Final Report
JANUARY 1989

EVT 13-89

BOXCAR TRANSPORTABILITY ENGINEERING TEST OF PROPELLING CHARGE PLASTIC CONTAINERS ON METAL PALLETS

Prepared For:
U.S. Army Armament Research, Development and Engineering Center
ATTN: SMCAR-AEP
Picatinny Arsenal, NJ 07806-5000

Distribution Unlimited

US ARMY ARMAMENT MUNITIONS CHEMICAL COMMAND
US ARMY DEFENSE AMMUNITION CENTER AND SCHOOL

SAVANNA, ILLINOIS 61074-9639
AVAILABILITY NOTICE

A complimentary copy of this report is furnished each attendee on automatic distribution. Should additional copies be required or authority for reprinting of report may be obtained by requesting same in writing from Director, U.S. Army Defense Ammunition Center and School, ATTN: SMCAC-DEV, Savanna, IL 61074-9639.

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.
The U.S. Army Defense Ammunition Center and School (USADACS) was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC) to design a unitization system for M203 155mm propelling charge plastic containers. The unitization system, consisting of a standard metal pallet, pallet adapter, spacing posts, and a top lift assembly was previously tested and met the requirements of MIL-STD-1660, Design Criteria for Ammunition Loads. Propelling charge plastic containers on a standard metal pallet have not previously been tested in a rail transportation environment. This engineering test, based on a blocking and bracing procedure developed by the Storage and Outloading Division (SMCAC-DEO), was performed to determine the adequacy of the unitization in a rail transportation environment.

(Continued)
19. Abstract (CONT)

To accomplish this procedure, a 50-foot boxcar was center loaded with propelling charge plastic container pallets. Two test configurations were used. The first test consisted of orienting the containers parallel in the direction of impact. The second test had the pallet skids and containers perpendicular to the direction of impact. Each configuration was subjected to impacts of 4, 6 and 8 miles per hour (mph) in a forward direction and one impact at 8 mph in the reverse direction.

The first configuration was tested on 10 January 1989. The load configuration consisted of 24 pallets of propelling charge containers in the rear of the boxcar and 6 PA116 standard metal pallets used for filler at the impact end of the car. Two biaxial accelerometers were installed; one on the boxcar floor and the other on top of the third pallet from the rear. The test load experienced peak accelerations of 4.67 g's on the floor and 5.38 g's on the top of the third pallet.

The second configuration was tested on 12 January 1989. The load configuration consisted of 24 pallets of propelling charge containers. Two biaxial accelerometers were installed; one on the boxcar floor and the other on top of the third pallet from the rear. The test load experienced peak accelerations of 2.91 g's on the floor and 6.8 g's on top of the pallet.

After impacting with the pallets in longitudinal orientation, the boxcar was unloaded. The only damage experienced was a scuffing of the propelling charge plastic container bases. Two pallets on the upper pallets became disengaged from the stacking lugs. Based on this test, rail transportation in the longitudinal configuration is acceptable.

After impacting with the pallets in the lateral orientation, the boxcar was unloaded. No damage was observed. Also, no damage was observed on the propellant plastic container on metal pallets after impacting in the lateral orientation. The remainder of this report contains detailed information about the rail impact test including: test car data, weights, acceleration, velocity and displacement data, and the blocking and bracing procedures for longitudinal and lateral pallet orientations.
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
   A. Longitudinal Orientation...................................... 5-2
   B. Lateral Orientation............................................ 5-19

6. CONCLUSIONS AND RECOMMENDATIONS................................ 6-1

7. BLOCKING AND BRACING PROCEDURES................................ 7-1
PART 1

INTRODUCTION

A. BACKGROUND. 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) to design a unitization system for M203 155mm propelling charge plastic containers. When the unitization system design was completed, it was tested and met the requirements of MIL-STD-1660, Design Criteria for Ammunition Unit Loads. In order to further ensure satisfactory design performance over the logistics life of the M203 155mm propelling charge plastic container unitization, testing in a rail transportation environment was required.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by ARDEC, U.S. Army Armament, Munitions and Chemical Command (AMCCOM), and AR740-1.

