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FINAL REPORT

JUNE 1989

REPORT NO. EVT 32-89

ENGINEERING TEST OF
UNITIZATION PROCEDURES FOR
155MM M203A1 PROPELLING
CHARGES

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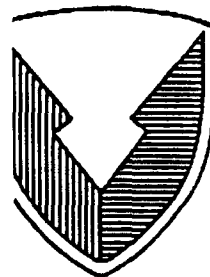
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19. ABSTRACT (Continue on reverse if necessary and identify by block number) The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV), has been tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-ESK, Rock Island, IL, to test unitization procedures for shipping 155MM M203A1 propelling charges. The unitization procedure being tested was proposed in VECF #M8A9-029. The methods and results of MIL-STD-1660 testing of the unitization procedure proposed in the VECF are contained within this report. As a result of the MIL-STD-1660 tests, the Evaluation Division is recommending that this unitization procedure be approved for Army-wide use in storing and shipping 155MM M203A1 propelling charges.					
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22a. NAME OF RESPONSIBLE INDIVIDUAL THOMAS J. MICHELS, CHIEF, EVALUATION DIVISION			22b. TELEPHONE (Include Area Code) 815-273-8928		22c. OFFICE SYMBOL SMCAC-DEV

U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
Evaluation Division
Savanna, IL 61074-9639

REPORT NO. EVT 32-89
ENGINEERING TEST OF UNITIZATION PROCEDURES FOR 155MM
M203A1 PROPELLING CHARGES

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PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division, was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-ESK, to validate VECP #M8A9-029 which proposed the elimination of an intermediate dunnage assembly in unitization procedures for 155MM M203A1 propelling charges. The testing procedures that were used for evaluating the VECP consisted of MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

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 these tests is to assess the capability of the modified unitization procedures to meet Army functional/operational requirements for MIL-STD-1660, Design Criteria for Ammunition Unit Loads.



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PART 2

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). MIL-STD-1660 identifies four steps the 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 load of a 16-foot-high unit stack.

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 a magnitude of ± 1 G. 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 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. 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:

Table 1: Drop Levels		
GROSS WEIGHT NOT EXCEEDING	DIMENSIONS ON ANY EDGE NOT EXCEEDING	HEIGHT OF DROP LEVEL A PROTECTION
600 lbs.	72 inches	36 inches
3,000 lbs.	no limit	24 inches
no limit	no limit	12 inches

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 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.

PART 4

TEST EQUIPMENT

1. TEST SPECIMEN.

- a. Drawing Number: 19-48-4042A/22
- b. Width: 47-3/4 inches
- c. Length: 38-1/8 inches
- d. Height: 36 inches
- e. Weight: 1396 pounds

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

1. STACKING TEST. The test pallet was loaded to 7,600 pounds compression for a period of one hour. At the end of the one hour period, the compression load had decreased to 7,100 pounds, but the load had not compressed.
2. REPETITIVE SHOCK TEST. The test pallet successfully passed both the longitudinal and lateral transportation simulation. Duration of the test was 90 minutes for each orientation of the pallet. In order to achieve the required 1/16-inch clearance between the pallet and the Transportation Simulator bed, the equipment was operated at 190 rpm for the longitudinal orientation and 185 rpm for the lateral orientation. There was no damage sustained by the pallet during the test.
3. EDGEWISE DROP TEST. Each side of the pallet base was placed on a beam displacing it 6 inches above the floor. The opposite side was raised to a height of 24 inches above the floor and then dropped. This process was repeated in a clockwise direction until all four sides of the pallet had been tested. No damage was sustained during the edgewise test. The cans did shift during the initial impact, but returned to a vertical position during rebound.
4. IMPACT TEST. The incline impact tester was set to allow the pallet to travel .8 feet before impacting the bumper of the impact tester. In between impacts, the pallet was rotated in a clockwise direction until all four sides of the pallet had been impacted.

No damage was sustained from the impact testing; however, a cross-member on the top frame opposite the bell ends was broken during slinging.

PART 6

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS. The test pallet successfully passed all phases of the MIL-STD-1660 criteria for ammunition unit loads. The only damage to the pallet was sustained during the slinging operation required to complete the impact test. This damage did not affect the stability or stackability of the unit load and was not considered a basis for failure.

2. RECOMMENDATIONS. Since the pallet successfully passed all phases of the MIL-STD-1660 test, it is hereby recommended that the unitization procedures for 155MM M203A1 propelling charges as proposed in VECF #M8A9-029 be approved for Army-wide use.

