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FINAL REPORT

DECEMBER 1987

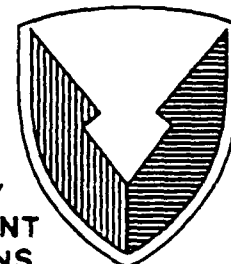
EVT 30-87-1

MIL-STD-1660 TEST OF
STANDARD OAK PALLET
COMPARISON OF
BIG LEAF MAPLE PALLET

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APR 25 1989
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Prepared for:
U.S. Army Armament, Munitions and
Chemical Command
ATTN: SMCAR-ESK
Rock Island, IL 61299-7300

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FIELD	GROUP	SUB-GROUP	MIL-STD-1660 standard wood pallet			
			hardwood			
			MIL-L-15011-J			
19. ABSTRACT (Continue on reverse if necessary and identify by block number) The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division was tasked by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), SMCAR-ESK, to evaluate a MIL-P-15011-J type pallet fabricated from West Coast Big Leaf Maple wood. Maple, as determined by the wood industry, is classified as a softwood not meeting the requirements of MIL-P-15011-J requirements for fabrication of ammunition pallets. Oak, however, is a satisfactory hardwood for the fabrication of ammunition pallets. In order to compare the test results of Big Leaf Maple and oak pallets in their performance when subjected to MIL-STD-1660 testing criteria, a second pallet was fabricated identical to the Big Leaf Maple on an oak base. The subject pallet was then tested in accordance with MIL-STD-1660 and found to perform equally as well as the Big Leaf Maple pallet. The results of these tests indicate that oak and Big Leaf Maple perform identically when tested to MIL-STD-1660.						
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U.S. Army Defense Ammunition Center and School

Savanna, IL 61073-9429

REPORT NO. EVT-30-87-1

MIL-STD-1660 TEST OF BIG LEAF MAPLE PALLET

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PART 1

A. INTRODUCTION. The U.S. Army Defense Ammunition Center and School (USADACS) has been tasked by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), SMCAR-ESK, to evaluate a softwood pallet fabricated from Big Leaf Maple. This has been done and is documented in Report EVT 30-87, November 1987. As a comparison, an identical load was fabricated on a standard oak pallet and subjected to the same MIL-STD-1660 testing sequence. The results of this test and the previous tests of Big Leaf Maple form a basis of pallet material comparison.

B. AUTHORITY. This study was conducted in accordance with mission responsibilities delegated by AMCCOM.

C. OBJECTIVE. The objective of this test is to evaluate a standard oak pallet loaded to a test weight of 4,300 pounds and subjected to MIL-STD-1660 Design Criteria for Ammunition Pallets as a control comparison to the Big Leaf Maple pallet.

PART 2

ATTENDEES

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PART 3

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.

PART 4

TEST EQUIPMENT

1. TEST SPECIMEN.

- a. Drawing Number: 19-48-4116/15C
- b. Width: 40 inches
- c. Length: 48 inches
- d. Height: 49 inches
- e. Weight: 4,300 pounds

2. COMPRESSION TESTER.

- a. Manufacturer:
- 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

PART 5

TEST RESULTS

1. STACKING TEST.

Pallet Weight: 4,300 pounds

Pallet Height: 49 inches

Test Load Weight: 17,000 pounds

The subject pallet was loaded to 17,500 pounds compression for a period of one hour. At the end of that period of time, the compression load decreased to 16,200 pounds. When the test specimen was removed from the compression tester, no measurable deformation to the unit load was realized.

2. REPETITIVE SHOCK TEST.

The subject pallet successfully passed the longitudinal transportation test in a 90-minute 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. Operational speed of the transportation simulator for these two tests was 200 rpm. Approximate driving force into the load from the transportation simulator table is .5 G acceleration.

3. EDGEWISE DROP TEST.

Each side of the pallet is placed on a beam in turn displacing it 6 inches above the floor. The opposite side is raised to a height of 24 inches above the floor and then dropped. (The normal drop height for a pallet weighing over 3,000 pounds is 12 inches. The drop height for this test was 24 inches.) Impacts 1 and 3 had the skids oriented laterally to the direction of the drop. In drops 2 and 4, the skids were oriented longitudinal to the direction of drop. The results of the drops 1, 2, and 4 did not cause any damage to the pallet. Drops 1 and 3 caused the outside

skids to crack, but not separate from the pallet base. No damage was caused to the test load.

4. IMPACT TEST.

The inclined impact tests consisted of placing the oak pallet with its 4,000-pound unit load on an inclined sled with two inches of the pallet projecting over the edge of the sled. This sled is then raised approximately 8 feet up the inclined ramp and released, allowing it to accelerate and impact into a solid wall. This test was repeated once on each side of the pallet. After completing this test, the pallet was observed to find no additional breaks or damage caused to the unitization.

