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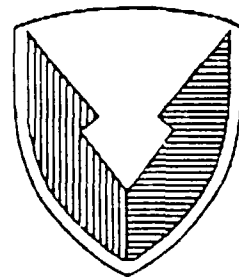
MIL-STD-1660 TEST OF
UNITIZATION PROCEDURES FOR
M2A1 CONTAINERS
PROJECT CA 185/56-81

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U.S. Army Armament Research, Development and
Engineering Center
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Rock Island, IL 61299-7300



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EVALUATION DIVISION
SAVANNA, ILLINOIS 61074-9639

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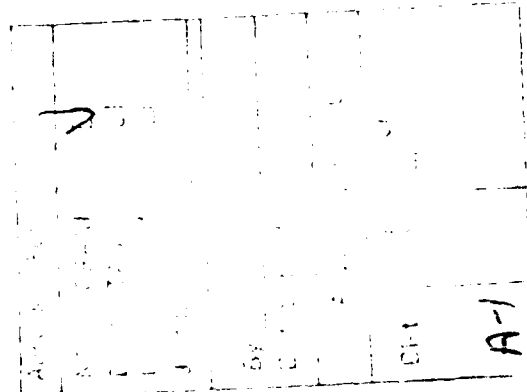
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The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV), has been tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), Rock Island, IL, to test unitization procedures for shipping M2A1 containers. Under project no. CA 185/56-81, the Storage and Outloading Division (SMCAC-DEO) developed two procedures for shipping M2A1 containers. The methods and results of MIL-STD-1660 testing and APE 1958 leak testing of the wirebound unitization procedure described in project CA 185/56-81 are contained within this report. As a result of these tests, it was found that the referenced procedure satisfactorily protected the M2A1 containers in the unitized load.					
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MIL-STD-1660 TEST OF UNITIZATION
PROCEDURES FOR M2A1 CONTAINERS
PROJECT CA 185/56-81

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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 test unitization procedures for M2A1 containers. Unitization procedures for M2A1 containers in wirebound and fiberboard pallet boxes were developed by the Storage and Outloading Division, SMCAC-DEO, under project no. CA 185/56-81. The testing procedures that were used for evaluating the wirebound pallet box consisted of MIL-STD-1660, Design Criteria for Ammunition Unit Loads and APE 1958, Container Leak Test.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command, Rock Island, IL.

C. OBJECTIVE. The objective of these tests was to determine if the wirebound pallet box loaded with M2A1 containers could pass the APE 1958 leak test after being subjected to the stresses of the MIL-STD-1660 test.

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), and Operation manual for Container Leak Test Device APE 1958 (June 1978). MIL-STD-1660 identifies four steps, the unitized load must undergo if it is considered to be acceptable. The operation Manual for APE 1958 identifies a series of steps that must be performed to determine if the M2A1 cans meet the leak criteria. These tests are synopsized below:

1. LEAK TESTING. Prior to unitization of the M2A1 cans and after MIL-STD-1660 testing of the load, each M2A1 container will be leak tested using APE 1958 so that an accurate record of container failure can be established. The criteria for failure of an M2A1 container is a leakage rate that exceeds 0.4 CC per second when a 3 psi gage minimum external vacuum is applied.

2. 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.

3. 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.

4. 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

<u>GROSS WEIGHT</u> <u>NOT EXCEEDING</u>	<u>DIMENSIONS ON ANY EDGE</u> <u>NOT EXCEEDING</u>	<u>HEIGHT OF DROP LEVEL</u> <u>A PROTECTION</u>
600 lbs.	72 inches	36 inches
3,000 lbs.	no limit	24 inches
no limit	no limit	12 inches

5. 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: 4169/56
- b. Width: 49-3/4 inches
- c. Length: 37-1/2 inches
- d. Height: 33 inches
- e. Weight: 1,790 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 feet by 8 feet

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 10,400 pounds compression for a period of one hour. At the end of the one hour period, the compression load had decreased to 9,400 pounds, and the load had compressed 1/2 inch. Upon removal of the load, the height of the pallet returned to 32-3/4 inch.

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 245 rpm for the longitudinal orientation and 235 rpm for the lateral orientation. No significant damage was noted during the repetitive shock 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. The damage to the pallet consisted of a broken bottom cleat and partially pulled nails in one of the skids.

The test was not halted due to the damage sustained because the bottom cleat does little to either support the pallet base or hold the pallet top to the base. Also, past

history of pallets of this type with similar dimensions and loads show that this is a reliable pallet for storing and transporting ammunition.

