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AUGUST 1990

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MIL-STD-1660 TESTS OF VOLCANO PALLET AND PALLET ADAPTER

Prepared for:

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U.S. Army Armament Research, Development
and Engineering Center
ATTN: SMCAR-ESK
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VALIDATION ENGINEERING DIVISION
SAVANNA, ILLINOIS 61074-9639

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The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by the U.S. Army Armament Research, Development and Engineering Center, SMCAR-ESK, Rock Island, IL to test the Volcano pallet and pallet adapter. This report contains the procedures, results, and recommendations from the MIL-STD-1660 tests conducted. As tested, the Volcano pallet and pallet adapter successfully passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

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REPORT NO. EVT 15-90-1

MIL-STD-1660 TESTS ON VOLCANO PALLET AND PALLET ADAPTER

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PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School, Evaluation Division (SMCAC-DEV), was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-ESK, to test the Volcano pallet and pallet adapter.

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

C. OBJECTIVE. The objective of this series of tests was to assess the ability of the Volcano pallet and pallet adapter to prevent damage during transportation. Also, the test was done three times to assure that the pallet complies with the MIL-STD-1660 requirements.

PART 2

MIL-STD-1660 TESTS ON

VOLCANO PALLET AND PALLET ADAPTER

AUGUST 1990

TEST ATTENDEES

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PART 3

TEST PROCEDURES

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

1. SUPERIMPOSED LOAD TEST. The unit load shall be loaded to simulate a stack of identical unit loads stacked 16 feet high for a period of one hour as specified in Method 5016, Federal Standard 101. 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 multiplied by 192 minus the unit height in inches then divided by the unit height in inches, it is then multiplied by a safety factor of two. 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 gage 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 1 ± 0.1G. Midway into the testing period, the specimen shall be rotated 90 degrees, and the test continued for the duration. Unless failure occurs, the total time of vibration shall be two hours when the specimen is tested in one position. When the specimen is tested in more than one position, the total time shall be three hours.

3. EDGEWISE ROTATIONAL DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The test procedure for the Edgewise Rotational Drop Test is as follows: The specimen shall be placed on its skids with one end of the pallet supported on a beam 4-1/2 inches high. The height of the beam shall be increased, if necessary, to ensure that there will be no support for the skids between the ends of the pallet when dropping takes place, but should not be high enough to cause the pallet to slide on the supports when the dropped end is raised for the drops. The unsupported end of the pallet 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. INCLINE-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 two 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 4- by 4-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. MECHANICAL HANDLING TEST. This test shall be conducted by using Method 5011, Federal Standard 101. Unit loads utilizing special design for nonstandard 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.

PART 4

TEST EQUIPMENT

1. TEST PALLET.

a. Drawing Number:	AC200000414
b. Unitization:	5 high X 4 wide
c. Width:	28-13/16 inches (73.2cm)
d. Length:	59 inches (149.9cm)
e. Height:	41-1/4 inches (104.8cm)
f. Weight:	1,905 pounds (864kg)

2. COMPRESSION TESTER.

a. Manufacturer:	Ormond Manufacturing
b. Platform:	60 inches by 60 inches
c. Compression Limit:	50,000 pounds
d. Tension Limit:	50,000 pounds

3. TRANSPORTATION SIMULATOR.

a. Manufacturer:	Gaynes Laboratory
b. Capacity:	6,000-pound pallet
c. Displacement:	1/2-inch Amplitude
d. Speed:	50 to 400 rpm
e. Platform:	5 foot by 8 foot

4. INCLINED RAMP.

a. Manufacturer:	Conbur Incline
b. Type:	Impact Tester
c. Grade:	10 percent Incline
d. Length:	12-foot Incline

PART 5

TEST RESULTS

MIL-STD-1660 TESTS

FIRST ITERATION

1. SUPERIMPOSED LOAD TEST. The test pallet was loaded to 14,200-pounds compression for a period of one hour. Periodic adjustments were made to maintain the desired stacking weight of 14,200-pounds. At the end of one hour, no noticeable deformation of the pallet or pallet assemblies was noted.

2. REPETITIVE SHOCK TEST. The test pallet successfully passed the longitudinal and lateral transportation simulations. Duration of the test was 90 minutes for each orientation of the pallet. In order to achieve the required 1/16-inch minimum clearance between the pallet and the transportation simulator bed, the equipment was operated at 185 rpm for the longitudinal orientation and 165 rpm for the lateral orientation.

3. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam displacing it 4-1/2 inches above the floor. The first drop was the bell end of the pallet dropped from a height of 24 inches per MIL-STD-1660 specifications. This process was repeated in a clockwise direction until all four sides of the pallet had been tested. Since the pallet is susceptible to tipping, the sides were only dropped from 16 inches instead of 24 inches. The third drop, the base end, was dropped and because of the poor quality of the PA113 Volcano containers, four stacking pins on the bell end of the containers sheared off, causing the containers on three and a half layers to shift forward 2-1/2 inches. The problem was due to bent stacking ports, since some stacking lugs were not engaged in the containers above. The faulty containers were replaced and the remaining containers were repaired to continue on with testing.

MIL-STD-1660 resumed after re-unitization of the pallet. No noticeable deformation of the pallet or pallet assemblies was noted.

4. INCLINE-IMPACT TEST. The incline plane was set to allow the pallet to travel 8 feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. No noticeable deformation of the pallet or pallet assemblies was noted.

5. MECHANICAL HANDLING TEST. The sling test consisted of four different lifting configurations using the top adapter assembly and a four legged sling. The sling configurations included a three corner, two alternate corners, two adjacent corners, and a single corner lift. No noticeable deformation of the pallet or pallet assemblies was noted.

6. END OF TEST INSPECTION. During final inspection of the pallet and pallet assemblies, there were slight cracks approximately 1/4-inch on the outer attachment points of the pallet skids, which is not failure. No other damage was noted.

TEST RESULTS

MIL-STD-1660

SECOND ITERATION

1. SUPERIMPOSED LOAD TEST. The test pallet was loaded to 14,200-pounds compression for a period of one hour. Periodic adjustments were made to maintain the desired stacking weight of 14,200-pounds. At the end of one hour, no noticeable deformation to the pallet or pallet assemblies was noted.

2. REPETITIVE SHOCK TEST. The test pallet successfully passed the longitudinal and lateral transportation simulations. Duration of the test is 90 minutes for each orientation of the pallet. In order to achieve the required 1/16 inch minimum clearance between the pallet and the transportation simulator bed, the equipment was operated at 195 rpm for the longitudinal orientation and 175 rpm for the lateral orientation.

3. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam displacing it 4-1/2 inches above the floor. The first drop was the bell end of the pallet dropped from a height of 24 inches per MIL-STD-1660 specifications. This process was repeated in a clockwise direction until all four sides of the pallet had been tested. Since the pallet is susceptible to tipping, the sides were only dropped from 16 inches instead of 24 inches. No noticeable deformation of the pallet or pallet assemblies was noted.

4. INCLINE-IMPACT TEST. The incline plane was set to allow the pallet to travel 8 feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. No noticeable deformation of the pallet or pallet assemblies was noted.

5. MECHANICAL HANDLING TEST. The sling test consisted of four different lifting configurations using the top adapter assembly and a four legged sling. The sling configurations included a three corner, two alternate corners, two adjacent corners, and a single corner lift. No noticeable deformation of the pallet or pallet assemblies was noted.

6. END OF TEST INSPECTION. During final inspection of the pallet and pallet assemblies, there were slight cracks approximately 1/4-inch on the outer attachment points of the pallet skids, which is not failure. No other damage was noted.

TEST RESULTS

MIL-STD-1660

THIRD ITERATION

1. SUPERIMPOSED LOAD TEST. The test pallet was loaded to 14,200-pounds compression for a period of one hour. Periodic adjustments were made to maintain the desired stacking weight of 14,200-pounds. At the end of one hour, no noticeable deformation of the pallet or pallet assemblies was noted.

2. REPETITIVE SHOCK TEST. The test pallet successfully passed the longitudinal and lateral transportation simulations. Duration of the test was 90 minutes for each orientation of the pallet. In order to achieve the required 1/16-inch minimum clearance between the pallet and the transportation simulator bed, the equipment was operated at 190 rpm for the longitudinal orientation and 175 rpm for the lateral orientation.

3. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam displacing it 4-1/2 inches above the floor. The first drop was the bell end of the pallet dropped from a height of 24 inches per MIL-STD-1660 specifications. This process was repeated in a clockwise direction until all four sides of the pallet had been tested. Since the pallet is susceptible to tipping, the sides were only dropped from 16 inches instead of 24 inches. No noticeable deformation of the pallet or pallet assemblies was noted.

4. INCLINE-IMPACT TEST. The incline plane was set to allow the pallet to travel 8 feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. No noticeable deformation of the pallet or pallet assemblies was noted.

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6. END OF TEST INSPECTION. During final inspection of the pallet and pallet assemblies, there were slight cracks approximately 1/4-inch on the outer attachment points of the pallet skids, which is not failure. No other damage was noted.