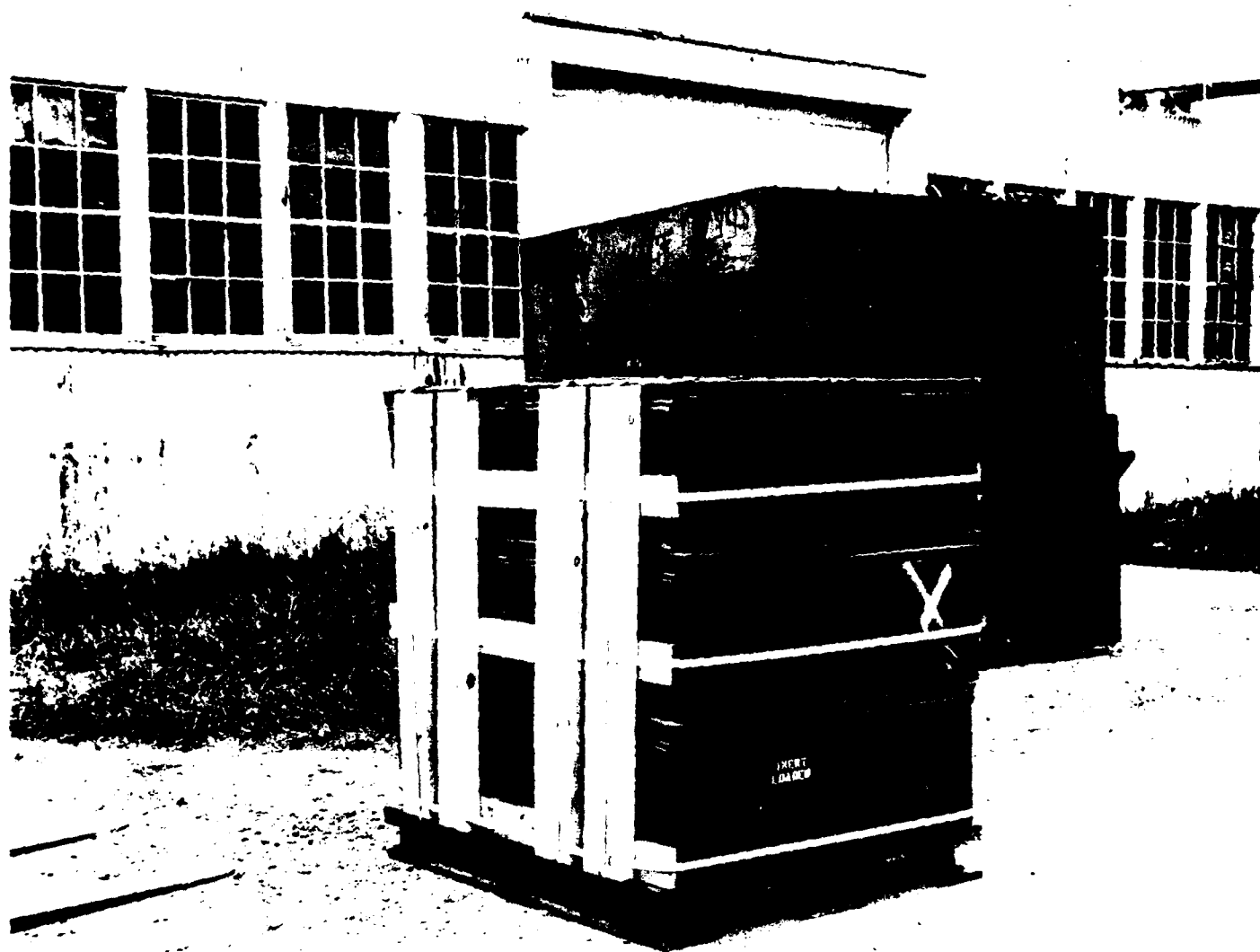
PART 6

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS. The oak comparison pallet to the Big Leaf Maple pallet was subjected to MIL-STD-1660 testing procedures for ammunition pallets. The oak pallet was fabricated to MIL-P-15011-J specifications. This pallet performed successfully in satisfying the requirements of design criteria for ammunition unit loads. When dropped in an extended height edgewise rotational drop test, the outer skids cracked. Even though this is damage to the pallet, it is not cause for rejection, since the unitization remained intact and was suitable for safe movement.