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 during the impact test but, a pallet skid was broken when the pallet fell from the impact tester. The pallet falling from the impact tester was considered unusual and the damage sustained from the fall was not considered a basis for failure.

5. LEAK TEST. The M2A1 cans were leak tested before being placed on the pallet to ensure that all the cans had good seals prior to testing. At the completion of the pallet testing, the straps were cut on the pallet and the cans were again leak tested. The APE 1958 leak test indicated that all containers still had acceptable leak rates.

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 noted during the edgewise drop test and the inclined impact test. The damage sustained during the drop test was considered minor and was not used as a basis for failing the pallet. The damage sustained during the inclined impact test was caused during from a fall from the inclined impact tester. The fall from the incline impact tester is not part of the test so it was not taken into account as a pass/fail parameter.

2. APPROVAL. Since the pallet maintained the unit load and protected the contents from damage, it is hereby recommended that the wirebound box unitization procedures for M2A1 containers described under project CA 185/56-81 be approved for Army-wide use.

PART 7

PHOTOGRAPHS

Photos unavailable due to camera malfunction.

PART 8

DRAWINGS

APPENDIX 56

UNITIZATION PROCEDURES FOR MILITARY AMMUNITION AND COMPONENTS PACKED IN FIBERBOARD BOXES IN WIREBOUND OR FIBERBOARD 4-WAY ENTRY PALLET BOXES

GRENADE, LAUNCHER, SMOKE, PACKED 4 PER M2AI
AMMUNITION CONTAINER, UNITIZED 72 PER WIREBOUND
PALLET BOX (PALLET UNIT A) OR 63 PER FIBERBOARD
PALLET BOX (PALLET UNIT B); APPROX BOX SIZE
 $12\frac{1}{32}"$ L X $6\frac{3}{32}"$ W X $7\frac{1}{2}"$ H

PALLET UNIT DATA							
ITEMS INCLUDED		HAZARD CLASSIFICATION ①				WEIGHT (LBS)	WEIGHT (LBS)
NSN	DODIC	DOT CLASS	CG CLASS	QD CLASS	COMP GROUP	UNIT A	UNIT B
1330- 01-171-8869	G826	13	C	II-C	G	1,787	1,615

NOTICE: THIS APPENDIX CANNOT STAND ALONE BUT MUST BE USED IN
CONJUNCTION WITH THE BASIC UNITIZATION PROCEDURES DRAWING
19-43-4169-20PA1006.

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).

DO NOT SCALE

REVISIONS				DRAFTSMAN F.S.	dh	PROJECT LAF/WRF	LOG STENOGRAPHIC OFFICE
				CHECKER GRG			
APPROVED: U.S. ARMY AMMUNITION CENTER AND SCHOOL							
APPROVED BY: CHIEF OF COMMANDING GENERAL, U.S. ARMY MATERIAL COMMAND (AMC)							
U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL							
U.S. ARMY AMC DRAWING							
				CLASS	DIVISION	DRAWING	FILE
				19	48	4169/56	20PA 1006

PROJECT CA 18956-91

GENERAL NOTES

- A. THIS APPENDIX CANNOT STAND ALONE BUT MUST BE USED IN CONJUNCTION WITH THE BASIC UNITIZATION PROCEDURES DRAWING 19-48-4159-20PA1006, 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 BOX UNIT WILL VARY SLIGHTLY DEPENDING UPON THE ACTUAL DIMENSIONS OF THE BOXES AND THE WEIGHT OF THE SPECIFIC ITEM BEING UNITIZED.
- C. OUTLOADING AND STORAGE OF THE ITEMS COVERED BY THIS APPENDIX SHALL BE ACCOMPLISHED IN ACCORDANCE WITH AMC (DARCOT) DRAWINGS IDENTIFIED WITHIN DA PAMPHLET 75-5.
- D. IF THE ITEMS COVERED HEREIN ARE UNITIZED PRIOR TO ISSUANCE OF THIS APPENDIX, THE BOXES NEED NOT BE REUNITIZED SOLELY TO CONFORM TO THIS APPENDIX.
- E. THE UNITIZATION PROCEDURES DEPICTED HEREIN MAY ALSO BE USED FOR UNITIZING GRENADE, LAUNCHER, SMOKE, 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.

TIEDOWN STRAP, 3/4" X .035" OR .001" X 12'-3" LONG STEEL STRAPPING (3 REQD).
SEE SPECIAL NOTE 2.