PART 6

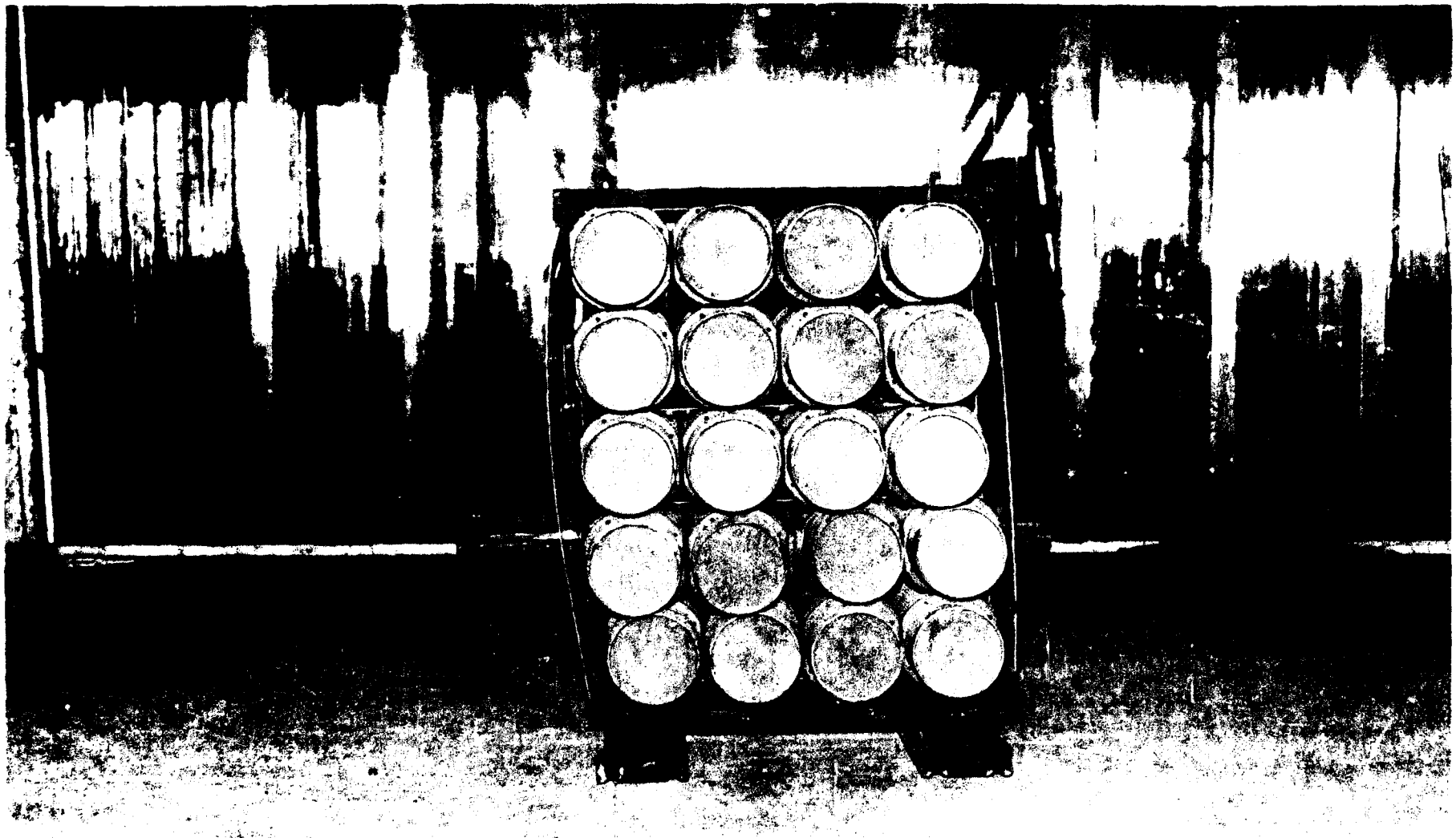
CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS. The Volcano pallet and pallet adapter passed MIL-STD-1660 design criteria for ammunition unit loads. Except for the damage to the substandard containers in the first iteration of MIL-STD-1660, which allowed the containers to shift substantially, no problems occurred during subsequent testing.

