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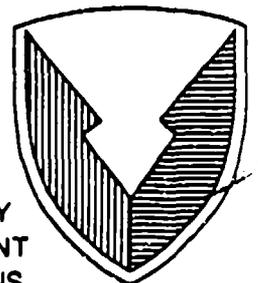
MIL-STD-1660 TESTS OF
120MM MORTAR CONTAINERS
ON WOODEN PALLETS

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

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FIELD	GROUP	SUB-GROUP			
19. ABSTRACT <i>(Continue on reverse if necessary and identify by block number)</i> 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, to test unitization procedures for the 120mm mortar containers on wooden pallets. This report contains the procedures and test results from MIL-STD-1660 tests. As tested, the 120mm mortar containers on wooden pallets met all design requirements for MIL-STD-1660, Design Criteria for Ammunition Unit Loads.					
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U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
VALIDATION ENGINEERING DIVISION
SAVANNA, IL 61074-9639

REPORT NO. 92-26

MIL-STD-1660 TESTS ON 120MM MORTAR CONTAINERS ON WOODEN PALLETS

MARCH - APRIL 1992

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PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-AEP, to conduct tests on the 120mm mortar containers on wooden pallets. This report contains the procedures and test results from the MIL-STD-1660 tests conducted. As tested, the 120mm mortar containers on wooden pallets passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

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

C. OBJECTIVE. The objective of these tests was to assess the capability of the 120mm mortar containers on wooden pallets to meet U.S. Army (USA) functional and operational requirements for MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

D. CONCLUSION. Test pallet no. 1 passed MIL-STD-1660 tests marginally; however, after some design changes which included shortening of intermediate dunnage resulting in a tighter unitized pallet and repositioning of vertical strapping boards to test pallet no. 2, MIL-STD-1660 tests were passed without any problems.

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PART 2

MARCH - APRIL 1992

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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 four tests that were conducted on the test specimen are synopsized below.

A. SUPERIMPOSED LOAD TEST. The unit load was 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 was 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 two. The resulting number is the equivalent compressive force of a 16-foot-high load.

B. REPETITIVE SHOCK TEST. The repetitive shock test was conducted IAW Method 5019, Federal Standard 101. The procedure for the Repetitive Shock Test is as follows: The test specimen was placed on, but not fastened to, the platform. With the specimen in one position, the platform was vibrated at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of about 3 cycles-per-second. The frequency was steadily increased until the package left 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 $1 \pm 0.1G$. Midway into the testing period, the specimen was 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.

C. EDGEWISE ROTATIONAL DROP TEST. This test was conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the Edgewise Rotational Drop Test is as follows: The specimen was 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 was then 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

D. INCLINE-IMPACT TEST. This test was 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 was placed on the carriage with the surface or edge to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage was 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 was 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

A. TEST PALLET.

- a. Drawing Number: 19 48 4116/38A
- b. Width: 40 inches
- c. Length: 48 inches
- d. Height: 36-3/4 inches
- e. Weight: 2,477 pounds

B. 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

C. TRANSPORTATION SIMULATOR.

- a. Manufacturer: Gaynes Laboratory
- b. Capacity: 4,000-pound pallet
- c. Displacement: 1/2-inch Amplitude
- d. Speed: 25 to 400 rpm
- e. Platform: 5 foot by 8 foot