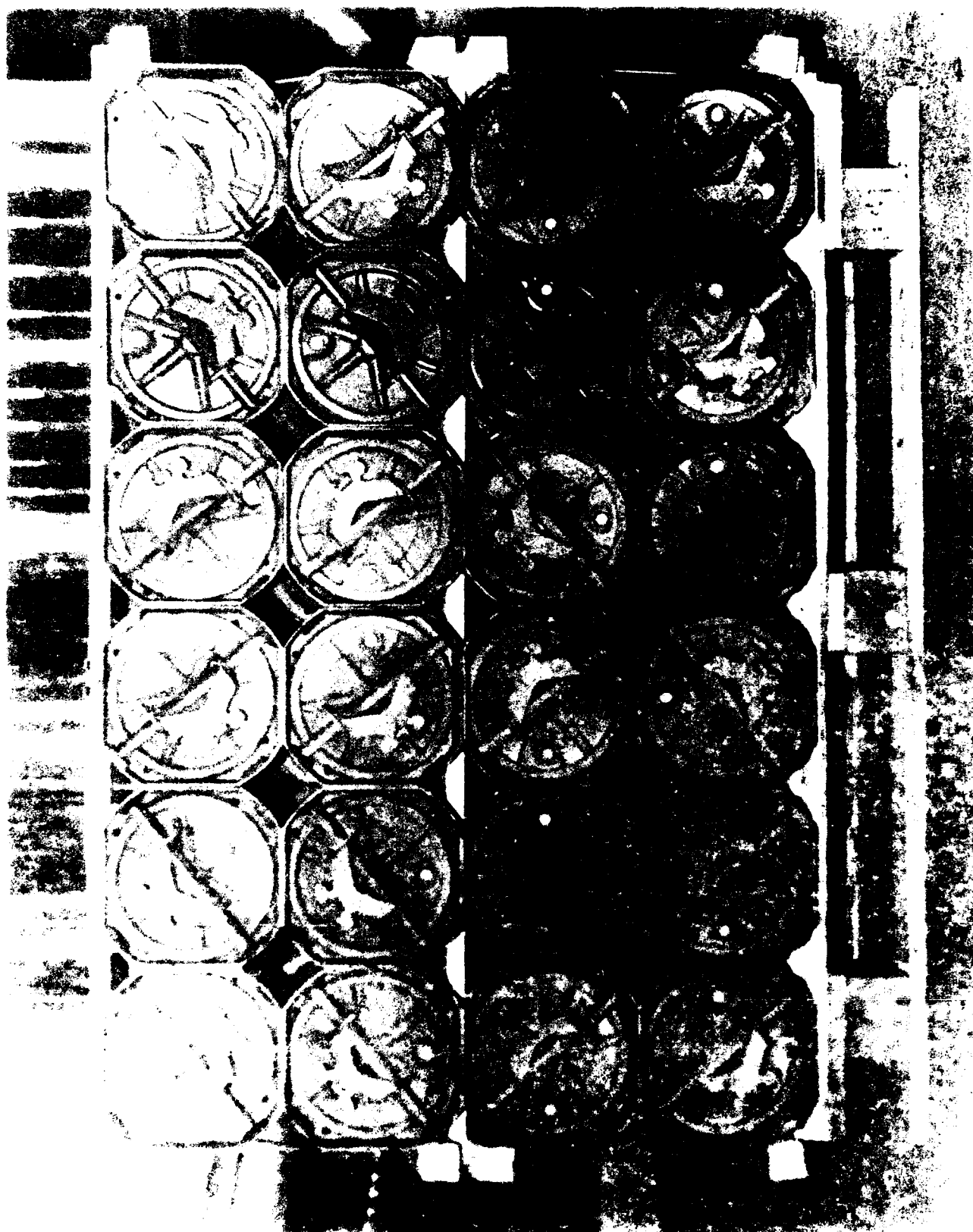
PART 7

PHOTOGRAPHS



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

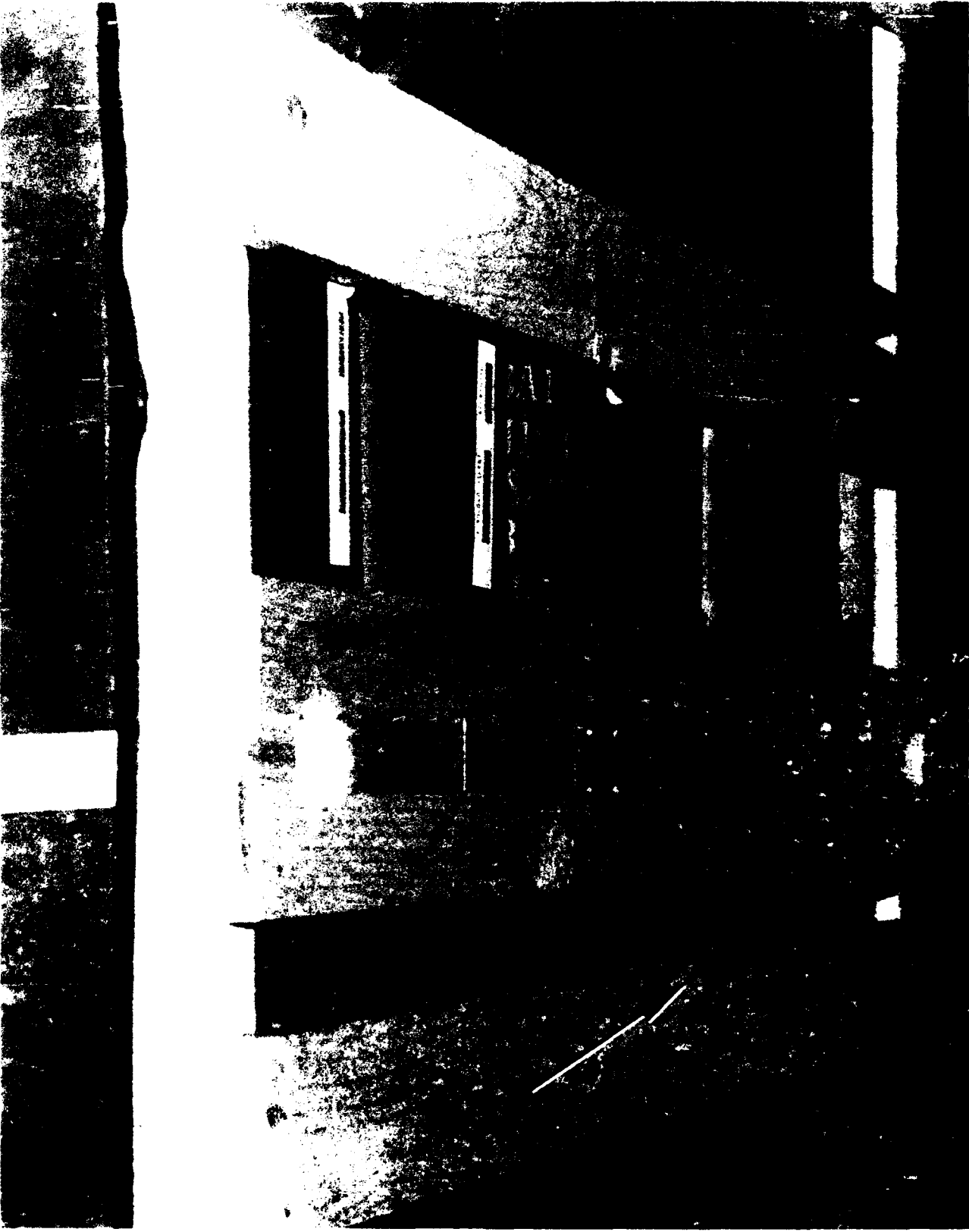
Photo 1: Side view of the test pallet.





DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo 3: Corner view of test pallet.



DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo 4. This photo shows the cracked cross member in the top frame assembly.

PART 8

DRAWINGS

APPENDIX 22

UNITIZING PROCEDURES FOR PROPELLING CHARGES PACKED IN CYLINDRICAL METAL CONTAINERS ON 4-WAY ENTRY PALLETS

PAIO3 SERIES CONTAINER .

INDEX

<u>ITEM</u>	<u>PAGE(S)</u>
GENERAL NOTES -----	2
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DUNNAGE DETAILS -----	5
FILLERS AND INSTALLATION PROCEDURES FOR OMITTED CONTAINERS -----	6,7

PALLET UNIT DATA						
ITEMS INCLUDED		HAZARD CLASSIFICATION ①				WEIGHT (LBS)
NSN	DODIC	DOT CLASS	CG CLASS	QD CLASS	COMP GROUP	
1320- 01-202-8938	0532	8	II A	1,3	C	1,370

NOTICE: THIS APPENDIX CANNOT STAND ALONE BUT MUST
BE USED IN CONJUNCTION WITH THE BASIC UNITIZATION
PROCEDURES DRAWING 19-48-4042A-20PM1001.

- ① 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).