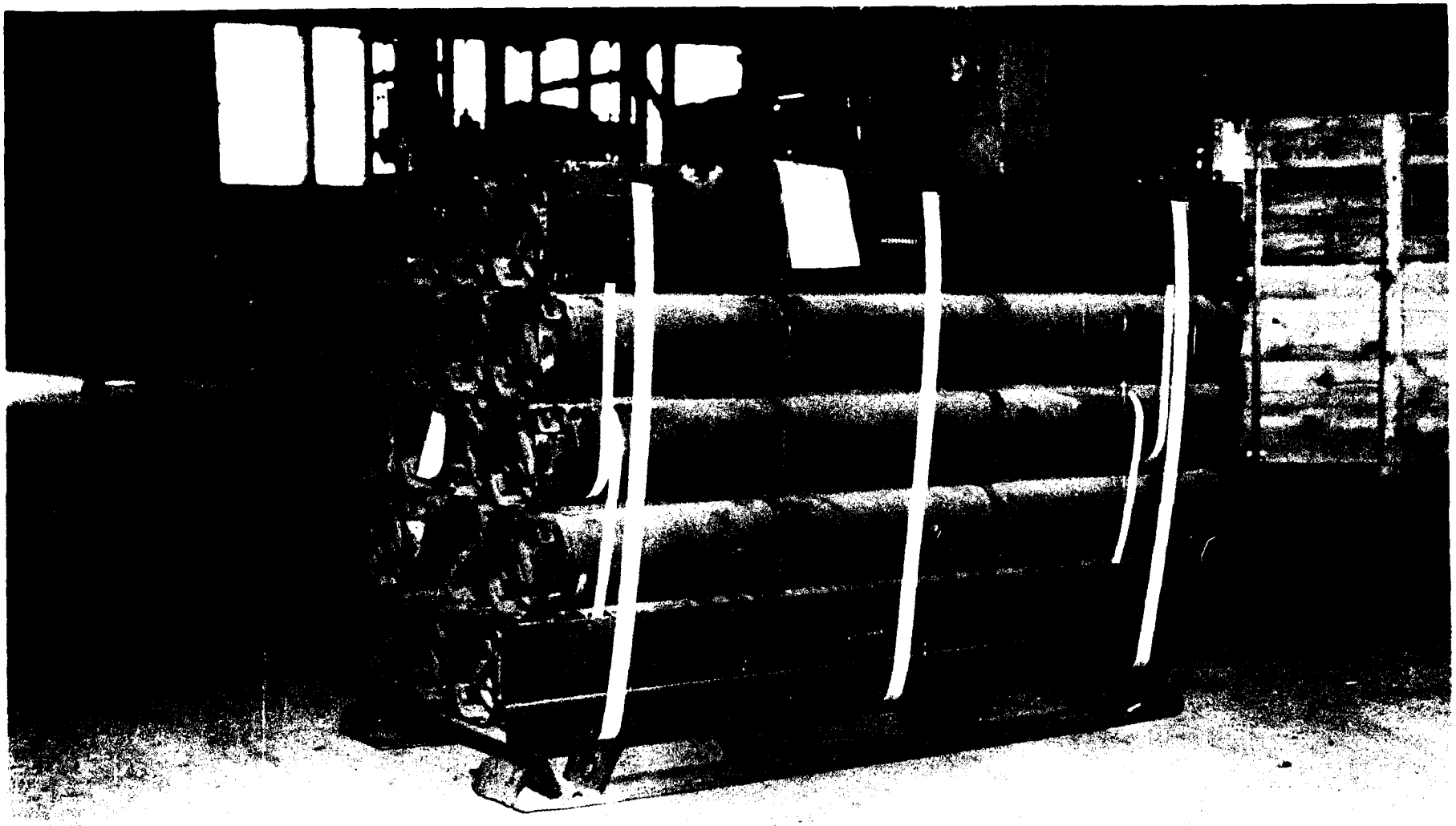
2. RECOMMENDATION. Assure all PA113 containers are in good condition while unitizing. The stacking pins must engage in the upper container for safe palletization.

PART 7

PHOTOGRAPHS



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-354-5327. This photo shows the deformation of the unitized load following the first iteration of testing.		



