Notice the accelerometer mounted on the Inclined Impact Tester Sled. It is used to measure the impact forces which are tabulated in Part V, Section 4.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. EVT 7-87-34. This photo shows the Arena Associates Steel Reinforced Plastic Pallet on the Inclined Impact Tester. Notice the use of a web strap to keep the pallet load on the Inclined Impact Tester Sled. Impact velocities are 7-feet per second.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

IN 1. No. 8717 at 35. This photo shows a close up of the side talk packer's wire straps as they apply to hold the unitized load in place. Note the reinforcing webs yielding under the stress of testing.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. EVT 7-87-36. This photo shows the Arena Associates Steel Reinforced Plastic Pallet after impact. Note that some of the blocking on the pallet has broken under the impact stress and that some of the inert loaded ammunition boxes are coming apart on the lower levels.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. EVT 7-87-37. This photo shows the Arena Associates Steel Reinforced Plastic Pallet on the Inclined Impact Tester ready for impacting on the lateral length side.