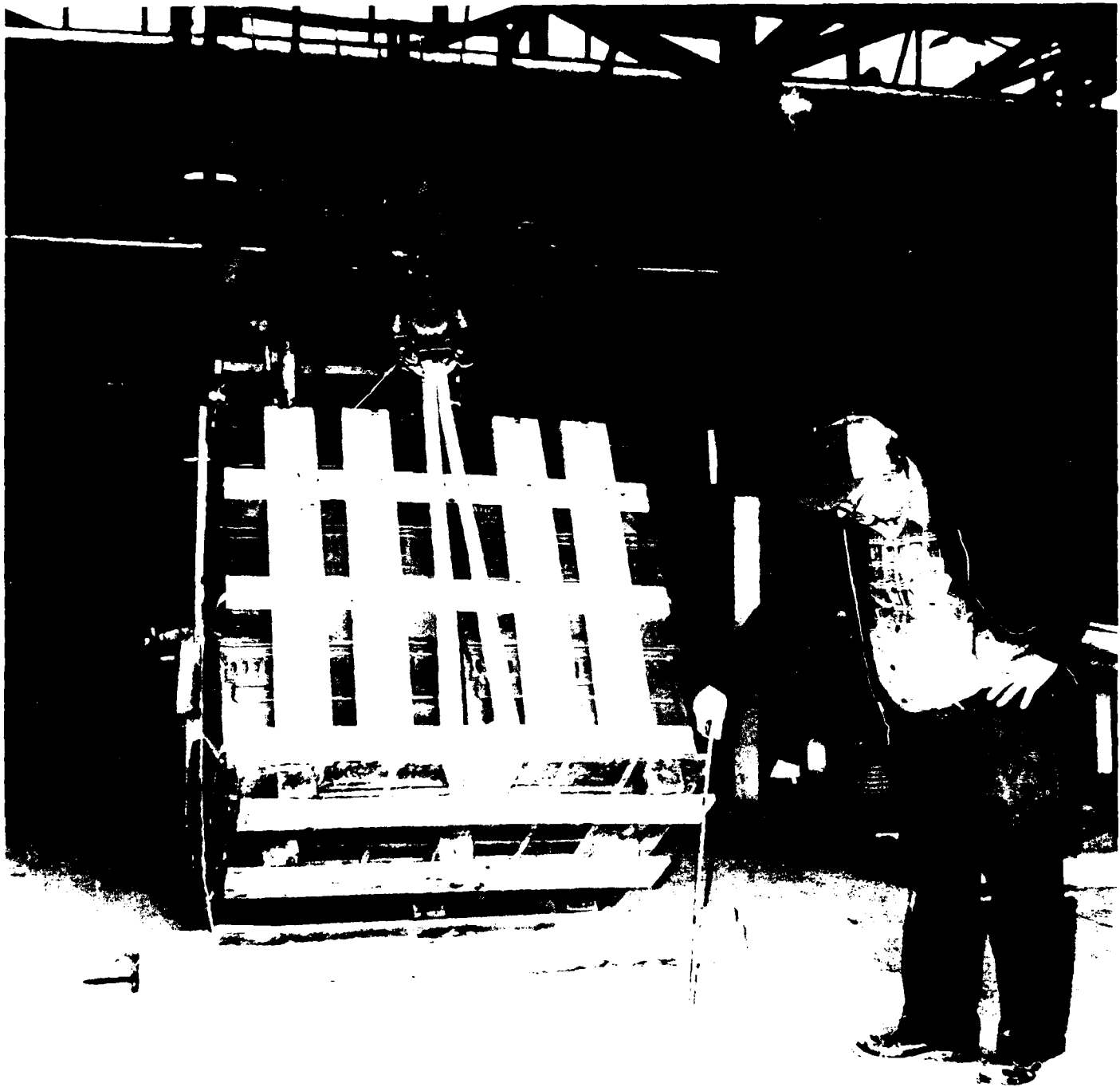
2. RECOMMENDATIONS. The oak pallet, as tested, is a standard pallet that has been used for many years in transporting ammunition unit loads. This test further verifies that oak, as a hardwood used in fabrication of this pallet, is a satisfactory material and shows, thru identical minimal damage areas, that the Big Leaf Maple pallet, which is categorized as a softwood, compares favorably to oak when used in these applications. The previous test (EVT 30-87) of the Big Leaf Maple pallet compares favorably to the results recorded in this report; however, Big Leaf Maple as a wood species is classified as a softwood. Oak is a wood species that is classified as a hardwood. In order to satisfy the requirements for a hardwood pallet, as per MIL-P-15011-J, Big Leaf Maple must be reclassified as a hardwood or MIL-P-15011-J must identify an exception that this particular species of maple is acceptable for ammunition unit loads. These tests are performed strictly as a performance comparison of the two materials in terms of design criteria for ammunition pallets and not to be used as a basis for reclassifying maple as a hardwood.