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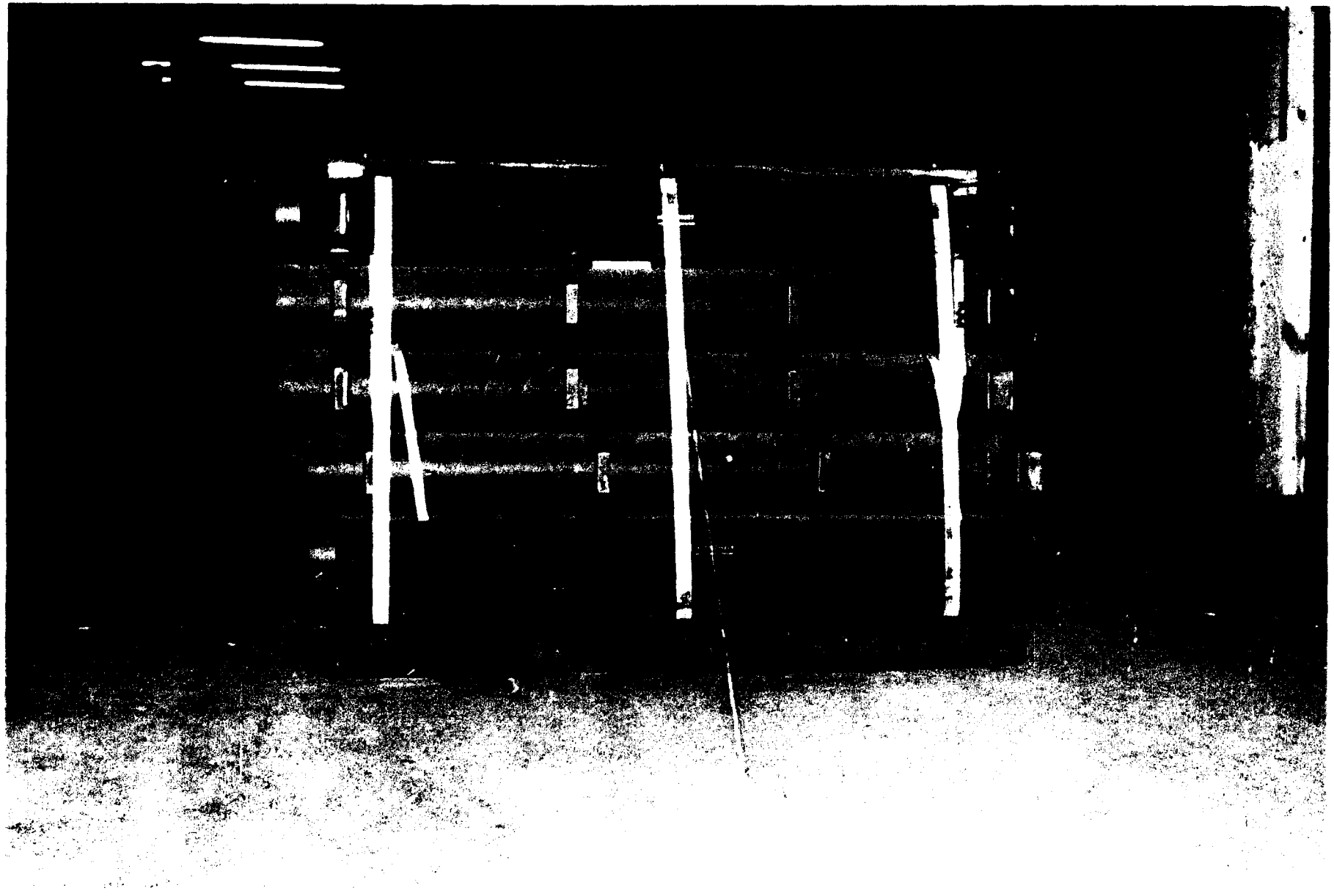