C. OBJECTIVE. The objective of this engineering test is to determine the boxcar transportability of propelling charge plastic containers on metal pallets.
### ATTENDEES

<table>
<thead>
<tr>
<th>Name and Telephone</th>
<th>ADDRESS</th>
</tr>
</thead>
</table>
| Mr. Ray Dunscomp  
AV 880-2813 | Commander  
U.S. Army Armament Research,  
Development and Engineering Center  
ATTN: SMCAR-AEP  
Picatinny Arsenal, NJ 07806-5000 |
| Mr. A. C. McIntosh  
Test Engineer  
AV 585-8989  
Comm. (815) 273-8989 | Director  
U.S. Army Defense Ammunition Center and School  
ATTN: SMCAC-DEV  
Savanna, IL 61074-9639 |
| Mr. Jerry H. Krohn  
AV 585-8908  
Comm. (815) 273-8908 | Director  
U.S. Army Defense Ammunition Center and School  
ATTN: SMCAC-DEV  
Savanna, IL 61074-9639 |
| Ms. Laurie Fieffer  
AV 585-8075  
Comm. (815) 273-8075 | Director  
U.S. Army Defense Ammunition Center and School  
ATTN: SMCAC-DEV  
Savanna, IL 61074-9639 |
| Mr. Quinn Hartman  
AV 585-8089  
Comm. (815) 273-8089 | Director  
U.S. Army Defense Ammunition Center and School  
ATTN: SMCAC-DEV  
Savanna, IL 61074-9639 |
| Mr. David Valant  
AV 585-8988  
Comm. (815) 273-8988 | Director  
U.S. Army Defense Ammunition Center and School  
ATTN: SMCAC-DEV  
Savanna, IL 61074-9639 |
PART 3

TEST PROCEDURES

RAIL IMPACT TEST. The test load or vehicle should be positioned in/on a railcar. The loaded container shall be positioned on a container chassis and securely locked in place using the twist locks at each corner. The container chassis shall be secured to a railcar. Equipment needed to perform the test includes the specimen (hammer) car, five empty railroad cars connected together to serve as the anvil, and a railroad locomotive. These anvil cars are positioned on a level section of track with air and hand brakes set and with the draft gear compressed. The locomotive unit pulls the specimen car several hundred yards away from the anvil cars and, then, pushes the specimen car toward the anvil at a predetermined speed, disconnects from the specimen car about 50 yards away from the anvil cars and allows the specimen car to roll freely along the track until it strikes the anvil. This constitutes an impact. Impacting is accomplished at speeds of 4, 6, and 8 mph in one direction and at a speed of 8 mph in the opposite direction. The 4 and 6 mph impact speeds are approximate; the 8 mph speed is a minimum. Impact speeds are to be determined by using an electronic counter to measure the time required for the specimen car to traverse an 11-foot distance immediately prior to contact with the anvil cars.
ASSOCIATION OF AMERICAN RAILROADS (AAR)
STANDARD TEST PLAN

5 BUFFER CARS WITH DRAFT GEAR
COMPRESSED AND AIR BRAKES IN
A SET POSITION

BUFFER CAR TOTAL WT 250,000 LBS (APPROX)

SPECIMEN CAR
IS RELEASED BY
SWITCH ENGINE AT:
IMPACT NO. 1  4 MPH
IMPACT NO. 2  6 MPH
IMPACT NO. 3  8 MPH
THEN CAR IS REVERSED
AND RELEASED AT
IMPACT NO. 4  8 MPH
PART 4