D. INCLINED RAMP.

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

PART 5

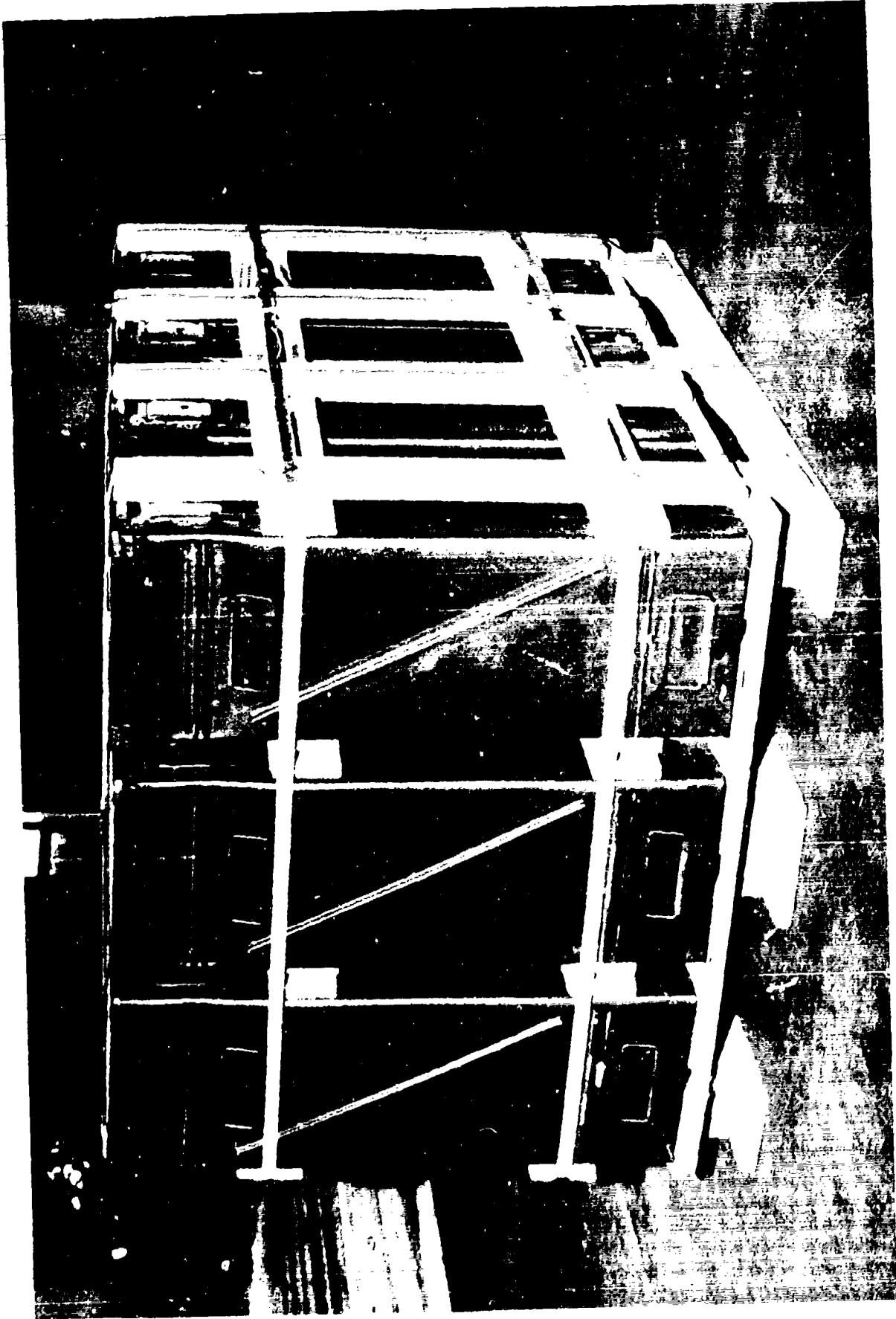
TEST RESULTS

- A. SUPERIMPOSED LOAD TEST. Both test pallets nos. 1 and 2 were loaded to 25,000 pounds of compression for a period of one hour. After this test was conducted, inspection of the pallets showed no deformation.
- B. REPETITIVE SHOCK TEST. Both pallets passed the longitudinal and lateral transportation simulations. The first pallet endured vibrations at 210 rpm and 215 rpm. It was noted that the middle row of containers shifted outward approximately 2.5 inches. The second test pallet, with new spacer designs, endured vibrations at 195 rpm and 205 rpm and passed the test with no problems.
- C. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam 4-1/2 inches above the floor while the other side was raised to a height of 24 inches and then dropped. This process was repeated until all four sides of test pallet no. 1 had been tested. After completion of all four drops, inspection of the pallet showed that there were several vertical banding boards broken. Test pallet no. 2, with a new design, was tested in the same manner and passed without any problems.
- D. INCLINE-IMPACT TEST. Both pallets were impacted on all four sides at speeds of approximately 7 feet-per-second. After the first pallet was tested, it was noted that one of the vertical bands was very close to becoming disengaged but still remained intact. The new design of the second pallet overcame this problem and passed this test without difficulty.

E. END OF TEST INSPECTION. Test pallet no. 1 experienced some damage during testing, but passed marginally. The newly designed test pallet no. 2 passed all tests without difficulty, after solving the problems encountered with test pallet no. 1.

