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Final Report

May 1989

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MIL-STD-1660 TEST OF 53- BY 42-INCH
STANDARD METAL PALLET

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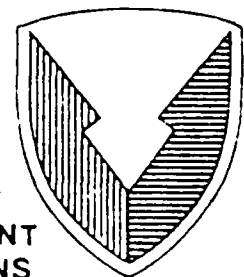
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EVALUATION DIVISION
SAVANNA, ILLINOIS 61074-9639

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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), was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-ESK, to test a 53- by 42-inch Standard Metal Pallet with a maximum load of 4,000 pounds. The test configuration consisted of 36 each M548 cans inert filled to 112 pounds, metal pallet adapter, and lumber as unitizing materials. The gross weight of the unit was 4,240 pounds. The unitization satisfied the test requirements of MIL-STD-1660, Design Criteria for Ammunition Unit Loads. It was found that when lifting this unit load with chain basket slings, there was not enough distance between the edge of the pallet and outside posts to safely hold the load. It is recommended that the outside posts be recessed several more inches and the pallet corners not be cut off at a 45 degree angle.

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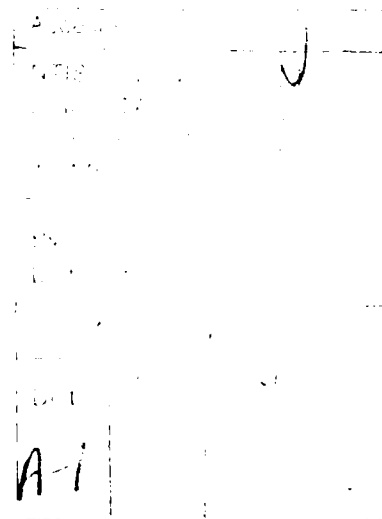
REPORT NO. EVT 82-89

MIL-STD-1660 TEST OF 60- BY 40-INCH

STANDARD METAL PALLET

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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 the 53- by 42-inch Standard Metal Pallet to a maximum load of 4,000 pounds. The inert load was made up of M548 cans, inert filled to 112 pounds. Thirty-six cans made up the test load. The unit load had a gross weight of 4,240 pounds. The criteria used for evaluating this pallet was 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 was to determine if 53- by 42-inch Standard Metal Pallet could satisfy the testing requirements of MIL-STD-1660.

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, 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 stack.
2. LOOSE CARGO TRANSPORTATION TEST. The Loose Cargo Transportation 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 ROTATIONAL 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 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.

5. DISASSEMBLY TEST. Following all rough handling tests, the unit load may be squared up within 2 inches of its original shape and on a flat level surface. The strapping shall then be cut and removed from the palletized load. Assembly of the load shall be such that it retains its unity upon removal of the strapping.

PART 4

TEST EQUIPMENT

1. TEST SPECIMEN.

- a. Width: 42 inches
- b. Length: 53 inches
- c. Height: 49 inches
- d. Weight: 4,240 pounds

2. COMPRESSION TESTER.

- a. Manufacturer: Ormond Scientific
- 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: 5,000 pounds
- c. 1/2-inch Amplitude
- d. Speed: 50 to 300 rpm
- e. Platform: 5 feet by 8 feet

4. INCLINED RAMP.

- a. Manufacturer: Conbur Incline
- b. Impact Tester
- c. 10 Percent Incline
- d. 12-Foot Ramp

PART 5

TEST RESULTS

1. COMPRESSION TEST

a. Pallet Data

(1) Weight	4,240 pounds
(2) Height	49 inches
(3) Test Load	15,610 pounds

b. Applied test load duration 60 minutes

c. Observations: M548 can lids compressed allowing the locking handles to be freely opened.

2. LOOSE CARGO TRANSPORTATION TEST

a. Longitudinal orientation.

(1) Operating speed	175 rpm
(2) Test Duration	90 minutes
(3) Observations:	Visible damage.

b. Lateral orientation.

(1) Operating speed	285 rpm
(2) Test Duration	90 minutes
(3) Observations:	Visible damage. Heating at welds attaching pallet posts to skid.

3. EDGEWISE ROTATIONAL DROP TEST

a. Side 1

(1) Drop Height	12 inches
(2) Unit orientation	lateral
(3) Observations:	No visible damage.

b. Side 2

(1) Drop Height	12 inches
(2) Drop orientation	longitudinal
(3) Observations:	No visible damage.

c. Side 3

(1) Drop Height	12 inches
(2) Drop orientation	lateral
(3) Observations:	No visible damage.

d. Side 4.