TEST EQUIPMENT

1. TEST SPECIMEN

   a. M203 155mm Plastic Propelling Charge Unitization
      (1) Length: 47 inches
      (2) Width: 37 inches
      (3) Height: 52 inches
      (4) Weight: 1,800 pounds
      (5) Quantity: 24 each

   b. Inert Filler Pallets
      (1) Weight: 2,400 pounds
      (2) Quantity: 12 each

   c. Box Car, 50 feet long
      (1) Car Number: BN 249,341
      (2) Capacity: 154,000 pounds
      (3) LD. LMT: 161,000 pounds
      (4) LT. WT: 59,000 pounds
      (5) Manufacturer: Pullman Standard, Bessemer, CA., Lot 9831

2. TRACK TIMER

3. DATA ACQUISITION

   a. Accelerometers - 5 each
   b. Instrumentation Pack
   c. Honeywell 5600c tape recorder

4. DATA ANALYSIS EQUIPMENT

   a. Zenith AT Microprocessor
   b. Software - ASYST
PART 5

TEST RESULTS
PART 5

TEST RESULTS

Two series of impact tests were performed. One series of impacts was accomplished with the test specimen pallets oriented longitudinal to the direction of impact; and in the second series, the orientation was lateral to the direction of impact. The following sections contain the results of these tests.

RAIL IMPACT TEST NO. 1.

TEST SPECIMEN: M203, 155MM PROPELLING CHARGE PLASTIC CONTAINERS

TEST BOXCAR NO. BN 249,341

L.T. WT. 59,000 pounds

LADING AND DUNNAGE WT. 60,700 pounds

TOTAL SPECIMEN WT. 119,700 pounds

BUFFER CAR (5 CARS) WT. 220,000 pounds

<table>
<thead>
<tr>
<th>IMPACT NO.</th>
<th>END STRUCK</th>
<th>VELOCITY (MPH)</th>
<th>REMARKS</th>
</tr>
</thead>
</table>
| 1          | forward    | 4.45           | 1. Load shifted toward impact end 3 inches.  
|            |            |                | 2. Dunnage broken at center gate.          |
| 2          | forward    | 6.41           | Load shifted toward impact end 1/2-inch.   |
|            |            |                | 2. Second layer pallet, third from rear end disengaged stacking lugs.  |
| 4          | reverse    | 8.59           | 1. Load shifted 3-1/2 inches to close up gap from previous impacts  
|            |            |                | 2. Two pallets disengaged from stacking lugs.    |
RESULTS FROM THE RAIL IMPACT TEST ON PLASTIC M203 CONTAINERS ON METAL PALLET IN CONFIGURATION #1, DATE: 10 JANUARY 1989

TAPE CHANNEL 3: LONGITUDINAL ACCELERATION ON CAR BED

<table>
<thead>
<tr>
<th>TEST</th>
<th>SPEED MPH</th>
<th>PEAK VALUE G'S</th>
<th>DURATION MILLISECONDS</th>
<th>AREA G'S-SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT 1</td>
<td>4.49</td>
<td>1.71</td>
<td>53.63</td>
<td>0.0607</td>
</tr>
<tr>
<td>IMPACT 2</td>
<td>6.41</td>
<td>2.43</td>
<td>33.76</td>
<td>0.0529</td>
</tr>
<tr>
<td>IMPACT 3</td>
<td>8.40</td>
<td>4.08</td>
<td>21.32</td>
<td>0.0550</td>
</tr>
<tr>
<td>IMPACT 4 (REVERSE)</td>
<td>8.31</td>
<td>-3.38</td>
<td>46.77</td>
<td>0.0870</td>
</tr>
</tbody>
</table>

TAPE CHANNEL 4: VERTICAL ACCELERATION ON CAR BED

<table>
<thead>
<tr>
<th>TEST</th>
<th>SPEED MPH</th>
<th>PEAK VALUE G'S</th>
<th>DURATION MILLISECONDS</th>
<th>AREA G'S-SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT 1</td>
<td>4.49</td>
<td>-.26</td>
<td>5.63</td>
<td>0.0000</td>
</tr>
<tr>
<td>IMPACT 2</td>
<td>6.41</td>
<td>-.41</td>
<td>6.76</td>
<td>0.0013</td>
</tr>
<tr>
<td>IMPACT 3</td>
<td>8.40</td>
<td>-1.14</td>
<td>10.10</td>
<td>0.0053</td>
</tr>
<tr>
<td>IMPACT 4 (REVERSE)</td>
<td>8.31</td>
<td>-2.28</td>
<td>16.52</td>
<td>0.0224</td>
</tr>
</tbody>
</table>