PART 7
PHOTOGRAPHS



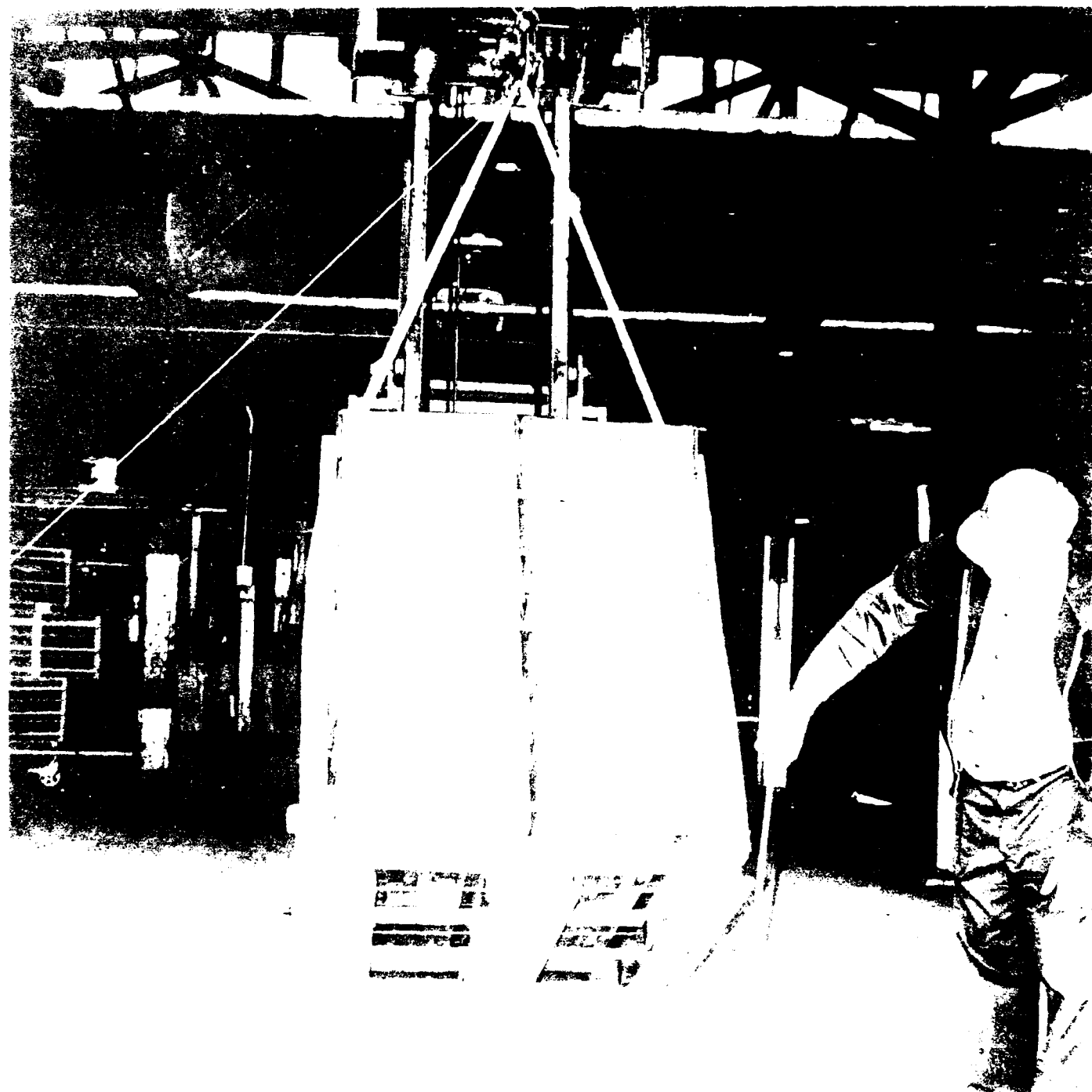
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Photo 1. This photo shows the standard oak pallet loaded with inert-filled M548 cans to a weight of 4,300 pounds.

