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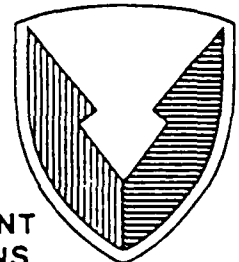
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REPORT NO. EVT 37-87

DROP TEST - 21C FIBERBOARD DRUMS  
and  
NO 4. TYPE (TNT) FIBERBOARD BOXES

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**EVALUATION DIVISION**  
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DROP TEST - 21C FIBERBOARD DRUMS  
AND  
NO. 4 TYPE (TNT) FIBERBOARD BOXES

September 1987

EVALUATION DIVISION  
DEFENSE AMMUNITION CENTER AND SCHOOL  
Savanna, IL 61074-9639

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with all test samples, both new and used, passing POP drop tests.

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U.S. Army Defense Ammunition Center and School

Savanna, IL 61073-9429

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DROP TEST OF 21C FIBERBOARD DRUMS

AND

NO. 4 TYPE (TNT) FIBERBOARD BOXES

TABLE OF CONTENTS

	PAGE
PART I - GENERAL	
A. INTRODUCTION.....	I-1
B. AUTHORITY.....	I-1
C. OBJECTIVE.....	I-1
D. CONCLUSIONS.....	I-1
PART II - LIST OF ATTENDEES.....	II-1
PART III - TEST PROCEDURES.....	III-1
PART IV - TEST RESULTS.....	IV-1
PART V - PHOTOGRAPHS.....	VI-1

ABSTRACT

The U.S. Army Defense Ammunition Center and School (USADACS) was tasked by U.S. Army Armament Research, Development and Engineering Center (ARDEC) to conduct drop tests on DOT 21C fiberboard drums and No. 4 (TNT) fiberboard boxes to determine conformity to United Nations Proposed Performance Oriented Packaging (POP) rules for hazardous materials. During September 1987, USADACS conducted drop tests on six new and six used DOT 21C fiberboard drums, as well as five new and five used No. 4 type fiberboard boxes. Tests were conducted in accordance with Federal Register Proposed Rule Changes, Part 178.603 with all test samples, both new and used, passing POP drop tests.



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PART I

GENERAL

A. INTRODUCTION. The U.S. Army Armament Research, Development and Engineering Center (ARDEC) requested DOT 21C fiberboard drums and No. 4 (TNT) fiberboard boxes be tested to determine compliance with proposed rule changes in the U.S. Federal Register. The United Nations committee of experts has made recommendations for the safe transport of dangerous goods which included Performance Oriented Packaging (POP) requirements. If adopted, it would go into effect 1 January 1990. During September 1987, USADACS performed POP drop tests for compliance with Packaging Group II requirements.

B. AUTHORITY. Testing has been accomplished in accordance with mission responsibilities delegated by the U.S. Army Armament Munitions and Chemical Command (AMCCOM).

C. OBJECTIVE. The objective of this drop test is to determine if new as well as used DOT 21C fiberboard drums and No. 4 (TNT) fiberboard boxes will meet the proposed U.N. POP requirements due to go into effect 1 January 1990.

D. CONCLUSION.

1. All new fiberboard drums and boxes passed the proposed POP standards at a drop height of 3.92 ft (Packaging Group II) without rupture or spillage. Permanent damage was noted to all drums as well as the fiberboard boxes diagonally dropped on their corners.

2. The used fiberboard drums and boxes also passed the proposed rule changes, but showed a slight increase in box and drum sidewall damage due to

previous stressing of the cellulose material contained within the fiber-board. This suggests a limit to reusability of used drums and boxes; as an example, failures might be seen after the fourth or fifth reuse. Additional tests would have to be conducted to determine maximum safe reusability while still conforming to POP requirements.

PART II

ATTENDEES

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## PART III

### TESTING PROCEDURES

The test procedures outlined herein were extracted from the Federal Register, Title 49 CFR, para 178.603, containing proposed rule changes to comply with United Nations Performance Oriented Packaging (POP), Packing Group II, requirements. Pass/fail criteria for all tests is "no rupture of the packaging occurs," as set forth by the Federal Register, Vol. 52, No. 86, para 178.603 (E) (6).