TAPE CHANNEL 5: LONGITUDINAL ACCELERATION ON TOP LAYER PALLET

<table>
<thead>
<tr>
<th>TEST</th>
<th>SPEED MPH</th>
<th>PEAK VALUE G'S</th>
<th>DURATION MILLISECONDS</th>
<th>AREA G'S-SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT 1</td>
<td>4.49</td>
<td>3.27</td>
<td>27.06</td>
<td>0.0880</td>
</tr>
<tr>
<td>IMPACT 2</td>
<td>6.41</td>
<td>3.15</td>
<td>103.55</td>
<td>0.1205</td>
</tr>
<tr>
<td>IMPACT 3</td>
<td>8.40</td>
<td>4.24</td>
<td>70.73</td>
<td>0.1776</td>
</tr>
<tr>
<td>IMPACT 4 (REVERSE)</td>
<td>8.31</td>
<td>-5.38</td>
<td>32.05</td>
<td>0.1013</td>
</tr>
</tbody>
</table>

TAPE CHANNEL 6: VERTICAL ACCELERATION ON TOP LAYER PALLET

<table>
<thead>
<tr>
<th>TEST</th>
<th>SPEED MPH</th>
<th>PEAK VALUE G'S</th>
<th>DURATION MILLISECONDS</th>
<th>AREA G'S-SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT 1</td>
<td>4.49</td>
<td>-1.47</td>
<td>7.32</td>
<td>0.0027</td>
</tr>
<tr>
<td>IMPACT 2</td>
<td>6.41</td>
<td>-1.57</td>
<td>23.30</td>
<td>0.0108</td>
</tr>
<tr>
<td>IMPACT 3</td>
<td>8.40</td>
<td>.58</td>
<td>25.57</td>
<td>0.0110</td>
</tr>
<tr>
<td>IMPACT 4 (REVERSE)</td>
<td>8.31</td>
<td>-1.68</td>
<td>9.94</td>
<td>0.0100</td>
</tr>
</tbody>
</table>
RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS
IMPACT SPEED: 4.49 MPH

LONGITUDINAL ACCELERATION ON CAR-BED IN G'S X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS
IMPACT SPEED: 4.49 MPH

VERTICAL ACCELERATION ON CAR BED

IN G'S X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 6.41 MPH

Time in Seconds
X 1.00
RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS
IMPACT SPEED: 6.41 MPH

VERTICAL ACCELERATION ON TOP LAY-ER PALLETS X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS
IMPACT SPEED: 8.40 MPH

IN G.S X 1.00
LAYER PALLET
LONGITUDINAL ACCELERATION ON TOP
RAIL IMPACT #3 ON M223 PLASTIC CONTAINERS
IMPACT SPEED: 8.40 MPH

Time in Seconds
X 1.00
RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 8.40 MPH

LONGITUDINAL ACCELERATION ON CAR-BED

G'S X 1.00

Time in Seconds

X 1.00
RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS

IMPACT SPEED: 8.31 MPH (REVERSE)

LONGITUDINAL ACCELERATION ON TOP LAYER PALLET IN G'S X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS
IMPACT SPEED: 8.31 MPH (REVERSE)

TIME IN SECONDS
0.900 0.300 -0.300 -0.900 -1.500

IN G'S X 1.00
VERITCAL ACCELERATION ON TOP LAYERS
RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS
IMPACT SPEED: 8.31 MPH (REVERSE)