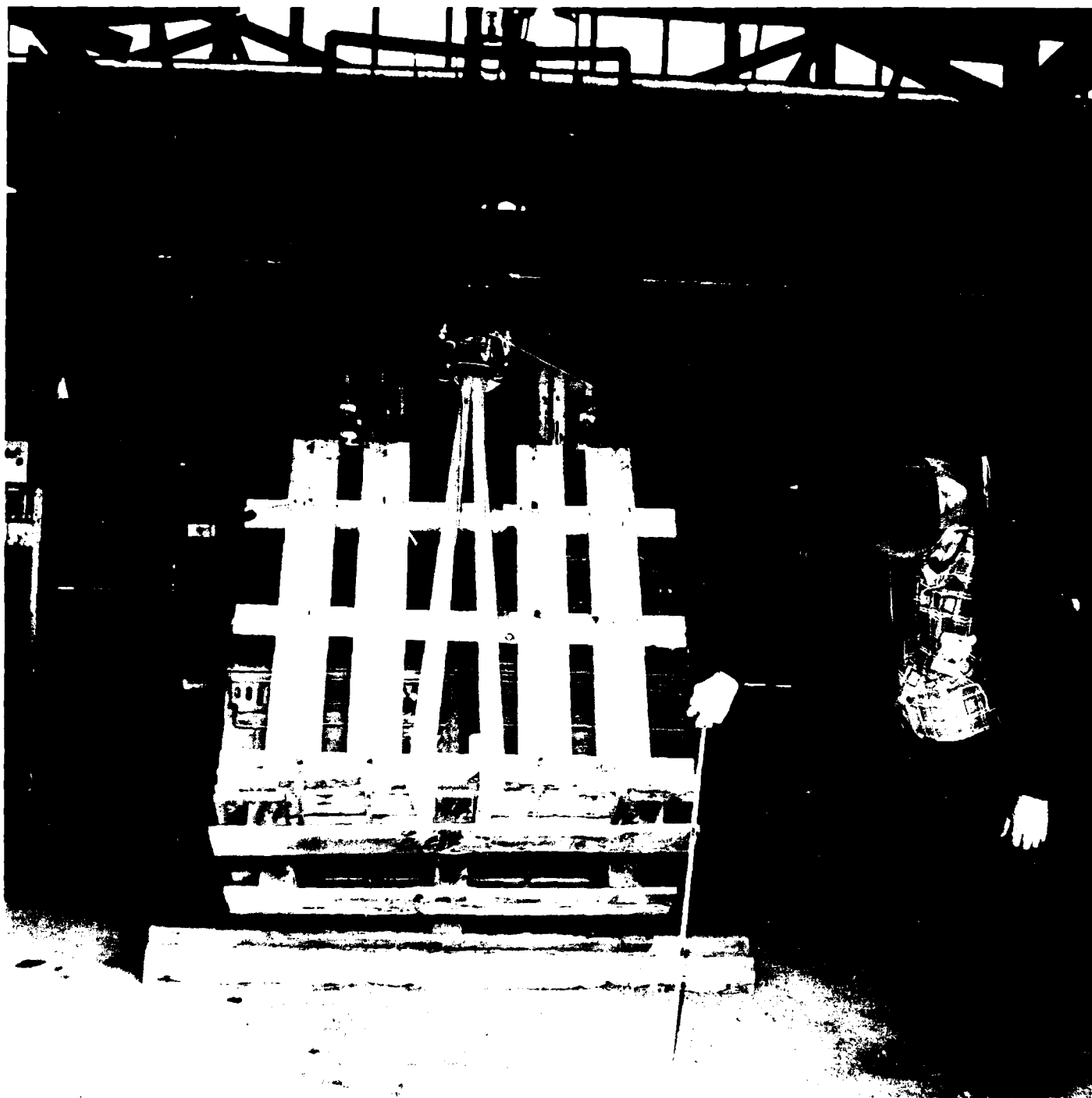


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Photo No. 2. This photo shows the standard oak pallet ready for edgewise rotational drop on side one. Damage sustained in this drop was a cracked outer skid.



REFERENCE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL
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Photo 4. This photo shows the standard oak pallet ready for the edgewise rotational drop on the third side. This drop caused the outer skid to crack.