REVISIONS				Drawn by	Checked by	Approved by	U.S. Army
1	OCT 88	WRF	WRF	WRF	WRF	WRF	WRF
2	OCT 87	WRF	WRF	WRF	WRF	WRF	WRF
3	SEP 89	WRF	WRF	WRF	WRF	WRF	WRF
				U.S. ARMY DARCOM DRAWING			
				OCTOBER 1983			
				CLASS	DIVISION	DRAWING	FILE
				19	48	4042A/ 22	20PM 1001

DO NOT SCALE

GENERAL NOTES

- A. THIS APPENDIX CANNOT STAND ALONE BUT MUST BE USED IN CONJUNCTION WITH THE BASIC UNITIZING PROCEDURES DRAWING 19-48-4042A-20PM1001. 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 CONTAINER, WEIGHT OF THE SPECIFIC ITEM, AND METHOD OF UNITIZATION.
- C. FOR OUTLOADING AND STORAGE OF THE ITEMS COVERED BY THIS APPENDIX, SEE DARCOM DRAWING 19-48-4042-1-2-5-11-14PM1000, REV NO. 1 (WILL BE SUPERSEDED BY ANOTHER 19-48 SERIES DARCOM DRAWING SPECIFICALLY FOR THE PA100 SERIES CONTAINER).
- D. FOR METHOD OF SECURING A STRAP CUTTER TO THE PALLET UNIT, SEE AMC (DARCOM) DRAWING 19-48-4127-20P1000.
- E. IF ITEMS COVERED HEREIN ARE UNITIZED PRIOR TO ISSUANCE OF THIS APPENDIX, THE CONTAINERS NEED NOT BE REUNITIZED SOLELY TO CONFORM TO THIS APPENDIX.
- F. THE UNITIZATION PROCEDURES DEPICTED HEREIN MAY ALSO BE USED FOR UNITIZING PROPELLING CHARGES WHEN IDENTIFIED BY DIFFERENT NATIONAL STOCK NUMBERS (NSN) THAN THOSE SHOWN ON THE COVER PAGE, PROVIDED THE ITEM IS PACKED IN THE PA100 SERIES CONTAINER. THE EXPLOSIVE CLASSIFICATION OF OTHER ITEMS MAY BE DIFFERENT THAN THOSE SHOWN.
- G. FOR DETAILS OF THE PA100 SERIES CONTAINER, SEE US ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER, DRAWING NO. 9349390.
- CONTAINER DIMENSIONS----- 38" LONG BY 7-1/2" WIDE BY 7-1/2" HIGH.
CONTAINER CUBE ----- 1.24 CUBIC FEET.
CONTAINER WEIGHT (WITH CHARGE)----- 54 LBS (APPROX).
- H. IF DEEMED MORE ECONOMICAL FOR SHIPPING AND STORAGE BY THE RESPONSIBLE COMMAND, THE UNIT DEPICTED ON THE FOLLOWING PAGES MAY BE INCREASED BY ONE OR TWO COMPLETE LAYERS OF CONTAINERS. FOR FURTHER UNITIZATION GUIDANCE, SEE SPECIAL NOTE 3 ON PAGE 4.
- J. THE STYLE 1A PALLET DELINEATED IN THE VIEW ON PAGE 4 NEED NOT HAVE CHAMFERS OR STRAP SLOTS AS SPECIFIED WITHIN MILITARY SPECIFICATION MIL-P-15011 WHEN USED FOR THE UNITIZATION OF THE ITEMS COVERED BY THIS APPENDIX.

REVISIONS

REVISION NO. 1, DATED OCTOBER 1985, CONSISTS OF:

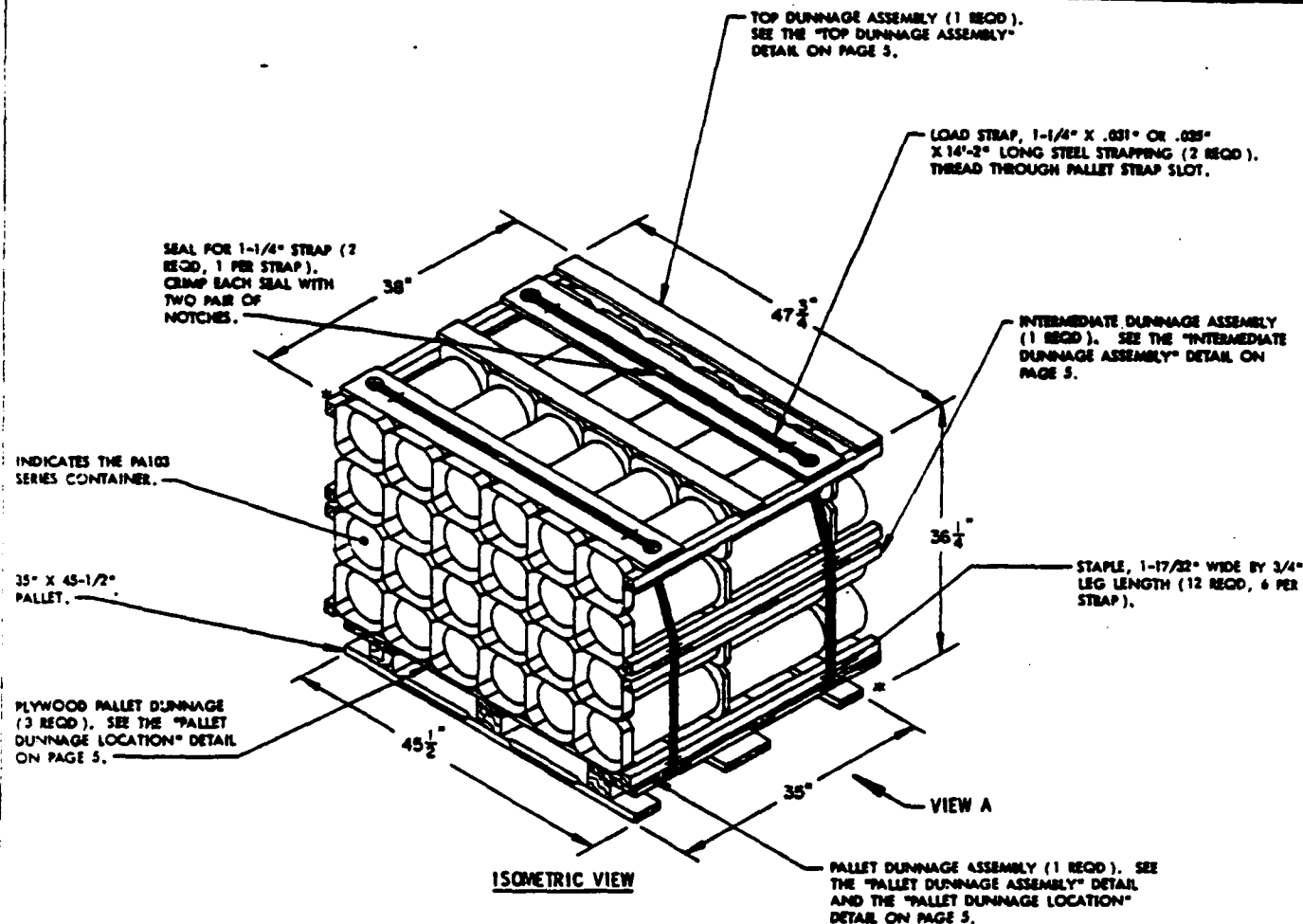
1. ADDING ITEM BY NATIONAL STOCK NUMBER TO PALLET UNIT DATA CHART.
2. CHANGING UNIT WEIGHT.

REVISION NO. 2, DATED OCTOBER 1987, CONSISTS OF:

1. ADDING ITEM BY NATIONAL STOCK NUMBER TO PALLET UNIT DATA CHART.
2. ADDING DATA TO PALLET UNIT DATA CHART.

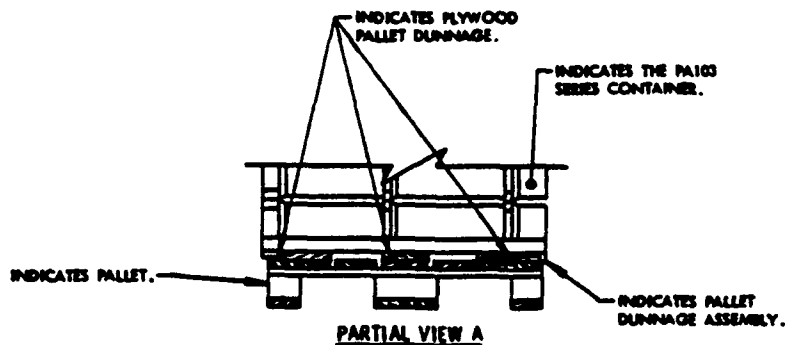
REVISION NO. 3, DATED SEPTEMBER 1989, CONSISTS OF:

1. DECREASING PALLET UNIT BY TWO LAYERS OF CONTAINERS.
2. DELETING ITEM BY NATIONAL STOCK NUMBER FROM PALLET UNIT DATA CHART.
3. CHANGING WEIGHT FOR NSN IN PALLET UNIT DATA CHART.
4. CHANGING SPECIAL NOTE 3 AND DELETING SPECIAL NOTE 4.