Time in Seconds
X 1.00
## PART 5

### TEST RESULTS

**RAIL IMPACT TEST**

**DATE:** 10 JANUARY 1989

**TEST SPECIMEN:** M203, 155mm PROPELLING CHARGE PLASTIC CONTAINERS LATERAL ORIENTATION

**TEST BOXCAR NO.** BN 249,341  **LT. WT.**  59,000 pounds

**LADING AND DUNNAGE WT.**  60,700 pounds

**TOTAL SPECIMEN WT.**  119,700 pounds

**BUFFER CAR (5 CARS) WT.**  220,000 pounds

<table>
<thead>
<tr>
<th>IMPACT NO.</th>
<th>END STRUCK</th>
<th>VELOCITY (MPH)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>forward</td>
<td>4.22</td>
<td>Load shifted toward impact end 1 inch.</td>
</tr>
<tr>
<td>2</td>
<td>forward</td>
<td>6.31</td>
<td>Load shifted toward impact end 1/2 inch.</td>
</tr>
<tr>
<td>3</td>
<td>forward</td>
<td>8.47</td>
<td>No load movement</td>
</tr>
</tbody>
</table>
| 4          | reverse    | 8.36           | 1. Load shifted 2 inches to close up gap.  
            |            |                | 2. No damage or excessive load movement. |
RESULTS FROM THE RAIL IMPACT TEST ON
PLASTIC M203 CONTAINERS ON METAL PALLET IN
CONFIGURATION #2, DATE: 12 JANUARY 1989

TAPE CHANNEL 3: LONGITUDINAL ACCELERATION ON CAR BED

<table>
<thead>
<tr>
<th>TEST</th>
<th>SPEED MPH</th>
<th>PEAK VALUE G'S</th>
<th>DURATION MILLISECONDS</th>
<th>AREA G'S-SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT 1</td>
<td>4.22</td>
<td>1.93</td>
<td>50.17</td>
<td>.0510</td>
</tr>
<tr>
<td>IMPACT 2</td>
<td>6.31</td>
<td>2.60</td>
<td>25.25</td>
<td>.0429</td>
</tr>
<tr>
<td>IMPACT 3</td>
<td>8.47</td>
<td>2.60</td>
<td>37.99</td>
<td>.0652</td>
</tr>
<tr>
<td>IMPACT 4 (REVERSE)</td>
<td>8.36</td>
<td>-2.89</td>
<td>35.56</td>
<td>.0675</td>
</tr>
</tbody>
</table>

TAPE CHANNEL 4: VERTICAL ACCELERATION ON CAR BED

<table>
<thead>
<tr>
<th>TEST</th>
<th>SPEED MPH</th>
<th>PEAK VALUE G'S</th>
<th>DURATION MILLISECONDS</th>
<th>AREA G'S-SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT 1</td>
<td>4.22</td>
<td>-2.24</td>
<td>20.96</td>
<td>.0041</td>
</tr>
<tr>
<td>IMPACT 2</td>
<td>6.31</td>
<td>.46</td>
<td>10.05</td>
<td>.0028</td>
</tr>
<tr>
<td>IMPACT 3</td>
<td>8.47</td>
<td>-4.79</td>
<td>16.97</td>
<td>.0040</td>
</tr>
<tr>
<td>IMPACT 4 (REVERSE)</td>
<td>8.36</td>
<td>-3.22</td>
<td>17.49</td>
<td>.0074</td>
</tr>
</tbody>
</table>

TAPE CHANNEL 5: LONGITUDINAL ACCELERATION ON TOP LAYER PALLET

<table>
<thead>
<tr>
<th>TEST</th>
<th>SPEED MPH</th>
<th>PEAK VALUE G'S</th>
<th>DURATION MILLISECONDS</th>
<th>AREA G'S-SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT 1</td>
<td>4.22</td>
<td>-4.11</td>
<td>15.07</td>
<td>.0400</td>
</tr>
<tr>
<td>IMPACT 2</td>
<td>6.31</td>
<td>-6.18</td>
<td>42.30</td>
<td>.1197</td>
</tr>
<tr>
<td>IMPACT 3</td>
<td>8.47</td>
<td>-5.79</td>
<td>15.03</td>
<td>.0098</td>
</tr>
<tr>
<td>IMPACT 4 (REVERSE)</td>
<td>8.36</td>
<td>-4.97</td>
<td>29.01</td>
<td>.1027</td>
</tr>
</tbody>
</table>