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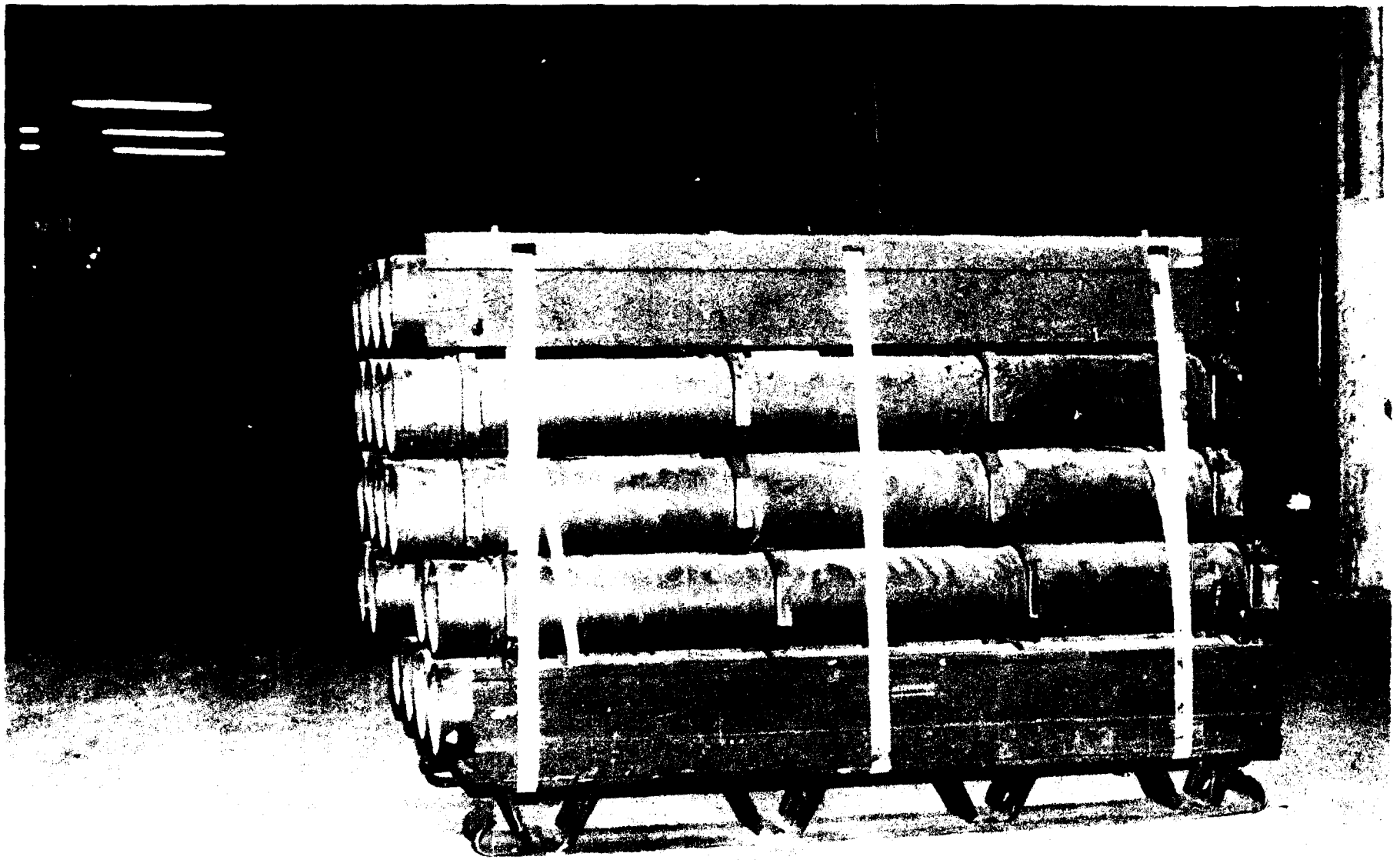