DROP TEST - FIBERBOARD DRUMS. The test samples were weighted to not less than 95 percent of their capacity with an inert-filled material, with a drop height of not less than 3 ft, 11-1/4 in (1.2 meters). Three samples were dropped (one drop each) diagonally on the chime, circumference seam, or edge. Three additional samples were dropped (one drop each) on the weakest part not tested by the first three drops, such as the closure, or longitudinal seam of the drum body. Six new fiberboard drums were tested first, followed by six used fiberboard drums.

DROP TEST - FIBERBOARD BOXES. The test samples were weighted to not less than 95 percent of their capacity with an inert-filled material with a drop height of not less than 3 ft, 11-1/4 in (1.2 meters), with each sample dropped one (1) time only. First drop was flat on the bottom; second drop, flat on the top; third drop, flat on the long side; fourth drop, flat on the short side; and the fifth drop on a corner. Five (5) new fiberboard boxes were tested first, followed by five (5) used fiberboard boxes.

PART IV

TEST RESULTS

Drop tests were conducted with the use of a one-ton overhead crane, one quick-release hook, two 1/2-in-wide plastic straps of equal length for the fiberboard box drop tests; two 3/4-in-wide steel straps and one canvas-covered chain sling for the fiberboard drum drop tests.

Slings arrangement A (photograph 1) shows metal and/or plastic strapping procedures for parallel drops to the floor. This procedure was used both for the drums as well as the boxes.

Slings arrangement B (photograph 2) shows the diagonal drop test on the fiberboard drums which had an angle (floor to bottom of container) of about 30 degrees.

Slings arrangement C (photograph 3) shows the diagonal drop on the fiberboard box corners with the corners at approximate 45 degree angles to the floor.

A. FIBERBOARD DRUM - DIAGONAL DROP TEST.

Table 1, below, shows the permanent physical damage caused by the diagonal drop impact to the fiberboard containers. Refer to Figure 1 on page IV-5 for an explanation of permanent damage measurement.

TABLE 1  
PERMANENT DEFORMATION - DIAGONAL DROP TESTS ON FIBERBOARD DRUMS

TEST SAMPLE	NEW DRUMS		OLD DRUMS	
	WIDTH DAMAGE	HEIGHT DAMAGE	WIDTH DAMAGE	HEIGHT DAMAGE
1	13.00 in	1.75 in	16.00 in	1.75 in
2	15.50 in	1.75 in	16.00 in	1.75 in
3	15.50 in	1.875 in	16.00 in	2.38 in
MEAN X	14.67 in	1.79 in	16.00 in	1.96 in
STANDARD DEVIATION	±1.18 in	±0.06 in	±0.0 in	±0.29 in

Test results indicate that used drums collapsed at the maximum diameter of the base, 16.00 ± 0.0 in, with 50 percent of the total base area (100.5 sq in) being damaged. New drums, on the other hand, had about 79.6 sq in of base damage on the average, or 20.8 percent less than used drums. This is to be expected with the majority of the kinetic energy being absorbed by the container sidewall, with used drums having somewhat weaker sidewalls.

B. FIBERBOARD DRUM - LONGITUDINAL DROP TEST.

Table 2, below, shows test results of permanent container damage after longitudinal impact on the container seam and lid closure latch. Refer to Figure 2 on page IV-6 for an explanation of permanent damage measurements.

TABLE 2

PERMANENT DEFORMATION - LONGITUDINAL (DRUM) DROP TESTS ON FIBERBOARD DRUMS

TEST SAMPLE	NEW DRUMS		OLD DRUMS	
	BASE DAMAGE	LID DAMAGE	BASE DAMAGE	LID DAMAGE
1	15.63 in	14.63 in	15.50 in	15.00 in
2	15.38 in	15.25 in	15.25 in	14.88 in
3	15.25 in	14.63 in	15.50 in	15.00 in
MEAN X	15.42 in	14.83 in	15.41 in	14.96 in
STANDARD DEVIATION	±0.15 in	± .29 in	±0.12 in	±0.06 in

Test results indicate no significant difference between new and used drums in the longitudinal drop test. This is not unexpected in that the majority of kinetic energy developed during the fall is absorbed by the metal container lid and base which does not deteriorate at the same rate as the container sidewall. It should be noted that during this test one new container base and two used container lids buckled inward as depicted on Figure 2 page IV-6. Also, one used container latch opened on impact. (NOTE:

the latch was not safety wired prior to test). Regardless of the physical damage that occurred to the containers, no ruptures or spillage of the inert fill was noted.