TAPE CHANNEL 6: VERTICAL ACCELERATION ON TOP LAYER PALLET

<table>
<thead>
<tr>
<th>TEST</th>
<th>SPEED MPH</th>
<th>PEAK VALUE G'S</th>
<th>DURATION MILLISECONDS</th>
<th>AREA G'S-SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPACT 1</td>
<td>4.22</td>
<td>-3.12</td>
<td>6.24</td>
<td>.0142</td>
</tr>
<tr>
<td>IMPACT 2</td>
<td>6.31</td>
<td>-6.36</td>
<td>14.13</td>
<td>.0640</td>
</tr>
<tr>
<td>IMPACT 3</td>
<td>8.47</td>
<td>-4.96</td>
<td>12.23</td>
<td>.0417</td>
</tr>
<tr>
<td>IMPACT 4 (REVERSE)</td>
<td>8.36</td>
<td>-4.71</td>
<td>11.86</td>
<td>.0417</td>
</tr>
</tbody>
</table>
TAPE CHANNEL 7: LONGITUDINAL ACCELERATION ON CAR SILL

<table>
<thead>
<tr>
<th>TEST</th>
<th>SPEED</th>
<th>PEAK VALUE</th>
<th>DURATION</th>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MPH</td>
<td>G'S</td>
<td>MILLISECONDS</td>
<td>G'S-SECONDS</td>
</tr>
<tr>
<td>IMPACT 1</td>
<td>4.22</td>
<td>2.00</td>
<td>40.34</td>
<td>0.0515</td>
</tr>
<tr>
<td>IMPACT 2</td>
<td>6.31</td>
<td>2.30</td>
<td>24.88</td>
<td>0.0345</td>
</tr>
<tr>
<td>IMPACT 3</td>
<td>8.47</td>
<td>2.65</td>
<td>31.33</td>
<td>0.0606</td>
</tr>
<tr>
<td>IMPACT 4 (REVERSE)</td>
<td>8.36</td>
<td>-3.16</td>
<td>31.78</td>
<td>0.0653</td>
</tr>
</tbody>
</table>
RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 4.22 MPH

VERTICAL ACCELERATION ON CAR BED

IN G'S X 1.00

Time in Seconds X 1.00
RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 4.22 MPH
RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: \textit{4.22 MPH}

\begin{center}
\includegraphics[width=\textwidth]{graph.png}
\end{center}

\textit{Time in Seconds X 1.00}
RAIL IMPACT #1 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 4.22 MPH

LONGITUDINAL ACCELERATION ON CAR

IN G'S X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 6.31 MPH

LONGITUDINAL ACCELERATION ON CAR-BED IN G'S X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 6.31 MPH

VERTICAL ACCELERATION ON CAR BED

IN G'S X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 6.31 MPH

LONGITUDINAL ACCELERATION ON TO LAYER PALLET IN G'S X 1.00

Time in Seconds X 1.00
RAIL IMPACT #2 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 6.31 MPH
RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 8.47 MPH

LONGITUDINAL ACCELERATION ON CAR-BED IN G'S X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.47 MPH

VERTICAL ACCELERATION ON CAR BED

IN G'S X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 8.47 MPH
RAIL IMPACT #3 ON M283 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.47 MPH

IN G'S X 1.00

VERTICAL ACCELERATION ON TOP LAY-ER PALLET

5-35
RAIL IMPACT #3 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 8.47 MPH

Time in Seconds
X 1.00
RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.36 MPH (REVERSE)

IN G.S. x 100
LONGITUDINAL ACCELERATION ON CAR

Time in Seconds
x 1.00
RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 8.36 MPH (REVERSE)

