FINAL REPORT
DECEMBER 2002

REPORT NO. 02-15

NAILED FLOOR-LINE BLOCKING METHODS
TP-94-01,
"TRANSPORTABILITY TESTING PROCEDURES"

Prepared for:  Distribution Unlimited:

Director
U.S. Army Defense Ammunition Center
ATTN: SOSAC-DET, Bldg 35
McAlester, OK 74501-9053

VALIDATION ENGINEERING DIVISION
MCALESTER, OKLAHOMA 74501-9053
AVAILABILITY NOTICE

A copy of this report will be furnished each attendee on automatic distribution. Additional copies or authority for reprinting may be obtained by written request from:

Director
U.S. Army Defense Ammunition Center
ATTN: SOSAC-DEV
1 C Tree Road, Bldg. 35
McAlester, OK 74501-9053

Reports may also be downloaded or viewed in PDF format from our web site at:

http://www/dac.army.mil/DEV/TestReports

DISTRIBUTION INSTRUCTIONS

Destroy this report when no longer needed. Do not return.

***

Citation of trade names in this report does not constitute an official endorsement.

***

The information contained herein will not be used for advertising purposes.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>PART</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INTRODUCTION</td>
<td>1-1</td>
</tr>
<tr>
<td>A. BACKGROUND</td>
<td>1-1</td>
</tr>
<tr>
<td>B. AUTHORITY</td>
<td>1-1</td>
</tr>
<tr>
<td>C. OBJECTIVE</td>
<td>1-1</td>
</tr>
<tr>
<td>D. CONCLUSION</td>
<td>1-1</td>
</tr>
<tr>
<td>2. ATTENDEES</td>
<td>2-1</td>
</tr>
<tr>
<td>3. TEST EQUIPMENT</td>
<td>3-1</td>
</tr>
<tr>
<td>4. TEST PROCEDURES</td>
<td>4-1</td>
</tr>
<tr>
<td>A. ON/OFF ROAD TEST</td>
<td>4-1</td>
</tr>
<tr>
<td>1. HAZARD COURSE</td>
<td>4-1</td>
</tr>
<tr>
<td>2. ROAD TRIP</td>
<td>4-2</td>
</tr>
<tr>
<td>3. PANIC STOPS</td>
<td>4-3</td>
</tr>
<tr>
<td>4. WASHBOARD COURSE</td>
<td>4-3</td>
</tr>
<tr>
<td>5. TEST RESULTS</td>
<td>5-1</td>
</tr>
<tr>
<td>5.1 TESTING DATE (7 MAY 2002)</td>
<td>5-1</td>
</tr>
<tr>
<td>A. ON/OFF ROAD TEST. HAZARD COURSE</td>
<td>5-2</td>
</tr>
<tr>
<td>B. CONCLUSIONS</td>
<td>5-4</td>
</tr>
<tr>
<td>5.2 TESTING DATE (9 MAY 2002)</td>
<td>5-5</td>
</tr>
<tr>
<td>A. ON/OFF ROAD TEST. HAZARD COURSE</td>
<td>5-5</td>
</tr>
<tr>
<td>B. CONCLUSION</td>
<td>5-7</td>
</tr>
<tr>
<td>5.3 TESTING DATE (9 MAY 2002)</td>
<td>5-8</td>
</tr>
<tr>
<td>A. ON/OFF ROAD TEST. HAZARD COURSE</td>
<td>5-8</td>
</tr>
<tr>
<td>B. CONCLUSION</td>
<td>5-9</td>
</tr>
</tbody>
</table>
5.4 TESTING DATE (20 MAY 2002) ......................................................... 5-10
   A. ON/OFF ROAD TEST ......................................................... 5-10
      1. HAZARD COURSE ......................................................... 5-10
      2. ROAD TRIP ................................................................. 5-11
      3. PANIC STOPS ............................................................... 5-11
      4. HAZARD COURSE ......................................................... 5-11
      5. WASHBOARD COURSE ..................................................... 5-11
   B. CONCLUSION ................................................................. 5-13

5.5 TESTING DATE (13 AUGUST 2002) .............................................. 5-14
   A. ON/OFF ROAD TEST ......................................................... 5-14
      1. HAZARD COURSE ......................................................... 5-14
      2. ROAD TRIP ................................................................. 5-15
      3. PANIC STOPS ............................................................... 5-15
      4. HAZARD COURSE ......................................................... 5-16
      5. WASHBOARD COURSE ..................................................... 5-16
   B. CONCLUSION ................................................................. 5-16

5.6 TESTING DATE (16 AUGUST 2002) .............................................. 5-17
   A. ON/OFF ROAD TEST ......................................................... 5-17
      1. HAZARD COURSE ......................................................... 5-17
      2. ROAD TRIP ................................................................. 5-18
      3. PANIC STOPS ............................................................... 5-18
      4. HAZARD COURSE ......................................................... 5-18
      5. WASHBOARD COURSE ..................................................... 5-19
   B. CONCLUSION ................................................................. 5-20

5.7 TESTING DATE (22-26 AUGUST 2002) ........................................... 5-21
   A. ON/OFF ROAD TEST ......................................................... 5-21
      1. HAZARD COURSE ......................................................... 5-21
      2. ROAD TRIP ................................................................. 5-22
      3. PANIC STOPS ............................................................... 5-23
      4. HAZARD COURSE ......................................................... 5-23
      5. WASHBOARD COURSE ..................................................... 5-24
   B. CONCLUSION ................................................................. 5-25

6. ACCELEROMETER DATA ............................................................... 6-1

7. DRAWINGS ............................................................................. 7-1
ABSTRACT

The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SOSAC-DEV), was tasked by the Transportation Engineering Division (SOSAC-DET) to conduct transportability testing of Nailed Floor-Line Blocking Methods. The testing was conducted in accordance with TP-94-01, "Transportability Testing Procedures", with the exception that the washboard course testing was optional.

The Nailed Floor-Line Blocking Methods used during testing on 20 May 2002, 13 August 2002, 16 August 2002, and 22-26 August 2002 successfully completed the Hazard Course Testing and the Road Trip Testing as specified in TP-94-01, "Transportability Testing Procedures". The nailing criteria and procedures for the nailed floor line blocking methods utilized during the successful testing are adequate and safe for transportation of ammunition in closed van trailers for highway movement. The nails that were utilized during the successful testing were hand driven and conformed to the ASTM F1667 requirements for common steel nails.

Prepared by: Reviewed by:

PHILIP W. BARICKMAN JERRY W. BEAVER
Lead Validation Engineer Chief, Validation Engineering Division
PART 1 – INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SOSAC-DEV), was tasked by the Transportation Engineering Division (SOSAC-DET) to conduct transportability testing of Nailed Floor-Line Blocking Methods. The testing was conducted in accordance with TP-94-01, “Transportability Testing Procedures,” with the exception that the Washboard Course was optional.

B. AUTHORITY. This test was conducted IAW mission responsibilities delegated by the U.S. Army Operations Support Command (OSC), Rock Island, IL. Reference is made to the following:


C. OBJECTIVE. The objective of the testing was to validate adequacy of the Nailed Floor-Line Blocking Methods as designed by the Transportation Engineering Division.