C. FIBERBOARD BOX DROP TEST. Permanent physical damage was noted to both the new and used fiberboard boxes during diagonal impact on the container corners. The used container showed about a 31.3 percent increase in deformation as compared to the new box. This was to be expected due to previous stressing and weakening of the fiberboard material caused by previous use. Table 3, below, shows measurements taken after impact with explanation given on Figure 3, page IV-7.

TABLE 3

PERMANENT DEFORMATION - DIAGONAL CORNER DROP TO FIBERBOARD BOXES		
DIMENSION	NEW FIBERBOARD BOX	USED FIBERBOARD BOX
A	5.0 in*	2.5 in
B	2.0 in	3.4 in
C	2.0 in	3.0 in

\*Indicates the box did not impact at a 45 degree angle to the floor.

Table 4, below shows the test results for the bottom, top, long side and short side drop tests, in reference to dimensional changes after impact.

TABLE 4

DIMENSIONAL CHANGES FLAT SURFACE PARALLEL DROPS TO FLOOR ON FIBERBOARD BOXES		
IMPACT SURFACE	NEW FIBERBOARD BOX	USED FIBERBOARD BOX
BOTTOM	NO CHANGE	NO CHANGE
TOP	NO CHANGE	NO CHANGE
LONG SIDE	NO CHANGE	PLUS 1/2 IN
SHORT SIDE	PLUS 3/4 IN	PLUS 3/4 IN

Mushrooming (widening) of the test samples was noted for the short side impacts on new and used boxes as well as the long side of the used box, due to inert fill compaction. No permanent deformations, spillage, or ruptures were noted for this series of tests.