(1) Drop Height	12 inches
(2) Drop Orientation	longitudinal
(3) Observations:	No visible damage. Pallet deck warped 1/4 inch.

4. INCLINED IMPACT

- a. Drop height for all impacts 7
- b. Side 1
 - (1) Orientation Lateral
 - (2) Observations: No visible damage.
- c. Side 2
 - (1) Orientation Longitudinal
 - (2) Observations: No visible damage. Cans slid forward 1-1/2 inches in adapter assembly.
- d. Side 3
 - (1) Orientation Lateral
 - (2) Observations: No visible damage.
- e. Side 4
 - (1) Orientation Longitudinal
 - (2) Observations: No visible damage. Cans slid forward 1 inch.

5. DISASSEMBLY OBSERVATIONS

- a. Pallet was approximately 1/4-inch out of flat from centerline to outside edges in the longitudinal orientation.
- b. Weld cracking was observed at three points of attachment between all posts and skids.
- c. Individual weld breakage was about 10 to 30 percent of the weld length. Propagation of the crack started at the outside of the weld toward the center.

PART 6

CONCLUSION, APPROVAL and RECOMMENDATION

1. CONCLUSION. As tested, the 53- by 42-inch Standard Metal Pallet met the test requirements of MIL-STD-1660, Design Criteria for Ammunition Unit Loads.
2. APPROVAL. This pallet is approved for use with Army ammunition.
3. RECOMMENDATION. The outside pallet posts should be recessed several inches into the pallet and the 45 degree angle on the pallet corners should be removed.

PART 7

UNITIZATION DRAWINGS

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	APPROVED BY
1	NOV 81	1	11/1/81	John A. Smith	WRE/1001	WRE/1001
2	NOV 82	2	11/1/82	John A. Smith	WRE/1001	WRE/1001
3	DEC 83	3	12/1/83	John A. Smith	WRE/1001	WRE/1001
U.S. ARMY DARGOM DRAWING						
JUNE 1981						
CLASS DIVISION DRAWING FILE						
19 48 4116/ 15C 20PA 1002						

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

TIEDOWN STRAP, 1-1/4" X .035" OR .031" X 12'-0" LONG STEEL STRAPPING (4 REQ'D). SEE GENERAL NOTE "D" AT RIGHT.

LOAD STRAP, (ALTERNATE FOR HORIZONTAL STRAP), 1-1/4" X .035" OR .031" X 14'-3" LONG STEEL STRAPPING. THREAD LOAD STRAPS THRU PALLET STRAP SLOTS.

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

48" X 48" PALLET.

HORIZONTAL STRAP, 1-1/4" X .035" OR .031" X 16'-0" LONG STEEL STRAPPING (2 REQ'D). 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 6"	19.00	19.00
NAILS	NO. REQ'D	POUNDS
6d (2")	48	0.28
PALLET, 48" X 48"	1 REQ'D	80 LBS
STEEL STRAPPING, 1-1/4"	82.67 REQ'D	11.81 LBS
SEAL FOR 1-1/4" STRAPPING	6 REQ'D	NIL
STAPLE	24 REQ'D	NIL

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

VERTICAL PIECE 2" X 6" X 14-1/2" (2 REQ'D).

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

FILLER ASSEMBLY

(FOR MINUS ONE BOX)

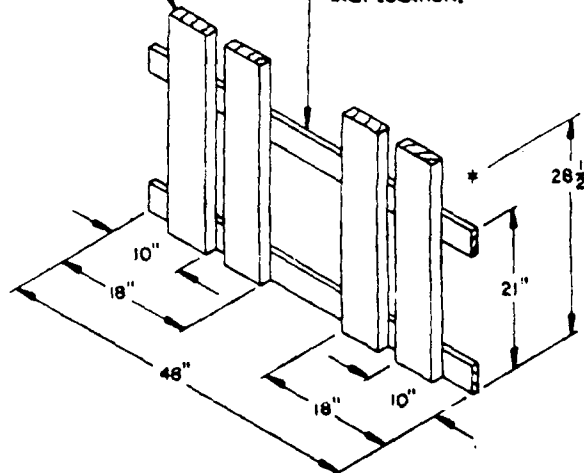
GENERAL NOTES

- 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 PROCEDURE 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 ENIRCLE EACH LAYER OF BOXES ON THE PALLET AND TO BE ALIGNED WITH THE VERTICAL 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 19-48-4115-3PA1002
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.