D. CONCLUSION. The Nailed Floor-Line Blocking Methods used during testing on 20 May 2002, 13 August 2002, 16 August 2002, and 22-26 August 2002 successfully completed the Hazard Course Testing and the Road Trip Testing as specified in TP-94-01, “Transportability Testing Procedures”. The nailing criteria and procedures for the nailed floor line blocking methods utilized during the successful testing are adequate and safe for transportation of ammunition in closed van trailers for highway movement. The nails that were utilized during the successful testing were hand driven and conformed to the ASTM F1667 requirements for common steel nails.
# PART 2 - ATTENDEES

<table>
<thead>
<tr>
<th>ATTENDEE</th>
<th>MAILING ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philip Barickman</td>
<td>Director U.S. Army Defense Ammunition Center</td>
</tr>
<tr>
<td>General Engineer</td>
<td>ATTN: SOSAC-DEV</td>
</tr>
<tr>
<td>DSN 956-8992</td>
<td>1 C Tree Road, Bldg. 35</td>
</tr>
<tr>
<td>(918) 420-8992</td>
<td>McAlester, OK 74501-9053</td>
</tr>
<tr>
<td>Gregory Willis</td>
<td>Director U.S. Army Defense Ammunition Center</td>
</tr>
<tr>
<td>Industrial Engineer</td>
<td>ATTN: SOSAC-DET</td>
</tr>
<tr>
<td>DSN 956-8075</td>
<td>1 C Tree Road, Bldg. 35</td>
</tr>
<tr>
<td>(918) 420-8075</td>
<td>McAlester, OK 74501-9053</td>
</tr>
<tr>
<td>Walter Gordon</td>
<td>Director U.S. Army Defense Ammunition Center</td>
</tr>
<tr>
<td>Civil Engineer</td>
<td>ATTN: SOSAC-DET</td>
</tr>
<tr>
<td>DSN 956-8050</td>
<td>1 C Tree Road, Bldg. 35</td>
</tr>
<tr>
<td>(918) 420-8050</td>
<td>McAlester, OK 74501-9053</td>
</tr>
<tr>
<td>Michael Bartosiak</td>
<td>Director U.S. Army Defense Ammunition Center</td>
</tr>
<tr>
<td>Mechanical Engineer</td>
<td>ATTN: SOSAC-DET</td>
</tr>
<tr>
<td>DSN 956-8083</td>
<td>1 C Tree Road, Bldg. 35</td>
</tr>
<tr>
<td>(918) 420-8083</td>
<td>McAlester, OK 74501-9053</td>
</tr>
<tr>
<td>Art Stanton</td>
<td>Naval PHST Center</td>
</tr>
<tr>
<td>Supervisory Engineer</td>
<td>201 Highway 34 South</td>
</tr>
<tr>
<td>DSN 449-2947</td>
<td>Colts Neck, NJ 07722-5023</td>
</tr>
<tr>
<td>(732) 866-2947</td>
<td></td>
</tr>
<tr>
<td>Richard Eaves</td>
<td>Naval PHST Center</td>
</tr>
<tr>
<td>Test Engineer</td>
<td>201 Highway 34 South</td>
</tr>
<tr>
<td>DSN 449-2906</td>
<td>Colts Neck, NJ 07722-5023</td>
</tr>
<tr>
<td>(732) 866-2906</td>
<td></td>
</tr>
</tbody>
</table>
PART 3 - TEST EQUIPMENT

1. Trailer, Cargo, 48-Foot
   Manufacturer: Fruehauf, Detroit, MI
   Date of Manufacturer: 10/87
   Gross Vehicle Weight
   Rating: 68,000 Lbs.
   VIN: 1HV04825JJ015705
   Model: FB9-F2-48

   Used for May 2002 Testing

2. Trailer, Cargo, 48-Foot
   Manufacturer: Stoughton
   Date of Manufacturer: 7/95
   Gross Vehicle Weight
   Rating: 70,000 Lbs.
   VIN: 1DW14826TS969383
   Model: AVW-485T-S-WEDGE
   Used for August 2002 Testing

   Used for August 2002 Testing

3. Truck, Tractor
   5 Ton, 6 X 6
   Model #: XM818 with winch
   ID #: 05A-74971-C124-13529
   Weight: 20,955 Lbs.
PART 4 - TEST PROCEDURES

The test procedures outlined in this section were extracted from TP-94-01, "Transportability Testing Procedures," July 1994, for validating tactical vehicles and outloading procedures used for shipping munitions by tactical truck, railcar, and ocean-going vessel.

Inert (non-explosive) items will be used to build the load. The test loads will be prepared using the blocking and bracing procedures proposed for use with munitions (see Part 7 for procedures). The weight and physical characteristics (weights, physical dimensions, center of gravity, etc.) of the test loads will be similar to live (explosive) ammunition.

A. ON/OFF ROAD TEST.

1. HAZARD COURSE. The test load or vehicle will be transported over the 200-foot-long segment of concrete-paved road consisting of two series of railroad ties projecting 6 inches above the level of the road surface. The hazard course will be traversed two times (see Figure 1).
a. The first series of 6 ties are spaced on 10-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 50 feet.

b. Following the first series of ties, a paved roadway of 75 feet separates the first and second series of railroad ties.

c. The second series of 7 ties are spaced on 8-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 50 feet.

d. The test load is driven across the hazard course at speeds that will produce the most violent vertical and side-to-side rolling reaction obtainable in traversing the hazard course (approximately 5 mph).

2. **ROAD TRIP.** The test load or vehicle will be transported for a distance of 30 miles over a combination of roads surfaced with gravel, concrete, and asphalt. The test route will include curves, corners, railroad crossings and stops
and starts. The test load or vehicle will travel at the maximum speed for the particular road being traversed, except as limited by legal restrictions.

3. **Panic Stops.** During the road trip, the test load or vehicle will be subjected to three (3) full airbrake stops while traveling in the forward direction and one in the reverse direction while traveling down an approximate 7 percent grade. The first three stops are at 5, 10, and 15 mph while the stop in the reverse direction is approximately 5 mph. This testing will not be required if the Rail Impact Test is performed.

4. **Washboard Course.** The test load or vehicle will be driven over the washboard course at a speed that produces the most violent response in the vertical direction. The washboard course test was conducted for informational purposes only.

![Washboard Course Sketch](Figure 2. Washboard Course Sketch)
PART 5 - TEST RESULTS

5.1 Testing Date: 7 May 2002
Payload: 155MM Separate Loading Projectiles (SLPs)

Photo 1. 155MM SLP

Photo 2. 155MM SLPs Test Load
A. **ON/OFF ROAD TEST. HAZARD COURSE.**

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Elapsed Time</th>
<th>Avg. Velocity (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31 Seconds</td>
<td>5</td>
</tr>
</tbody>
</table>

*Figure 2*

![Photo 3](image_url)  
*Photo 3. 155MM SLP over Hazard Course*

**Remarks:**
1. Figure 2 lists the average speed of the test load through the Hazard Course.
2. The front header at the door end passenger side moved 2 inches toward the door of the trailer. This permitted the 155MM SLP to move excessively.
3. The side blocking located in the closed end of the trailer on the passenger side pulled loose from the floor. This allowed the 155MM SLP to slide against the trailer wall.
4. Due to the excessive load movement the testing was stopped.
Photo 4. Movement of the Front Header

Photo 5. Movement of the Payload at the Door End of the Trailer
B. **CONCLUSION:** The nails used to secure the header to the trailer floor were box nails instead of common nails. Therefore, the shank size was not correct. This resulted in a decrease in nail holding ability compared to common nails.
5.2 Testing Date: 9 May 2002
Payload: PA116 Metal Containers on Metal Pallets

![Photo 7. PA116 Metal Containers on Metal Pallets Test Load](image)

A. **ON/OFF ROAD TEST. HAZARD COURSE.**

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Elapsed Time</th>
<th>Avg. Velocity (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31 Seconds</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 3.
Photo 8. Hazard Course Testing of PA116 Containers on Metal Pallets

Remarks:
1. Figure 3 lists the average speed of the test load through the Hazard Course.
2. The top header board at the trailer door separated from the bottom board and the payload was resting on the bottom board upon completion of Pass #1. Due to the failure testing was stopped.

Photos 9 and 10. Separated Header Board
B. **CONCLUSION:** The nails used to secure the header to the trailer floor were box nails instead of common nails. Therefore, the shank size was not correct. This resulted in a decrease in nail holding ability compared to common nails.
5.3 Testing Date: 9 May 2002
Payload: PA116 Metal Containers on Metal Pallets

Photo 11. PA116 Metal Containers on Metal Pallets Test Load

A. **ON/OFF ROAD TEST. HAZARD COURSE.**

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Elapsed Time</th>
<th>Avg. Velocity (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26 Seconds</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>26 Seconds</td>
<td>6</td>
</tr>
</tbody>
</table>

Figure 4.