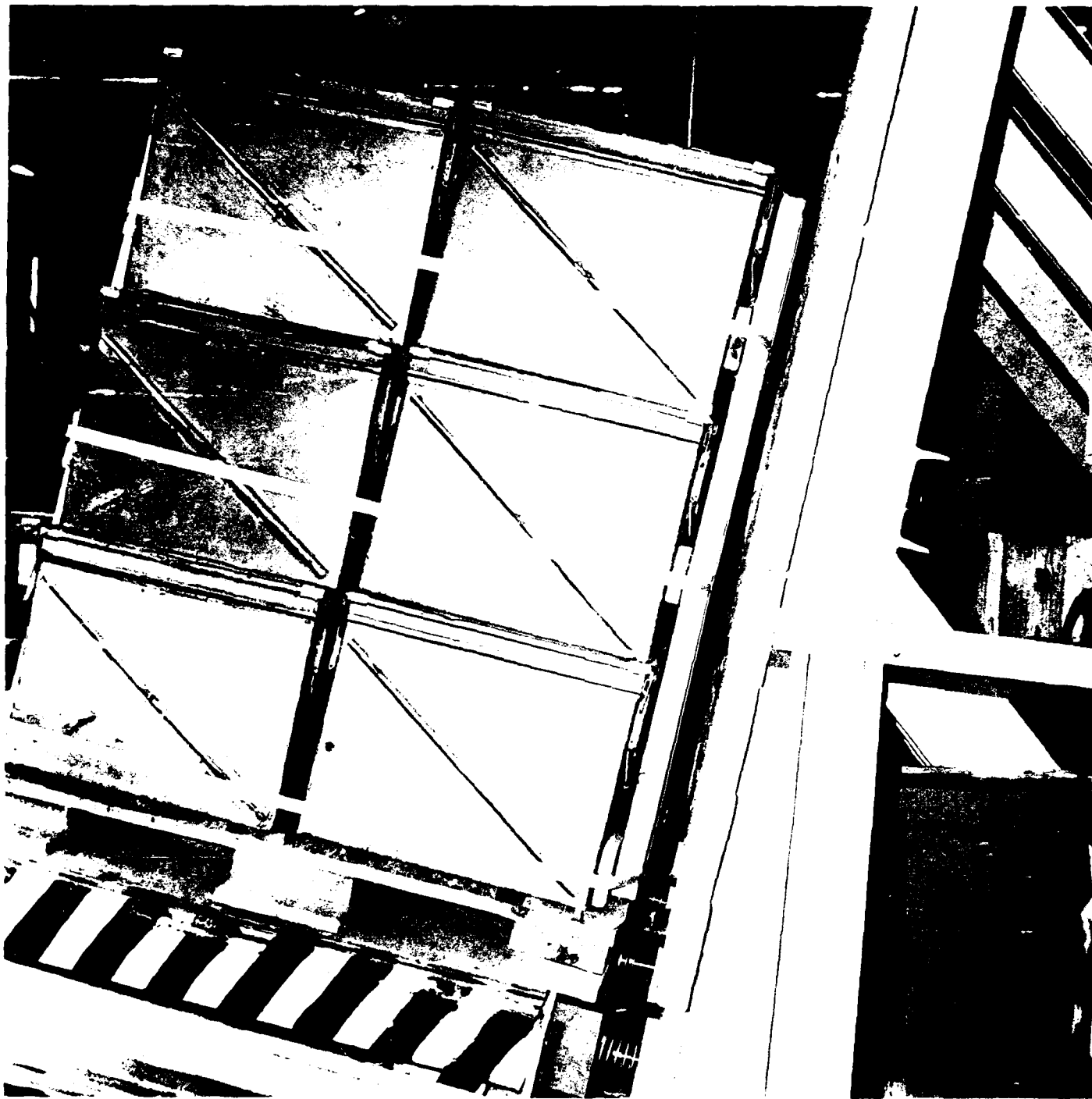


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Photo 5. This photo shows the standard oak pallet ready for edgewise dropping from a height of 24 inches. No additional damage was caused to the pallet during this drop.



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DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo 8. This photo shows the standard oak pallet after the inclined impact on the third side. No damage was sustained by the pallet or the unitization load.



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Photo 9. This photo shows the standard oak pallet after inclined impact testing on the fourth side. No damage occurred during this impact.

PART 8
UNITIZATION PROCEDURE

APPENDIX 15C

UNITIZATION PROCEDURES FOR BOXED AMMUNITION AND COMPONENTS ON 4-WAY ENTRY PALLETS

CARTRIDGE, 20MM, PACKED VARIOUS QUANTITIES
PER M548 METAL BOX, UNITIZED 24 BOXES PER
40" X 48" PALLET; APPROX BOX SIZE $18\frac{19}{32}$ " L X
 $8\frac{19}{64}$ " W X $14\frac{19}{32}$ " H

① HAZARD CLASSIFICATION DATA CONTAINED IN THE CHART AT LEFT 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).