VERTICAL PIECE, 2" X 6" X 28-1/2" (4 REQ'D).

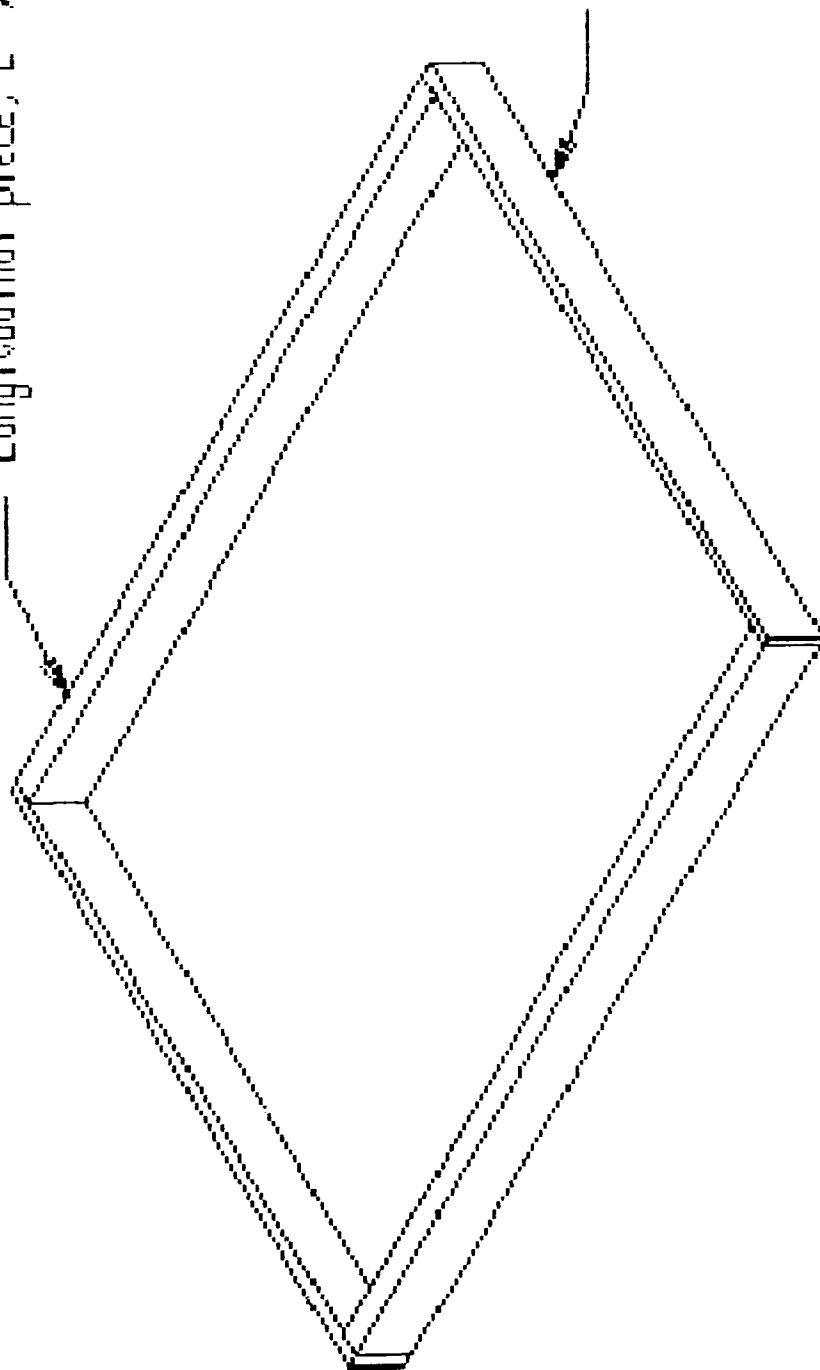
HORIZONTAL PIECE, 1" X 4" X 48" (2 REQ'D). NAIL TO VERTICAL PIECES W/3-6d NAILS AT EACH LOCATION.



SUPPORT GATE

(2 REQ'D).

Longitudinal piece, 2" x 4" x 51-1/2" (2 reqd).



Lateral piece, 1" x 4" x 42" (2 reqd). Nail to the longitudinal piece 1/2" bd nails at each end.

Bottom Adapter

(Staple tiedown straps to bottom adapter)