**Remarks:**
1. Figure 4 lists the average speed of the test load through the Hazard Course.
2. A vertical 2" X 4" board was added between the header boards and the pallet bases.
3. During Pass #2 banding on one pallet at the closed end of the trailer broke and caused the pallet contents to spill onto the trailer floor.
B. **CONCLUSION:** Testing was stopped and the pallet was reloaded and rebanded. In order to accomplish this, all payload and dunnage was removed from the trailer.
5.4 Testing Date: 20 May 2002
Payload: PA116 Metal Containers on Metal Pallets

Note: The payload and nail pattern for this series of tests were the same as Section 5.3.

![Photo 13. PA116 Metal Containers on Metal Pallets Test Load](image)

### A. ON/OFF ROAD TEST.

1. **HAZARD COURSE.**

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Elapsed Time</th>
<th>Avg. Velocity (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30 Seconds</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>29 Seconds</td>
<td>5</td>
</tr>
</tbody>
</table>

**Figure 5.**

Remarks:
1. Figure 5 lists the average speed of the test load through the Hazard Course.
2. Rear bay of payload moved 0.5 toward the trailer door.
3. The 2nd anti-sway brace from the trailer door end came loose from the wire tie.
4. Inspection following Passes # 1 and # 2 revealed no excessive movement of the payload or damage to the trailer or blocking and bracing.
2. **ROAD TRIP:** Inspection revealed no excessive movement of the payload, damage to the trailer or blocking and bracing.

3. **PANIC STOPS:** Inspection revealed no excessive movement of the payload, damage to the trailer or blocking and bracing.

4. **HAZARD COURSE:**

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Elapsed Time</th>
<th>Avg. Velocity (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>29 Seconds</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>29 Seconds</td>
<td>5</td>
</tr>
</tbody>
</table>

*Figure 6.*

**Remarks:**
1. Figure 6 lists the average speeds of the test load through the Hazard Course.
2. Inspection following Pass #4 revealed that the load moved 0.5 inches toward the door of the trailer.
3. Inspection following Passes #3 and #4 revealed no excessive movement of the payload or damage to the trailer or blocking and bracing.

5. **WASHBOARD COURSE.** The washboard test was conducted for informational purposes only. The rear header (door end) separated from the trailer floor. This allowed the entire load to move toward the trailer door. One pallet of the PA116 Containers fell from the trailer.
Photo 14. PA116 Pallet Falling from the Trailer During the Washboard Test

Photo 15. PA116 Container Pallet After Dropping From the Trailer During Washboard Course
B. **CONCLUSION:** The nail pattern successfully completed the required testing. The failure that occurred was during the optional washboard testing, and, therefore, did not constitute a test failure.
5.5 Testing Date: 13 August 2002
Payload: PA116 Metal Containers on Wood Pallets
Payload Weight: 39,220 Pounds

Photo 17. PA116 Metal Containers on Wood Pallets Test Load

A. ON/OFF ROAD TEST.
   1. HAZARD COURSE.

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Elapsed Time</th>
<th>Avg. Velocity (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26 Seconds</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>29 Seconds</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 7.
Photo 18. Washboard Course Testing of PA116 Containers on Wood Pallets

**Remarks:**

1. Figure 7 lists the average speed of the test load through the Hazard Course.
2. Inspection following Pass #2 revealed that the load moved toward the rear of the trailer 1.5 inches. The movement was caused by shifting of the pallet contents. The blocking and bracing was not damaged.

2. **ROAD TRIP:** Inspection revealed no excessive movement of the payload, damage to the trailer, or blocking and bracing.

3. **PANIC STOPS:**

**Remarks:**

1. Inspection following the forward 5 MPH stop revealed that the load moved forward 1.5 inches.
2. Inspection following the reverse 5 MPH revealed the load moved toward the rear of the trailer 1.5 inches. The movement was caused by shifting of the pallet contents. The blocking and bracing was not damaged.
4. **HAZARD COURSE:**

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Elapsed Time</th>
<th>Avg. Velocity (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>28 Seconds</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>29 Seconds</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 8.

**Remarks:**
1. Figure 8 lists the average speeds of the test load through the Hazard Course.
2. Inspection following Pass #3 revealed that the load moved 0.5 inches forward.
3. Inspection following Passes #3 and #4 revealed no excessive movement of the payload, damage to the trailer or blocking and bracing.

5. **WASHBOARD COURSE:** The washboard test was conducted for informational purposes only. Inspection following the completion of the test revealed that the load had moved toward the rear of the trailer 2.6 inches.

![Photo 19](image_url)  
**Photo 19. Washboard Course Testing of the PA116 Containers on Wood Pallets**

**B. CONCLUSION:** The nail pattern successfully completed the required testing.
5.6 Testing Date: 16 August 2002

Payload: 155MM Separate Loading Projectiles
Payload Weight: 42,480 Pounds

Photos 20. and 21. 155MM Separate Loading Projectiles Test Load

A. ON/OFF ROAD TEST.

1. HAZARD COURSE.

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Elapsed Time</th>
<th>Avg. Velocity (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34 Seconds</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>32 Seconds</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 9.
Photo 22. Hazard Course Testing of the 155MM SLP Payload

Remarks:

1. Figure 9 lists the average speed of the test load through the Hazard Course.
2. Inspection following Pass #2 revealed that the front load moved 0.25 inches toward the front of the trailer.
3. Inspection following Passes #1 and #2 revealed no excessive movement of the payload, damage to the trailer or blocking and bracing.

2. ROAD TRIP: Inspection revealed no excessive movement of the payload, damage to the trailer or blocking and bracing.

3. PANIC STOPS: Inspection revealed no excessive movement of the payload, damage to the trailer or blocking and bracing.

4. HAZARD COURSE:

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Elapsed Time</th>
<th>Avg. Velocity (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>30 Seconds</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>28 Seconds</td>
<td>6</td>
</tr>
</tbody>
</table>

Figure 10.
Remarks:
1. Figure 10 lists the average speeds of the test load through the Hazard Course.
2. During Pass #4 the payload bounced onto the rear header at the trailer door. However, the pallet did reseat prior to the completion of the pass.
3. Inspection following Passes #3 and #4 revealed no excessive movement of the payload, damage to the trailer or blocking and bracing.

5. WASHBOARD COURSE.
Remarks:
1. The washboard test was conducted for informational purposes only.
2. The load-bearing gate, at the trailer door was damaged. During transport over the hazard course the passenger side bay of 155MM SLPs bounced onto the end blocking. The load moved toward the door of the trailer and damaged the gate.
3. The end blocking separated from the floor 0.3 inches at the door end of the trailer.
4. The end blocking (closed end) of the second bay of 155MM SLPs moved forward 0.25 inches due to the nails bending.
5. The load bearing gate (door end) fill piece of the second bay of 155MM SLPs disengaged.
Photo 23. Washboard Course Testing of the 155MM SLP Payload

Photos 24. and 25. Damaged Load Bearing Gates

B. **CONCLUSION:** The nail pattern successfully completed the required testing.
5.7 Testing Date: 22-26 August 2002
Payload: PA116 Metal Containers on Metal Pallets
Payload Weight: 39,460 Pounds

Photo 26. PA116 Metal Containers on Metal Pallets Test Load

A. ON/OFF ROAD TEST.

1. HAZARD COURSE.

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Elapsed Time</th>
<th>Avg. Velocity (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28 Seconds</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>29 Seconds</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 11.
Photo 27. Washboard Course Testing of the PA116 Containers on Metal Pallets

**Remarks:**
1. Figure 11 lists the average speed of the test load through the Hazard Course.
2. Inspection following Passes #1 and #2 revealed no excessive movement of the payload, damage to the trailer or blocking and bracing.