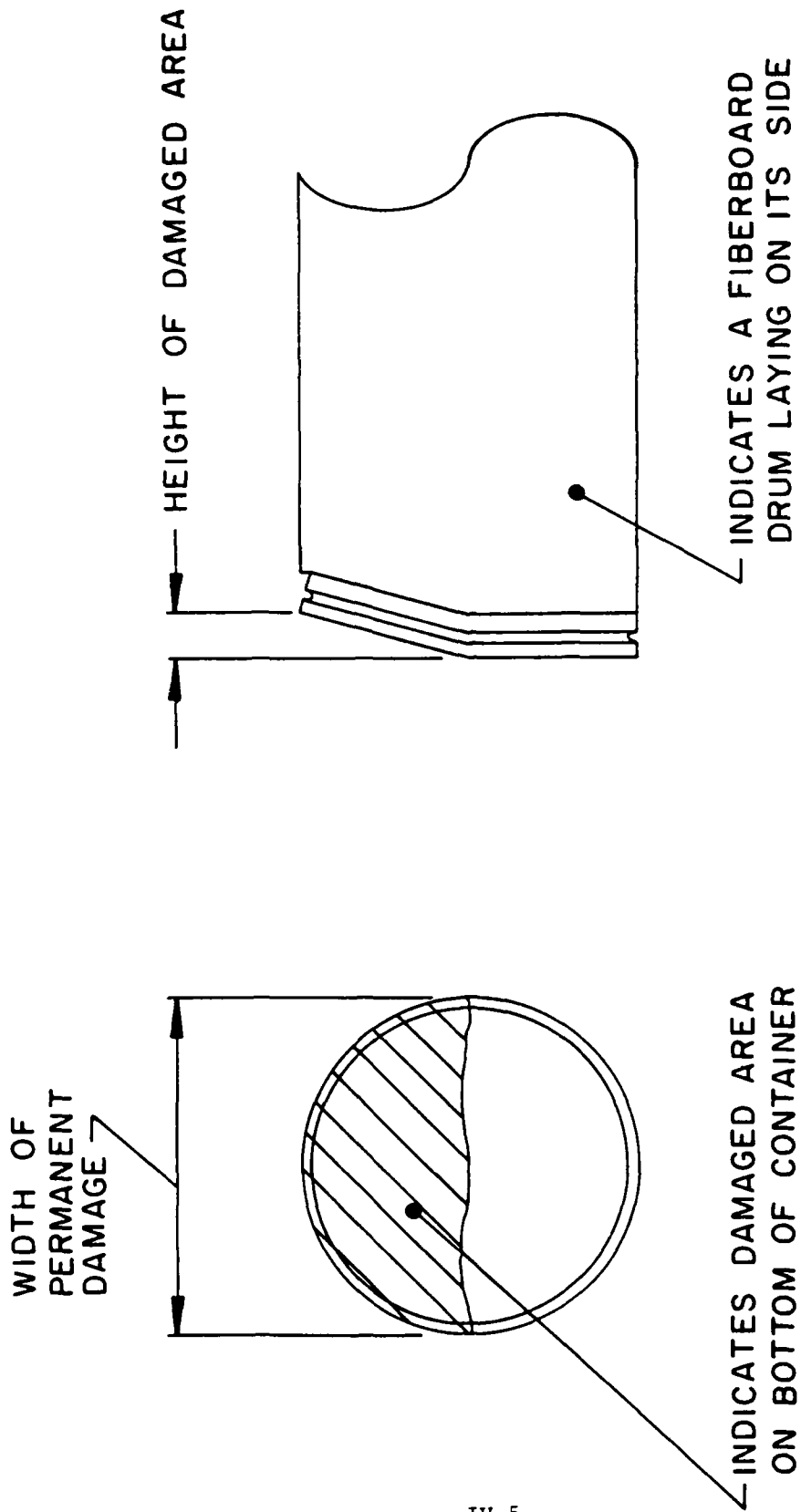


FIGURE 1

INDICATES SHAPE OF CONTAINER BEFORE IMPACT

INDICATES SHAPE OF CONTAINER AFTER IMPACT

