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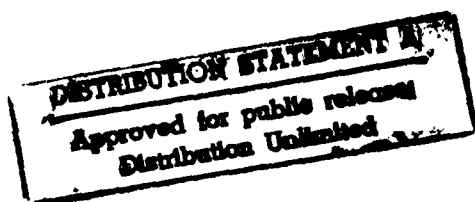


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FINAL REPORT

REPORT NO. 91-15

EVALUATION OF
ARMY IDEAS FOR EXCELLENCE
PROGRAM (AIEP) SUGGESTION
NO. AMVO900593



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Prepared for:
U.S. Army Armament Research, Development
and Engineering Center
ATTN: SMCAR-ESK
Rock Island, IL 61299-7300

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U.S. ARMY
ARMAMENT
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CHEMICAL COMMAND

U.S. ARMY DEFENSE AMMUNITION
CENTER AND SCHOOL

VALIDATION ENGINEERING DIVISION
SAVANNA, ILLINOIS 61074-9639



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1. ABSTRACT (Continue on reverse if necessary and identify by block number)			
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-ESK, Rock Island, IL, to evaluate an Army Ideas for Excellence Program (AIEP) entry which involved modifying unitization procedures for 4.2-inch chemical munitions. The proposed idea would replace a 3/4-inch piece of plywood that has 24 drilled 1 1/4-inch-diameter holes with 5 3/4-inch-long plywood slats. The 3/4-inch plywood provides protection for the bottom of the 4.2 inch chemical projectiles. In order to access the validity of this AIEP entry, MIL-STD-1660 tests were performed on a pallet that was prepared to the specifications detailed in the AIEP entry. As a result of these tests, the Validation Engineering Division is recommending that this AIEP entry be approved for U.S. Army (USA)-wide use in the transportation and storage of 4.2-inch munitions.			
3. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
2a. NAME OF RESPONSIBLE INDIVIDUAL JEROME H. KROHN		22b. TELEPHONE (Include Area Code) 815-273-8929	
		22c. OFFICE SYMBOL SMCAC-DEV	

U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
VALIDATION ENGINEERING DIVISION
SAVANNA, IL 61074-9639

REPORT NUMBER 91-15
EVALUATION OF ARMY IDEAS FOR EXCELLENCE PROGRAM (AIEP)
SUGGESTION NO. AMV0900593

TABLE OF CONTENTS

PART	PAGE NO.
1. INTRODUCTION	1-1
A. BACKGROUND.....	1-1
B. AUTHORITY	1-1
C. OBJECTIVE.....	1-1
2. ATTENDEES	2-1
3. TEST PROCEDURES	3-1
4. TEST EQUIPMENT	4-1
5. TEST RESULTS.....	5-1
6. CONCLUSION AND RECOMMENDATION.....	6-1
7. PHOTOGRAPHS	7-1
8. DRAWINGS	8-1

PART 1

INTRODUCTION

A. **BACKGROUND.** 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-ESK, to evaluate an Army Ideas for Excellence Program (AIEP) entry. This entry proposed modifying the current unitization procedures for 4.2-inch chemical munitions in order to reduce the manufacturing costs. The proposed modification would replace one piece of 3/4-inch plywood that has 24 drilled 1 1/4-inch-diameter holes with 5 3/4-inch-long plywood slats. The piece of the pallet that would be changed by this suggestion provides protection for the striker assembly at the base of the projectile. MIL-STD-1660 test procedures were used to evaluate the proposed AIEP entry.

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 feasibility of the proposed AIEP, entry no. AMV0900593.

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PART 2

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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.

1. SUPERIMPOSED LOAD TEST. The unit load shall be 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 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 multiplied by 192 minus the unit height in inches, 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.
2. REPETITIVE SHOCK TEST. The repetitive shock test shall be conducted IAW 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 approximately 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 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+0.1G. 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 ROTATIONAL DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the edgewise rotational drop test is as follows: The specimen shall be 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 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.

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

4. INCLINE-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 two 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. Suggestion No: AMV0900593
- b. Width: 28-3/8 inches
- c. Length: 38-3/8 inches
- d. Height: 27-1/4 inches
- e. Weight: 533 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

The 4.2-inch chemical munitions pallet assembly was provided by ARDEC, SMCAR-ESK, Rock Island, IL, and was assembled by USADACS, Validation Engineering Division (SMCAC-DEV). During assembly, a side deck board was cracked from excessive tension in one of the 3/4-inch straps. The damage was considered to be minor, and the test was continued without modification.

1. STACKING TEST. The test pallet was loaded to 6,500 pounds compression for a period of 1 hour. At the end of the 1-hour period, the load had compressed 1/4 inch. After the compression was removed, the load returned to the original height.
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 225 rpm for the longitudinal orientation and 235 rpm for the lateral orientation. There was no damage sustained by the pallet during the test.
3. EDGEWISE ROTATIONAL 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. During the test, one skid tip was cracked, and there was additional damage to the upper deck board from the excessively tight 3/4-inch band.