2. **ROAD TRIP:**

**Remarks:**
1. The Road Trip was conducted between the Road Hazard Course Passes #2 and #3.
2. Inspection following the completion of the Road Trip revealed that the top board of the rear header at the door end on the passenger side had separated 0.25 inches from the board below.
3. Inspection revealed no excessive movement of the payload, damage to the trailer or the blocking and bracing.
3. **PANIC STOPS:**

**Remarks:**
1. The panic stops were conducted during the Road Trip.
2. The reverse panic stop was repeated due to equipment problems.
3. Inspection revealed no excessive movement of the payload, damage to the trailer or blocking and bracing.

4. **HAZARD COURSE:**

<table>
<thead>
<tr>
<th>Pass No.</th>
<th>Elapsed Time</th>
<th>Avg. Velocity (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>29 Seconds</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>28 Seconds</td>
<td>6</td>
</tr>
</tbody>
</table>

_Figure 12._

**Remarks:**
1. Figure 12 lists the average speeds of the test load through the Hazard Course.
2. Inspection following Pass #3 revealed that the load (12 pallet bay) moved 1.25 inches on the driver's side and 0.75 inches on the passenger's side toward the rear of the trailer.
3. Inspection following Pass #3 revealed that the top of the rear header at the door end on the passenger side had separated an additional 0.38 inches from the board below.
4. Inspection following completion of Passes #3 and #4 revealed no excessive movement of the payload, damage to the trailer or the blocking and bracing.
5. **WASHBOARD COURSE:**

![Photo 28. Washboard Course Testing of the PA116 Containers on Metal Pallets](image)

**Remarks:**

1. The washboard test was conducted for informational purposes only.
2. Inspection following completion of the washboard course revealed that the top of the rear header at the door end on the passenger side had separated an additional 0.38 inches from the board below. Total separation was now 1.0 inch.
3. Inspection following completion of the washboard course revealed no excessive movement of the payload, damage to the trailer or the blocking and bracing.
Photo 29. Separation of the Rear Header Board

B. **CONCLUSION:** The nail pattern successfully completed the required testing. However, during testing the top board of the rear header at the door end passenger side did separate a total of 1 inch from the header bottom.
PART 6 – ACCELEROMETER DATA

The accelerometers were located on the trailer floor and on the payload throughout testing. The axial orientation of the accelerometers is as follows: Also following are the graphic depictions of each of the railcar impacts, hazard course, road course, and washboard course. The axial orientation of the accelerometers is as follows:

r - resultant vector  x – longitudinal   y – lateral   z – vertical

A table depicting the identification and location of the graphic illustrations is below:

<table>
<thead>
<tr>
<th>PAYLOAD: PA116 ON WOOD PALLETS</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Course – Pass #1</td>
<td>6-2</td>
</tr>
<tr>
<td>Hazard Course – Pass #2</td>
<td>6-2</td>
</tr>
<tr>
<td>Road Trip</td>
<td>6-2</td>
</tr>
<tr>
<td>Hazard Course – Pass #3</td>
<td>6-3</td>
</tr>
<tr>
<td>Hazard Course – Pass #4</td>
<td>6-3</td>
</tr>
<tr>
<td>Washboard Course</td>
<td>No data</td>
</tr>
</tbody>
</table>

Photo 20. PA116 on Wood Pallets Trailer Floor Sensor Location

Photo 21. PA116 on Wood Pallets Payload Sensor Location
### NAILED FLOOR-LINE BLOCKING METHODS

<table>
<thead>
<tr>
<th>PAYLOAD: 155MM SEPARATE LOADING PROJECTILES</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Course – Pass #1</td>
<td>6-2</td>
</tr>
<tr>
<td>Hazard Course – Pass #2</td>
<td>6-2</td>
</tr>
<tr>
<td>Road Trip</td>
<td>6-3</td>
</tr>
<tr>
<td>Hazard Course – Pass #3</td>
<td>6-3</td>
</tr>
<tr>
<td>Hazard Course – Pass #4</td>
<td>6-3</td>
</tr>
<tr>
<td>Washboard Course</td>
<td>No data</td>
</tr>
</tbody>
</table>

Photo 22. 155MM SLP on Trailer Floor Sensor Location

Photo 23. 155MM SLP on Payload Sensor Location

### NAILED FLOOR-LINE BLOCKING METHODS

<table>
<thead>
<tr>
<th>PAYLOAD: PA116 ON METAL PALLETS</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Course – Pass #1</td>
<td>6-2</td>
</tr>
<tr>
<td>Hazard Course – Pass #2</td>
<td>6-2</td>
</tr>
<tr>
<td>Road Trip</td>
<td>6-3</td>
</tr>
<tr>
<td>Hazard Course – Pass #3</td>
<td>6-3</td>
</tr>
<tr>
<td>Hazard Course – Pass #4</td>
<td>6-3</td>
</tr>
<tr>
<td>Washboard Course</td>
<td>No data</td>
</tr>
</tbody>
</table>

Photo 24. PA116 on Metal Pallets Trailer Floor Sensor Location

Photo 25. PA116 on Metal Pallets Payload Location
Multiple Wave View: PA116 on Wood Pallets - Hazard Passes 1 & 2, EDR3 #0186 Acceleration

Sensor Location: Trailer Floor

Acceleration (g)

Testing Date: 13 August 2002
Sensor Location: Trailer Floor

Testing Date: 13 August 2002
Multiple Wave View: PA116 on Wood Pallets - 30 Mile Road Course, EDR3 #0186 Acceleration

Sensor Location: Payload

Acceleration (g)

X

Y

Z

R

Testing Date: 13 August 2002
Sensor Location: Trailer Floor

Testing Date: 13 August 2002
Testing Date: 13 August 2002
Sensor Location: Payload

Testing Date: 16 August 2002

Time (s)
Multiple Wave View: 155MM SLP, 30 Mile Road Course, EDR3 #0186 Acceleration

Sensor Location: Payload

Acceleration (g)

Time (s)

Testing Date: 16 August 2002
Sensor Location: Payload

Testing Date: 16 August 2002
Multiple Wave View: 155MM SLP, Washboard Course, EDR3 #0185 Acceleration

Sensor Location: Trailer Floor

Acceleration (g)

X

Y

Z

R

Time (s)

Testing Date: 16 August 2002
Multiple Wave View: PA116 on Metal Pallets - Hazard Passes 1 & 2, EDR3 #0185  Acceleration

Sensor Location: Trailer Floor

Testing Date: 22-26 August 2002
Sensor Location: Payload

Testing Date: 22-26 August 2002
Sensor Location: Trailer Floor

Testing Date: 22-26 August 2002

6-23
**PART 7—DRAWINGS**

The following drawings represent the load configuration that was subjected to the test criteria.
TEST SERIES NO. 2

TEST SKETCH FOR THE TESTING OF NAILED FLOOR-LINE BLOCKING OF PA116 METAL CONTAINERS ON WOOD PALLETS

THIS FIVE PAGE DOCUMENT DEPICTS PROCEDURES FOR NAILED FLOOR-LINE BLOCKING TESTING OF BALLAST FILLED PA116 CYLINDRICAL METAL CONTAINERS ON WOOD PALLETS.

Prepared during July 2002 by:
U.S. Army Defense Ammunition Center
ATTN: SOSAC-DET
McAlester, OK 74501
POC: Mr. Gregory Willis
DSN 956-8075
Comm (918) 420-8075
Fax 956-8811
E-mail: gregory.willis@dasd.army.mil

Gregory L. Willis
Acting Chief, Transportation Engineering Division
**ISOMETRIC VIEW**

**LOAD AS SHOWN**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>WEIGHT (APPROX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pallet Unit</td>
<td>16</td>
<td>38,592 LBS</td>
</tr>
<tr>
<td>Dunnage</td>
<td>1</td>
<td>254 LBS</td>
</tr>
<tr>
<td><strong>TOTAL WEIGHT</strong></td>
<td></td>
<td><strong>38,846 LBS (APPROX)</strong></td>
</tr>
</tbody>
</table>

**BILL OF MATERIAL**

<table>
<thead>
<tr>
<th>LUMBER</th>
<th>LINEAR FEET</th>
<th>BOARD FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; X 4&quot;</td>
<td>341</td>
<td>94</td>
</tr>
<tr>
<td>2&quot; X 6&quot;</td>
<td>31</td>
<td>31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NAILS</th>
<th>NO. REQD</th>
<th>POUNDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10d (3&quot;)</td>
<td>197</td>
<td>3</td>
</tr>
<tr>
<td>20d (4&quot;)</td>
<td>9</td>
<td>1/4</td>
</tr>
</tbody>
</table>

| WIRE, .0800" DIA | 40" REQD | 2/3 LBS |

**KEY NUMBERS**

1. FRONT HEADER, 2" X 6" by Trailer Width Minus 1/2" in Length (Doubled) (1 Req'd). Position at 10" from the front of the trailer as shown. Nail the first piece to the trailer floor with 10d nails. Nail the second piece to the first with 20d nails.


