FINAL REPORT
SEPTEMBER 1990

REPORT NO. EVT 28-90

MIL-STD-1660 TESTS OF 25MM CONTAINER PALLET

Prepared for:
U.S. Army Armament Research, Development and Engineering Center
ATTN: SMCAR-AEP
Picatinny Arsenal, NJ 07806-5000

Distribution Unlimited

ARMY
ARMAMENT
MUNITIONS
CHEMICAL COMMAND
U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL

VALIDATION ENGINEERING DIVISION
SAVANNA, ILLINOIS 61074-9639

AVAILABILITY NOTICE

A copy of this report will be 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.

DISTRIBUTION 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.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT UNLIMITED
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) EVT 28-90	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Defense Ammunition Center and School 6b. OFFICE SYMBOL (if applicable) SMCAC-DEV	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) ATTN: SMCAC-DEV Savanna, IL 61074-9639	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING / SPONSORING ORGANIZATION U.S. Army Armament Research, Development and Engineering Center 8b. OFFICE SYMBOL (if applicable) SMCAR-AEP	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) ATTN: SMCAR-AEP Picatinny Arsenal, NJ 07806-5000	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) MIL-STD-1660 Tests of 25mm Container Pallet	
12. PERSONAL AUTHOR(S) Jason Solberg	
13a. TYPE OF REPORT Final 13b. TIME COVERED FROM _____ TO _____	14. DATE OF REPORT (Year, Month, Day) 1990 September 15. PAGE COUNT
16. SUPPLEMENTARY NOTATION	

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

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 (ARDEC), SMCAR-AEP, Picatinny Arsenal, NJ to conduct tests on a 25mm container pallet. This report contains the procedures, results, and recommendations from the MIL-STD-1660 tests conducted. As tested, the top, center, and bottom pallet adapter assembly successfully passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT XX UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL JEROME H. KROHN	22b. TELEPHONE (Include Area Code) 815-273-8929 22c. OFFICE SYMBOL SMCAC-DEV

DD Form 1473, Jun 86 *Previous editions are obsolete*

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

REPORT NO. EVT 28-90

MIL-STD-1660 TESTS
OF
25MM CONTAINER PALLET

TABLE OF CONTENTS

PART	PAGE NO.
1. INTRODUCTION	1-1
A. BACKGROUND	1-1
B. AUTHORITY	1-1
C. OBJECTIVE	1-1
2. ATTENDEES	2-1
3. TEST PROCEDURES	3-1
4. TEST EQUIPMENT	4-1
5. TEST RESULTS	5-1
6. CONCLUSIONS AND RECOMMENDATIONS	6-1
7. PHOTOGRAPHS	7-1
8. DRAWINGS	8-1

PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), SMCAC-DEV, was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-AEP, to test the 25mm container pallet.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by 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 25mm container pallet and pallet assemblies to prevent damage during transportation.

PART 2

MIL-STD-1660 TESTS

OF

25MM CONTAINER PALLET

SEPTEMBER 1990

ATTENDEES

Jason B. Solberg
Test Engineer
DSN 585-8079
815-273-8079

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

Sandra M. Schultz
Industrial Engineer
DSN 585-8086
815-273-8086

Director
U.S. Army Defense Ammunition Center
and School
ATTN: SMCAC-DES
Savanna, IL 61074-9639

Ken W. Dreier
Design Engineer
DSN 585-8083
815-273-8083

Director
U.S. Army Defense Ammunition Center
and School
ATTN: SMCAC-DES
Savanna, IL 61074-9639

Steven L. Von Thun
Technical Writer
DSN 585-8093
815-273-8093

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

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, then multiplied by a safety factor of 2. 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 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 procedures of 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:	ACV00053
b. Unitization:	2 high x 3 deep x 7 wide
c. Length:	44 inches (111.76cm)
d. Width:	41 inches (104.14cm)
e. Height:	34.5 inches (87.63cm)
f. Weight:	2,475 pounds (1,125kg)

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 22,600-pounds compression for a period of one hour. Periodic adjustments were made to maintain the desired stacking weight of 22,600-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 clearance between the pallet and the transportation simulator bed, the equipment was operated at 200 rpm for the longitudinal orientation and 195 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 opposite side of the pallet was raised to a height of 24 inches and then dropped. The process was repeated in a clockwise direction until all four sides of the pallet had been tested. No noticeable deformation was noted to the pallet or pallet assemblies during this test.