4. INCLINE-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.

PART 6

CONCLUSION AND RECOMMENDATION

1. CONCLUSION. The modified 4.2-inch chemical munitions pallet that was proposed in the AIEP, entry no. AMV090053, successfully passed all phases of MIL-STD-1660 testing. The only damage sustained by the pallet was caused by an excessively tight 3/4-inch band. The excessively tight band caused one of the side deck boards to crack during testing.

2. RECOMMENDATION. Since the proposed change to the 4.2-inch chemical pallet (as described in AIEP, entry no. AMV090053) did not effect the ability of the pallet to pass MIL-STD-1660 testing, the modified unitization procedures will be approved for U.S. Army (USA)-wide use.

PART 7

PHOTOGRAPHS



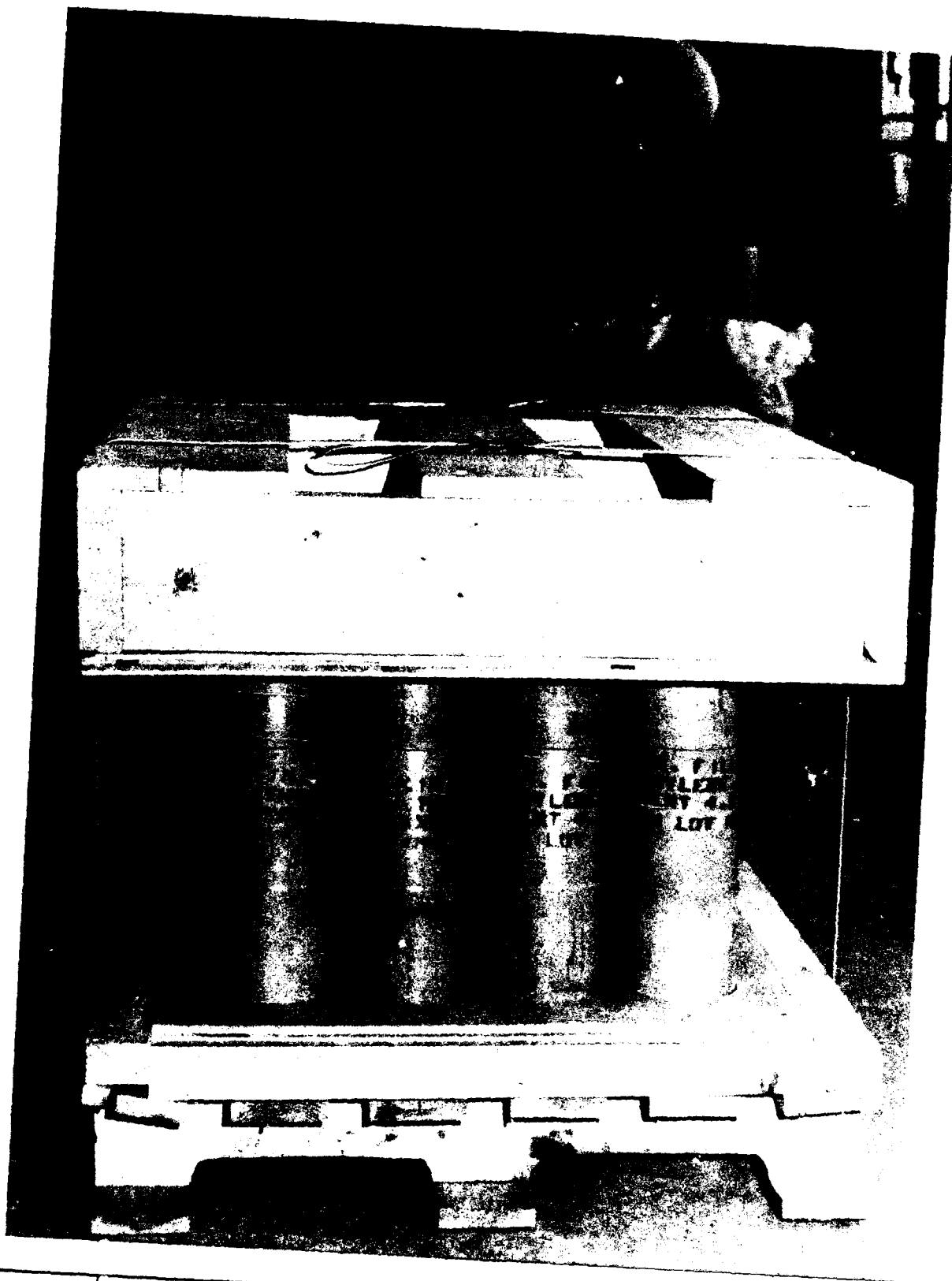
U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL

Photo No. AO317-SPN-91-277-3996. This photograph shows the assembled test pallet.



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL
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Photo No. AO317-SPN-91-277-3995. This photograph shows an additional view of the test pallet.



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

Photo No. AO317-SPN-91-277-3993. This photograph shows the extent of the
damage caused by the excessively tight 3/4-inch strap.