3. Top-of-Load Anti-Sway Brace (9 Req'd). Wire tie to the pallet unitizing straps with .0800" dia. wire as shown by the "Tie Wire Application" detail on page 4. See the "Top-of-Load Anti-Sway Brace" detail on page 5.

4. Rear Header A, 2" X 4" by Trailer Width Minus 1/2" in Length (Doubled) (1 Req'd). Position against the rear anti-sway brace assembly and the pallet skids. Nail the first piece to the trailer floor with 10d nails. Nail the second piece to the first in a like manner.

5. FRONT HEADER, 2" X 6" by Trailer Width Minus 1/2" in Length (Doubled) (2 Req'd). Position at 10" front from the front of the trailer as shown. Nail the first piece to the trailer floor with 20d nails. Nail the second piece to the first with 20d nails.

6. Rear Header B, 2" X 4" by Trailer Width Minus 1/2" in Length (Doubled) (1 Req'd). Position against the afo blocking assembly. Nail the first piece to the trailer floor with 10d nails. Nail the second piece to the first in a like manner.
WOOD PALLET UNIT

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>WEIGHT (APPROX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTAINERS OF 120MM CARTRIDGES (INCOMPLETE LOADED) AT 75 LBS</td>
<td>30</td>
<td>2,250 LBS (APPROX)</td>
</tr>
<tr>
<td>DUMMY</td>
<td></td>
<td>85 LBS</td>
</tr>
<tr>
<td>PALLET</td>
<td></td>
<td>77 LBS</td>
</tr>
<tr>
<td>TOTAL WEIGHT</td>
<td></td>
<td>2,412 LBS (APPROX)</td>
</tr>
<tr>
<td>CUBE</td>
<td></td>
<td>54.2 CU FT</td>
</tr>
</tbody>
</table>

*NOTE: PALLET UNIT CONSTRUCTED IN ACCORDANCE WITH UNITIZATION PROCEDURES Delineated WITHIN DRAWING 19-46-4070/7B.*

GENERAL NOTES

A. WHEN STEEL STRAPPING IS SEALING AT AN END-OVER-END LAP JOINT, A MINIMUM OF ONE SEAL WITH TWO PAIRS OF NOTCHES WILL BE USED TO SEAL THE JOINT WHEN A NOTCH-TYPE SEALER IS BEING USED. A MINIMUM OF TWO SEALS, BUTTED TOGETHER WITH TWO PAIRS OF CRIMPS PER SEAL WILL BE USED TO SEAL THE JOINT WHEN A CRIMP-TYPE SEALER IS BEING USED. REFER TO THE *STRAP JOINT A* AND *STRAP JOINT B* DETAIL AT RIGHT.

B. DUMMY LUMBER SPECIFIED THROUGHOUT THIS PROCEDURE drawing IS OF NOMINAL SIZE. FOR EXAMPLE, 2" X 4" MATERIAL IS ACTUALLY 1-1/2" THICK BY 3-1/2" WIDE AND 2" X 6" MATERIAL IS ACTUALLY 1-1/2" THICK BY 5-1/2" WIDE.

C. NOTICE: A STAGGERED NAILING PATTERN WILL BE USED WHEREVER POSSIBLE WHEN NAILS ARE DRIVEN INTO JOINTS OF DUMMY ASSEMBLIES. ALSO, A STAGGERED NAILING PATTERN WILL BE USED WHEN DUMMY IS NAILLED TO THE FLOOR OF THE TRANSPORTING VEHICLE, OR WHEN LAMINATING DUMMY. THE NAILING PATTERN WILL BE ADJUSTED AS REQUIRED SO THAT A NAIL DOES NOT PENETRATE INTO OR NEAR A CRACK BETWEEN FLOOR BOARDS. ADDITIONALLY, THE NAILING PATTERN FOR AN UPPER PIECE OF LAMINATED DUMMY WILL BE ADJUSTED AS REQUIRED SO THAT A NAIL FOR THAT PIECE WILL NOT BE DRIVEN THROUGH THE PIECE OR RIGHT BEHIND A NAIL IN A LOWER PIECE.

D. PORTIONS OF THE TRAILER, SUCH AS SIDEWALLS, ENDOALLS, AND ROOFS, HAVE NOT BEEN SHOWN IN THE LOAD VIEW ON PAGE 2 FOR CLARITY PURPOSES.

MATERIAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUMBER</td>
<td>SEEN #743-200-1 (DUMMY LUMBER).</td>
</tr>
<tr>
<td>NAILS</td>
<td>ASTM F1567; COMMON STEEL NAILS (HCS).</td>
</tr>
<tr>
<td>STRAPPING, STEEL</td>
<td>ASTM 93953; FLAT STRAPPING, TYPE I, HEAVY DUTY, FINISH A, B (GRADE 2), OR C.</td>
</tr>
<tr>
<td>SEAL, STRAP</td>
<td>ASTM 93953; CLASS H, FINISH A, B (GRADE 2), OR C, DOUBLE NOTCH TYPE, STYLE I, II, OR IV.</td>
</tr>
<tr>
<td>WIRE, CARBON STEEL</td>
<td>ASTM 4513; ANNEALED AT FINISH, BLACK OXIDE FINISH, 0.080&quot; DIA, GRADE 1006 OR BETTER.</td>
</tr>
</tbody>
</table>

END-OVER-END LAP JOINT DETAILS

*METHOD OF SECURING A STRAP JOINT WHEN USING A NOTCH-TYPE SEALER.*

*METHOD OF SECURING A STRAP JOINT WHEN USING A CRIMP-TYPE SEALER.*
ANTI-SWAY BRACE

THIS ASSEMBLY IS DESIGNED FOR USE ON THE FLOOR BETWEEN LATERALLY ADJACENT PALLET UNITS. NOTE THAT AN ASSEMBLY NEED NOT BE CONSTRUCTED FOR A TIGHT FIT; UP TO 1/2" VOID IS PERMITTED.

INDICATES TOP-OF-LOAD ANTI-SWAY BRACE. SEE THE DETAIL ON PAGE 5.

TIE WIRE APPLICATION

DEPICTED ABOVE IS A PARTIAL VIEW SHOWING THE TOP LAYERS OF A PALLET UNIT. ADJACENT TIE WIRE NOT SHOWN ON ANTI-SWAY BRACE.
SUPPORT PIECE, 2" X 4" X 32" (1 REQD). NAIL TO THE CENTERED SPACER PIECE W/3-10d NAILS.

SPACER PIECE, 2" X 4" BY CUT-TO-FIT BETWEEN LATERALLY ADJACENT PALLET UNITS (1 REQD).

TOP-OF-LOAD ANTI-SWAY BRACE
TEST SERIES NO. 2

TEST SKETCH FOR THE TESTING OF NAILED FLOOR-LINE BLOCKING OF PA116 METAL CONTAINERS ON METAL PALLETS

THIS FIVE PAGE DOCUMENT DEPICTS PROCEDURES FOR NAILED FLOOR-LINE BLOCKING TESTING OF BALLAST FILLED PA116 CYLINDRICAL METAL CONTAINERS ON METAL PALLETS.