SPECIAL NOTES:

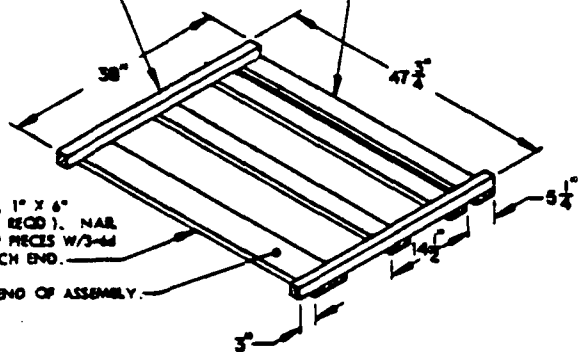
1. DIMENSIONS GIVEN FOR DUNNAGE PIECES OR DUNNAGE ASSEMBLIES WILL BE FIELD CHECKED PRIOR TO THEIR ASSEMBLY TO THE PALLET UNIT. CONTAINERS MUST FIT SNUGLY IN THE DUNNAGE ASSEMBLIES. ALSO, DUE TO THE VARIATION OF CONTAINER DIMENSIONS, ADJUSTMENTS MAY BE REQUIRED AS TO THE LOCATION OF CERTAIN PIECES OF DUNNAGE IN A DUNNAGE ASSEMBLY.
2. ALTHOUGH THE PROPELLING CHARGE CONTAINERS DEPICTED IN THE UNIT LOAD ABOVE ARE CONSTRUCTED WITH INTERLOCKING DEVICES, THE INTERLOCKS WILL NOT FUNCTION PROPERLY UNLESS THE CONTAINERS ARE POSITIONED SO THAT THE "PINS" OF THE INTERLOCKS ARE IN AN UPRIGHT ORIENTATION. THIS ORIENTATION WILL PRECLUDE INTERFERENCE OF THE "PINS" AND THE PLYWOOD PALLET DUNNAGE AND WILL AID IN THE PREVENTION OF CONTAINER MOVEMENT, BOTH LATEROALLY AND LONGITUDINALLY, DURING SHIPMENT OF THE UNIT LOAD.
3. THE UNIT LOAD DEPICTED ABOVE MAY BE INCREASED BY ONE OR TWO LAYERS WHEN DEEMED ADVANTAGEOUS FOR A CERTAIN MODE OF TRANSPORTATION. IN THIS EVENT, A SECOND "INTERMEDIATE DUNNAGE ASSEMBLY" MUST BE ADDED AND THE LOAD STRAP LENGTHS MUST BE INCREASED. THE DECISION TO INCREASE THE LOAD BY ONE OR TWO LAYERS WILL BE MADE BY THE RESPONSIBLE COMMAND AND WILL BE BASED ON THE ECONOMICS OF TRANSPORTATION AND HANDLING.



UNIT DETAIL

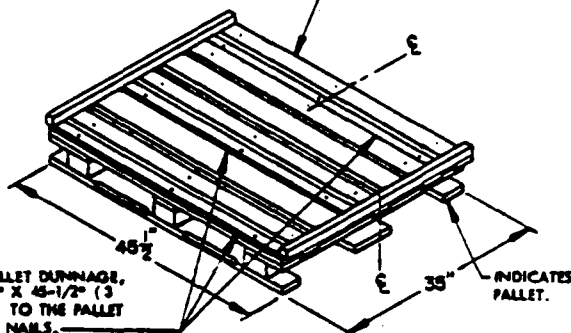
STOP PIECE, 2" X 2" X 38" (2 REQD).

CROSS PIECE, 1" X 4" X 47-3/4" (3 REQD). NAIL TO THE STOP PIECES W/3-6d NAILS AT EACH END.



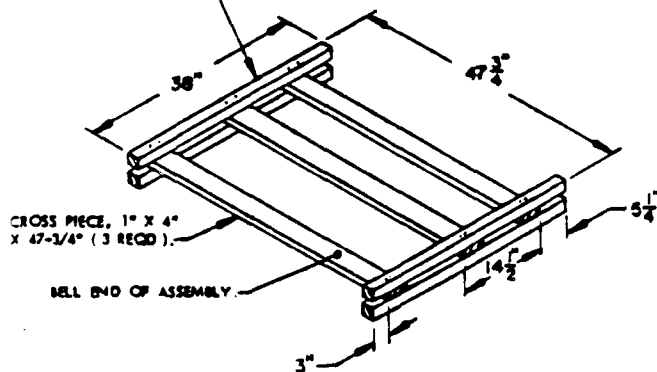
PALLET DUNNAGE ASSEMBLY
(1 REQD)

PALLET DUNNAGE ASSEMBLY. NAIL EACH CROSS PIECE TO THE PALLET DECK W/3-6d NAILS. DO NOT NAIL THRU THE STRAP SLOTS.