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

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

6. END OF TEST INSPECTION. During final inspection of the pallet and pallet assemblies, no noticeable deformation to the pallet or pallet assemblies was noted.

MIL-STD-1660 TESTS

SECOND ITERATION

1. SUPERIMPOSED LOAD TEST. The test pallet was loaded to 22,600-pounds compression for a period of one hour. Periodic adjustments were made to maintain the desired stacking weight of 22,600-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 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 longitudinal to the skids and was dropped from a height of 24 inches per MIL-STD-1660 specifications. The process was repeated in a clockwise direction until all four sides of the pallet had been tested. The second drop was lateral to the skids. One container, in the middle of the second row on the side of impact, dislodged forward one inch causing the center piece adapter to bow out approximately one inch. No other noticeable deformation was noted to the pallet or pallet assemblies during this test.

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

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

6. END OF TEST INSPECTION. During final inspection of the pallet and pallet assemblies, the center piece adapter was bowed approximately one inch due to the container which was dislodged during the Edgewise Rotational Drop Test. Otherwise, no noticeable deformation to the pallet or pallet assemblies was noted.

MIL-STD-1660 TESTS

THIRD ITERATION

1. SUPERIMPOSED LOAD TEST. The test pallet was loaded to 22,600-pounds compression for a period of one hour. Periodic adjustments were made to maintain the desired stacking weight of 22,600-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 200 rpm for the longitudinal orientation and 185 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 longitudinal to the skids and 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. The second drop was lateral to the skids. After this impact, the three middle containers on the top row on the side of impact, were dislodged forward one inch causing the center piece adapter to bow out one inch. On the final drop, the middle container on the top row, on the side of impact, was dislodged forward one inch causing the center piece adapter to bow in that direction approximately one inch; also, there was a noticeable buckle near the edge of the center piece adapter.

4. INCLINE-IMPACT TEST. The incline plane was set to allow the pallet to travel eight 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 five different lifting configurations using the top pallet assembly and a four-legged-sling. The sling configurations include a three corner, two alternate corners, two pair of adjacent corners, and a single corner lift. No permanent deformation of the pallet or pallet assemblies was noted.

6. END OF TEST INSPECTION. During final inspection of the pallet and pallet assemblies, the center piece adapter was permanently bowed one inch on one side and approximately one inch on the opposite side; also, it permanently buckled near the edge of the assembly due to the containers being dislodged during the Edgewise Rotational Drop Test. The pallet was also rocking diagonally.

ENGINEERING TEST

EDGEWISE ROTATIONAL DROP TEST. To avoid movement of the top row of containers, the addition of a longitudinal strengthening member was made to the center adapter (see photos nos. 4 and 5) and tested in accordance with Method 5008, Federal Standard 101. The center adapter allowed the middle container to move slightly, since the sides of the center adapter were bowed out when the longitudinal strengthening member was attached. The strengthened design is acceptable as long as the sides are near square following assembly.