PART 8

DRAWINGS

UNITIZATION PROCEDURES* FOR CHEMICAL FILLED PROJECTILES, 105MM AND 4.2-INCH, UNITIZED 24 PROJECTILES PER SPECIAL 4-WAY ENTRY PALLET

- THE PROCEDURES DELINEATED IN THIS DRAWING ARE FOR INTRA-INSTALLATION MOVEMENT ONLY.

U.S. ARMY MATERIEL COMMAND DRAWING					
APPROVED, U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND		DRAFTSMAN		D. WHITMORE	
		ENGINEER		SANDRA M. SCHULTZ	
SMCAR-ESK AMSMC-TMO		SUPPLY ENGINEERING DIVISION	TRANSPORTATION ENGINEERING DIVISION	VALIDATION ENGINEERING DIVISION	
		LOGISTICS ENGINEERING OFFICE			
APPROVED BY ORDER OF COMMANDING GENERAL, U.S. ARMY MATERIEL COMMAND		JULY 1989			
		CLASS	DIVISION	DRAWING	FILE
U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL		19	48	4538	CB 20PE1
REVISION NO. 2					
SEE THE REVISION LISTING ON PAGE 2					

DO NOT SCALE

GENERAL NOTES

- A. THIS DOCUMENT HAS BEEN PREPARED AND ISSUED IN ACCORDANCE WITH AR 740-1 AND AUGMENTS TM 743-200-1 (CHAPTER 5) AND CONFORMS TO MIL-STD-1660.
- B. DIMENSIONS, CUBE AND WEIGHT OF A PALLET UNIT WILL VARY SLIGHTLY DEPENDING UPON THE ACTUAL DIMENSIONS OF THE PROJECTILES AND THE WEIGHT OF THE SPECIFIC ITEM BEING UNITIZED.
- C. DETAILS OF THE 105MM AND 4.2" PROJECTILES
- | | |
|---------------|-----------------|
| HEIGHT, 105MM | 19-1/2" |
| WEIGHT, 105MM | 32 LBS (APPROX) |
| HEIGHT, 4.2" | 18-1/2" |
| WEIGHT, 4.2" | 22 LBS (APPROX) |
- D. DIMENSIONAL LUMBER SPECIFIED THROUGHOUT THIS PROCEDURAL DRAWING IS OF A NOMINAL SIZE, UNLESS OTHERWISE SPECIFIED. FOR EXAMPLE, 1" X 4" MATERIAL IS ACTUALLY 3/4" THICK BY 3-1/2" WIDE AND 2" X 4" MATERIAL IS ACTUALLY 1-1/2" THICK BY 3-1/2" WIDE.
- E. A PLUS OR MINUS 1/8" IS ALLOWED ON OVERALL DIMENSIONS OF THE PALLET OR ANY DUNNAGE ASSEMBLY, HOWEVER, SIMILAR PIECES IN AN ASSEMBLY MUST BE WITHIN 1/8" OF THE SAME DIMENSION. HOLE DIMENSION TOLERANCES ARE PLUS 0", MINUS 1/16".
- F. WHEN ASSEMBLING A PALLET UNIT, CARE SHALL BE TAKEN TO INSURE THAT THE COVER ASSEMBLY AND PALLET ARE EVENLY ALIGNED HORIZONTALLY AND VERTICALLY SO THAT THE SIDES AND ENDS OF THE PALLET UNIT DO NOT EXCEED A 1/2" TOLERANCE.
- G. IN ORDER TO OBTAIN COMPACT (SOUND) UNITS, ALL STRAPS SHALL BE LOCATED IN PROPER ALIGNMENT AND TENSIONED UNTIL THEY CUT INTO THE EDGE OF THE COVER ASSEMBLY AND THE PALLET DECK. AFTER TENSIONING, ALL STRAPS WILL BE SECURED USING ONE SEAL CRIMPED WITH TWO PAIR OF NOTCHES PER SEAL.
- H. WHEN APPLYING ANY STRAP, CARE MUST BE EXERCISED TO ASSURE THAT THE END OF THE STRAP ON THE UNDERSIDE OF THE JOINT EXTENDS AT LEAST 6" BEYOND THE SEAL. THIS EXTRA MINIMUM LENGTH OF STRAP IS REQUIRED TO PERMIT SUBSEQUENT TIGHTENING OF LOOSENED STRAPPING. RETENSIONING CAN BE ACCOMPLISHED WITHOUT REPLACING STRAPPING OR SPLICING STRAPPING THROUGH THE USE OF A FEEDWHEEL TYPE TENSIONING TOOL, MANUAL OR PNEUMATIC, AND THE APPLICATION OF ONE ADDITIONAL SEAL.
- J. INSTALL EACH TIEDOWN STRAP TO PASS UNDER THE TOP DECK BOARDS OF THE PALLET AND TO BE LOCATED AS SHOWN ON PAGE 3.