Prepared during July 2002 by:
U.S. Army Defense Ammunition Center
ATTN: SOSAC-DET
McAlester, OK 74501
POC: Mr. Gregory Willis
DSN 956-8075
Comm (918) 420-8075
Fax 956-8811
E-mail: gregory.willis@dac.army.mil

[Signature]

Gregory L. Willis
Acting Chief, Transportation Engineering Division
ISOMETRIC VIEW

LOAD AS SHOWN

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>WEIGHT (APPROX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pallet Unit</td>
<td>16</td>
<td>39,360 LBS</td>
</tr>
<tr>
<td>Dunnage</td>
<td></td>
<td>290 LBS</td>
</tr>
<tr>
<td>TOTAL WEIGHT</td>
<td></td>
<td>39,650 LBS (APPROX)</td>
</tr>
</tbody>
</table>

BILL OF MATERIAL

<table>
<thead>
<tr>
<th>LUMBER</th>
<th>LINEAR FEET</th>
<th>BOARD FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; X 4&quot;</td>
<td>143</td>
<td>95</td>
</tr>
<tr>
<td>2&quot; X 6&quot;</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>NAILS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10d (3&quot;)</td>
<td>227</td>
<td>3-1/2</td>
</tr>
<tr>
<td>12d (3-1/4&quot;)</td>
<td>4</td>
<td>MIL</td>
</tr>
<tr>
<td>20d (4&quot;)</td>
<td>9</td>
<td>1/4</td>
</tr>
<tr>
<td>WIRE, .0800&quot; DIA</td>
<td></td>
<td>40&quot; REQ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2/3 LBS</td>
</tr>
</tbody>
</table>

KEY NUMBERS

1. FRONT HEADER, 2" X 6" BY TRAILER WIDTH MINUS 1/2" IN LENGTH (DOUBLED) (1 REQD). POSITION AT 10" FROM THE FRONT OF THE TRAILER AS SHOWN. NAIL THE FIRST PIECE TO THE TRAILER FLOOR W/5-10d NAILS. NAIL THE SECOND PIECE TO THE FIRST W/5-10d NAILS.


4. REAR HEADER A, 2" X 4" BY TRAILER WIDTH MINUS 1/2" IN LENGTH (DOUBLED) (1 REQD). POSITION AGAINST THE REAR ANTI-SWAY BRACE ASSEMBLY AND THE PALLETT SKIDS. NAIL THE FIRST PIECE TO THE TRAILER FLOOR W/6-10d NAILS. NAIL THE SECOND PIECE TO THE FIRST IN A LIKE MANNER.

5. FRONT HEADER, 2" X 6" BY TRAILER WIDTH MINUS 1/2" IN LENGTH (DOUBLED) (1 REQD). POSITION AT 19'-4" FROM THE FRONT OF THE TRAILER AS SHOWN. NAIL THE FIRST PIECE TO THE TRAILER FLOOR W/6-10d NAILS. NAIL THE SECOND PIECE TO THE FIRST W/6-10d NAILS.


7. REAR HEADER B, 2" X 4" BY TRAILER WIDTH MINUS 1/2" IN LENGTH (DOUBLED) (1 REQD). POSITION AGAINST THE AFT BLOCKING ASSEMBLY. NAIL THE FIRST PIECE TO THE TRAILER FLOOR W/12-10d NAILS. NAIL THE SECOND PIECE TO THE FIRST IN A LIKE MANNER. TOENAIL THOUGH REAR HEADER B INTO THE BEARING PIECE OF THE AFT BLOCKING ASSEMBLY, PIECE MARKED (B), W/4-12d NAILS.
GENERAL NOTES
A. WHEN STEEL STRAPPING IS SEALED AT AN END-OVER-END LAP JOINT, A MINIMUM OF ONE SEAL WITH TWO PAIR OF NOTCHES WILL BE USED TO SEAL THE JOINT WHEN A NOTCH-TYPE SEALER IS BEING USED. A MINIMUM OF TWO SEALS, BUTTED TOGETHER WITH TWO PAIR OF CRIMPED SEALS WILL BE USED TO SEAL THE JOINT WHEN A CRIMP-TYPE SEALER IS BEING USED. REFER TO THE "STRAP JOINT A" AND "STRAP JOINT B" DETAIL AT RIGHT.

B. DUNNAGE LUMBER SPECIFIED THROUGHOUT THIS PROCEDURAL DRAWING IS OF NOMINAL SIZE. FOR EXAMPLE, 2" X 4" MATERIAL IS ACTUALLY 1-1/2" THICK BY 3-1/2" WIDE AND 2" X 6" MATERIAL IS ACTUALLY 1-1/2" THICK BY 5-1/2" WIDE.

C. NOTICE: A STAGGERED NAILING PATTERN WILL BE USED WHENEVER POSSIBLE. WHEN NAILS ARE DRIVEN INTO JOINTS OF DUNNAGE ASSEMBLIES. ALSO, A STAGGERED NAILING PATTERN WILL BE USED WHEN DUNNAGE IS NAILLED TO THE FLOOR OF THE TRANSPORTING VEHICLE, OR WHEN LAMINATING DUNNAGE. THE NAILING PATTERN WILL BE ADJUSTED AS REQUIRED SO THAT A NAIL DOES NOT PENETRATE INTO OR NEAR A CRACK BETWEEN FLOOR BOARDS. ADDITIONALLY, THE NAILING PATTERN FOR AN UPPER PIECE OF LAMINATED DUNNAGE WILL BE ADJUSTED AS REQUIRED SO THAT A NAIL FOR THAT PIECE WILL NOT BE DRIVEN THROUGH THE PIECE ONTO OR RIGHT BEHIND A NAIL IN A LOWER PIECE.

D. PORTIONS OF THE TRAILER, SUCH AS SIDEWALLS, ENDWALLS, AND ROOFS, HAVE NOT BEEN SHOWN ON THE LOAD VIEW ON PAGE 2 FOR CLARITY PURPOSES.

MATERIAL SPECIFICATIONS
LUMBER - - - - - - : SEE TM 743-200-1 (DUNNAGE LUMBER).

NAILS - - - - - - - : ASTM F1667; COMMON STEEL NAILS (N.L.O.S).

STRAPPING, STEEL - - - : ASTM D3953; FLAT STRAPPING, TYPE I
HEAVY DUTY, FINISH A, B (GRADE 2), OR C.

SEAL, STRAP - - - - - : ASTM D3953; CLASS H, FINISH A, B (GRADE 2),
OR C, DOUBLE NOTCH TYPE, STYLE I, II, OR IV.

WIRE, CARBON STEEL - - : ASTM A853; ANNEALED AT FINISH, BLACK
OXIDE FINISH, 0.080" DIA, GRADE 1006 OR BETTER.

END-OVER-END LAP JOINT DETAILS

METAL PALLETS
ITEM QUANTITY WEIGHT (APPROX)

CONTAINERS OF 120MM CARTRIDGES
(IN EJECT LOADED) AT 75 LBS - - - - 30 - 2,250 LBS (APPROX)
DUNNAGE - - - - - - - 105 LBS
PALLETS - - - - - - - 105 LBS

TOTAL WEIGHT - - - - - - 2,460 LBS (APPROX)
CUBE - - - - - - - - - - - - - 53.5 CU FT

NOTE: PALLETS UNIT CONSTRUCTED IN ACCORDANCE WITH UNITIZATION PROCEDURES Delineated WITHIN DRAWING 13-45-4239/49.
ANTI-SWAY BRACE

THIS ASSEMBLY IS DESIGNED FOR USE ON THE FLOOR BETWEEN LATERALLY ADJACENT PALLET UNITS. NOTE THAT AN ASSEMBLY NEED NOT BE CONSTRUCTED FOR A TIGHT FIT; UP TO 1/2" VOID IS PERMITTED.

INDICATES TOP-OF-LOAD ANTI-SWAY BRACE. SEE THE DETAIL ON PAGE 5.