PART 6

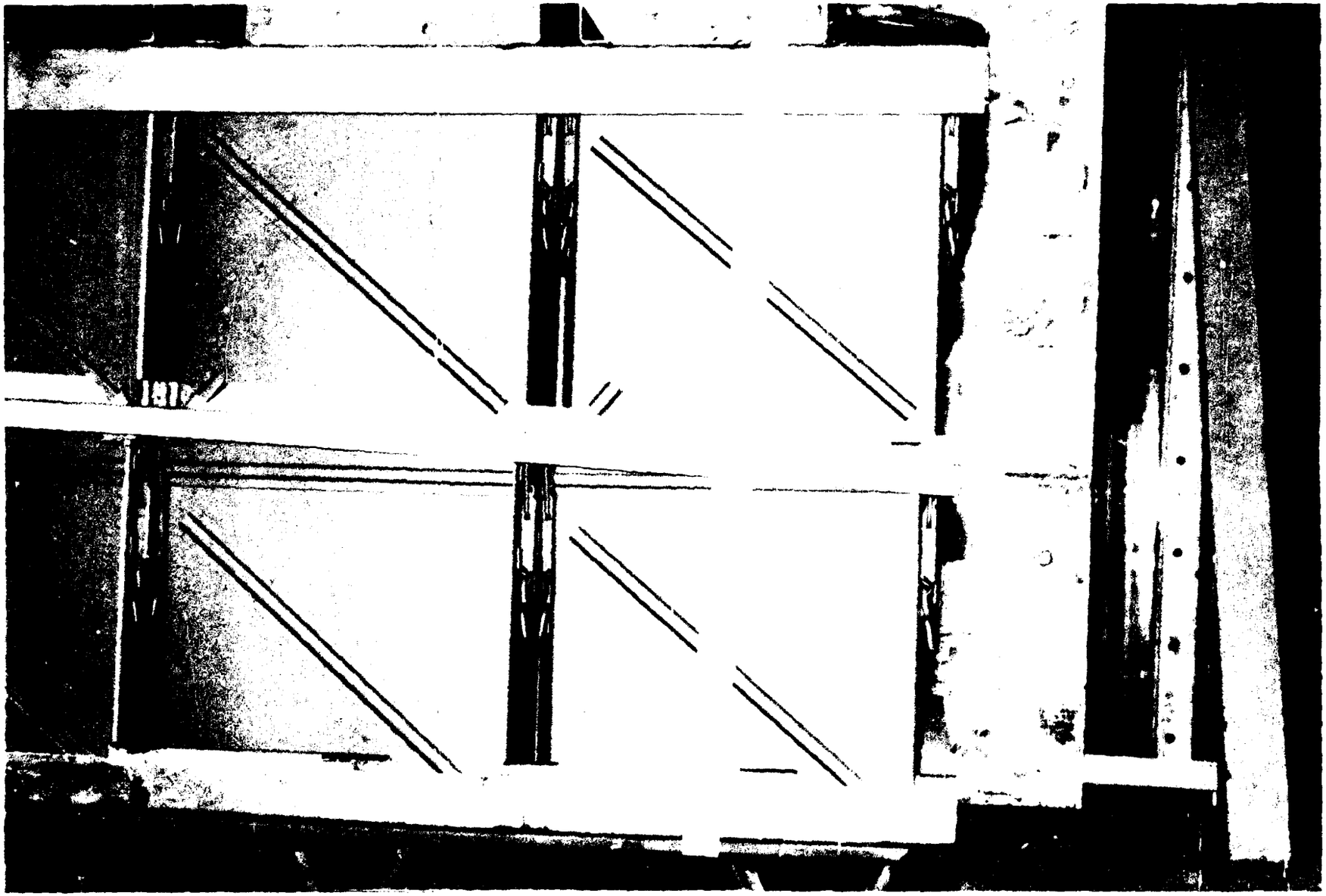
CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS. The 25mm container top, center, and bottom pallet adapter passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads, with the understanding the center adapter will be strengthened longitudinally for production. The center adapter for the 25mm container unitization pallet tends to bow enough to allow movement of the top middle containers.