PART 6

PHOTOGRAPHS

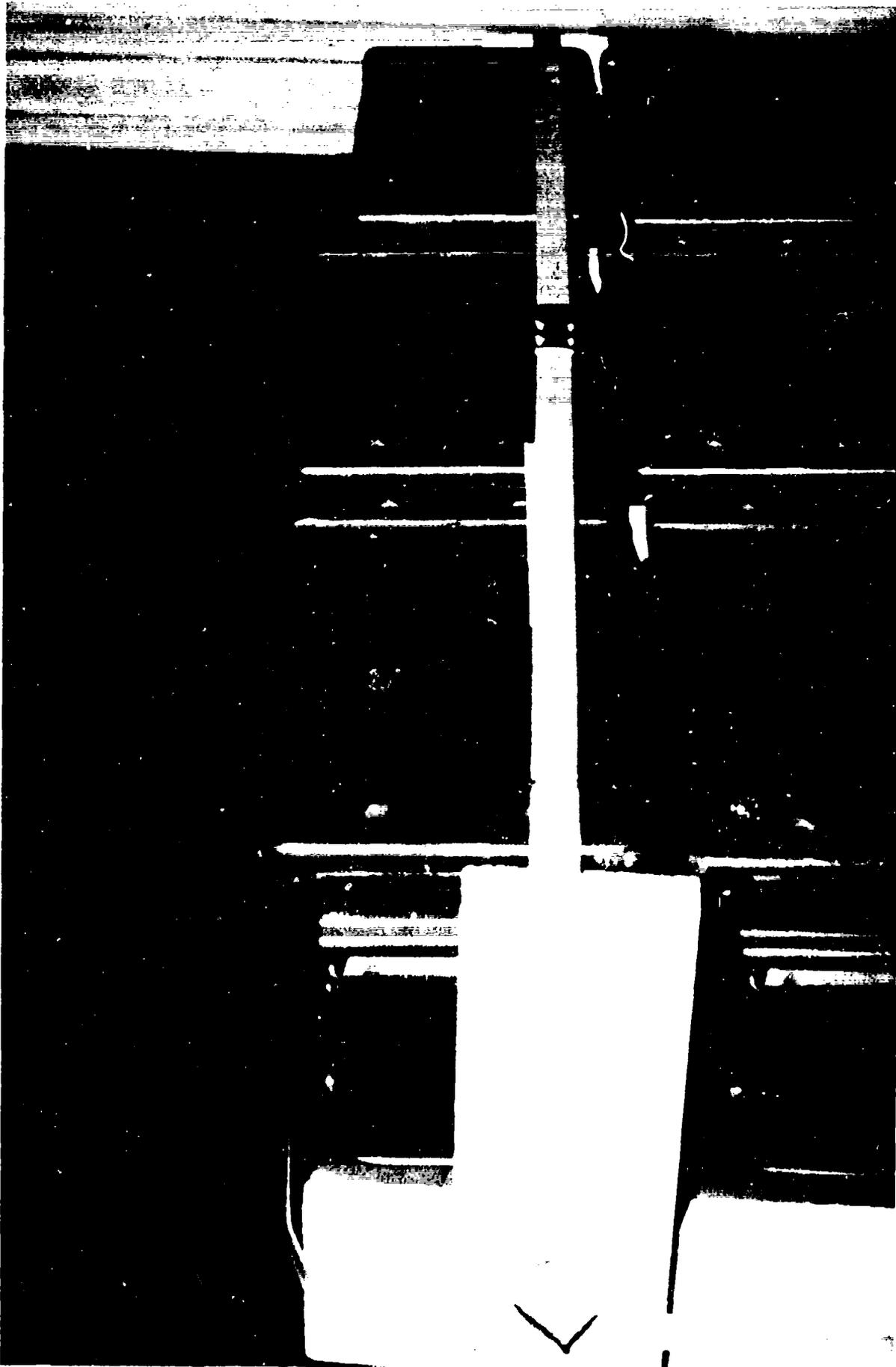


	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SCN-92-303-3595. This photo shows the overall view of the 120mm mortar pallet.		



U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. AO317-SCN-92-303-3596. This photo shows the closeup view of the unitization strap lodged between the 120mm mortar containers.



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Photo No. AO317-SCN-92-303-3597. This photo shows the 120mm mortar containers racked out approximately 1 inch after testing.