VERTICAL ACCELERATION ON CAR BED

IN G'S X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.36 MPH (REVERSE)

LONGITUDINAL ACCELERATION ON TO
LAYER PALLET
IN G'S X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS IN
CONFIGURATION #2, IMPACT SPEED: 8.36 MPH (REVERSE)

VERTICAL ACCELERATION ON TOP LAY-
ER PAYLET
IN G'S X 1.00

Time in Seconds
X 1.00
RAIL IMPACT #4 ON M203 PLASTIC CONTAINERS IN CONFIGURATION #2, IMPACT SPEED: 8.36 MPH (REVERSE)

Time in Seconds
X 1.00

LONGITUDINAL ACCELERATION ON CAR-SILL, N X 1.00
PART 6

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS. At the conclusion of these tests, it was found that the only damage to the M203 155mm Propelling Charge Plastic Containers on Metal Pallets was a slight shuffling of the container ends when tested in the longitudinal orientation. No damage was observed when tested in the lateral orientation. Test loads shifted approximately six inches during the longitudinal orientation due to failure of the load filler pallets. Shift of the lateral load configuration was three inches. Two of the upper layer pallets became disengaged from the stacking lugs at the third and fourth impacts. One skid was deformed at the stacking lug entry point. The deformation was not enough to warrant rejection of test specimen.

B. RECOMMENDATIONS. Based on these tests, it is recommended that the propelling charge plastic container unitized on metal pallets can be transported by rail inside a boxcar. Modifications to the unitization procedure should be made to the center gates limiting the spacer width to the frontal surface of the unit.
PART 7

BLOCKING AND BRACING PROCEDURE
BOXCAR TRANSPORTABILITY TEST PROCEDURES FOR
PLASTIC PROPELLING CHARGE CONTAINERS ON METAL PALLETS

This 15-Sheet document depicts the plastic propelling charge container unitized 36 on a
metal pallet loaded into a 50'-6" long boxcar for impact testing purposes. PAll6 containers
loaded on a metal pallet are used as fillers in one load. Sheet 3 depicts the pallets loaded
so that the 47" dimension is across the car. Sheet 5 depicts the pallets loaded so that the
36-7/8" dimension is across the car.

MATERIAL SPECIFICATIONS


NAILS-------------------------------: Common, Fed Spec FF-N-105.

Prepared during December 1988 by:

U.S. Army Defense Ammunition Center
and School
ATTN: SNCAC-DEO
Savanna, IL 61074-9639
PALLET UNIT

Container----------36 each @45 lbs (approx)
Cube-----------------52.2 cubic feet (approx)
Gross Weight---------1,786 lbs (approx)
KEY NUMBERS
(For longitudinal load)

1. Crib fill gate, 36-7/8' long (48 reqd). See the 'Crib Fill Gate' detail on Sheet 7. Note that the four gates adjacent to the Separator Gate must be 37-5/8' long instead of 36-7/8'.

2. Strut, 2' x 4' by cut-to-fit (Ref: 28-1/2') (192 reqd). Nail to the vertical pieces of the Crib Fill Gates w/2-10d nails at each end.

3. Crib fill gate, 40-1/8' long (12 reqd). See the 'PA116 Pallet Crib Fill Gate' detail on Sheet 8.

4. Strut, 2' x 4' by cut-to-fit (Ref: 29-3/4') (48 reqd). Nail to the vertical pieces of the Crib Fill Gates w/2-10d nails at each end.

5. Separator gate (1 reqd). See the 'Separator Gate' detail on Sheet 9.

6. Center gate (2 reqd). See the 'Center Gate A' details on Sheets 10 and 11.

7. Strut, 4' x 4' by cut-to-fit (Ref: 36-1/2') (12 reqd). Toenail to piece marked w/2-16d nails at each joint.

8. Doorway protection (2 reqd). See the 'Doorway Protection' detail on Sheet 14. Nail to the door posts w/12d nails.
KEY NUMBERS
(For crosswise load)

1. Crib fill gate, 47' long (48 reqd). See the 'Crib Fill Gate' detail on Sheet 7.

2. Strut, 2' x 4' by cut-to-fit (Ref: 33-5/8") (192 reqd). Nail to the vertical pieces of the Crib Fill Gates w/2-10d nails at each end.