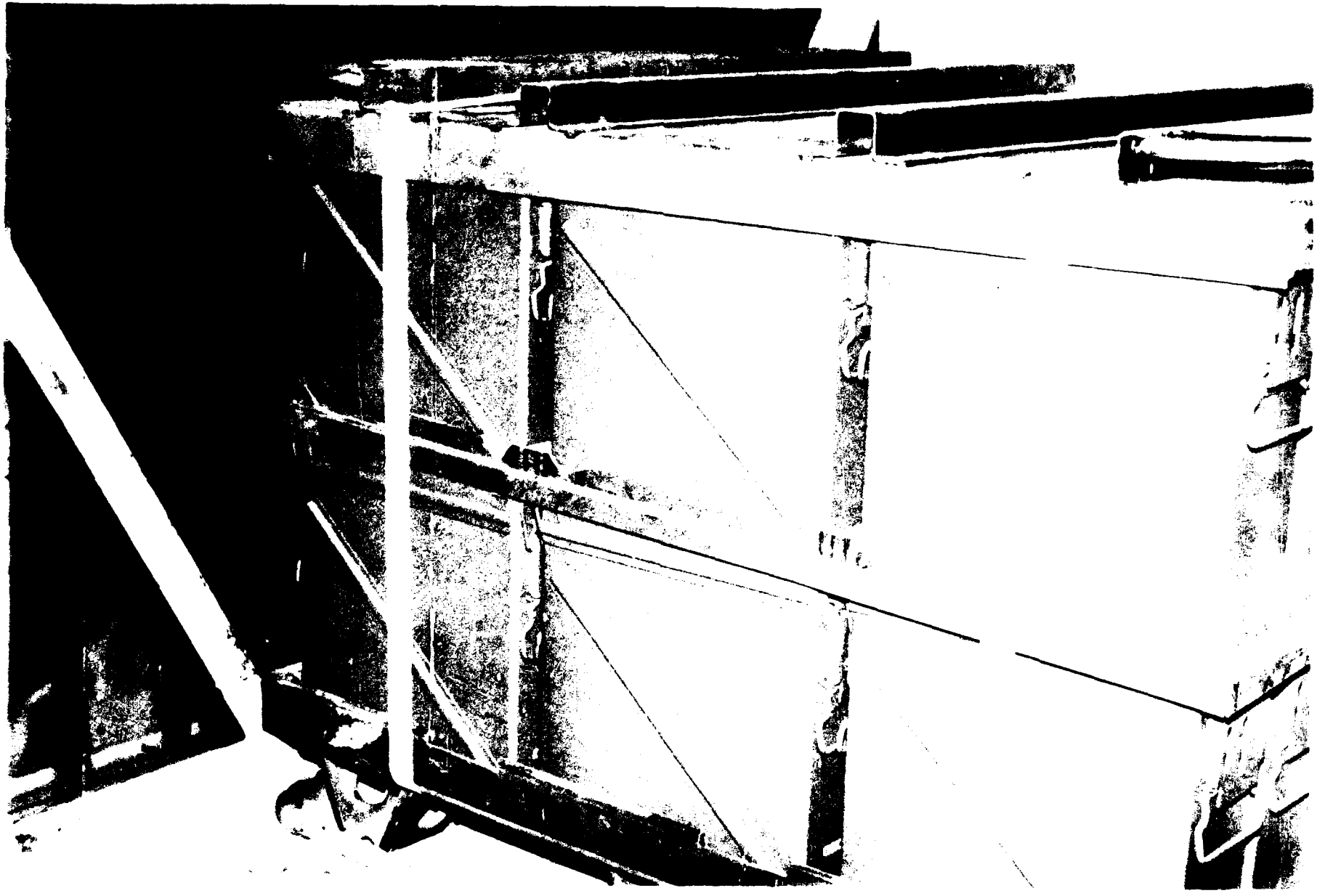
2. RECOMMENDATIONS. Since the middle containers of the top row are allowed to move approximately one inch, a longitudinal strengthening member should be added to prevent bowing of the center adapter.