(CONTINUED AT RIGHT)

MATERIAL SPECIFICATIONS

- PALLET - - - - - SPECIAL 4-WAY ENTRY, SIZE 28-3/8" LONG BY 38-5/8" WIDE. PALLET SHALL BE CONSTRUCTED OF WOODS FROM GROUPS 1, 2, OR 3, OR ANY COMBINATION THEREOF, AS SPECIFIED IN MIL-STD-731
- LUMBER - - - - - SEE TM 743-200-1 (DUNNAGE LUMBER) AND FED SPEC MM-L-751.
- NAILS - - - - - FED SPEC FF-N-105; COMMON. ALT: ANNULAR-RING TYPE NAIL, PALLET TYPE (MECHANICALLY DEFORMED) NAIL, OR COOLER NAIL OF SAME SIZE.
- PLYWOOD - - - - - FED SPEC NN-P-530; GROUP B, CONSTRUCTION AND INDUSTRIAL PLYWOOD, INTERIOR WITH EXTERIOR GLUE, GRADE C-D. IF SPECIFIED GRADE IS NOT AVAILABLE, A BETTER INTERIOR OR AN EXTERIOR GRADE MAY BE SUBSTITUTED.
- STRAPPING, STEEL - - - - - ASTM D 3953; FLAT STRAPPING, TYPE 1 OR 2, HEAVY DUTY, ZINC-COATED (GRADE 2), SIZE 3/4" X .035" OR .031".
- SEAL, STRAP - - - - - ASTM D 3953; CLASS H, FINISH B (GRADE 2), TYPE D, STYLE I, II, OR IV.
- STAPLE - - - - - FED SPEC FF-N-105; 15/16" WIDE X 3/4" LEG LENGTH FOR 3/4" STRAPPING, TYPE III, STYLE 3.

(GENERAL NOTES CONTINUED)

- K. DUE TO PALLET UNIT DESIGN, A MAXIMUM OF 20 PROJECTILES MAY BE OMITTED FROM A PALLET TO SATISFY A LESS THAN-FULL PALLET UNIT REQUIREMENT. NO FILLER ASSEMBLIES ARE REQUIRED FOR THE OMITTED PROJECTILES PROVIDED THE FOUR REMAINING ONES ARE PLACED IN THE FOUR CORNER LOCATIONS.
- L. FOR STORAGE OF THE ITEMS COVERED BY THIS DRAWING, REFER TO AMC DRAWING 19-48-4539-CB1-14PE2.