PALLET DUNNAGE LOCATION

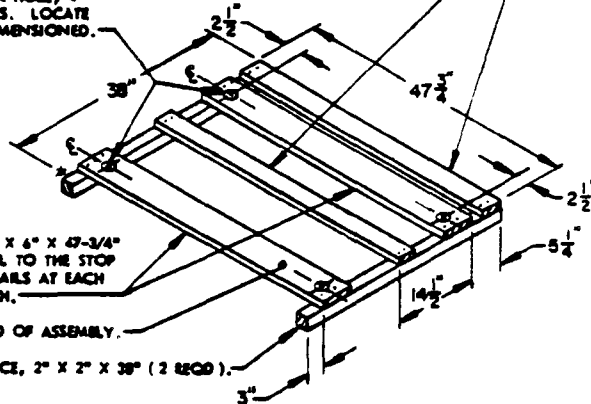
STOP PIECE, 2" X 2" X 38" (4 REQD). NAIL TO THE CROSS PIECES W/2-6d NAILS AT EACH JOINT.



INTERMEDIATE DUNNAGE ASSEMBLY
(3 REQD)

CROSS PIECE, 1" X 4" X 47-3/4" (2 REQD). NAIL TO THE STOP PIECES W/2-6d NAILS AT EACH END AND CLINCH.

2" DIA HOLE, 4 PLACES. LOCATE AS DIMENSIONED.



TOP DUNNAGE ASSEMBLY
(1 REQD)

BILL OF MATERIAL

LUMBER	NO. REQD	LINEAR FEET	BOARD FEET
1" X 4" X 47-3/4"	6	31.83	10.48
1" X 4" X 47-3/4"	3	11.94	5.97
2" X 2" X 38"	6	25.33	8.44
NAILS	NO. REQD	POUNDS	
4d (1-1/2")	9	0.03	
6d (2")	36	0.18	
8d (2-1/2")	44	0.46	
PALLET, 38" X 45-1/2"	1 REQD	65 LBS	
STEEL STRAPPING, 1-1/4" X .031" OR .035" - 28.33"	28 REQD	4.08 LBS	
SEAL FOR 1-1/4" STRAPPING	2 REQD	N/A	
STAPLE, 1-17/32" X 3/4"	12 REQD	N/A	
PLYWOOD, 3/8"	1.44 SQ FT REQD	1.71 LBS	

UNIT DATA

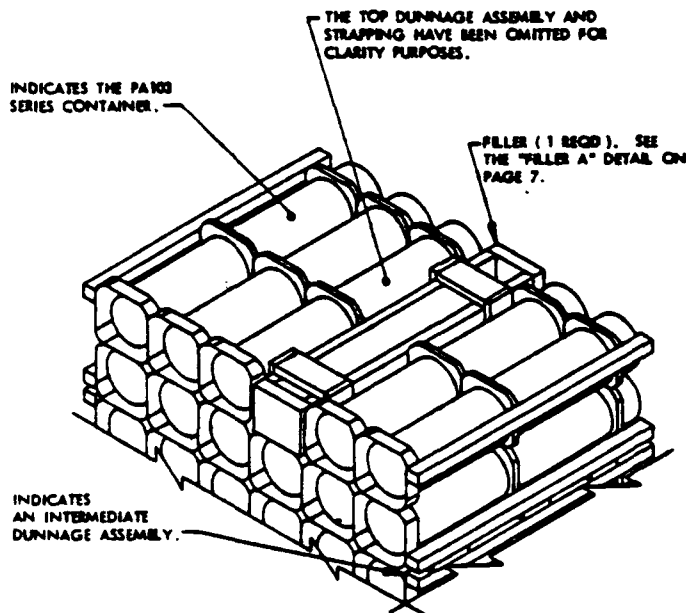
WEIGHT

CUBE — 38.1 CUBIC FEET (APPROX)
CONTAINER, PAKED SERIES—34 EACH @ 52 LBS—1,748 LBS (APPROX)
DUNNAGE — 57 LBS
PALLET — 65 LBS
TOTAL WEIGHT — 1,870 LBS (APPROX)

DUNNAGE DETAILS

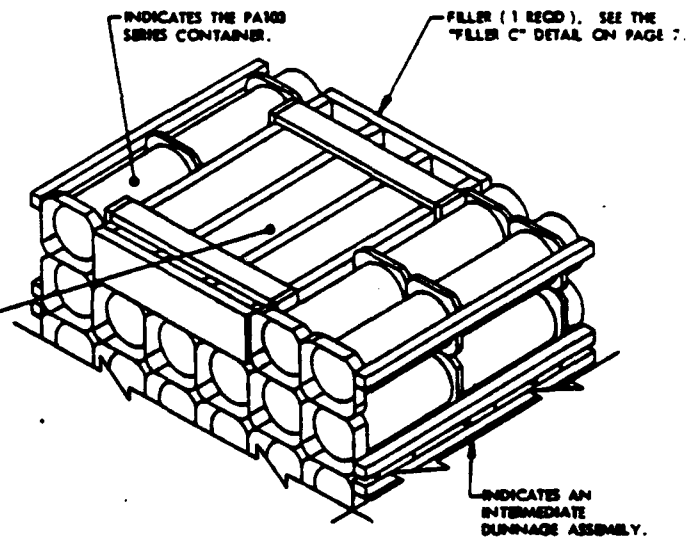
SPECIAL NOTES:

1. WHEN SIX CONTAINERS ARE TO BE OMITTED FROM A PALLET UNIT, A COMPLETE LAYER OF CONTAINERS MUST BE OMITTED. WHEN FIVE CONTAINERS ARE TO BE OMITTED FROM A PALLET UNIT, A COMBINATION OF FILLER ASSEMBLIES DEPICTED ON PAGE 7 MUST BE USED. WHEN FOUR OR LESS CONTAINERS ARE TO BE OMITTED FROM A PALLET UNIT, A COMBINATION OF ONE OF THE FILLER ASSEMBLIES DEPICTED ON PAGE 7 MAY BE USED. ALL FILLER ASSEMBLIES MUST BE INSTALLED IN THE MIDDLE OF THE TOP LAYER OR LAYERS OF A PALLET UNIT.
2. THE OVERALL HEIGHT OF THE FILLER ASSEMBLIES DEPICTED ON PAGE 7 MUST BE REDUCED FROM 7-1/4" TO 6-1/2" WHEN INSTALLED BETWEEN A TOP DUNNAGE ASSEMBLY AND AN INTERMEDIATE DUNNAGE ASSEMBLY OR BETWEEN ANOTHER FILLER ASSEMBLY AND AN INTERMEDIATE DUNNAGE ASSEMBLY.



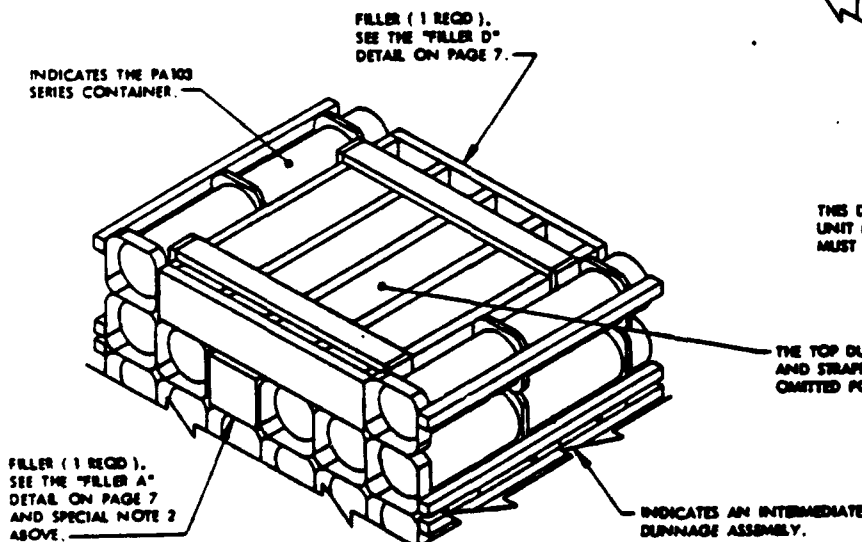
DETAIL A

THIS DETAIL DEPICTS PROCEDURES TO BE USED WHEN A STANDARD PALLET UNIT MINUS ONE CONTAINER IS TO BE UNITIZED. THE FILLER ASSEMBLY DEPICTED MUST BE INSTALLED IN THE MIDDLE OF THE TOP LAYER OF THE PALLET UNIT.



DETAIL B

THIS DETAIL DEPICTS PROCEDURES TO BE USED WHEN A STANDARD PALLET UNIT MINUS THREE CONTAINERS IS TO BE UNITIZED. THE FILLER ASSEMBLY MUST BE INSTALLED IN THE MIDDLE OF THE TOP LAYER OF THE PALLET UNIT.



DETAIL C

THIS DETAIL DEPICTS PROCEDURES TO BE USED WHEN A STANDARD PALLET UNIT MINUS FIVE CONTAINERS IS TO BE UNITIZED. THE FILLER ASSEMBLIES DEPICTED MUST BE INSTALLED IN THE MIDDLE OF THE TOP LAYERS OF THE PALLET UNIT.

FILLERS AND INSTALLATION PROCEDURES FOR OMITTED CONTAINERS