PART 7

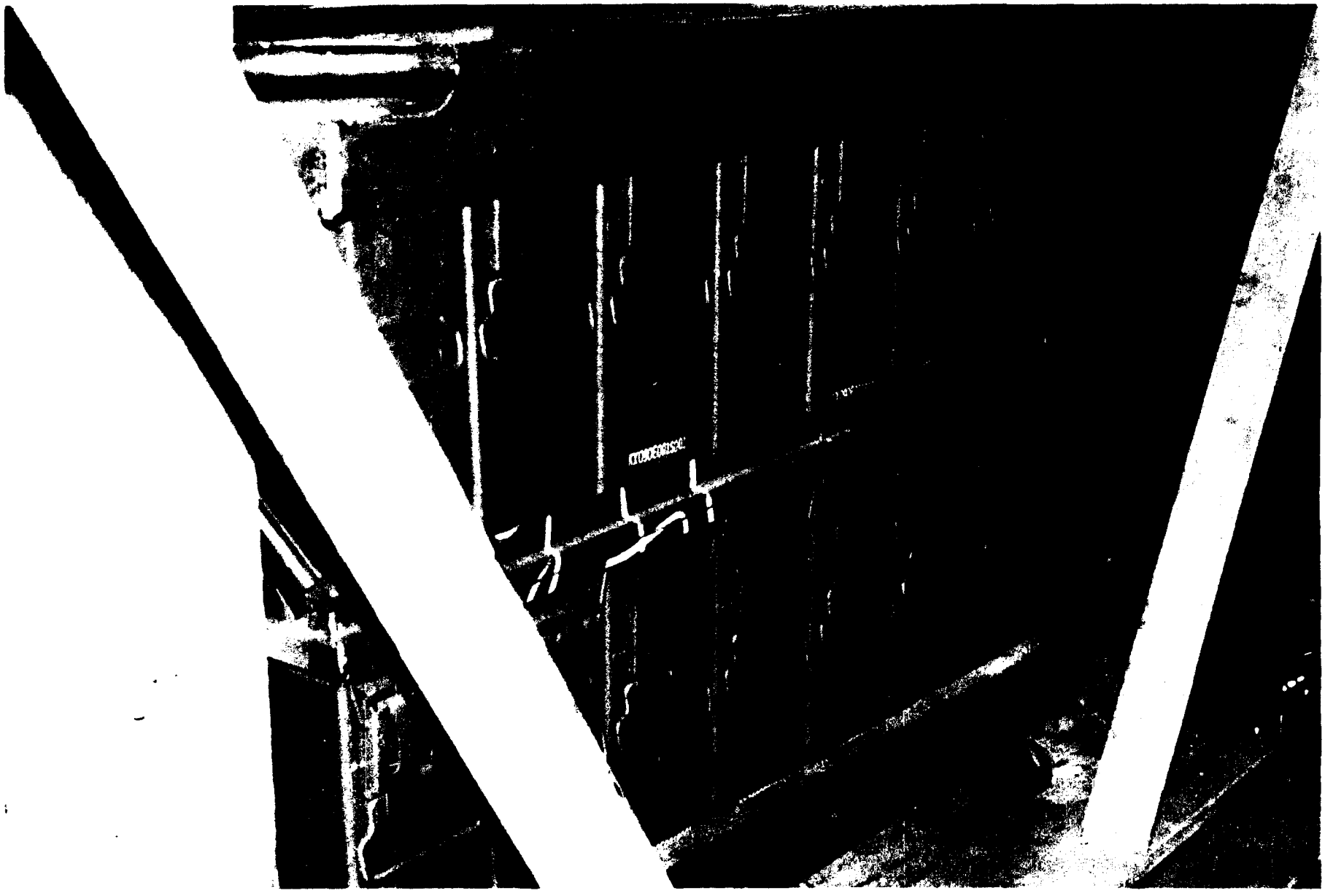
PHOTOGRAPHS



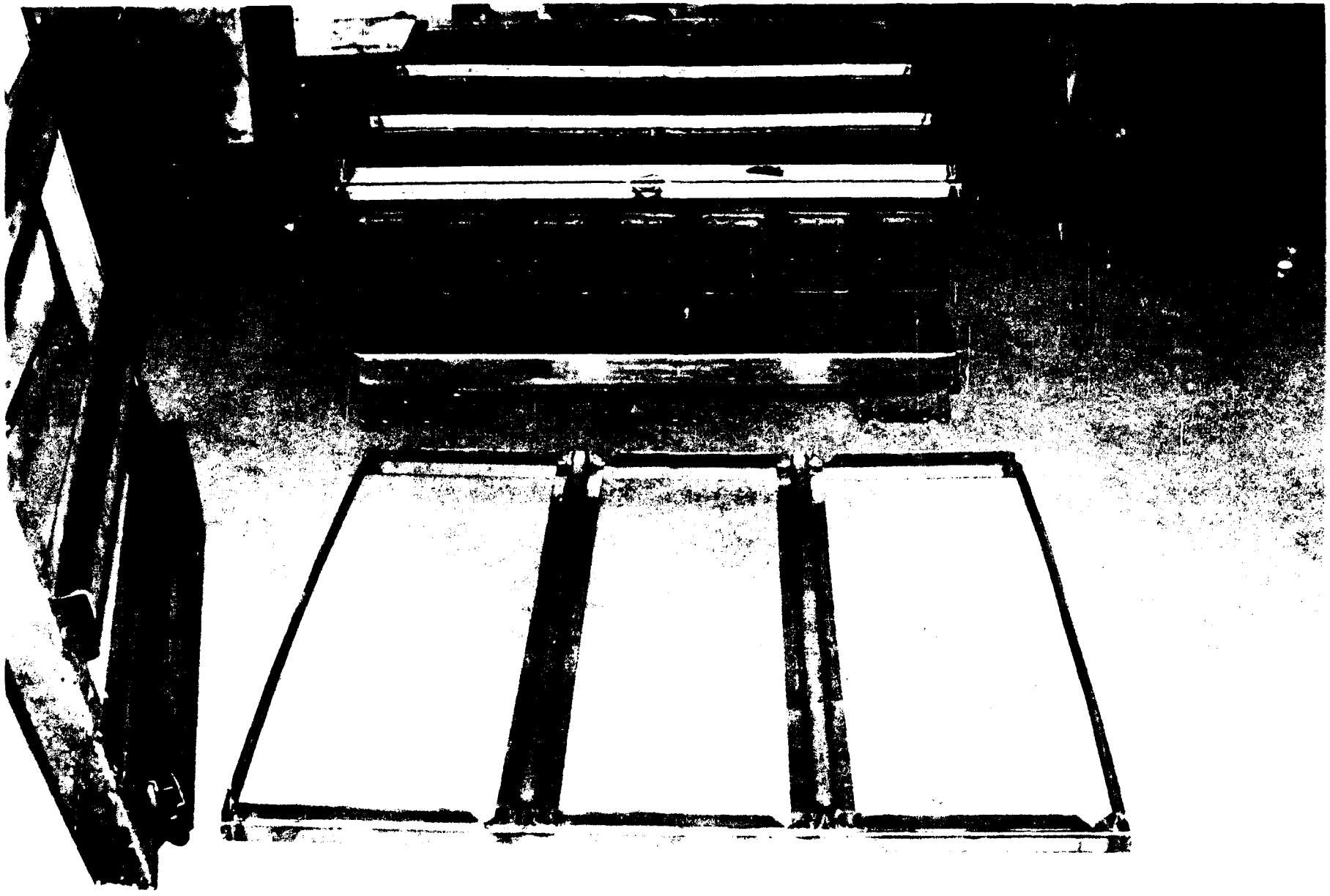
	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-326-5200. This photo shows the shifting of the top layer of containers and the intermediate adapter following vibration testing.		