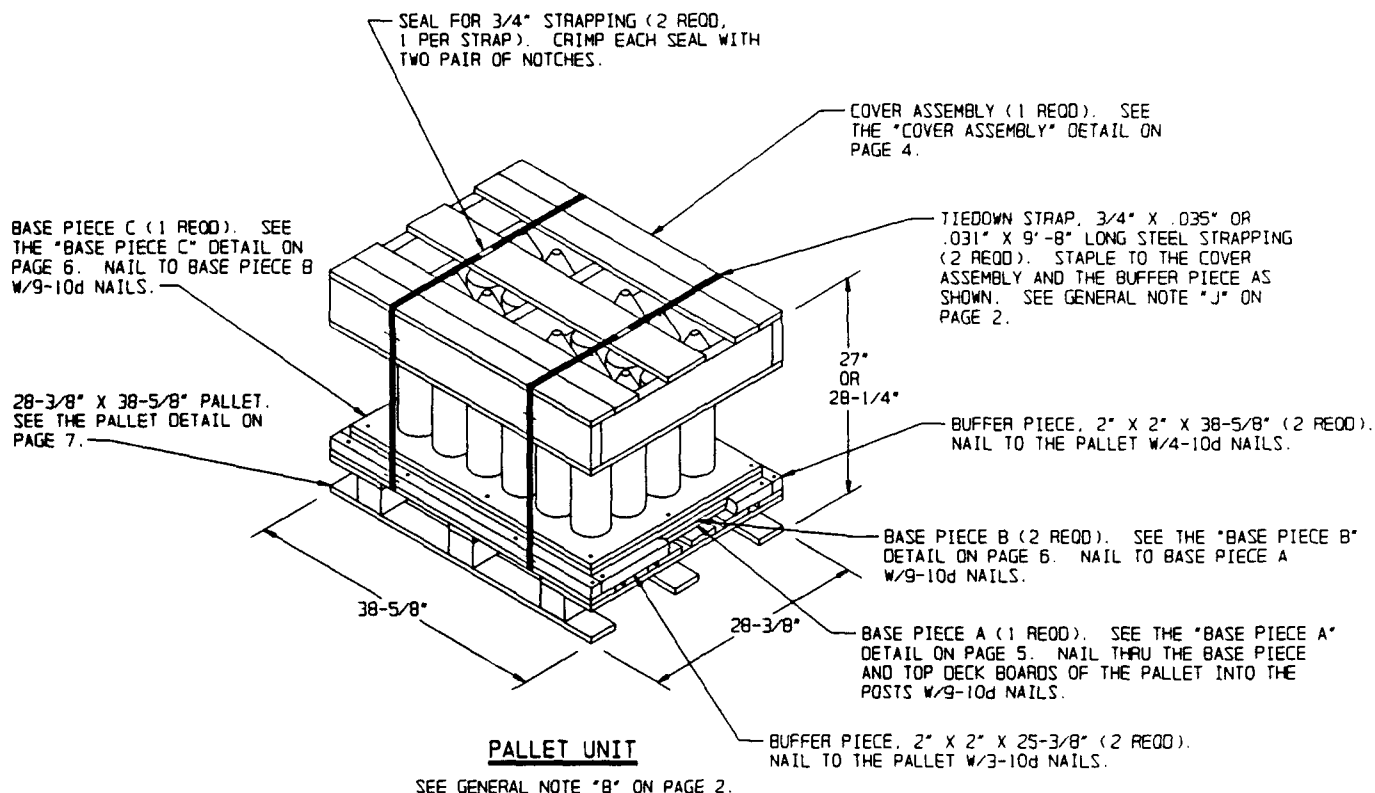
REVISIONS

REVISION NO. 1, DATED JULY 1989, CONSISTS OF:

1. CHANGING DIMENSIONS ON THE BASE PIECES AND THE SPACER PIECE.

REVISION NO. 2, DATED _____ CONSISTS OF:

1. ADDING ALTERNATE TO BASE PIECE A.

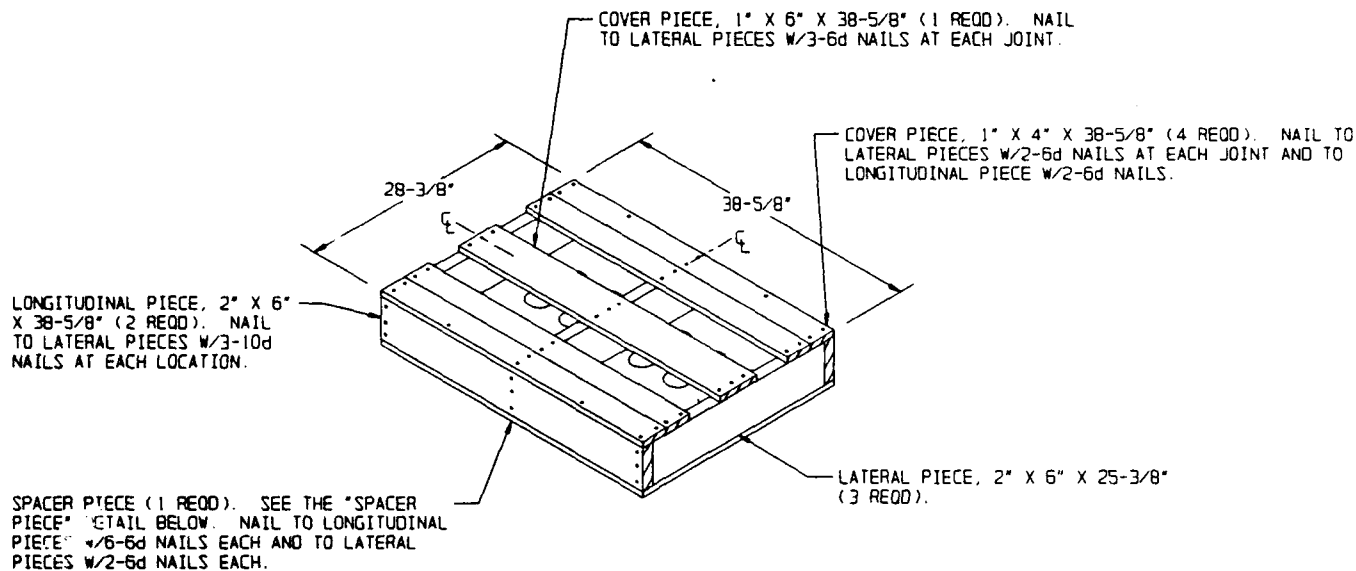


PALLET UNIT DATA

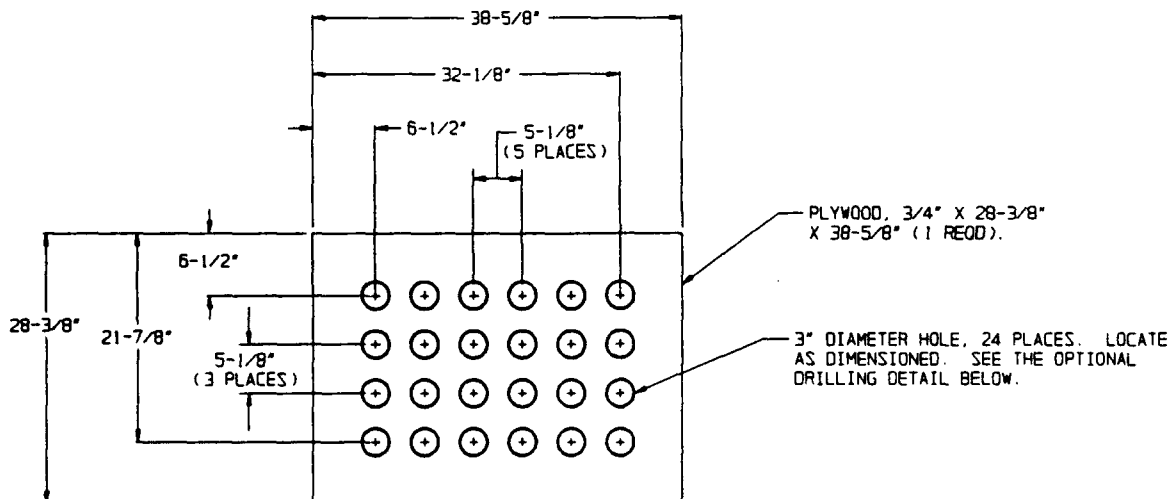
24 4.2" OR 105MM PROJECTILES AT 22 OR 32 LBS	---	528 OR 768 LBS
CUNNAGE	---	115 LBS
PALLET	---	35 LBS
TOTAL WEIGHT	---	678 OR 918 LBS (APPROX)
CUBE	---	17.1 OR 17.9 CU FT (APPROX)

BILL OF MATERIAL

LUMBER	LINEAR FEET	BOARD FEET
1" X 4"	12.88	4.30
1" X 6"	3.22	1.61
2" X 2"	10.67	3.56
2" X 6"	12.78	12.78
NAILS	NO. REQD	POUNDS
6d (2")	55	0.33
10d (3")	62	0.95
PALLET, 28-3/8" X 38-5/8"	1 REQD	35 LBS
STEEL STRAPPING, 3/4"	19.33' REQD	1.38 LBS
SEAL FOR 3/4" STRAPPING	2 REQD	NIL
STAPLES, 15/16" X 3/4"	8 REQD	NIL
PLYWOOD, 3/4"	32.72 SQ FT REQD	67.49 LBS