.0800" DIA WIRE BY LENGTH TO SUIT. FORM TWO LOOPS AROUND TOP-OF-LOAD ANTI-SWAY BRACE SUPPORT PIECE AND TWIST TO PREVENT DISPLACEMENT. THREAD EACH END OF THE WIRE UNDER AND AROUND THE CENTER UNITIZING STRAP ON THE UNIT AND TWIST WIRE TO SELF AS SHOWN. PARTIALLY DRIVE 1-10D NAIL INTO SUPPORT PIECE AND BEND NAIL OVER WIRE.

TIE WIRE APPLICATION

DEPICTED ABOVE IS A PARTIAL VIEW SHOWING THE TOP LAYERS OF A PALLET UNIT. ADJACENT TIE WIRE NOT SHOWN ON ANTI-SWAY BRACE.
BEARING PIECE, 2" X 6" BY TRAILER WIDTH MINUS 1/2" (2 REQD). NAIL TO THE STRUTS W/3-10d NAILS AT EACH JOINT.

STUT, 2" X 6" X 6" (4 REQD).

RETAINER PIECE, 2" X 4" X 9" (2 REQD). NAIL TO THE BEARING PIECE W/3-10d NAILS.

AFT BLOCKING ASSEMBLY
THE ASSEMBLY DEPICTED ABOVE IS FOR USE AT THE AFT END OF A LOAD. NOTE THAT THE ABOVE VIEW IS ROTATED 180 DEGREES FROM THE POSITION IN WHICH IT WILL BE INSTALLED.

SUPPORT PIECE, 2" X 4" X 32" (1 REQD). NAIL TO THE CENTERED SPACER PIECE W/3-10d NAILS.

SPACER PIECE, 2" X 4" BY CUT-TO-FIT BETWEEN LATERALLY ADJACENT PALLET UNITS. (1 REQD).

TOP-OF-LOAD ANTI-SWAY BRACE
LOADING AND BRACING (TL & LTL) IN VAN TRAILERS OF PALLETIZED SEPARATE LOADING PROJECTILES

INDEX

ITEM
GENERAL NOTES, AND MATERIAL SPECIFICATIONS ................................................. 2-3
PALLETT UNIT DETAILS.................................................................................. 4-5
155MM PROJECTILE, 8SMALL PALLETS......................................................... 6-10
155MM PROJECTILE, 8/LARGE PALLETS....................................................... 12-16
8" PROJECTILE, 6SMALL PALLETS................................................................. 18-23
8" PROJECTILE, 6/LARGE PALLETS............................................................... 24-31
8" PROJECTILE, 6 TALL/SMALL PALLETS.............................................. 32-39
DETAILS........................................................................................................... 11, 17, 21, 29, 40-46

* CAUTION: THE LOADING PROCEDURES SHOWN HEREIN ARE ONLY APPLICABLE TO
HIGHWAY MOVEMENTS, NOT TRAILER-ON-FLATCAR (TOFC) MOVEMENTS.

U.S. ARMY MATERIEL COMMAND DRAWING

DO NOT SCALE
WEBSITE: HTTP://WWW.DAC.ARMY.MIL
JULY 1961

REVISION NO. 6 JULY 1998
SEE THE REVISION LISTING ON PAGE 3

PROJECT FSA 20-59

7-14
GENERAL NOTES

A. THIS DOCUMENT HAS BEEN PREPARED AND ISSUED IN ACCORDANCE WITH AR 740-1 AND AUGMENTS TM 743-200-1 (CHAPTER 5).

B. THE OUTLOADING PROCEDURES SPECIFIED IN THIS DRAWING ARE APPLICABLE TO PALLETTIZED SEPARATE LOADING PROJECTILES. SUBSEQUENT REFERENCE TO PALLETT UNIT MEANS THE PALLETT UNIT WITH AMMUNITION ITEMS.

C. LADING DATA: SEE PAGES 4 AND 5.

D. THE OUTLOADING PROCEDURES DEPICTED WITHIN THIS DOCUMENT ARE APPLICABLE FOR SHIPMENTS IN CONVENTIONAL TYPE VAN TRAILERS AND APPROPRIATE TO TRAILERS HAVING WOOD, OR WOOD AND METAL, OR ALL METAL FLOORS. REGARDLESS OF THE DIMENSIONS OF THE VAN TRAILERS SHOWN, THE PROCEDURES ARE ALSO APPLICABLE FOR TRAILERS WHICH ARE 80' THRU 94' IN WIDTH AND FOR TRAILERS OF OTHER LENGTHS FROM THE SHORTEST TO THE LONGEST AVAILABLE (REF: 24' TO 55'), AND FOR STRAIGHT TRUCK VANS. THE SPECIFIED BRACINGS ARE ADEQUATE FOR LOADS WEIGHING UP TO AND INCLUDING THE MAXIMUM WEIGHTS PERMITTED BY LAW.


G. NOTICE: A SHIPMENT WILL BE POSITIONED IN THE TRAILER CONSISTENT WITH STATE WEIGHT LAWS. THE NUMBER OF LADING UNITS MAY BE ADJUSTED TO FIT THE SIZE OF THE TRAILER TO BE LOADED OR THE QUANTITY TO BE SHIPPED. COMBINATIONS OF THE OUTLOADING PROCEDURES SPECIFIED MAY BE USED; HOWEVER, THE APPROVED METHODS SHOWN MUST BE FOLLOWED AS CLOSELY AS POSSIBLE FOR BLOCKING, BRACING, AND STAYING OF THE DESIGNATED ITEMS.

H. THE "LOAD AS SHOWN" FOR MOST OF THE FULL LOADS DEPICTED HEREIN IS BASED ON AN APPROXIMATE LADING WEIGHT OF 45,000 POUNDS. THE SPECIFIED BLOCKING AND BRACING FOR THE FULL LOADS IS ADEQUATE FOR THE RETENTION OF LOADS, UP TO 45,000 POUNDS, IF IT IS DESIRED TO INCREASE THE LADING WEIGHT.

(GENERAL NOTES CONTINUED)

J. OTHER TYPES OF LADING ITEMS MAY BE LOADED INTO TRAILERS WHICH ARE PARTIALLY LOADED WITH PALLETS OF PROJECTILES. PROVIDING THE TOTAL LOAD IS COMPATIBLE, EXISTING DIRECTIVES ARE NOT VIOLATED, AND THE OTHER LADING ITEMS ARE BLOCKED AND BRACED TO EQUAL THE BLOCKING AND BRACING CRITERIA SPECIFIED HEREIN.

K. SOME LOADS ARE SHOWN IN TRAILERS HAVING ROUNDED CORNERS AT THE FORWARD END. IF THE CONVENTIONAL VAN TRAILER BEING USED IS EQUIPPED WITH A SQUARE FRONT OR WITH AN INSTALLED BULKHEAD, OMIT THE FORWARD BLOCKING ASSEMBLY, AND POSITION THE PALLETS DIRECTLY AGAINST THE FORWARD PORTION OF THE TRAILER.

L. WHEN STEEL STRAPPING IS SEALED AT AN END-OVER-END LAP JOINT, A MINIMUM OF ONE SEAL WITH TWO PAIR OF NOTCHES WILL BE USED TO SEAL THE JOINT WHEN A NOTCH-TYPE SEALER IS BEING USED. A MINIMUM OF TWO SEALS RUTTED TOGETHER WITH TWO PAIR OF CRIMPS PER SEAL WILL BE USED TO SEAL THE JOINT WHEN A CRIMP-TYPE SEALER IS BEING USED. REFER TO THE "STRAP JOINT A" AND "STRAP JOINT B" DETAILS ON PAGE 45.

M. DUNNAGE LUMBER SPECIFIED THROUGHOUT THIS DRAWING IS OF NOMINAL SIZE. FOR EXAMPLE, 2" X 4" MATERIAL IS ACTUALLY 1-1/2" THICK BY 3-1/2" WIDE AND 2"-X-6" MATERIAL IS ACTUALLY 1-1/2" THICK BY 5-1/2" WIDE.