PART 7

APPENDIX

APPENDIX 38A

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

CARTRIDGE, 120MM MORTAR, PACKED 2 PER
PA154 METAL CONTAINER, UNITIZED 24
CONTAINERS PER 40" X 48" PALLET; APPROX
BOX SIZE 12-1/2" L X 6-3/8" W X 31-1/4" H

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

U.S. ARMY MATERIEL COMMAND DRAWING				
APPROVED, U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND SMCAR-ESK AMSMC-TMO	DRAFTSMAN		BETTY J. KUNCERT	
	ENGINEER		SANDRA M. SCHULTZ	
	SUPPLY ENGINEERING DIVISION	TRANSPORTATION ENGINEERING DIVISION	VALIDATION ENGINEERING DIVISION	
APPROVED BY ORDER OF COMMANDING GENERAL, U.S. ARMY MATERIEL COMMAND U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL	<i>J. Michel</i>		<i>W. Durick</i>	
	LOGISTICS ENGINEERING OFFICE			
	CLASS	DIVISION	DRAWING	FILE
	19	48	4116/ 38A	20PA 1002

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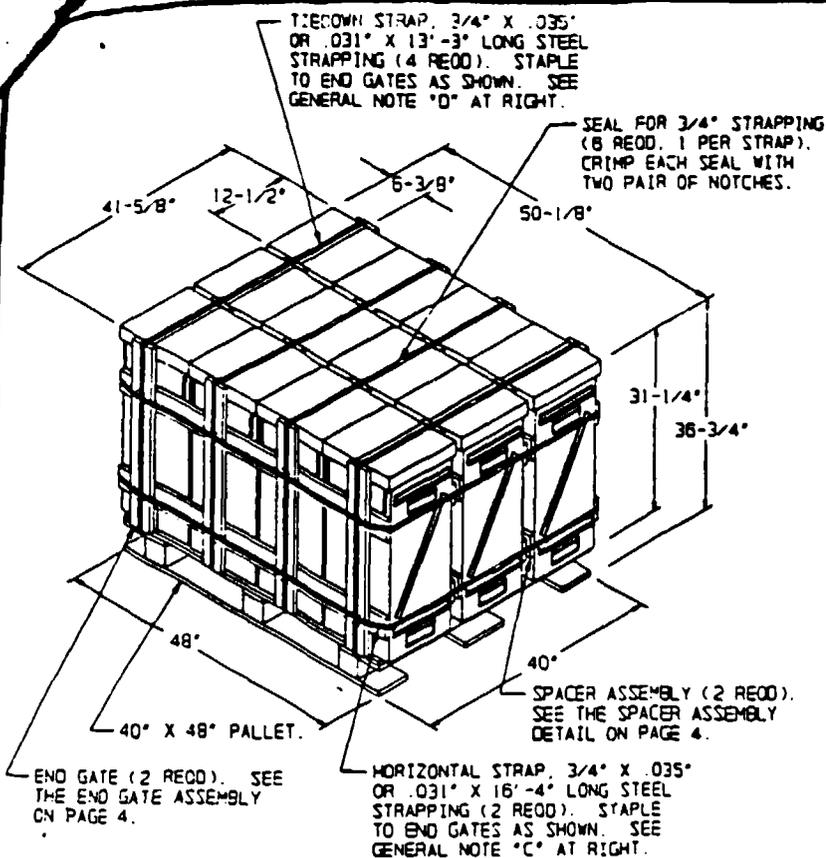
PROJECT FSA 146/38A-75

PALLET UNIT DATA					
ITEMS INCLUDED		HAZARD CLASSIFICATION ●			APPROX WEIGHT LBS
NSN	DDIC	CG CLASS	HAZARD CLASS AND DIVISION		
			OO CLASS	COMP GROUP	
1315-					
01-335-5016	C379	---	---	---	2,477
01-343-1941	C623	---	---	---	2,477
01-343-1940	C624	---	---	---	2,477
01-343-1942	C625	---	---	---	2,477

● HAZARD CLASSIFICATION DATA CONTAINED IN THE ABOVE CHART 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).