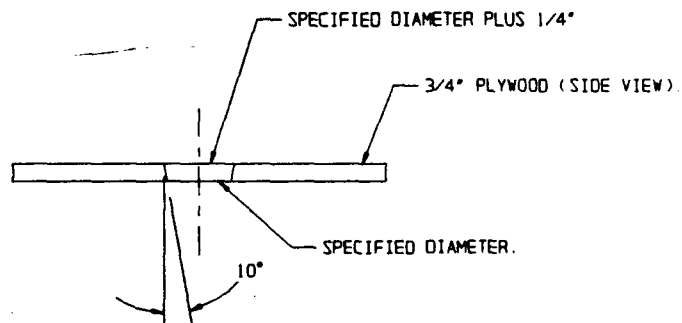


COVER ASSEMBLY

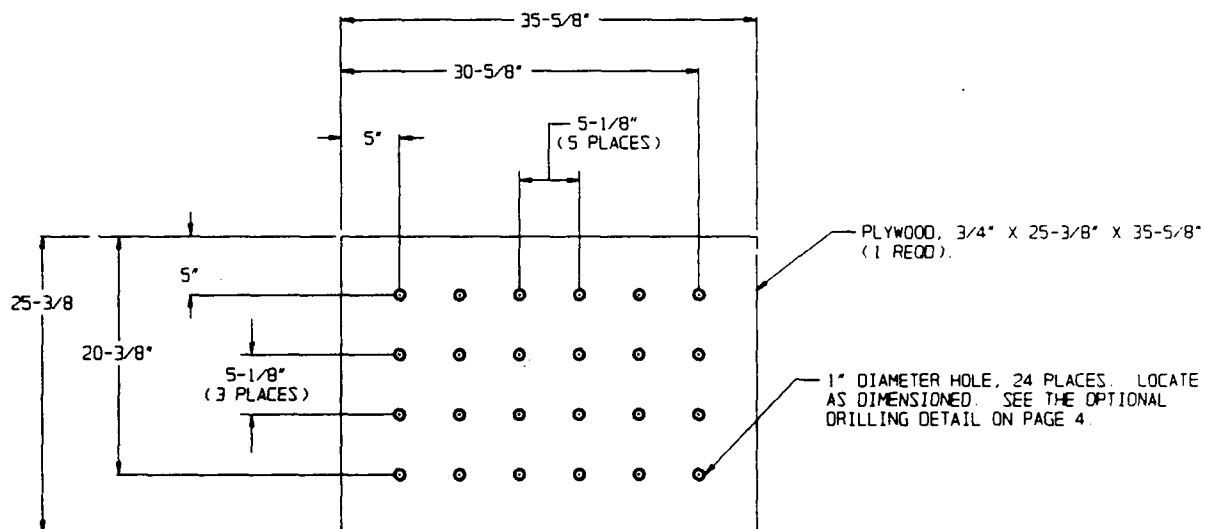


SPACER PIECE

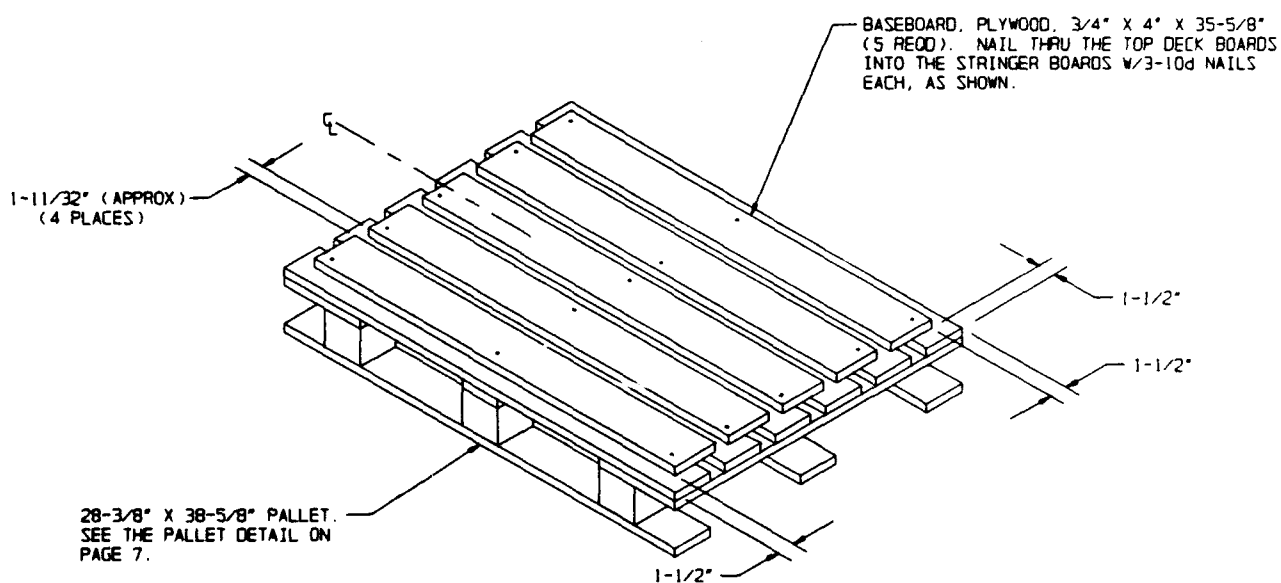
(BOTTOM VIEW)