N. NOTICE: A STAGGERED NAILING PATTERN WILL BE USED WHEREVER POSSIBLE WHEN NAILS ARE DRIVEN INTO JOINTS OF DUNNAGE ASSEMBLIES. ALSO, A STAGGERED NAILING PATTERN WILL BE USED WHEN DUNNAGE IS NAILED TO THE FLOOR OF THE TRANSPORTING VEHICLE, OR WHEN LAMINATING DUNNAGE. THE NAILING PATTERN WILL BE ADJUSTED AS REQUIRED SO THAT A NAIL DOES NOT PENETRATE INTO OR NEAR A CRACK BETWEEN FLOOR BOARDS. ADDITIONALLY, THE NAILING PATTERN FOR AN UPPER PIECE OF LAMINATED DUNNAGE WILL BE ADJUSTED AS REQUIRED SO THAT A NAIL FOR THAT PIECE WILL NOT BE DRIVEN THROUGH THE PIECE OR RIGHT BESIDE A NAIL IN A LOWER PIECE.

O. POWER DRIVEN STAPLE MAY BE USED AS ALTERNATIVE FASTENERS FOR NAILS WHEN CONSTRUCTING DUNNAGE ASSEMBLIES WHICH ARE TO BE USED IN THE DELINEATED TRAILER LOADS SHOWN THROUGHOUT THIS DRAWING. THE STAPLES TO BE USED MUST BE EQUAL IN LENGTH TO THE SPECIFIED NAIL SIZE AND MUST BE SUBSTITUTED ON A ONE STAPLE FOR ONE NAIL BASIS. STAPLES WHICH ARE 2-1/2" OR LESS IN LENGTH SHOULD BE IN ACCORDANCE WITH FEDERAL SPECIFICATION ASTM F1667 AS NEARLY AS PRACTICABLE. STAPLES WHICH ARE LONGER THAN 2-1/2" WILL BE A COMMERCIAL GRADE, OF A QUALITY EQUIVALENT TO THOSE MANUFACTURED BY Senco PRODUCTS INCORPORATED. NOTE: STAPLES WILL NOT BE SUBSTITUTED FOR NAILS IN ANY LOAD RESTRAINING FLOOR DUNNAGE APPLICATION.

P. THE NUMBER OF PALLETS MAY BE ADJUSTED TO FIT THE CAPACITY OF THE TRAILER BEING LOADED OR THE QUANTITY TO BE SHIPPED. HOWEVER, THE APPROVED METHODS SPECIFIED HEREIN MUST BE FOLLOWED AS CLOSELY AS POSSIBLE FOR BLOCKING, BRACING, AND STAYING OF THE SPECIFIED PALLETS UNITS.

Q. CAUTION: DO NOT NAIL BLOCKING TO THE TRAILER WALLS. ALL BLOCKING WILL BE WITHIN THE DUNNAGE OR TO THE TRAILER FLOOR, AS INDICATED.

R. PORTIONS OF THE TRAILERS, SUCH AS SIDEWALLS, END WALLS, AND ROOFS, HAVE NOT BEEN SHOWN IN THE LOAD VIEWS FOR CLARITY PURPOSES.

(MATERIAL SPECIFICATIONS)

LUMBER: SEE TM 745-300-1 (DUNNAGE LUMBER) AND VOLUNTARY PRODUCTS STANDARD PS 20.

NAILS: ASTM F1667; COMMON STEEL NAILS (NLCMS OR NLCMGS).

STRAPPING, STEEL: ASTM D585; FLAT STRAPPING, TYPE 1, HEAVY DUTY, FINISH A, B (GRADE 2), OR C.

SEAL, STRAP: ASTM D585; CLASS H, FINISH A, B (GRADE 2), OR C, DOUBLE NOTCH TYPE, STYLE I, II, OR IV.

WIRE, CARBON STEEL: ASTM A51; ANNEALED AT FINISH, BLACK OXIDE FINISH, .080" DIA, GRADE 1006 OR BETTER.

(continued at right)

(continued on page 3)
KEY NUMBERS

1. LOAD BEARING GATE (8 REQD). SEE THE DETAIL ON PAGE 44 AND GENERAL NOTE "H" ON PAGE 2. SEE SPECIAL NOTE 2 ON PAGE 16.

2. SIDE BLOCKING, 2" X 6" X 7'-0" (DOUBLED) (8 REQD). PRE-POSITION AND NAIL THE FIRST PIECE TO THE TRAILER FLOOR W/1-1/2" NAIL EVERY 12". NAIL THE SECOND PIECE TO THE FIRST IN A LIKE MANNER.

3. END BLOCKING, 2" X 4" X 7'-0" (DOUBLED) (7 REQD). NAIL THE FIRST PIECE TO THE TRAILER FLOOR W/8-1/2" NAILS. NAIL THE SECOND PIECE TO THE FIRST W/8-2" NAILS.

4. UNITIZING STRAP, 1-1/4" X .035" OR .031" X 23'-0" LONG STEEL STRAPPING (8 REQD). INSTALL TO ENCLOSE SIX PALLET UNITS AND TWO LOAD BEARING GATES, PIECES MARKED 1.

5. SEAL FOR 1-1/4" STRAPPING (16 REQD, 2 PER STRAP JOINT). SEE GENERAL NOTE "L" ON PAGE 2. DOUBLE CRIMP EACH SEAL.
SPECIAL NOTES:

1. A 48-UNIT LOAD OF 155MM PROJECTILES Palletized 8 per large pallet is shown in a 48'-0" long by 7'-4" wide (inside dimension) van trailer equipped with a nailable floor. Trailers of other dimensions can be used.

2. The loadbearing gate, piece marked (1), which is positioned against the trailer front wall must have fill pieces applied to both the upper and lower horizontal pieces. Depending upon the type and weight of the trailer being loaded, and the weight of the tractor to be used for transporting the loaded trailer, it may be necessary to adjust the quantity of units in the load, or to shift the location of the load portions in order to comply with the weight distribution requirements.

3. Load as shown

BILL OF MATERIAL

<table>
<thead>
<tr>
<th>LUMBER</th>
<th>LINEAR FEET</th>
<th>BOARD FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot; x 4&quot;</td>
<td>144</td>
<td>49</td>
</tr>
<tr>
<td>2&quot; x 4&quot;</td>
<td>144</td>
<td>96</td>
</tr>
<tr>
<td>2&quot; x 6&quot;</td>
<td>162</td>
<td>162</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NAILS</th>
<th>NO. REQD</th>
<th>POUNDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6d (2&quot;)</td>
<td>87</td>
<td>1/2</td>
</tr>
<tr>
<td>10d (3&quot;)</td>
<td>140</td>
<td>2</td>
</tr>
<tr>
<td>20d (4&quot;)</td>
<td>42</td>
<td>1-1/2</td>
</tr>
</tbody>
</table>

STEEL STRAPPING, 1-1/4" - 184' REQD - - - - - - - 36 LBS
SEAL FOR 1-1/4" STRAP - - - - 16 REQD - - - - 3/4 LBS

LOAD AS SHOWN

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>WEIGHT (APPROX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>155MM, 8/PALLETS</td>
<td>48</td>
<td>41,972 LBS</td>
</tr>
<tr>
<td>DUMMY - - - - - -</td>
<td>- - - - -</td>
<td>645 LBS</td>
</tr>
<tr>
<td>TOTAL WEIGHT - - - - - - - - - - - - - - - - - -</td>
<td>42,617 LBS (APPROX)</td>
<td></td>
</tr>
</tbody>
</table>

48-UNIT LOAD OF 155MM PROJECTILES (8 LARGE PALLET) IN A 48'-0" LONG TRAILER
LOAD BEARING GATE

NOTE 8:

The short and long fill pieces indicated by phantom lines at the top and near the bottom of the load bearing gate are required on gates to be positioned against the trailer front wall. At the rear of a load, the short and long fill pieces are required only at the bottom level. When load bearing gates are used within a load, the requirement for fill pieces will be specified in the special notes section which is immediately adjacent to a depicted load.