GENERAL NOTES

- A. THIS APPENDIX CANNOT STAND ALONE BUT MUST BE USED IN CONJUNCTION WITH THE BASIC UNITIZATION PROCEDURES DRAWING 19-48-4115-20PA1002. 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.
- B. 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.
- C. INSTALL EACH HORIZONTAL STRAP TO BE LOCATED AS SHOWN. HORIZONTAL STRAPS MUST BE TENSIONED AND SEALED AFTER THE APPLICATION OF TIEDOWN STRAPS.
- D. INSTALL EACH TIEDOWN STRAP TO PASS UNDER THE DECK/STRINGER BOARDS OF THE PALLET AND TO BE LOCATED AS SHOWN.
- E. THE FOLLOWING AMC DRAWINGS ARE APPLICABLE FOR UNLOADING AND STORAGE OF THE ITEMS COVERED BY THIS APPENDIX.
 - CARLOADING - - - - 19-48-4115-SPA1002
 - TRUCKLOADING - - - - 19-48-4117-11PA1003
 - STORAGE - - - - - 19-48-4118-1-2-3-4-14-22PA1002
 - COMMERCIAL CONTAINER - - - - 19-48-4153-1SPA1002
 - MILVAN - - - - - 19-48-4166-1SPA1003
 - SIDE OPENING COMMERCIAL CONTAINER - - - - 19-48-6267-1SPA1009
- F. FOR METHOD OF SECURING A STRAP CUTTER TO THE PALLET UNIT. SEE AMC DRAWING 19-48-4127-20P1000.
- G. IF ITEMS COVERED HEREIN ARE UNITIZED PRIOR TO ISSUANCE OF THIS APPENDIX, THE BOXES NEED NOT BE REUNITIZED SOLELY TO CONFORM TO THIS APPENDIX.
- H. THE UNITIZATION PROCEDURES DEPICTED HEREIN MAY ALSO BE USED FOR UNITIZING 120MM MORTAR CARTRIDGES WHEN IDENTIFIED BY DIFFERENT NATIONAL STOCK NUMBERS (NSN) THAN WHAT IS SHOWN ON PAGE 2, PROVIDED THE CONTAINER DOES NOT VARY FROM WHAT IS DELINEATED HEREIN. THE EXPLOSIVE CLASSIFICATION OF OTHER ITEMS MAY BE DIFFERENT THAN WHAT IS SHOWN.
- J. THE STYLE 1 PALLET DELINEATED IN THE DETAIL AT LEFT NEED NOT HAVE CHAMFERS OR STRAP SLOTS AS SPECIFIED WITHIN MILITARY SPECIFICATION MIL-P-15011 WHEN USED FOR THE UNITIZATION OF ITEMS COVERED BY THIS APPENDIX.
- K. CONTAINERS MUST ALL BE ORIENTED IN THE SAME DIRECTION ON THE PALLET SO THE INTERLOCKING DEVICES WILL ENGAGE.



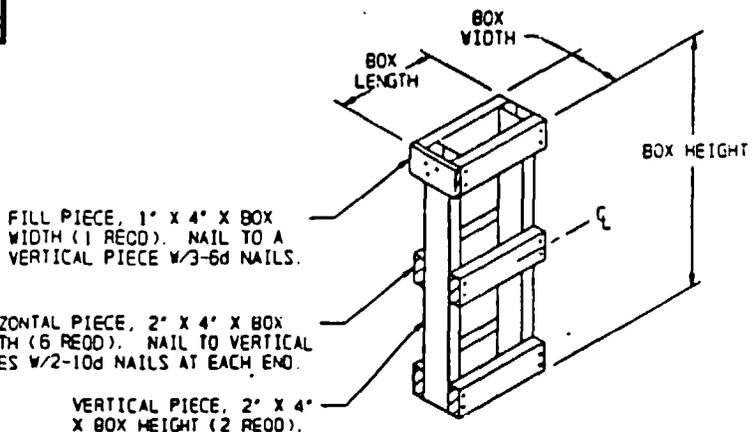
PALLET UNIT

SEE GENERAL NOTE "B" AT RIGHT

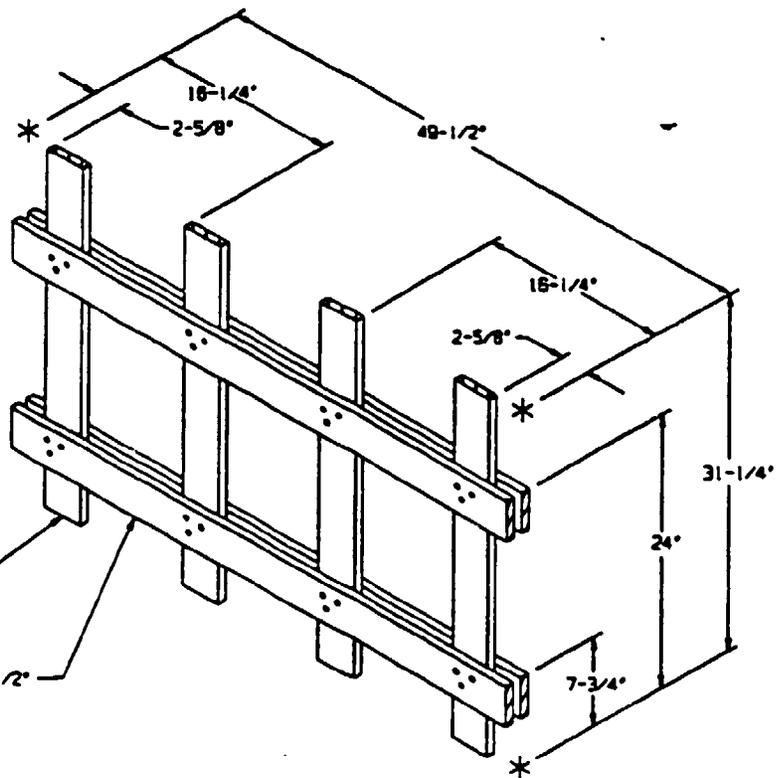
24 BOXES OF 120MM MORTAR CTG (2 PER BOX) @ 97 LBS	-	2,328 LBS (APPROX)
OLNAGE	-	69 LBS
PALLET	-	80 LBS