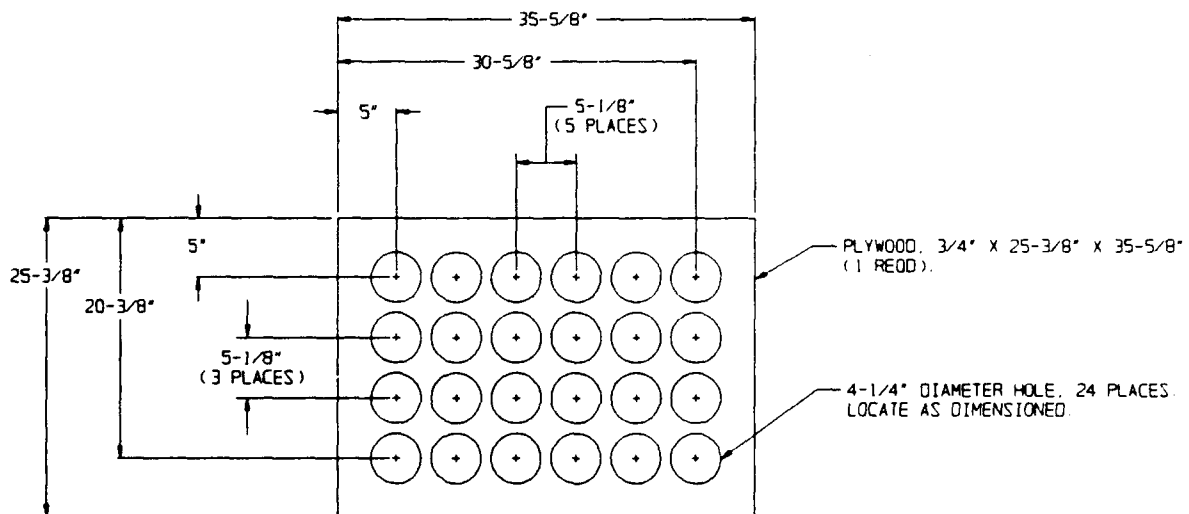
OPTIONAL DRILLING DETAIL



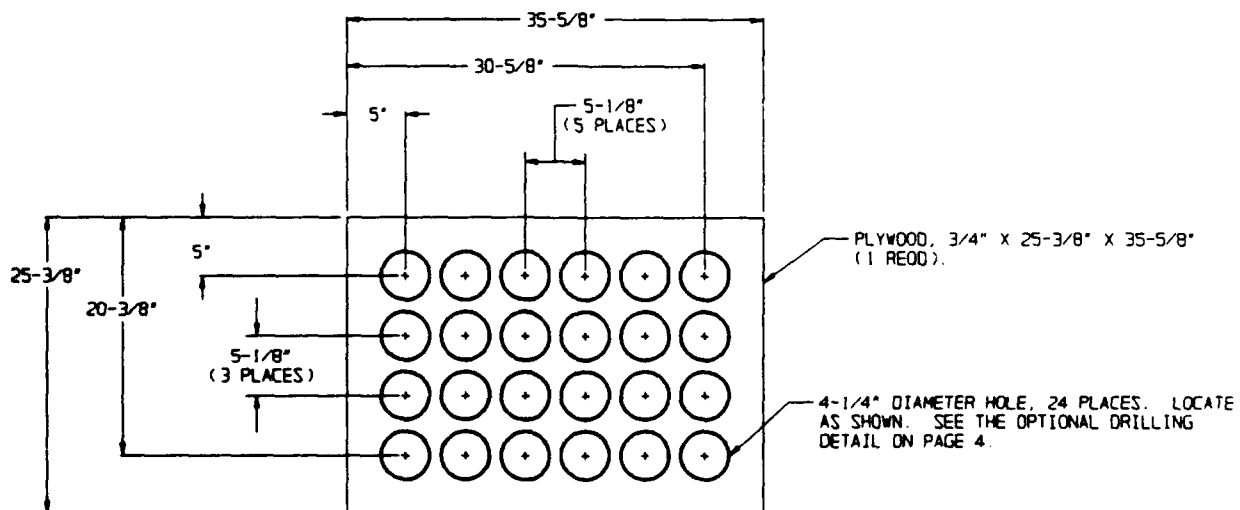
BASE PIECE A



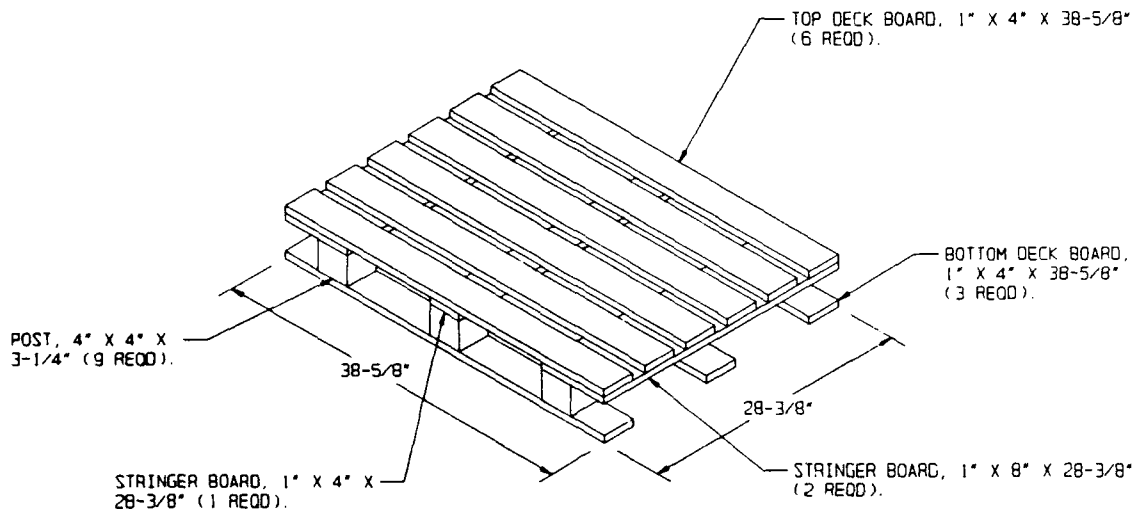
ALTERNATE TO BASE PIECE A



BASE PIECE B



BASE PIECE C



PALLET

NOTE: THIS PALLET WILL BE CONSTRUCTED AND ASSEMBLED IN ACCORDANCE WITH MIL-P-15011, TYPE I, CLASS 1, STYLE IA PALLETS WITH THE FOLLOWING EXCEPTIONS.

- THE PALLET MAY BE CONSTRUCTED OF WOODS FROM GROUPS 1, 2, OR 3, OR ANY COMBINATION THEREOF, AS SPECIFIED IN MIL-STD-731.
- THE LUMBER WILL BE SIZED AS SPECIFIED ABOVE.
- NAILS MAY BE TYPE I, STYLE 10, OR TYPE II, STYLE 18, AS SPECIFIED IN FED SPEC FF-N-105.

BILL OF MATERIAL (PALLET)		
LUMBER	LINEAR FEET	BOARD FEET
1" X 4"	31.33	10.45
1" X 8"	4.73	3.16
4" X 4"	2.44	3.25
NAILS	NO. REQD	POUNDS
4d (1-1/2")	36	0.13
8d (2-1/2")	27	0.28
12d (3-1/4")	27	0.45

* SEE PART C OF THE NOTE ABOVE.