SEAL FOR 3/4" STRAPPING (5 REQD, 1 PER STRAP). CRIMP EACH SEAL WITH TWO PAIR OF NOTCHES.

FILLER PIECE, HONEYCOMB VOID FILLER, 2" X 37" X 26-1/2" (2 REQD).

FILLER PIECE, HARBORD, 3/8" X 18-1/4" X 26-1/2" (2 REQD).

FILLER PIECE, HARBORD, 1/4" X 37" X 26-1/2" (1 REQD).

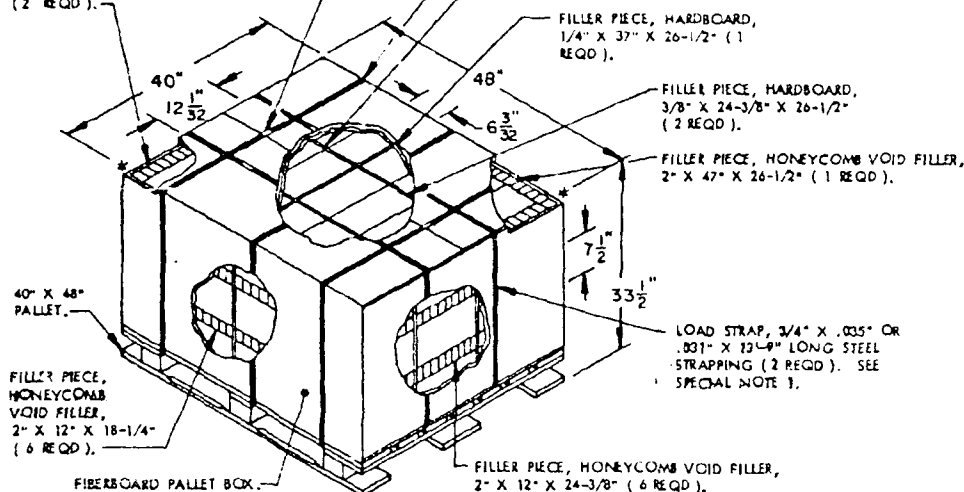
FILLER PIECE, HARBORD, 3/8" X 24-3/8" X 26-1/2" (2 REQD).

FILLER PIECE, HONEYCOMB VOID FILLER, 2" X 47" X 26-1/2" (1 REQD).

LOAD STRAP, 3/4" X .035" OR .001" X 12'-3" LONG STEEL STRAPPING (2 REQD). SEE SPECIAL NOTE 1.

SPECIAL NOTES:

1. THE LOAD STRAPS MUST BE THREADED THROUGH THE STRAP SLOTS OF THE PALLET. AS SHOWN. LOAD STRAPS MUST BE TENSIONED AND SEALED PRIOR TO APPLICATION OF TIEDOWN STRAPS.
2. INSTALL EACH TIEDOWN STRAP TO PASS UNDER THE TOP DECK BOARDS OF THE PALLET. TIEDOWN STRAPS MAY BE APPLIED BUT NOT TENSIONED UNTIL LOAD STRAPS HAVE BEEN INSTALLED, TENSIONED AND SEALED.



PALLET UNIT B

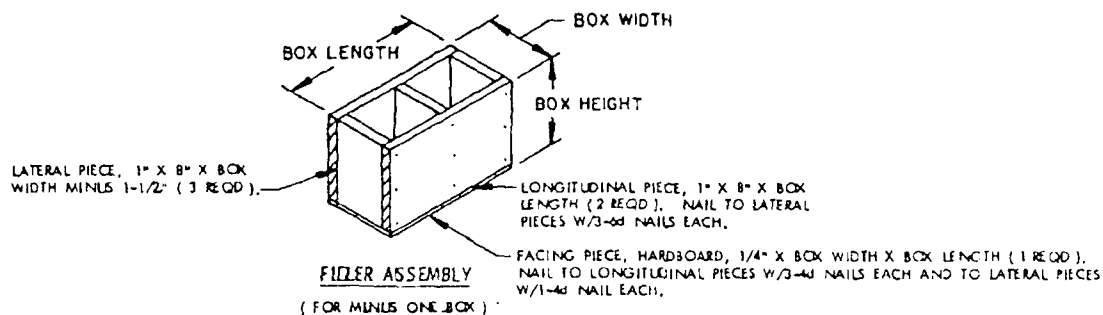
SEE GENERAL NOTE "B" ON PAGE 2.