TOTAL WEIGHT	-	2,477 LBS (APPROX)
CUBE	-	44.37 CU FT (APPROX)

BILL OF MATERIAL		
LUMBER	LINEAR FEET	BOARD FEET
1" X 4"	91.17	30.39
NAILS		POUNDS
6d (2")	56	.33
10d (3")	48	.74
PALLET, 40" X 48"	1 RECD	80 LBS
STEEL STRAPPING, 3/4"	85.67' RECD	6.12 LBS
SEAL FOR 3/4" STRAPPING	8 RECD	NIL
STAPLE, 15/16" X 3/4"	24 RECD	NIL



FILLER ASSEMBLY
(FOR MINUS ONE BOX)

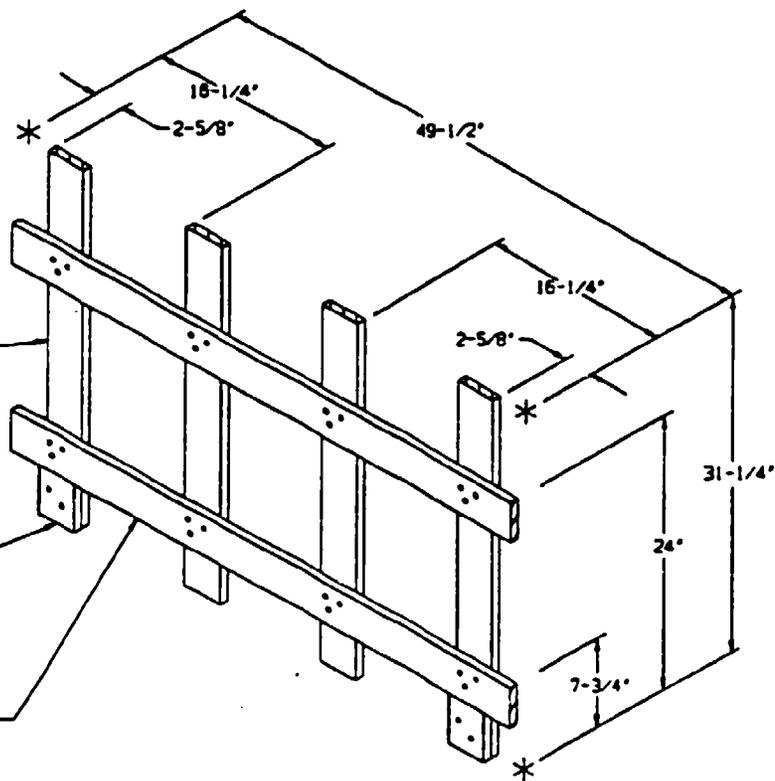


VERTICAL PIECE, 1" X 4" X 31-1/4" (4 REQD).

HORIZONTAL PIECE, 1" X 4" X 49-1/2" (4 REQD). NAIL TO THE VERTICAL PIECES W/3-10d NAILS AT EACH JOINT.

SPACER ASSEMBLY

(2 REQD)



VERTICAL PIECE, 1" X 4" X 31-1/4" (4 REQD).

SUPPORT PIECE, 1" X 4" X 4-1/4" (2 REQD). NAIL TO VERTICAL PIECE W/2-6d NAILS AND CLINCH.

HORIZONTAL PIECE, 1" X 4" X 49-1/2" (2 REQD). NAIL TO THE VERTICAL PIECES W/3-6d NAILS AT EACH JOINT AND CLINCH.

END GATE

(2 REQD)