INDICATES CONTAINER BASE OR LID BUCKLING INWARD

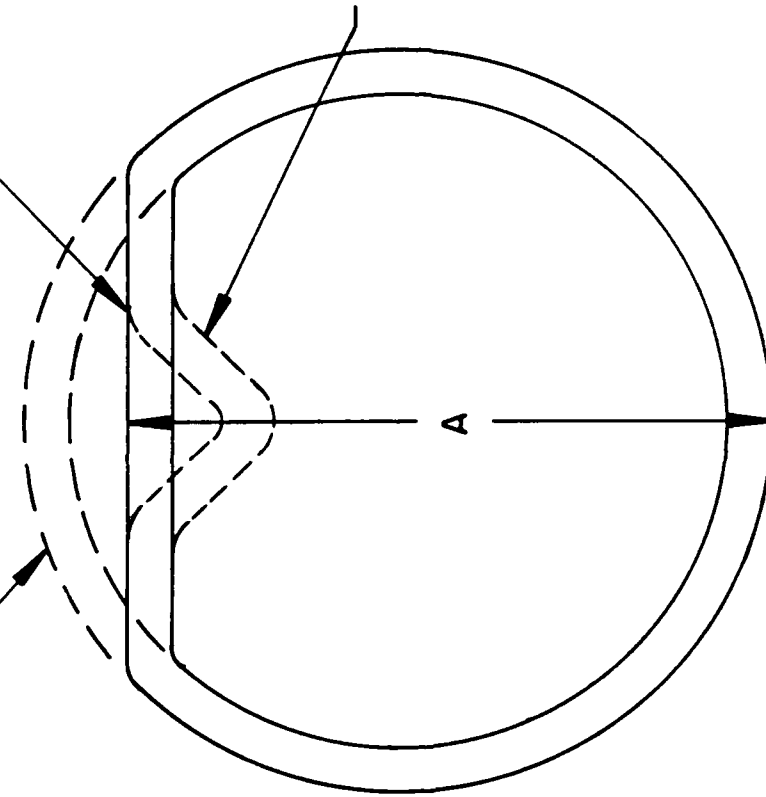
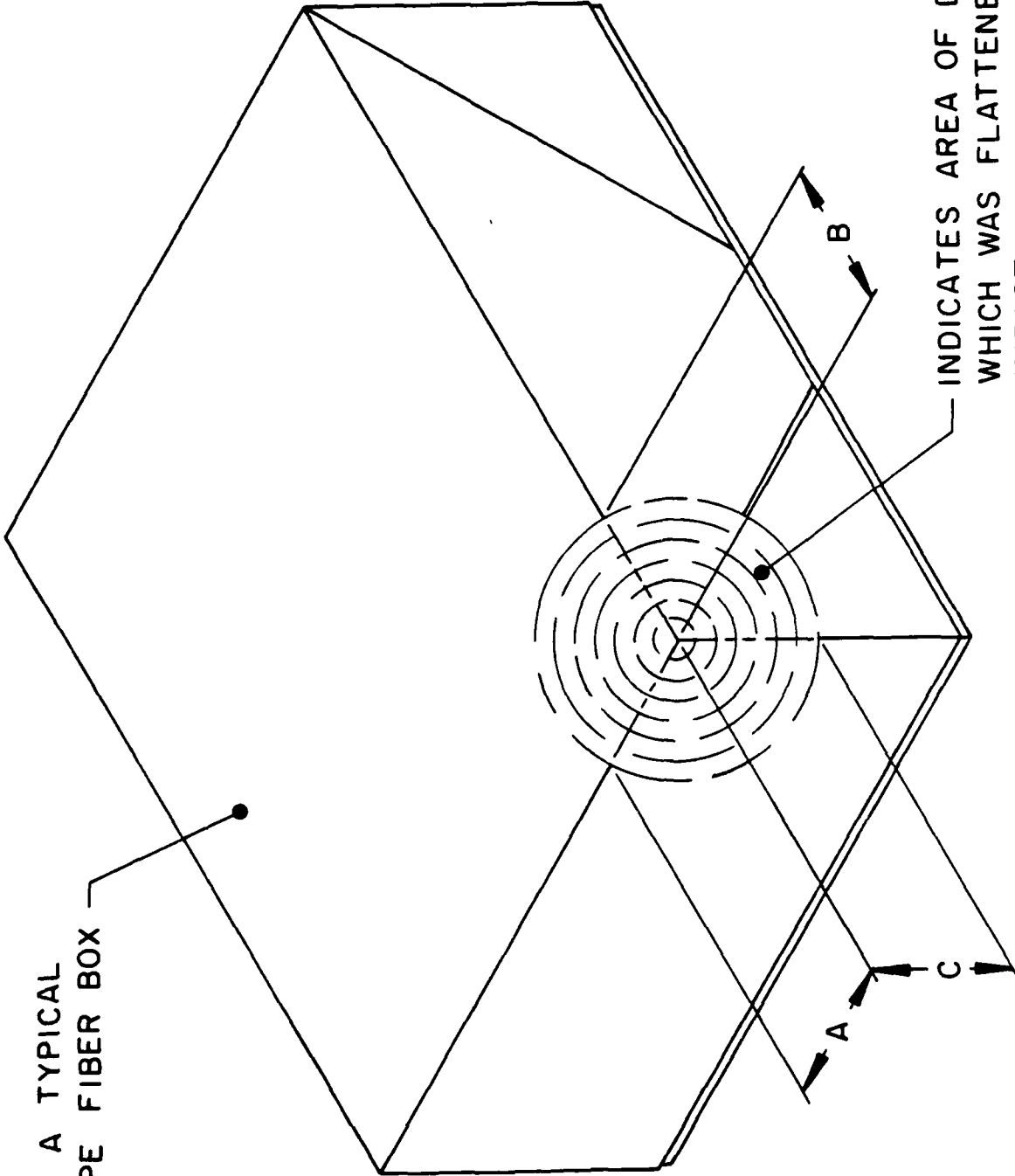