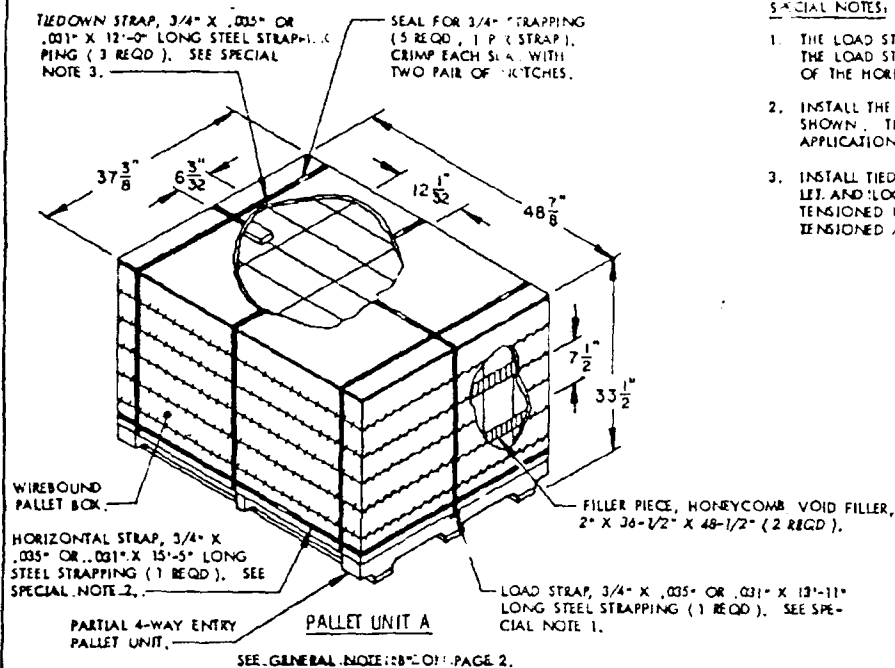
63 BOXES OF SMOKE GRENADE LAUNCHERS (4 PER BOX) @ 23 LBS EA ----- 1,449 LBS (APPROX)
DUNNAGE ----- 46 LBS
FIBERBOARD PALLET BOX ----- 120 LBS

TOTAL WEIGHT ----- 1,615 LBS (APPROX)
CUBE ----- 37.2 CU FT (APPROX)

BILL OF MATERIAL (UNIT B)

FIBERBOARD PALLET BOX	1 REQD	120 LBS
STEEL STRAPPING, 3/4"	64.75' REQD	4.63 LBS
SEAL FOR 3/4" STRAPPING	5 REQD	NIL
HONEYCOMB, 2"	43.58 SQ FT REQD	14.49 LBS
HARBORD, 1/4"	6.81 SQ FT REQD	3.96 LBS
HARBORD, 3/8"	15.69 SQ FT REQD	20.59 LBS





SPECIAL NOTES:

1. THE LOAD STRAP MUST BE THREADED THROUGH THE STRAP SLOT OF THE PALLET. THE LOAD STRAP MUST BE TENSIONED AND SEALED PRIOR TO THE APPLICATION OF THE HORIZONTAL STRAP.
2. INSTALL THE HORIZONTAL STRAP TO ENCIRCLE THE PALLET BOX UNIT AS SHOWN. THE HORIZONTAL STRAP MUST BE TENSIONED AND SEALED PRIOR TO APPLICATION OF TIEDOWN STRAPS.
3. INSTALL TIEDOWN STRAPS TO PASS UNDER THE TOP DECK BOARDS OF THE PALLET AND LOCATE AS SHOWN. TIEDOWN STRAPS MAY BE APPLIED BUT NOT TENSIONED UNTIL THE HORIZONTAL AND LOAD STRAPS HAVE BEEN INSTALLED, TENSIONED AND SEALED.

72 BOXES OF SMOKE GRENADE LAUNCHERS (4 PER BOX) @ 23 LBS EA	1,656 LBS (APPROX)
DUNNAGE	13 LBS
WIREBOUND PALLET BOX	118 LBS
TOTAL WEIGHT	1,787 LBS (APPROX)
CUBE	35.4 CU FT (APPROX)

BILL OF MATERIAL (UNIT A)

WIREBOUND PALLET BOX	1 REQD	118 LBS
STEEL STRAPPING, 3/4"	65.33' REQD	4.67 LBS
SEAL FOR 3/4" STRAPPING	5 REQD	NIL
HONEYCOMB, 2"	24.40 SQ FT REQD	8.11 LBS