PALLET UNIT DATA						
ITEMS INCLUDED		HAZARD CLASSIFICATION ①				WEIGHT
NSN	DODIC	DOT CLASS	CG CLASS	QD CLASS	COMP GROUP	(LBS)
1305-						
00-785-2829	A651	C	I	1.4	C	3,981
00-522-3700	A651	C	I	1.4	C	3,981
00-935-6171	A659	A	IV	(04) 1.2	E	3,981
00-143-6919	A769	A	IV	(04) 1.2	E	3,189
00-143-6918	A770	A	IV	(04) 1.2	E	3,189
00-926-9278	A791	A	IV	(04) 1.2	E	3,981
00-143-7050	A813	A	IV	(04) 1.2	G	3,189
00-143-7049	A814	A	IV	(04) 1.2	G	3,189
00-180-9270	A833	A	IV	(04) 1.2	E	3,189
00-180-9271	A834	A	IV	(04) 1.2	E	3,189
00-143-7176	A835	A	IV	(04) 1.2	E	3,189
00-143-7177	A836	A	IV	(04) 1.2	E	3,189
00-143-7167	A846	A	IV	(04) 1.2	G	3,189
00-112-0491	A865	A	IV	(04) 1.2	E	3,189
00-112-0494	A865	A	IV	(04) 1.2	E	3,189
00-112-0492	A866	A	IV	(04) 1.2	E	3,189
00-112-0493	A866	A	IV	(04) 1.2	E	3,189
00-935-9104	A890	A	IV	(04) 1.2	E	3,981
00-935-2019	A892	C	I	1.4	C	3,981
00-799-8669	A924					3,981
01-116-3923	A924					3,501
01-116-3931	A890	A	IV	(04) 1.2	E	3,981
01-116-3930	A892	C	I	1.4	C	3,981
00-752-8114	A891	C	I	1.4	C	3,525
01-116-4560	A891	C	I	1.4	C	3,525
01-118-9928	A890	A	IV	(04) 1.2	E	3,981
01-118-9930	A651	C	I	1.4	C	3,981
01-118-9929	A659	A	IV	(04) 1.2	E	3,981

THIS APPENDIX SUPERSEDES THE TWO-LAYER UNITIZATION PROCEDURES OF INTERIM DRAWING 19-48-4141-20PA1003, DATED FEBRUARY 1977.

DO NOT SCALE

REVISIONS

REVISION NO. 1, DATED NOVEMBER 1981, CONSISTS OF:

1. ADDING NATIONAL STOCK NUMBER TO THE "PALLET UNIT DATA" CHART.

2. REDESIGNING "FILLER ASSEMBLY".

REVISION NO. 2, DATED NOVEMBER 1982, CONSISTS OF:

ADDING NOTE "J" TO GENERAL NOTES SECTION ON PAGE 2.

REVISION NO. 3, DATED DECEMBER 1983, CONSISTS OF:

1. CHANGING BOX DIMENSIONS.

NOTICE: THIS APPENDIX CANNOT STAND ALONE BUT MUST BE USED IN CONJUNCTION WITH THE BASIC UNITIZATION PROCEDURES DRAWING 19-48-4116-20PA1002.

REVISIONS				REVISION NO.	DATE	BY	CHKD BY
1	NOV 81	WFE	John & Boyd	1	NOV 81	WFE	WFE
2	NOV 82	WFE	WFE	2	NOV 82	WFE	WFE
3	DEC 83	WFE	WFE	3	DEC 83	WFE	WFE
				U.S. ARMY DARCOM DRAWING			
				JUNE 1981			
				CLASS	REVISION	REVISION	FILE
				19	48	4116/15C	20PA1002

SEAL FOR 1-1/4" STRAPPING (6 REQD, 1 PER STRAP). CRIMP EACH SEAL WITH TWO PAIR OF NOTCHES.

TIEDOWN STRAP, 1-1/4" X .035" OR .031" X 12'-8" LONG STEEL STRAPPING (4 REQD). SEE GENERAL NOTE "D" AT RIGHT.

LOAD STRAP, (ALTERNATE FOR HORIZONTAL STRAP), 1-1/4" X .035" OR .031" X 14'-2" LONG STEEL STRAPPING. THREAD LOAD STRAPS THRU PALLET STRAP SLOTS.

SUPPORT GATE (2 REQD). SEE DETAIL BELOW. STAPLE HORIZONTAL AND TIEDOWN STRAPS TO SUPPORT GATE AS SHOWN.

40" X 48" PALLET.

HORIZONTAL STRAP, 1-1/4" X .035" OR .031" X 16'-0" LONG STEEL STRAPPING (2 REQD). SEE GENERAL NOTE "C" AT RIGHT.

TYPICAL LOCATION FOR SECUREMENT OF A STRAP CUTTER. SEE GENERAL NOTE "F" AT RIGHT.

PALLET UNIT

SEE GENERAL NOTE "B" AT RIGHT.

24 BOXES OF 20MM CARTRIDGE (200 PER BOX) @ 160 LBS	3,840 LBS (APPROX)
DUNNAGE	61 LBS
PALLET	80 LBS
TOTAL WEIGHT	3,981 LBS (APPROX)
CUBE	40.0 CU FT (APPROX)

BILL OF MATERIAL		
LUMBER	LINEAR FEET	BOARD FEET
1" X 4"	16.00	5.33
2" X 4"	19.00	19.00
NAILS	NO. REQD	POUNDS
6d (2")	48	0.28
PALLET, 40" X 48"	1 REQD	80 LBS
STEEL STRAPPING, 1-1/4"	82.67 REQD	17.87 LBS
SEAL FOR 1-1/4" STRAPPING	6 REQD	NIL
STAPLE	24 REQD	NIL

FILL PIECE, 1" X 4" X 8-1/4" (2 REQD). NAIL TO THE VERTICAL PIECE W/3-6d NAILS.