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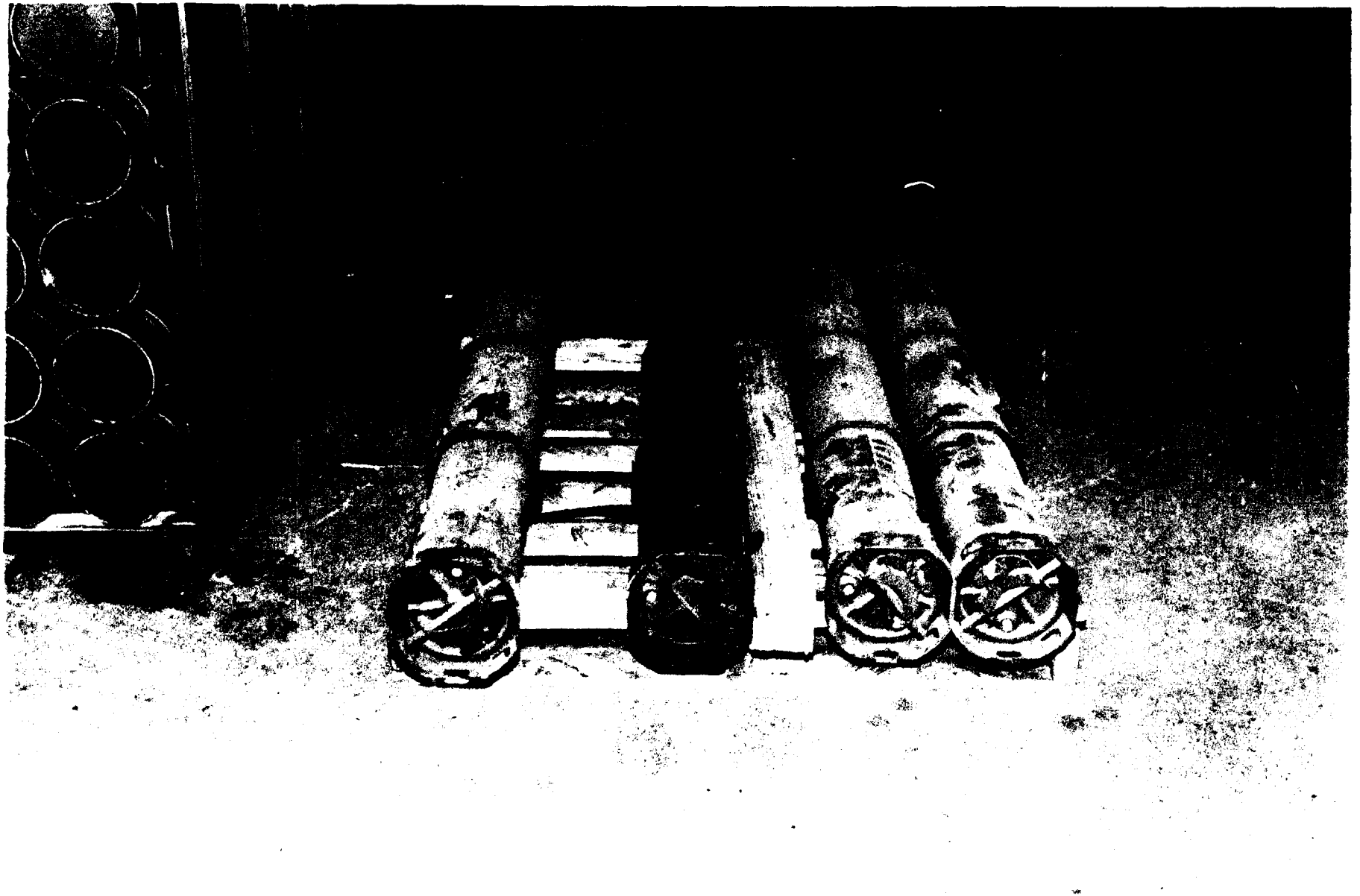
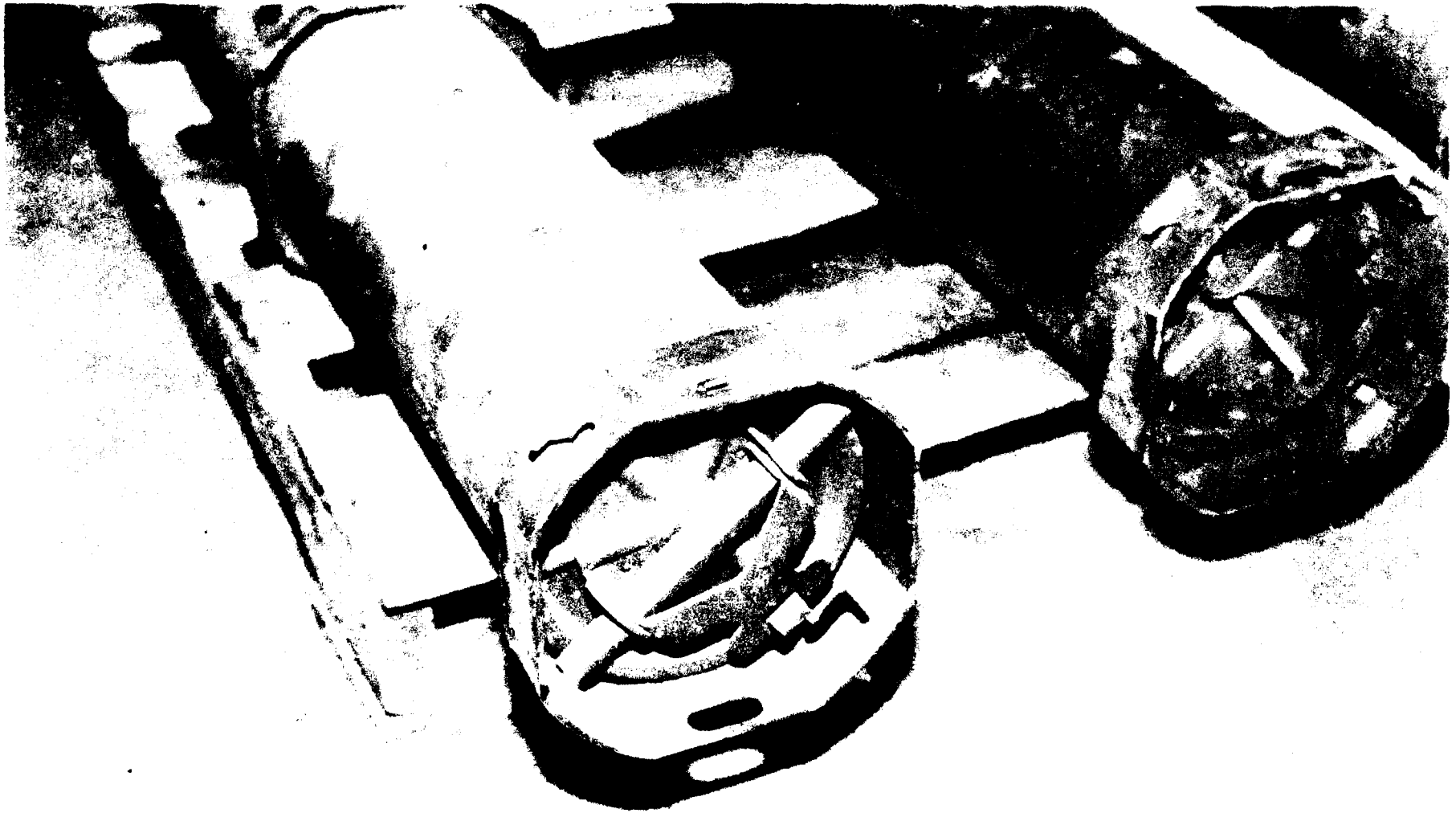
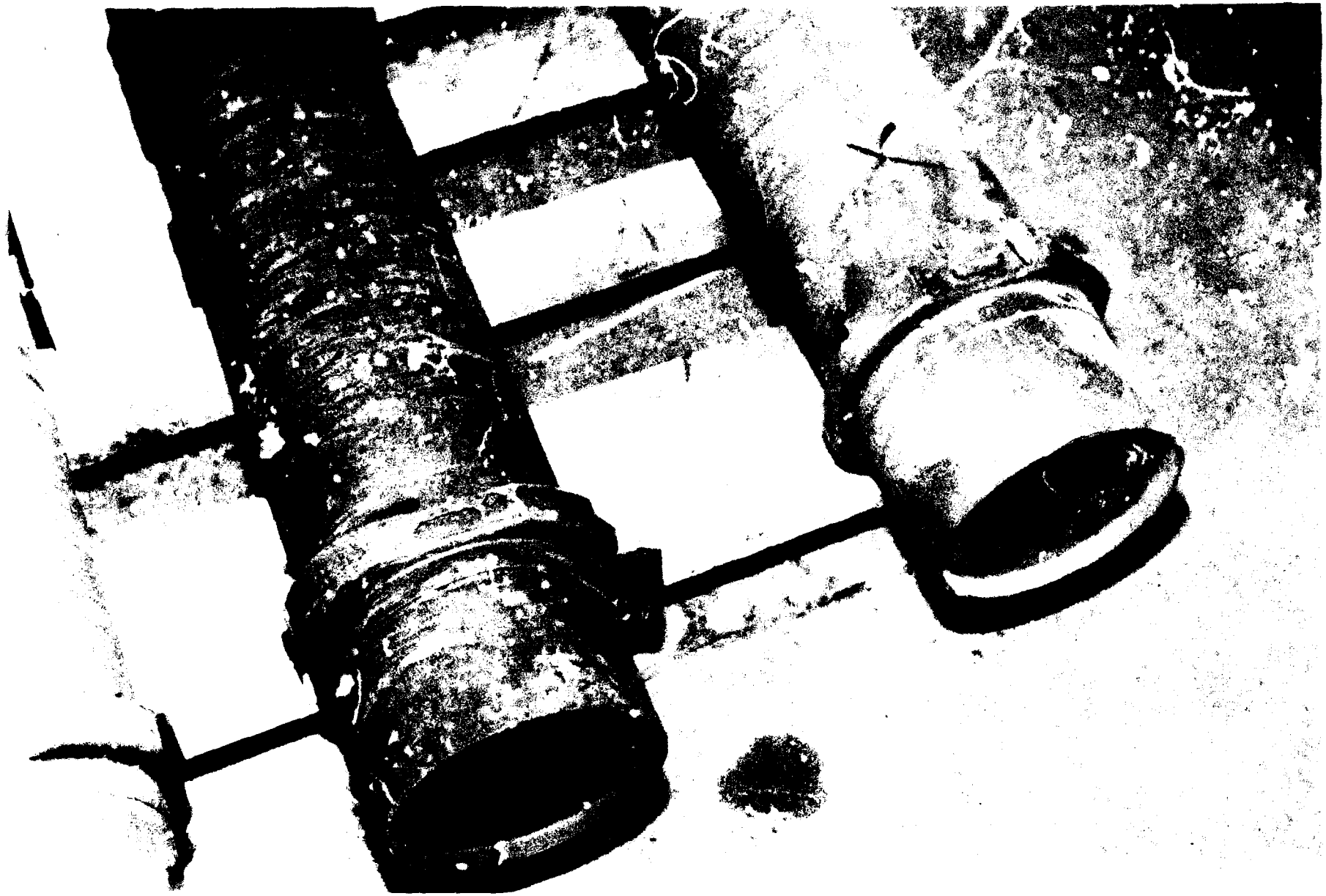
Photo No. AO317-SPN-90-354-5324. This photo shows the deformation of the unitized load following the first iteration of testing.		



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-354-5445. This photo shows damage to four Volcano containers following the first iteration of testing. Note the damage to the stacking pins on the bell end of the container and the crushed stacking bell on the opposite end.		



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-354-5446. This photo shows damage to a Volcano container following the first iteration of testing. Note the removed stacking pin.		



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-354-5447. This photo shows damage to two Volcano containers following two iterations of testing. Note the crushed stacking bell and damaged lip grips.		