3. Center gate (2 reqd). See the 'Center Gate B' details on Sheets 12 and 13.

4. Strut, 4' x 4' by cut-to-fit (Ref: 36") (8 reqd). Toenail to piece marked w/2-16d nails at each joint.

5. Doorway protection (2 reqd). See the 'Doorway Protection' detail on Sheet 14. Nail to the door posts w/12d nails.
-36-7/8" for longitudinal container load, 47" for crosswise container load. **Note:** The four crib fill gates located adjacent to the separate gate in the longitudinal container load must be 37-5/8" long instead of 36-7/8"

Vertical piece, 2" x 4" x 8' (2 reqd).

Horizontal piece, 2" x 4" by length-to-suit (4 reqd). Nail to the vertical pieces w/3-10 nails at each end.

Indicates location of CRIB FILL GATE

48 reqd for lengthwise load; 48 reqd for crosswise load.
Vertical piece, 2" x 4" x 8' - 7" (2 reqd).

Horizontal piece, 2" x 4" x 40 - 1/8 (4 reqd). Nail to the vertical pieces w/3-10d nails at each end.

Indicates location of strut.

PA116 PALLET CRIB FILL GATE

12 reqd for lengthwise load
Vertical piece, 1" x 6" x 9'-0" (2 reqd).

Vertical piece, 1" x 4" x 9'-0" (2 reqd).

Tie piece, 1" x 3" x 47" (2 reqd). Nail to the vertical pieces w/ 7-1/4 nails at each joint and clinch.

SEPARATOR GATE
1 reqd for lengthwise load
Horizontal piece, 2" x 6" by car width minus 1/2" (3 reqd). Nail to the vertical pieces w/3-10d nails at each joint.

Vertical piece, 2" x 6" x 8'-7" (2 reqd).

Horizontal piece 2" x 6" x 67/2" (4 reqd). Nail to the vertical pieces w/3-10d nails at each joint.

Gate hold down, 2" x 4" x 9" (doubled) (2 reqd). Nail the first piece to a horizontal piece w/3-10d nails. Laminate the second piece to the first in a like manner.

CENTER GATE A
For longitudinal containers load
Strut Ledger, 2" x 2" x 42" (6 reqd). Nail to the vertical pieces w/2-10d nails at each joint.

Vertical piece.

Indicates 4" x 4" strut (12 reqd). Toenail w/2-16d nails at each end.

Gate hold-down.

END VIEW OF CENTER GATE A
Horizontal piece, 2" x 6" by car width minus 1/2" (2 reqd). Nail to the vertical pieces w/3-10d nails at each joint.

Vertical piece, 2" x 6" x 8'-10" (2 reqd).

Gate hold down, 2" x 4" x 6" (doubled) (2 reqd). Nail the first piece to a horizontal piece w/3-10d nails. Laminate the second piece to the first in a like manner.

Center Gate B

For crosswise containers loads
Strut ledger, 2" x 2" x 40" (4 reqd). Nail to the vertical pieces w/2-10d nails at each joint.

Vertical piece.

Indicates 4" x 4" strut (8 reqd). Toenail w/2-16d nails at each end.

Gate hold down.

END VIEW OF CENTER GATE B
Vertical piece, 2" x 3" x 8'-8" (2 reqd). Nail to a door post w/12d nails.

Horizontal piece, 1" x 6" by door opening width (4 reqd). Nail to the vertical pieces w/3-6d nails at each end.

DOORWAY PROTECTION
PA116 Pallet Unit (Filler)

Container: 30 each @ 75 lbs (approx)
Cube: 53.5 cubic feet (approx)
Gross Weight: 2,444 lbs (approx)