VERTICAL PIECE, 2" X 6" X 14-1/2" (2 REQD).

HORIZONTAL PIECE, 2" X 4" X 18" (4 REQD). NAIL TO VERTICAL PIECES W/2-10d NAILS AT EACH JOINT.

FILLER ASSEMBLY (FOR MINUS ONE BOX)

VERTICAL PIECE, 2" X 6" X 28-1/2" (4 REQD).

HORIZONTAL PIECE, 1" X 4" X 48" (2 REQD). NAIL TO VERTICAL PIECES W/3-6d NAILS AT EACH LOCATION.

SUPPORT GATE (2 REQD).

GENERAL NOTES

- THIS APPENDIX CANNOT STAND ALONE BUT MUST BE USED IN CONJUNCTION WITH THE BASIC UNITIZATION PROCEDURES DRAWING 19-48-4116-20PA1002. 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.
- DIMENSIONS, CUBE AND WEIGHT OF A PALLET UNIT WILL VARY SLIGHTLY DEPENDING UPON THE ACTUAL DIMENSIONS OF THE BOXES AND THE WEIGHT OF THE SPECIFIC ITEM BEING UNITIZED.
- INSTALL EACH HORIZONTAL STRAP TO ENCIRCLE EACH LAYER OF BOXES ON THE PALLET AND TO BE ALIGNED WITH THE HORIZONTAL PIECES OF THE "SUPPORT GATE" AS SHOWN. HORIZONTAL STRAPS MUST BE TENSIONED AND SEALED PRIOR TO APPLICATION OF TIEDOWN STRAPS.
- INSTALL EACH TIEDOWN STRAP TO PASS UNDER THE TOP DECK BOARDS OF THE PALLET AND TO BE ALIGNED WITH THE VERTICAL PIECES OF THE "SUPPORT GATE" AS SHOWN. TIEDOWN STRAPS WILL NOT BE APPLIED UNTIL THE HORIZONTAL STRAPS HAVE BEEN TENSIONED AND SEALED.
- THE FOLLOWING DARCOM DRAWINGS ARE APPLICABLE FOR OUTLOADING AND STORAGE OF THE ITEMS COVERED BY THIS APPENDIX.

CARLOADING	DRAWING 19-48-4115-SPA1002
TRUCKLOADING	DRAWING 19-48-4117-11PA1003
STORAGE	DRAWING 19-48-4118-1-2-3-4-14-22PA1002
- FOR METHOD OF SECURING A STRAP CUTTER TO THE PALLET UNIT, SEE DARCOM DRAWING 19-48-4127-20P1000.
- IF ITEMS COVERED HEREIN ARE UNITIZED PRIOR TO ISSUANCE OF THIS APPENDIX, THE BOXES NEED NOT BE REUNITIZED SOLELY TO CONFORM TO THIS APPENDIX.
- THE UNITIZATION PROCEDURES DEPICTED HEREIN MAY ALSO BE USED FOR UNITIZING 20MM CARTRIDGES WHEN IDENTIFIED BY DIFFERENT NATIONAL STOCK NUMBERS (NSN) THAN WHAT IS SHOWN ON THE TITLE PAGE, PROVIDED THE BOX PACK DOES NOT VARY FROM WHAT IS DELINEATED HEREIN. THE EXPLOSIVE CLASSIFICATION OF OTHER ITEMS MAY BE DIFFERENT THAN WHAT IS SHOWN.
- REGARDLESS OF THE QUANTITY OF BOXES TO BE PALLETIZED, THE TOTAL WEIGHT OF ANY PALLET UNIT WILL NOT EXCEED 4,000 POUNDS. WHEN THE TOTAL WEIGHT OF A FULLY LOADED PALLET UNIT EXCEEDS 4,000 POUNDS, ONE OR MORE LOADED BOXES MUST BE REMOVED, AND EITHER FILLER ASSEMBLIES, AS DEPICTED BELOW, OR EMPTY BOXES MUST BE SUBSTITUTED THEREFORE. FOR ADDITIONAL GUIDANCE, SEE THE "PROVISIONS FOR LESS-THAN-FULL-LAYER LOADS" ON PAGE 5 OF THE BASIC UNITIZATION PROCEDURES DRAWING 19-48-4116-20PA1002.