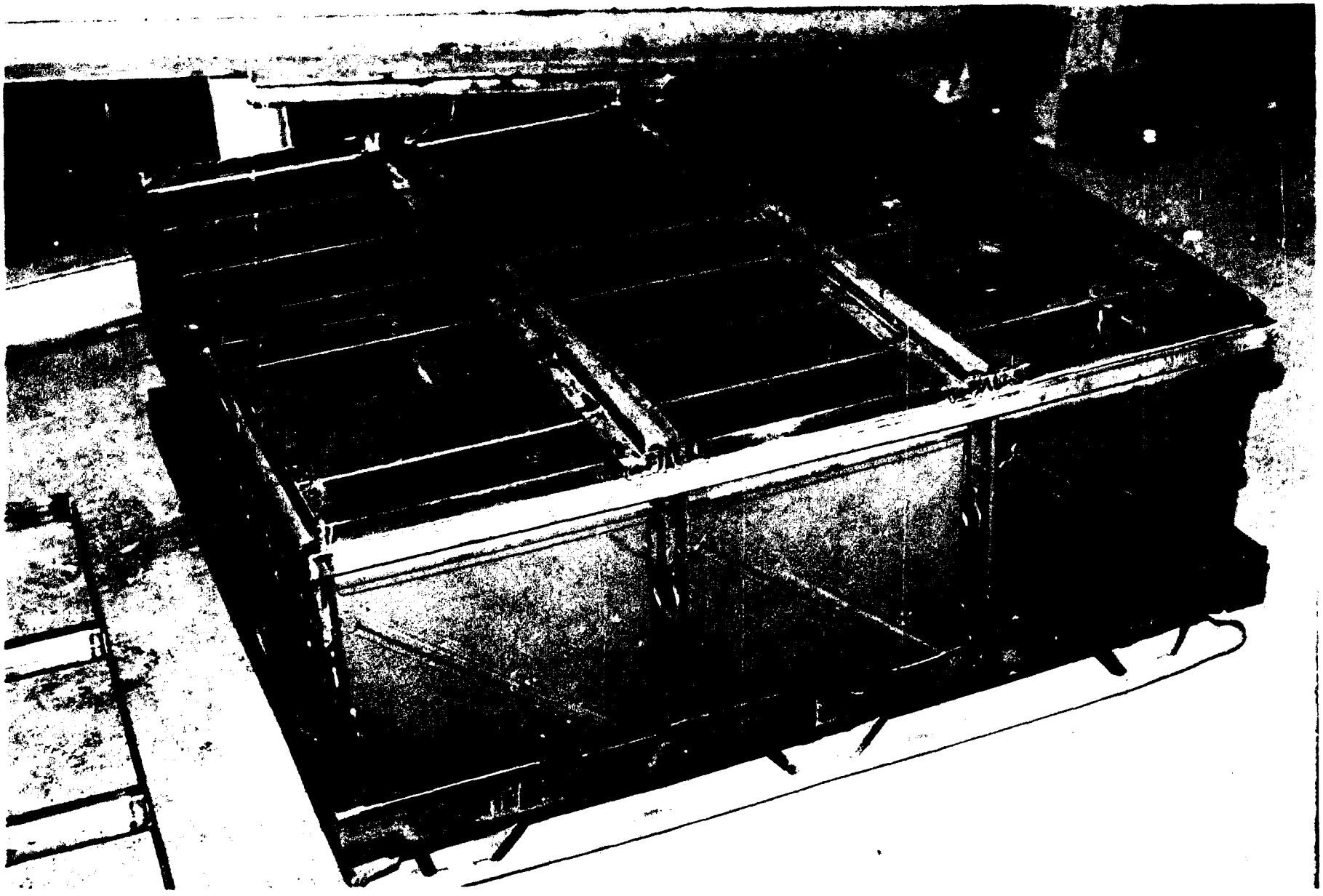
	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-326-5199. This photo shows the shifting of the top layer of containers and the intermediate adapter following vibration testing.		



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-326-5198. This photo shows the shifting of the top layer of containers and the intermediate adapter following vibration testing.		



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SCN-91-15-6744-90. This photo shows the intermediate adapter (below) and the reinforced intermediate adapter on the bottom layer of containers.		



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SCN-91-15-6747. This photo shows the reinforced intermediate adapter.		

PART 8

DRAWINGS