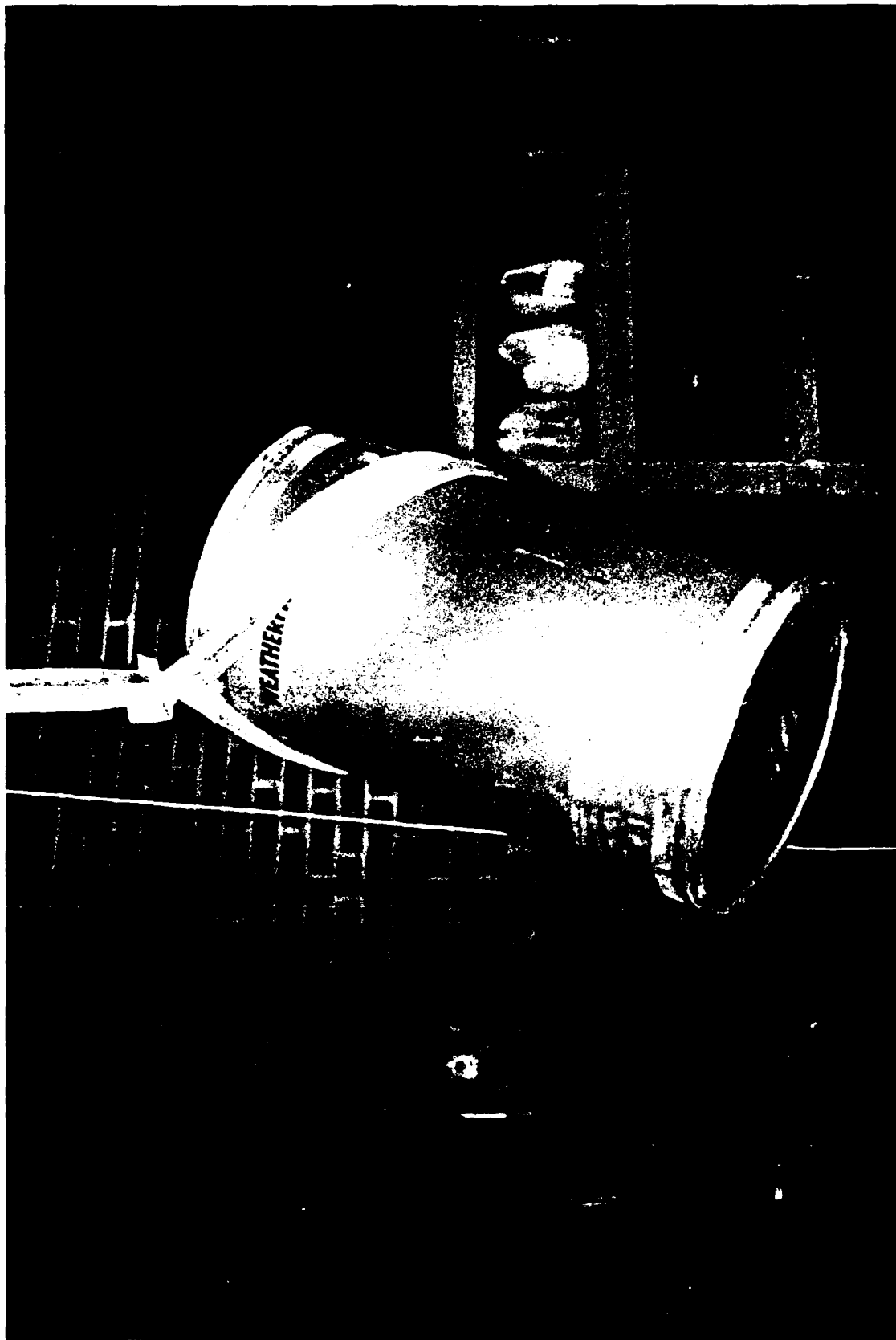
FIGURE 2

INDICATES A TYPICAL  
NO. 4 TYPE FIBER BOX



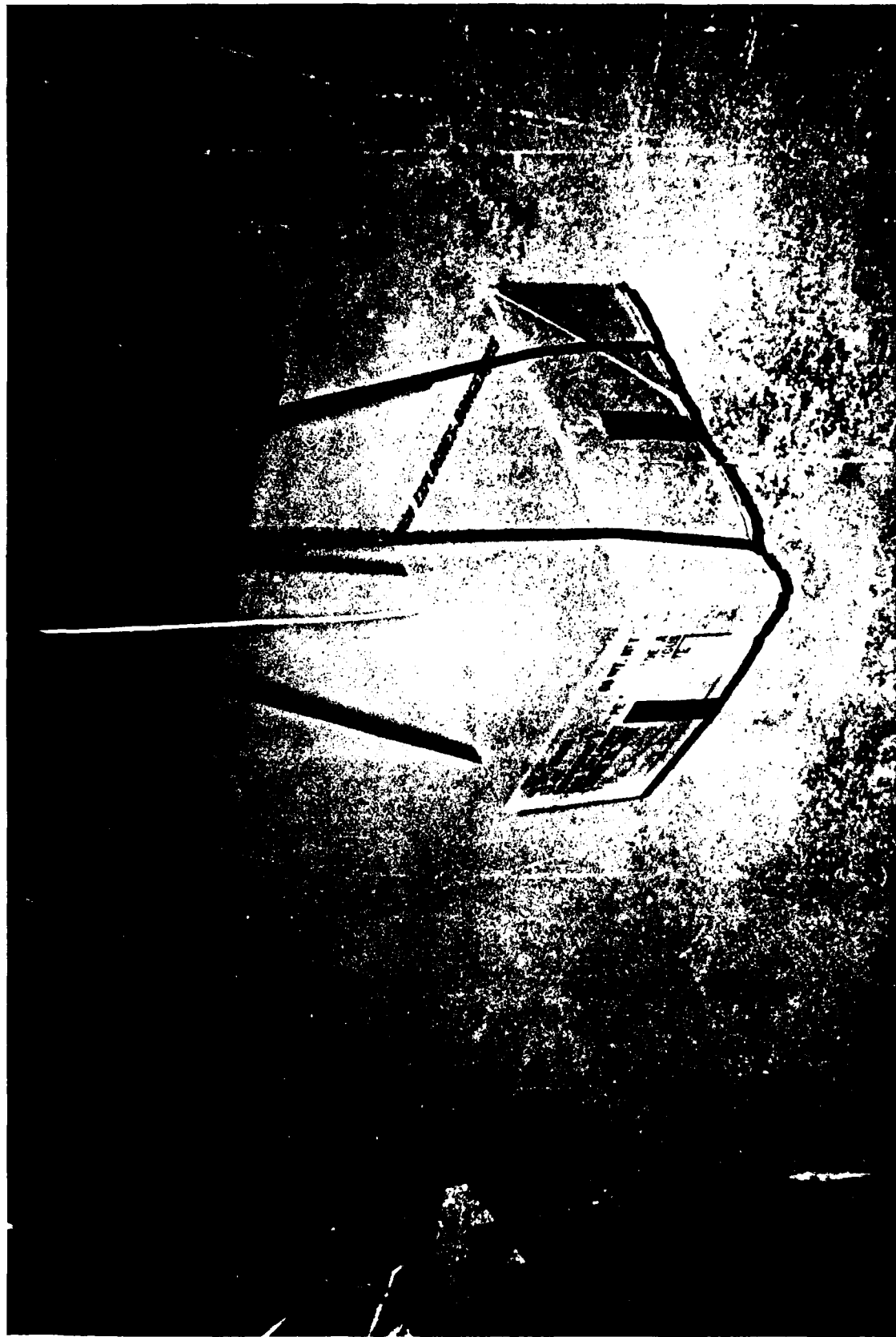
INDICATES AREA OF DAMAGE  
WHICH WAS FLATTENED UPON  
IMPACT

FIGURE 3



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photograph No. 2. Typical 'Sling Arrangement B' used for diagonal impacts to the fiberboard drum circumferential seam.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photograph No. 1. Typical 'Sling Arrangement A' for impacts parallel to the floor with plastic straps being used for fiberboard boxes and metal straps used for fiberboard drums.



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

Photograph No. 4. Typical permanent deformation that occurred to new and used fiberboard drums during diagonal impacts.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photograph No. 3. Typical 'Sling Arrangement C' used for diagonal corner drops on fiberboard boxes. NOTE: Straps were taped to the test sample to avoid the strap slipping of the test sample prior to impact.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photograph No. 6. Typical new and used fiberboard box damage that occurred from diagonal corner impacts.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photograph No. 5. Typical permanent deformation that occurred to new and used fiberboard drums during longitudinal impacts to the container sidewall. NOTE: Flattened lid closure latch bottom of picture.

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